PALAEOZOIC STRATIGRAPHY OF THE ORD BASIN, WESTERN AUSTRALIA AND NORTHERN TERRITORY

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ABSTRACT

The stratigraphy of the Ord Basin is reviewed in the light of field work carried out in 1982. Three major subdivisions of the Palaeozoic sequence are made, based on lithological changes and differences in age. In ascending order these are: the Antrim Plateau Volcanics-?Early Cambrian; the Goose Hole Group (new name)-Cambrian; and the Mahony Group (new name)-?Devonian.

The Goose Hole Group incorporates all sediments considered to be Cambrian in age and consists of the Negri Subgroup and Elder Subgroup. In the Negri Subgroup (formerly Negri Group) the Panton Formation is expanded to include the Hudson Formation. The Elder Subgroup comprises the Eagle Hawk and Overland Sandstones (new names) which, together with the overlying Mahony Group, were previously included in the ?Devonian Elder Sandstone.

The Mahony Group is considered to be Devonian in age, based on a lithological correlation with the Cockatoo Formation in the Bonaparte Basin. The group is divided into the Glass Hill Sandstone, Buchanan Sandstone and Boll Conglomerate (new names). The latter two units are, in part, laterally equivalent to the former.

INTRODUCTION

The Ord Basin was the name given by Gentilli and Fairbridge (1951) to the physiographic unit encompassing the area dissected by the middle course of the Ord River and its tributaries. Subsequently, McWhae and others (1958) defined the Ord Basin, in a geological context, as the area underlain by Cambrian volcanics and clastics south of the Bonaparte Basin.

This paper presents a summary of the Palaeozoic stratigraphy of the Ord Basin in the East Kimberley region of Western Australia and in the Northern Territory (Figs 1 and 2) based on field work carried out in 1982. The depositional environments of the units described in this paper will be discussed on a Geological Survey of Western Australia report on the Bonaparte and Ord Basins presently in preparation. The Ord Basin lies within the following 1:250 000 geological sheets: Dixon Range, Gordon Downs, and Lissadell (W.A.), and Limbunya and Waterloo (N.T.)

PREVIOUS INVESTIGATIONS

The first geological investigation in the basin was that of Hardman (1885). Although his geological map is reasonably accurate, especially considering the reconnaisance nature of his work, Hardman recognized only two units above the Antrim Plateau Volcanics and this makes correlation with modern units difficult (Fig. 3).

Subsequent surveys by Jack (1906), Blatchford (1922, 1927), Mahony (1922) and Wade (1924) relied substantially on Hardman's work. Mahony (1922) proposed the "Negri series", and "Mount Elder sandstones" and through his fossil collection the Cambrian age of the "Negri series" first suggested by Foord (1890), was confirmed by Chapman (1924).

Matheson and Teichert (1948) concentrated on the basaltic rocks (Antrim Plateau Volcanics) and "Negri Series" in the Ord Basin. The seven informal units they proposed for the "Negri Series" formed the basis of the formal nomenclature of Traves (1955).

The results of Bureau of Mineral Resources (BMR) mapping of the Western Australian portion of the Ord Basin in 1962/63 have so far been published only in map form (Dow and Gemuts, 1967; Plumb, 1968). The unpublished account in Dow and others (1964) has recently been revised in another unpublished BMR record (Dow, 1980). The results of BMR mapping in the Northern Territory portion of the Ord Basin were reported in Sweet and others (1974). Differences in the interpretation of the sequence across the N.T./W.A. border by these two parties have been resolved by the work reported upon herein and are summarized in Figure 3 (columns 6-8).

Reviews of the Ord Basin sequence by McWhae and others, (1958), Playford and others (1975) and Jones (1976) are based on Traves (1955) and the unpublished work of Dow and others (1964).

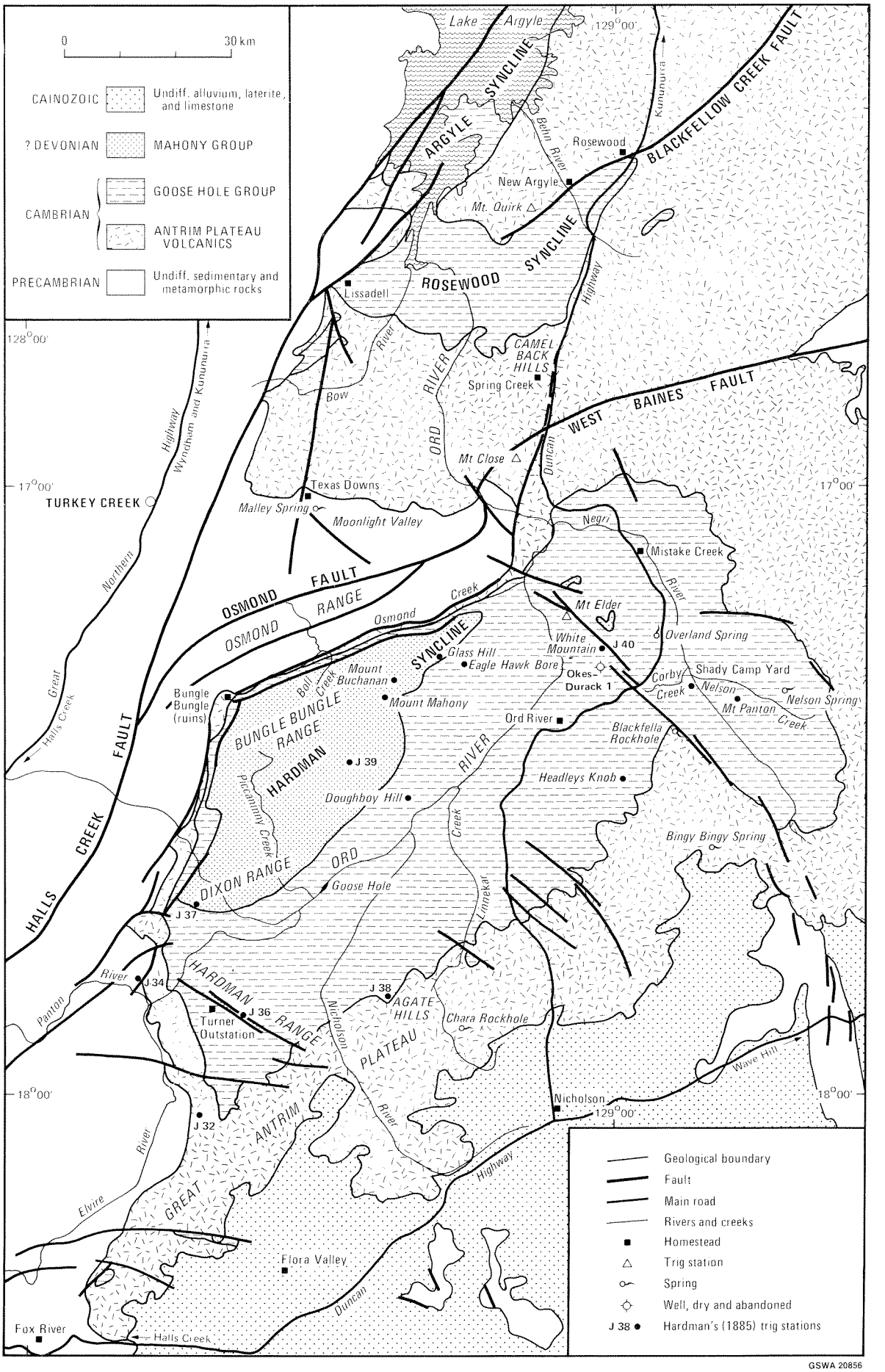

Figure 1. Locality map, Ord Basin.

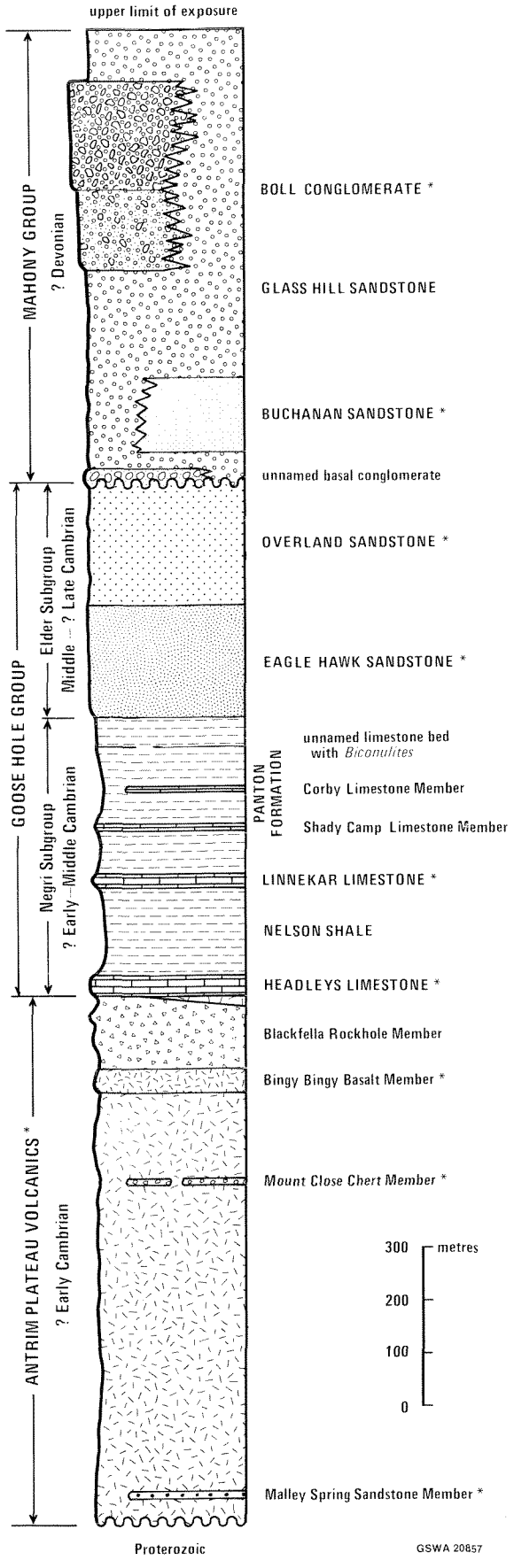

Figure 2. Generalized stratigraphic column showing the Ord Basin sequence. Thicknesses marked * are from type sections, otherwise the maximum thickness is shown. (See text for description of lithologies.)

STRATIGRAPHY

Three major subdivisions of the Palaeozoic sequence in the Ord Basin are proposed herein. These divisions correspond to significant lithological changes and differences in age (Fig. 2). In descending order these are:

Mahony Group (new name)—

yellow and white friable sandstone and conglomerate of probable Devonian age.

Goose Hole Group (new name)—

red, grey and white siltstones, arkosic sandstones and minor limestones of Cambrian age.

Antrim Plateau Volcanics—

basalt, agglomerate, minor chert, sandstone and siltstone of probable Early Cambrian age.

ANTRIM PLATEAU VOLCANICS

Definition: Hardman (1885) named the dissected basaltic hills east of the Elvire River the Great Antrim Plateau. David (1932) was, however, the first to use the name Antrim Plateau Basalts. Traves (1955) modified the name to Antrim Plateau Volcanics because, although dominated by basalt, the sequence also includes minor agglomerate and rare sandstone, tuff, siltstone and chert. Although Traves did not designate a type section, all subsequent workers have considered the Great Antrim Plateau to be the type area. Playford and others (1975, p.398) suggested that the section west of Hardman's trig. station J37 "may be taken as the type section." This designation is presumably based on the two sections shown by Dow and Gemuts (1967) on the Dixon Range sheet. As Dow (1980, p.3) later stated that "these sections have been shown, incorrectly, as type sections . . . " Playford and others' suggestion is not followed here. The only well-exposed section in the Great Antrim Plateau with both the upper and lower contacts visible is an east-west transect through Hardman's (1885) trig. station J32, 20 km south of "Turner". However, ground access to that section is only via "Fox River" and is difficult. Consequently the type section is here designated to be in the "Spring Creek" area where the diverse lithologies which make up this unit are better shown and where access, via the Duncan Highway, is much easier than at J32. The type section extends 12 km north from the eastern end of Moonlight Valley at 17°02′20″S and 128°44′25″E (base), to the base of the Blackfella Rockhole Member at 16°36′25″S and 128°45′50″E, and from there 24 km along strike to the Camel Back Hills at 16°45′55″S and 128°54′00″E, finishing 2.5 km NNW at the base of the Headleys Limestone at 16°44′50″S and 128°53′30″E.

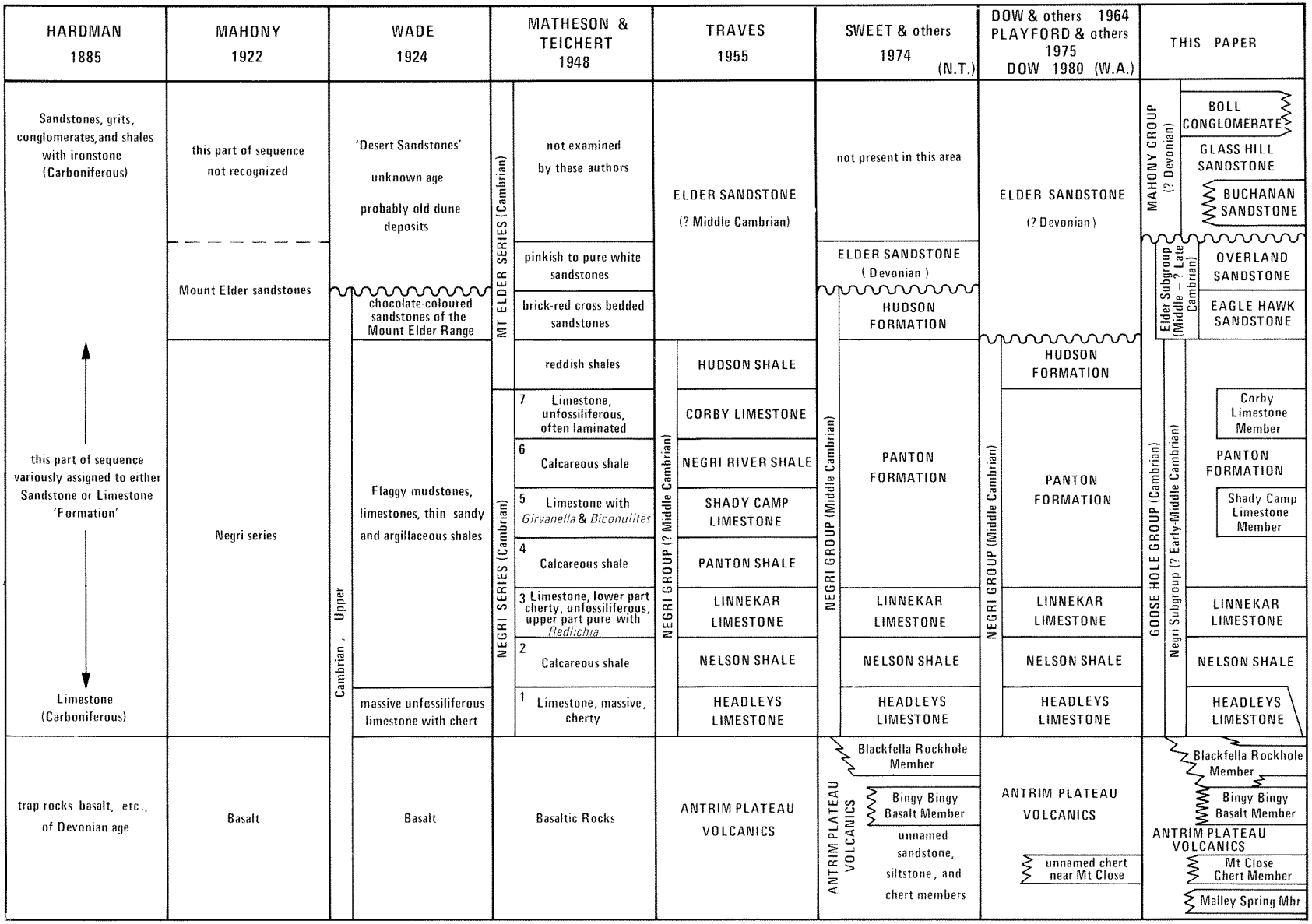

Figure 3. Correlation of previous stratigraphic nomenclature, Ord Basin.

Stratigraphic relationships: The Antrim Plateau Volcanics unconformably overlies Proterozoic sediments, locally with a marked angular relationship, and is conformably overlain by the Goose Hole Group.

Distribution and thickness: The Antrim Plateau Volcanics outcrops continuously around the edge of the Ord Basin and is also found in outliers west of the Halls Creek Fault, in the Bonaparte Basin, and along the western margins of the Wiso and Daly River Basins in the Northern Territory. Generally, the thickness of the unit ranges from 237 to 1 100 m in the Ord Basin and is thinnest to the north and east. The type section is approximately 1 000 m thick.

Fossils and age: The only fossils recovered from the Antrim Plateau Volcanics are the stromatolites *Conophyton basalticum* and *Conophyton* cf. *gaubitza* (Walter, 1972), from the Mount Close Chert Member, and these are not diagnostic of a particular age. The age of this unit, then, must be determined from stratigraphic relationships. The 650 m.y. radiometric date determined by Bofinger from the underlying Albert Edward Group (Dow, 1980), and the Middle Cambrian age of the overlying Goose Hole Group (Opik, 1967) indicate an Early Cambrian age.

Members: Four named members within the Antrim Plateau Volcanics are recognized. These are (in ascending order): the Malley Spring Member (new name), the Mount Close Chert Member (new name), the Bingy Bingy Basalt Member and the Blackfella Rockhole Member (amended).

The Malley Spring Member consists of 3 to 5 m of white to grey siltstone and medium- to coarse-grained sandstone exposed approximately 50 m above the base of the Antrim Plateau Volcanics in Moonlight Valley over a distance of 25 km from its eastern end. The type section is at the eastern end of Moonlight Valley (at 17°02′50″S and 128°43′05″E) and consists predominantly of siltstone. Sandstone becomes more common to the west.

The Mount Close Chert Member is named after Mount Close and consists of up to 5 m of laminated chert with intraformational breccias and non-branching, conical, columnar stromatolites up to 12 cm in diameter. The stromatolites are similar to those illustrated by Sweet and others (1974, figs 42 and 43) from the Wave Hill sheet. The type section is 2.5 km northeast of Mount Close by the side of the Duncan Highway at 16°56′25″S and 128°51′30″E. In this section the Mount Close Chert is 650 m above the base of the Antrim Plateau Volcanics.

Apart from the type area this unit is also recognized west of J37 and, questionably, at Mount Wittenoom on the Gordon Downs sheet.

The Bingy Bingy Basalt Member was originally defined in the Northern Territory by Sweet and others (1974, p.100). It is a massive, fine- to medium-grained glomeroporphyritic basalt with clots of plagioclase crystals up to 0.5 cm in diameter. The type section is 0.7 km north of Bingy Bingy Springs at 17°32′S and 129°15′E.

This member is present only betweeen Agate Hill and the Negri River at the southeastern end of the Ord Basin, and as lenses near "Spring Creek". At the type section it is 40 m thick. Near Charra Rockhole, the Bingy Bingy Basalt Member reaches a maximum thickness of 130 m, while at "Spring Creek" it is 20 m thick. The Bingy Bingy Basalt Member is presumably concordant with underlying and overlying basalt flows.

The Blackfella Rockhole Member was originally defined by Sweet and others (1974, p.99) in the Northern Territory and can be traced into Western Australia. This member, which constitutes the uppermost part of the Antrim Plateau Volcanics, is present in all sections of the formation and consists predominantly of fine-grained to very fine-grained basalt, agglomerate and minor amygdaloidal basalt, sandstone and siltstone. Sweet and others (1974) defined the base of this member as being the lowest agglomerate horizon. This definition is here amended to include the fine-grained basalt below the agglomerate which is virtually identical to that above. The abrupt upper contacts and gradational lower contacts of the agglomerate with the fine-grained basalt suggest that the agglomerate represents the upper part of single lava flows and that the fine-grained basalt and agglomerate should be included within the one unit.

The type section of this member is at Blackfella Rockhole (17°23′S, 129°06′E) in the Northern Territory, where 71 m of this unit is exposed. The base of the Blackfella Rockhole Member, as defined here, is not exposed at the type section and so the section east of Linnekar Creek near Charra Rockhole is suggested as a reference section—this is the thickest known section (140 m).

The Blackfella Rockhole Member has a lower conformable contact with the Bingy Bingy Basalt Member south and east of Ord River station, whereas to the north up to 50 m of undifferentiated basalt separates the two members. The upper contact is with the basal limestone of shale of the Goose Hole Group, except between Agate Hill and Headleys Knob, where up to 20 m of fine-grained, flow-banded, massive basalt is present above the Blackfella Rockhole Member.

GOOSE HOLE GROUP

Definition: The Goose Hole Group (new name) is named after Goose Hole on the Ord River and incorporates all sediments considered to be of Cambrian age within the Ord Basin. Thus defined, the Goose

Hole Group is composed of the Negri Subgroup (Negri Group of Traves, 1955) and the Elder Subgroup (previously the ?Devonian Elder Sandstone, in part).

The units which make up the Goose Hole Group are (in descending order):

Elder Subgroup (c)	Overland Sandstone (a)	white clayey arkose.
	Eagle Hawk Sandstone (a)	red, micaceous, arkosic sandstone.
Negri Subgroup (c)	Panton Formation (b)	grey-purple siltstones, arkosic sandstones, & minor limestone members.
	Linnekar Limestone	flaggy grey limestone & siltstone.
	Nelson Shale	red-purple siltstone & flaggy arkosic sandstones.
	Headleys Limestone	grey laminated limestone with chert.

(a) new name (b) amended (c) change in status

Distribution and thickness: The Goose Hole Group outcrops in three post-depositional synclines named the Hardman, Rosewood and Argyle Basins by Matheson & Teichert (1948). These were subsequently designated as sub-basins by McWhae and others (1958). The Hardman Syncline was referred to as the Ord River Basin by Wade (1924, p.26). However the Ord Basin (McWhae and others, 1958) has become well established in the literature and the name Hardman is retained for the syncline between Osmond Range and the Great Antrim Plateau.

The thickest sections of the Goose Hole Group are preserved between the hills north of White Mountain and the junction of the Ord and Negri Rivers—there the Goose Hole Group is approximately 700 m thick. Within the Hardman Syncline, the thinnest sections (500 m), in the vicinity of Linnekar Creek-Doughboy Hill, are chiefly the result of thinning of the Eagle Hawk Sandstone and the removal, by erosion, of most of the Overland Sandstone. In the Argyle Syncline the Goose Hole Group is inferred to be 180 m thick. Exposures of other than the resistant limestone units within the group are exceptionally rare in the Argyle and Rosewood Synclines.

NEGRI SUBGROUP

The Negri Subgroup was originally called the "Negri series" by Mahony (1922) and refers to the "limestone, mudstone, and shale" which overlie the basalts. It is thus equivalent to the Negri Group of Traves (1955) and Dow (1980). Two publications have adopted different definitions: Matheson and Teichert (1948), who excluded the siltstones above the highest limestone they recognized (Corby Limestone of Traves, 1955); and Sweet and others (1974), who included the red feldspathic sandstones and arkose (their Hudson Formation which is equivalent to the Eagle Hawk Sandstone of this paper) above the siltstone sequence.

HEADLEYS LIMESTONE

Definition: The Headleys Limestone is the basal unit of the Negri Subgroup in the Hardman and Rosewood Synclines. It appears to be absent in the Argyle Syncline. The limestone consists of approximately 40 m of grey, massive, or laminated micrite with chert nodules common in the lower half of the unit. Traves (1955,p.37) stated that "the type locality is at Headleys Knob 11 miles [18 km] southeast of Ord River Homestead". This renders invalid the "type section" proposed by Dow (1980, p.8) to be 3 km south of Dixon Range. At Headleys Knob dips are low (less than 2°), and so to include the base and top of the unit, the type section here defined runs 4.5 km in a NNW traverse across Headleys Knob from 17°30′25″S and 129°01′25″E (base) to 17°27′25″S and 129°00′25″E (top).

Stratigraphic relationships: The lower contact of the Headleys Limestone with the Antrim Plateau Volcanics is sharp but concordant. Ferruginization and silicification of the basalts below the limestone are possibly recent events, not necessarily the result of erosion or weathering prior to deposition of the Headleys Limestone as suggested by Sweet and others (1974) and Dow (1980). The contact with the overlying Nelson Shale is similarly abrupt and is presumably conformable.

Fossils and age: The only fossils recovered from the Headleys Limestone are simple, non-branching stromatolites which have not been described. Based on the stratigraphic position of this unit, Traves (1955) suggested an uppermost Lower Cambrian or basal Middle Cambrian age.

Nelson Shale

Definition: The Nelson Shale is a purple siltstone with thin beds of fine arkosic sandstone and rare laminated micrite. The unit is named after Nelson Springs where exposures are incomplete (Traves, 1955). In the absence of a completely exposed section, the exposures between Nelson Spring and Mount Panton in the Northern Territory (from 17°19′20″S, 129°19′15″E (base) to 17°21′10″S, 129°13′20″E (top)) are, as the nominal area, here designated as the type section.

Stratigraphic relationships: In the Argyle Syncline the Nelson Shale rests directly on the Antrim Plateau Volcanics, but the only section in which the Nelson Shale was exposed is now covered by the waters of Lake Argyle. Elsewhere in the Ord Basin the Nelson

Shale conformably overlies the Headleys Limestone. The upper contact with the Linnekar Limestone is sharp but apparently conformable.

Distribution and thickness: The Nelson Shale occurs in the Hardman, Rosewood and Argyle Synclines, but inthe latter two synclines outcrop is practically non-existent. In the Hardman Syncline, the Nelson Shale is between 100 and 183 m thick, with the greatest thickness being recorded in Okes-Durack 1.

Fossils and age: Girvanella is the only fossil recorded from the Nelson Shale: The Middle Cambrian age suggested by Traves (1955) is based on the stratigraphic position below the fossiliferous Linnekar Limestone.

Linnekar Limestone

Definition: The Linnekar Limestone consists of flaggy limestone and shale lying conformably between the Nelson Shale below and the Panton Formation above. The unit was named by Traves (1955) after Linnekar Creek [Linacre on Hardman's (1885) and Matheson and Teichert's (1948) maps]. Playford and others (1975) and Dow (1980) consider the type section to be near the junction of Linnekar and Brook Creeks (at 17°32′50″S and 128°42′35″E).

The Linnekar Limestone is subdivided into three unnamed members: basal laminated micrite with chert nodules and circular, non-columnar, flat-laminated, domed stromatolites up to 1.5 m in diameter; middle-grey to olive trilobitic shale; and upper fossiliferous flaggy limestone and shale with rare turnbinate, non-branching, columnar stromatolites.

The first known occurrence of galena in the East Kimberley region was discovered in this unit by Hardman (1885) in the bed of the Elvire River, 10 km north of "Turner".

Distribution and thickness: The Linnekar Limestone is present in all three synclines in the Ord Basin. In the Hardman Syncline the limestone is between 8 and 21 m thick with 18 m, measured at the type section, being close to the mean.

Fossils and age: The presence of *Redlichia forresti* in the middle and upper parts of the Linnekar Limestone suggests an early Middle Cambrian age (Opik, 1967). *Redlichia* is also known from the Early Cambrian in South Australia (Jell, 1983), which suggests that the unit could be somewhat older. Besides *Redlichia* the only other fossils known in this unit are *Girvanella, Biconulites hardmanni* and unnamed stromatolites.

PANTON FORMATION

Definition: The Panton Formation (amended), as defined herein, is the sequence of purple siltstone, flaggy, chocolate-brown arkosic sandstone and minor limestone which conformably overlies the Linnekar Limestone. Thus, as in Sweet and others (1974), the Panton Formation incorporates (in ascending order) the Panton Shale, Shady Camp Limestone, Negri River Shale, Corby Limestone and Hudson Shale of Traves (1955). The Hudson Formation cannot be distinguished from the Panton Formation (as defined by Dow, 1980) in the absence of the intervening lenticular Corby Limestone: the flaggy chocolate-brown sandstone and the siltstone which Dow (1980) claimed characterized the Hudson Formation are also common below the Corby Limestone. The Hudson Formation of Sweet and others (1974) is equivalent to the Eagle Hawk Sandstone of this paper.

Dow and others (1964) stated that the type locality for the Panton Formation is the Mount Panton—White Mountain area but did not designate a specific type section. Playford and others (1975) designated Mount Panton in the Northern Territory (17°16′15″S and 129°12′40″E) as the type section. This designation has priority over the subsequent designation of Dow (1980) who suggested the section in Hudson Creek on the southwest flank of White Mountain. As the uppermost part of the Panton Formation (the Hudson Formation as defined by Dow, 1980) is not present at Mount Panton, the section in Hudson Creek (from 17°15′30″S, 128°57′30″E (base to 17°15′35″S, 128°57′50″E (top)) is here proposed as a reference section for the Panton Formation.The correlation between Mount Panton and White Mountain was demonstrated by Dow (1980, Fig. 4.)

Distribution and thickness: The greatest thickness through the Panton Formation was recorded in the reference section at White Mountain (308 m). At the type section (Mount Panton) only 85 m is exposed but this section is incomplete. In the Hardman Syncline the thinnest section, at 105 m, was measured in Osmond Creek 40 km west of White Mountain, a thickness comparable to that estimated in the Argyle Syncline.

Fossils and age: The most fossiliferous part of the Ord Basin sequence is the shale and limestone succession between the Shady Camp and Corby Limestone Members, especially in the Mount Panton area. The assemblage of *Redlichia* and *Xystridura* from this part of the Panton Formation suggests a Middle Cambrian age (Opik, 1967; Jell, 1983). Also reported from the Panton Formation are the brachiopods *Billingsella* and *Winanella*, girvanellids, stromatolites, and a small conical shell of uncertain affinities, *Biconulites hardmani* (Traves, 1955). In the collection made by Mahony (1922), presumably from the Panton Formation, Chapman (1924) identified "a stromatoporoid, foraminifera, (encrusting), radiolaria, ostracoda and archeocyathina". This collection has been reassessed by P. Jell (written comm.,

1982), who identified these fossils as a stromatolite, pisolites, carbonate pellets, *Biconulites* fragments and cone-in-cone *Biconulites* respectively.

Members: Two members within the Panton Formation can be recognized: the Shady Camp Limestone, and the Corby Limestone of Traves (1955). Both limestones lens out to the west in the Hardman Syncline and cannot be traced beyond 128°35′E.

The Shady Camp Limestone Member consists of up to 4 m of oncolitic, fossiliferous limestone with abundant *Biconulites* and trilobites. The type section is here designated as Mount Panton, where this member occurs 41 m above the base of the Panton Formation. The Shady Camp Limestone may occur between 30 m (in the Argyle Basin) and 92 m (at White Mountain) above the base of the Panton Formation.

The Corby Limestone Member consists of up to 4 m of massive to laminated, unfossiliferous micrite with chert nodules, and is similar to the Headleys Limestone. The type section is here designated as Hudson Creek, 160 m above the base of the Panton Formation (at 17°15′35″S and 128°57′20″E). At Mount Panton, where the limestone is 83 m above the base of the Panton Formation, the overlying shales are not exposed. In the Hardman Syncline the top of the Corby Limestone may be as little as 55 m above the base of the Panton Formation (estimated in Osmond Creek, 40 km west of White Mountain)—a thickness comparable to that in the Argyle Syncline (40 m).

ELDER SUBGROUP

Mahony (1922) originally named the "Mount Elder sandstones" after the "red sandstone . . . which forms a conspicuous chain of hills of which Mount Elder is the most conspicuous point." Subsequent workers have applied the name "Elder" to the entire arenaceous sequence above the Panton Formation, as defined herein, and in doing so have grouped together sandstones here considered to be of probable Cambrian age (Elder Subgroup) and sandstones of probable Devonian age (Mahony Group). Since Mahony (1922) named his "Mount Elder sandstones" after Mount Elder, Playford and others (1975) and Dow (1980) considered the type area to be in the immediate vicinity of Mount Elder, that is, in the White Mountain Hills. In this area two sandstone units may be recognized: a lower red, micaceous, arkosic sandstone and an overlying white, clayey arkose, here named the Eagle Hawk Sandstone and Overland Sandstone (new names) respectively, and together comprising the Elder Subgroup. The Elder Subgroup has a contact with the underlying Panton Formation which, although generally gradational, may also be abrupt. Diagnostic fossils have yet to be recovered from these two sandstone units. The gradational contacts suggest that a significant hiatus between them, or with the underlying Negri Subgroup, is unlikely.

EAGLE HAWK SANDSTONE

Definition: The Eagle Hawk Sandstone (new name) is named after Eagle Hawk bore and consists of thin-to medium-bedded, festoon cross-bedded and current-lineated, fine-grained, red, micaceous, arkosic sandstone and minor red siltstone. The type section is here designated as Hudson Creek on the southwestern flank of White Mountain from 17°17′45″S and 128°58′45″E (base) to 17°15′30″S and 128°57′30″E (top), since this is the most accessible section where both the upper and lower contacts are exposed.

Stratigraphic relationships: The Eagle Hawk Sandstone overlies, generally with a transitional contact, the flaggy, ripple-cross-laminated, arkosic sandstone and siltstone characteristic of the uppermost part of the Panton Formation. The Eagle Hawk Sandstone is readily distinguished from the white, clayey arkose of the conformably overlying Overland Sandstone, although the contact is gradational. Where the Overland Sandstone has been removed by erosion, the Eagle Hawk Sandstone is easily distinguished from the pebbly quartz sandstones of the disconformably overlying Mahony Group.

Distrubution and thickness: Outcrop of Eagle Hawk Sandstone is primarily in the Hardman Syncline. Red sandstones, poorly exposed in the centre of the Argyle Syncline, are also referred to this unit. In the type section at Hudson Creek, the unit reaches a maximum thickness of 210 m. At Doughboy Hill, 80 m (estimated from air photographs) of Eagle Hawk Sandstone is present, and is comparable to the thickness (75 m) determined by Sweet and others (1974) in the Northern Territory for their Hudson Formation (the Eagle Hawk Sandstone of this paper). These are the thinnest non-eroded and non-faulted sections in this unit.

Fossils and age: The only fossils discovered in the Eagle Hawk Sandstone are trilobite tracks which are not age-diagnostic. The Middle Cambrian age here suggested for this unit is based on its stratigraphic position above the fossiliferous Negri Subgroup and on a lithological correlation with the Middle Cambrian Hart Spring Sandstone in the Bonaparte Basin, a correlation previous suggested by Traves (1955) for his Elder Sandstone.

OVERLAND SANDSTONE

Definition: The Overland Sandstone (new name) consists of white, medium- to fine-grained, clayey lithic arkose which overlies the Eagle Hawk Sandstone with a gradational lower contact and which is

disconformably overlain by pebbly sandstone and conglomerate of the Mahony Group. The sandstone is named after Overland Spring, 7 km southeast of the type section which runs from 17°09′15″S and 129°00′15″E (base) to 17°10′55″S and 128°59′50″E (top) and is the thickest known section (230 m) in which both the underlying and overlying units are exposed. The Overland Sandstone was formerly included in the Elder Sandstone (Fig. 3) together with the underlying Eagle Hawk Sandstone and overlying Mahony Group.

Distrubution and thickness The chief area of outcrop of the Overland Sandstone is the range of hills north of White Mountain where thicknesses of up to 230 m have been estimated from aerial photographs, although only the uppermost 50 m is well exposed. The unit thins to the southwest, being approximately 10 m thick near Mount Buchanan and Doughboy Hill, and pinches out just north of where the Ord River cuts through Dixon Range. This thinning appears to be the results of erosion prior to the deposition of the Mahony Group. The overland Sandstone is not known in the Rosewood or Argyle Synclines.

White Mountain takes its name from the brilliant white cliff of Overland Sandstone near its summit. The name "White Mountain" has, however, previously been applied to the Tertiary limestone which caps this hill (Matheson and Teichert, 1948).

MAHONY GROUP

Definition: The Mahony Group (new name), named after Mount Mahony, is the white and yellow quartz sandstone, pebbly sandstone, and conglomerate which disconformably overlies the Goose Hole Group. The group is divided into three formations of which two, the Boll Conglomerate and Buchanan Sandstone (new names), interfinger with and are laterally equivalent to parts of the third—the Glass Hill Sandstone (new name).

Distribution and thickness: The Mahony Group outcrops chiefly in the centre of the Hardman Syncline in the triangular area between Bungle Bungle Outcamp, Dixon Range and Mount Buchanan. Small inliers also occur at Hardman Range, west-northwest of "Flora Valley" and north of White Mountain. The maximum thickness in Bungle Bungle Range, estimated perpendicular to the syclinal axis, is between 750 and 1 000 m. This thickness may, nevertheless, be considered as a minimum as the upper parts of this group have been removed by recent erosion.

Fossils and age: The only fossils recovered from the Mahony Group are several species of bivalve from north of White Mountain and these are too poorly preserved to determine the age of the Group. The Mahony Group is here considered to be of probable Devonian age, based on a lithological correlation with the Frasnian Cockatoo Formation in the Bonaparte Basin. Previously the Mahony Group was included in the Elder Sandstone and assigned a Cambrian age by Matheson and Teichert (1948) and Traves (1955) on the basis of the gradational lower contact of the Eagle Hawk Sandstone with the Negri Subgroup. Dow and others (1964) and Dow (1980), however, suggested a Devonian age, based on a correlation of the basal conglomerates at Dixon Range with the Ragged Range Conglomerate Member in the Bonaparte Basin. At Dixon Range the Eagle Hawk Sandstone below the disconformity was mapped as Hudson Formation by these workers.

GLASS HILL SANDSTONE

Definition: The Glass Hill Sandstone (new name) consists of pebbly quartz sandstone, rare siltstone, and a lenticular basal conglomerate. The sandstones chiefly consist of medium- to fine-grained, well-sorted, friable, clean quartz sandstone in which pebbles generally make up less than 1% and rarely greater than 5% of the bulk. The type section is at the south end of Dixon Range, near Hardmans' (1885) trig. station J37, beginning at a small breakaway at 17°41′45″S and 128°16′50″E and continuing 1 km NE to the top of the range. In this section approximately 200 m is exposed. Thicker sections of up to 850 m have been estimated to the north on the eastern side of Bungle Bungle Range.

Stratigraphic relationships: The basal lithologies disconformably overlie either the Eagle Hawk Sandstone or Overland Sandstone of the Elder Subgroup. The uppermost part of this unit is exposed at the top of the range southeast of Bungle Bungle Outcamp where younger strata are unknown. The Glass Hill Sandstone has conformable contacts with and is in part equivalent to the two other formations of the Mahony Group—the Buchanan Sandstone and Boll Conglomerate.

BUCHANAN SANDSTONE

Definition: The Buchanan Sandstone (new name) is a clean, well-sorted, medium-grained quartz sandstone in which well-rounded, frosted grains are common. The type section begins at the base of a hill 5.5 km south of Mount Buchanan (17°22′20″S and 128°36′50″E) and continues northwest across a line of hills for 1.5 km. As dips are low in this area and the upper parts of the cliff exposures are largely inaccessable a reference section is proposed. This reference section lies 3 km southwest of the type section and extends from 17°23′25″S and 128°35′00″E (base) to 17°23′05″S and 128°33′50″E (top).

Stratigraphic relationships: Although the lower contact is nowhere exposed, it is known that the lateral and upper contacts of the Buchanan Sandstone interfinger with the Glass Hill Sandstone.

Distribution and thickness: The Buchanan Sandstone outcrops along the eastern margin of Bungle Bungle Range. The unit is appropriately 130 m thick in the type area but the lower contact is not exposed. The total thickness of the Buchanan Sandstone is, however, unlikely to exceed 140 m.

BOLL CONGLOMERATE

Definition: The Boll Conglomerate (new name) consists of a lower unit of conglomerate, pebbly sandstone and sandstone in which clasts rarely exceed 18 cm in diameter, and an upper, cliff-forming, massive conglomerate with quartzite boulders up to 0.9 m in diameter. The type section is the west wall of the north-directed gorge 3 km east-southeast of Bungle Bungle Outcamp at 17°22′10″S and 128°22′10″E.

Stratigraphic relationships: The lower contact of the Boll Conglomerate with the Glass Hill Sandstone is abrupt but concordant. Laterally, the conglomerate appears to interfinger with the Glass Hill Sandstone. The upper contact of the Boll Conglomerate is not accessible but on airphotos it appears to be overlain by Glass Hill Sandstone.

Distribution and thickness: The Boll Conglomerate outcrops in a narrow belt running 10 km east-northeast from Bungle Bungle Outcamp along the southern side of Red Rock Creek. A thin tongue also extends 8 km south along the top of the range to the head of Piccaninny Creek. In the type section the Boll Conglomerate is approximately 350 m thick.

REFERENCES

Blatchford, T., 1922, Interim report on the occurrence of glance pitch near the junction of the Negri and Ord Rivers, known as "Oakes Find": West. Australia Geol. Survey, Ann. Rept 1921, p.20-22.

——1927, The geology of portions of the Kimberley Division, with special reference to the Fitzroy Basin and the possibilities of the occurrence of mineral oil: West. Australia Geol. Survey, Bull. 93.

Chapman, F., 1924, Age and contents of limestone specimens from the Negri Series, Kimberley Division: West. Australian Geol. Survey, Ann. Rept 1923, p.123.

David, T. W. E., 1932, Explanatory notes to accompany a new geological map of the Commonwealth of Australia: Australia, Council for Scientific and Industrial Research, Sydney.

Dow, D. B., 1980, Palaeozoic Rocks of the Hardman, Rosewood and Argyle Basins, East Kimberley Region, Western Australia: Australia Bur. Mineral Resources, Rec. 1980/54 (unpublished).

Dow, D. B., Gemuts, I., Plumb, K. A. and Dunnet, D., 1964, The geology of the Ord River region, Western Australia: Australia Bur. Mineral Resources, Rec. 1964/104 (unpublished).

Dow, D. B., and Gemuts, I., 1967, Dixon Range, W.A.: Australia Bur. Mineral Resources, 1:250 000 Geological Series Explanatory Notes, 15p.

Foord, A. H., 1890, Description of fossils from the Kimberley District, Western Australia: Geol. Mag., v.7, p.98-100.

Gentilli, J. and Fairbridge, R. W., 1951, Physiographic diagrams of Australia: New York, Columbia University Geographical Press.

Hardman, E. T., 1885, Report on the geology of the Kimberley District, Western Australia: West. Australian Parliamentary Paper No. 34

Jack, R. L., 1906, The prospects of obtaining artesian water in the Kimberley District: West. Australia Geol. Survey, Bull. 25.

Jell, P. A., 1983, The Early to Middle Cambrian boundary in Australia: *in* Abstracts No. 9, Geol. Soc. Aust., 6th Convention, Canberra, 1983, p.236.

Jones, P. J, 1976, Ord Basin: *in* Economic geology of Australia and Papua New Guinea, 3, Petroleum: Aust. Inst. Mining Metall., Monograph Series, No. 7. p.242-246.

Mahoney, D. J., 1922, Report on oil prospects near Ord-Negri River junction, East Kimberley District: "West Australian" Newspaper, June 15th, 1922.

Matheson, R. S., and Teichert, C., 1948, Geological reconnaissance in the eastern portion of the Kimberley Division, W.A.: West. Australia Geol. Survey, Ann. Rept. 1945, p.27-41.

McWhae, J. R. H., Playford, P. E., Linder, A. W., Glenister, B. F. and Balme, B. E., 1958, The stratigraphy of Western Australia: Geol. Soc. Australia Jour., v.4 pt 2.

Opik, A. A., 1967, The Ordian Stage of the Cambrian and its Australian Metadoxididae: Australia Bur. Mineral Resources, Bull. 92, p.133-165.

Playford, P. E., Cope, R. N., Cockbain, A. E., Low, G. H., and Lowry, D. C., 1975. Ord Basin *in* Geology of West Australia: West. Australia Geol. Survey, Memoir 2 p.395-399.

Plumb, K. A., 1968, Lissadell, W.A.: Australia Bur. Mineral Resources, 1:250 000 Geological Series Explanatory Notes, 31p.

Sweet, I. P., Mendum, J. R., Bultitude, R. J., and Morgan, C. M., 1974, The geology of the southern Victoria River region, Northern Territory: Australia Bur. Mineral Resources, Rept. 167.

Traves, D. N., 1955, The geology of the Ord-Victoria region, Northern Australia: Australia Bur. Mineral Resources, Bull. 27.

Wade, A., 1924, Petroleum prospects, Kimberley district of Western Australia and Northern Territory: Rept to Commonwealth Parliament, Australia, No. 142.

Walter, M. R., 1972, Stromatolites and the biostratigraphy of the Australian Precambrian and Cambrian: Palaeont. Assoc., Spec. Papers in Palaeontology, 11.