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ARTICLE

A Holocene sequence from Walufeni Cave, Southern Highlands Province, and its implications for the settlement of the Great Papuan Plateau, Papua New Guinea

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ABSTRACT

This paper presents preliminary results from the 2019 excavations at Walufeni Cave, at the eastern end of the Great Papuan Plateau (GPP) in western Papua New Guinea. Preliminary dating and analysis of the unfinished excavations at Walufeni Cave span the Holocene and probably continue into the Late Pleistocene, confirming the presence of people on the Plateau from at least the Early Holocene and potentially much earlier. The data presented here offer a site-specific model of early intensive site use from at least 10,000 years ago, then ephemeral use, followed by a sustained Late Holocene occupation. Although there are significant changes in the quantity of material discard over time, there is little evidence for significant change in the subsistence base or technology, reflecting a degree of relative homogeneity until the Late Holocene, when we see the introduction of pig, a change of focus in the plant economy and the presence of marine shell from the southern coast.

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Great Papuan Plateau; Terminal Pleistocene; Nassarius shell; Holocene occupation; Southern Highlands; Migration; rainforest subsistence

Introduction

This paper presents preliminary results from the 2019 excavations at Walufeni Cave, at the eastern end of the Great Papuan Plateau (GPP) in western Papua New Guinea. The Walufeni Cave excavation represents the first systematic archaeological exploration of the Plateau. It is part of a wider project which posits a model for the human occupation of the Great Papuan Plateau (GPP) in which we explore whether the Plateau was a corridor of movement eastward from western Sahul by early populations of hunter-gatherers in the Pleistocene. The presence of large limestone caves and rockshelters across the Plateau – many with previously undescribed petroglyph rock art – provide a range of potential sites to test this model. Preliminary dating and analysis of the unfinished excavations at the Walufeni Cave site span the Holocene and probably continue into the Late Pleistocene, confirming the presence of people on the Plateau from at least the Early Holocene and potentially much earlier.

The GPP is the single largest mid-montane land mass in the tropical zone of Sahul. It is a limestone karst plateau of mid-altitude, dense tropical forest in the Southern Highlands and Western Provinces of Papua New Guinea, stretching from the Strickland River in the west to the Hegigio/Kikori River in the east. It covers an area of 1709 km^2 at an elevation of approximately 225–1100 m above sea level (Schieffelin 1976). Bordering the Plateau to the north is the New Guinea Highlands (Karius Range) and to the south, the peaks of an extinct volcano, Mt Bosavi. Beyond that, the lowlands extend to the south coast of Papua New Guinea (Schieffelin and Crittenden 1991). The study area encompasses six main language groups – the Gubusi, Biami, Sonia, Onabasulu, Kaluli and Kasua – grouped together under the Bosavi language phylum.

Although very little archaeological research has been carried out in this part of Papua New Guinea,

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anthropological studies focussing on the GPP have been relatively extensive (e.g. Brunois 2004; Dwyer 1990; Freund 1979; Knauft 2005; Schieffelin 1976; Schieffelin and Crittenden 1991). From these studies of contemporary and historical populations it is proposed that Plateau societies lacked 'the high intensity food production and population density of the highlands [and] the sago and fish foraging lifestyle of their lowland neighbours' (Knauft 2005:31); thus, painting a picture of a mobile, low-density population living in a relatively marginal environment which was possibly only occupied relatively recently (Swadling 1983). We consider that such descriptions are a result of comparisons to high-density, highland agricultural populations and that, in fact, early hunter-gatherers moving on to the Plateau would have had no difficulty in adapting to Plateau environments – just as those hunter-gatherers who populated southern Sahul were able to inhabit the varied environments of all of what is now Australia between 65,000 and 40,000 years ago (Cosgrove et al. 2014). There is evidence that whether it be savannah grassland or tropical rainforest, people were quick to colonise these uninhabited areas of Sahul and that high elevations and mountainous/montane environments were not necessarily a barrier to early hunter-gatherers populating these environments (Crabtree et al. 2021; Denham et al. 2009; Fairbairn et al. 2006; Fairbairn and Florin 2022; Field et al. 2022; Gaffney et al. 2015, 2021; Roberts et al. 2017; Summerhayes et al. 2010). It is our view that rather than being a resource-poor, recently-settled region, the GPP could have provided an attractive and relatively easy corridor of movement for early peoples moving eastward from the western Sahul coast; a proposition first proposed by Dwyer (1984) in which he suggested that 'early and successful colonisation within prehistoric New Guinea may have occurred in the middle altitudes' (i.e. the GPP) and that the Pleistocene subsistence base on the GPP would probably have supported early occupation. We will explore that proposition further, as we continue to excavate in the study area.

The Walufeni Cave excavation

Walufeni Cave, belonging to the Hetagi clan of the Kasua, is a large limestone cave situated 1.72 km south of the Kasua village of Fogamaiyu, 1.95 km southwest of the Hegigio River (the Hegigio eventually becomes the Kikori River, 70 km southeast of Fogamaiyu) at the eastern end of the GPP at an elevation of 225 m (Figure 1). There is a creek running through the cave, entering approximately 20 m inside its western entrance, and exiting the cave at its eastern opening. The cave is approximately 350 m long and extends 35 m across at its widest, with a ceiling height of 26 m at its western entrance (Figure 2). There is a substantial sediment deposit extending to a potential depth of 6-8 m at the western entrance of the cave. The deposit slopes steeply away to the southeast and is interspersed with large rock roof fall (Lamb et al. 2021:308). At four places, benches have been cut into the steep slope to create flat living spaces (Figure 3). Cultural material in the form of burnt bone and stone artefacts are apparent, eroding out of the deposit through the entire sequence. At the top of the deposit, on the eastern wall of the cave and on the surfaces of some of the roof fall rocks, there are some 339 petroglyph motifs (Lamb et al. 2021) (Figure 4).

Two 1 × 1 m squares were excavated in Walufeni Cave, designated SQA and SQB. Square A was initiated as a 50 × 50 cm test-pit in 2018, and subsequently expanded to a 1 × 1 m square in the 2019 field season. Square A was situated on the very top of the cave deposit, closest to the western entrance, and was excavated to a maximum depth of 173 cm below the surface before encountering large, non-basal roof-fall rock. Square B was subsequently situated on the first cut bench, 3.3 m southeast of SQA, the top of which was 159 cm below the top surface of the cave deposit, and thus 14 cm above the bottom of SQA (Figures 3 and 5). SQB was excavated to a total depth of 133.1 cm. The volume of Excavation Units (XUs) in Square A and B was fairly uniform throughout the sequence with an overall average depth of 3.3 cm (Table 1).

Excavation proceeded in arbitrary excavation units following stratigraphy. Wet-sieving was undertaken at the site with 2 mm sieves, and preliminary sorting was carried out in the field at Fogomaiyu village. The material was then transported back to the archaeology laboratory at the University of Papua New Guinea where it was thoroughly washed, for transport back to the University of Southern Queensland (USQ) in accordance with the Australian Government's Biosecurity import regulations. Detailed sorting into the various material components was undertaken in the archaeology laboratory at the USQ, and the material was then subject to preliminary analysis by the various specialists in the team, the results of which are presented here.

Stratigraphy

The Stratigraphic Units (SUs) were all clearly defined and showed little visible evidence of any serious mixing of sediments (Figure 5). Square A consisted of five main stratigraphic units. SU1 extended to a maximum depth of 24 cm and was characterised by a dark grey (10YR 3/1) sediment interspersed with lighter ashy material. SU2, extending to a depth of 35 cm, consisted of similar dark

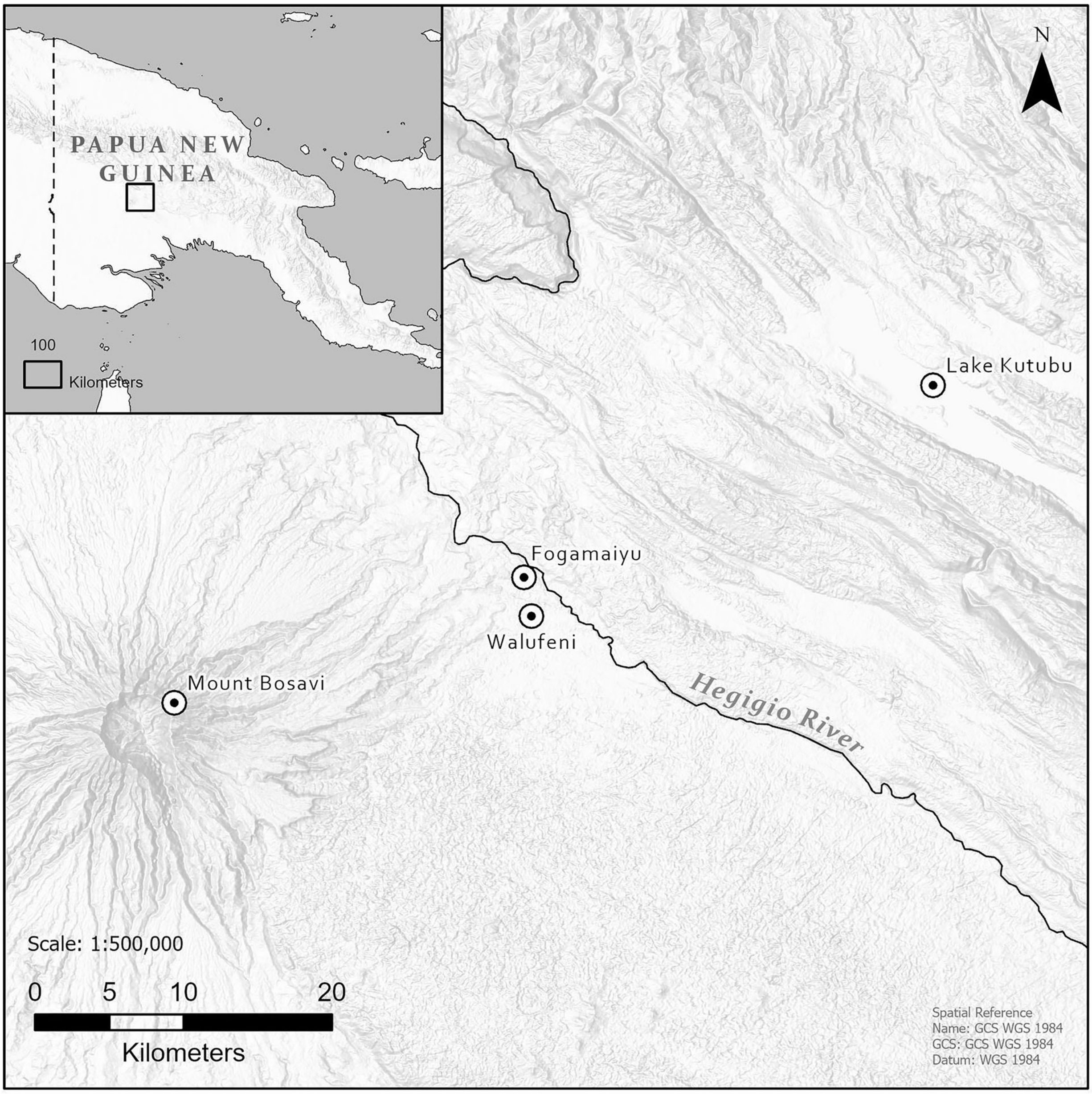


Figure 1. Study region and site location (Coe 2021).

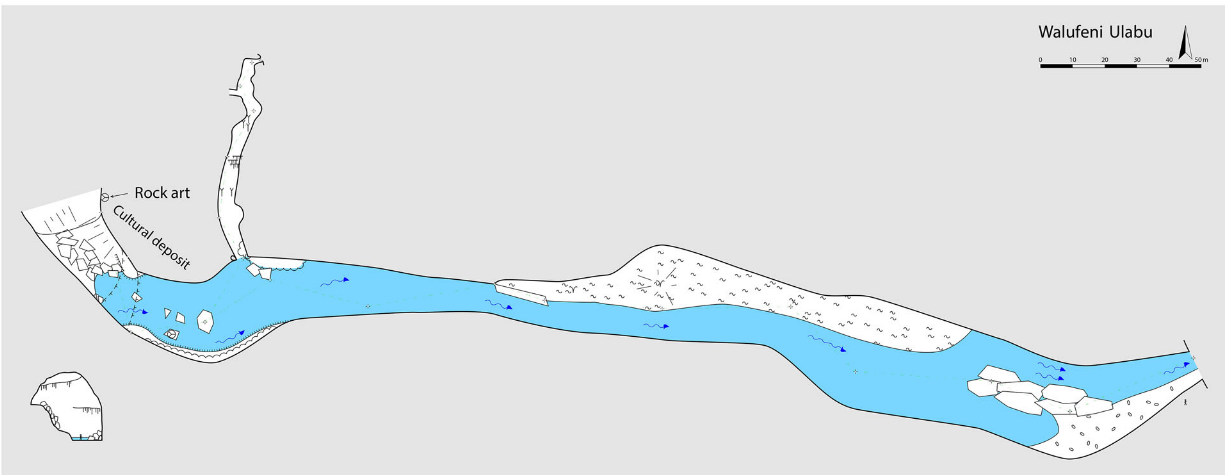


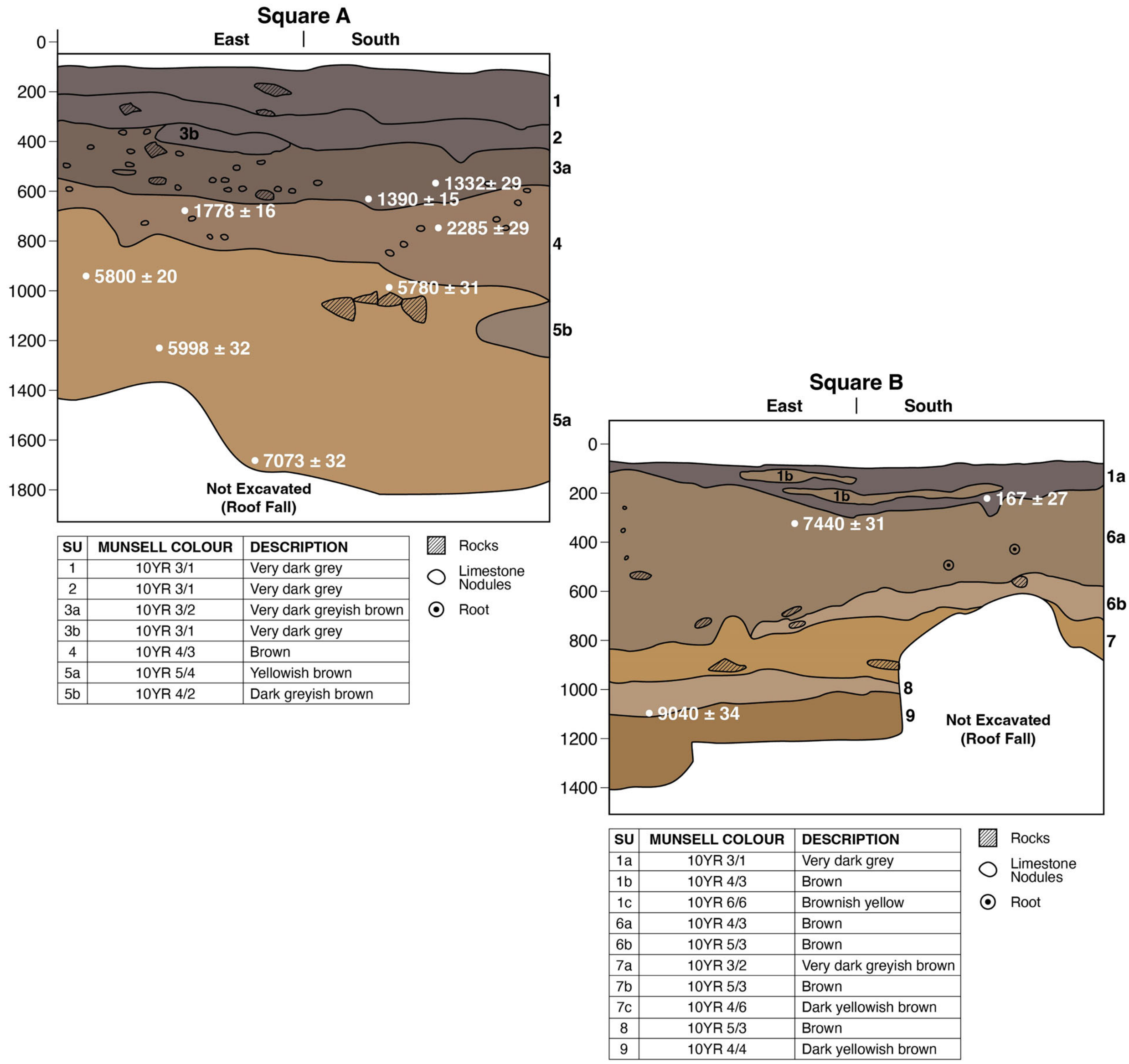
Figure 2. Map of Walufeni Cave (adapted from Beatus et al. 2011).

Figure 3. Walufeni Cave showing location of SQA and B and examples of benches (red arrows) cut into the sloping deposit (Photograph: Bryce Barker).

grey (10YR 3/1) material as SU1 but was more homogenous and slightly more compact in texture. SU3, extending to a maximum depth of 56 cm, is characterised by a dark greyish brown (10YR 3/2) sediment of similar texture as SU2. The sediment at SU4 became noticeably darker (10YR 4/3) and more compact and extended to a maximum depth of 90 cm below the surface with some evidence for probable intermingling of sediments at the interface between SU4 and SU5. SU5 extended down to 172 cm before encountering what was considered to be non-basal roof fall. SU5 saw a marked change in colour and texture to a looser sediment, yellowish brown in colour (10YR 5/4) and included a small subunit (SU5b) in the southwestern corner of the southern section, which was darker brown in colour (10YR 4/2).

Square B also has 5 stratigraphic units (SU) all of which, with the exception of SU1, follow stratigraphically from SU5 in SQA. SU1, extending to a maximum depth of 20 cm, consists of dark ashy sediment (10YR 3/1) also containing a small, discreet dark greyish brown (10YR 4/3) ashy lens and charcoal which was removed separately as SU1b. SU1 in SQB corresponds to SU1 in SQA as they are contemporaneous (see below). Situated directly below SU1, SU6 consisted of the main unit SU6a and a subunit, SU6b. SU6a, at a maximum depth of 75 cm, comprised compact dark greyish brown sediment (10YR 4/3) interspersed with low densities of small limestone nodules. SU6b, mainly in the southern portion of the square, was a very fine dark brown sediment flecked through with ash and charcoal (10YR 5/3), and was removed separately. SU7, at a maximum depth of 86 cm, comprised dark

Figure 4. Petroglyph rock art in Walufeni Cave, scale = 30 cm (Photograph: Lara Lamb).



SU	MUNSELL COLOUR	DESCRIPTION
1	10YR 3/1	Very dark grey
2	10YR 3/1	Very dark grey
3a	10YR 3/2	Very dark greyish brown
3b	10YR 3/1	Very dark grey
4	10YR 4/3	Brown
5a	10YR 5/4	Yellowish brown
5b	10YR 4/2	Dark greyish brown

SU	MUNSELL COLOUR	DESCRIPTION
1a	10YR 3/1	Very dark grey
1b	10YR 4/3	Brown
1c	10YR 6/6	Brownish yellow
6a	10YR 4/3	Brown
6b	10YR 5/3	Brown
7a	10YR 3/2	Very dark greyish brown
7b	10YR 5/3	Brown
7c	10YR 4/6	Dark yellowish brown
8	10YR 5/3	Brown
9	10YR 4/4	Dark yellowish brown

Figure 5. Stratigraphic sections of SQA and SQB showing their relationship in the sequence. Plotted dates are those obtained on in situ charcoal samples.

Table 1. Volume and weight/XU.

	Square A		Square B	
XU	Volume (L)	Weight (kg)	Volume (L)	Weight (kg)
1	10	8.4	31	23.3
2	30	21.9	42	33.5
3	41	28.9	40	34.2
4	41	28.9	50.5	37.1
5	46	40.1	40	34.7
6	41	25.7	33.5	28.4
7	41	31.9	48.5	37.0
8	41	32.9	46.5	38.5
9	40	33.9	51	43.9
10	39	33.7	34	35.8
11	41	46.4	41	32.6
12	41	35.1	33.5	28.2
13	32	27.2	40.5	33.4
14	37.5	29.1	45	35.7
15	41	33.9	39.5	35.0
16	22.5	18.0	42	33.6
17	41	33.3	41.5	32.9
18	41	33.4	41.5	33.3
19	39	32.6	71	49.6
20	40	26.2	46.5	38.1
21	46	36.4	45.5	41.0
22	45	37	35	29.7
23	36	38.9	35	29.4
24	40.5	32.2	39.5	30.9
25	41	33.7	48	38.7
26	46	38.5	34.5	36.3
27	37.5	31.5	17	14.8
28	33.5	34.1	26.5	22.8
29	24	19.7	21.5	18.9
30	42.5	38.5	21	19.2
31	47	38.6	19.5	20.1
32	44	37.5	19	18.9
33	52	42.5	12.5	12.1
34	47.5	39.1	10	11.6
35	46	38.8	17.3	15.4
36	46.5	39.6	12	10.7
37	47.5	41.2	12	10.8
38	45.0	39.2	12	10.4
39	46.0	39.6	12	11.1
40	34	30.5	8.5	6.6
41	23.5	20.6	7.5	8.0
42	23	19.8	7	6.6
43	22	18.7	7	6.5
44	23.5	20.4		
45	15.1	13.9		
46	9	7.0		
47	6	4.4		
48	3	2.4		
Total	1718.6	1435.8	1338.8	1129.3

greyish brown (10YR 3/2) sediment, interspersed with non-discreet yellowy sediment and an increase in small limestone nodules. SU7b, although present in the profile, did not extend into the excavated square. SU8 extends to a maximum depth of 104 cm, and consists of a darker brown sediment (10YR 5/3) interspersed with very fine particles of charcoal. SU9 extending to non-basal roof fall at 133.1 cm, consists of a relatively compact, fine yellow-brown sediment free of limestone nodules (10YR 4/4) with some apparent low-level admixing at the boundary between SU8 and SU9.

Chronology

Eighteen AMS dates were obtained from the 2018/2019 excavations – 15 in SQA and three in SQB (Table 2). Although SQA and SQB represent two separate squares it is important to note that they are contiguous chronologically and stratigraphically (Figures 3 and 5). The date of 7840–7970 cal BP at 160.9 cm near the bottom of SQA is 24.3 cm above the date of 8180–8350 cal BP near the top of SQB. The date of 130–230 cal BP at the top of SQB at 13.8 cm and at the bottom of SU1 dates the creation of the cut bench event, with the more recent activity associated with creating this bench sitting directly on top of the older deposit and is thus contemporaneous with SU1 in SQA.

Eight dates were initially obtained in SQA from available 3D plotted in situ charcoal – all of which were in sequential order. From this initial tranche of dates further dating was carried out to obtain a finer-grained Late Holocene sequence relevant to the palaeobotanical analysis (the subject of another paper). In the absence of datable in situ charcoal, further attempts at dating were made on non-in situ bone from the sieve residue, which was unsuccessful due to a lack of bone collagen. Thus, macro-floral remains in the form of *Pandanus* seeds (probably marita, *Pandanus conoideus*) from XUs 2 and 6 (to date the marked floral change in the upper levels) and *Canarium* from XUs 17, 20, 21, 22 and 23 were obtained from non-in situ floated, wet-sieved material. Unlike the initial tranche of dates, the seven non-in situ dates are not entirely in sequential order in relation to the plotted dates, and although they broadly accord with the plotted dates, the unplotted dates of 1580–1710 cal BP in XU20 in SU4 between 65.1 and 70.3 cm depth ostensibly sits on top of a date of 6540–6670 cal BP in XU21 in SU5 between a depth of 70.0 and 71.0 cm. However, these dates are bracketed by the in situ dates on charcoal of 2300–2360 cal BP in XU19 at 61.6 cm and 6530–6670 cal BP in XU25 at 84.6 cm, signifying a time span of 4270 years, separated by 23 cm of deposit. This represents a slow but consistent rate of sedimentation at 5.7 cm/1000 years. Given the small size of the dated seeds, their unplotted nature and the sequential robustness of the plotted dates, we consider that the plotted charcoal samples are more likely to be representative of the true chronology of the site.

Magnetic susceptibility measurements show that there are several layers that reveal increases in both magnetic susceptibly (χfd) and in frequency dependence (χfd%), indicating a change in the fine-grained component of magnetic grains relating to the SU4/SU5 interface at about 65 cm and continue to a depth of about 110 cm in SU5 in Square A (Figure 6). When compared to the faunal assemblage there are correlations between the proportion of burnt bone fragments and magnetic enhancement. For example, burnt bone increases at about 60–65 cm

Table 2. Calibrated ^{14}C ages for SQA and SQB.

SQ	XU	SU	Material	Depth cm	Code	Date	%C	Cal BP 95.4%
A	2	1	Pandanus seed	3.2–5.9	Wk-52332	163 ± 19	70.0	230–130
A	6b	1	Pandanus seed	15.8–18.5	Wk-52333	124 ± 18	85.4	150–20
A	**14**	**3**	**Charcoal**	**46.6**	**Wk-50725**	**1332 ± 29**	**73.2**	**1310–1230**
A	**16**	**3**	**Charcoal**	**49.2**	**Wk-49423**	**1390 ± 15**	**65.4**	**1330–1280**
A	17	4	Canarium seed	53.8–58.3	Wk-52334	1747 ± 18	68.8	1710–1580
A	**18**	**4**	**Charcoal**	**58.2**	**Wk-49425**	**1778 ± 16**	**70.6**	**1740–1610**
A	**19**	**4**	**Charcoal**	**61.6**	**Wk-50726**	**2285 ± 29**	**71.3**	**2360–2300**
A	20	4	Canarium seed	65.1–70.3	Wk-52334	2273 ± 19	68.8	1710–1580
A	21	5	Canarium seed	70.0–71.0	Wk-52336	5803 ± 19	69.5	6670–6540
A	22	5	Canarium seed	71.3–75.3	Wk-52337	5777 ± 19	65.1	6650–6490
A	23	5	Canarium seed	75.3–81.8	Wk-52338	7091 ± 20	56.3	7970–7860
A	**25**	**5**	**Charcoal**	**84.6**	**WK-51714**	**5800 ± 20**	**69.4**	**6670–6530**
A	**27**	**5**	**Charcoal**	**86.2**	**Wk-50727**	**5780 ± 31**	**75.0**	**6660–6490**
A	**35**	**5**	**Charcoal**	**114.4**	**Wk-50728**	**5998 ± 32**	**69.5**	**6930–6740**
A	**45**	**5**	**Charcoal**	**160.9**	**Wk-50729**	**7073 ± 32**	**76.3**	**7970–7840**
B	**4**	**1**	**Charcoal**	**13.8**	**Wk-50722**	**167 ± 27**	**67.9**	**230–130**
B	**9**	**6**	**Charcoal**	**23.2**	**Wk-50723**	**7440 ± 31**	**70.6**	**8350–8180**
B	**37**	**8**	**Charcoal**	**102.1**	**Wk-50724**	**9040 ± 34**	**60.0**	**10250–10180**

Bold indicates 3D plotted, in situ dates. Radiocarbon ages were calibrated using Calib v.8.2 (Stuiver and Reimer 1993) and SHCal20 (Hogg et al. 2020).

depth, at the SU4/5 interface where we see increases in both magnetic susceptibly (χfd) and in the frequency dependence (χfd%). These increases suggest burning or paedogenesis (i.e. soil formation) spanning the 23 cm between the in situ dates. This correspondence between the abundance of burnt bone and magnetic enhancement, leads us to characterise the similar magnetic grain size in SU4–SU5 samples, as finer grains resulting from burning.

Given that the in situ dates – all on charcoal – are in sequential order, it is considered that this temporal sequence is probably the most reliable. In SQB the date of 130–230 cal BP marks the more recent use of this bench which was cut into the older deposit and removed to create a flat space for use on the steep slope and is identical in timing of use to the top of SQA (Figures 3 and 5). Otherwise, SQB consists almost entirely of an Early Holocene sequence with a date of 8180–8350 cal BP in XU9 at 23.2 cm, and a non-basal date of 10,180–10,250 cal BP in XU37 at 102.1 cm.

Fauna

Apart from the rounded river cobbles probably used as cooking stones, cultural material is dominated by the bone assemblage totalling 9470.49 g in SQA and SQB combined (Tables 3 and 4). While burnt bone is present throughout the SQA sequence, the majority of burnt bone occurs between XU1 and XU18 (between 130 and 1740 cal BP). In SQB, the most intensely burnt bone occurs in SU1 (XU1 to XU5), followed by limited quantities of burning in every XU in SQB down to XU31. After this, burnt bone only occurs in XU38, just below the 10,180–10,250 cal BP date, and in XUs 41 and 43 (Figure 7). Although the greater degree of carbonised and calcined bone in the upper levels of SQA may be seen to explain the difference in discard densities of bone between the two sequences, it is worth noting that differences in discard rates between the two squares is also reflected in stone artefact weights. The marked increase in carbonised and calcined bone in SU1 to SU3 in SQA and SU1 in SQB suggests that bone was deliberately discarded into hearths (Aplin et al. 2016).

A diverse range of fauna, representing over 20 taxa of commonly found terrestrial and aquatic fauna make up the assemblage, which is largely representative of a hunter-gatherer subsistence strategy, including the presence of pig (*Sus scrofa*) found in XUs 3 down to XU17 (between 130 and 1740 cal BP) in SQA and dog (*Canis familiaris*) in XU2, SQA. Today, pigs are a hunted resource on the Plateau and are not kept as domesticates, as is typical of the Highlands to the north. Human bone appears between XUs 15 and 22 in SQA and in XUs 15 and 19 in SQB. This bone is disarticulated and highly fragmented – unlike bone found in traditional clan ossuaries in the region today (Barker et al. 2016; Busse et al. 1993). The presence of a range of forest species between the dates of 10,180–10,250 and 8180–8350 cal BP, including cuscus (XU18, SQB) and cassowary eggshell (XU27, SQB) and bone (XUs 15 and 28, SQB), indicate a heavily wooded 'rainforest' landscape from at least the Early Holocene. In addition to cuscus, other taxa found consistently throughout the sequence include snakes (Pythonidae), lizards (Varanidae, Agamidae) and at least two species of bats (Chiroptera). Aquatic species include freshwater mussel and catfish (Siluriformes) and the presence of the marine molluscs Nassarius ($n = 58$), Cypraea ($n = 3$) and Olividae ($n = 3$) from between XUs 24 to 8 in SQA. Twelve of the 58 Nassarius shells had evidence of red pigment or resin. Although ostensibly first

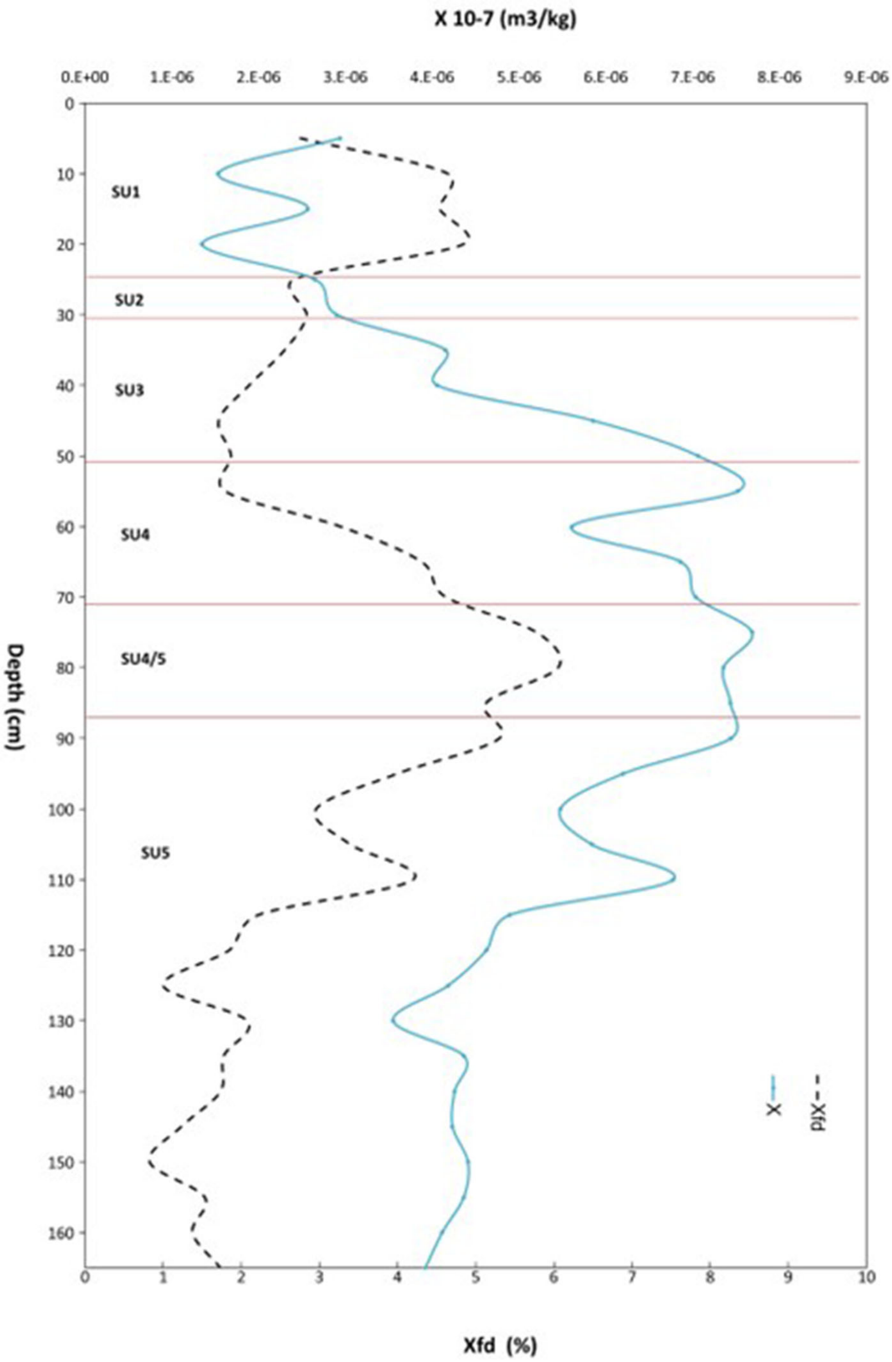


Figure 6. Profile of low-field magnetic susceptibility (χ) and frequency dependence of susceptibility (χfd%).

appearing in SU5 in XU24 Nassarius sits just a few centimetres below the SU4/5 stratigraphic boundary and is thus considered that it may belong in SU4, dating to the Late Holocene from around 2330 cal BP. Marine shell is not present in Square B and from after XU8 in SQA.

Lithics

The stone artefact assemblages of SQA and SQB were sorted into the essential fracture type categories of flake (including all broken flake categories) and flaked piece, per XU. Artefacts less than 4 mm in maximum dimension were excluded from this analysis. Additional categories identified were retouched flake, bipolar flake, core, bipolar core, hammerstone, 'other' (either potlids or diagnostically ambiguous), and the geologically exotic, non-flaked, igneous raw material we identified as most likely being bought into the cave for use as earth oven cooking stones (mumu stones). The flaked artefact and mumu stone assemblages are treated as different categories and in this context mumu stone was identified as any igneous rock that did not exhibit flaking properties, which was consistent with contemporary mumu stone assemblages observed at Fogomaiyu village. Small nodules of red 'iron oxide' were also present throughout the assemblage –

Table 3. Cultural material SQA.

XU	Flaked artefacts (g)	Non-Flaked artefacts (g)	Bone (g)	Shell f/water (g)	Shell marine (g)	Ochre (g)	Charcoal (g)
1	6.54	639.06	67.74	1.62			
2	25.85	917.56	67.87	0.14			
3	0.99		147.01				
4	14.70	155.62	307.98				
5	11.81	348.05	313.50				
6	24.23	263.06	242.37	0.74			
7	179.19	61.89	190.71	7.57			9.53
8	75.22	351.52	253.68	3.51	0.44		7.32
9	36.66	81.22	163.67	4.10		6.64	
10	19.49	77.56	96.35	5.51		0.21	6.46
11	62.49	255.99	44.12	5.70		0.23	2.13
12	2.99	55.37	63.65	6.14	0.04	1.44	2.61
13	9.56	65.61	52.06	5.16		0.46	2.22
14	46.22	74.79	42.96	5.20		0.08	1.07
15	73.00	143.39	63.46	5.19	0.11	0.95	0.77
16	22.09	30.28	39.35	2.10	0.32	0.95	
17	68.79	123.55	64.93	2.08	1.65		0.01
18	42.50	130.54	67.48	2.95	1.59		
19	113.50	183.33	71.17	2.65	2.17	2.58	
20	27.22	48.76	67.45	5.86	0.45		
21	96.69	176.41	65.53	10.17	1.26	7.66	
22	43.42	521.52	65.36	11.64	2.10	56.59	
23	121.44	45.37	37.88	9.80		1.85	0.16
24	16.65	75.98	25.60	5.49	1.13	0.12	
25	25.77	416.14	13.82	2.05			0.27
26a	31.06	12.59	18.96	0.31			
26b	8.04	9.67		5.21		0.22	0.02
27	1.42	38.91	10.81	1.25		0.24	0.03
28	0.73	6.17	9.80	1.76			0.26
29	6.84	7.78	5.63	1.06			0.42
30	0.45	512.90	7.62	0.64			0.06
31	7.47	13.28	7.50				
32a	0.52	58.72	7.31	0.05			
32b	4.58	3.20		2.22		0.42	0.31
33a	1.29	24.94	6.89	0.02			1.20
33b	0.03	0.91		0.51			0.14
34	0.13	61.76	10.93	0.23			0.70
35		30.45	9.11				
36	0.44	27.22	7.13	0.59			
37	9.92	6.09	5.89	0.08			
38		9.95	9.94				
39	1.22	9.70	6.03				
40	0.93	6.78	3.07	0.62			
41	0.70	47.78	3.16				
42	3.27	38.03	7.88	0.84		0.17	1.37
43	3.00	14.15	3.33	0.25			1.16
44	0.11	2.02	2.92	0.46			0.62
45			1.66				0.27
46			0.29	0.07			0.07
47	0.13		0.17				0.12
48	0.02		0.32				0.15
	1249.31	**6185.57**	**2782.05**	**121.54**	**11.26**	**80.81**	**39.45**

identified as 'ochre' although none exhibited use striations (Tables 3 and 4). Throughout the flaked assemblage, raw material was identified where possible, and broader categories of material were utilised where it was not (e.g. 'other sedimentary' or 'other igneous'). The identification of heat alteration was limited to the presence of potlid scars or to potlids themselves. The SQA stone artefact assemblage had a total weight of 1249.31 g, plus 6185.57 g of mumu stone. Square B had a considerably larger assemblage of stone artefacts with 2727.96 g, plus 15,303.97 g of mumu stone. As with other flaked stone artefacts described elsewhere in Papua New Guinea (e.g. Maloney 2021; Watson 1995), the Walufeni Cave preliminary analyses indicate that the lithic assemblage is dominated by expedient technological strategies (see also Coe 2021), and consists of unretouched flakes and flaked pieces (Figure 8), with very modest numbers of retouched flakes, bipolar flakes, hammerstones and cores.

In terms of overall patterns, the flaked stone artefacts in SQA and SQB were generally small throughout. The average weight of artefacts per XU ranged from 20.4 g to 0.02 g in SQA and from 19.73 to 0.05 g in SQB. The discard pattern of flaked artefacts closely follows that for the rest of the cultural material in the sequence, with highest densities in the Mid-to-Late Holocene in SQA, and from after XU25 in SQB, in the Early Holocene (Figure 9). Chert predominates in SQA and in the top of SQB down to XU6, just above the 8180–8350 cal BP date, after which there is an increase in basalt and other

Table 4. Cultural material SQB.

XU	Flaked artefacts (g)	Non-flaked artefacts (g)	Bone (g)	Shell f/ water (g)	Shell marine (g)	Ochre (g)	Charcoal (g)	Contact artefacts (g)
1	24.05	643.74	123.13	2.54			28.39	11.09
2	31.08	937.69	143.39	2.97	0.23		6.81	0.22
3a	0.83	4.26	116.73	0.22		0.01	1.81	0.87
3b	21.36	0.95		0.77			4.59	0.02
4b	13.9	61.90	320.42	1.0			8.28	
4c	32.50	1.91						
4d	0.10			0.05			0.64	0.02
5b	21.64	222.33	318.73	0.24		0.04	6.61	
5c	4.24						0.25	
5d	5.21	2.85		0.12			1.98	
6	41.40	131.61	139.53	0.37		0.16	11.18	
7b		436.37	174.16	1.55			0.69	
7c								
8b	186.64	1191.77	190.47	1.81			1.23	
8c	0.5							
9b	201.09	1432.26	229.42	3.71			11.78	
9c	1.56	9.62						
10	459.53	1137.23	251.47	1.99			7.75	
11	67.92	445.65	197.01	3.41			9.73	
12	290.74	536.54	209.07	3.73			12.36	
13	84.59		205.28	1.29		7.07	12.28	
14	135.24	126.76	181.59	2.54		11.04	11.65	
15	162.99	478.19	206.15	1.63		8.77	15.72	
16	74.22	861.27	132.14	2.26			5.13	
17	57.32	410.52	158.59	2.26			0.13	
18	21.52	224.30	159.62	2.98			9.36	
19	66.04	1339.59	327.72	6.92		0.67	6.06	
20	179.03	455.58	268.62	4.92		0.06	17.69	
21	84.95	1139.22	365.35	6.65			17.2	
22	44.93	1226.29	251.04	3.90			1.1	
23	46.90	334.57	314.84	7.96			8.26	
24	101.67	776.96	423.15	5.13		0.24	16.9	
25a	33.36	289.98	437.96	7.52			14.05	
25b								
25c	0.08						0.1	
26a	43.46	316.54	310.88	11.47			1.08	
26c				0.02			0.02	
27a	1.59	118.52	40.49	0.63			0.79	
27c							0.01	
28a	138.17		36.39	0.53		0.13	0.28	
28c							0.10	
29			25.48	0.25			0.77	
30	0.05		18.78	0.59				
31	1.78		57.72	0.1			0.05	
32	0.88		114.11	0.02			0.04	
33	1.89		127.97	0.09			0.19	
34	12.30		73.34					
35	26.63		26.20	0.04			0.03	
36	4.08	9	4.61					
37			2.31					
38			3.09					
39			0.57					
40			0.17					
41			0.12	0.01				
42								
43			0.63					
	2727.96	**15303.97**	**6688.44**	**94.19**	**0.23**	**28.19**	**253.07**	**12.22**

raw material types and a decline in chert use (Figure 10). No clear recurring morphological 'types' were discerned in the assemblage. There were no associated fragments recovered related to adze/axes or edge-ground implements, or other technologies associated elsewhere with activities such as land clearing, agriculture or plant processing (Ford 2017; see also Coe 2021:73). The findings reveal a relatively stable system that yielded little technological change through the sequence. Therefore, albeit small, this aggregate of Holocene flaked stone from Walufeni Cave shares many technological elements with other similarly dated flaked stone assemblages uncovered in the Highlands and other areas of Papua New Guinea (Ford 2017). As with many of these assemblages, the technological strategies employed throughout could also be referred to as 'expedient' in nature (Evans 2000; Maloney 2021; Torrence 2011; White 1972). Both ethnographic observations (Sillitoe and Hardy 2003) and the nature of the Walufeni Cave assemblage suggest that non-lithic technologies readily available in the

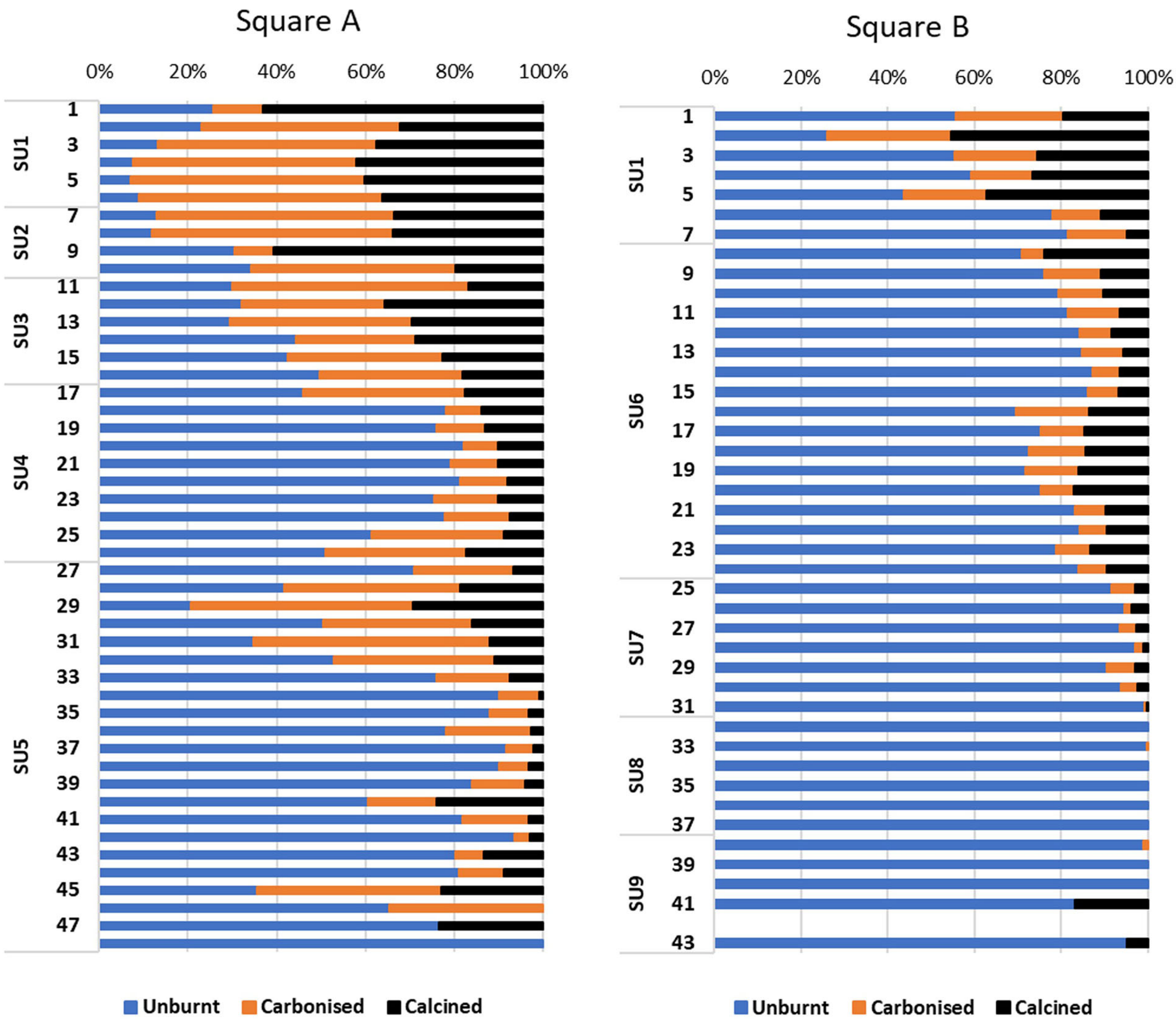


Figure 7. Percentage of unburnt, carbonised and calcined bone.

Papua New Guinea rainforest, such as bamboo knives, hard wood and cassowary bone arrows and spear points, render lithic technologies less important than is elsewhere the case (Brumm 2010; Watanabe 1985).

Plant remains

Charred plant remains were recovered throughout the excavated strata via wet-sieving (see above), including wood charcoals, endocarps (nutshells) and underground storage organs. The general pattern of preservation is shown in Tables 3 and 4, with the uppermost XUs in both squares, dating to the last c.200 years, containing large quantities of charred remains dominated by wood charcoals. Below this in SQA, XUs contained c.10 g of charcoal or more down to XU10, with values below that declining with depth to 2 g or less. In Square B values generally increased from XU10-25 to between 10 and 20 g per XU, again declining below that level.

Macrofossils of potential food plants were variably preserved through the whole excavated sequence, though dominated throughout by endocarps of tree fruits. Most abundant were the endocarps of *Canarium*, found throughout the sequence and dominating the older XUs. These included a small-fruited *Canarium*, close in form to *C. acutifolius* and *C. australianum*, with remains of a larger-fruited *Canarium* sporadically present through the sequence. The latter includes a 'base plate', which is a distinctive fragmentation type associated with nut cracking. A major change is seen in the upper XUs of SQA with a significant change in focus in the plant economy after 1610–1740 cal BP in XU18 with an increased breadth of fruit/nut resources exploited and the dominance of abundant endocarps of marita (*Pandanus coneoideus*), alongside frequent remains of an as yet unidentified endocarp and occasional fragments of *Buchanania* and *Aleurites*. The upper XUs also have some remains of possible underground storage organs and other stem/leaf remains.

Both *Canarium* and *Pandanus* are present archaeologically in Papua New Guinea from the Late Pleistocene

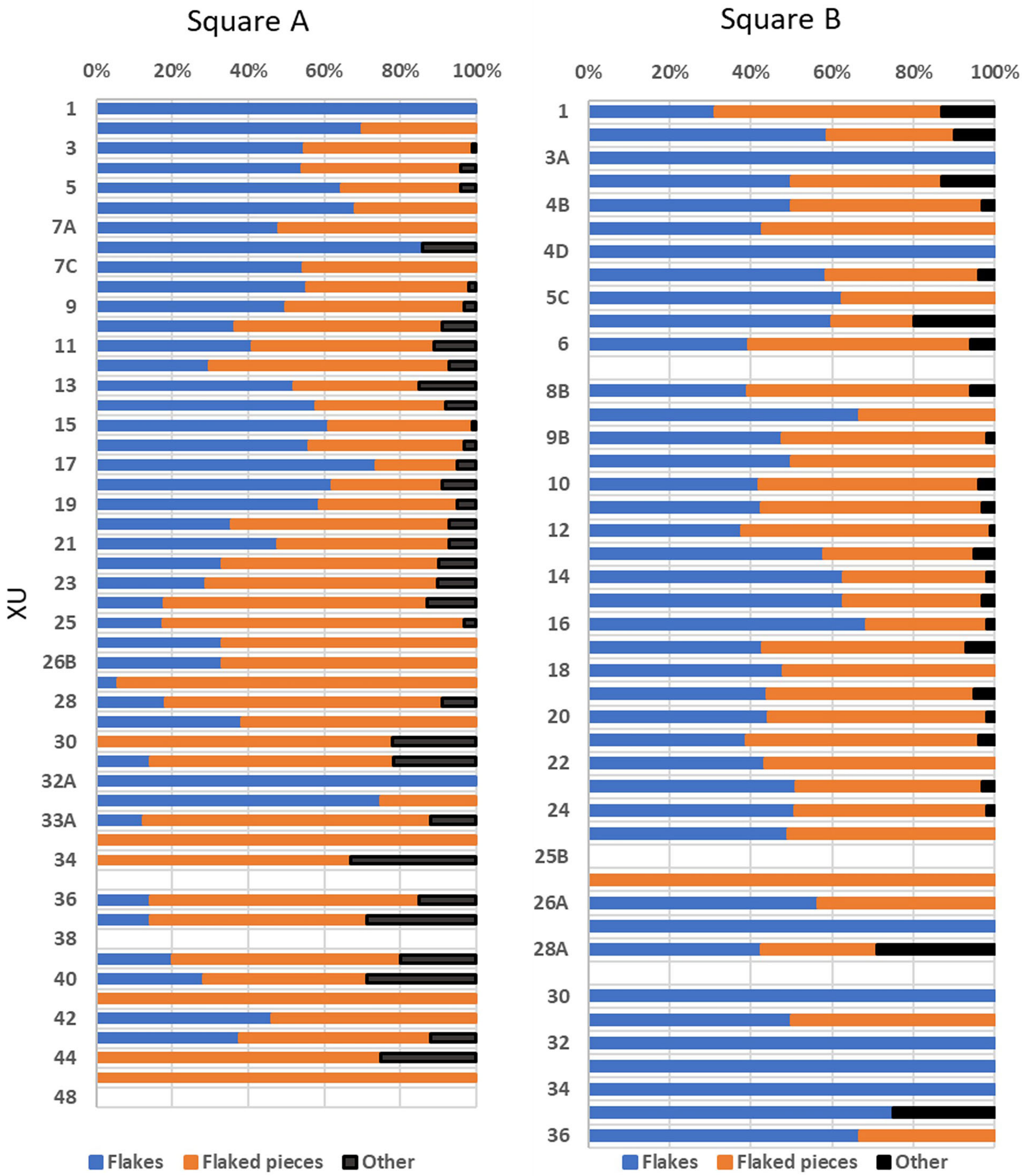


Figure 8. Frequency of essential fracture type categories including flakes, flaked pieces and 'other'. Note that in these graphs, 'other' includes all artefacts that are not flakes or flaked pieces.

(Fairbairn and Florin 2022) and have been presented elsewhere as evidence of early plant domestication (Summerhayes et al. 2010; Swadling and Hide 2005; Yen 1990). Analysis of the plant material continues and preliminary research demonstrates that Walufeni Cave preserves a >10,000-year record of tree-nut exploitation, which is both a valuable new addition to Papua New Guinea's history of plant exploitation and, in being well-preserved at depth, offers a strong possibility of older records as excavation continues.

Rock art

Walufeni Cave contains a large body of petroglyph rock art with some 338 motifs recorded inside the cave (Lamb et al. 2021). A total of nine petroglyph rock art sites have now been recorded across the Plateau, from Yehebi village on the Strickland River (Gebusi) at the western end, to Fogamaiyu village on the Hegigio River in the east (Kasua), many containing common art styles. Although including a range of non-figurative motifs, the art is dominated

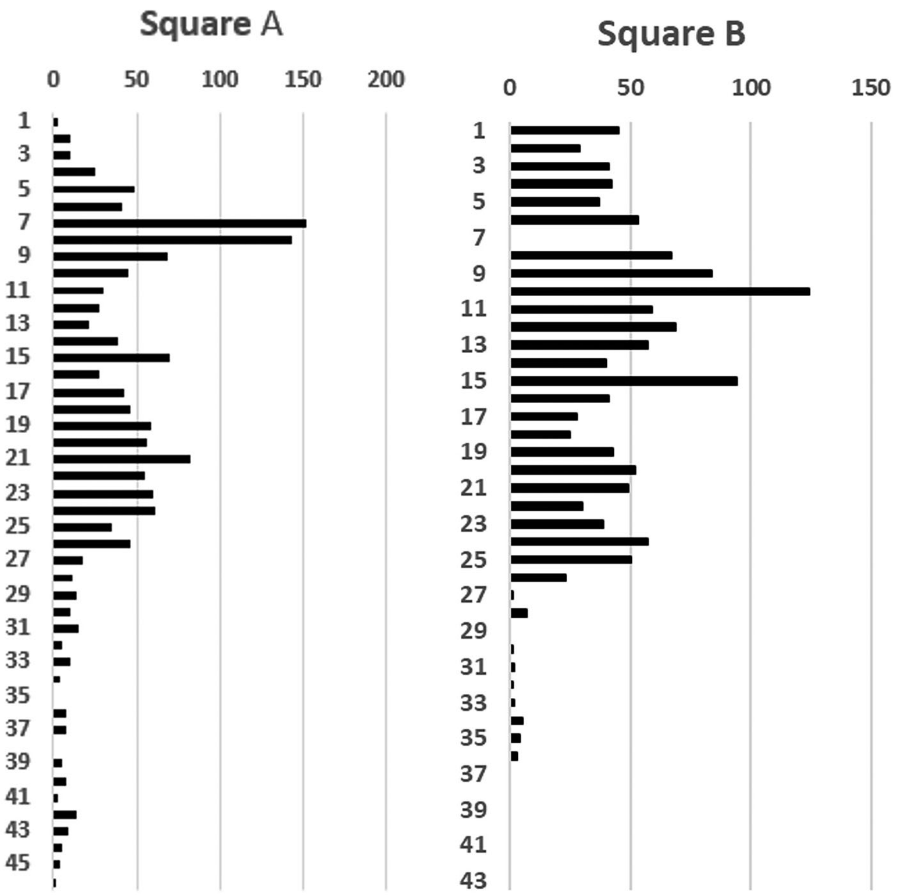


Figure 9. Number of flaked artefacts, per XU.

by barred ovals and cupules (Figure 4). At the eastern end of the Plateau, a major Kasua creation myth contextualises the art, but at the western end of the Plateau, Gabusi speakers claim no knowledge or ownership of the petroglyph motifs in their region. A possible explanation for this is that Kasua once had extended clan lands far west of their current boundaries, encompassing the territory now latterly occupied by Gabusi speakers, and that at some time in the past they consolidated their territory in the east. Another possibility is that the art is very old, pre-dating both Kasua and Gabusi on the Plateau, and that in the east the Kasua incorporated the existing body of art into their creation mythology. We may gain clarity on this through our plans to date the petroglyphs, using Uranium Series dating techniques similar to those successfully employed in Indonesia (i.e. Aubert et al. 2014).

Discussion

Taken as a whole it appears that the discard of cultural material represents three phases of occupation throughout the sequence, indicating differential use of Walufeni Cave during the Holocene. With several metres of deposit potentially left to excavate, it is probable that occupation of the cave pre-dates the Holocene, and that a Late Pleistocene sequence is almost certainly present at this site. We discuss indicative occupation trends in Walufeni Cave below, proceeding from the Early Holocene in SQB to the contemporary past in SQA.

Prior to the date of 10,180–10,250 cal BP discard of cultural materials is very low – perhaps marking the Holocene/Pleistocene transition (Figure 11), however it should also be noted that from XU45 to XU34 large limestone roof-fall slabs encroach into all but the eastern side of the square, reducing the excavatable deposit to approximately 0.25 m^2. It is apparent that, in terms of discard densities, Walufeni Cave was intensively occupied in the Early Holocene between the dates of 10,180–10,250 and 8180–8350 cal BP, possibly related to use by pre-village hunter-gatherers during a much wetter phase of the Holocene (Haberle 2005; Moss et al. 2012), when large caves may have offered attractive habitation sites (Figure 11). Although caves and rockshelters have been consistently used as ephemerally visited hunting camps – a practice continued today – the density of discard of cultural material present in the early phase of the Walufeni occupation reflects something more than low intensity visitation expected of a hunting camp (McNiven 2010 for a comparison). Although studies in the region indicate a change from a more moist/humid environment in the Early-to-Mid-Holocene to a drier one around

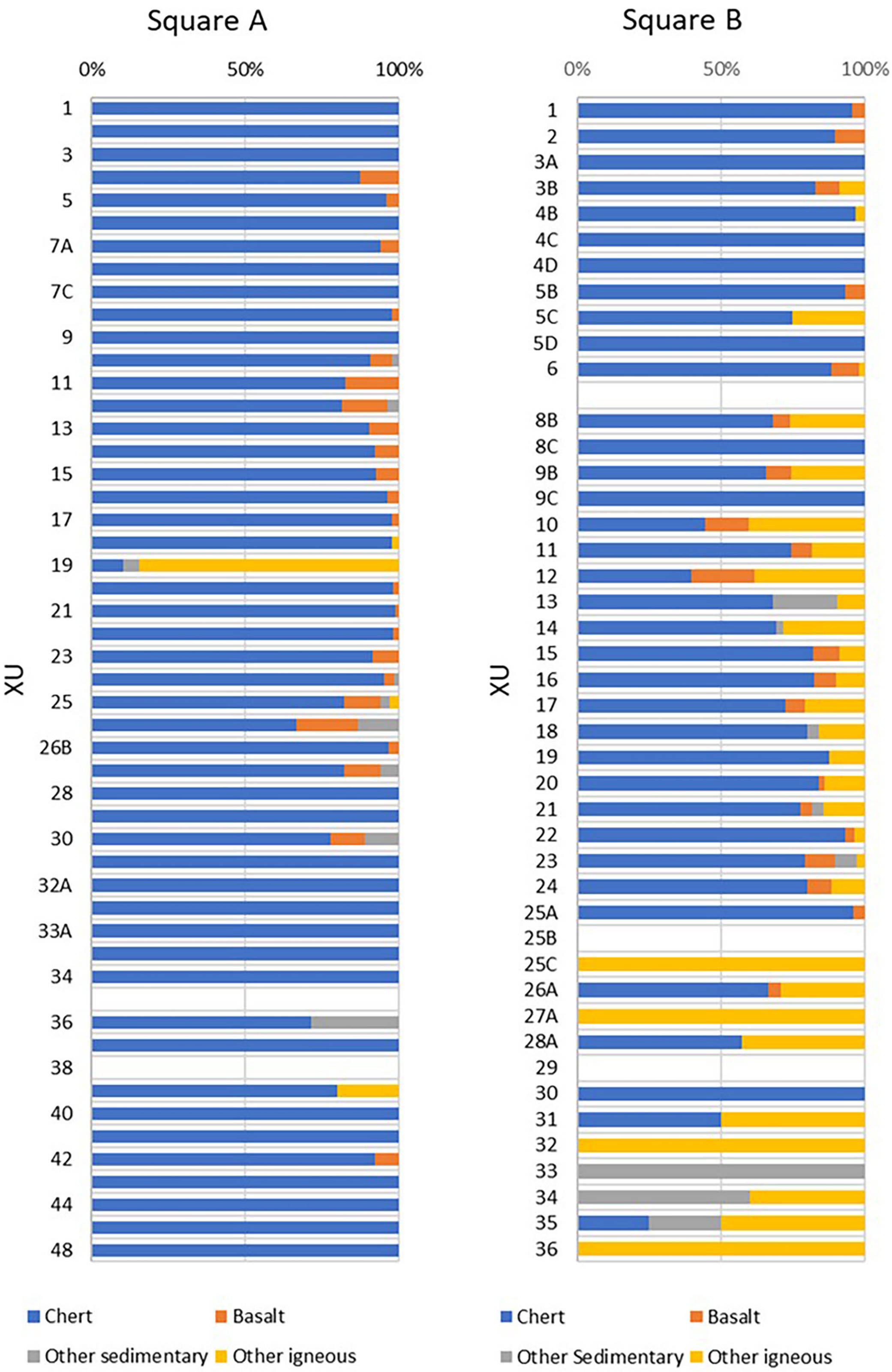


Figure 10. Raw material frequency.

2000 years ago, it is evident from the presence of rainforest faunal species such as cassowary (*Casuarius* sp.) and cuscus (Phlangeridae), and tropical plant species such as *Canarium* throughout the sequence that elements of rainforest similar to those present today were present throughout the Holocene (Haberle 2017). From 8180 to 8350 cal BP in SQB and 6530 to 6670 cal BP in SQA, a period spanning 1400 years, discard is greatly reduced, indicating continuing but low-intensity use of the cave in the Mid-Holocene (Figure 11). This apparent ephemeral use of the cave during the latter part of the Early Holocene, in which there is little evidence for change to technology or subsistence, seems to indicate either localised or broader demographic changes affecting cave visitation. The dates between

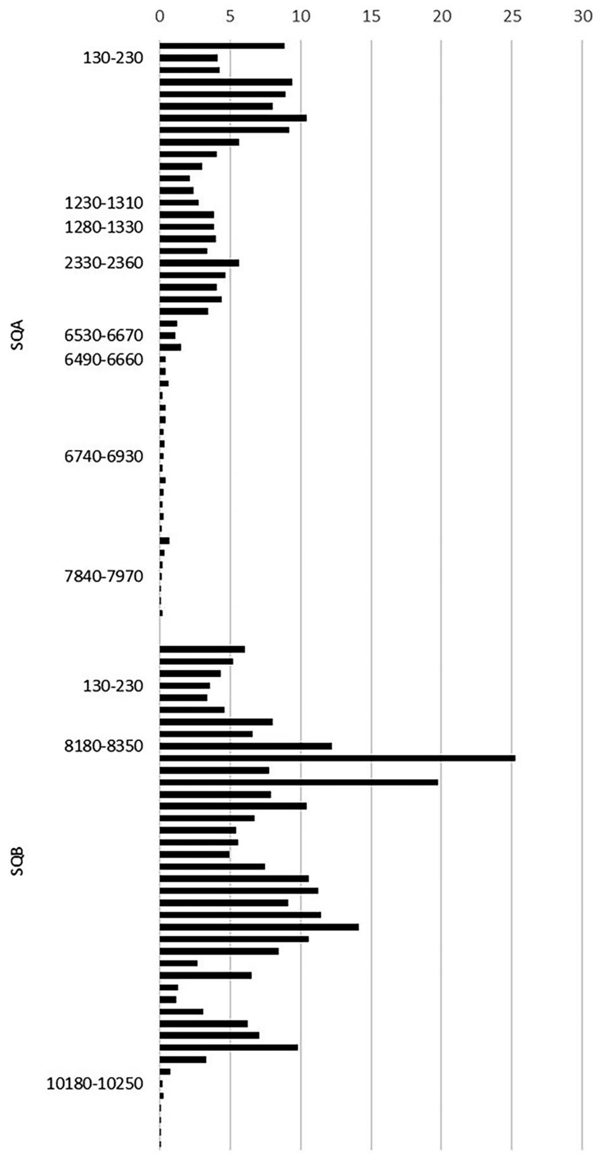


Figure 11. Discard of total cultural material SQA and SQB (g/L) (in situ plotted dates only – 'mumu' stones not included).

6490 and 6660 and 2300 and 2360 cal BP, a period spanning 4245 years separated by 24.6 cm of deposit at 5.7 cm/1000 years on either side of the SU4 and SU5 stratigraphic change, marks a significant decrease in sedimentation rates, but an overall increase in cultural material (Figure 11). Increases in discard appear just before the 6530 and 6670 cal BP date in XU25 in SU5. It is considered however that this increase may be actually related to SU4, as there is some evidence for intermingling of sediments at the SU4/SU5 stratigraphic interface. Decreases in discard at the very top of SQA and SQB most probably relates to change in use at the beginning of the colonial period (and the removal of the top of the older sequence in SQB) and its more recent reuse as evidenced by contact artefacts found from XU1 to 4, SQB (Figure 11, Tables 3 and 4).

Although there are significant changes in discard of material over time, there is little evidence for significant change in the subsistence base or technology, reflecting a degree of relative homogeneity until the Late Holocene, when we see the introduction of pig and a change of focus in the plant economy at 1580 –1710 cal BP. This includes an increased range of fruit/nut resources exploited and the dominance of marita in the assemblages from after this date. Marita is a cultivated species, as are the other tree species present and along with evidence for a spike in sago production at nearby Lake Kutubu at 1500 cal BP (Haberle 2017) the most parsimonious explanation for the change at this time is that it marks the start of tropical rainforest swidden agriculture at the site and possible village establishment.

Another significant Late Holocene change is the presence of the marine molluscs – Nassarius, Cypraea and Olividae – a minimum of 200 km distance from the southern coast and found in the sequence from around 2500 years ago (Table 3). These species are ubiquitous along the southern coast of Papua New Guinea and the shell was widely traded and used for decoration. All of the shell present displayed evidence of alteration for use with either the removal of the dorsal surface (Nassarius and Cypraea) or with a drilled hole through the apex (Olividae). Marine shell is not present after XU8 suggesting that this trade may have been disrupted in the historical period. The presence of these exotic species indicates the first material evidence for an ongoing pattern of interaction with people on the south coast, beginning in the Late Holocene and ceasing sometime in the historical period. Freund (1979), an anthropologist working with the Kasua in 1973–1974, recounts that his Kasua informants 'place their origins somewhere near the Purari Gulf region' on the southern coast. Other Kasua people, residing in Sayandicke Village on the southern slopes of Mt Bosavi, tell of their origins as being in the Kasere region (Freund 1979:30) in the upper Kikori River area, having moved to their current position between 1934 and 1936 (Freund 1979:104). Taken together with Austen's observations (Austen 1934:25) about Kasere coming from the Bosavi region, and with people on the south coast from Urama Island claiming that their mythical being Irivake taught the Kasere all they knew about 'civilization' (Newton 1961:14), an ongoing pattern of interaction between the Kasua and Kasere lands is implied, with possible origins on the coast. Further linking the two groups, both Kasua (author notes 2018 and 2019; Freund 1979:30) and the Kasere of the Baina region (author notes 2009) have myths that place their origins on the southern coast via the Lake Kutubu region. This is in concert with an analysis of available linguistic data undertaken by Shaw (1973:197–201) which suggests that people initially arrived at Lake Kutubu, possibly from the Gulf District. Upon reaching Lake Kutubu they continued to migrate westward, splitting into at least two groups; one that continued in a westerly direction onto the Papuan Plateau and one that moved southwest to the area around Mt Bosavi approximately 1000 years ago. Indeed, Kasua possess a mythical ancestral figure called Sito or Sido (Brunois 2004), which is a widespread culture hero shared by the southern lowlands, the south coast and as far away as the Torres Strait (Austen 1932; Busse 2005; Haddon 1935; Landtman 1913; Lawrence 1994; Wagner 1972). This most northerly distribution of the Sito figure is also suggestive of a combination of ritual, mythical, migration or trading links between the Mt Bosavi area, the southern lowlands and the south coast (e.g. Biersack 1995). We have the first material evidence for these links in the form of marine shell, from approximately 2500 years ago.

In spite of the evidence for Late Holocene links to the south coast there is no pottery present in the Walufeni Cave sequence and pottery is not mentioned in ethno/historical accounts for the Plateau. The northern-most evidence for pottery on the Kikori River is at Epe Amaho (McNiven et al. 2010) on the mid-Kikori some 60 km from the delta and 150 km southeast of Fogamaiyu village. Excavations at Waredaru and Baikaboria, an old village site and an ossuary near Baina on the upper Kikori River and some 80 km southeast of Fogamaiyu, also had no evidence of pottery (Barker et al. 2016; David et al. 2015). David's (2008) excavations on the mid-Kikori indicate that there were two major pulses of occupation between 950 and 1450 cal BP associated with large quantities of imported ceramics and another from 0 to 500 cal BP – linked to the Motu Hiri pottery trade – there being no tradition of locally made pottery. Although further excavations are needed to support this, it would appear that although there is clear evidence of links to the coast with the presence of marine shell coinciding with the movement of pottery up the Kikori River it would seem the movement of pottery from the south coast did not extend beyond the mid-Kikori.

It may be no coincidence that these changes coincide with a range of other dynamic changes occurring on the south coast and the nearby mid-Kikori region. There is evidence for sago (*Metroxylon sagu*) exploitation at Epe Amoho (McNiven et al. 2010) on the mid-Kikori River just to the south of the Plateau, at 2500 BP, and a significant spike in sago pollen at Lake Kutubu at 1500 BP, 25 km to the northeast of Walufeni Cave, which Haberle (2017) equates to Late Holocene drought stress (see also Denham et al. 2017; Haberle 2017; McNiven et al. 2010) but may in fact be a marker of village establishment. David (2008:468) has shown that occupation in the mid-Kikori River region, just to the south of the Plateau, was subject to pulses of occupation throughout the Holocene. Although people were present in the mid-Kikori region from between at least 13,000 and 8000 years ago, their use of the landscape was 'fleeting' with almost no evidence for cultural sites after 8000 until 2750 cal BP. This was followed by 'an almost total absence of archaeological evidence until c.1450 cal BP' which marks the first evidence for sustained human presence centred on the first establishment of villages and the earliest evidence of pottery (David 2008: 468). Coming on the heels of a period of very ephemeral use, it is possible that the Late Holocene phase of occupation at Walufeni Cave, marked by the introduction of pig, marine shell, the presence of cultivated plant species, a change in bone discard practices and a marked decrease in cultural discard when compared to the Early Holocene, relates to a more recent migration of peoples from the south coast, and subsequent village establishment, accompanied by the more intensive use of sago in semi-cultivated stands, as practiced today. It is clear however that there were people already on the Plateau from the Early Holocene, and possibly earlier.

Conclusion

The data presented here offer a site-specific model of early intensive site use from at least 10,000 years ago, then ephemeral use, followed by a sustained Late Holocene occupation. The sustained occupation of the site corresponds with a range of other dynamic changes including evidence for trade, exchange and indeed possible Late Holocene migration from the south coast; sago production on the mid-Kikori River and at Lake Kutubu by approximately 2500–1500 BP (Denham et al. 2017; Haberle 2017; McNiven et al. 2010); the arrival of Lapita peoples on the south eastern coast of New Guinea at around 2600 BP (David et al. 2011); and a period of major cultural changes and demographic expansion (the Coral Sea Cultural Interaction Sphere) along the southern New Guinea coast, Torres Strait and northern Australia from approximately 3000 years (McNiven 2021). The Walufeni Cave excavation has thus far established the presence of people on the Great Papuan Plateau by at least 10,000 years ago. The completion of the excavations – disrupted by the COVID-19 pandemic – will almost certainly extend this further into the Terminal Pleistocene.

This, and the investigation of other archaeological sites in the region, will allow us to offer a regional model of the human use of the Plateau.

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References

Aplin, K., T. Manne and V. Attenbrow 2016 Using a 3-stage burning categorization to assess post-depositional degradation of archaeofaunal assemblages: Some observations based on multiple prehistoric sites in Australasia. *Journal of Archaeological Science: Reports* 7: 700–714.

Aubert, M., A. Brumm, M. Ramli, T. Sutikna, E.W. Saptomo, B. Hakim, M.J. Morwood, G.D. van den Bergh, L. Kinsley and A. Dosseto 2014 Pleistocene cave art from Sulawesi, Indonesia. *Nature* 514(7521): 223–227.

Austen, L. 1934 The dance of the gope in Kerewo. *Man* 34:4–8.

Barker, B., L. Lamb and T. Manne 2016 Baikaboria ossuary and the origins of the Kesele clan, upper Kikori River, Papua New Guinea. *Journal of Pacific Archaeology* 7(1):89–105.

Beatus, A., S. Breathnach, A. Hack, B. MacCoitir, S. Macnamara, S. McCullagh, S. Read and E. Whelan 2011 Irish Caving Expedition, Papua New Guinea. Unpublished report prepared for the Speleological Union of Ireland.

Biersack, A. 1995 *Papuan Borderlands: Huli, Duna, and Ipili Perspectives on the Papua New Guinea Highlands*. Ann Arbor: The University of Michigan Press.

Brumm, A. 2010 The Movius Line and the Bamboo Hypothesis: Early Hominin stone technology in Southeast Asia. *Lithic Technology* 35(1):7–24.

Brunois, F. 2004 La forêt peut-elle être plurielle? Définitions de la forêt des Kasua de Nouvelle-Guiné. *Anthropologie et Sociétés* 28(1):89–107.

Busse, M. 2005 Wandering hero stories in the Southern Lowlands of New Guinea: Culture areas, comparison, and history. *Cultural Anthropology* 20(4):443–473.

Busse, M., S. Turner and N. Araho 1993 *The People of Lake Kutubu and Kikori: Changing Meanings of Daily Life*. Port Moresby: Papua New Guinea National Museum and Art Gallery.

Coe, A. 2021 A Technological Analysis of Lithics from Walufeni Cave, Papua New Guinea. Unpublished BA(Hons) thesis, School of Humanities and Communication, University of Southern Queensland, Toowoomba.

Cosgrove, R., A. Pike-Tay and W. Roebroeks 2014 Tasmanian archaeology and reflections on modern human behaviour. In R. Dennell and M. Porr (eds), *Southern Asia, Australia and the Search for Human Origins*, pp.175–188. Cambridge: Cambridge University Press.

Crabtree, S.A., D.A. White, C.J.A. Bradshaw, F. Saltré, A.N. Williams, R.J. Beaman, M.I. Bird and S. Ulm 2021 Landscape rules predict optimal superhighways for the first peopling of Sahul. *Nature Human Behaviour* 5: 1303–1313.

David, B. 2008 Rethinking cultural chronologies and past landscape engagement in the Kopi region, Gulf Province, Papua New Guinea. *The Holocene* 18(3):463–479.

David, B., I.J. McNiven, T. Richards, S.P. Connaughton, M. Leavesley, B. Barker and C. Rowe 2011 Lapita sites in the Central Province of mainland Papua New Guinea. *World Archaeology* 43(4):576–593.

David, B., J. Mialanes, F. Petchey, K. Aplin, J-M. Geneste, R. Skelly and C. Rowe 2015 Archaeological investigations at Waredaru and the origins of the Keipte Kuyymen clan estate, upper Kikori River, Papua New Guinea. *Paléo* 26:33–57.

Denham, T.P., R. Fullagar and L. Head 2009 Plant exploitation on Sahul: From colonisation to the emergence of regional specialisation during the Holocene. *Quaternary International* 202:29–40.

Denham, T., J. Golson and P. Hughes 2017 Phase 2: Mounded cultivation during the Mid Holocene. In J. Golson, T. Denham, P. Hughes, P. Swadling and J. Muke (eds), *Ten Thousand Years of Cultivation at Kuk Swamp in the Highlands of Papua New Guinea*. pp.201–220. Terra Australis 46. Canberra: ANU Press.

Dwyer, P.D. 1984 Colonizing New Guinea: A Case for the Middle Altitudes. Unpublished manuscript, University of Queensland, Brisbane.

Dwyer, P.D. 1990 *The Pigs That Ate the Garden: A Human Ecology from Papua New Guinea*. Ann Arbor: University of Michigan Press.

Evans, B. 2000 A Technological Evaluation of the Chipped Stone Assemblage from Nombe, Papua New Guinea. Unpublished PhD thesis, Australian National University, Canberra.

Fairbairn, A.S. and S.A. Florin 2022 Archaeological identification of fragmented nuts and fruits from key Aisa-Pacific economic tree species using anatomical criteria: Comparative analysis of *Canarium, Pandanus* and *Terminalia*. *Archaeology in Oceania* 57(3):160–188.

Fairbairn, A.S., G.S. Hope and G.R. Summerhayes 2006 Pleistocene occupation of New Guinea's highland and subalpine environments. *World Archaeology* 38(3):371–386.

Field, J.H., B. Shaw and G.R. Summerhayes 2022 Pathways to the interior: Human settlement in the Simbai-Kaironk Valleys of the Madang Province, Papua New Guinea. *Australian Archaeology* 88(1):2–17.

Ford, A. 2017 Late Pleistocene lithic technology in the Ivane valley: A view from the rainforest. *Quaternary International* 448:31–43.

Freund, P.J. 1979 Social Change Among the Kasua, Southern Highlands, Papua New Guinea. Unpublished PhD thesis, Univeristy of Iowa, Iowa City.

Gaffney, D., A. Ford and G.R. Summerhayes 2015 Crossing the Pleistocene–Holocene transition in the New Guinea Highlands: Evidence from the lithic assemblage of Kiowa rockshelter. *Journal of Anthropological Archaeology* 39:223–246.

Gaffney, D., G.R. Summerhayes, S. Luu, J. Menzies, K. Douglass, M. Spitzer and S. Bulmer 2021 Small game hunting in montane rainforests: Specialised capture and broad spectrum foraging in the Late Pleistocene to Holocene New Guinea Highlands. *Quaternary Science Reviews* 253:1–27.

Haberle, S.G. 2005 A 23,000-year pollen record from Lake Euramoo, wet tropics of NE Queensland, Australia. *Quaternary Research* 64(3):343–356.

Haberle, S.G. 2017 Palaeoecological Perspectives on the Antiquity of Sago Cultivation in Papua New Guinea. Paper to Department of Archaeology and Natural History, School of Culture, History and Language, Australian National University, Canberra.

Haddon, A.C. 1935 *Reports of the Cambridge Anthropological Expedition to Torres Straits: General Ethnography*. Vol. 1. Cambridge: Cambridge University Press.

Hogg, A.G., T.J. Heaton, Q. Hua, J.G. Palmer, C.S.M. Turney, J. Southon, A. Bayliss, P.G. Blackwell, G. Boswijk, R.C. Bronk, C. Pearson, F. Petchey, P. Reimer, R. Reimer and L. Wacker 2020 SHCal20 Southern Hemisphere calibration, 0–55,000 years cal BP. *Radiocarbon* 62(4):759–778.

Knauft, B. 2005 *The Gebusi: Lives Transformed in a Rainforest World*. New York: McGraw Hill.

Lamb, L., B. Barker, M. Leavesley, M. Aubert, A. Fairbairn and T. Manne 2021 Rock engravings and occupation sites in the Mount Bosavi Region, Papua New Guinea: Implications for our understanding of the human presence in the Southern Highlands. *Archaeology in Oceania* 56(3):304–321.

Landtman, G. 1913 The poetry of the Kiwai Papuans. *Folklore* 24(3):284–313.

Lawrence, D. 1994 Customary exchange across Torres Strait. *Memoirs of the Queensland Museum* 34(2):241–446.

Maloney, T.R. 2021 Flaked stone tools of Holocene Sahul: Case studies from northern Australia and Papua New Guinea. In I.J. McNiven and B. David (eds), *The Oxford Handbook of the Archaeology of Indigenous Australia and New Guinea*. Oxford: Oxford University Press.

McNiven, I. J. 2021 The Coral Sea Cultural Interaction Sphere. In I.J. McNiven and B. David (eds), *The Oxford Handbook of the Archaeology of Indigenous Australia and New Guinea*. Oxford: Oxford University Press.

McNiven, I.J., B. David, K. Aplin, M. Pivoru, W. Pivoru, A. Sexton, J. Brown, C. Clarkson, K. Connell, J. Stanisic, M. Weisler, S. Haberle, A. Fairbairn and N. Kemp 2010 Historicising the present: Late Holocene emergence of a rainforest hunting camp, Gulf Province, Papua New Guinea. *Australian Archaeology* 71:41–56.

Moss, P.T., R. Cosgrove, Å. Ferrier and S.G. Haberle 2012 Holocene environments of the sclerophyll woodlands of the Wet Tropics of northeastern Australia. In S.G. Haberle and B. David (eds), *Peopled Landscapes: Archaeological and Biogeographic Approaches to Landscapes*, pp.329–341. Terra Australis 34. Canberra: ANU ePress.

Newton, D. 1961 *Art Styles of the Papuan Gulf*. New York: Museum of Primitive Art.

Roberts, P., D. Gaffney, J. Lee-Thorp and G.R. Summerhayes 2017 Persistent tropical foraging in the highlands of terminal Pleistocene/Holocene New Guinea. *Nature Ecology & Evolution* 1(3):44.

Schieffelin, E.L. 1976 *The Sorrow of the Lonely and the Burning of the Dancers*. New York: St Martin's Press.

Schieffelin, E.L. and R. Crittenden 1991 *Like People You See in a Dream: First Contact in Six Papuan Societies*. Stanford: Stanford University Press.

Shaw, D. 1973 A tentative classification of the languages of the Mt Bosavi region. In K. Franklin (ed.), *The Linguistic Situation in the Gulf District and Adjacent Areas, Papua New Guinea*, pp.187–216. Canberra: Linguistic Circle of Canberra.

Sillitoe, P. and K. Hardy 2003 Living lithics: Ethnoarchaeology in Highland Papua New Guinea. *Antiquity* 77:555–566.

Stuiver, M. and P.J. Reimer 1993 Extended ^{14}C data base and revised CALIB 3.0 ^{14}C calibration program. *Radiocarbon* 35(1):215–230.

Summerhayes, G.R., M. Leavesley, A. Fairbairn, H. Mandui, J.K. Field, A. Ford and R. Fullagar 2010 Human adaptation and plant use in Highland New Guinea 49,000 to 44,000 years ago. *Science* 330(6000): 78–81.

Swadling, P. 1983 *How Long Have People Been in the Ok Tedi Impact Region*. Papua New Guinea National Museum Record 8. Boroko, PNG: PNG National Museum.

Swadling, P. and R. Hide 2005 Changing landscape and social interaction, looking at agricultural history from a Sepik-Ramu perspective. In A. Pawley, R. Attenborough, J. Golson and R. Hide (eds), *Papuan Pasts: Studies in the Cultural, Linguistic and Biological Histories of the Papuan-Speaking Peoples*, pp.289–327. Pacific Linguistics 572. Canberra: Research School of Pacific and Asian Studies, Australian National University.

Torrence, R. 2011 Finding the right question: Learning from stone tools on the Willaumez Peninsula, Papua New Guinea. *Archaeology in Oceania* 46(2):29–41.

Wagner, R. 1972 *Habu: The Innovation of Meaning in Daribi Religion*. Chicago: University of Chicago Press.

Watanabe, H. 1985 The chopper-chopping tool complex of Eastern Asia: An ethnoarchaeological-ecological re-examination. *Journal of Anthropological Archaeology* 4:1–18.

Watson, V.D. 1995 Simple and significant: Stone tool production in Highland New Guinea. *Lithic Technology* 20(2):89–99.

White, J.P. 1972 *Ol Tumbuna: Archaeological Excavations in the Eastern Central Highlands, Papua New Guinea*. Terra Australis 2. Canberra: Australian National University.

Yen, D. 1990 Environment, agriculture and the colonization of the Pacific. In D. Yen and J.M.J. Mummery (eds), *Pacific Production Systems: Approaches to Economic History*, pp.258–277. Canberra: Department of Prehistory, Research School of Pacific and Asian Studies, The Australian National University.