Archaeological Investigation of Site U14/3081, Poplar Lane (Papamoa) Quarry, Tauranga, Bay of Plenty

report to
Fulton Hogan Ltd
and
the New Zealand Historic Places Trust

Warren Gumbley and Andrew Hoffman

CFG Heritage Ltd.
7 Plunket Terrace
Hamilton
ph. (07) 856 4877
warren.g@cfgheritage.com

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Prepared by: .....
Warren Gumbley

Reviewed by: .....
Matthew Campbell

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CFG Heritage Ltd.
7 Plunket Terrace
Hamilton
ph. (07) 856 4877
warren.g@cfgheritage.com

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Introduction

The archaeological investigation described in this report was carried out as a condition of Authority 2006/83 issued by the New Zealand Historic Places Trust to Fulton Hogan Ltd to destroy archaeological site U14/3081. Fulton Hogan will extend the Poplar Lane quarry boundaries to the west and into the area where U14/3081 is located (Figure 1). The archaeological investigation took place from 31 January to 4 February 2006.

Physiography and site location

U14/3081 lies between 120–130 m ASL on a knoll at the eastern terminus of a ridge spur, approximately 600 metres east of and 70 metres below, the crest of the main Otawa/Papamoa ridge (see Figure 1). An approximate map grid reference for the site is E 2798900 N 6379100 (NZ Map Grid). To the west of the knoll upon which U14/3081 is located a narrow saddle separates it from the main body of the ridge to the west. Topographically, U14/3081 is flanked on its northern and eastern sides by a steeply sided gully, which contains a tributary of Te Toki a Tamaheke Stream. From U14/3081 one can look east down the lower section of the Te Toki a Tamaheke Stream valley and onto the drained swampland beyond. On the south side of the knoll the gully has been used as an over-burden dump by the quarry over the past twenty years. In places the over-burden is level with the lowest part of U14/3081.

Site description and previous work

Prior to the investigation of U14/3081 reported here, Phillips (2000: Figure 2) had identified five potential terraces at the site; one on the knoll crest and others to the east downslope of the crest (Figure 2). Phillips also dug test-pits in the area around the terraces which exhibited mixed soils and interpreted this as suggestive of in-fill of archaeological features such as pits. Gumbley noted morphological similarities between U14/3081 and U14/1675 (Bowers and Phillips 1998), which is located approximately 2 km north of U14/3081. U14/1675 consisted of a platform and a lower terrace on its eastern side, with a further small terrace below that. Excavation of U14/1675 revealed the site included nine storage pits, two groups of postholes representing two structures, hearths, shell midden and areas of burnt soil and fire rake-out debris. This accumulation of features and their layout indicates a domestic context typical of a small household or kainga. Prior to this investigation it was proposed that the terraced site U14/3081 may have been a functional equivalent to U14/1675 and to other undefended kainga (settlement sites) found in the lowlands around Tauranga Harbour and on the Papamoa dune-plain. The likelihood that the site had not been subjected to European cultivation meant that it potentially offered an intact undefended hill top settlement site.

Methodology

The methodology employed was designed to answer questions raised by this assessment:

- what were the functions of the platform and terraces identified on the knoll crest and the eastern slopes of the knoll respectively; and
- could the presence of any features reflecting a defensive role for the site, particularly in the area of the saddle be idenitified;

Figure 1. Location map for U14/3081.

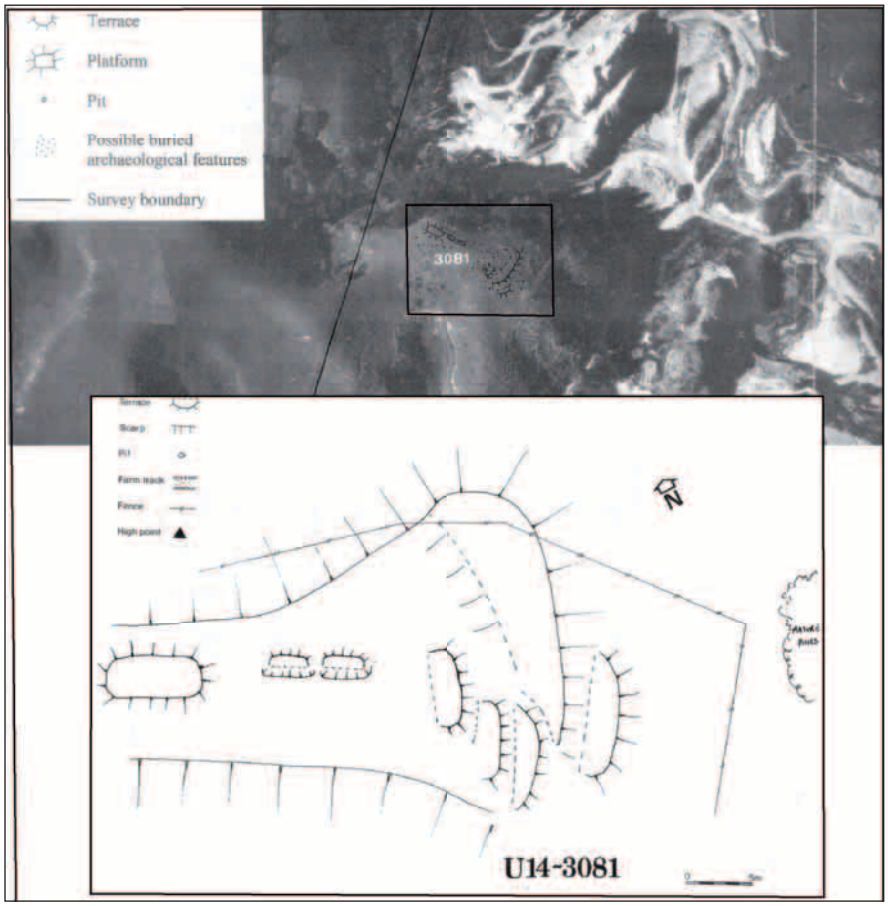


Figure 2. Aerial photograph and site plan (after Phillips 2000).

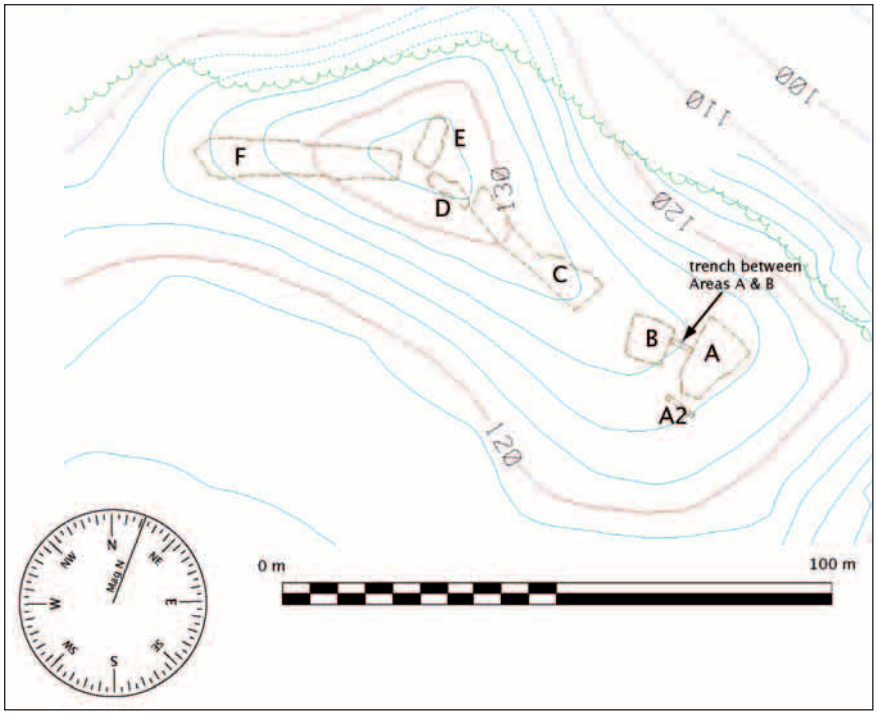


Figure 3. Excavation areas.

In addition the methodology sought to:

- Recover sufficient radiocarbon samples to permit a clear internal chronology of the site's history and to permit effective comparison with the results of archaeological investigations elsewhere; and
- Recover economic and palaeoenvironmental samples for analysis.

A total area of approximately 600 m^2, comprising six separate Areas (A-F), was excavated. Figure 3 shows the topography of the knoll and the locations of the excavated Areas. Areas A and B were on the terraces identified by Phillips on the eastern slope of the knoll. Area C was a long transect along the eastern limb of the knoll crest and encompassed the location of two small possible terraces identified by Phillips (2000). Areas D and E both spanned a part of the knoll crest and their locations aimed to investigate the possible presence of a platform there. Area F was excavated down the eastern slope of the knoll to the saddle to identify any features relating to defences. Another area was investigated on a lower limb of the ridge, oriented north-south where blackened topsoil had also been found. No features were found here other than the remains of burnt tree stumps. This lower area will not be discussed further.

The topsoil from each area was removed using a mechanical excavator and the exposed surface investigated for evidence of archaeological features. Features encountered were completely excavated by hand and their attributes, such as dimensions and nature of their fill were recorded. A trench between Areas A and B, and one to the south of Area A (referred to as Area A2) were cut to add to the understanding of the stratigraphy across this portion of the site and in the expectation they may yield evidence of the terrace scarps or cuts in their profiles. A number of section profiles were drawn following the excavation down to the natural deposit. Figure 4 shows which profiles were drawn.

Charcoal samples were collected from the profiles of Areas A, B and C to provide data for an assessment of the palaeoenvironment at U14/3081, and these were later identified by Rod Wallace (see Appendix A). Soil samples from Areas A and B were taken for pollen and phytolith analysis, which was carried out by Mark Horrocks of Microfossil Research in Auckland (see Appendix B).

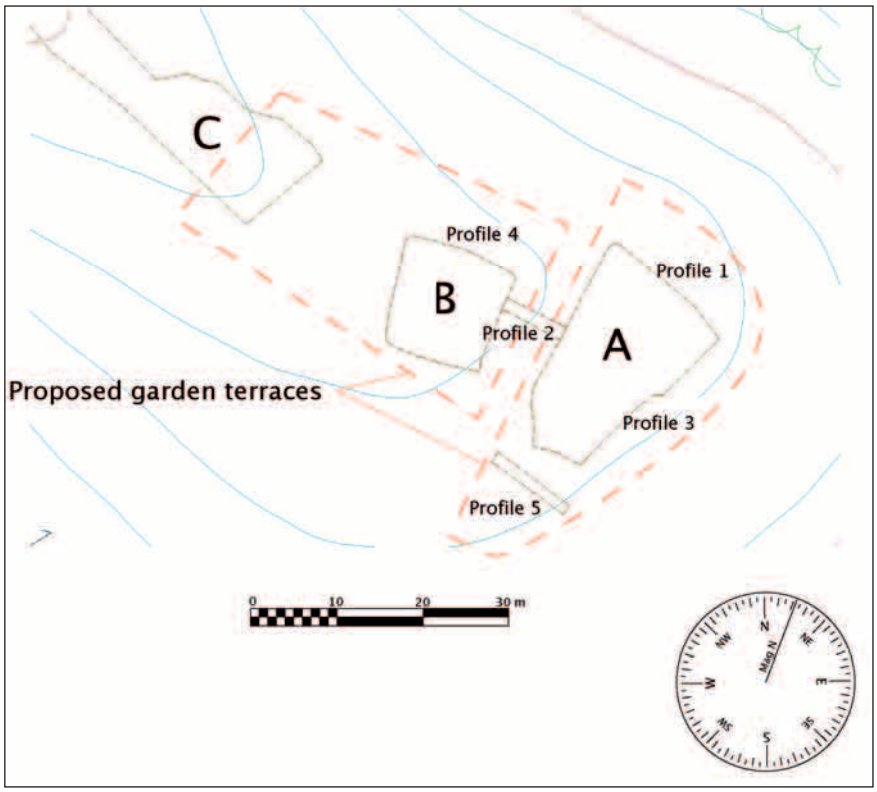


Figure 4. Locations of soil section profiles.

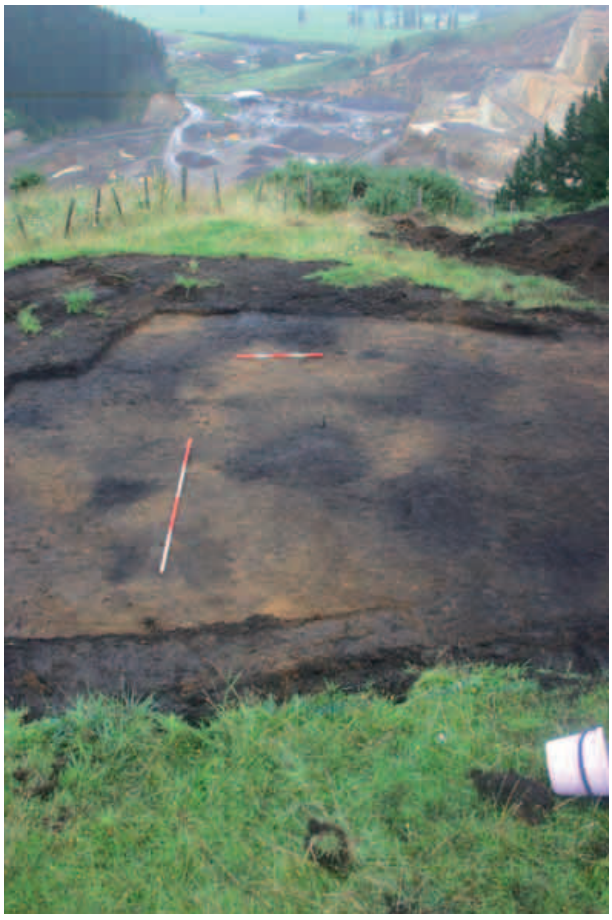


Figure 5. Photograph showing pattern of soil mixing in Area A after turf stripping.

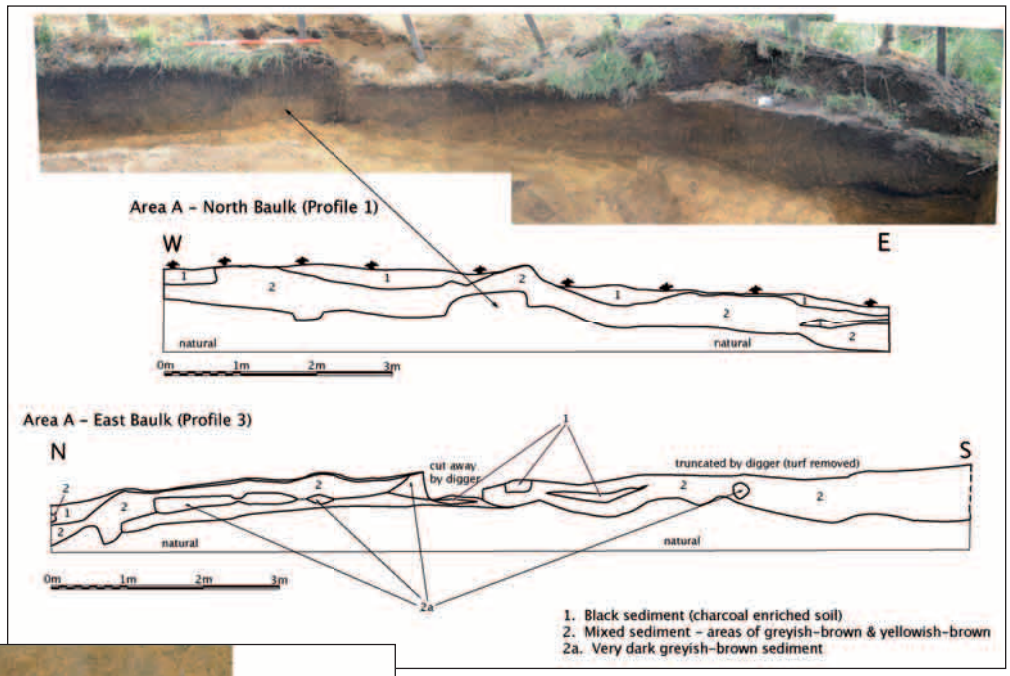


Figure 6. North and east profiles of Area A.

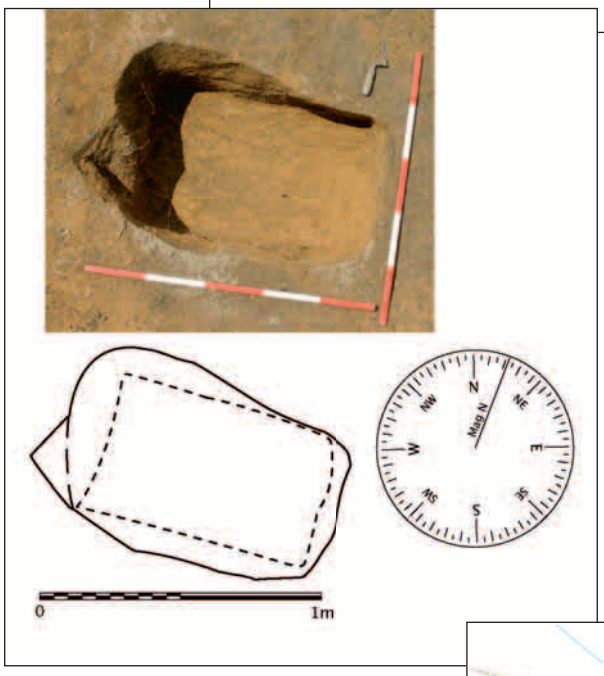


Figure 7. Bin pit (Feature 17).

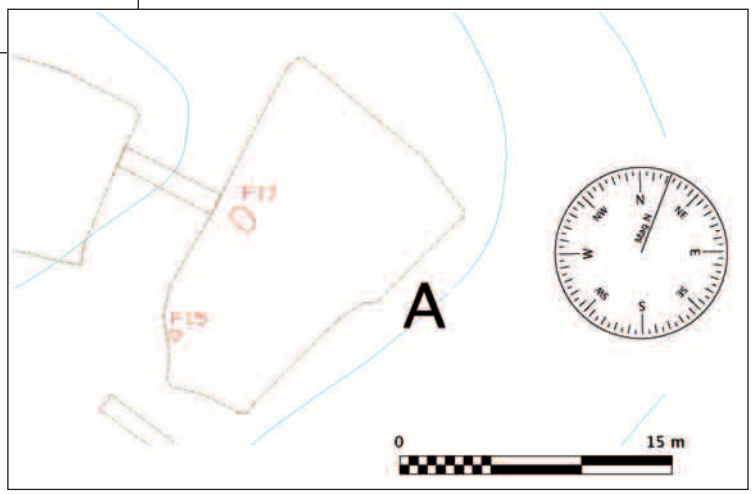
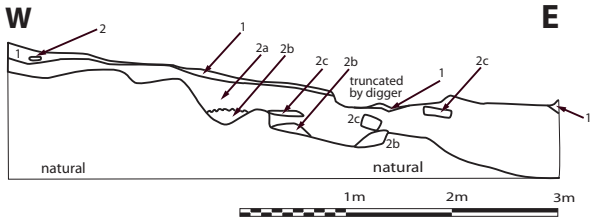


Figure 8. Locations of Features 15 and 17 in Area A.

Area A2 North Baulk (Profile 5)



1. Black sediment (charcoal enriched)
2. Mixed sediment

2b. Yellowish-brown homogenous fill

2c. Very dark greyish-brown sediment (softer than surrounding natural)

Figure 9. Area A2 soil profile.

Results

Area A

Area A was located in the area where Phillips identified a large terrace (Figure 2) and covered approximately 100 m^2. Stripping of the topsoil (Layer 1) revealed a very mixed soil surface (Figure 5) that included large, irregular patches of dark greyish-brown soil, yellowish-brown soil and black soil. Investigation revealed that this patchy appearance was a reflection of the extensive soil mixing and disturbance of the natural stratigraphy across the area to a depth of approximately 500 mm. The section profiles of the northern and eastern baulks are shown in Figure 6. These profiles demonstrate the extent to which this Area had been disturbed through soil mixing. The topsoil layer (1) was a black soil, which was highly enriched with charcoal. The profile demonstrates an anthropogenic mixed soil (Layer 2) comprising the original topsoil (dark greyish-brown), yellowish-brown subsoil and black soil heavily stained with charcoal. The latter may have originated as either the product of initial burn-off or a second gardening episode where a highly melanised topsoil similar to Layer 1 was mixed into the earlier gardening-produced soil. A combination of the two cannot be excluded.

Although several potential features were identified, numbered and investigated across Area A, most were simply artefacts of the patchy soil mixing across the area. Only two of the potential features proved to be real. In the south-western corner of the Area A, a cluster of fire cracked rocks (Feature 15) was identified at the base of Layer 2 at an approximate depth of 300 mm. This feature was clearly once a larger hearth/umu structure, which had been truncated by Layer 2 and the presence of other fire cracked rocks within Layer 2 reinforces this. Charcoal securely associated with Feature 15 was recovered for radiocarbon dating. A single bin pit (Feature 17, see Figure 7) was identified and excavated. The pit dimensions were 950 x 570 x 490 mm – these dimensions relate to the size of the pit as it was cut into the natural subsoil beneath Layer 2. The pit was filled mixed soils similar to Layer 2 and the top of the pit had almost certainly been truncated during the formation of Layer 2. A sample of the bin-pit's fill was analysed for pollen and phytolith content and these details are provided below. The locations of Features 15 and 17 within Area A is presented in Figure 8.

No midden deposits were encountered in this area, however, a single tuatua shell (*Paphies subtriangulata*) was recovered from Layer 2.

Area A2

Area A2 was a trench approximately 1 m wide and 6 m long. No artefacts were recovered from this area and no midden was present. The section profile for Area A2 is shown in Figure 9 and it also clearly demonstrates soil mixing across this part of the site. Discrete lenses or patches showing varying degrees of mixing between an old topsoil and the natural yellowish-brown tephra-based subsoil deposit are present. In the photomontage of this profile (see Figure 9) the eastern section of it shows filling, or 'throw back', within a large basin-like feature cut by the soil mixing process into the natural subsoil. The depth of disturbance here is just less than 1 m.

Area B

Area B covered approximately 50 m^2 in the area of another, smaller terrace identified by Phillips. Stripping of the topsoil (Layer 1) from Area B revealed a similar mixed deposit (Layer 2) to that identified in Area A. No features were apparent in Layer 2. A single well preserved Tuatua shell (*Paphies subtriangulata*) was recovered from Layer 2 in this area, and was retained for radio-carbon dating. Charcoal samples were taken from this area along with soil samples for pollen and phytolith analysis and the results are described below. Figure 10 shows the soil profile for Area B's northern baulk.

Trench between Area A and B

To facilitate identification of terraces visible on the ground surface and the investigations of Areas A and B a short trench (approximately 1 x 4m long) was cut between the west baulk of Area A and the east baulk of Area B (Figure 4). The stratigraphy of this trench was the same as Areas A and B, with mixed soils visible in the trench's profile (see Figure 11) No artefacts were recovered and no midden was visible. The back scarp of the large terrace where Area A was sited was clearly visible as a feature cutting Layer 2 approximately 1 m from the western edge of Area A. Patches of well mixed very dark grey soil occurred within this feature and may have been related to its formation.

Area C

Area C was a wide rectangular trench covered approximately 120 m^2 and was located on the eastern slope between the flat knoll crest and Area B (see Figure3). This was in the area where Phillips had identified two small possible terraces. The stratigraphy of this Area was the same as for Areas A and B, with mixed soil again present as Layer 2. No conclusive evidence of the formation of either terrace was visible and no artefacts, features or midden were present.

Areas D and E

Area D was approximately 30 m^2 and Area E was approximately 40 m^2. These areas were located on the flat crest of the knoll and both were each excavated down to the sub-soil. Although some soil disturbance had occurred in both areas this appeared to be natural and no archaeological features were found.

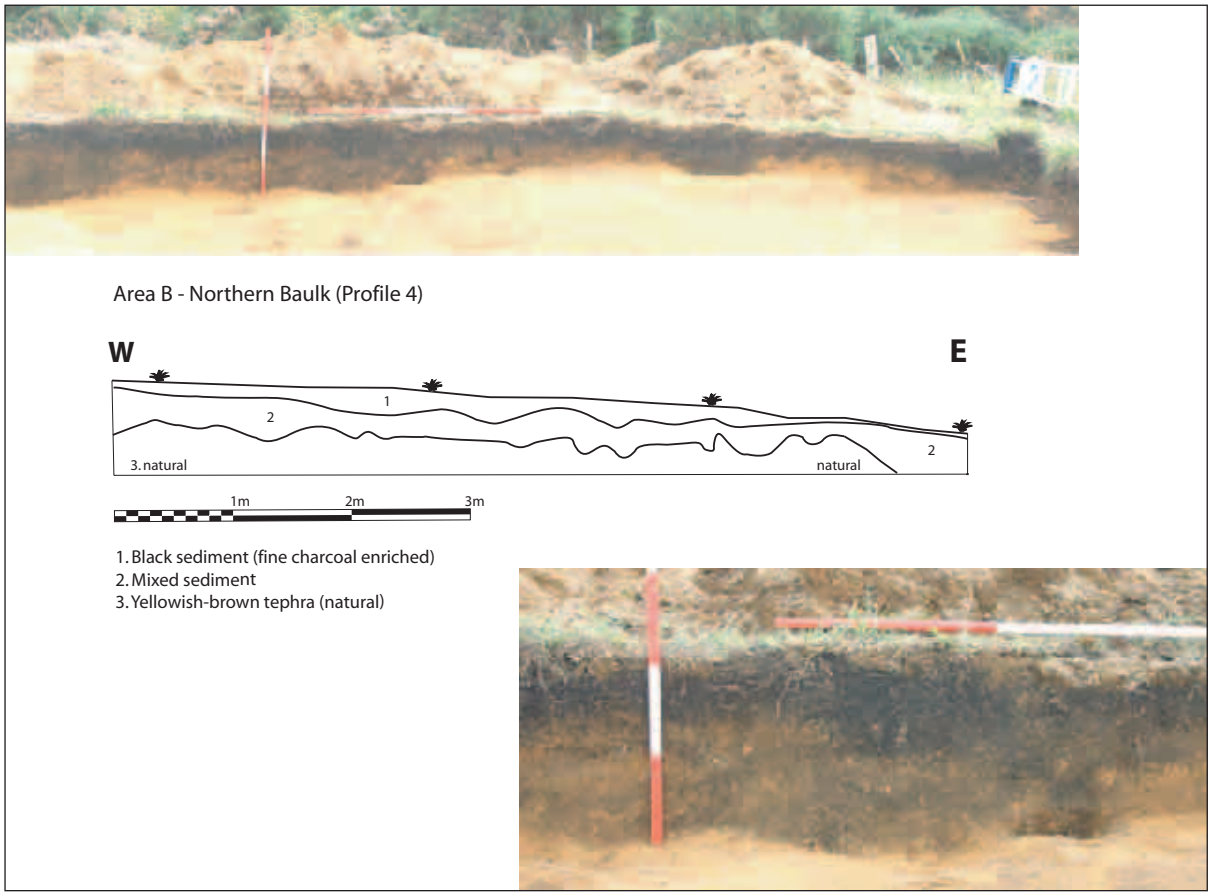


Figure10. North soil profile in Area B.

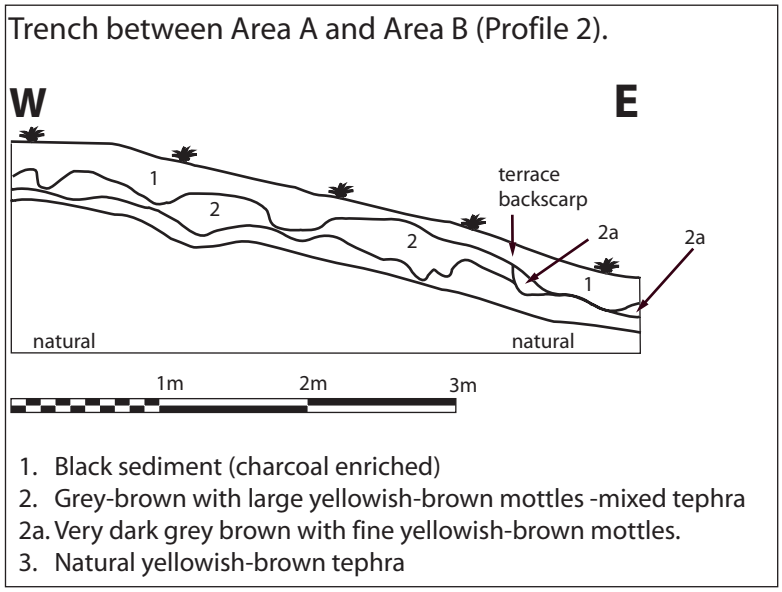


Figure11. North soil profile in Trench A–B.

Area F

Area F was approximately 180 m^2 and was excavated to find any remains of defences for the knoll such as palisade post-holes. None were found. Three patches of burning were found but the slope of the ground makes it unlikely that they are fireplaces or earth ovens. They are probably the result of forest burn-off, whether natural or human-induced is not possible to say.

Palaeoenvironmental analyses

A summary of the results and interpretation of Wallace's identification of charcoal from four samples and Horrock's pollen and phytolith analysis of five soil samples are presented here (see Appendices A and B for full reports).

Charcoal

The charcoal assemblage identified from the samples collected in Areas A and B strongly supports and extends the hypothesis that a significant proportion of the charcoal was generated during forest clearance with later addition from secondary burning. The identified totara, rewarewa and rata are clearly from the original bush. The bracken, tutu, coprosma, ramarama, mapau and mahoe are the typical fern and shrub species that regenerate between landscape fires. Horrocks also noted that fragments of microscopic charcoal were present in all the soil samples, and interpreted this as reflecting anthropogenic fires.

Microfossil analysis

All soil samples were dominated by bracken spores (*Pteridium*). *Cyathea* tree fern spores are also abundant in most of the samples. Very low proportions of pollen from forest plants were coincident with charcoal and bracken spores, which Horrocks interpreted as indicative of repeated firing of the forest in the immediate vicinity. He concluded that bracken fernland was a significant part of the vegetation around the sampling sites, while rata (*Metrosideros*) and rewarewa (*Knightia*), both local pollen dispersers, would have been present in forest remnants in the vicinity of U14/3081. Pollen and spores of other taxa typically indicating vegetation disturbance, namely tutu (*Coriaria*), puha/dandelion (*Sonchus*/*Taraxacum*), *Pteris* fern and hornworts (Anthocerotae) are also present in some of the samples. No starch grains survived in the soil samples for analysis.

Chronology

Two radiocarbon samples were submitted for analysis; Wk-19093[1] and Wk-19481[2]. Appendix D contains the Waikato Radiocarbon laboratory's age determination reports and the calibration curves for both dates.

The charcoal for Wk-19481 was from a sample taken from Feature 15 in Area A. When the CRA for Wk-19481 is calibrated the results give a wide possible age range between AD 1500–1800. At one sigma error there is a 51% probability the actual date falls between AD 1620–1670, while at two sigma error there is a 54% probability the age is between AD 1610–1680. Wk-19481 can be interpreted as representing the timing of occupation at U14/3081 during which Feature 15 was utilized.

Wk-19093 was analysed using the AMS process because of the small size of the shell sample. Like Wk-19481the calibrated age for Wk-1909 3 has wide possible age range between AD 1500–

[1] Sample was tuatua (marine shell). Conventional radiocarbon age 624 +/- 35 years BP.
[2] Sample was charcoal (tutu). Conventional radiocarbon age 296 +/- 31 years BP.

1800. At one sigma error there is 64 % probability that the date falls between AD 1570–1730; at two sigma error there is 95% probability the date falls between AD 1520–1830.

The two radiocarbon dates together indicate the initial occupation phase at U14/3081 occurred in the 17th century AD.

Discussion and Conclusions

Occupation at this site is principally visible as substantial mixing of the topsoils and subsoils at the site. The evidence from the charcoal and microfossil analyses associate this with contemporaneous forest clearance by burning and subsequent repeated burning of regenerating fern and shrubland, which may possibly represent a fallow period before reuse of the site. Evidence from the soil profiles indicate episodes of soil mixing with topsoils being mixed down and yellowish-brown subsoils mixed up. The greyish-brown aspects of the mixed soils probably represent elements of the original topsoil when the soil mixing first occurred. The yellowish-elements were remnants of the disturbed subsoil.

This pattern of clearance through burning with subsequent abandonment, or fallow, periods is typical of the Maori gardening practice. The presence of the single bin-pit, Feature 17 suggests a crop (probably kumara) was grown at this site, and that crop storage formed a limited and temporary component of the occupation at U14/3081. Nonetheless, given the presence of bracken at the site and known harvesting of its root for food we believe it is likely both bracken was harvested and also kumara grown.

No shell midden deposits were present across any of the areas excavated, no evidence of postholes relating to above ground storage structures were identified, and no evidence of any defensive structures were visible. The two tuatua shells found at the site, along with the presence of the partial hearth (Feature 15) indicates cooking activities formed a minor component of occupation at the site.

The number of gardening related disturbance episodes that affected this site is difficult to determine from the disturbed stratigraphy. Nonetheless, the patchiness, or lack of homogeneity in the mixed soil's colour suggests this area had not been intensively mixed as would be expected after a site had been repeatedly gardened on many occasions. Furthermore, the lack of significant archaeological deposits, such as midden and cooking material, which would otherwise indicate more substantial phases of residence associated with gardening, tends to suggest this site was gardened in one or two episodes and that people accessed the site from nearby, possibly from one of the pa on Papamoa Hill.

There is an overall paucity of archaeological data relating to comparable terraced sites across the Bay of Plenty. Prior to the excavation of site U14/3081, it was tentatively posited that the terraced site U14/3081 may be a functional equivalent to U14/1675 and to other undefended kainga found in the lowlands around Tauranga Harbour and on the Papamoa dune-plain (Gumbley 2005:3-6). Results of this excavation now indicate otherwise; that the principal function of U14/3081 related to gardening activity. The two radiocarbon dates indicate occupation at this site occurred between 1500-1800AD, and probably between 1600-1700AD. The pa U14/1810, which was located on the opposite side of Te Toki a Tamaheke Stream, and which was investigated in 2003 (Gumbley 2004) post-dated U14/3081 and therefore a relationship between the two sites is unlikely.

References

Bowers L. and Phillips K., 1998. Archaeological Investigation Report, pursuant to an authority under section 14 of the Historic Places Act 1993, no. 1996/91, Reid Road, Papamoa. Unpublished report prepared for J & N Cooper and N.Z. Historic Places Trust.

Gumbley W., 2004. U14/1810: Report on archaeological investigations of the defences of a pa at Papamoa, BoP. Unpublished report to Fulton Hogan Ltd and N.Z. Historic Places Trust.
Gumbley W., 2005. U14/3081: Assessment of archaeological values. Unpublished report prepared for Fulton and Hogan.
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Appendix A: Charcoal Identification - Sites U14/3081, Fulton Hogan quarry, Papamoa, Bay of Plenty. Dr Rod Wallace, Anthropology Department, University of Auckland

Four charcoal samples from an archaeological site (U14/3081) at Fulton Hogan quarry, Papamoa, Bay of Plenty were submitted for identification. The results are given below.

[1] U14/3081 – Area B – charcoal from mixed soil

Bracken root	6
Mapau	6

[2] U14/3081 – Area A – charcoal from FCR feature 15

Bracken root	2
Tutu	6
Rewarewa	1

NB. I have extracted a dating sample of the first two of the above species.

[3] U14/3081 – Area A – charcoal from mixed soil

Bracken root	2
Coprosma	4
Ramarama	1
Mahoe	3
Rata	3
Totara	3

[4] U14/3081 – Area C – charcoal from west baulk

Tutu	6

Species	# pieces	# samples	% pieces	Plant type
Bracken root	10	3	23%	Fern
Tutu	12	2	40%	Shrubs
Coprosma	4	1		
Ramarama	1	1		
Mapau	6	1	21%	Small trees
Mahoe	3	1		
Rewarewa	1	1	9%	Broadleaf trees
Rata	3	1		
Totara	3	1	7%	Conifer
TOTALS	43	N=4	100%	

Table 1. Summary of charcoal from all samples

Comments

The charcoal assemblage identified in the laboratory strongly supports and extends the above hypothesis. The totara, rewarewa and rata are clearly from the original bush. The bracken and tutu represent fern land while the coprosma, ramarama, mapau and mahoe are the typical broadleaf species that re-generate between landscape fires.

Species names

Bracken	*Pteridium esculentum*
Tutu	*Coriaria arborea*
Coprosma	One of several possible *Coprosma* species
Ramarama	*Lophomyrtus bullata*
Mapau	*Myrsine australis*
Mahoe	*Melicytus ramiflorus*
Rata	*Metrosideros robusta*
Rewarewa	*Knightia excelsa*
Totara	*Podocarpus totara*

Appendix B: Microfossil analysis of samples from Papamoa. Dr Mark Horrocks, Microfossil Research Ltd.

Methods

Palynology

Palynological analysis includes pollen grains of seed plants and spores of ferns. It provides insight into palaeo-vegetation and environments and in New Zealand allows the differentiation of sediments deposited in pre-human, Polynesian and European times (Hayward et al. 2004, Matthews et al. 2005). Pollen may also provide direct evidence of introduced Polynesian plants, namely bottle gourd (*Lagenaria ciceraria*) and paper mulberry (*Broussonetia papyrifera*) (Horrocks 2004), and European crops such as maize (*Zea mays*) (Horrocks & Lawlor 2006).

Samples were prepared for pollen analysis by the standard acetylation and hydrofluoric acid method (Moore et al. 1991). At least 100 pollen grains and spores were counted for each sample and slides were scanned for types not found during the count. Fragments of microscopic charcoal are extracted along with pollen during preparation, providing evidence of fires.

Phytolith analysis

Phytoliths are particles of silica formed in inflorescences, stems, leaves and roots of many higher plants (Piperno 1988). Phytolith analysis compliments pollen analysis and because silica is generally more resistant than pollen to degradation, is also useful when pollen is not preserved. Phytoliths (like pollen) may provide direct evidence of bottle gourd and paper mulberry (Horrocks 2004). Other types of biogenic silica, notably diatoms and sponge spicules, are extracted along with phytoliths during preparation. Diatoms are unicellular algae found in aquatic and sub-aquatic environments and have cell walls composed of silica. Sponges, exclusively aquatic, are multi-cellular animals with an internal skeleton often composed of siliceous spicules. Diatoms and sponges are found in both marine and freshwater environments.

Samples were prepared for phytolith analysis by density separation (Horrocks 2005). At least 100 phytoliths were counted for each sample and slides were scanned for biogenic silica types not found during the count.

Analysis of starch and other residues

This analysis includes starch grains, calcium oxalate crystals and xylem cells (Torrence & Barton 2006). Starch is the main substance of food storage for plants and is mostly found in underground stems (eg tubers, corms), and roots and seeds. It may provide direct evidence of Polynesian starch crops, namely kumara (*Ipomoea batatas*), taro (*Colocasia esculenta*) and yams (*Dioscorea* spp.) (Horrocks & Barber 2005, Horrocks & Weisler in press), and European crops such as potato (*Solanum tuberosum*) (Horrocks & Best 2004). Starch is present in tubers etc in very high concentrations of grains. Calcium oxalate crystals are mainly found in plants as either raphides (needle-like) or druses (compound spherical crystals with many component crystals projecting from their surfaces). The family which taro belongs to, the Araceae (aroids), is characterised by abundant calcium oxalate crystals. Xylem is a complex vascular tissue through which most of the water and minerals of a plant is conducted, and is characterised by the presence of tracheary elements with distinctive thickenings.

Starch and other residues were prepared for analysis by density separation (Horrocks 2005). Samples were analysed for starch and other significant material.

Results and interpretation

Fragments of microscopic charcoal are present in all five samples, reflecting anthropogenic fires. However, the two pit samples have quite low concentrations, suggesting that these pits were not associated with intensive or prolonged human activity. Sample A/black has an extremely high concentration of charcoal, hence its black colour.

All samples are dominated by spores of bracken (*Pteridium*), an invasive ground fern (Figure 1). *Cyathea* tree fern spores are also abundant in most of the samples. Very low proportions of pollen of forest plants (ie woody taxa) coincident with charcoal and bracken spores indicate repeated firing of forest. Bracken often dominates New Zealand pollen assemblages deposited within the last millennium and is commonly associated with Polynesian deforestation which occurred after settlement c. 800-600 years ago (McGlone 1983). Bracken fernland was a significant part of the vegetation around the sampling sites at the time, while rata/pohutukawa (*Metrosideros*) and rewarewa (*Knightia*), both local pollen dispersers, would have been present in forest remnants. *Cyathea* typically colonises gullies in fernland. Pollen and spores of other taxa indicating vegetation disturbance, namely tutu (*Coriaria*), puha/dandelion (*Sonchus*/*Taraxacum*), *Pteris* fern and hornworts (Anthocerotae) are also present in some of the samples. Hornworts are inconspicuous plants that colonise freshly exposed soils. Notwithstanding the clear evidence of forest destruction, the high proportions of bracken and *Cyathea* spores are almost certainly in large part due to greater resistance of these types to degrading soil micro-organisms (Dimbleby 1985). Most pollen grains and spores show signs of corrosion, indicating well-drained deposits allowing aerobic activity and decomposition of organic material.

A fragment of a pine (*Pinus*) pollen grain was found in sample Area A/black, suggesting that this particular deposit is of European age or that European and prehistoric deposits have been mixed by percolation, bioturbation or mechanical disturbance. European-introduced pollen types were not found in any of the other samples, suggesting prehistoric times.

All samples had good preservation of phytoliths, providing further insight into the local vegetation at the time. The phytolith assemblages are dominated by spherical nodular, smooth and especially verrucose phytoliths (Figure 2). The latter type is common in rewarewa and *Fuscopsora* (beech spp. other than silver beech) (Kondo et al. 1994). Spherical smooth phytoliths are found in rata, pohutukawa, beech, kamahi (*Weinmannia*), tawa (*Bielschmeidia*) and *Cyathea*. Spherical spinulose phytoliths, found in U14/3081 samples, occur in palms (Arecaceae) and bromeliads (Bromeliaceae) (Piperno 1988). New Zealand has no indigenous bromeliads therefore in this case this phytolith type is from nikau (*Rhopalostylis*) palm, New Zealand's only representative of this family. Little is yet known about the types of plants that produce spherical nodular phytoliths Grass phytoliths have low proportions throughout, supporting the pollen and spore evidence that ferns dominated open areas at the sites. The generally low proportions of fern phytoliths, which appear at odds with the pollen results (abundant fern spores), is not unusual because ferns are under-represented in New Zealand phytolith spectra.

No starch or other residues (including pollen and phytoliths) of introduced crops were found in any of the samples. This suggests that the sampled areas were not used for intensive cultivation or preparation of introduced agricultural plants.

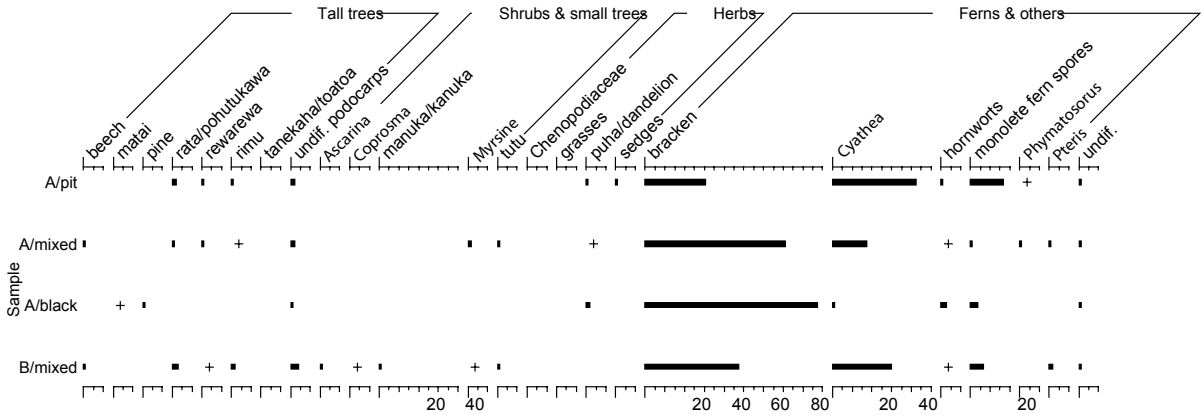

Figure 1. Percentage pollen diagram from Papamoa (+ represents found after count).

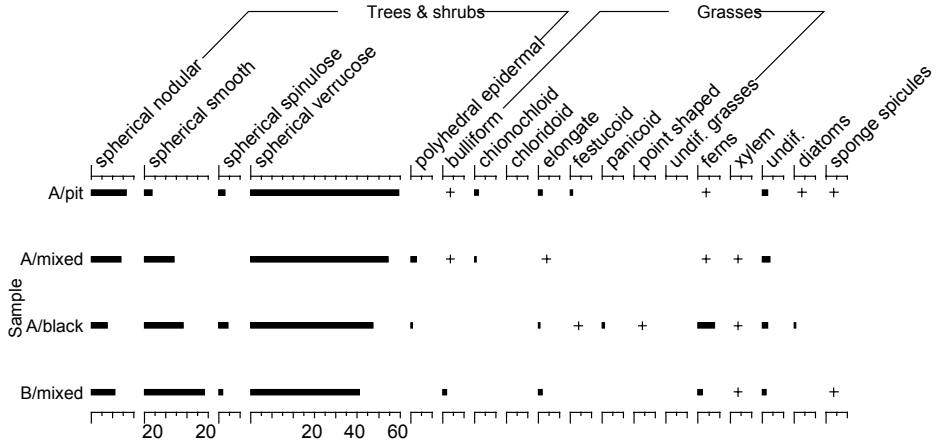

Figure 2. Percentage phytolith diagram from Papamoa (+ represents found after count).

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The University of Waikato

Radiocarbon Dating Laboratory

Private Bag 3105
Hamilton,
New Zealand.
Fax +64 7 838 4192
Ph +64 7 838 4278
email c14@waikato.ac.nz
Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 19481

(AMS measurement by IGNS [NZA-26464])

Submitter	W. Gumbley
Submitter's Code	FCR feature 15
Site & Location	U14/308 area A, New Zealand
Sample Material	Charcoal
Physical Pretreatment	Possible contaminants were removed. Washed in ultrasonic bath.
Chemical Pretreatment	Sample washed in hot 10% HCl, rinsed and treated with hot 1% NaOH. The NaOH insoluble fraction was treated with hot 10% HCl, filtered, rinsed and dried.

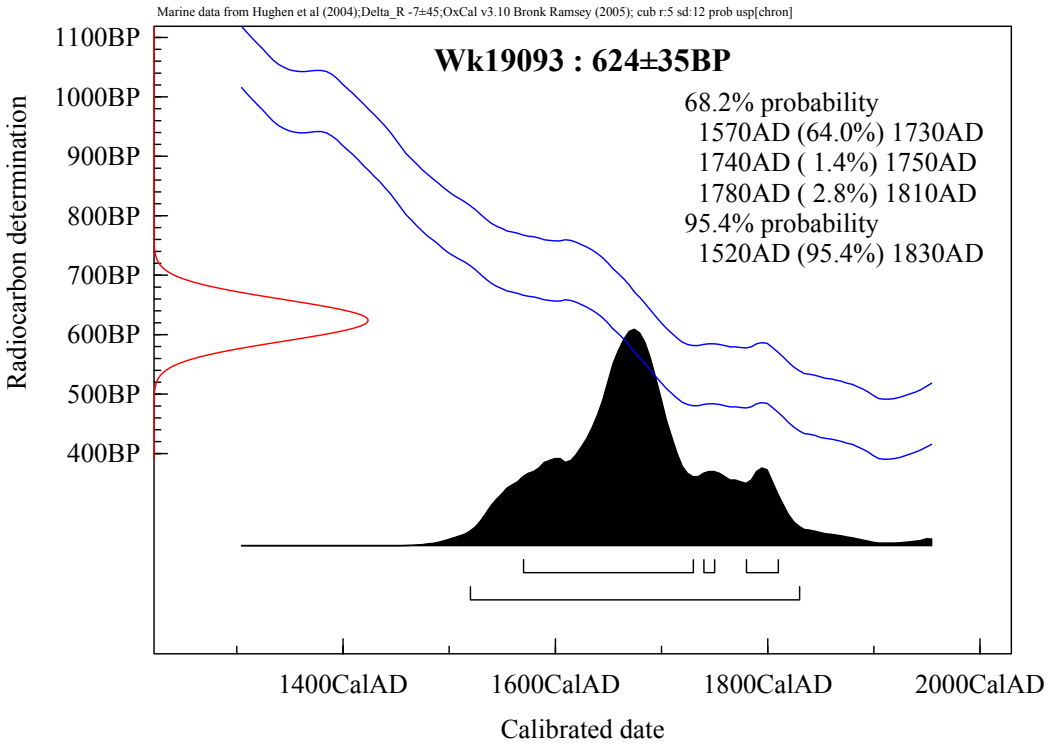
$d^{14}C$	-30.4 ± 3.5	‰
$\delta^{13}C$	-24.0 ± 0.2	‰
$D^{14}C$	-36.1 ± 3.7	‰
% Modern	96.4 ± 0.4	%
Result	**296 ± 31 BP**	

Comments

A G Hogg

16/10/06

- Result is *Conventional Age or % Modern* as per Stuiver and Polach, 1977, Radiocarbon 19, 355-363. This is based on the Libby half-life of 5568 yr with correction for isotopic fractionation applied. This age is normally quoted in publications and must include the appropriate error term and Wk number.
- Quoted errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory Error Multiplier of 1 .
- The isotopic fractionation, $\delta^{13}C$, is expressed as ‰ wrt PDB.
- Results are reported as *% Modern* when the conventional age is younger than 200 yr BP.


Marine data from Hughen et al (2004);Delta_R -7±45;OxCal v3.10 Bronk Ramsey (2005); cub r:5 sd:12 prob usp[chron]
Wk19093 : 624±35BP
68.2% probability
1570AD (64.0%) 1730AD
1740AD (1.4%) 1750AD
1780AD (2.8%) 1810AD
95.4% probability
1520AD (95.4%) 1830AD
Radiocarbon determination
1100BP
1000BP
900BP
800BP
700BP
600BP
500BP
400BP
1400CalAD
1600CalAD
1800CalAD
2000CalAD
Calibrated date

The University of Waikato

Radiocarbon Dating Laboratory

Private Bag 3105
Hamilton,
New Zealand.
Fax +64 7 838 4192
Ph +64 7 838 4278
email c14@waikato.ac.nz
Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 19093

(AMS measurement by IGNS [NZA-25982])

Submitter	W. Gumbley
Submitter's Code	Area B F1 11
Site & Location	, New Zealand
Sample Material	Tuatua
Physical Pretreatment	Surfaces cleaned. Washed in an ultrasonic bath. Tested for recrystallization: Some indication of surface exchange (ie calcite). Aragonite selected for dating.
Chemical Pretreatment	Sample acid washed using 2 M HCl for 300 seconds, rinsed and dried.

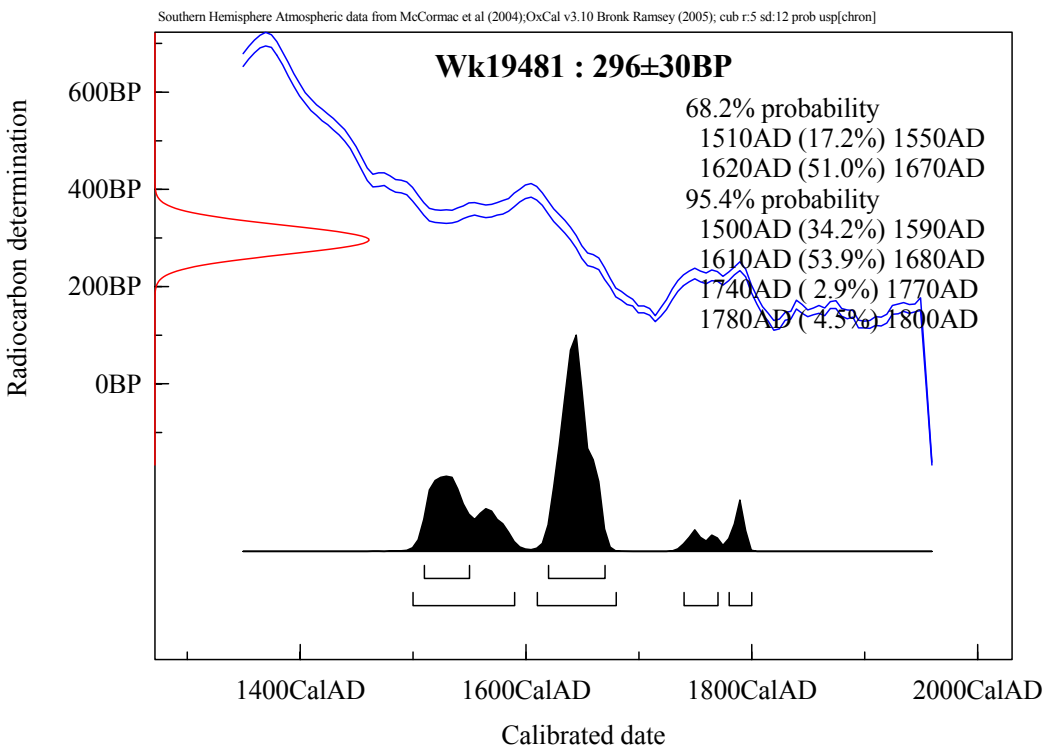
$d^{14}C$	-19.7 ± 3.8	‰
$\delta^{13}C$	1.1 ± 0.2	‰
$D^{14}C$	-74.8 ± 4.0	‰
% Modern	92.5 ± 0.4	%
Result	**624 ± 35 BP**	

Comments

AGHogg

25/8/06

- Result is *Conventional Age or % Modern* as per Stuiver and Polach, 1977, Radiocarbon 19, 355-363. This is based on the Libby half-life of 5568 yr with correction for isotopic fractionation applied. This age is normally quoted in publications and must include the appropriate error term and Wk number.
- Quoted errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory Error Multiplier of 1 .
- The isotopic fractionation, $\delta^{13}C$, is expressed as ‰ wrt PDB.
- Results are reported as *% Modern* when the conventional age is younger than 200 yr BP.


Southern Hemisphere Atmospheric data from McCormac et al (2004);OxCal v3.10 Bronk Ramsey (2005); cub r:5 sd:12 prob usp[chron]
Wk19481 : 296±30BP
68.2% probability
1510AD (17.2%) 1550AD
1620AD (51.0%) 1670AD
95.4% probability
1500AD (34.2%) 1590AD
1610AD (53.9%) 1680AD
1740AD (2.9%) 1770AD
1780AD (4.5%) 1800AD
Radiocarbon determination
600BP
400BP
200BP
0BP
1400CalAD
1600CalAD
1800CalAD
2000CalAD
Calibrated date