DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

REPORT BOOK 92/24

ABORIGINAL STONE TOOLS: A GEOLOGICAL STUDY OF SOURCE, NATURE AND DISTRIBUTION IN THE NULLARBOR PLAIN REGION

M C BENBOW
Geological Survey of South Australia

and

ANNIE NICHOLSON
(Research Assistant to Prof I McBryde,
Australian National University)

APRIL 1992 DME 177/87

©Department of Mines and Energy South Australia 1992.
A report for Professor Isabel McBryde, (Consultant to DASETT) to be used in the assessment of the Nullarbor Plain, for World Heritage listing.

G04145.MCB

CONTENTS PAGE

FIGURES Plan No

APPENDICES

DEPARTMENT OF MINES AND ENERGY
GEOLOGICAL SURVEY
SOUTH AUSTRALIA

REPORT BOOK 92/24 DME 177/87

Aboriginal Stone Tools: A Geological Study of Source, Nature and Distribution in the Nullarbor Plain Region.

M C BENBOW
A NICHOLSON

Examination of the lithologies of Aboriginal artefacts from western South Australia has been undertaken and the lithologies categorised. Stone tools were manufactured from a range of indurated silicified materials, derived from abundant local sources. In the SA Museum and other collections that were examined in this brief study, artefacts derived from Wilson Bluff on the Nullarbor Plain were not observed in the material from sites to the north and are rare or minor to the east, implying no economic significance in the trade or movement of this resource. This finding is at variance with the reported trading with desert peoples, by Daisy Bates and Norman Tindale, but supports the technological analyses carried out by Barry Cundy at the Wilson Bluff sites of tool manufacture. The significance of the occurrence of silicified Wilson Bluff Limestone artefacts east of the Nullarbor Plain, toward the Gawler Ranges, is not clear and may only be resolved by field examination. The material at these five sites may have either been locally derived, in which case additional geological information is being provided, or if derived from the Nullarbor Plain, could indicate a ritual or mythological significance.

INTRODUCTION

In recent years archaeological study has been undertaken to examine the nature and tradition of the Aborigines use of tools manufactured from silicified limestone derived from the cliffs and caves of the Nullarbor Plain. Daisy Bates, amongst others, described flint artefacts from Wilson Bluff as being "widely distributed in the exchange networks of the western deserts and central Australia" (McBryde, 1991, p.3). A central problem of such research has been determining whether the trading of artefacts derived from such sites as Wilson Bluff had a primary economic or ritualistic significance.
Examination of a number of collections of artefacts from western SA has been carried by one of us, to assess the distribution and use of stone artefacts derived from the Nullarbor Plain (Nicholson, 1992). This is to form a contribution towards an assessment of the Nullarbor Plain for World Heritage listing.

There have been problems in making a confident identification of the source of stone artefacts, particularly those of translucent to transparent nature, found at different localities in the Nullarbor Plain-Great Victoria Desert region. The Geological Survey of South Australia, which is currently active in the region, was thus invited by Prof Isabel McBryde (Department of Prehistory and Anthropology, ANU) to assist in the lithological characterisation of the stone from which the tools were made and thus assist in the identification of sites of origin.

METHOD

Silicified samples derived from the Eocene Wilson Bluff Limestone, from Wilson Bluff, Koonalda Cave and Head of the Bight, were assembled as key reference material against which artefacts collected from beyond the Nullarbor Plain might be compared. A limited number of artefacts (determined by time and financial constraints) were thin sectioned with the approval of Prof McBryde. A lithological and microscopic study was then undertaken, to enable categorisation of the material into a number of definable groups. (The use of a hand lens and cut

face helped the recognition of fossils and description of lithology). It was hoped that the Wilson Bluff Limestone artefacts were significantly different to form one identifiable group (Appendix 1).

Artefacts from as many localities as time allowed were examined (Fig 1; Appendix 2). The artefacts included those of the SA Museum and Moeller collections, and also those collected by one of the authors (AN; from western Eyre Peninsula). Note was taken of the types of material used for the manufacture of the tools and care was taken to identify silicified Wilson Bluff Limestone.

A reference collection was asssembled for use in future work that may be carried out. The thin sections generated by this study are held by Prof McBryde (ANU).

RESULTS

Based on lithology, the artefacts can be divided into five groups (Table 1).

TABLE 1

Division of artefacts based on lithology

Group	A:	silicified limestone
	A1:	Wilson Bluff type; bryozoan
	A1a:	non-translucent
	A1b:	translucent
	A2:	Nullarbor Limestone
Group	B:	silicified claystone or mudstone
	B1:	non-translucent
	B2:	translucent
Group	C:	silicified sandstone
	C1:	groundwater type
	C2:	pedogenic type
Group	D:	silicified rock of unknown origin
	D1:	non-translucent
	D2:	translucent
Group	E:	various non-silicified lithologies

Group A1 - Silicified Wilson Bluff Limestone artefacts from the Nullarbor Plain

The artefacts and specimens collected from known sites of Wilson Bluff Limestone, namely Wilson Bluff, Koonalda Cave and Head of the Bight, have a distinctive lithology. However, recognition of artefacts from specific sites (ie Wilson Bluff, Koonalda Cave) is not possible. The degree of silicification varies.

The distinctive lithological properties are:

1. The preservation of fossils, particularly of bryozoans.
2. The developement of a zonation within specimens outlined by:

a. an inner, silicified, very hard, core zone, that is more obviously fossiliferous (ie A1a).
b. an adjacent, silicified, very hard, glassy zone that is translucent to transparent; colour may be grey, brown to black and it may be colourless (A1b).
c. and an outer rind or crust that is white and that varies in thickness; fossil fragments can be apparent on the weathered surface.

An individual specimen may display each of these characters (eg WBN4CB 2) or may lack one of the zones (eg WBBC1 2). Some of the artefacts of the Moeller collection indicate that the tools can be manufactured from non-translucent silicified Wilson Bluff Limestone (ie A1a). Bryozoans are conspicuous on the white to pale grey discoloured, weathered surface of such material.

The distinctive microscopic properties are:

1. With polarised light there are relict bioclasts. With ordinary transmitted light they are less apparent in the translucent to transparent material.
2. The matrix is very fine grained chalcedony which is commonly even-textured. Coarser grained, radiating, fibrous chalcedony can selectively infill bioclast chambers or replace bioclasts.

Group A1 Silicified limestone artefacts from east of the Nullarbor Plain

The are five sites east and beyond the Nullarbor

Plain from which silicified bryozoan limestone has been collected which is very similar (ie in lithology and microscopic character) to the Wilson Bluff Limestone (non- translucent A1a). The sites are Pinjarra Rock Hole, Round Rock Hole, Yellabinna Rocks, OTC Rock Hole and Eagle Rock Hole; they occur in the Great Victoria Desert, in the region of extension of the Eucla Basin (see figs 1 and 2 of Benbow, 1990).

Group A2 Silicified Nullarbor Limestone from the Nullarbor Plain

This younger (ie Miocene) limestone that outcrops over the Nullarbor Plain, has been silicified in groundwater environments around the Plain's margin as in the Yarle Lakes - Ooldea area. There is also patchy silicification developed over the Plain; the most obvious sign of this are black (desert varnish-coated) rubbly masses.

The contrasting nature of the lithology of the Wilson Bluff and Nullarbor Limestones, and their contrasting macro-scale styles of silicification, suggest that artefactual material derived from both should be distinguishable at least in thin section. No silicified material that could definitely be referred to as silicified Nullarbor Limestone was apparent in the artefacts that were thin sectioned.

Matrix supported, in contrast to framework supported, - textures, are typical of the Wilson Bluff Limestone and Nullarbor Limestone respectively. Previous observations of silicification of the latter, suggest that there is more variation in grain size and silica type; micro-crystalline silica has been commonly recorded.

Iron Lake southeast of the Nullarbour Plain and 60 km NW of Penong (H. Moeller, pers. comm., 1992) includes several translucent artefacts that have weathering on their surface numerous bioclasts. The original texture of the sediment may have been grainy (ie framework supported). Thin sectioning may aid in identification, but it is suspected that the artefacts are derived from silicified Nullarbor Limestone (A2) which is known to outcrop nearby.

Group B Silicified claystone and mudstone

Lithology is very indurated where intensely silicified and a conchoidal, brittle, habit may be evident. Colour is commonly pale brown, brown, pale grey and varies to include various other colours due to the presence of iron oxide impurities etc; individual specimens may be mottled. Jasper can also be included (B1).

Clay-rich sediment may be less silicified and thus the induration is less. Intensely silicified sediment can be translucent to transparent (B2).

Sedimentary bedding, or lamination was noted in some of the material. This is defined by silt and sand-sized detrital quartz grains.

Group C Silicified sandstone

Sand or sandstone silicified in a groundwater or pedogenic environment make up this division. Artefacts manufactured from the former silcrete type have a glassy and /or clean appearance. The primary sedimentary texture may be seen with a hand lens. Colour varies (eg pale grey, brown, yellow) and as for the finer grained counterparts (ie group B) the variation is due to iron content. Some artefactual material would in fact be better described as being a ferricrete rather than a silcrete.

Sand silicified in a pedogenic or soil profile commonly has a grey matix; this may support the detrital grains. Such silcretes tend to have a dirty appearance.

The average grain size of silicified sandstones ranges from very fine to coarse sand, and granule to very small pebbles of quartz may also be present.

Group D Silicified rock artefacts of uncertain lithological origin

Lithology of the non-translucent artefacts is very fine grained and very indurated with a white interior, and an exterior that is white or discoloured pale brown, yellow etc, due to weathering. Note that part of the surface colouration at least, post-dates artefact manufacture.

The distinctive microscopic properties of the material thin sectioned (see Appendix 1) are:

1. Quartz silt to fine sand-sized detrital grains may be present.
2. Absence of fossils; the exception is Yanerbie Sand Dune 5 which may contain several bioclasts.
3. The matrix of chalcedony is overall coarser grained and shows considerably more variation in texture (eg grain size) than the fossil-bearing material of A1.

The non-translucent lithology (D1) can grade transitionally to sharply to translucent and transparent silica (D2). The outward appearance of D2 is similar to the translucent silicification of the Wilson Bluff Limestone (A1).

Group E Artefacts of non silicified rock of various origins

Quartz, granite, quartzite and volcanics have also been used to manufacture tools. Volcanics occur in the artefactual material in the region to the west of the Gawler Ranges from where they were probably derived. Quartzite pebbles and indurated sandstone occur in the collections north and northeast of the Nullarbor Plain, in the region of the Eromanga Basin.

DISCUSSION AND CONCLUSIONS

The Aboriginal artefacts of western South Australia have been manufactured from a diverse range of lithologies; they are mostly of silicified sediments. The distribution and abundance of lithology types indicates plentiful sources and derivation from nearby, local supplies. For example, most of the artefacts of Ooldea on the margin of the Plain (Fig. 1), were manufactured from the adjacent outcrops of the playa lakes, ie mainly silicified Yarle Sandstone with a lesser component of likely silicified Nullarbor Limestone. The artefacts of Tallaringa Well and the Stuart Range, located over 100 km northeast of the Nullarbor Plain (Fig. 1), were manufactured from the local silicified claystones of the marginal Arckaringa Basin and Eromanga Basin. There is also a component at these sites of artefacts derived from the pedogenic silcretes that mantle much of the inland of the continent.

The Moornaba Rock Hole artefact suite is instructive. This site is located on the crest of the southeast end of the ancient coastal Ooldea Range (Benbow, 1990). The 1:250 000 geological map of the region indicates the rock hole to be outcopping granitoids of the Precambrian Gawler Craton. The high elevation is well above that at which the artefacts could have been derived, indicating they must have been carried there, perhaps from outcrops that may occur in nearby depressions. This also appears, therefore, to have occured at the other rock holes (formed in similar granitoids) in the region east of the Nullarbor Plain, some of which occur at low elevations. Artefacts of granitic lithologies are not apparent at these localities, or if present, are rare to minor.

The artefacts manufactured from the Wilson Bluff Limestone on the Nullarbor Plain have a distinctive lithology that enables recognition of the formation from which they were derived. What distinguishes the translucent to transparent artefacts from here and those from other formations and sites, is the texture and presence of relict bryozoan bioclasts in the former. Artefacts were also manufactured from silicified Wilson Bluff Limestone that is not translucent; bioclasts are more readily identifiable in such material.

There is no evidence for the trading of artefacts derived from sites on the Nullarbor Plain such as Wilson Bluff, to the north via Waldana Well, Tjurina (Churina Native Well) and Bringyna Well, and to the northeast to places such as Tallaringa Well and the Stuart Range via the important meeting place of Ooldea; ie to the lands of the Kokata. It is difficult therefore to corroborate Daisy Bates on this matter. Artefacts that may have been derived from the Nullarbor Plain sites are only known to occur in the Great Victoria Desert to the east; that is, in the lands of the Wirangu. It is interesting to note that the five sites beyond the Plain occur between the Ooldea and Barton Ranges and the area toward the Gawler Ranges. This region that is now known to be an extension of the Cainozoic Eucla Basin, has several subsurface occurrences of Wilson Bluff Limestone (Benbow, 1990). It is possible that there could be isolated surface exposures of this formation and that the artfacts from Eagle Rock Hole etc were therefore locally derived. The occurrence of an artefact manufactured from Wilson Bluff Limestone at Ooldea, supports the former suggestion, for here at least the formation is known not to outcrop.

The absence of Wilson Bluff Limestone-derived artefacts north and northeast of the Nullarbor Plain and the rarity or minor amount of such material to the east, indicates that any trading of this resource had little if any importance in the stone age economy. This is consistent with the technological analyses by Barry Cundy of the Wilson Bluff work sites (see McBryde, 1991,p7). His analyses of these sites "do not suggest large-scale production by specialists working to meet the demands of an exchange system".

The alternative model regarding the significance of "trading" of the Nullarbor Plain material to the north reported by Daisy Bates and Norman Tindale, is also not given direct support. From the absence of such artefacts it could be implied that there was either no such significance or that if there was, such a valued possession might be very rare. It is possible that whilst Wilson Bluff had mythological significance for the people to the north, there was no exchange of material from the site. If derived from Wilson Bluff and not locally, the occurence of such material in limited quantities to the east however, could be taken to reflect a possible ritual or mythological importance.

To resolve the issue of possible trading to the east will require field examination of these particular sites during future work. Subsequent work that is also recommended is the collection of a reference collection of silicified Nullarbor Limestone and its characterisation; this would include petrological examination.

This brief study of the lithology of Aboriginal artefacts of western South Australia has added to the geological knowledge of the margin of the Eucla Basin. The occurence of the marine or estuarine, sponge spicule-bearing Hampton Sandstone and/or Pidinga Formation in the Bringyna Well area, suggests either the extension of the Basin north of Wyola Lakes or, the presence of the southern end of a drowned palaeoriver (estuary). The occurrence of these sediments east of the Nularbor Plain adds further evidence for this region being an extension of the Basin. The occurrence of Wilson Bluff Limestone artefacts draws attention to the possibility of surface exposures of this formation at other places beyond the Nullarbor Plain.

This study is an example of the value of an interdisciplinary approach to resolving a problem of Quaternary history.

ACKNOWLEDGMENTS

One of the authors (MCB) wishes to acknowledge the experience and benefit of making this contribution and of working with Annie Nicholson and Isabel McBryde on the project. Approval was given by Prof McBryde to quote from her recent paper presented to the 1991 International Flint Symposium in Madrid.
Thanks is expressed to Mr and Mrs Moeller (Adelaide) and Mr Graham Pretty (SA Museum) for permission to examine the collections of artefactual material. The prompt production of thin sections prepared by Trevor Lambert of AMDEL, Adelaide, is greatly appreciated.

REFERENCES

Benbow, M.C., 1990. Tertiary coastal dunes of the Eucla Basin, Australia. Geomorphology, 3;9-19.

Gara, T. and Cane, S., 1988. Environmental, anthropological and archaeological background to the Nullabor Plains. A resource document for stage 1 of the Nullarbor Plains project. Unpublished.

McBryde, I., 1991. Flint on the rim of a continent: exploitation of flint sources on the Nullarbor Plain, Australia. A paper presented to the Madrid, 1991 International Flint Symposium. Unpublished.

Nicholson, N., 1992. Preliminary assessment of the distribution of Nullarbor flint: a study of artefactual material collected from the Nullarbor and surrounding regions. A summary of information collected for Professor Isabel McBryde for the DASETT project. Rundle Street, Adelaide. Unpublished.

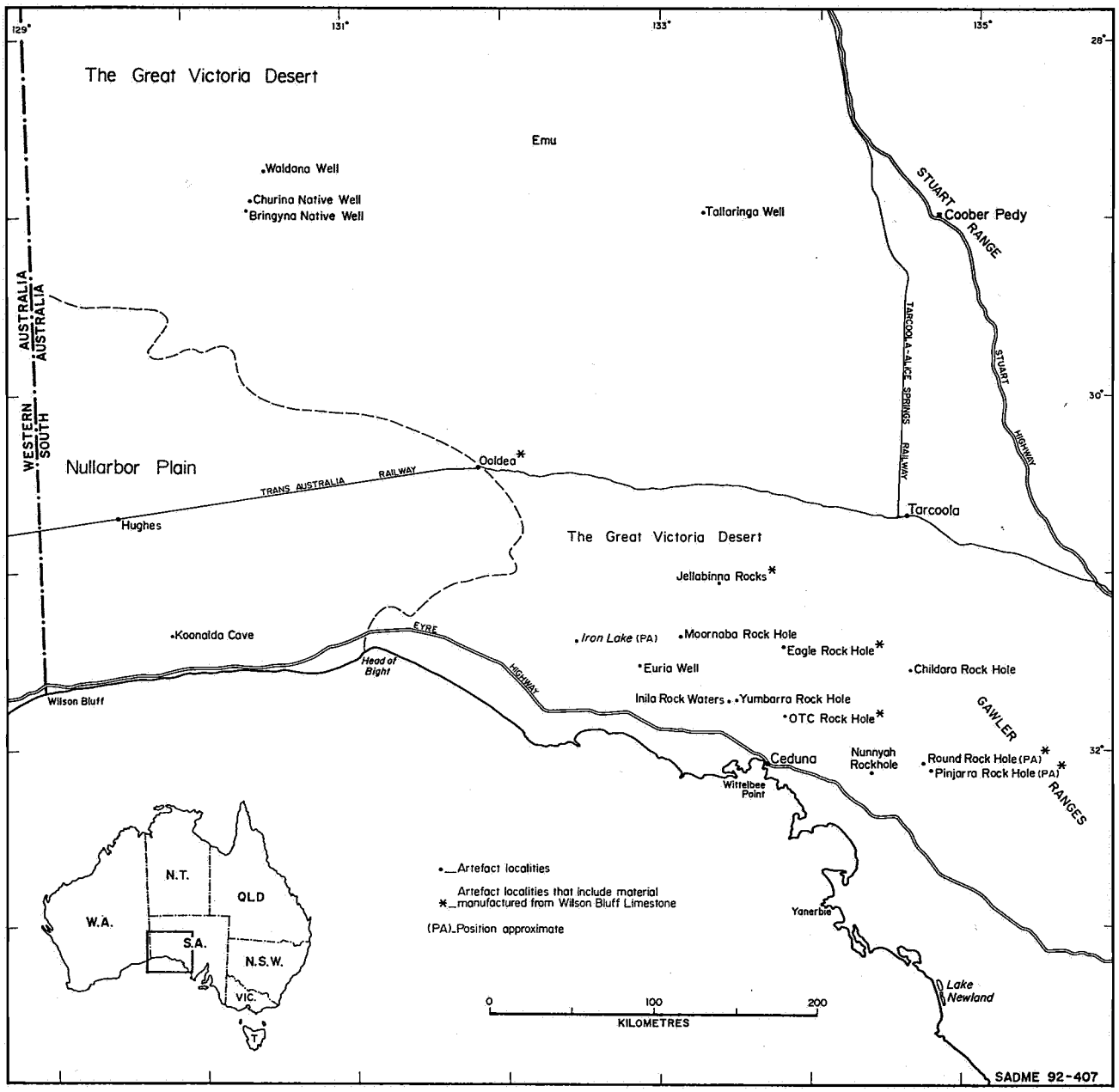

Figure 1. Location of sites of studied artefacts of western South Australia

APPENDIX 1

LITHOLOGY AND THIN SECTION DESCRIPTIONS

Sample: WBN4CB 2
Location: Notch 4, cobble bed on beach, Wilson Bluff
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: I McBryde

Hand specimen: Pale grey (predominantly) to dark grey and very indurated. The pale grey domain is not obviously translucent and displays traces of fossil fragments (including bryozoans); there are also homogeneous areas devoid of fossil traces. Colour darkens toward the exterior of the cobble (nodule) where the rock also becomes translucent. There is a similar white crust as occurs in samples 3 and 4 from this site.

Thin section: This specimen is very similar to the non translucent core of KC1 and of WBN4CB 4. Microcrystalline silica infills fibrous chalcedony-lined cavities or chambers of the bryozoans.

Sample: WBN4CB 3
Location: as for WB4CB 4
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: I McBryde

Hand specimen: Part of cobble ? There is a white exterior or crust, the thickness of which ranges from sub mm to about 1 cm. This has a porous appearance and discloses numerous fragments of bioclasts; these are likely to be bryozoan-derived. This crust envelopes very indurated, translucent, silicified limestone similar to sample WBN4CB 4. Colour ranges from pale grey to black. Bioclast remains are apparent in the paler coloured domains. The dark, black domains are homogeneous and lack obvious fossil remains.

Thin section: The pale grey part of the rock is similar to the fossiliferous part of WB4CB 4. The translucent, black exterior is similar to the translucent part of WBBC1 2.

Sample: WBN4CB 4
Location: Cobble beds at base of cliffs, on beach, east of Wilson Bluff (below N4 workshop).
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: I McBryde

Hand specimen: Rounded cobble, with white, rough, abraded surface. Cut discloses pale grey to grey, very indurated, silicified, fossiliferous limestone. The paler grey part of the rock is notably fossiliferous. The darker grey area, probably a discrete bed, is homogeneous.

Thin section: The fossiliferous part of the rock is prominently so under ordinary transmitted light. Bioclasts are of fragmented bryozoans; several echinoid grains were also evident. It has a similar appearance to the fossiliferous part of KC1, both in terms of its fossiliferous habit and also in the general nature of recrystallisation. However it does differ in that there are relict biolcasts that have not been replaced by chalcedony.

The homogeneous area of the hand specimen has bioclasts that are more ghost-like. The nature of the recrystallisation, as is evident under crossed-nichols, is similar to the bulk of the rock. Note that microcrystalline silica infils fibrous chalcedony-lined cavites. As in the bulk of the rock recrystalllisation was not complete.

Sample: WBBC1 2
Location: From cliff face below border cairn at Wilson Bluff.
Sample name: Silicified limestone (A1)
Collector: I McBryde
Formation: Wilson Bluff Limestone

Hand specimen: Part of nodule. As for specimen WBN4CB 3 there is a white, indurated crust that is 0.5-1.5 cm thick. Within this there are relict fossil fragments. The core of the rock is brownish grey. This is very indurated, homogeneous, translucent and it also contains what are likely to be trace outlines of fossils; these appear to have a preferred orientation. In detail the contact between core and crust is sharp with some irregularities.

Thin section: The translucent part of the specimen has a similar appearance under ordinary as the translucent part of the KC1 specimen. That is, under ordinary light there are only ghost outlines of bioclasts, but under crossed-nichols they are prominent. The recrystallisation and replacement by chalcedony is similar. Under ordinary transmitted light there are also scattered domains that are grey and clotted. The crust is also similar to that of KC1.

Sample: KC1
Location: Koonalda Cave
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: I McBryde

Hand specimen: This small fragment displays a white crust in sharp contact with a core, similar to the specimens from Wilson Bluff. There is a darkening from pale grey to brownish grey toward the exterior; it is the latter that is distinctly translucent. The central part of the core is fossiliferous.

Thin section: The core is of chalcedony which is very finely microcrystalline (ie <10micron). Scattered throughout are relict bioclasts; these include bryozoan-derived clasts (the predominant identifiable clasts). Coarser grained, radiating, fibrous chalcedony infills or partially infills chambers within the bryozoan fragments. These would have been devoid of primary matrix infill. It is also apparent however that recrystallisation of these bioclasts has taken place. Clast size ranges from 0.5mm to < 0.1mm. They are "matrix-supported", consistent with an original wackestone-textured limestone that had a micrite mud matrix that was micro-bioclastic.

Toward the exterior, adjacent to the crust, the bioclasts disappear or appear as ghost outlines only under ordinary light. However under crossed-nichols, bioclasts are as recognisable as in the core of the rock, that is two domains are not apparent. In addition there are scattered domains of clotting somewhat similar to that apparent in the crust. They are grey however and are made up of smaller subdomains.

The crust has a distinct clotted appearance, there being black spots within brown transparent

bodies. These have a radiating array of fibrous crystals. They can occur as discrete interlocking or separate bodies, or not be discrete. In addition, they can occur as mammelons adjacent to cavities infilled with very finely crystalline chalcedony. There are scattered bioclasts. Under crossed-nichols the bioclasts are more apparent than in the core of the rock, with the bryozoans being prominent. The clotting is dark with very finely recrystalline chalcedony in between.

Sample: 5135 RS18
Location: Head of Bight. Base of cliff section.
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: M Benbow

Thin section: This is a bryozoan-rich, bioclastic, micritic limestone that has been variably silicified to chert. The nature of the silicification is identical in part to that of the formation at Wilson Bluff. The translucent part of the specimen displays ghost outlines of bioclasts under ordinary transmitted light. Under crossed-nichols the bryozoan-derived bioclasts are prominent. There are rare silt sized quartz grains. Silicification was not complete for there is relict calcium carbonate. The chalcedony is very fine grained throughout, however bioclasts have been replaced by coarser grained chalcedony including the fibrous variety.

In part of the rock the matrix is brown to dark. This appears not to have undergone the same degree of silicification and in contrast, the bioclasts have been selectively replaced.

Sample: Pinjarra
Location: Pinjarra Rock Hole
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: Moeller

Hand specimen: Off-white to pale grey. Very indurated. Conchoidal fracture. On this small fragment there is a white, porous rind or crust (0.2-0.8mm thick) about a flint core flint similar to the specimens from Wilson Bluff. The core displays traces of small bioclasts. Colour darkens adjacent to the rind; this is translucent and is not obviously fossiliferous.

Thin section: The three domains are similar to, and match with, those of the artefacts from Wilson Bluff.

Sample: Yellabinna
Location: Yellabinna Rocks
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: Moeller

Hand specimen: Very indurated, pale grey (fresh) and pale yellow to off-white (weathered surface). The cut surface displays a translucency and trace of oriented bioclasts including bryozoans; these are also apparent on the weathered face. Similar to the formation from Wilson Bluff in the Moeller collection.

Thin section: Very like the material from Wilson Bluff, ie not distinguishable. Rich in bryozoan remains.

No indication of detrital quartz.

Sample: ERH 1 (C57282)
Location: Eagle Rock Hole
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: Moeller

Hand specimen: Numerous bryozoan remains on the brown weathered surface. (Colour of other fossil-bearing specimens from here are creame to pale brown). Very indurated. Cut face displays off-white colouration. Bryozoan fagments apparent. Minor porosity. Similar to the material (MC) from Wilson Bluff.

Thin section: Very bryozoan. Trace silt sized quartz. Matrix of very fine chalcedony.

Sample: Round Rock Hole
Location: Round Rock Hole
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff Limestone
Collector: Moeller

Hand specimen: Very small specimen that is off-white with a brown crust in part; the crust contains numerous bryozoan remains. The cut face indicates mostly pale brown colour with a white exterior.

Thin section: Bryozoan remains throughout and several spicules. The matrix is very fine chalcedony as is typical for the formation at Wilson Bluff. Rare siltsized quartz.

Sample: Ooldea
Location: Ooldea, near old mission ruins
Sample name: Silicified limestone (A1)
Formation: Wilson Bluff
Collector: A Nicholson

Hand specimen: Very indurated. Weathered face is off-white to creame and the cut face is grey and translucent. A few bryozoan remains on the exterior. White, porous rind.

Thin section: This artefact from Ooldea is very similar to, in fact is not distinguishable from, the material collected from Wilson Bluff. No detrital quartz is apparent.

Sample: Inala 1
Location: Inila Rock Waters
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: Very indurated fragments with conchoidal fracture. Colour is white, to pale grey. The latter is translucent. The specimen sectioned is white and has a homogeneous texture.

Thin section: Finely crystalline chalcedony (distinctly coarser than that of the Wilson Bluff artefacts). Locally is coarser grained, forming radiating, fibrous masses, surrounding voids.

Sample: Inala 2
Location: Inila Rock Waters
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: White, very indurated, conchoidal fracture, homogeneous texture.

Thin section: Finely crystalline chalcedony and domains that are of radiating fibrous chalcedony.

Sample: Inala 3
Location: Inila Rock Waters
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: White, very indurated. Discoloured brown pitting on weathered surface.

Thin section: Under ordinary transmitted light, there is a dusty character to part of the slide. In part also discoloured pale brown. As the hand specimen suggests, it does not have a homogeneous texture. There are domains of very fine and also coarser grained chalcedony. Radiating fibrous masses of chalcedony can occur as domains in both. The porosity (< 15%) could be partly be an artefact of thin section preparation. There are several elongate fragments that may be relict bioclasts.

Sample: ERH 1
Location: Eagle Rock Hole
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: Weathered surface is mostly pale grey and smooth. On the cut face colour is off-white and the texture appears not to be homogeneous. There is a brown weathering porous rind on the exterior of part of the specimen; this is white on the cut face.

Thin section: There is 10-15% silt to fine sand-sized quartz grains scattered throughout. Many of these detrital grains are well rounded. Corrosion has resulted in embayments in the grains and irregularities in shape. Under ordinary light they have ghost outlines, a consequence of reaction with the matrix. Primary texture was matrix supported.

The matrix is now exceedingly fine grained silica (<5 microns). This has a dusty habit under ordinary light. There are domains of coarser chalcedony, part of which has a radiating fibrous habit.

Sample: ERH 2
Location: Eagle Rock Hole

Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: Creame to brown and pitted surface. Cut face is white. Very indurated. Somewhat porous about part of the margin (boxwork-like).

Thin section: Under ordinary light apppearance is dusty, pale brown to grey. There are also outlines of pale brown, coloform silica and domains having a brown clotted appearance. The porosity is locally up to 10-20%. The voids are lined by a black, opaque, possibly iron oxide mineral. Part of the porosity, at least, post-dates silicification.

Under crossed-nichols the chalcedonic nature of the silica matrix is readilly apparent. There are domains of contrasting crystal size and habit. Overall grain size is distinctly coarser than the cherts of the Wilson Bluff Limestone.

Sample: ERH 3
Location: Eagle Rock Hole
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: Weathered surface is brown, creame to pale grey. Part is translucent. Very indurated, conchoidal fracture. Texture is complex.

Thin section: There is a good trace of detrital quartz grains similar to ERH 1. Mostly dusty grey under ordinary light. The rock is now chalcedony with domains of contrasting grain size and habit as is also the case for ERH 2. This type of variation is not a prominent feature of the Wilson Bluff cherts. For example there are dark, very fine, rounded, domains surrounded by lighter coloured, coarser grained chalcedony. The domains of fibrous chalcedony have no obvious control on occurrence.

Sample: ERH 4
Location: Eagle Rock Hole
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: White. Very indurated. Translucent in part. Very fine (<1mm), white, non-translucent rind or skin.

Thin section: Approximately 10% of silt to fine sand sized quartz grains scattered throughout. Sharply defined. Rounded but corrosion is also apparent. The finer grains appear to be distictly more angular. Sediment was originally matrix supported. Rare, silt-sized, rounded, heavy mineral grains. The matrix is mostly clear under ordinary light. The rind part the matrix is brown and there are similarly coloured silt to sand sized domains throughout. The latter are likely to be relict or less altered primary sediment.
The matrix is opaque under crossed-nichols, that is, it is composed of isotropic silica.

Sample: ERH 5

Location: Eagle Rock Hole
Sample name: Silicifed sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: Pale brown weathered face that has a concoidal fracture; cut face is white. Very indurated.

Thin section: Chalcedony and microcrystalline silica, with domains of contrasting grain size. Minor part of the silica has a fibrous, radiating habit.

Sample: ERH 6
Location: Eagle Rock Hole
Sample name: Silicified sediment (D)
Formation: ?
Collector: Moeller

Hand specimen: Not available

Thin section: Chalcedony. Domains of contrasting grain size. Distinctly coarser grained than the Nullarbor artefacts.

Sample: Wittelbee 4
Location: Wittelbee
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: Cut face is white, homogeneous, and non-translucent. Weathered face is white and pitted. Very indurated.

Thin section: Very similar chalcedony to ERH 6 but has a more fibrous character.

Sample: Lake Newland CP
Location: Lake Newland Conservation Park
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: White to pale grey; the latter is translucent. Very indurated.

Thin section: Chalcedony. Domains of contrasting grain size. Radiating fibrous chalcedony lines voids.

Sample: Yanerbie Sand Dune 1
Location: Yanerbie Sandpatch
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: White. Homogeneous texture. Indurated, conchoidal fracture and brittle.

Thin section: Chalcedony. Very fine grained with subtle variation in grain size. A little coarser grained than the Wilson Bluff artefacts.

Sample: Yanerbie Sand Dune 2
Location: Yanerbie Sandpatch
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: White to pale grey. Stained(?) black in part. Homogenous textured. Indurated.

Thin section: Good trace of silt to fine sand-sized quartz grains. The coarser grains are rounded. There has been some dissolution.

The matrix is coarser than that of YSD 1 and shows more obvious variation in grain size. Fibrous form lines minor porosity. The exterior is in part empregnated and stained.

Sample: Yanerbie Sand Dune 3
Location: Yanerbie Sandpatch
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: White, indurated, brittle, conchoidal fracture. Non-homogenous texture.

Thin section: Good trace of detrital quartz as in YSD 2.

The matrix is mostly very fine as for YSD 1 but is not as homogeneous. There are also discrete patches or domains of radiating fibrous chalcedony which commonly are associated with a micro-porosity.

Sample: Yanerbie Sand Dune 4
Location: Yanerbie Sandpatch
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: White, very indurated, homogeneous texture.

Thin section: Chalcedony. Very fine to fine with variation in grain size. Coarser chalcedony is in part associated with minor porosity.

Sample: Yanerbie Sand Dune 5
Location: Yanerbie Sandpatch
Sample name: Silicified sediment (D)
Formation: ?
Collector: A Nicholson

Hand specimen: Translucent, pale grey. Very indurated. Surface is smooth and in part is also rough with an associated vuggy porosity. Non-homogenous texture.

Thin section: There is 5-10% of silt to fine sand-sized quartz scattered throughout. The coarser grains, at least, are rounded. Corrosion of grain margins has occurred. There are several elongate grains that have been replaced by chalcedony. They may have been of bioclastic origin.

The primary sediment was matrix supported. The matrix is now chalcedony and grain size variation defines domains. Radiating fibrous chalchedony is also present, in part rimming a secondary porosity.

APPENDIX 2

CATEGORISATION OF ARTEFACT COLLECTIONS

MC = Moeller collection
NC = Nicholson collection
MS = SA Museum collections

Uppercase letter and number refers to litholgical grouping. Lowercase letter refers to approximate quantity; that is d = dominant, sd = subdominant, cd = codominant, m = minor, r = rare. Number in brackets refers to actual number of artefacts.

* Symbol refers to artefacts derived from Wilson Bluff Limestone

Eucla Basin; Nullarbor Plain

Wilson Bluff (MC) * A1
Much of the material is white to creame, with bryozoans on the weathered face. The general appearance is unlike that thin sectioned from Wilson Bluff (Appendix 1).

Hughes (MS) B1(1), D2(4).
D2 could be silicified Nullarbor Limestone

Eucla Basin; Nullarbor Plain, Great Victoria Desert margin

Ooldea (NC) * A1
Thin sectioned

Ooldea (MS) B1(m), C1(d).
(A22257, numerous)

Ooldea (MS)
(A22260)
Contains a translucent artefact that could be A2

Ooldea (MC) A(m), B1(r), C1(d), E(r).
(numerous)
In the boxes examined, there are a few artefacts of silicified and non-silicified Nullarbor Limestone. Most of the material (ie C1) is derived from Yarle Sandstone. E includes a quartzite cobble and a dolomite, the origin of which is unknown.

Iron Lake (MC) ?A2(4), C1(d), E.
Bryozoans weather out on the surface of several translucent, grey to creame artefacts. This site is described as being 60 km NW of Penong. Some of the silcrete is feruginised. E includes a volcanic artefact.

Eucla Basin; Great Victoria Desert (east of the Nullarbor Plain) (MC)

Euria Well B1, C1
11 artefacts)

Euria Well D

Inila Rock Waters D1
(5 artefacts)
Thin sectioned

Inila Rock Waters B1(3), D1(6), D(15).
(24 artefacts)

Inila Rock Waters B1(m), C1(d), C2(r), D(m), E(r).
(numerous)
C1 is possibly Hampton Sandstone or Yarle Sandstone.

Yumburra Rock Hole B1, B2, C1(d), D.
(numerous)
The B1 material is in part sponge spicule-bearing; ie this is either Pidinga Formation or Hampton Sandstone. C1 is likely Hampton Sandstone. D is like the Eagle Rock Hole and Inila Rock Waters material. (Elevation is about 115m AHD).

OTC Rock Hole D1(d)
(31 artefacts)
Similar to Inila and Eagle. Exact location unknown; near Ceduna satellite station.

OTC Rock Hole D1
(3 artefacts)
Similar to Inila and Eagle.

OTC Rock Hole * A1b(r), D (d)
(20 artefacts)
A1 are off white to very pale grey, with a smooth surface. They are like the thin-sectioned Inila material but are rich in bryozoans.

OTC Rock Hole C1(d), E.
(181 artefacts)
C1 is Hampton Sandstone or Yarle Sandstone. E includes granite and volcanics of the Gawler Ranges.

Yellabinna Rocks C1(d), C2, B1(m), E.
(numerous)
Most of the artefacts from this site are made from C1. B1 includes laminated mudstone that may be wood-bearing. C2 occurs as rounded pebble. E includes silicified wood that may be derived from the Pidinga Formation.

Yellabinna Rocks * A1(3), B1(2), D1(1), D(6).
(10 artefacts)
A1 is thin sectioned. D is like material from Inila and Eagle Rock Hole. (Elevation is 125 m AHD and the locality is at the east end of the prominent low on FOWLER).

Eagle Rock Hole * A1(4), B1(2), D(36).
(39 artefacts)
A1 and D are thin sectioned. The former is similar in general appearance to the latter apart from the difference in fossil content. Exact location unknown. In regional low. Note that the surface colouration post-dates manufacture.

Eagle Rock Hole D1,2
(50 artefacts)
Creame coloured; white interior. Some of the translucent material appears to have been silicified clay.

Eagle Rock Hole D1,2
(36 artefacts)
Bright yellow-orange weathered face; white interior. Partial translucency.

Eagle Rock Hole E
(5 artefacts)

Eagle Rock Hole B1
(8 artefacts)
White to creame.

Eagle Rock Hole B1(d), B2(m).
(16 artefacts)
Creame to off white. In part quartz silt-bearing. May be Pidinga Formation.

Pinjarra Rock Hole * A1(1), B1(2), D1(16), D(3).
(22 artefacts)
A1 thin sectioned. D is creame; white interior. The bulk of the collection (179 total), is if memory is correct, C1 and includes volcanics ie E.

Round Rock Hole * A1(1), D1,2(15).
(16 artefacts)
A1 is thin sectioned. This locality is near Wirrula, in the lakes to the north. D is like creame coloured D of Eagle Rock Hole.

Round Rock Hole C2(d), B1, E.
(numerous)
There is a silicified claystone that has a red brown ochreous appearance that contains silceous sponge spicules; this is either Hampton Sandstone or Pidinga Formation. E includes volcanics of the Gawler Ranges and quartz.

Moornaba Rock Hole B1(1), C1(5).
(6 artefacts)
One specimen of C1 contains numerous sponge spicules (ie this is Hampton Sandstone). (Moornaba Rock Hole is located on the top of the Ooldea Range at an elevation of 210m AHD).

Childara Rock Hole B2, C1(d), C2, D, E.
(91 artefacts)
E includes volcanics and granites of the Gawler Ranges area.

Nunya Rock Hole C1(d), C2(m), D(m), E.
(65 artefacts)
Location is about 45km east of Ceduna, on the margin of the Gawler Ranges.

Western Eyre Peninsula

Lake Newland CP (NC) D
(1 artefact)
Thin sectioned

Wittelbee (NC) D1
(1 artefact)
Thin sectioned

Officer Basin, Eucla Basin margin; Great Victoria Desert (MC)

Waldana Well B1(cd), C1(cd), C2, D.
(16 artefacts)

Waldana Well B1, B2.
(6 artefacts)

Churina Native Well B1(cd), C1(cd), D(r), E(r).
(ie Tjurina)
C1 is in part siliceous, sponge, spicule-bearing. This is Hampton Sandstone.

Bringyna Well B(m), C1(d), C2 (m), E(r).
(36 artefacts)
C1 is in part siliceous, sponge, spicule-bearing. E is a quartzite pebble.

Bringyna Well D2.
(2 artefacts)
D2 could be silicified Garford Formation.

Eromanga Basin; Great Victoria Desert and Stuart Range (MS)

Tallaringa Well E
(A40840, 1 artefact)
Quartzite cobble

Tallaringa Well B1
(A40840, 8 artefacts)

Tallaringa Well
(A40840, 2 artefacts) B1

Tallaringa Well
(A53544, 13 artefacts) B1(4), C1(4), C2(5)

Tallaringa Well B1(d), C2(1), D2(1), E(2)
(A40840)

Tallaringa B1(10), C1(2), C2(1), E(1).
(A53544, 14 artefacts)
Largest adze is sandstone possibly derived from the Algebuckina Sandstone (ie E).

Tallaringa B1(d), C2(1), D(4).
(A58251, numerous)

Tallaringa
(A52995, 6 artefacts) B1(5), D(1).

Tallaringa B1(15), D2 (probably B2)(1).
(A40840, 16 artefacts)

Tallaringa B1(71), D2(10).
(A53544, 81 artefacts)

Tallaringa B1(35), C2(1), D2(2).
(A53544, 38 artefacts)

Tallaringa B1
(A53544, 6 artefacts)

Tallaringa C2(2), D2(1).
(A58295, 3 artefacts)

Tallaringa B1(15), C1(1), C2(2), D(1), E(5).
(A53544, 24 artefacts)
E is represented by quartz, quartzite cobble and sandstone (possibly Algebuckina Sandstone).

Tallaringa, Mabel Creek B1(37), C1(23), C2(3), D(3), E(2).
(A60244, 68 artefacts)
E is represented by quartz and quartzite pebble.

Emu Field A(1), C1(4), D2(1).
(A47876, 6 artefacts)
A is fossiliferous and of uncertain origin, but not Wilson Bluff Limestone however. It could be Garford Formation).

Stuart Range B1(d).
(A28502)