Rec. West. Aust. Mus. 1981, **8** (4)

ARCHAEOLOGICAL INVESTIGATIONS AT THE QUININUP BROOK SITE COMPLEX, WESTERN AUSTRALIA*

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ABSTRACT

Cultural materials recovered in recent archaeological investigations at the coastal Quininup Brook Site Complex in the south-west of Western Australia include a South-West Early Phase assemblage of flaked and ground stone artifacts and several clusters of granite-gneiss manuports. On Site 4 of the complex most of these artifacts appear to come from a single cultural horizon buried deep within siliceous sands. This horizon has been radiocarbon dated from before 18 000 BP to after 10 000 BP. The site complex is suggested to have been a series of inland domestic camping sites which were abandoned during the early to early-middle Holocene, perhaps because of the deterioration and reduction of exploitable environment resulting from the onset of wetter conditions and rising sea levels.

INTRODUCTION

Quininup Brook is a small stream which drains into the Indian Ocean on the south-western coast of Western Australia (**Fig. 1** inset). In December 1976, C.E. Dortch of the Archaeology Department, Western Australian Museum, recorded the presence of four open sites surrounding the mouth of the brook. When the author began intensive investigations in February 1977, two other sites were discovered bringing the total number in the complex to six. These important sites are all actively eroding and the initial aim of the investigations was simply to salvage as much of the remaining archaeological information as possible. The ultimate goal, however, was to use this information to gain further insight into the processes of environmental adaptation by the late Pleistocene-early Holocene human inhabitants of this region; this has previously been studied in detail only from excavations at the nearby cave site of Devil's Lair (Dortch 1979a and references).

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* This paper is based in part on a B.A. Honours thesis submitted to the Anthropology Department of the University of Western Australia, November 1977. The research was completed while the author was Assistant Curator of Archaeology, Western Australian Museum, Perth, W.A.

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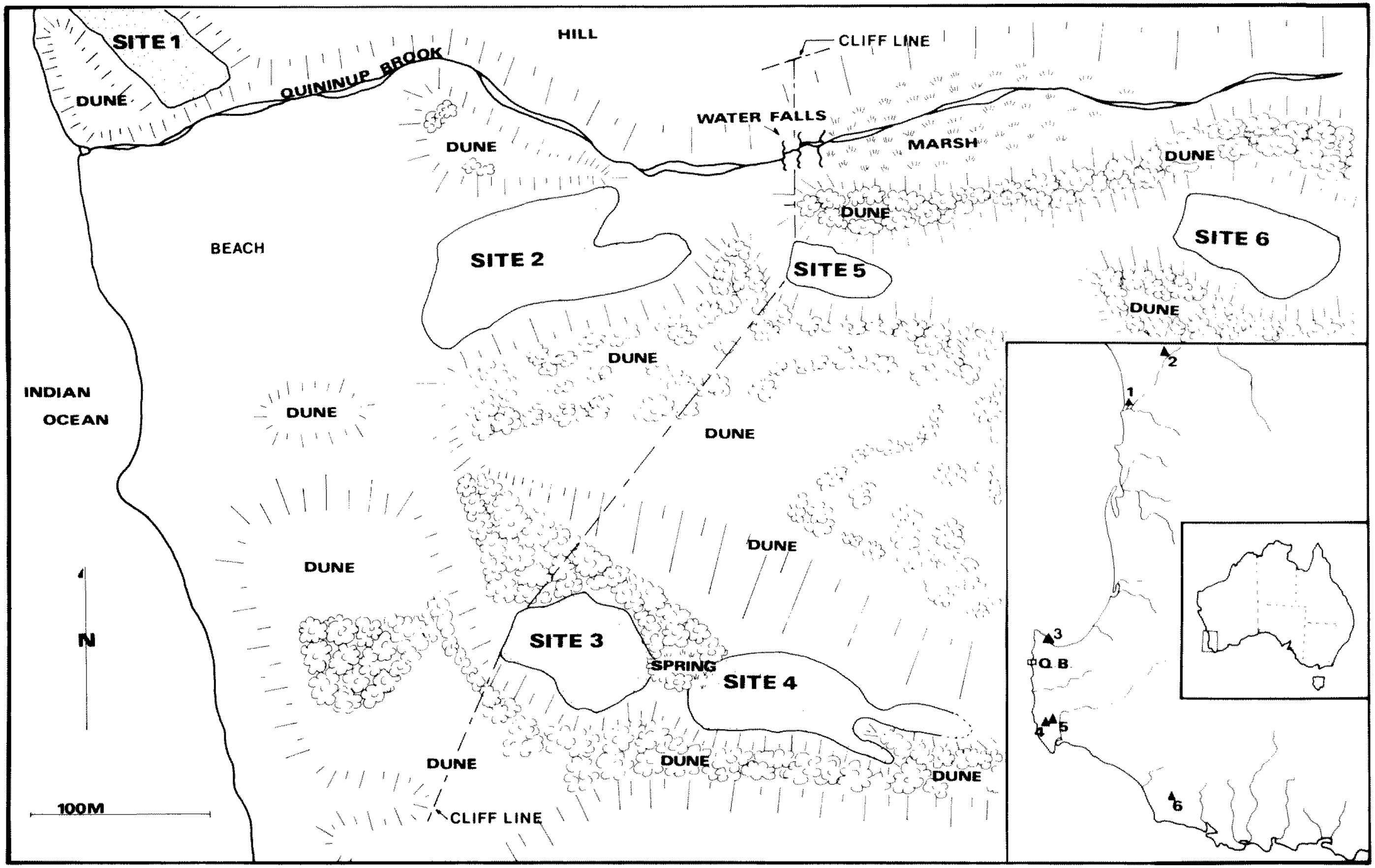

Fig. 1: Map of Quininup Brook Site Complex with inset showing locations of south-western archaeological sites referred to in the text. *Inset:* 1—Minim Cove; 2—Walyunga; 3—Dunsborough; 4—Devil's Lair; 5—Arumvale; 6—Northcliffe.

A description of the flaked stone implements recovered from these sites has already been published (Ferguson 1980). This present paper provides a general summary of the results of the archaeological investigations. It describes the sites and their setting, and as much as possible attempts to isolate the changes in the archaeological deposit brought about by erosion. The artifacts and cultural features are discussed placing emphasis where possible on the information they provide about the range of past human behaviour in this setting. Finally, an attempt is made to fit the site complex into a regional pattern of Aboriginal adaptation to the prehistoric environment, and some suggestions are made as to why these sites were apparently abandoned in the early to mid-Holocene after a long history of occupation.

THE SITE COMPLEX

Environmental Setting

The site is located on the coastal Leeuwin-Naturaliste ridge, a formation of a medium grained Precambrian granulite with concordant bodies of granite-gneiss. Overlying the basement rock in many places along the coast is a Pleistocene aeolian calcarenite known locally as 'Coastal Limestone'. Overlying the calcarenite are soils of primarily Pleistocene and Holocene sands (Lowry 1965).

Extreme south-western Australia is a region of forests, woodland, sand heath and swamp. It has a Mediterranean climate characterized by high winter rainfall and summer drought (Gardner 1942, 1959). Locally, water is plentiful throughout the year. Quininup Brook flows nearly year-round, and immediately above a waterfall 300 m from the mouth of the brook there is a long, narrow marsh which contained standing water at the end of the exceptionally dry summer of 1976-77. There is also a small, apparently permanent spring within the site complex.

The local vegetation has been described by Smith (1973). The coastal limestone area adjacent to the coast is covered with *Acacia* dominated open heath, and the lee side of the ridge supports peppermint open scrub, primarily *Agonis flexuosa*. Jarrah-Marri (*Eucalyptus marginata-E. calophylla*) low open forest predominates on the undulating lateritic plateau east of the ridge. Today, Quininup Brook is an ecotonal centre and Smith's vegetation map shows no less than 10 different formations and plant associations, including the northernmost stand of Karri (*E. diversicolor*) forest, within a 2 km radius of the site complex.

Sites

The site complex is a roughly rectangular area, 500 by 800 m, extending inland from the rugged and retrograding coast. This area includes the beach formed at the mouth of the brook and a field of partially vegetated, grey calcareous sand dunes behind the beach (**Fig. 1**). The sites comprise scatters of stone artifacts and granite-gneiss manuports on weathered, reddish-brown siliceous sands in deflation zones within the eroding grey sands.

Site 1 is the only site north of the brook. It is situated on a severely eroded elevation overlooking the beach. On this site the reddish-brown sands have been entirely deflated leaving only a few stone artifacts lying on the exposure of calcarenite rubble and loose, probably redeposited, calcareous sands.

Sites 2, 3 and 5 are also extremely eroded, although the brown sands are still present. Site 2 is adjacent to the beach at the base of the dune covered cliffs. It is subject to storm-wave action and flooding from the brook. Sites 3 and 5 are located on the edge of the cliffs directly behind the beach. The ground here slopes steeply, and these sites are badly eroded by both wind and water. The spring at the top of Site 3 has produced deep gullies across the surface of the site, and Site 5 has been worn down in many places to the basement granulite. It is extremely unlikely that the archaeological material on any of these sites is in primary position.

Sites 4 and 6 are in the dunes behind the top of the slope. They are not subject to water erosion and are partially protected from the winds by the surrounding vegetated dunes. Site 4 is a 160 x 40 m area of weathered brown siliceous sands exposed in a deep depression within the younger grey sand. It is immediately to the east of Site 3 and separated from it only by the spring. Here is preserved an apparent occupational surface whose most striking feature is a number of slightly mounded clusters of granite-gneiss stones. These are scattered over the western two-thirds of the site (**Fig. 8**). Site 6 is somewhat smaller (90 m x 50 m), but stratigraphically similar, with the difference that erosion has been greater and the stone clusters occur only on the south-east corner of the site. In the central portion of the site the brown sands are blown-out well below the level of the clusters, exposing a number of calcarenite pinnacles, and leaving a hollow depression which is strewn with granite-gneiss stone.

THE STRATIGRAPHY OF SITE 4

Site 4 perhaps is representative of the entire site complex, and with the exception of a single test trench (Trench 2) on Site 6, all collection and excavation took place here (**Fig. 2**). Two surface samples were collected. Sample A is a total collection from a 10 m^2 square near the centre of the site. Sample B is a salvage collection from 107 one metre squares so arranged as to include a broad range of artifact forms.

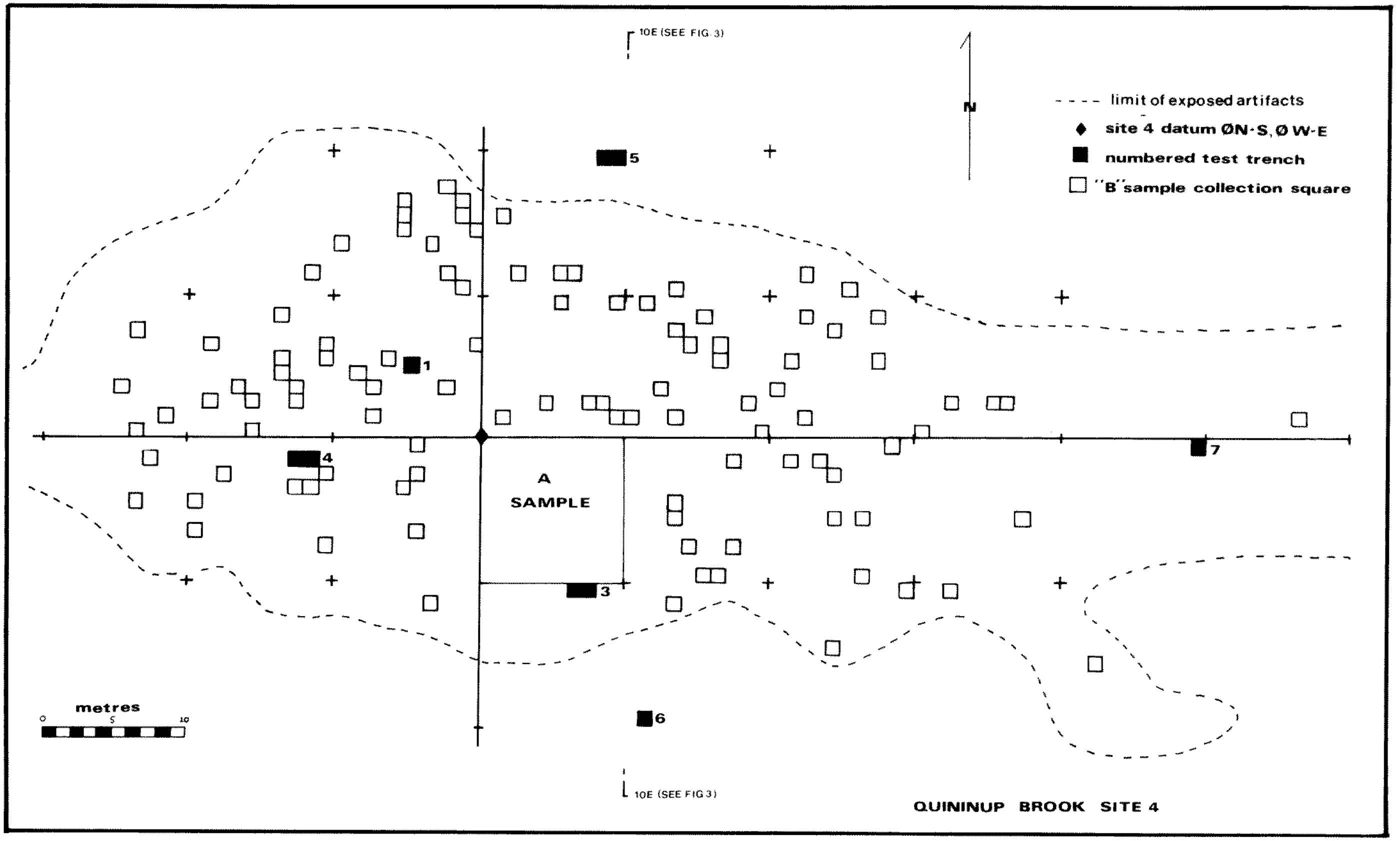

Fig. 2: Plan of archaeological investigations on Site 4.

The seven 1 x 1 m and 1 x 2 m test trenches were excavated in 5 and 10 cm arbitrary levels except where a buried humic horizon was encountered and the natural stratigraphy followed. The following examination of the Site 4 stratigraphy is based on Trenches 1, 5, 6 and 7 but chiefly on Trenches 5 and 6 which are located on either side of the narrow axis of the site, just outside the main deflation zone. Trenches 2, 3 and 4 are discussed in a later section.

Geological Strata

On the north side of Site 4, the grey calcareous sands reach a height of approximately 15 m above the surface of the deflation zone. Buried in the eroded face of this dune are three immature humic horizons. These sands are slightly alkaline throughout, and composed primarily of sub-angular organic grains with 20 to 30 per cent sub-rounded quartz grains. Samples taken from the humic horizons show heavy organic staining.

The interface between this deposit and the underlying siliceous sands is marked by a dark brown, weathered humic horizon exposed on the north side of the site. On the south side of the site, this humic horizon was intercepted in Trench 6. Here the overlying calcareous sand is largely deflated and the humic horizon is overlain instead by redeposited siliceous sands derived from the adjacent deflation zone (**Fig. 3**).

The siliceous sands below the humic horizon are minimally 2 m thick, but excavation in all trenches ended before reaching any underlying stratum. The colour of this soil grades uniformly from strong brown, just below the humic horizon, to reddish-yellow at a depth of 160 cm. It consists entirely of sub-rounded quartz grains with no traces of calcium carbonate. It is slightly alkaline, has heavy iron staining which decreases with depth, and occasionally shows traces of charcoal.

Following Lowry (1967) the calcareous and siliceous sands are equated respectively with the Quindalup and Spearwood Dune Systems as described for the Swan Coastal Plain, 30 km to the north (McArthur & Bettenay 1960). The geological history of the Spearwood Dunes (siliceous sands) is still subject to some controversy (Clarke & Dortch 1977) but there is general agreement that the Quindalup Dunes (calcareous sands) began to accumulate only when sea level reached its present position (McArthur & Bettenay 1960, Clarke & Dortch 1977). It can therefore be estimated from sea level curves (e.g. Chappell & Thom 1977) that the terminal date for the accumulation of the brown siliceous sands would be sometime around 6 000 BP.

The Cultural Sequence

There are apparently no artifacts associated with the calcareous sand anywhere within the site complex. All the artifacts found were either lying

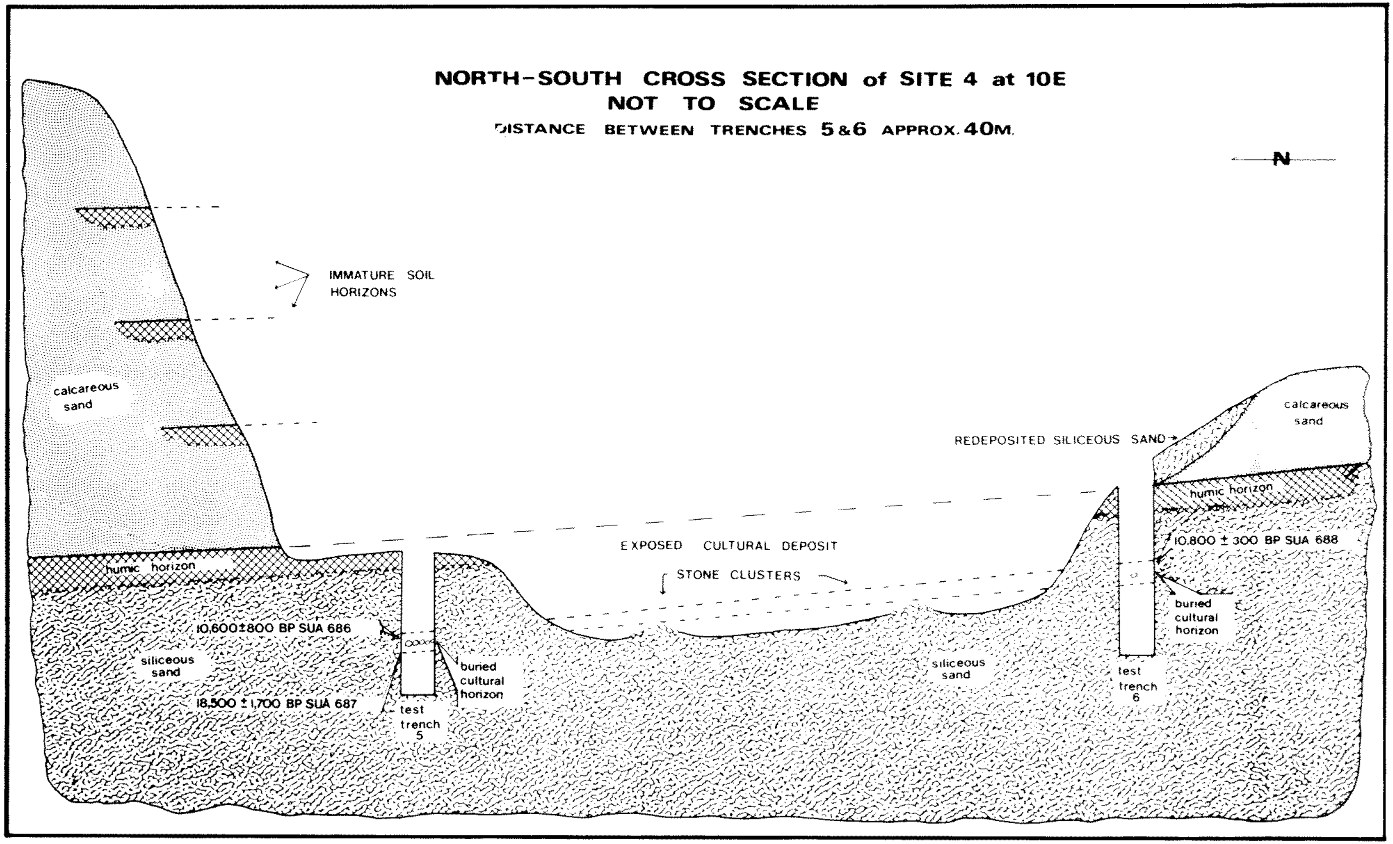

Fig. 3: North-south cross-section of Site 4.

on the surface of the deflated siliceous sand or buried within it. Excavations in the undisturbed siliceous sand below the humic horizon on Site 4 revealed that the vertical structure of the buried cultural deposit is quite similar on both the north and south sides of the site (**Fig. 3**). This can be seen on **Table 1** where the depths of artifacts for Trenches 5 and 6 are compared, and leads to the provisional assumption that the sequences in these two trenches are representative, although peripheral, remnants of the now partly deflated deposit. Depths used in the description of the deposit are from the top of the humic horizon which divides the siliceous sand from the calcareous sand. This is 26 cm below the surface of Trench 6 and approximately at the surface of Trench 5.

Artifacts are rare down to 50 cm below the top of the humic horizon. From this depth their numbers increase until, at a depth of 70 to 80 cm, the vast majority are found concentrated within a 30-40 cm thick vertical zone. This zone of artifact concentration contains almost all the large granite-gneiss stones excavated (94 per cent in Trench 5 and 93 per cent in Trench 6). In Trench 5 several of these stones are clustered, and resemble the previously mentioned stone clusters on the deflation surface. Below this zone (approximately 100 cm in Trench 5 and 110 cm in Trench 6), artifact numbers decline rapidly. No artifacts are found in Trench 5 below 140 cm, but isolated pieces are still encountered in Trench 6 where the excavation ended at 160 cm below the top of the humic horizon. The total depth of the cultural deposit remains unknown.

Trenches 1 and 7 are located in areas of Site 4 where the siliceous sand is partially deflated; they provide truncated sequences similar to the lower portions of those found in Trenches 5 and 6. Trench 7 is located on the eastern end of the deflated area where there are few artifacts exposed, and no stone clusters. This trench reaches a depth of 120 cm, but artifacts are recovered only between 20 and 60 cm below the surface. This 40 cm thick band probably equates with the zone of artifact concentration found in Trenches 5 and 6, but since the humic horizon is not present here, correlation is difficult. Trench 1 is located in the central part of the deflated area, between trenches 5 and 6, where the surface is littered with artifacts and granite-gneiss manuports. The trench reaches a depth of 115 cm below the surface, and artifacts are only found in the top 15 cm. It is probable that deflation in this area has continued to a level somewhat below the zone of artifact concentration, corresponding to the lower parts of Trenches 5 and 6.

Many small artifacts (each less than 2.5 g) in the redeposited siliceous sands above the humic horizon in Trench 6 are derived from the adjacent deflated area and were carried to their present position by the wind. Evidence for this is obtained by comparing the percentage of chips (flakes less than 1.5 cm long) in the excavated assemblages with the percentage of chips in the assemblage collected from the surface of the deflated area. Below the

TABLE 1

Numbers and percentages of artifacts recovered from Trenches 5 and 6, by depth below surface.

	Trench 5										Trench 6										
		DBS	Granite		Chert & Qtz Chips		Chert & Qtz Other		Total			DBS	Granite		Chert & Qtz Chips		Chert & Qtz Other		Total		Total
			no.	%	no.	%	no.	%	no.	%			no.	%	no.	%	no.	%	no.	%	
												0-18			25		5		30		
												18-26	2		17		4		23		53
Humic Horizon																					
		0-10			1				1			26-36					1		1		
		10-20										36-46									
		20-30			1				1			46-56									
		30-40		4	2	17		15	2	13		56-66		7		4		12		7	
		40-50			6		1		7			66-76									
		50-60	1		6		4		11			76-86	1				1		2		
		60-70	2		3		2		7			86-96			2				2		
Zone of Artifact Concentration		70-80	8		16		2		28			96-106	3		2		2		7		
	10 600 ± 800 BP SUA 686	80-90	14	94	27	65	13	79	51	77	10 800 ± 300 BP SUA 688	106-116	2	93	10	62	3	63	15	68	76
	18 500 ± 1 700 BP SUA 687	90-100	46		31		22		99			116-126	5		7		3		15		
		100-110	1				3					126-136	4		9		2		15		
		110-120			20				24			136-146			3				3		
		120-130		2		10		6		10		146-156			7		3		10		
		130-140										156-166					1		1		
		140-150										166-176			2	33		25	2	25	
		150-160										176-186			3				3		
		Total	69		113		47		229				15		54		16		76		129

humic horizon in the test trenches, chips account for 58 per cent (Trench 5) and 49 per cent (Trench 6), while the surface assemblage contains only 6 per cent of these small artifacts (Sample A).

Radiocarbon Dates

Charcoal samples were taken from about the middle of the zone of artifact concentration, between 80 and 90 cm below the top of the humic horizon, in both Trenches 5 and 6. These provide the very similar dates of 10 600 ± 800 BP (SUA 686) from Trench 5 and 10 800 ± 300 BP (SUA 688) from Trench 6, reinforcing the assumption that these two zones are extensions of the same, now partially deflated, cultural deposit.

Only 5 cm below this level in Trench 5, however, a charcoal sample associated with the buried cluster of granite-gneiss stones at 90 to 95 cm below the surface of the humic horizon provided the much older date of 18 500 ± 1 700 BP (SUA 687). This suggests that the zone of artifact concentration accumulated over several thousand years, and is not the product of a single period of relatively intensive occupation. Whether the concentration results from a period of long stability in soil accumulation, or from a previous episode of deflation is a matter of conjecture as there is no evidence for either of these suggestions in the soil profile.

THE CULTURAL RESIDUE

Flaked Stone Artifacts

A total of 1 437 flaked stone pieces were collected from the two surface samples and seven test trenches (**Tables 2, 3** and **4**). Post-depositional alteration of this assemblage during deflation has been extensive since winds have removed and probably shifted many of the artifacts. Deflation in the central portion of the site where Sample A was collected has reached at least the bottom of the zone of artifact concentration (see above). From the numbers of artifacts above the bottom of the zone in the test trenches on either side of this area it can be predicted that the density on the exposed surface should be between 42 (Trench 6) and 126 (Trench 5E) flaked stones per square metre. Since the actual density on that surface as shown by Sample A is only 6.42 artifacts per square metre, the relative composition of the assemblage shown on **Table 2** and referred to below is most certainly not a reflection of that present at the time of deposition.

TABLE 2

Summary of flaked stone artifact assemblage: Sample A.

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Chert</th><th colspan="2">Quartz</th><th colspan="2">Granite</th><th colspan="2">Silcrete</th><th colspan="2">Total</th></tr>
<tr><th>no.</th><th>%</th><th>no.</th><th>%</th><th>no.</th><th>%</th><th>no.</th><th>%</th><th>no.</th><th>%</th></tr>
<tr><td colspan="2">Unworked Fragment</td><td>10</td><td>3.9</td><td>64</td><td>16.4</td><td></td><td></td><td></td><td></td><td>74</td><td>11.4</td></tr>
<tr><td rowspan="5">Debitage</td><td>Flake</td><td>146</td><td rowspan="5">76.0</td><td>200</td><td rowspan="5">76.0</td><td>1</td><td rowspan="5">100</td><td>1</td><td rowspan="5">100</td><td>348</td><td rowspan="5">76.1</td></tr>
<tr><td>Chip</td><td>7</td><td>33</td><td></td><td></td><td>40</td></tr>
<tr><td>Flaked Frag.</td><td>39</td><td>58</td><td>2</td><td></td><td>99</td></tr>
<tr><td>Core</td><td>1</td><td>1</td><td></td><td></td><td>2</td></tr>
<tr><td>Scalar Core</td><td></td><td>5</td><td></td><td></td><td>5</td></tr>
<tr><td colspan="2">Utilized Debitage</td><td>45</td><td>17.7</td><td>27</td><td>6.8</td><td></td><td></td><td></td><td></td><td>72</td><td>11.1</td></tr>
<tr><td rowspan="2">Re-touched Impl.</td><td>Cutting</td><td>1</td><td rowspan="2">2.4</td><td>1</td><td rowspan="2">0.8</td><td></td><td rowspan="2"></td><td></td><td rowspan="2"></td><td>2</td><td rowspan="2">1.4</td></tr>
<tr><td>Scraping</td><td>5</td><td>2</td><td></td><td></td><td>7</td></tr>
<tr><td colspan="2">Total</td><td>254</td><td>39.1</td><td>391</td><td>60.2</td><td>3</td><td>0.5</td><td>1</td><td>0.2</td><td>649</td><td>100</td></tr>
</table>

TABLE 3

Summary of flaked stone artifact assemblage: Sample B.

	Chert	Quartz	Granite	Silcrete	Total
Flake	17	5			22
Flaked Piece	8	7	1		16
Core	2			1	3
Scalar Core	8	2			10
Utilized Piece	12	7			19
Cutting Implement	14				14
Scraping Implement	38	6	1		45
Composite Implement	10	1			11
Microlith		1			1
Chopper			1		1
Upper Grindstone			3		3
Lower Grindstone			4		4
Total	109	29	10	1	149

TABLE 4

Summary of flaked stone artifact assemblage: Test Trenches.

	Trench 1		Trench 2		Trench 3		Trench 4		Trench 5		Trench 6		Trench 7		Total		Total
	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	Chrt	Qtz	
Fragment		3	1	4	3	1		3		1					4	12	16
Flaked Fragment		1				1	2	5	1	2	2	1		1	5	11	16
Flake	1	2	8	1	2	10	13	4	21	20	12	7	1		58	44	102
Chip		6	1	2	2	10	12	18	64	56	34	53	5	5	118	150	268
Utilized Piece	1								1		2	1			4	1	5
Scraping Implement							1		1		1				3		3
Total	2	12	10	7	8	22	27	30	88	79	51	62	6	6	192	218	
Total	14		17		30		57		167		113		12				408

Petrology

Four types of stone were used in the flaked stone industry at Quininup Brook: quartz, chert, granite-gneiss and silcrete. The last two are found only as very minor components, together comprising only 0.7 per cent of the assemblage. The quartz, which makes up 60.2 per cent of the flaked stone includes rock crystal quartz, white milky quartz, and smaller amounts of what is more accurately defined as quartzite as it consists of quartz grains cemented with quartz. Most of these stones were probably taken from veins in the nearby granite-gneiss outcrops, although some of the fragments show a remainder of pebble cortex and indicate a stream bed or shoreline source.

The second major component of the flaked stone assemblage is fossiliferous chert. This stone is yellowish-orange in appearance as a result of iron staining from the surrounding sands. The colour of the freshly cut interior varies from white to brownish-grey. Analysis shows this to be cryptocrystalline Bryozoan chert formed from the silicification of fossiliferous

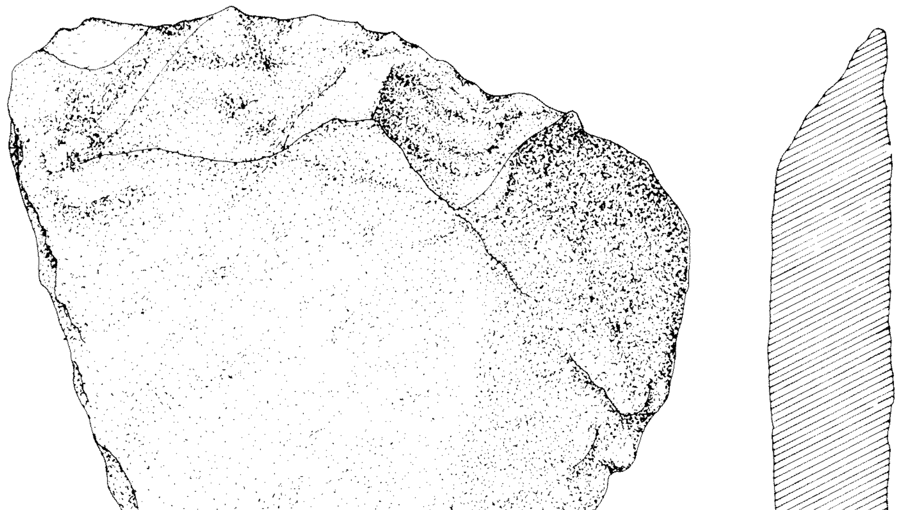

Fig. 4: Granite-gneiss chopper from Site 4.

limestone (J.E. Glover, pers. comm.). This chert is similar to that described from the nearby Devil's Lair deposit (Glover 1974) and to that found on the surface sites of the Swan Coastal Plain (Glover 1975b, Glover & Cockbain 1971). The source of this stone has been postulated as quarries on the continental shelf drowned by rising sea level approximately 6 000 BP (Glover 1975a), a proposal which is supported by recent archaeological finds at the site of Walyunga, near Perth (Pearce 1977, 1978). At Quininup Brook this chert seems to have been preferred to the more abundant quartz for more elaborate stone working. While chert comprises only 39.1 per cent of the flaked stone assemblage, 84 per cent of the retouched tools are of this material.

The granite-gneiss component of the flaked stone assemblage is understandably quite small since this stone, although readily available and extensively utilized on the site for other purposes, possesses few of the fracture qualities desirable for stone knapping. However, two retouched tools, a scraping implement and a chopper (**Fig.** 4), as well as two flakes and two flaked pieces are present in the assemblage.

The fourth stone type, silcrete, is represented only by two pieces, a flake and a globular core. The specific source of this material is unknown. However, a quarry near Northcliffe, approximately 140 km south-east, has been investigated (Dortch 1975, Dortch & Gardner 1976), and it has been suggested that a similar, nearer south-coast quarry could be the source of the small amounts of silcrete found in the Leeuwin-Naturaliste region (Dortch 1977a: 128).

Stoneworking Technology

Site 4 at Quininup Brook is a single phase site, and the entire assemblage is typical of the 'South-West Early Phase'. This phase extends back to include the oldest recovered materials in this region at Devil's Lair. It terminated sometime after the abandonment of Quininup Brook, between 6 000 BP and 3 000 BP with the introduction to the area of microlithic industries (Dortch 1977a, Dortch & Bordes 1977). The only representative of the subsequent phase, whether it be called 'Late Phase' (Dortch 1977a) or 'Middle Phase' (Hallam 1972), is a single anomalous microlith which was collected from the undeflated surface on the eastern end of Site 4 (**Fig.** 5).

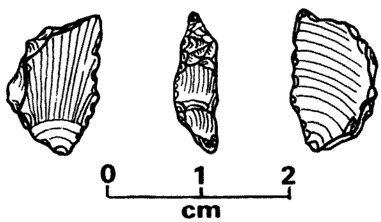

Fig. 5: Quartz microlith from east end of Site 4.

No evidence of deliberate blade production is found at Quininup Brook. Consequently, the term 'blade' is not used in classification even though occasional flakes might be of blade proportions, twice or more as long as wide. Most of the flakes from Site 4 were evidently knapped from pieces chosen at random. The majority of these flaked pieces are formless, possessing no other distinguishing characteristics than one to three negative flake scars, and are classified simply as flaked fragments. Only a few recognizable cores were recovered. Four of these, two globular cores and two amorphous cores, are entirely covered with negative flake scars. There are also six chert 'micro-cores with single striking platforms' (Gould 1977: 81), and two ovate discoidal cores of chert very similar to those which Stockton describes as 'alternatively flaked double domed discs with wavy margins' (1971: 46). All of the single platform cores and one of the discoidal cores show further modification in the form of use-wear and are classified with the implements.

The bipolar stoneworking technique was used on the site and 15 scalar cores were recovered (White 1968). These artifacts, made equally from quartz and chert, show battering on opposed margins with visible negative flake scars invading the piece below the battering on both faces. Two of these specimens had been re-oriented in the course of battering, resulting in the above characteristics on more than one axis. Quatrapolar specimens of this type are noted by McCarthy (1976: 38), and one of the pieces from Quininup Brook is hexipolar with three different axes along which battering was directed.

Flaked Stone Implements

Most of the flaked stone from Site 4 appears to be merely a by-product of stoneworking, and was not utilized or further modified. About 11 per cent of the flakes and flaked fragments show traces of what was initially considered to be use-wear, but since the majority of the pieces are badly weathered, this classification is often doubtful. In the few cases where use-wear is clearly present, these artifacts, along with the 1.4 per cent of the assemblage which exhibits secondary retouch, are classified as implements.

The flaked stone implements from Quininup Brook are described fully elsewhere (Ferguson 1980). They are a collection of generally amorphous flakes and flaked fragments, including notched and denticulated pieces, typical of the South-West Early Phase. From an analysis of the angles of their working edges and from their use-wear patterns a model of function has been developed and tested against an array of ethnographic implements. This confirms that these artifacts can be divided into two basic functional categories. scraping implements, used for scraping wood and possibly bone, and cutting implements, probably used for cutting flesh.

Several of the artifacts which have been classified as scraping implements resemble worn adze flakes (Mulvaney 1975: 77-83). Artifacts of this type were present at Puntutjarpa in the Western Desert by 10 000 years ago (Gould 1977: 103) and similar pieces are found in late Pleistocene deposits at Devil's Lair and in Kimberley (Dortch 1977a). Since in ethnographic time adzes were an exclusively male tool (Spencer & Gillen 1904: 638) the inclusion of adze flakes in the assemblage suggests the presence of men at the site.

Grinding Stones

The Quininup Brook Site Complex has yielded the first grindstones associated with a South-West Early Phase assemblage. Such a discovery is not surprising since an antiquity of 18 000 years has been claimed for these implements elsewhere in Australia (Dortch 1977b, Mulvaney 1975: 133). On Site 4 grinding material is not rare, and the surface of the deflation zone is littered with fragments of granite-gneiss exhibiting smooth surfaces which may be the result of artificial grinding.

Seven unequivocally ground pieces were collected in the surface samples. These are four lower and three upper grindstones. Of the former, one has four ground surfaces, two of which are concave, and another, which was found broken in two pieces approximately a metre apart, is a small (17 x 7 cm) 2 cm thick slab with one surface polished very smooth (**Fig. 6a**). The remaining two lower grindstones have deep dimples pecked into one or more surfaces. One of these is quite large, weighing over two kilograms (**Fig. 6b**). The rounded upper grindstones are smoothly worn on several of their surfaces, and one also shows percussion damage on the edge, probably as a result of use as a hammer stone.

During historical times grinding stones were used in the South-West for preparing several varieties of edible or otherwise useful seeds, nuts, leaves, vines, roots, barks and gums (Meagher 1974), and many of the species of plants so prepared are available in the Quininup Brook region at the present time. Since grindstones were implements used primarily by females, their inclusion in the assemblages suggests the presence of women at the site (Peterson 1968).

Granite-gneiss Manuports — The Stone Clusters

The surface of the deflation zone on Site 4 is strewn with thousands of granite-gneiss stones at an average density of 5.75 stones per m^2 (Sample A). Since the closest outcrops are over 100 m distant, many hours of work are represented in transporting these stones to the site. Their distribution across the site is uneven, and as suggested above, many seem to be clustered together in groups, taking on a slightly mounded appearance (**Fig. 7**).

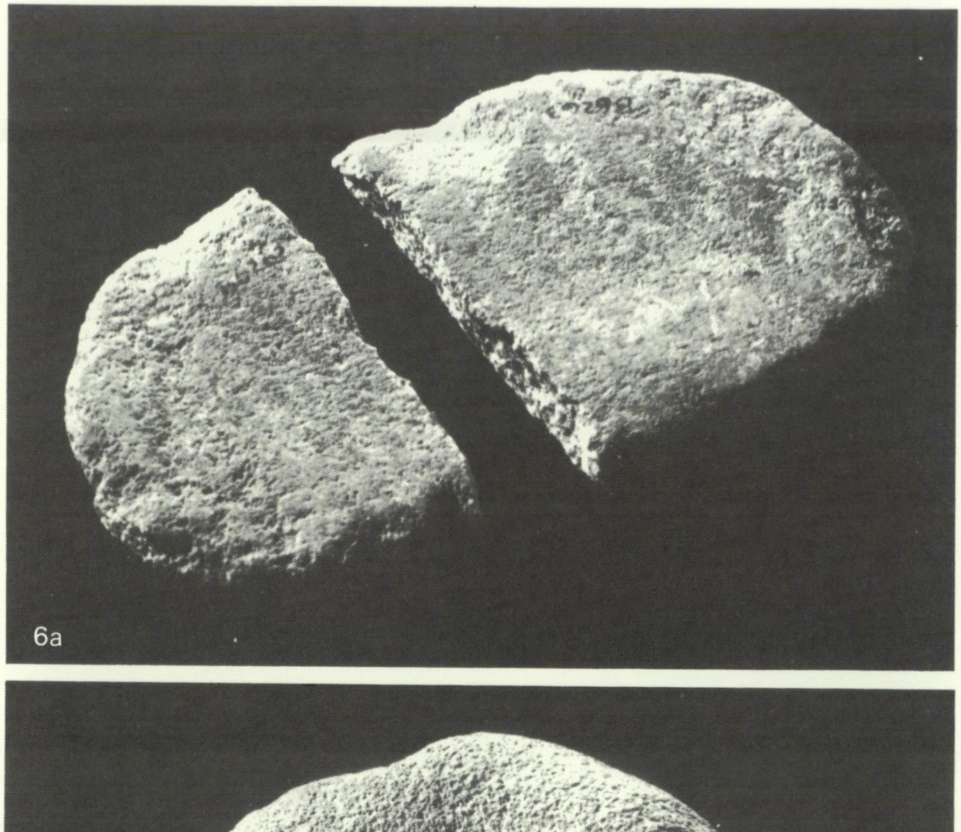

Fig. 6: Photographs of grindstones from Quininup Brook, Site 4.

Fig. 7: Photograph of stone cluster, surface of Trench 4, Site 4. (See also **Fig. 8e**, for plan and elevation.)

Nearest-Neighbour Analysis (Pinder & Witherick 1972) applied to those stones within the Sample A area confirms this visual impression. The analysis produced a statistical value of R = .0451, indicating a strong degree of clustering which is significant at the .001 level. It can only be assumed that these stones were purposefully grouped together by the people who carried them to the site.

Thirty-eight clusters can be visually isolated on Site 4, and another five on Site 6 (**Fig. 8**). They range from one to two metres in diameter, and consist of from 27 to 81 stones which vary in diameter from 1.2 to 25 cm. With the exception of a single stone (**Fig. 8c**), only sand was found within the mounds beneath the surface clusters excavated in Trenches 2, 3 and 4. It is probable that before these clusters became exposed, their stones were arranged on a horizontal plane like those of the unexposed cluster excavated in Trench 5 (**Fig. 9**). The mounds appear to be only a result of the deflation process, created because the clustered stones prevented the sand directly beneath them from being blown away.

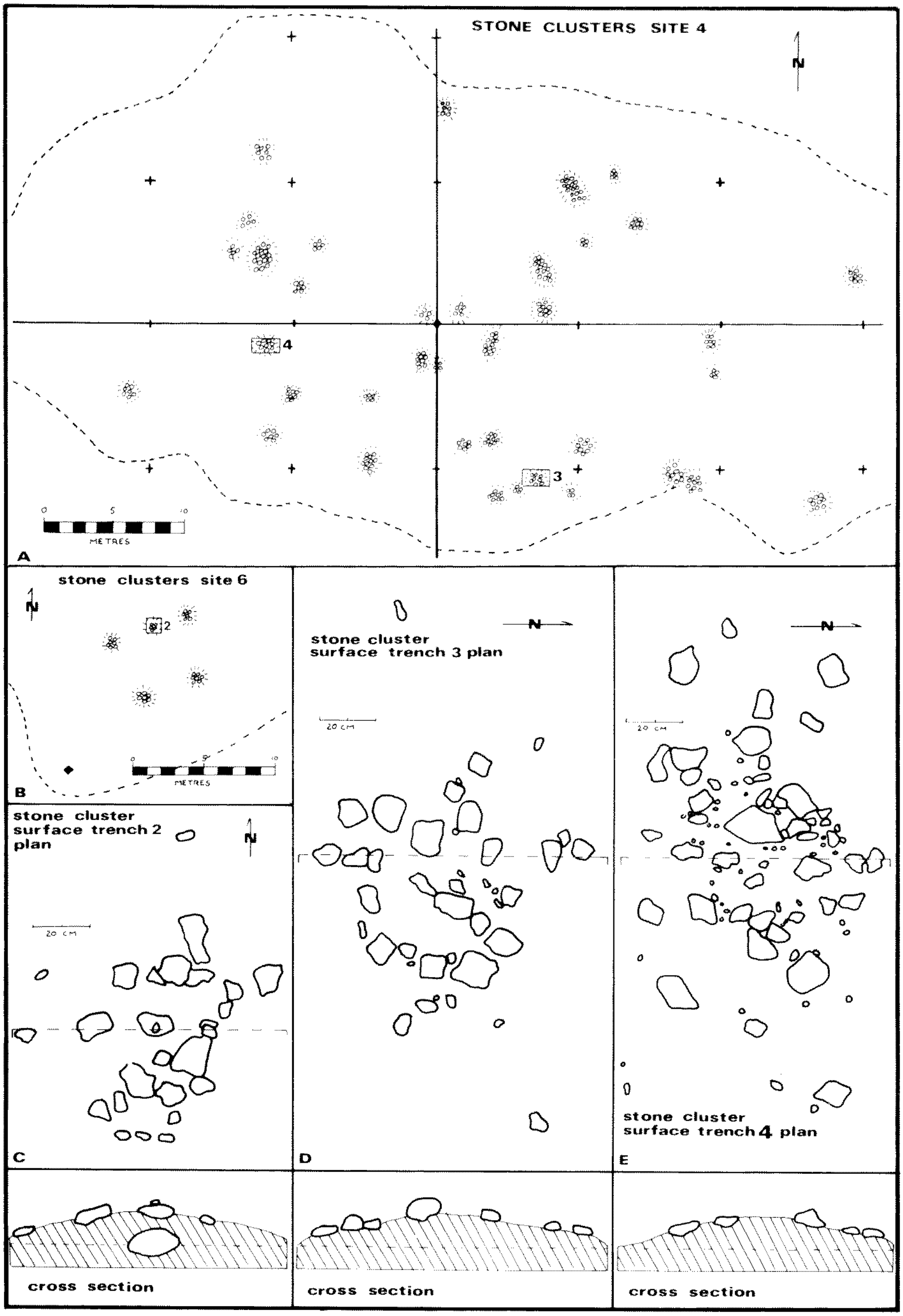

Fig. 8: Stone clusters on Sites 4 and 6.

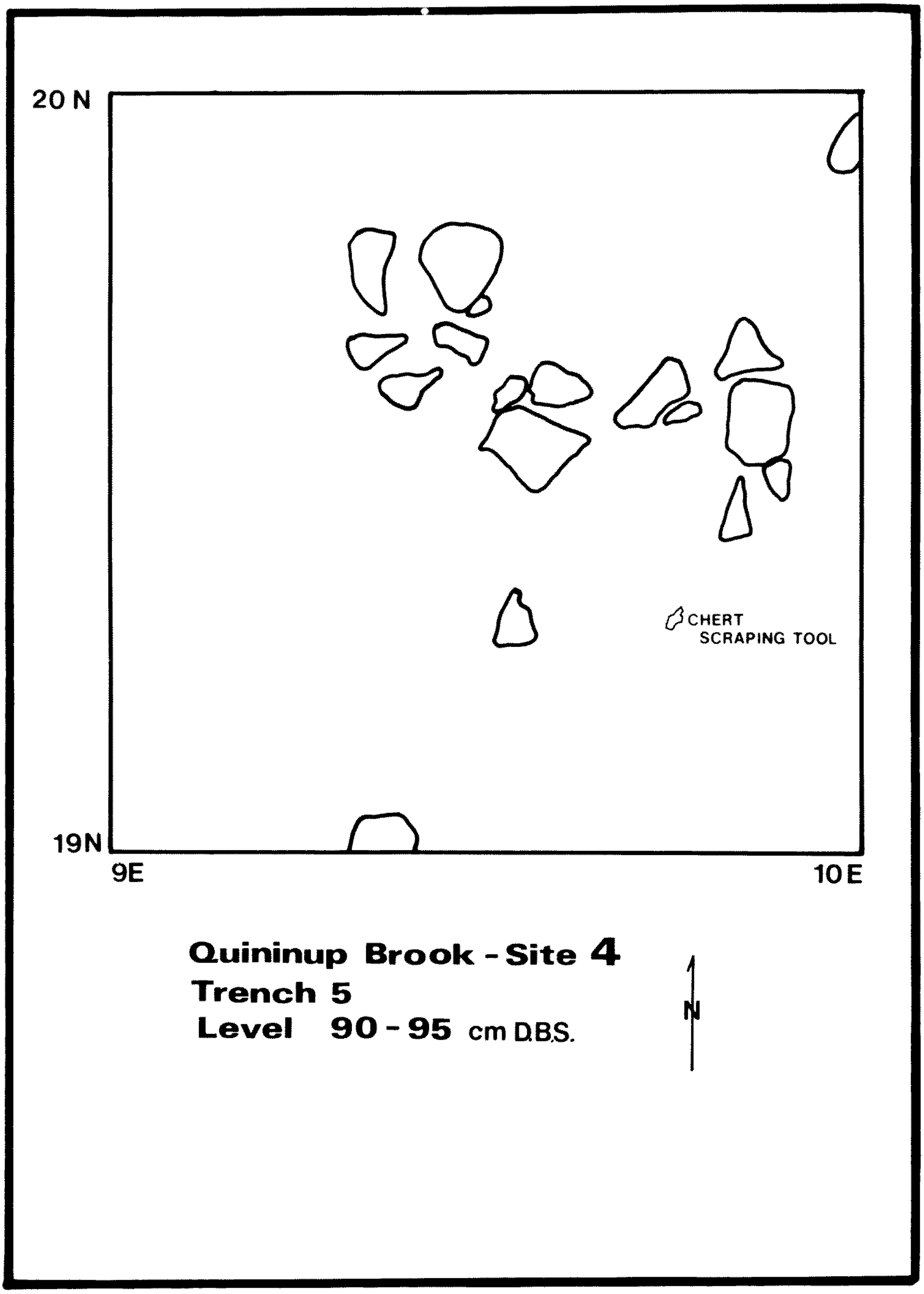

Fig. 9: Buried stone cluster in Trench 5.

The purpose of the clusters is still unknown, although numerous possibilities, both domestic and ritual, have been considered. As described above, the diverse range of ground and flaked stone also found on the site suggests that a number of domestic activities took place here. In Aboriginal Australia ritual sites are normally removed from domestic sites, and since the clusters bear little resemblance to any known form of Aboriginal ritual stone arrangements, it has been concluded that they probably served a domestic rather than a ritual function.

Of several domestic purposes considered only two seem feasible. The most obvious is that clusters could be remnants of hearths, an interpretation perhaps supported by the presence of charcoal and a chert flake with thermal fracturing in association with the buried cluster in Trench 5. Unfortunately such fracturing and fire crazing is not uncommon on artifacts from all parts of the site, and no more charcoal is found in direct association than in the rest of the relatively intensive occupational horizon. Several of the stones in this cluster are fractured in place with sand filling the cracks between the pieces. These fractures could result from the high temperature of a fire, but the structure of the granite-gneiss is such that fracturing can also be easily produced under normal weathering conditions. The fire hearth interpretation remains the most plausible, but no real confirmation is possible at present.

The only other plausible suggestion seems to be that the stones were shelter weights. Scott Nind, an early observer at King George Sound 250 km to the east, noted that the Aborigines placed stones on top of their huts of bowered branches in order to prevent the strips of bark used as roofing material from blowing away during rainy weather (Nind 1831: 27). Collapse and decay of such a structure might result in a cluster of stones similar to those at Quininup Brook, but corroborating evidence such as post holes is not found on the Quininup Brook sites.

DISCUSSION

Quininup Brook and South-West Prehistory

Prehistory in the South-West, as elsewhere in Australia, can be approached in two different but complementary ways. The first uses the traditional archaeological method of excavation, and builds a picture of the past from the cultural residue and the contexts of its recovery. A second approach, ethnohistorical inference, establishes its picture by projecting backward from the period of terminal hunter-gatherer exploitation as revealed in the writing of the early 19th century explorers and settlers. Both methods are used in the following attempt to gain an understanding of the prehistoric Quininup Brook Site Complex.

Archaeology

Two other sites quite close to Quininup Brook have also been dated to the late Pleistocene. Most notable is the cave site of Devil's Lair, 40 km south of Quininup Brook, where excavation has produced evidence of intermittent human occupation of the region from 33 000 to 5 000 years ago (Dortch 1979a). Preservation within the cave is good and a large sample of faunal remains as well as bone implements and ornaments, engraved limestone plaques, stone artifacts, living floors and features, and human skeletal remains have been recovered and reported (Allbrook 1976; Balme 1978; Balme, Merrilees & Porter 1978; Baynes, Merriless & Porter 1975; Davies 1968; Dortch 1974, 1976, 1979a, 1979b; Dortch & Merrilees 1971, 1973; Freedman 1976; Glover 1974; Shackley 1978). The highest frequency of occupation within the cave was between about 24 000 and 12 000 years ago (Balme *in press*).

The second site is at Arumvale, 2-3 km south of Devil's Lair. This is a stratified open site which has charcoal dated at 18 400 ± 540 BP (SUA 456) and 9 220 ± 136 BP (SUA 455) in association with chert and quartz artifacts (Dortch & McArthur *in prep.*).

A third nearby site may also date from the late or terminal Pleistocene. At Dunsborough, 20 km north of Quininup Brook, the author has recently conducted a test excavation of an open site previously reported by Glover, Dortch & Balme (1978). Here there is a 2 m deep cultural deposit containing chert and quartz artifacts. The lowest charcoal in the test trench was found about the middle of the deposit, 100 to 110 cm below the surface, and this yielded a date of 7 145 ± 275 BP (SUA 888).

Only one other site in the entire South-West, Minim Cove near Perth, has been dated to the late Pleistocene. Although approximately 250 km north, Minim Cove is similar in location to the Quininup Brook sites, being a coastal site situated within Spearwood Dunes. It is dated to 9 930 ± 130 BP (SUA 454) from charcoal which was recovered over 1 m below the surface and 90 cm above the lowest chert artifact (Clarke & Dortch 1977).

Ethnohistory

In historical times the coastal region between Capes Leeuwin and Naturaliste was within the *Wardandi* 'tribal' area (Tindale 1974). The Aboriginal inhabitants of this region were a mobile people utilising a variety of sometimes widely spaced resources which they exploited via a series of interconnecting pathways. These pathways were along zones of easy movement, often following stream courses, and were kept open by periodic burning. Camping places were nodes in this network of exploitation, located where paths came together at sources of permanent water (Hallam 1975: 66-71).

When Europeans first arrived, this region appears to have been more sparsely populated by Aborigines than the neighbouring Swan Coastal Plain to the north (Birdsell 1953; Hallam 1977). Hallam believes this was due primarily to the comparatively high rainfall which nurtured the thick Karri and Jarrah forests. These forests were detrimental to high human population densities because they supported a relatively low herbivore biomass and restricted the ease of human movement (Hallam 1977: 172-173).

The Late Pleistocene South-West

Recent research suggests that in southern Australia the late Pleistocene climate was generally cooler and more arid than at present (Bowler 1976a, 1976b; Rognon & Williams 1977; Wyrwoll 1977; Wyrwoll & Milton 1976). This aridity may have been somewhat ameliorated under the maritime conditions of the extreme south-west, but evidence from faunal studies in the local limestone caves suggests that this region, too, was notably drier. In Devil's Lair much of the vertebrate fauna recovered from this period appears to be adapted to a drier, more open environment. The range of species from diverse ecological zones suggests water was still plentiful nearby, but that large sections of what is now forest might have been more sparsely vegetated (Balme, Merrilees & Porter 1979).

Merrilees has recently published a paper dealing with the fossil remains of a now locally extinct rock wallaby (probably *Petrogale penicillata*) found in Devil's Lair and other limestone cave deposits of the region (1979). This animal is thought to require a more open environment than is currently present in the region and first appears in the local fossil record about 30 000 BP, increasing significantly in numbers from about 21 000 BP. The presence of rock wallaby remains in the Yallingup Cave deposit, near Dunsborough, has led Merrilees to suggest that in the northern part of the Leeuwin-Naturaliste region where Quininup Brook is located, conditions must have been so dry that much of the now forested areas would have then been covered with open plant formations (1979: 82).

This postulated more open environment would have enabled freer movement by humans. It would have also probably supported a much larger population of game animals. In the South-West today, populations of the larger macropods are lowest in the wet sclerophyll (Karri) formations with a dense shrub layer and highest in the more open dry sclerophyll (Jarrah-Marri) forests (Christensen & Kimber 1975: 98-99). In Devil's Lair radiocarbon dated stratigraphic layers containing the richest vertebrate remains roughly coincide with the glacial maximum about 19 000 to 12 000 years ago (Balme, Merrilees & Porter 1978: 54-55, Table 3).

At the height of the last glacial maximum there was also a larger area of land in the South-West available for exploitation. About 17,000 years ago, not long after occupation seems to have begun at Quininup Brook, sea level was 150 m lower than at present (Chappell & Thom 1977: 282). From the bathymetric data on Lowry's geological map (1965) it appears the shoreline was about 40 km west of the present mouth of the brook. These sites which are now being eroded by the sea, were then situated well inland on a ridge overlooking a vast coastal plain.

The Use and Abandonment of Quininup Brook

Although the late Pleistocene environment was considerably different from that of the present, the technology by which it was exploited was probably similar. The Quininup Brook investigations have shown that grindstones were part of the South-West Early Phase tool assemblage. This addition reinforces Dortch's suggestion (1974: 202) that these assemblages seem to indicate methods of exploitation which are similar to those of the Aborigines found in this region in historical times.

Information presented above and elsewhere (Ferguson 1980) suggests that the Quininup Brook Site Complex was a cluster of domestic sites at which family groups were present. It was a generalized camping area where fires were built, stone and wooden implements were made, and probably both vegetable and animal foodstuffs were prepared. In view of apparent similarities in the methods of exploitation it seems reasonable to draw an analogy with the campsites of the ethnohistorical period (Ascher 1961: 319), and to see the site complex as part of a late Pleistocene exploitation network, a node where paths of this network came together at permanent water.

One of these Pleistocene paths possibly followed Quininup Brook toward the sea across the now submerged coastal plain. Modern paths often followed the stream courses, and the presence of the fossiliferous chert from the continental shelf at the Quininup Brook sites indicates that at least part of that coastal plain must have been included in the late Pleistocene network. Other paths may have run through the then more open country along the ridge and across the undulating plateau east of it. Some of these possibly connected Quininup Brook with the nearby sites of Arumvale, Devil's Lair and Dunsborough which were then also located well inland. All of these sites appear to be at least in part contemporaneous, and all are within the boundaries of the ethnographic *Wardandi* network.

There is little likelihood that any remains of these paths are preserved, and attempts to reconstruct the exact patterns of such a Pleistocene network will probably always remain speculative. At the same time is is useful to view these late Pleistocene sites as part of a larger exploitative network in order to understand how their use may have changed gradually over time. During the more than eight thousand years that Quininup Brook seems to have been frequented, the land to the west was slowly but steadily disappearing under the encroaching sea. Eventually, as the sea neared its present level, there would, of course, have been radical alterations to the resource area immediately surrounding the site complex. However, perhaps hundreds or even thousands of years before this happened, marine transgression could already have been changing the regional pattern of human movement. Changes of this kind may have influenced the frequency and duration of visits to the site complex, so altering the way in which the resource area immediately surrounding it was exploited.

Much has been said in the Australian literature about the effect of rising sea levels on Aboriginal ecological adaptation in coastal and near coastal environments (Bowdler 1977; Flood 1974; Jones 1968; Lambert 1977; Wright 1971). In the South-West this stress of a shrinking exploitation area is suggested to have been coupled with a deterioration in the habitability of that part which remained. In southern Australia generally there was an increase in wet conditions during the terminal Pleistocene-early Holocene that peaked between 7 000 and 5 000 years ago (Rognon & Williams 1977: 305). This was about the time that sea level reached its present position, and may correspond with the development of the thick weathered humic horizon in the reddish-brown siliceous sands at Quininup Brook. Pollen studies have shown a major increase in the distribution of the Karri forests at this time (Churchill 1968). This formation probably then spread to include at least the locally wet areas of the northern Leeuwin-Naturaliste ridge, e.g. the area around Quininup Brook where an outlier of Karri remains today. Faunal studies in the region document the local extinction of a number of non-forest species in the early to middle Holocene (Balme, Merrilees & Porter 1978; Merrilees 1979; Porter 1979). The ranges of other species, such as the Brush Wallaby (*Macropus irma*) which is one of the commonest large marsupials in the area today (Christensen & Kimber 1975: 99), are believed to have contracted northward at this time, with recolonization only after the first felling of the forests during the 19th century (Baynes, Merrilees & Porter 1975).

The abandonment of the Quininup Brook Site Complex after a long history of occupation can be seen in the context of this shrinking and possibly deteriorating environment. Under such conditions human population might have dwindled in the region, perhaps with the focus of the exploitation shifting further inland. East of the forested block the onset of wetter conditions would have enhanced the habitability of regions which had been extremely arid during the late Pleistocene. In the heavily forested regions, the zones of easy movement would have become more difficult to maintain with less reward for doing so. As more and more land disappeared beneath the sea, there would have been less and less reason to venture down the paths that once joined at what is now the mouth of Quininup Brook.

ACKNOWLEDGEMENTS

Special thanks go to Charlie Dortch who read the draft of this paper; and to Sylvia Hallam, my academic supervisor, without whose encouragement this project would haver have been undertaken. I have benefited from discussions with John Clarke and John Glover, geologists, and Jane Balme and Duncan Merrilees, palaeontologists, and have appreciated the opportunity to read some of their then unpublished works. Mance Lofgren also read and commented on an earlier version of this paper. All of these people contributed to my understanding of the site complex, but they must be absolved from any blame for errors that may be found in this publication.

Thanks also go to J. Eaton and B. Wilson, who helped with the illustrations, to E. Lawson, E. Eaton, H. Nicol, D. McGrath and S. Cole, who typed the various drafts of the manuscript, and to the following persons, staff members of the Western Australian Museum and staff and students of the University of Western Australia, who gave their time to aid in the fieldwork and excavations: S. Brown, D. Byrne, P. Chapman, I. and S. Kirkby, J. Scimone, G. Thomas and A. Ure. And finally, thanks to the owners of the property adjacent to the site complex, Mr and Mrs Bob Randall, for allowing us a place to camp and for supplying us with free food.

The radiocarbon dates were provided under a grant from the Australian Institute of Aboriginal Studies.

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Received 27 November 1978 Accepted 4 July 1980 Published 30 January 1981

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