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National Library of Australia card number
ISSN 0079-8835

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ARCHAEOLOGICAL INVESTIGATIONS AT YOULAIN SPRINGS, SOUTHWEST QUEENSLAND

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Robins, R.P. 1998 04 20: Archaeological investigations at Youlain Springs, southwest Queensland. *Memoirs of the Queensland Museum, Cultural Heritage Series* 1(1): 57-74. Brisbane. ISSN 1440-4788.

Youlain Springs is on the eastern edge of the Australia arid zone, near the intersection of the Queensland/ NSW border and Paroo R., southwest Queensland. This site has a 2m deep deposit with a sequence of dates extending from terminal Pleistocene to late Holocene. It demonstrates the potential of open sites associated with springs to provide important archaeological evidence relating to the timing, spread and adaptation of humans in the arid zone. □ *Arid zone archaeology, mound springs, Queensland, Aboriginal prehistory, Pleistocene occupation.*

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Knowledge of the history of Aboriginal occupation of Australia's arid zone has increased dramatically over the last 15 years (Veth, 1989; Smith, 1989; Robins, 1993). This research, coupled with improved palaeoenvironmental reconstructions, has resulted in a better understanding of the interaction between people and the arid environment throughout the late Pleistocene and early Holocene. Prior to this, only meagre archaeological evidence could be invoked to support general theories of the timing and spread of Aboriginal occupation (e.g. Bowdler, 1977; Horton, 1981). Given the size of the arid zone and the potential time span of occupation (at least 50,000 years) however, current evidence can be regarded only as a framework. Further research is required for resolution of major questions about the timing, spread, and subsequent adaptations of human populations there.

A major issue still to be resolved is whether the patterns in the archaeological record are an accurate reflection of settlement events or the result of bias in research emphases, the distribution of particular types of sites or failure to recognise alternative types of evidence. Much of the available Pleistocene occupational evidence comes from rockshelters such as Colless Creek (Hiscock, 1984), Cuckadoo (Davidson & Noble, 1992), Koolan I (O'Connor, 1989), Mandu Mandu (Morse, 1988), Puritjarra (Smith, 1989), Koonalda (Wright, 1971) and Newman PO187 (Brown, 1987), or from areas that have soils that provide relatively good preservation conditions such as the Willandra Lakes (Allen, 1972; Bowler & Thorne, 1976; Webb, 1989; Balme & Hope, 1990), Murray River (Pardoe, 1988) and

the Lower Darling River (Hope et al., 1983; Balme & Hope 1990). Although some open sites away from the southeastern edge of the arid zone have provided important evidence of Pleistocene occupation — JSN 11 in the Strzelecki Desert (Smith et al., 1991), sites in the Cooper Creek corridor (Veth & Ham, 1989; Veth et al., 1990) Hawker Lagoon (Lampert & Hughes, 1988) and Silver Dollar (Bowdler, 1990) — these are in the minority. Given the generally low topographic relief of much of the arid zone (Mabbutt, 1986), and a consequent absence of suitable rockshelters, considerably more reliance will have to be placed on open sites if the archaeological evidence needed to define regional patterns in settlement and adaptation is to be obtained.

On the eastern edge of the arid zone, archaeological sites associated with springs (including mound springs) are one form of open site that have the potential to provide evidence of Pleistocene occupation and/or extended occupation sequences.

ARCHAEOLOGICAL BACKGROUND

This excavation was part of a larger project centred around a system of ephemeral and semi-permanent lakes commonly termed the Currawinya Lakes, in southwest Queensland (Fig. 1). The study adopted a landscape approach (Rossignol, 1992) to explore the archaeology of the region, and included investigations of aspects of taphonomy, spatial distributions, chronology and geomorphology.

Prior to this work only two excavations had been carried out in southwest Queensland. An early reconnaissance excavation in sand dunes at

Nappermerrie Station by Hughes & Lampert (1980) indicated, on the basis of geomorphological associations, the possibility of Pleistocene occupation in lower Cooper Creek. The other was a rescue excavation undertaken in 1983 on an open site near the Dynevor Lakes, which yielded a late Holocene date (P. Hiscock, pers. comm.).

Veth et al. (1990) and Smith et al. (1991) confirmed late Pleistocene occupation for lower Cooper Creek and the adjacent Strzelecki Desert. The nature of the occupation is, however, still a matter of conjecture due to limitations for obtaining detailed settlement information imposed by the excavation of isolated hearths.

Although rock shelters are common in the Ranges that run through southwest Queensland, it is unlikely that they will provide a source for old dates or long occupation sequences due to both their nature and the deposits found in them (Robins, 1995). As part of this regional study, excavation of Murderer's Bore rock shelter on Kilocowera Station and at Kyeenee I and II rock shelters on Kyeenee Station, revealed shallow deposits younger than 2,000 years old (Robins, 1993, 1995). Open hearths indicated little potential for providing a chronological framework for Aboriginal occupation. Excavation of six hearths (two from the surface of a Pleistocene lake lunette) from three localities in the vicinity of the Currawinya lakes gave ages ranging from about 1,700BP to about 400BP (Robins, 1993, 1996).

Numerous springs and mound springs common throughout the study area offered a further source of archaeological evidence (Fig. 2). The occurrence of springs in this area may be related to several factors including the presence of faults in the thin Jurassic and Cretaceous sediments, the onlapping of these sediments with basement rock inliers, or the pressure of water breaking through thin confining beds near the margins of the Artesian basin (Habermehl, 1982:15). In some cases spring activity may not be associated with the Great Artesian Basin but with aquifers within the tertiary caprock. The most obvious local expression of these springs is the formation of groups of conical mounds up to 7m in height. The mounds are formed from a smectite clay-mud slurry transported to the surface from aquifers in the Hooray Sandstone (Habermehl, 1982). In some springs this slurry is accompanied by large silcrete blocks that become embedded in the walls of the springs. In other places groundwater seepage results in small isolated soaks or springs. Associated with both the above types of springs are extensive areas of chemically altered surface deposits that are the

result of the precipitation of chemicals dissolved in the artesian water.

Little is known about the mound springs in the study area. There have been no recordings of spring flow and no chemical analyses or detailed mapping. Many of these springs are dry today, presumably as a consequence of the tapping of the Artesian Basin by bores resulting in a drop in water pressure. No studies of their fauna or flora have been published. However, in view of their possible importance to Aboriginal people, particularly during periods of extended drought, some investigation of their archaeological potential was warranted. After investigating a number of spring sites during reconnaissance survey (Robins, 1993), Youlain Springs was selected as the site with most potential to provide evidence of a long occupational sequence.

ENVIRONMENTAL SETTING

Youlain Springs is located on Kilocowera Station, situated between the Paroo and Bulloo Rivers, approximately 80km SSE of the town of Thargomindah, and 40km NW of the village of Hungerford.

The most prominent topographic features of the area are the dissected residuals of the north-south trending Willies Range and a lake system 15km to the east. The two largest lakes in this system are Wyara and Numulla. The anastomosing channels of the Paroo R. lie approximately 21km to the east (Fig. 1).

Lake Wyara is a shallow saline lake with an internal drainage system. Lake Numulla at its closest point, lies 3km to the east of L. Wyara. This is a freshwater lake fed by Boorara Ck to the north and the Paroo R., through Carwarra Ck, to the south. Surrounding L. Numulla and abutting L. Wyara on its western, southern and northern margins are extensive, low relief sandplains graduating to hard and soft mulga lands. Dissected residuals with steep escarpments flanked by low hills and stony plains, dominate the topography to the west of L. Wyara (Fig. 1) (See Robins, this volume, for more regional environmental detail).

YOULAIN SPRINGS

Youlain Springs is in the mid-course of Youlaingee Ck (Fig. 3). A spring once flowed on the southern side of Youlaingee Ck, near its junction with a small unnamed creek. A windmill, turkey nest (earth dam), concrete trough and large galvanised tank had been constructed or erected in the

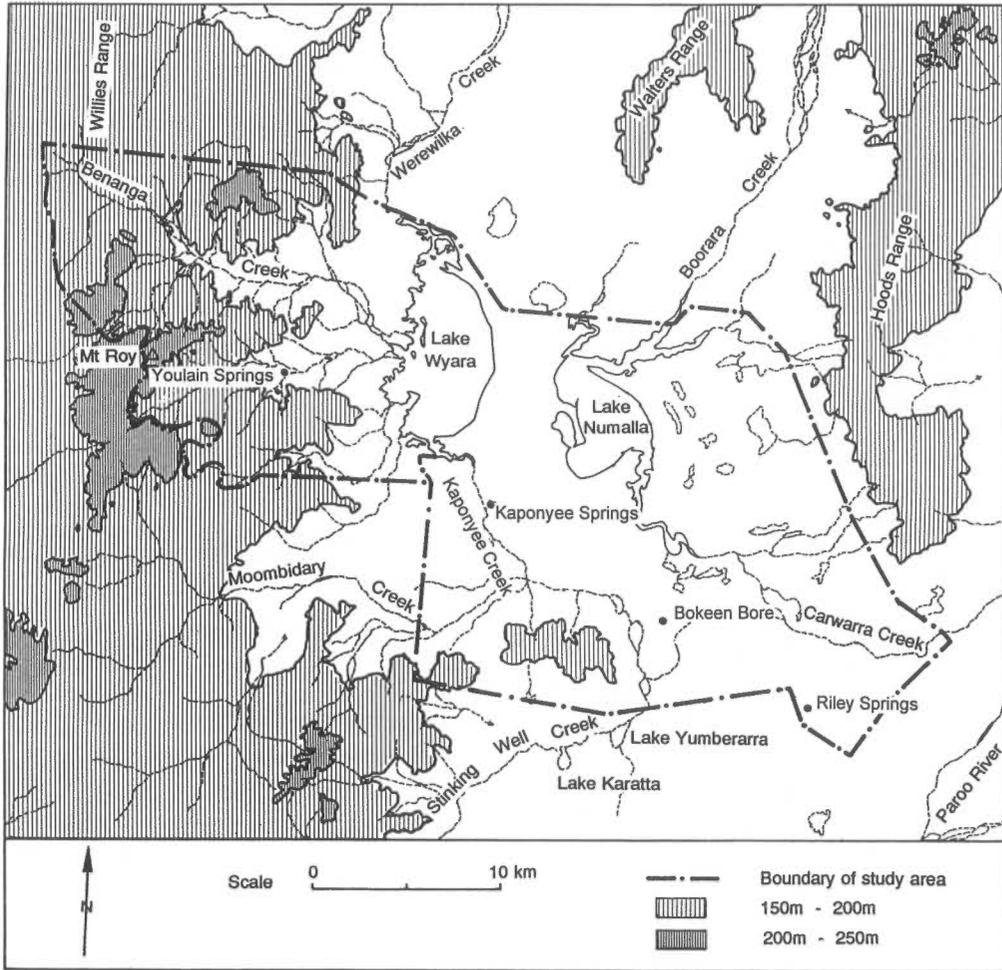


FIG. 1. Plan of Youlain Springs general location

vicinity of the site so the original position of the spring is obscured. The spring is dry and the windmill has fallen into disrepair. Small sections of a concrete dam wall placed at the end of the waterhole remain in the creek bed. Youlaingee Ck rises in the dissected residuals of the Grey (R3) landsystem to the west of L. Wyara and flows into its western side, approximately 6km to the east of the site. The Grey Land System has: 'Gently undulating to flat tops and scarps of dissected tablelands, mesas and buttes; mulga, bastard mulga, shrubby tall open shrubland; lithosols and shallow red earths with silcrete cover' (Dawson & Boyland, 1974).

These creeks have formed in a small valley separated from creek systems to the north, south and west by an arc of dissected residuals. Youlain Springs marks the approximate western boundary of a pocket of the Wanko (H3) hard mulga land system that encompasses the mid-to-lower course of Youlaingee Ck. This land system is: 'Gently undulating to undulating convex plains; mulga (sparse) tall open shrubland; shallow to moderately deep red earths with silcrete cover' (Dawson & Boyland, 1974).

Immediately to the north, west and south the Wanko land system is bounded by the gently undulating to undulating convex plains of the Wanko (H3)/Bingara (H4) hard mulga land sys-

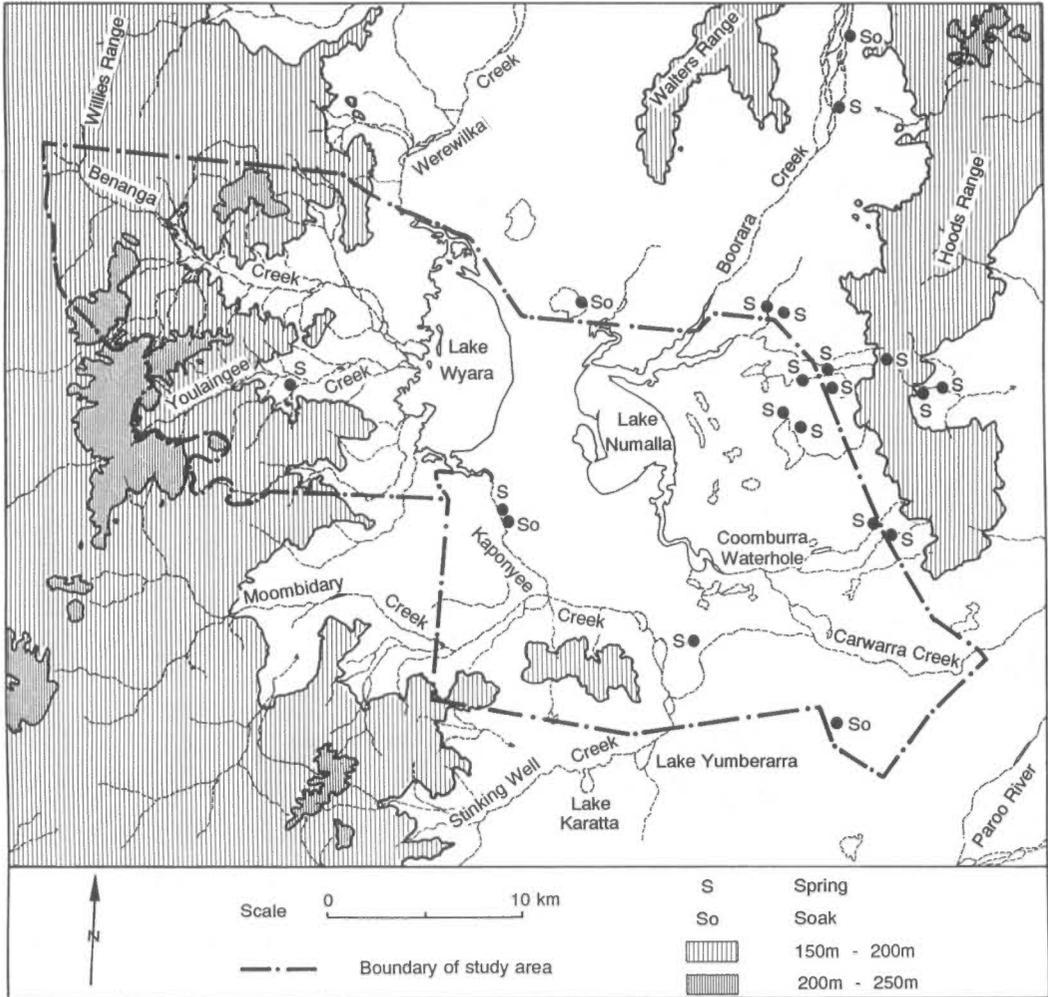


FIG. 2. Location of some of the springs and soaks in the vicinity of the study area

tems graduating to the Grey (R3) dissected residual land system (Dawson & Boyland, 1974). West of the junction of the two creeks is a semi-permanent waterhole approximately 200m long, fringed with river red gum (*Eucalyptus camaldulensis*) woodland. On its northern side, the bank varies in width up to 30m and consists of an uneven surface of gravel and boulders mixed with coarse sand. Behind this is a steep, in parts cliffed, slope up to 4m high that breaks onto the gently undulating surface of the convex plains. On the southern side of the waterhole, the bank is formed by gravels, in parts benched. Where the

creek has incised through the gravels of the Tertiary sediments, low conglomerate cliffs have formed. Covering the gravel bench, and in places the Tertiary sediments, is a complex mixture of gravels, hardpans and up to 2m depth of loam. These deposits have formed a very gently undulating surface about 100m long and up to 50m wide. To the south, this surface is bounded by a shallow gully that abuts a gently sloping gibber surface. To the north, this area is cliffed and falls away to the cobble bench. The surface is predominantly loam with some outcropping hardpan surfaces. In some areas, low sand dunes cover both the loams and the hardpans and the surface is

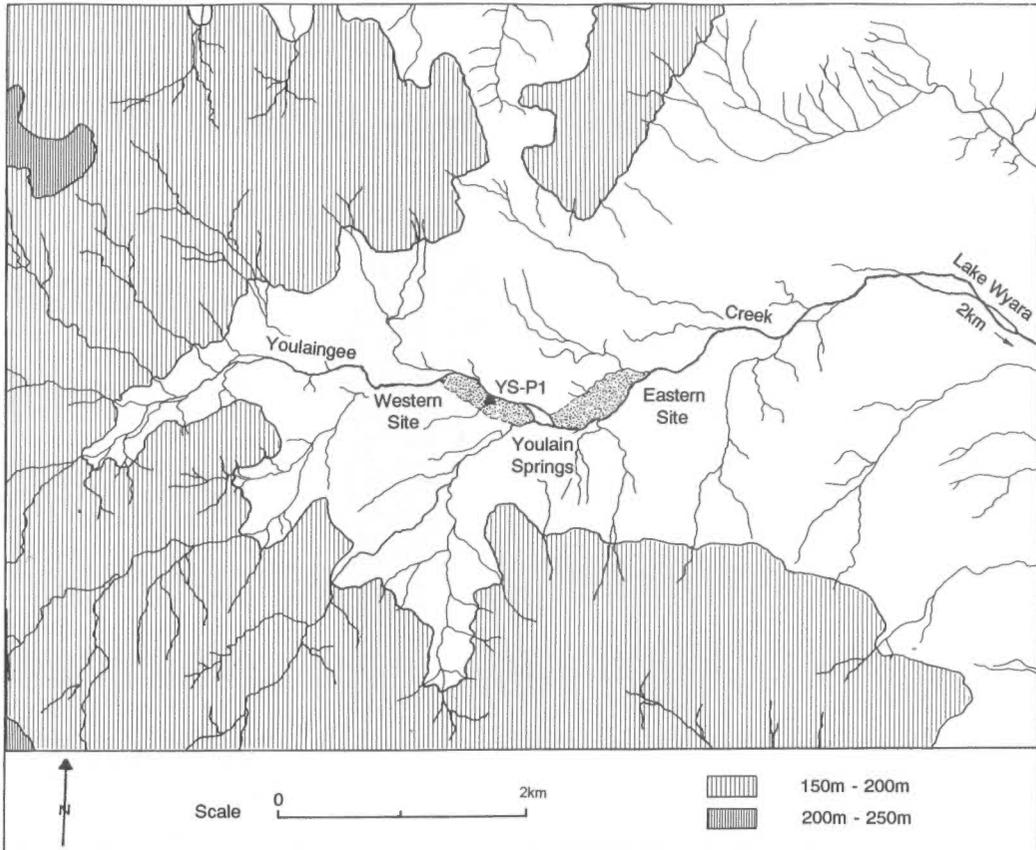


FIG. 3. Location of Youlain Springs eastern and western sites and Pit 1.

vegetated with low shrubs, forbs and herbs. This locality will be referred to as the Western Site (Fig. 3).

East of the creek junction, Youlaingee Creek turns to the northeast. Immediately to the northwest of the creek bed is a broad, bare hardpan surface that backs onto the convex plains. This hardpan surface is approximately 500m wide and 1km long and will be referred to as the Eastern Site (Fig. 3).

This locality has a rich and complex archaeology. Scatters of artefacts extend for approximately 500m north and south of the creek with the densest concentrations closer to the creek bed. A dense scatter extends about 1km west of the junction on the south side of the creek and about 1km east of the junction on the north side of the creek. As well as being rich in surface evidence, this site also offered opportunities for obtaining stratified dates. At both the Western and

Eastern Sites, artefacts are cemented into the upper 30cm of hardpan. At the Western Site, bone fragments are also embedded in hardpan and faunal material was found eroding from the lower levels of the loam. This bone was the only faunal material observed in association with archaeological material in the study area. In addition, exposed deposits of loam up to 2m deep and with artefacts scatters on the surface and (apparently) throughout the exposed section, provided an opportunity to obtain a more comprehensive chronology than that obtained from other sites in the study area. It also offered the opportunity to obtain information about open site formation processes in arid environments.

This site is on a valley floor at the confluence of two creeks close to the edge of the escarpment. Parts of the site are at the edges of a stream and others in the vicinity of a spring. Therefore, it is subject to aeolian, alluvial and colluvial depositional and erosional processes in addition to a variety of

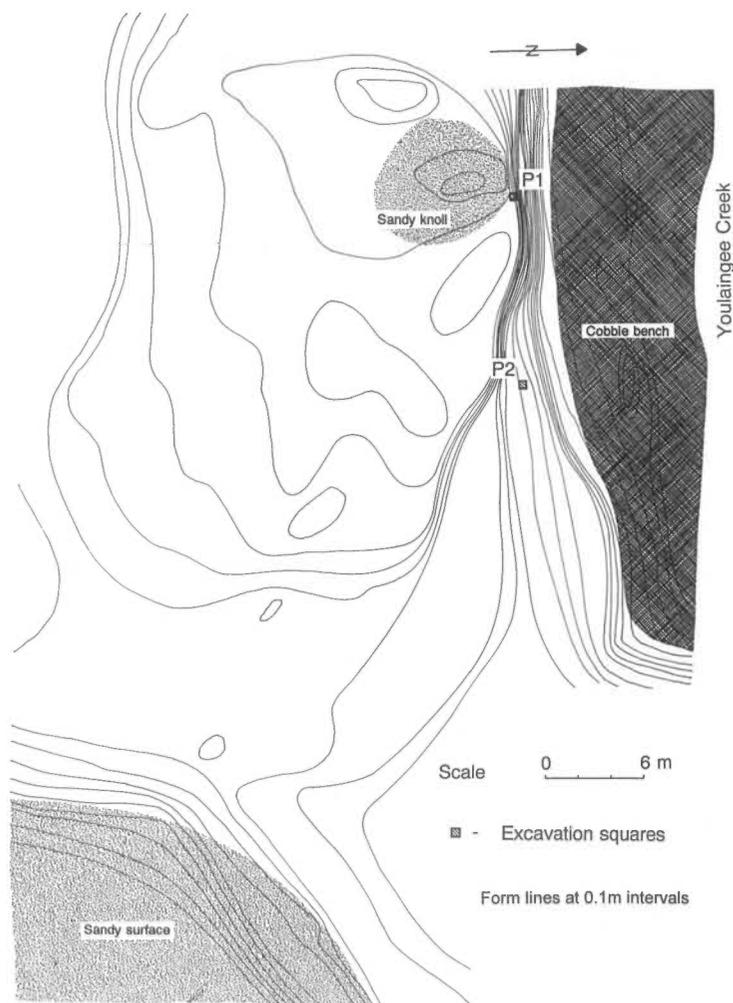


FIG. 4. Plan of Youlain Springs excavation site

pedogenic factors. Exposition of the complexities involved in this site's history is beyond the aims and means of this study. However, test excavations of the loam, coupled with dating of the hardpan associated with artefacts, would provide an informed basis for later, more detailed, investigations. For this reason it was decided to excavate a 50cm x 50cm column at the edge of the cliffed loams above the stony bench of the Western Site (Fig. 4). In this way, a deep section could be excavated without the necessity of opening up a large pit. This pit was named P1. A second exploratory pit (P2) was excavated 11m to the east to attempt to determine the origin of eroded fau-

nal material (Fig. 4). The results of this excavation will not be discussed in detail here.

EXCAVATION

The excavated pit, P1, was positioned at the cliff edge of the desert loam surface on the cobble bench, at a point where the maximum depth of deposit could be obtained (Fig. 4). To the west, the cliff continued for approximately 100m where it terminated against a low cliff of Tertiary conglomerates. About 25m to the east, the cobble bench gave way to a low cobble rise, in parts capped with hardpan. From this point the hardpan continued to the east and south and formed a hard cap to the undulating cobble layer below. A thin veneer of loam and sand with some herb and shrub growth, covered this hardpan in places.

The excavated part of the profile presented approximately 2m depth of loam capped with a thin layer of red loamy sand. The upper 80cm was vertical, the remainder was steeply sloping at approximately 45°. Silt drapes, in some cases carrying artefacts, covered

the surface of the profile face. To avoid contamination from this silt drape, the face was cut back 10-20cm. In order to maintain some continuity in the profile as well as to avoid contamination, the sloping, lower section of the profile was cut back until it was contiguous with the upper section. However, to avoid removing more deposit than was felt necessary, particularly in view of erosion from floods, the lower section of the excavation was offset by 50cm from the upper.

The deposit was excavated following the procedures outlined by Johnson (1979). The deposit was removed in 95 Excavation Units (XUs); the

upper part, termed P1a, in 57 XUs (1-57) and the lower part, termed P1b, in 37 XUs (53-90). Five units (53-57) were excavated concurrently to maintain continuity. In accordance with stratigraphic convention (and unless stated otherwise), the data from Units P1a 1-57 are combined with those from Units P1b 58-90. The deposit was excavated to a total mean depth of 2.3 m, with a mean XU thickness of 24 mm; 986kg deposit was removed.

Sediment samples (100g) were taken from each unit prior to sieving. The deposit was then wet sieved on site through 2mm and 4mm wire mesh. Apart from the three basal units sorted in the field, all the material retained in the sieves was kept for laboratory sorting.

LABORATORY PROCEDURE

The retained sieved material was washed in the laboratory and divided into stone artefactual and non-artefactual material, bone and organic fragments. Stone artefacts were identified according to the classification system presented in Robins (1995:Glossary). Particle-size analysis, Munsell soil colours and soil reaction was undertaken on the retained sediment samples for selected XUs (1, 3, 7, 9, 14, 20, 32, 39, 50, 58, 67, 86 and 90). Particle-size analysis was by the modified pipette method of McTainsh and Duhaylungsod (1989) involving pipette analysis (at 1/2 φ intervals) < 31µm, wet sieving between 31µm and 90µm (at 1/4 φ intervals) and dry sieving > 90µm (at 1/4 φ intervals). Samples were analysed in a dispersed condition following removal of organic material by digestion in Hydrogen Peroxide (H₂O₂) and removal of iron oxides according to the method of Mehra and Jackson (1960), and carbonates according to the method of McTainsh et al. (1988). Clay mineralogy of some samples was determined by X-ray diffraction (XRD) us-

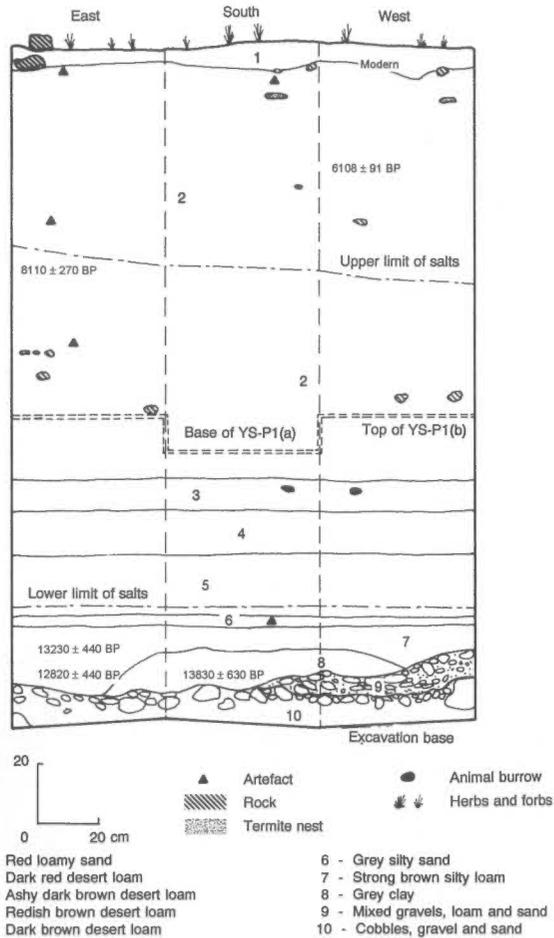


FIG. 5. Cross-section of three faces in Excavation Pit 1, Youlain Springs.

ing a Siemens D5000 X-ray Diffractometer with SIE 122 plus XPAS software for data analysis and presentation. As it was not possible to discriminate between naturally occurring stone and that introduced by people for, amongst other things, hearthstones, only the < 2mm in size categories are included in the soil analysis. The deposit is alkaline, and has a pH of 9.0.

DEPOSIT DESCRIPTION

Examination of the profile revealed 10 stratigraphic units distinguishable on the basis of

TABLE 1. Excavation Unit and mean depth for dates from Youlain Springs, Pit 1.

| XU | XU Thickness (mm) | Mean Depth (mm) | Age | Laboratory Numbers |
|-------|-------------------|-----------------|----------------------------|--------------------|
| 4 | 20 | 68 | Modern | NZA1207 |
| 17-18 | 38 | 332 | 4280 ± 120 | NZA1208 |
| 21 | 19 | 386 | 6108 ± 91 | NZA1575 |
| 35-37 | 89 | 764 | 8110 ± 270 | NZA1227 |
| 73-76 | 95 | 1933 | 13810 ± 260 | NZA1228 |
| 85 | 27 | 2197 | 13830 ± 630 | NZA671 |
| 87 | 23 | 2241 | 12820 ± 320 13230 ± 440 | NZA670 NZA606 |

their colour and/or their lithological characteristics (Figs 5 & 6):

Stratigraphic Unit 1. Capping of red (2.5YR 4/6) loamy sand 2-5cm thick. It has a distinct, but uneven boundary with Stratigraphic Unit (SU)2. It contains some flecks of charcoal, charcoal staining and roots. A number of artefacts are concentrated at the base of this unit.

Stratigraphic Unit 2. Dark reddish brown to dark red (2.5 YR 3/4-3/6) desert loam that continues to a depth of 1.4m. Mineral salts were detected approximately 15cm from the surface and increased to the base of this unit.

Stratigraphic Unit 3. Has a diffuse boundary with SUs 2 and 4. It is a band of dark brown (7.5 YR 3/3) to very dark grey (7.5 YR N3) ashy sediment approximately 10cm thick. A circular feature, possibly a burrow, filled with red sand was identified in the southwest corner. The amount of mineral salts diminishes with depth.

Stratigraphic Unit 4. Band of dark red to reddish brown (2.5 YR 3/6 - 2.5 YR 4/4) sediment with flecks of weathered charcoal throughout. This unit is approximately 15cm thick (150-165cm), and has diffuse boundaries with the units above and below. Mineral salts continue throughout but diminish with depth.

Stratigraphic Unit 5. Similar in appearance and colour to SU3. It is approximately 20cm thick and has diffuse boundaries. The incidence of mineral salts in this layer is much less than for the unit above.

Stratigraphic Unit 6. Four centimetres thick grey (7.5 YR N5) silty sand layer with flecks of charcoal throughout.

Stratigraphic Unit 7. Varies in thickness from between 10-24cm. It is a strong brown (7.5 YR 5/6) silty loam with flecks of weathered charcoal throughout.

Stratigraphic Unit 8. Grey (7.5 YR N6) clay layer with some evidence of banding. Some sands occur at the base of this unit. It has a distinct boundary with SU9.

Stratigraphic Unit 9. Wedge of gravels, sand and loam observable in the western and southern profile. It has a maximum thickness of about 15 cm. It blends into unit 10.

Stratigraphic Unit 10. Basal unit. It consists of coarse river cobbles, gravel and sand.

An elaboration of the formational history of these sediments can be made with reference to the particle-size analyses. There are similarities in the pattern of particle-size distribution for the lower XUs (Fig. 7). All have a similar clay content (8-13%), a minor silt contribution, and peaks in the fine sand (75µm and 150-180µm). However, there is also some variation. Excavation



FIG. 6. Youlain Springs Pit 1. (Scale = 2m)

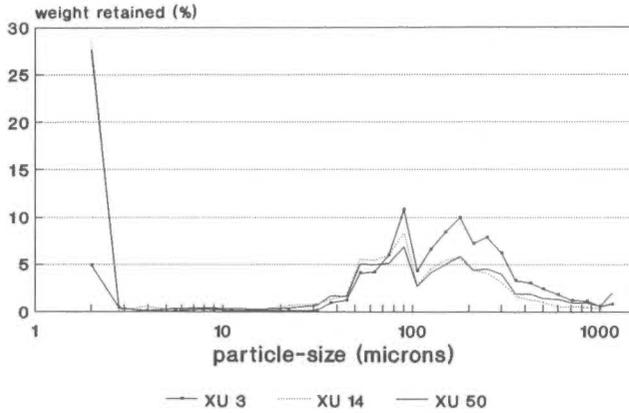


FIG. 7. Particle-size distribution in the <2mm field-sieved fractions from XUs 3, 14 and 50 Youlain Springs, Pit 1.

Unit 86 has a relatively high fine sand, but a relatively low silt contribution. Excavation Unit 67 has a subdued fine sand component, and a peak at 80µm. Excavation Units 86 and 58 have peaks at 55µm (silt/fine sand boundary) and at 80µm (fine sand). The upper XUs of the deposit have a more uniform particle-size distribution, and one that differs in important ways from the lower XUs. The particle-size distribution from XUs 14 and 50 have been selected to illustrate this point (Fig. 8). These units have a relatively high clay content (27%), very little silt, a small peak at 50-60 µm, a larger peak at 85µm and a similar fine to coarse sand representation. X-Ray diffraction of the fine

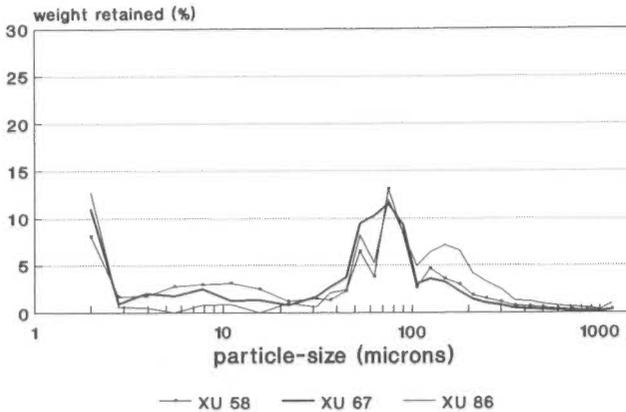


FIG. 8. Particle-size distribution in the <2mm field-sieved fractions from XUs 58, 67 and 86 Youlain Springs, Pit 1.

fraction identified kaolinite (probably from the local Winton formation) as a component. The loamy sand cap of the deposit has a low clay and high sand representation.

DATING. A series of charcoal samples were used to date the deposit. The quality of charcoal largely determined what could be dated and where the dates would come from. Eight age determinations were obtained (Table 1); all were Accelerator Mass Spectrometry dates from very small samples. In some cases, the amount of charcoal from individual XUs was insufficient and was combined with charcoal from adjacent XUs to obtain enough material for dating. In Table 1, and for the purposes of constructing the age-depth plot, the mean midpoint depth of the XUs is used (Fig. 9).

There is general consistency in the age-depth plot. The dates range from late Pleistocene for the basal XUs to Modern for the upper XUs. The basal XUs, however, show some minor inconsistencies. Although XU 87 yielded two dates whose standard deviations overlap, the date from XUs 73-76 is older than, and its standard deviation does not overlap, with that of the youngest date from XU 87. It does, however overlap with that of the oldest date from XU 87. In fact, every XU below 73 yields a date which overlaps every other date when standard deviations are taken into account. In view of this overlap, and the fact that the discrepancy of the aberrant date is not large, these ages are taken as a reasonable approximation of the age of the lower deposits. Stratigraphic Unit 1, of which XU 4 is a part (dated to 'Modern'), is a loamy sand and the vertical movement of material within it can be expected (Robins, 1993).

The dating is consistent with the interpretation of depositional history given in the discussion above. It appears that the lower half of the desert loam has accumulated very quickly at the end of the Pleistocene. In the Holocene, nett accumulation varies through time, with a noticeable reduction in the rate of deposition between about 6,000BP and about 4,000BP. Due to the sites location, this variation may be as much due to

TABLE 2. Identifiable faunal remains, Youlain Springs, Pit 1.

| Excavation Unit | Identified Faunal Remains |
|-----------------|---|
| 28 | Tooth Fragment |
| 51 | Large Macropod molar fragment |
| 60 | Mammal phalanx - brushtail possum size |
| 67 | Brushtail possum (<i>Trichosurus vulpecula</i>) mandible |
| 69 | Large mammalian bone fragments and complete small bones |
| 78 | Fragment of large macropod molar |
| 82 | 1 large macropod claw, a phalanx from a pademelon size wallaby and 2 fish vertebrae |
| 83 | Pelvic fragment of a small wallaby, femur head of a large kangaroo, claw fragment of a medium wallaby, jaw of <i>Onychogalea lunata</i> |
| 84 | Right maxillary fragment from a small rock wallaby size wallaby |
| 86 | Small macropod incisor tip and molar fragment |
| 87 | Wallaby size lower molar fragments |

local erosional/depositional factors as it is to wider climatic influences.

Artefacts were also embedded in hardpan approximately 40m to the southeast, in an area where the hardpan and desert loam meet. A Thermoluminescence date of $7,900 \pm 500$ BP (W802) was obtained from sediments 20cm below the surface. Particle-size analysis indicates that the sediments are more similar to the upper XUs in YS-P1 than to the lower, Pleistocene sediments. The sediments are a similar particle-size distribution to the East Site hardpan suggesting an early Holocene age for the artefacts cemented into that sediment.

FAUNAL REMAINS. A total of 84.3g of faunal material was recovered from 34 XUs. The amount recovered per XU varies from 0.01g to 26.34g. The distribution of remains is intermittent and restricted to the lower two-thirds of the pit (Fig. 10). They are therefore 6,000BP or older, with the majority coming from the Pleistocene layers. The relatively rapid accumulation of sediment on this site at the end of the Pleistocene probably acted as a buffer to exposure and weathering and assisted in their preservation. The remains are generally very fragmented, mineralised and in some cases probably burnt. Most are bone, although some teeth and claws were found. Colour variation in the bone

ranges from light to dark brown, and in the case of the burnt bone, white-blue.

The small size of fragments and their poor condition made identification difficult (Table 2). The majority of identifiable remains are from mammals, mostly macropods. Of interest is the jaw of the Crescent Nailtail Wallaby (*Onychogalea lunata*), now presumed extinct, whose recorded range was southwest Western Australia and central Australia (Burbidge, 1991). This specimen is securely dated to the late Pleistocene and is the first recorded for this area. The other remains of interest are the unidentifiable fish vertebrae. The closest habitat for fish would have been L. Wyara, 6km to the east.

Apart from considerable variation in quantity, the faunal assemblage has an uneven vertical distribution. In one case, between XUs 53 and 58, a gap of 13cm occurs (Fig. 10). In general, although only in small amounts, the pattern of distribution of fauna coincides with that of the recovered artefacts. There is, however, no way of linking this material directly to human occupation. The bone is small enough to represent scat remains from *Sarcophilus harrisii* (Tasmanian Devil) or from owl pellets (S. Solomon, pers. comm.). None of the bone had identifiable teeth or cut marks. Some of the bone had the characteristic white-blue colour that results from prolonged burning in hot fires (David, 1990; Shipman et al., 1984). However, without more detailed analysis, this can be no more than surmise. Even if the bone was burnt, this need not imply that it was burnt as food. Post-depositional burning may have occurred.

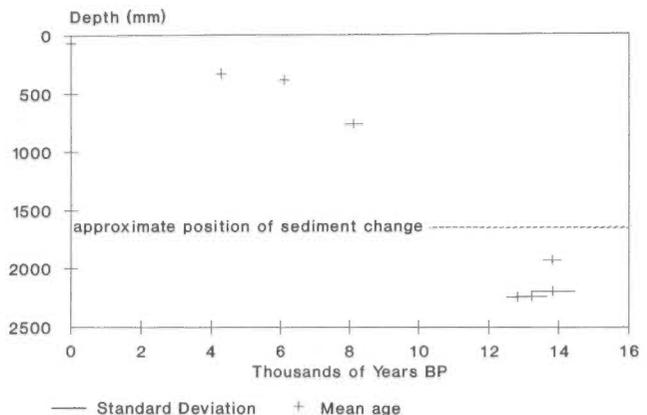


FIG. 9. Age-depth plot, Youlain Springs, Pit 1.

TABLE 3. Frequency and mass of retouched flakes and cores from Youlain Springs Pit 1.

| Type | No. | Length (mm) | | | Width (mm) | | | Thickness (mm) | | | Mass (g) | | |
|-----------------|-----|-------------|-----|------|------------|-----|------|----------------|-----|------|----------|------|-------|
| | | Max | Min | Mean | Max | Min | Mean | Max | Min | Mean | Max | Min | Mean |
| Retouched Flake | 16 | 52 | 5 | 25 | 42 | 6 | 21 | 25 | 1 | 9 | 53.5 | 0.06 | 10.0 |
| Cores | 10 | 143 | 23 | 69 | 136 | 18 | 57 | 99 | 19 | 46 | 655.0 | 14.6 | 223.6 |

Bone fragments were collected from the loam bench to the east of P1, near the position of P2, as well as the cobble bench. The precise location of the origin of this bone could not be ascertained, although it was determined that it is eroding from deposits lower than XU 43 in P1. This observation, coupled with its similar condition and appearance to that of the bone recovered from P1, supports an assumption that it is of similar age. Amongst these remains is a dentary from *Largorchestes conspicillatus* (Spectacled Hare-wallaby), a jaw of *Onychogalea* sp., and a mandible from an *Isoodon obesulus* (Southern Brown Bandicoot). These records expand their recorded range; the Bandicoot from southern Australia and Cape York (Braithwaite, 1991:94) and the Hare-wallaby from the tropical grasslands of northern Australia (Burbidge & Johnson, 1991). No mega-faunal remains were found.

FLORAL REMAINS. The highly alkaline nature of this deposit precluded pollen analysis. Floral remains (leaf fragments, wood fragments, and burrs) were recovered from XUs 40, 43, 47, 53 and 80. The only identifiable remain is a burr, possibly from a Spiny Emex (*Emex australis*) from XU 40 (R. Johnson, Qld. D.P.I. Botany Branch, pers. comm.).

STONE ARTEFACTS. A total of 501 stone artefacts were recovered from the >2mm sieve fractions. There are 253 flakes, 16 retouched flakes, 106 flaked pieces, 113 transversely snapped flakes, 4 single platform cores, 6 multi-platform cores, 1 piece of ochre, 1 hammerstone, and 1 backed blade (from XU5). With the exception of the ochre, all the stone artefacts are made from silcrete. No artefacts were found below XU 87.

Although artefacts are found throughout the excava-

tion, distribution is uneven (0-64/XU) (Fig. 11). Between XUs 1 and 87, 19 (22%) have no artefacts. Four distinct groupings of artefacts, interspersed with XUs with no or few artefacts, are evident. For the purpose of discussion, these four groups are used to illustrate aspects of the assemblage; they are XUs 1-13 (Group 1), 21-38 (Group 2), 44-53 (Group 3) and 78b-84b (Group 4). They represent 93% (466) of all artefacts recovered (Fig. 12). The criterion for defining each group was an arbitrary one; a group had to contain five or more consecutive XUs with artefacts. Excavation Units are used as the basis for discussion due to the lack of well-defined Stratigraphic Units for most of the deposit. The excavation method provides a unit of measure that is reasonably consistent and comparable throughout the excavation.

The following is a discussion of the characteristics of the assemblage, although the low numbers of some artefact types restricts detailed discussion to those better represented. The richness in artefact representation diminishes slightly with depth. Group 1 has seven artefact types,

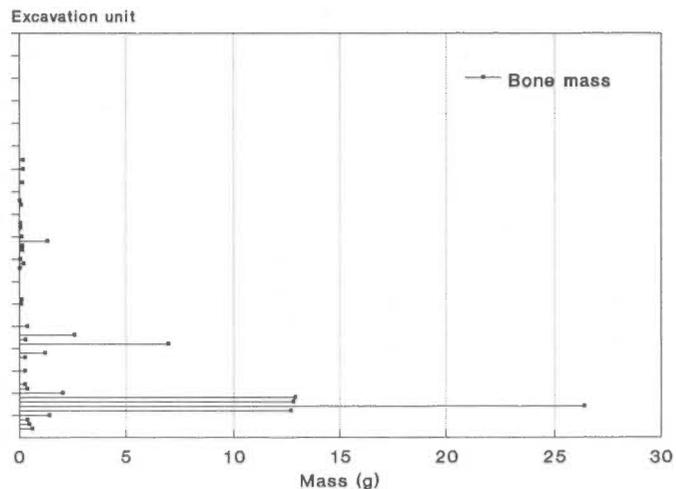


FIG. 10. Bone mass in the >2mm field-sieved fractions, Youlain Springs, Pit 1.

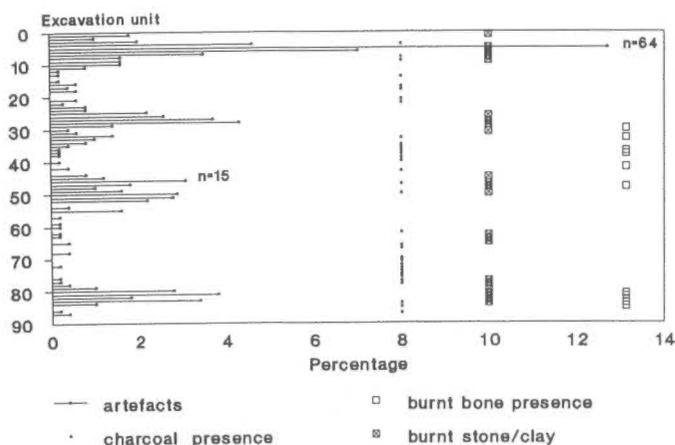


FIG. 11. Artefact abundance compared with the presence of burnt bone, burnt stone and charcoal, Youlain Springs, Pit 1.

Group 2 has six followed by five for Groups 3 and 4. However, this measure of richness is constrained by the poor sample size for some types. The only backed blade and ochre sample to be found are from Group 1. Although retouched flakes occur throughout, they are poorly represented. Each group is dominated by flakes followed closely, except in the case of Group 1, by flaked pieces. The proportion of snapped flakes declines slightly with depth while the proportion of retouched flakes remains consistent, with the exception of Group 2, where there is a sharp decline from 13.5% to 1% (Fig. 12).

Flakes have the greatest and most consistent representation throughout the excavation. On the

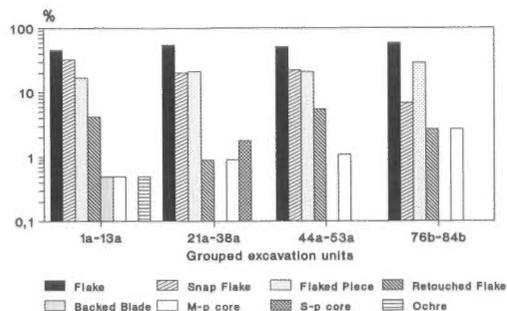


FIG. 12. Abundance of artefact types at Youlain Springs, Pit 1.

basis of comparison of their dimensions and mass, six observations are worthy of comment. These observations are made with reference to Figs 13-14.

a) The flakes are consistently of a small size; the mean length for flakes from any one XU is <math><15\text{mm}</math>.

b) There is a close and consistent relationship between length and width throughout the deposit. Flakes tend to be short and broad.

d) Although the correlation is not as close, thickness consistently reflects changes in length and width.

e) There is a slight increase in overall size with depth. The maximum length dimension, for example, increases from a mean of 14mm in the upper XUs to 20mm in the lower. This size increase is maintained when the data are presented by group. The overall increase is, however, modest.

f) Because the ratios between length, width and thickness are reasonably consistent, and because the raw material is of one type only, there is also a consistent relationship between dimension and mass.

g) There is no relationship between flake size and sample size. While the sample may be biased due to uneven numbers throughout, it is not the case that there is bias due to a simple relationship between size and numbers.

There are insufficient retouched flakes to present a meaningful analysis by XU, and this discussion is restricted to general observations. Table

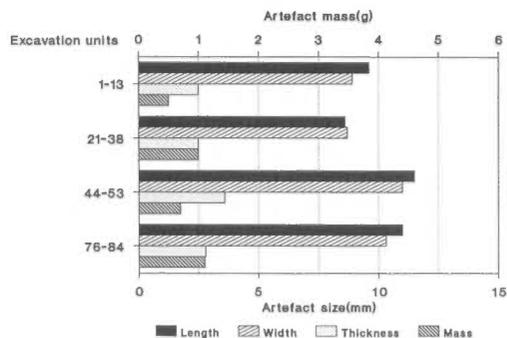


FIG. 13. Mean flake size and mass by grouped XUs Youlain Springs, Pit 1.

TABLE 4. Frequency and mass for flaked pieces and snapped flakes for Excavation Groups 1-4, Youlain Springs Pit 1.

| XU | Flaked Pieces | | | | Snapped Flakes | | | |
|-------|---------------|------------------|------------------|---------------|----------------|------------------|------------------|---------------|
| | Number | Maximum Mass (g) | Maximum Mass (g) | Mean Mass (g) | Number | Maximum Mass (g) | Minimum Mass (g) | Mean Mass (g) |
| 1-13 | 32 | 2.5 | 0.01 | 0.23 | 62 | 6.0 | 0.01 | 0.4 |
| 21-38 | 23 | 0.3 | 0.01 | 0.05 | 22 | 27.6 | 0.01 | 1.7 |
| 44-55 | 19 | 1.1 | 0.01 | 0.2 | 20 | 7.7 | 0.01 | 0.6 |
| 76-84 | 21 | 2.21 | 0.02 | 0.3 | 5 | 1.2 | 0.03 | 0.3 |

presents the combined data on their dimensions and mass. From this, it can be seen that there is considerable range in the size and mass of the retouched flakes, and the mean dimensions are considerably greater than those for flakes. However, the consistent relationship between length, width and thickness also applies. The small number of cores limits discussion. From figures in Table 3, it can be seen that there is considerable variation in the size and mass of the cores. Cores are generally small and have a mean length of only 69mm. Conjoin sets linking flakes with particular cores was attempted without success.

Table 4 presents the mean mass of transverse snapped flakes and flaked pieces by grouped XUs. As noted above, the proportion of snapped flakes and flaked pieces to flakes remains generally consistent throughout. The most outstanding characteristic of both these types is their small size, as inferred from their mean mass compared with those of the flakes. There is however, considerable variation in mass within type between the grouped XUs.

OTHER ARCHAEOLOGICAL EVIDENCE. Apart from the stone artefacts, two other types of archaeological evidence, and two possible sources of evidence, were noted. In XU 6 a small fragment of rust was recovered. This is modern and probably dates from the sites use as a stock camp or watering point. The second type of evidence was in the form of small pellets of burnt clay. Ninety four pellets totalling 26g in weight were recovered from seven XUs (48, 64, 80, 81, 82, 83 and 84). Although there was evidence of stone hearths on the

surface of the site and perhaps in the excavation, these are the only evidence for the possible use of clay for hearths.

There is a third, more equivocal form of occupational evidence — burnt stone and charcoal. When all the evidence for burning is taken into account (charcoal, clay pellets, burnt bone and stone), there is a continuous record of burning throughout the deposit. The types of evidence for burning are, however, not always associated with one other. On the surface of the site there are numerous stone hearths with ash-stained and heat-fractured (crenated and pottlidded) stone. Similar stones were also found throughout the occupation. Some artefacts showed comparable evidence of heat exposure and several potlids were also found in the deposit. This, however, does not constitute direct evidence for stone hearths in the excavation. Heat fracturing may also occur indirectly, for example, if the stone in question was directly below a fire (Hiscock, 1990), or if the

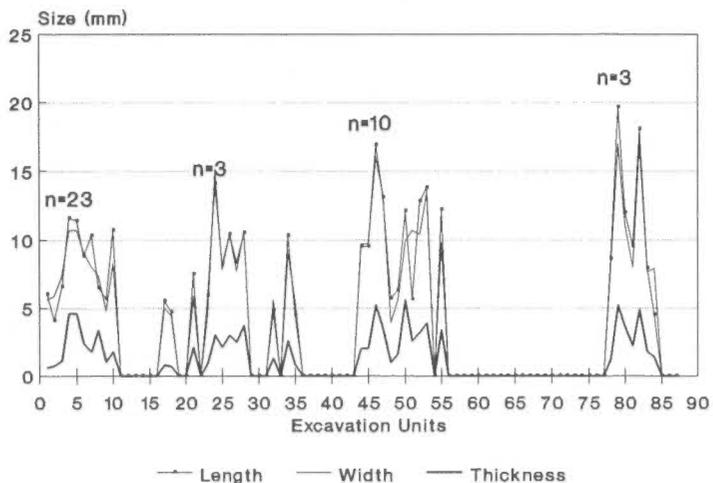


FIG. 14. Mean flake size from XUs with >1 flake represented, Youlain Springs, Pit 1.

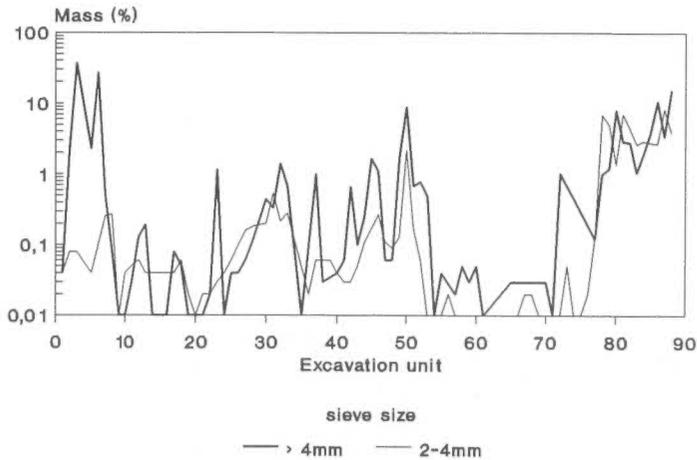


FIG. 15. Gross texture of field-sieved XUs Youlain Springs, Pit 1.

stone may have been brought to that point after it had been fired elsewhere. There is however, a generally good correlation between the peaks of artefacts and the presence of burnt stone and clay (Fig. 11). This is not the case for the charcoal. Apart from some XUs in Groups 1 and 4, charcoal is present in XUs where there are few or no artefacts. One possible explanation for this pattern is that this charcoal represents natural burning of the vegetation cover during times when there is no occupation and the vegetation has a chance to grow. This interpretation may also partly account for the poor quality of the charcoal, as the fuel at this locality may have been restricted to forbs, herbs and grasses with the occasional bush, as it is today.

The fourth potential source of occupational evidence, the presence of unflaked stones in the deposit, is more problematical. Much of the stone on the site may not be the result of natural processes, but may have been brought there as raw material for hearthstones, cores, hammerstones or some other cultural purpose. The excavation recording system compounds the difficulties for interpretation. Sieve fractions were recorded as a total mass only. It is therefore possible that high percentages in the coarse fraction are represented by only one large stone, although less likely for the medium fraction. Figure 15 presents a graph of the gross texture of field sieved XUs. This graph shows some similarity in the occurrence of the two sieve fractions. When the coarse fraction increases or decreases, the 2-4mm sieve fraction generally responds in a similar manner. While this indicates a correspondence between the

coarse and medium fraction, it does not identify a cause. However, if there were some relationship between the introduction of stone and occupation episodes, there should be some correlation between the occurrence of stones and artefacts. This expectation is met in some instances. There are, for example, peaks in the coarse and medium fractions co-incident with the four artefact rich groups. There are also some reductions where artefact numbers are less, for example between XUs 55-70. This correlation, however, does not always apply. There are, for example, no commensurate rises in artefact numbers

when the sieve mass fraction increases in XUs 23, 37, and 72. It is therefore not possible to differentiate between manuports and naturally occurring stone.

DISCUSSION

Youlain Springs has a complex depositional history of 13,000 years at least. Although this test excavation sampled only a small fraction of the deposit, evidence has been obtained to suggest a tentative temporal model for cultural activity in this part of the site. The occupational evidence commenced when a sequence of alluvial, followed by aeolian/colluvial deposits, began to accumulate over a cobble bench in the base of a narrow valley. This deposition was rapid, and by the end of the Pleistocene, approximately 1m of deposit had accumulated. The nature of the deposit then changes. The clay content becomes higher and the dust signature becomes clearer, indicating a change in the conditions of deposition at around the end of the Pleistocene or early Holocene. Aeolian deposition continues and there is a net accumulation throughout the Holocene. A thin layer of sand caps the deposit.

The variety of artefacts recovered from this deposit is small and interpretation can only be made at a general level. Fluctuations in artefact numbers can be accounted for by a number of competing explanations and caution must be exercised when ascribing causes to these patterns (Hiscock, 1981), particularly when dealing with a very small number of artefacts over a long period of

time. This fact is emphasised when mean artefact deposition rates, which range from 1 artefact every 18 years to 1 artefact every 304 years, are considered.

A critical issue is to determine the integrity of the deposit and to securely fix the artefacts in a temporal framework. It is clear that this deposit is largely natural but includes some cultural material. As such it has probably been subjected to a range of geomorphic processes which have resulted in mixing of cultural materials. The processes that may mix or sort material in deposits in arid regions are well documented in the literature (Jessup, 1960; Wood & Johnson, 1978; Foley, 1981; Schiffer, 1987; Johnson, 1990). They include plants, mass movement, water, gas, wind, air, salts and other chemicals, and soil expansion and contraction. Cultural processes, including re-use of cultural material left on a site (Baker, 1978), or site use, particularly trampling (Stockton, 1973; Hughes & Lampert, 1977; Siirinen, 1977; Villa & Courtin, 1983; Gifford-Gonzales et al., 1985; Nielson, 1991) can also result in loss of stratigraphic integrity. The first step to determine if post-depositional disturbance has occurred, and the degree to which it has, is to search for indicative patterns in the deposit.

At a gross level, a number of agencies may cause mixing or sorting of elements of a deposit. For example, the process known as argilliturbation, may force large stones (including stone artefacts) through desert loams to the surface by expanding and contracting clays (Wood & Johnson, 1978). This process has been reported for clay rich soils in arid and semi-arid regions, and is cited as one of the causes for desert pavements (Jessup, 1960; Wood & Johnson, 1978). It is, however, unlikely that a single natural agency has operated consistently throughout this deposit. The dates demonstrate the general integrity of the deposit. Examination of the sieve residue graph (Fig. 15) provides no indication of size sorting or gross movement, either up or down the profile. The particle-size analyses provides no evidence of illuviation of the clays. The artefact analysis provides no evidence of gross sorting (Figs 13 & 14).

Although there is no evidence of gross disturbance throughout the deposit, it is possible that disturbance takes place at a smaller scale. However, for a deposit of this age and complexity, these processes are unlikely to be uniform. The surface sand for example, is a disturbed deposit whose integrity is likely to be poor. The modern date from XU 4 and the piece of metal in XU 6 at-

test to that. In addition, the interface between the sand and the desert loam has the greatest concentration of artefacts, suggesting that they have migrated through the sand deposit to settle on the surface of the more compact desert loam. Throughout the study area there are examples of artefacts that appear to be eroding out of sand dunes and onto claypan, loam or red earth surfaces. The high incidence of artefacts on the loam but not in the sand indicates less penetration by artefacts in this denser surface. Experimental work on this site demonstrated less vertical artefact movement in loams compared to sands (Robins, 1993). In this experiment, artefacts moved down through sandy sediments up to 8cm over a three year period. Other experimental work by Gifford-Gonzales et al. (1985) adds support to this interpretation. In a trampling experiment, they compared the vertical movement of artefacts in sand with those in loam. They found that only a small percentage of artefacts in the loam were vertically displaced more than 2cm below the surface compared with 40% of artefacts displaced 3-8cm below the surface in sand.

There are, however, two other competing explanations for this abundance. The sand capping may have covered a lag of artefacts or an occupational surface that was already there as a result of deposition directly onto the loam. Secondly, there may have been artefacts in a sandy deposit that were left as a lag when that sand moved. These may have been then covered by a second episode of sand deposition. Further, the identification of processes to explain the artefact peak in XU 5, does not discount the alternative explanations for the other artefact peaks in the deposit.

The episodic nature of the incidence of stone throughout the rest of the deposit may be a result of natural processes, such as argilliturbation, occurring several times during the accumulation of this deposit. Such an explanation for the pattern of artefact distribution in this deposit is unlikely on several counts. Although the occurrence of artefacts is episodic, the incidence of non-artefactual material does not exhibit this episodic character to the same degree. When the graph of artefact distribution is compared to the distribution of coarse and medium sieve fractions, there is not always coincidence in occurrence, as would be expected if all material in the deposit were subjected to this sorting and mixing processes. There is concurrence in the presence of fire-affected stone and the densest artefact concentrations. Had the stone in the deposit been subject to considerable disturbance, this relationship would not

have been maintained. The consistent incidence of charcoal in artefact poor XUs would likewise not have been maintained. There is, furthermore, no evidence for the gross movement of bone, even though some of it is relatively large and quite dense. The evidence suggests the deposit had minimal gross vertical mixing of cultural material.

Even though this site can be interpreted as a natural deposit with incorporated cultural elements, the consequences of human behaviour on the pattern of artefact distribution can not be ignored. That is, the cultural elements of this deposit can not be regarded as though they are synonymous with, or secondary to, natural ones. It is not as though the dropping of artefacts is the end of the cultural influence in this deposit. Although clear distinction between the influence of cultural and natural post-depositional processes is not possible, there are three reasons for expecting the pattern of deposition not simply to mimic natural processes, but to be a unique blend of the two to produce complex depositional patterns.

1) Artefacts deposited on the site are the result of a range of cultural factors including population, intensity of occupation and activity range. These can be expected to vary over time and at rates independent of sediment deposition.

2) Culturally-derived post-depositional behaviour will affect the pattern of deposition. Artefact re-use and trampling, for example, will interrupt natural post-depositional processes.

3) The pattern of deposition expresses the relationship between the rate of cultural deposition and the rate of sediment deposition. The consequences of this fact will not only result in variations over time, but will influence other post-depositional processes. For example, experimental work indicates that artefacts trampled on the surface will be affected more by trampling than those that have a sediment buffer between them and the trampler (Gifford-Gonzales et al., 1985). The key to interpreting the post-depositional processes that gave rise to this pattern of deposition will lie with further experimental work coupled with more excavation.

Given the small excavated sample, the small number of artefacts recovered and the lack of detailed information about artefact response to several physical processes in desert soils, interpretation of this site is limited. Fluctuations in artefact numbers can be attributed to population change, changes in discard patterns and changes in the rates of discard or changes in the intensity with which the site was used. The most

parsimonious explanation is that camping was largely restricted to sandy surfaces. When the sand moved, a lag deposit of artefacts was left and subsequently covered by colluvially or aeolian derived loam, with some contribution from lateral drift of artefacts from other areas. While in the sand, and while on the surface of the loam, the artefacts have been subjected to minor mixing. When the sand moved back, the occupation moved with it and the process was repeated.

CONCLUSION

The excavation of the deposits at Youlain Springs provides evidence for Aboriginal occupation extending from the late Holocene to the late Pleistocene. The basal dates support evidence from the Strzelecki Desert (Smith et al., 1991) and the Cooper Ck Corridor (Veth et al., 1990) for evidence of occupation of the eastern part of the arid zone in the late Pleistocene. However, the evidence for initial occupation is coincident with alluvial deposits derived from a nearby creek. Under these circumstances, the evidence cannot be used to support models of continuous Pleistocene occupation, re-settlement following abandonment or initial occupation (Robins, 1993).

The results of this excavation indicate the potential for spring sites to contribute to knowledge of areas where other archaeological evidence is lacking. Such sites also bring with them a suite of interpretive problems different to those relating to rock shelter deposits. These issues will not be resolved by further excavation of this or other similar sites alone, but will also require the application of concurrent taphonomic, dating and geomorphic studies.

ACKNOWLEDGEMENTS

I thank Greg Sherwin for his advice and assistance. Without it this project would not have been possible. Julia Findlay, Rob Neale, Graham Duckworth, Tracy Adams, Doug Ward, and Lenart Johnson provided valuable help in the field. Grant McTainsh, Jay Hall, Bob Miles, Noel Dawson, Dan Witter, Su Solomon and Jeanette Hope provided useful comment and advice on the site. Jay Hall, Grant McTainsh, Bob Johnson, Jeanette Covacevich and Bruno David provided thoughtful comment and advice on the text. Jeff Johnson identified the fish remains, Steve Van Dyke the mammal remains and the Queensland Herbarium the floral remains. Tracy Adams and

Alan Lynch undertook the soil analyses and Laura Kiefert the X-Ray Diffraction. John Richter produced the illustrations. Mike Barbetti and Gillian Taylor provided advice and assistance on ¹⁴C dating. The Queensland Museum Board supported this research, and the Australian Heritage Commission, through the National Estate provided funds. Peter Veth and Peter Hiscock gave access to unpublished reports.

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