Northern Territory Government

# Geology and mineral resources of the Northern Territory


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## Chapter 33: Ord Basin


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# Chapter 33: ORD BASIN

**PD Kruse and TJ Munson**

## INTRODUCTION

The Ord Basin (Wade 1924, McWhae *et al* 1958) straddles the Northern Territory–Western Australia border and outcrops over an area of about 8500 $km^2$, of which about 1700 $km^2$ (ca 20%) is in the Northern Territory (**Figure 33.1**). It is an erosional remnant of an extensive, once-continuous middle Cambrian depositional area, spanning the northern and central portions of the Northern Territory and continuing southwards and eastwards into adjacent states. Contiguous portions of this depositional system in northern and central Australia are referred to in this volume as the Centralian B Superbasin (see **Centralian Superbasin**). Neighbouring basins that were also a part of this middle Cambrian depositional system include the Bonaparte Basin to the north, which is now separated from the Ord Basin by the Halls Reward Fault and by a thin belt of Proterozoic basement rocks, and the Wiso Basin to the east, which is now separated from the Ord Basin by the Kalkarindji Province and by the Proterozoic Birrindudu and Victoria basins. The western margin of the basin unconformably overlies and is adjacent to the Palaeoproterozoic Halls Creek Orogen.

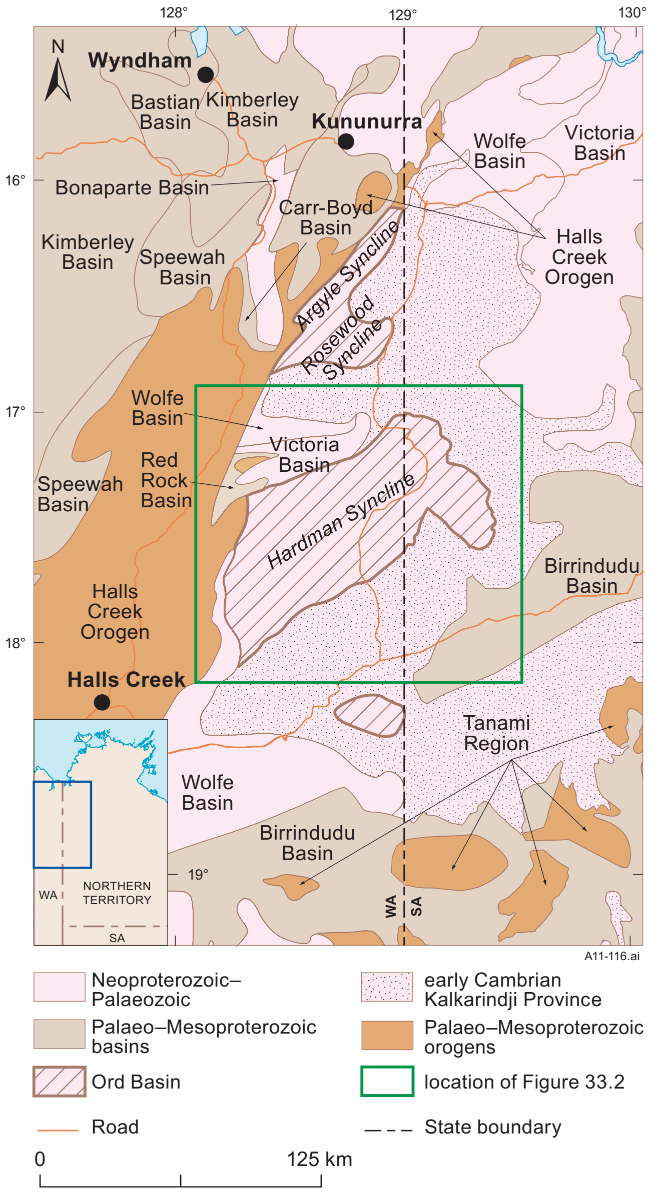



**Figure 33.1**. Regional geology of Ord Basin in NT and WA. NT geological regions from NTGS 1:2.5M geological regions GIS dataset. WA geological regions simplified and slightly modified from Tyler and Hocking (2001); some small outliers/inliers omitted. Extent of Kalkarindji Province in WA slightly modified from Glass and Phillips (2006).

The Ord Basin succession is mostly contained within three main outcrop tracts, from south to north, the Hardman, Rosewood and Argyle synclines (originally named as 'basins' by Matheson and Teichert 1948, **Figure 33.2 inset**). Of the three component synclines, only the largest, the Hardman Syncline, has appreciable extent within the Northern Territory. It includes the entire Cambrian succession and is exposed in northwestern LIMBUNYA[1] (Cutovinos *et al* 2002). The Rosewood Syncline also impinges on the Northern Territory, with small outliers of the Headleys Limestone in western WATERLOO (Sweet 1973).

The basin succession is disconformable on basement of early Cambrian Antrim Plateau Volcanics (Kalkarindji Province), above Proterozoic rocks of the Birrindudu and Victoria basins. In the Northern Territory, the entire succession is included within the middle to ?late Cambrian Goose Hole Group, which becomes progressively younger towards the west (**Figure 33.2**). In Western Australia, coarse siliciclastic rocks of the Mahony Group of probable Frasnian (Late Devonian) age unconformably overlie the Goose Hole Group in the Hardman Syncline (Mory and Beere 1988) and these form the top of the Ord Basin succession. Superficial Cenozoic units unconformably overlie the Ord Basin in numerous places.

Significant studies on the Ord Basin include Playford *et al* (1975), Dow (1980), Mory and Beere (1985, 1988), Mory (1990) and Kruse *et al* (2004). A stratigraphic correlation chart for the Ord and other NT basins of similar age is in **Centralian Superbasin: figure 22.6**.

## MIDDLE–?UPPER CAMBRIAN

### *Goose Hole Group*

The entire post-Antrim Plateau Volcanics Cambrian succession is included in the Goose Hole Group (Mory and Beere 1985). The group is altogether about 700 m thick and comprises middle Cambrian and possibly early late Cambrian rocks (**Table 33.1**, **Figure 33.3**). All internal formation contacts are conformable. Lithostratigraphic nomenclature was established by Traves (1955) and Mory and Beere (1985, 1988).

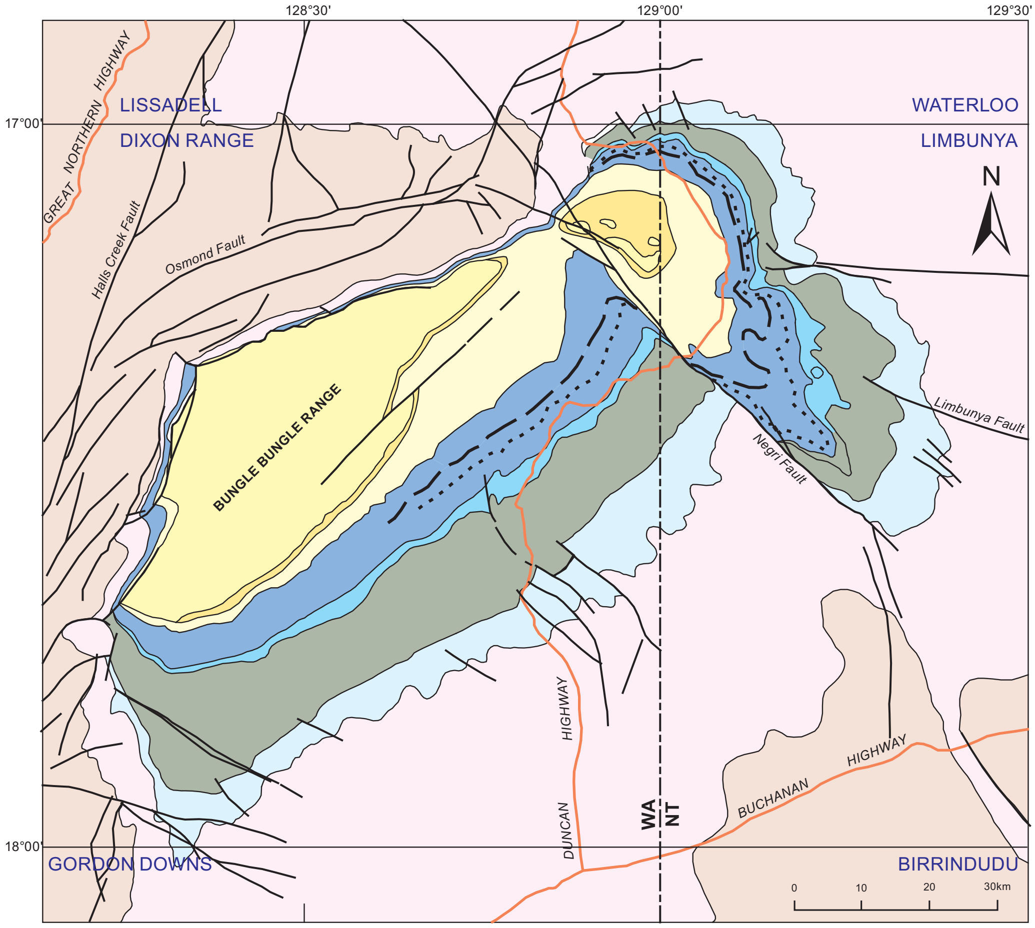
Mory and Beere (1985) divided the Goose Hole Group into the Negri Subgroup (maximum thickness 530 m) and the overlying Elder Subgroup (370 m). Elements of the two successive sedimentary successions that have been recognised from sequence stratigraphic studies

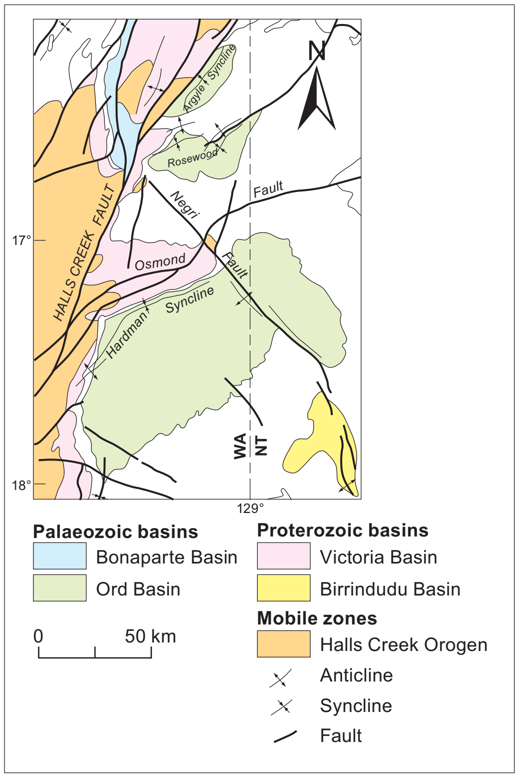
[1] Names of 1:250 000 and 1:100 000 mapsheets are shown in large and small capital letters, respectively, eg LIMBUNYA, NEGRI.

in the Georgina Basin to the east (Shergold *et al* 1988, Southgate and Shergold 1991, Laurie 2006) are also recognised within middle Cambrian strata of the Ord Basin: sequence 1 (Ordian) and sequence 2 (latest Ordian–early Mindyallan). The entire Negri Subgroup represents sequence 1, whereas much of the Elder Subgroup probably represents sequence 2.

### *Negri Subgroup*

The Negri Subgroup comprises, in ascending stratigraphic order, the Headleys Limestone, Nelson Shale, Linnekar Limestone and Panton Formation, the last with two constituent named members (**Figure 33.3**). The middle Cambrian succession of the subgroup is the most peritidal



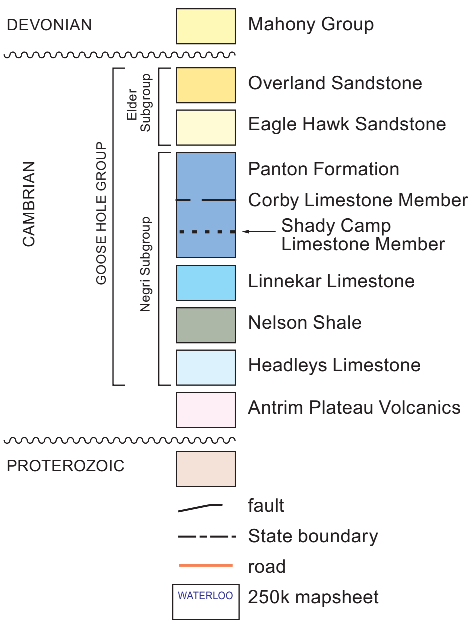




**Figure 33.2**. Geological map of Hardman Syncline (redrawn after Kruse *et al* 2004: figure 1). Location shown in **Figure 33.1**. Location of Hardman, Rosewood and Argyle synclines shown in inset map.

of all correlative intervals in any of the Northern Territory sedimentary basins. It is dominated by maroon gypsiferous siltstone and mudstone, punctuated by three brief marine carbonate incursions represented by the Linnekar Limestone and carbonate intervals within the Panton Formation. Closest comparisons are therefore with the equivalent successions in the Daly and Wiso basins, and Barkly Sub-basin of the Georgina Basin, all of which share a predominance of maroon, fine siliciclastic rocks. Carbonate rocks of the Linnekar Limestone and Panton Formation have yielded sequence 1 marine fossils (Kruse *et al* 2004) that enable the sub-group as a whole to be correlated with the Tindall Limestone (Daly Basin), the Montejinni Limestone and Hooker Creek Formation (Wiso Basin), and the Top Springs Limestone, Gum Ridge Formation, Thorntonia Limestone and Border Waterhole Formation (Georgina Basin). The subgroup as a whole is broadly correlated with the Tarrara Formation (Carlton Group) of the Bonaparte Basin (Mory and Beere 1988).

*Headleys Limestone*

The Headleys Limestone (Traves 1955) is resistant to weathering and forms bold karstified exposures, particularly around the southern and eastern margins of the Hardman Syncline (**Figure 33.2**) in LIMBUNYA and adjacent areas of Western Australia. Where it is gently dipping, it tends to form cuestas, but in areas where it is more steeply dipping, it forms parallel-sided ‘walls’ up to 50 m high (Dow 1980, Cutovinos *et al* 2002 (**Figures 33.4**, **33.5**). It also outcrops extensively in the Rosewood Syncline, but does not occur within the Argyle Syncline (Plumb 1968). Small isolated exposures of Headleys Limestone in western WATERLOO (Sweet 1973) mark the maximum eastward extent of the Rosewood Syncline into the Northern Territory. The formation is 35–50 m thick (Mory and Beere 1988) and overlies the Antrim Plateau Volcanics with apparent conformity, although there was probably a short time break between these units. Ferruginisation and silicification of the underlying basalts may be the result either of weathering

| **Unit, max thickness** | **Lithology** | **Depositional environment** | **Stratigraphic relationships** |
|---|---|---|---|
| **Late Devonian** | | | |
| **Mahony Group**, up to 1000 m | Quartz sandstone, pebbly sandstone, conglomerate, minor siltstone. | Alluvial fan, fluviatile, aeolian, minor intertidal. | Unconformable on Elder Subgroup. Not present in NT. |
| **GOOSE HOLE GROUP** | | | |
| **ELDER SUBGROUP** | | | |
| **middle–?late Cambrian: ?sequence 2** | | | |
| **Overland Sandstone**, 230 m | White to pale grey or fawn fine to medium lithic arkose and sandstone; trough and planar cross-beds, current ripple marks, parallel-lamination. | Braided fluviatile. | Conformable and gradational on Eagle Hawk Sandstone. |
| **middle Cambrian: sequence 2** | | | |
| **Eagle Hawk Sandstone**, 210 m | Fine to medium feldspathic to micaceous, red-brown to maroon sandstone; minor siltstone, mudstone; trough cross-beds, ripple marks, parallel lamination, mud pebble and cobble moulds, decimetre-scale channels, desiccation cracks; ichnofossil assemblage of arthropod tracks. | Intertidal sand- and mudflat. | Conformable and usually gradational on Panton Formation; possibly unconformable on Negri Subgroup in western Hardman Syncline (Dow 1980). |
| **NEGRI SUBGROUP** | | | |
| **middle Cambrian: sequence 1** | | | |
| **Panton Formation**, 308 m | Maroon gypsiferous siltstone, mudstone, minor feldspathic sandstone and limestone; limestone, marl and thin sandstone beds between named members; unfossiliferous, except for medial interval bracketed by named members, which contains trilobites (including *Redlichia* and *Xystridura*), brachiopods, hyoliths, molluscs, disarticulated echinoderms, chancelloriids and sponge spicules. | Peritidal; restricted shallow subtidal between named members. | Conformable and gradational on Linnekar Limestone. |
| *Corby Limestone Member, 4.6 m* | Microbial limestone, hyolith floatstone and oncoid bioclast limestone. | Intertidal, shoreface and shallow subtidal. | Conformable within upper Panton Formation. |
| *Shady Camp Limestone Member, 4 m* | Basal gypsiferous microbial laminite overlain by oncoid-rich nodular hyolith floatstone. | Intertidal to shallow subtidal. | Conformable within lower Panton Formation. |
| **Linnekar Limestone**, 40 m | Microbial, bioclast and oncoid limestone, alternating with fossiliferous grey to olive-brown mudstone and marl. Low-diversity fauna of trilobite *Redlichia forresti*, hyolith *Guduguwan hardmani*, and brachiopods. | Peritidal to shallow subtidal. | Conformable on Nelson Shale. |
| **Nelson Sh**ale, 183 m | Maroon to grey gypsiferous and pyritic shale and mudstone, minor fine sandstone, rare laminated limestone, unfossiliferous except for calcimicrobe *Girvanella*. | Intertidal to supratidal. | Conformable on Headleys Limestone. |
| **Headleys Limestone**, 50 m | Lower part medium- to thickly bedded microbial laminite with stromatolites; basal beds with ovoid and flat siliceous nodules. Upper part flat to slightly wavy, thinly bedded limestone, commonly with wrinkled surfaces due to original microbial biofilms and small siliceous spheroidal nodules possibly after former evaporitic minerals, ripple marks. | Intertidal to possibly supratidal. | Disconformable on Antrim Plateau Volcanics. |

**Table 33.1**. Summary of Palaeozoic stratigraphic succession of Ord Basin. See Mory and Beere (1988) for more information on Upper Devonian Mahony Group, which occurs only in Western Australia.

prior to deposition of the Headleys Limestone (Sweet *et al* 1974), or of recent processes (Mory and Beere 1985). The upper contact with the Nelson Shale is generally sharp.

The lower part of the Headleys Limestone consists of a medium- to thickly bedded microbial laminite, bearing common planar and some domical stromatolites. This interval features centimetre-scale pseudobeds of dark and light grey foetid limestone, ovoid and flat siliceous nodules in the basal beds (**Figure 33.6**), at least some of which have been interpreted to be of early diagenetic origin, and centrally raised and concentrically ringed features, 1–2 m diameter, that have been interpreted as cold seep structures (Cutovinos *et al* 2002, Kruse *et al* 2004). A thickness of about 15 m was measured for the lower interval in northeastern DIXON RANGE (Kruse *et al* 2004). The upper portion of the Headleys Limestone is of flat to slightly wavy, thinly bedded limestone, commonly with wrinkled surfaces due to original microbial biofilms and siliceous spheroidal nodules up to a millimetre in size, possibly after former evaporitic minerals. The wrinkling occurs uniformly on planar beds, but is confined to ripple troughs on rippled beds (Kruse *et al* 2004).

The Headleys Limestone lacks age-diagnostic fossils, but is constrained to the Ordian (middle Cambrian) by the securely dated Antrim Plateau Volcanics below and Linnekar Limestone above. It is entirely peritidal; planar stromatolites, fenestral fabrics, flat-pebble conglomerates and probable evaporites together indicate an intertidal to possibly supratidal depositional environment.

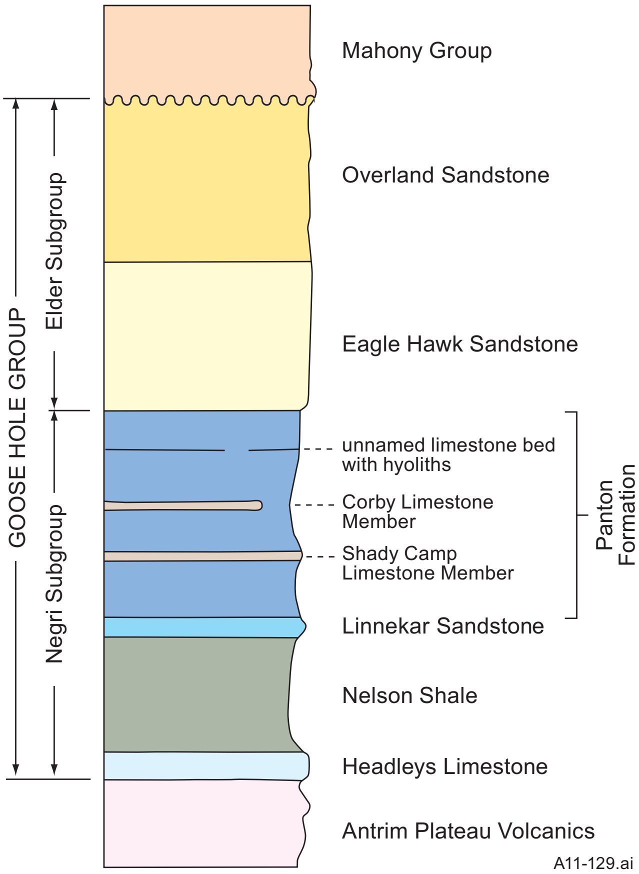



**Figure 33.3**. Schematic stratigraphic column of Goose Hole Group (based on Mory and Beere 1985: figure 2).

**Figure 33.4**. Typical outcrop of Headleys Limestone, near Blackfellow Rockhole (LIMBUNYA, NEGRI 52K 509500mE 8078500mN, after Cutovinos *et al* 2002: figure 17).

*Nelson Shale*

The recessive Nelson Shale (Traves 1955) is widely distributed, but very poorly exposed within the three component synclines of the Ord Basin. In the Hardman Syncline, the unit forms a narrow to wide belt concentrically

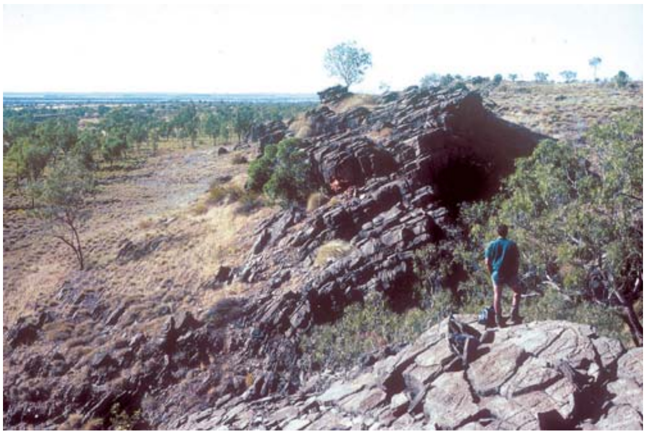


**Figure 33.5**. Section through fault-associated monocline in Headleys Limestone, near Blackfellow Rockhole (view to southeast at LIMBUNYA, NEGRI 52K 509500mE 8078500mN). Nelson Shale underlies flat terrain at left. Intervening Negri Fault (not exposed) is subparallel to base of scarp (after Cutovinos *et al* 2002: figure 28).

**Figure 33.6**. Ovoid and flat siliceous nodules in basal beds of Headleys Limestone, near Blackfellow Rockhole. (LIMBUNYA, NEGRI 52K 510700mE 8077700mN, after Cutovinos *et al* 2002: figure 18).

within the outcrop tract of the underlying Headleys Limestone (**Figure 33.2**). The unit weathers easily and typically forms rolling vertosol ('black soil') plains (**Figure 33.7**), with exposures mostly confined to creek beds (Dow 1980). It reaches a maximum known thickness of 100–183 m (Mory and Beere 1985). In the Argyle Syncline, where the Headleys Limestone is absent, the Nelson Shale is unconformable on the Antrim Plateau Volcanics. The upper contact with the Linnekar Limestone is sharp (Mory and Beere 1985, Cutovinos *et al* 2002).

The Nelson Shale consists of maroon to grey, gypsiferous and pyritic shale and mudstone, with minor fine sandstone and rare laminated limestone. It is generally unfossiliferous, except for the presence of the calcimicrobe *Girvanella* (Dow 1980), and has not been directly dated. However, like the Headleys Limestone, the unit is constrained to the Ordian (middle Cambrian), by the securely dated Antrim Plateau Volcanics below and Linnekar Limestone above. The gypsiferous nature of the maroon sedimentary rocks indicates that the Nelson Shale was deposited under peritidal conditions (Mory and Beere 1985, Kruse *et al* 2004) and the generally fine-grained sedimentary rocks are indicative of periodically exposed, mud-dominated intertidal flats.

*Linnekar Limestone*

The Linnekar Limestone (Traves 1955, Playford *et al* 1975) occurs within all three component synclines of the Ord Basin. It is slightly more resistant to erosion than the units above and below it, and is best exposed as low cuestas around the eastern and southern margins of the Hardman Syncline (**Figure 33.7**), concentrically within the outcrop tract of the underlying Nelson Shale (**Figure 33.2**). In other parts of the Hardman Syncline, where the formation is more steeply dipping, it forms a narrower, less well exposed outcrop tract under Cenozoic soils and alluvium. In the Rosewood and Argyle synclines, exposures are generally poor (Dow 1980). The Linnekar Limestone is up to 40 m thick (Playford *et al* 1975), but is generally in the range 8–31 m (Mory and Beere 1985, Cutovinos *et al* 2002). Its lower contact with the Nelson Shale is generally sharp, but the upper contact with the Panton Formation is gradational over about 6 m and is arbitrarily placed at the level where shale becomes predominant (Dow 1980).

The Linnekar Limestone consists of microbial, bioclast and oncoid limestones, alternating with fossiliferous grey to olive-brown mudstone and marl. An informal tripartite subdivision of the formation (Mory and Beere 1985, Kruse *et al* 2004) comprises lower and occasionally upper microbial limestones (**Figure 33.8**), locally with stromatolites, and a medial richly fossiliferous interval of thinly bedded limestone, marl and shale. A low-diversity fauna of the trilobite *Redlichia forresti*, hyolith *Guduguwan hardmani*, and brachiopods *Kyrshabaktella mudedirri* and rare *Wimanella* confirms an Ordian sequence 1 age for the formation (Kruse *et al* 2004). The fossiliferous medial interval of the Linnekar Limestone was deposited in subtidal conditions and represents the oldest marine incursion within the Ord Basin succession. The upper and lower microbial limestone intervals were deposited in a more restricted peritidal setting (Kruse *et al* 2004).

*Panton Formation*

The Panton Formation (*sensu* Mory and Beere 1985) is widely distributed within the three component synclines of the Ord Basin, but is generally recessive and poorly exposed. In the Hardman Syncline, the unit forms a narrow to wide belt concentrically within the outcrop tract of the underlying Linnekar Limestone, with the most extensive exposures being in the eastern and central areas (**Figure 33.2**). The bulk of the formation weathers easily and typically forms sandy vertosol ('black soil') plains. Exposures are mostly confined to incised creek beds, but minor limestone intervals are more resistant and tend to form subdued cuestas (Dow 1980). Mory and Beere (1985) reported thicknesses for the Panton Formation of 85 m (incomplete type section at Mount Panton), 105 m and 308 m (maximum). The upper boundary of the Panton Formation with the Eagle Hawk Sandstone is usually gradational, although it can be sharp, and is apparently conformable (Mory and Beere 1985, Kruse *et al* 2004), although Dow (1980) reported an unconformable relationship in the western Hardman Syncline. The formation was redefined by Mory and Beere (1985), so as to embrace

**Figure 33.7**. View looking west towards Mount Panton from about 52K 527000mE 808200mN. Nelson Shale underlies grassland in foreground; scarp in middle distance is Linnekar Limestone; Panton Formation forms Mount Panton; Shady Camp Limestone Member forms prominent bench midway up Mount Panton; Corby Limestone Member caps summit.

**Figure 33.8**. Basal 2 m of Linnekar Limestone, from Nelson Springs–Mount Panton track, near Mount Panton (LIMBUNYA, NEGRI 52K 523900mE 8081600mN). Section commences with planar microbial laminite (hammer), succeeded in turn by domical stromatolites (midway through section) and domical thrombolites (top; after Cutovinos *et al* 2002: figure 19).

five superseded formation-rank units of Traves (1955). Two of these former units have been included within the formation as the Shady Camp Limestone Member and the stratigraphically higher Corby Limestone Member (**Figure 33.7**).

The Panton Formation consists predominantly of unfossiliferous, maroon-purple gypsiferous siltstone and mudstone, which were deposited under peritidal conditions. However, the medial portion of the formation is richly fossiliferous and represents a subtidal marine incursion, the second within the Ord Basin succession. It includes the Shady Camp Limestone and Corby Limestone members, which bracket an interval of fossiliferous limestone and marl, with oncoids, microbial laminite, flat-pebble breccia and thin sandstone beds (Kruse *et al* 2004). The known fauna from this interval is more diverse than that in the Linnekar Limestone and is referred to the Ordian sequence 1. It contains many species that are also known from other Northern Territory sedimentary basins, including trilobites (such as *Redlichia* and *Xystridura*), brachiopods, hyoliths, molluscs, disarticulated echinoderms, chancelloriids and sponge spicules (Kruse *et al* 2004). The *Shady Camp Limestone Member* is 3–4 m thick and consists of a basal gypsiferous microbial laminite succeeded by oncoid-rich nodular hyolith floatstone (**Figure 33.9**) that marks the initial marine transgression from intertidal to shallow subtidal conditions. The *Corby Limestone Member* is 2–4.6 m thick and contains microbial limestone, hyolith floatstone and oncoid bioclast limestone (**Figure 33.10**) that were deposited in intertidal, shoreface and shallow subtidal conditions (Cutovinos *et al* 2002, Kruse *et al* 2004). The upper Panton Formation, which consists mostly of maroon shale with thin fine sandstone beds that become increasingly common up-section, also contains a thin oncoid hyolith-bearing limestone bed that represents a third brief marine interval within an otherwise peritidal interval.

### *Elder Subgroup*

The Elder Subgroup (**Figure 33.3**) is a sandstone-dominated succession overlying the Panton Formation. The subgroup outcrops mainly in the Hardman Syncline and, to a much lesser extent, in the Argyle Syncline. It reaches a maximum thickness of 370 m (Cutovinos *et al* 2002) and comprises two formations: the Eagle Hawk Sandstone and overlying Overland Sandstone (Mory and Beere 1985). The lower boundary of the group is generally regarded as being gradational and conformable on the Negri Subgroup (Mory and Beere 1985, Kruse *et al* 2004), although Dow (1980) reported that in the western Hardman Syncline, the former 'Elder Sandstone' was unconformable on former 'Hudson Formation' (now upper Panton Formation), Headleys Limestone and Antrim Plateau Volcanics. The presence of an apparently conformable contact between the subgroups is significant, as the correlative contact in other Northern Territory basins is commonly a disconformity, representing a time break of probably short duration (see **Centralian Superbasin: figure 22.6**). The Elder Subgroup is unconformably overlain by the Upper Devonian Mahony Group in the western Hardman Syncline in Western Australia.

The subgroup lacks age-diagnostic fossils, but as it has an apparently conformable relationship with underlying sequence 1 rocks of the Negri Subgroup, the lower part, at least, is probably equivalent to latest Ordian–early Mindyallan sequence 2 units in other Northern Territory basins. The Eagle Hawk and possibly Overland sandstones are therefore broadly correlated with the Jinduckin Formation–Oolloo Dolostone interval of the Daly Basin, the Point Wakefield beds of the Wiso Basin, and with the

**Figure 33.9**. Prominent beds of oncoid-rich, nodular hyolith floatstone in Shady Camp Limestone Member at Mount Panton (LIMBUNYA, NEGRI 52K 523200mE 8081200mN, after Cutovinos *et al* 2002: figure 22).

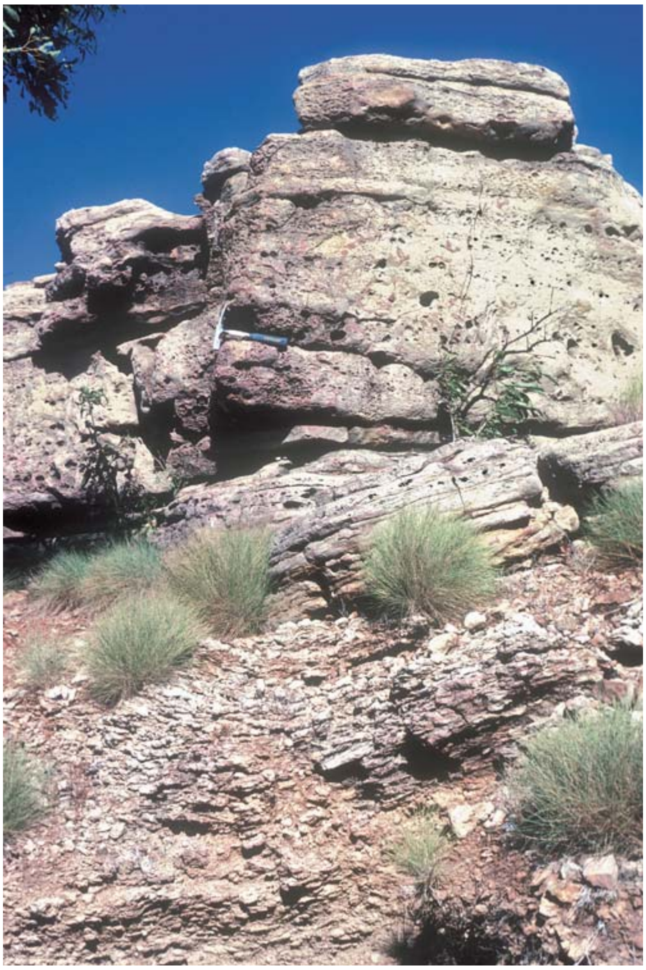


**Figure 33.10**. Cliff-forming, thickly bedded, oncoid bioclast floatstone in Corby Limestone Member at Mount Panton (LIMBUNYA, NEGRI 52K 523200mE 8081200mN, after Cutovinos *et al* 2002: figure 23).

Anthony Lagoon Formation, Wonarah Formation, Ranken Limestone and Camooweal Dolostone of the Georgina Basin (see **Centralian Superbasin: figure 22.6**). On the basis of lithological similarities, the Eagle Hawk Sandstone is also correlated with the Hart Spring Sandstone (Carlton Group) of the Bonaparte Basin (Traves 1955, Mory and Beere 1988). The overlying Overland Sandstone is therefore likely to be equivalent to the Skewthorpe Formation, or possibly to younger units of the Carlton Group (Mory and Beere 1988).

*Eagle Hawk Sandstone*

The Eagle Hawk Sandstone outcrops extensively within the Hardman Syncline (**Figure 33.2**) and in the centre of the Argyle Syncline. With the Overland Sandstone, it forms a narrow to moderately wide outcrop belt around the core of the syncline, which is occupied by the Upper Devonian Mahony Group. In the Northern Territory, the formation is restricted to western LIMBUNYA, where exposures were described by Cutovinos *et al* (2002) as 'poor to moderate'. The unit ranges in thickness from 75–80 m to a maximum of 210 m at its type section in northeastern DIXON RANGE in Western Australia (Mory and Beere 1985).

The Eagle Hawk Sandstone consists of feldspathic to micaceous, fine to medium, red-brown to maroon sandstone, and minor siltstone and mudstone (**Figure 33.11**). It contains a variety of sedimentary structures, including trough cross-beds, ripple marks, parallel lamination, mud pebble and cobble moulds, decimetre-scale channels and desiccation cracks (Mory and Beere 1988, Cutovinos *et al* 2002). It also contains an ichnofossil assemblage of arthropod tracks (Mory and Beere 1988, Kruse *et al* 2004), but these are not age diagnostic. The combination of rock types and sedimentary structures indicates deposition on intertidal sand- and mudflats (Mory and Beere 1988).

*Overland Sandstone*

The Overland Sandstone outcrops only within the Hardman Syncline, in two main areas: a narrow belt partially encircling Mahony Group rocks in the core of the syncline; and a smaller, but broader area straddling the Western Australia–Northern Territory border, a minor part of which is in northwestern LIMBUNYA (**Figure 33.2**). There, the formation forms a steep-sided plateau, which includes the 230 m-thick type section (Mory and Beere 1985, Cutovinos *et al* 2002). In Western Australia, the unit thins to the southwest and eventually pinches out, probably as a result of erosion prior to deposition of the Mahony Group (Mory and Beere 1985). The contact with the underlying Eagle Hawk Sandstone was described as gradational by Mory and Beere (1985, 1988).

The Overland Sandstone consists of fine to medium lithic arkose and sandstone, which is white to pale grey or fawn, readily distinguishing it from the underlying red-brown to maroon Eagle Hawk Sandstone. Lithic grains include quartz-mica schist, fine metasedimentary rock and quartzite, and sedimentary structures include trough and planar cross-beds, straight to sinuous current ripple marks and parallel-lamination (Mory and Beere 1988, Cutovinos *et al* 2002, **Figure 33.12**). The formation is unfossiliferous and is less assuredly dated than the Eagle Hawk Sandstone; it is most likely to be late middle or early late Cambrian. From its composition and sedimentary structures, Mory and Beere (1988) interpreted the environment of deposition as a braided fluviatile depositional system draining a hinterland of low relief.

## STRUCTURE

The Ord Basin is a part of the Hardman Fold Belt, which also affects rocks of the Mesoproterozoic Osmond Basin,

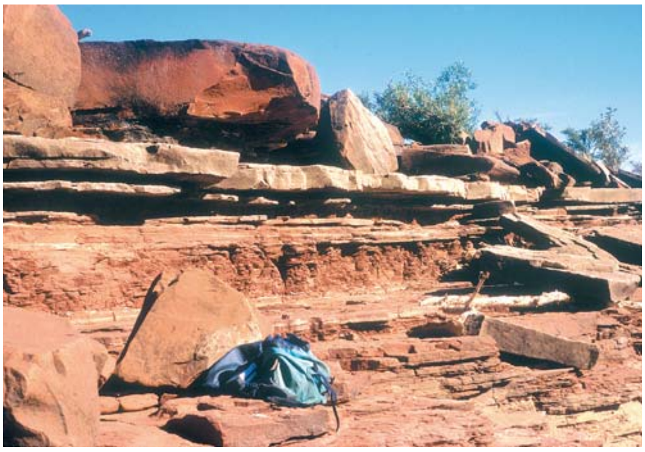


**Figure 33.11**. Interbedded sandstone and mudstone of Eagle Hawk Sandstone. North bank of Negri River at Duncan Highway crossing (LIMBUNYA, NEGRI 52K 500000mE 8111700mN, after Cutovinos *et al* 2002: figure 24).

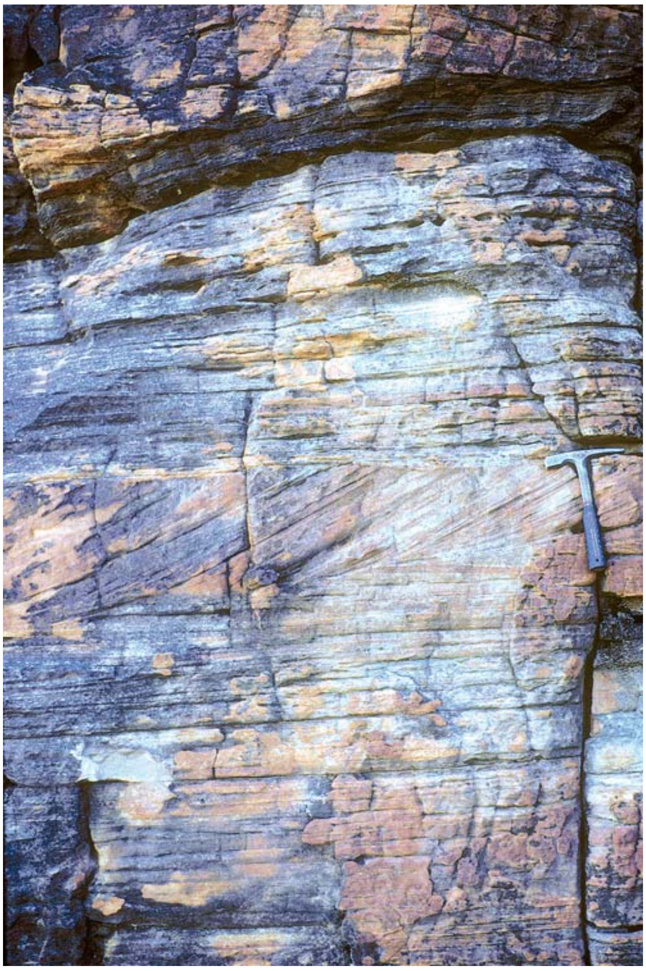


**Figure 33.12**. High-angle cross-bed set in parallel-laminated sandstone facies in Overland Sandstone, 9 km south-southwest of Mistake Creek community (LIMBUNYA, NEGRI 52K 501800mE 8100200mN, after Cutovinos *et al* 2002: figure 27).

the Mesoproterozoic to Neoproterozoic Victoria Basin and Neoproterozoic Wolfe Basin (Tyler and Hocking 2001). Erosion, folding and faulting, probably in the Late Carboniferous (Mory 1990), have resulted in the Ord Basin succession being preserved in three isolated east-northeast-trending asymmetric synclines (Hardman, Rosewood and Argyle synclines), separated by two anticlines (**Figure 33.13**). Normal faults that are subparallel to the synclinal axes are adjacent to the steep northern limbs of each syncline; these either branch off, or are a part of the Halls Creek Fault, which flanks the basin to the west.

Several significant faults cut the Northern Territory portion of the Hardman Syncline. The major northwest-trending Negri Fault transects the syncline and forms the southeastern basin margin for part of its length. The Negri Fault has a displacement of up to 25 km (Cutovinos *et al* 2002) and affects the Antrim Plateau Volcanics, the entire Goose Hole Group and in adjacent Western Australia, the Upper Devonian Mahony Group. It was a long-lived structure that shows evidence of having been a growth fault during deposition of the Palaeoproterozoic Stirling Sandstone (Limbunya Group) of the underlying Birrindudu Basin (Cutovinos *et al* 2002); it thus predates the Ord Basin and was periodically reactivated during its history, including major movements in the late Palaeozoic that displaced the Ord Basin succession. Along the upper reaches of the Negri River, the Headleys Limestone has been brittly deformed by the fault into a series of fault blocks, some of these internally folded into broad synclines or anticlines with fold axes subparallel to the fault trend. In this area, the faulting is associated with copper mineralisation in the topmost Antrim Plateau Volcanics and basal Headleys Limestone (see **Copper** in **Kalkarindji Province**). Northwestward, at least to the state border, en echelon faulting is a feature of the Negri Fault. The Headleys Limestone is folded into a spectacular monocline (**Figure 33.5**), with associated parasitic folds in adjacent overlying Goose Hole Group rocks. Fold limbs are most clearly traced out by the limestone units.

The Limbunya Fault offsets the Headleys Limestone at the eastern margin of the Hardman Syncline. This is also an older Proterozoic structure (Cutovinos *et al* 2002) that was reactivated after deposition of the Cambrian succession. Adjacent to the Nelson Springs–Inverway track, the upthrown northern side of the Limbunya Fault is a monocline in Headleys Limestone, which steepens toward the fault. A northwesterly extension of the fault, interpreted from aeromagnetic data, coincides with folding in the Linnekar Limestone and Corby Limestone Member, and possibly also the Eagle Hawk Sandstone.

To the north, a third, unnamed east-trending fault in the Stirling Creek area likewise affects the Headleys Limestone at the basin margin. The fault trace is marked by local breccia of subangular–subrounded pebbles to boulders of Headleys Limestone in a darker lime matrix. Fault splays bound upthrown blocks of Headleys Limestone within the adjacent ductile Nelson Shale, and the interpreted westerly extension of the fault highlights embayments in mapped formation boundaries up-section.

## MINERAL RESOURCES

The Ord Basin has some potential for base metals, particularly copper, and diamonds. However, despite a number of exploration programs conducted since the 1960s, no commercial discoveries have yet been made.

### Base metals

Widespread, but mostly economically insignificant copper occurrences at and adjacent to the Antrim Plateau Volcanics–Headleys Limestone contact are discussed elsewhere (see **Copper** in **Kalkarindji Province**). The largest of these copper prospects in the Northern Territory is *Caves*, which has an estimated 2000 t of ore averaging 2–20% Cu (Erskine *et al* 1970). In adjacent Western Australia, Ord River Resources Ltd-Suplejack Pty Ltd are currently exploring a number of copper prospects along the southern margins of the Hardman Syncline in their *Copper Flats* project area. Copper has also been reported from younger Goose Hole Group units.

Inspired by early reports (Hardman 1885, Simpson 1951), AO (Australia) Pty Ltd examined the Panton Formation throughout the Northern Territory portion of the Hardman Syncline for stratabound copper and lead-zinc (Munro *et al* 1976). Syngenetic galena and blebs and veinlets of chalcocite were the only visible mineral occurrences. Anomalous metal values, up to 0.18% Cu, were mostly in carbonate rocks and adjacent grey shale.

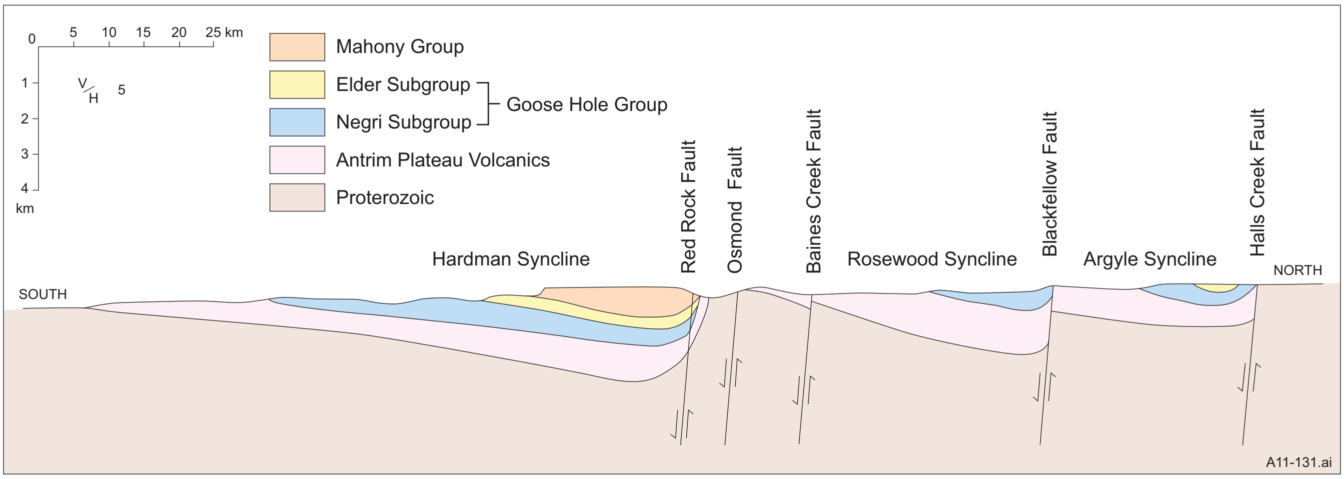



**Figure 33.13**. Schematic cross-section of Ord Basin, showing asymmetric nature of Hardman, Rosewood and Argyle synclines (redrawn after Mory and Beere 1988: figure 6).

Burdekin Resources explored the entire Goose Hole Group for base metals during 1994–1996 (Rugless and Pirajno 1995, Rugless 1996), using a variety of mineralisation models, including Superior-style Cu-Ag(-Co), Mississippi-style and Irish-style Pb-Zn, and stratabound sabkha-related Cu-Pb-Zn at the interface of evaporitic and limestone units (Linnekar Limestone and Panton Formation). Although a number of base metal anomalies were recorded, the continuity of mineralisation was considered to be insufficient to warrant further exploration (Rugless 1997).

Concurrently, the Headleys Limestone–Nelson Shale contact was unsuccessfully targeted for stratabound copper by a joint venture of PG Lewis and CRA Exploration (Lewis 1996a, b). The maximum stream sediment copper assay obtained was 116 ppm Cu.

### Diamonds

Several companies unsuccessfully explored for diamonds in the Ord Basin during the late 1970s and 1980s. Thus far, no confirmed microdiamonds and few kimberlitic indicator minerals have been recovered from the Northern Territory portion of the Hardman Syncline. A retrospective report of five small diamonds (Rofeld 1995) in stream sediment samples taken in the late 1970s from the Negri River between Stirling Creek and Mistake Creek was not substantiated by Cooper (1995).

Ashton Mining Ltd, Negri River Corporation Ltd and Stellar Minerals NL explored for diamonds during the 1980s. Stream gravel samples from Headleys Limestone and Nelson Shale outcrop areas yielded non-kimberlitic chromites (Ashton Mining 1981). Negri River Corporation obtained kimberlitic garnets and possibly kimberlitic chrome diopsides from stream sediment and bulk channel samples (Insearch 1981, 1982, 1983, Lohan 1983), but follow-up sampling was barren (Lohan 1984a, b, Marshall 1985). Pyrope, picroilmenite and chrome diopside obtained by Stellar Minerals from the fine fraction of heavy mineral concentrates were found to be non-kimberlitic (Stewart 1984, Hickling and Stewart 1985).

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