DATED GEOCONSERVATION SITES IN THE FOREST ESTATE IN TASMANIA 2004–2012

Forest Practices Authority Technical Report 2

P.D. McIntosh
Forest Practices Authority
Hobart
2012

Reference

McIntosh, P.D. 2012. Dated Geoconservation Sites in the Forest Estate in Tasmania, 2004–2012. *Forest Practices Authority Technical Report* 2.

Acknowledgements

David Price, University of Wollongong, provided the thermoluminescence ages. Forestry Tasmania funded thermoluminescence dating at site 4 (Warra dune). Radiocarbon ages were provided by the Waikato University Radiocarbon Laboratory, New Zealand. D. White (Forestry Tasmania) and A. Slee, C. Spencer and A. Hammond, all formerly employed by the FPA, helped with fieldwork.

CONTENTS

INTRODUCTION

The Forest Practices Authority has been actively involved in the protection of Tasmanian geomorphological heritage since its establishment as the Forest Practices Unit in 1987 (Kiernan 1990). Dated Quaternary sites are important not only for their geomorphological interest but also because they can provide information about climate and processes that shaped the present landscape. In addition, knowing the age and causes of landscape instability in the past may have implications for assessment of instability risks at present. This document collates detailed site information for dated sites that have either not been previously reported, or have been described in reports with limited circulation, or have only been briefly described in papers (McIntosh et al. 2008, 2009, 2012; Slee et al. 2012). Apart from a brief statement on each site's significance, discussion of the genesis of deposits has been kept to a minimum as this is better done in scientific papers (including the above) in which all influences such as climate and anthropogenic effects can be considered.

METHODS

Profile description methods follow the National Committee on Soil and Terrain (2009). Thermoluminescence (TL) dating was performed on undisturbed samples taken with tins 10 cm diameter and 12 cm high, using the methods described by Shepherd and Price (1990) and Nanson et al. (1991) and summarised by McIntosh et al. (2009). Charcoal for radiocarbon dating was washed and all visible contaminants such as fine roots and fungal hyphae removed under a binocular microscope. Radiocarbon ages were determined by Waikato Radiocarbon Dating Laboratory using the methods detailed at http://www.radiocarbondating.com/. Site locations are shown in Figure 1. Radiocarbon ages were calibrated using CalPal (Weiniger et al. 2006).

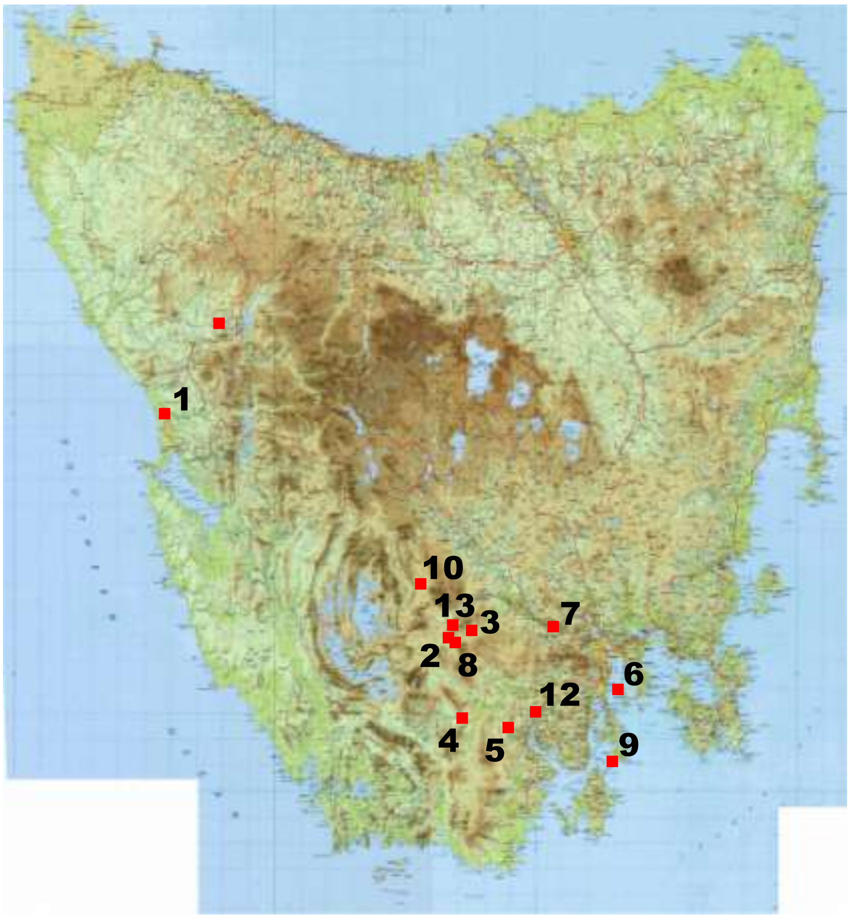


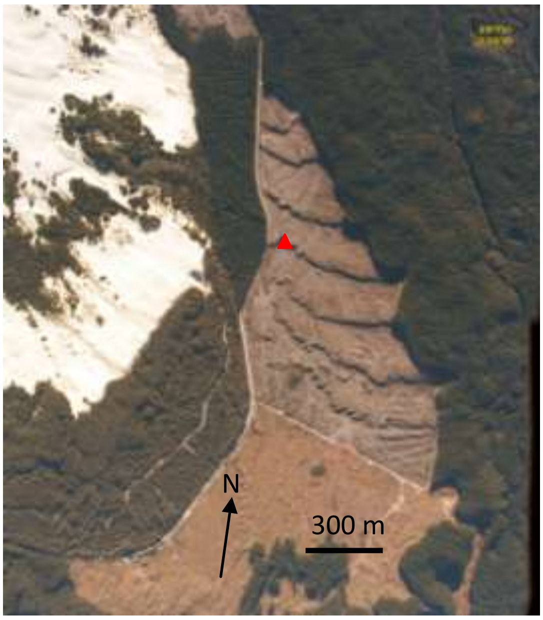
Figure 1. Site locations.

1. MU003C DUNE SYSTEM

Statement of significance: The coalesced parabolic dunes in coupe MU003C have apparently formed by the action of northerly winds in contrast to the presently active Henty dunes formed by winds from the westerly quarter. Each of the seven dune 'fronts' is 6–10 m high and slopes back in a northerly direction to the next 'front'.The TL age dates the formation of these dunes to c. 10 ka BP.

Date: 27 February 2012
Location: Pit on west side of crest of snig track parallel with Henty Road, GDA 358094 5341570
Described by: P. McIntosh
Slope: Flat crest
Altitude: 30 m
Geology: Quaternary sands
References: Not previously described

Layer	Depth (m)	Interpretation	TL age (ka BP)	Brief description
1	0–2.4+	Dunesand	W4452 **10.1±1.2** at 2.4 m	Pale yellow (5Y8/2) loose medium sand; indistinct light olive brown (2.5Y5/4) clay bands, 2 mm wide, at 5 cm spacing.



Left: detail of sampling site on snig track. Pick handle is 0.9 m long. Soils are not podzolised. *Right:* Red triangle marks the sampling site. Note active Henty dune encroaching on vegetated land from the northwest. *Photograph on right supplied by J.G. Hawkes.*

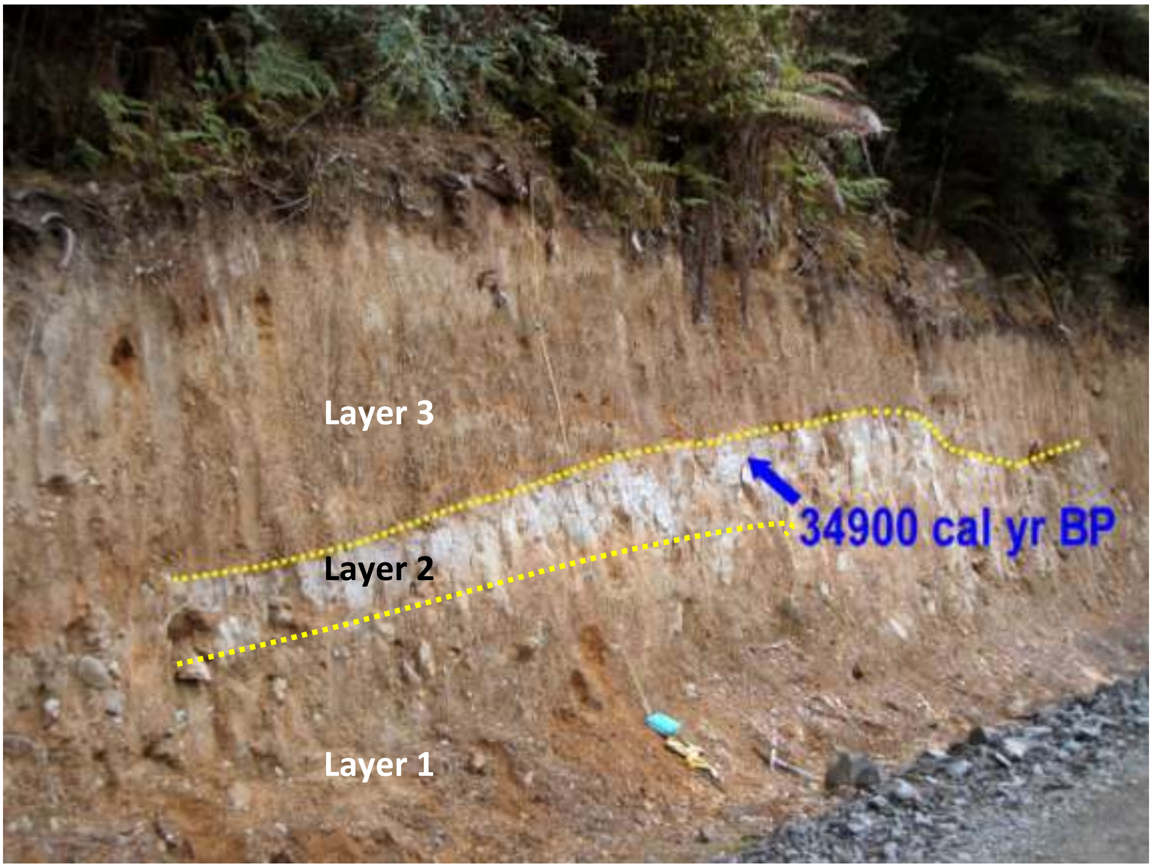
2. STYX ROAD COLLUVIUM

Statement of significance: The deposits represent a time of widespread hillside erosion on south aspects around Maydena, presumably caused by frost action on hillsides having little vegetation cover.

Date: 13 January 2010
Location: GDA 466771 5260621
Described by: P. McIntosh and A. Slee
Slope: 5^o to south
Altitude: 490 m
Geology: Underlying rock mapped as Permian on 1:25000 geological map, Maydena sheet 4626. No Quaternary deposits mapped at the site
References: Sharples (1997) noted the closely related fine layered shaly deposits on slopes in this area and described them as grèzes litées but did not date them. See also McIntosh et al. (2012)

Layer	**Depth** (m)	**Interpretation**	**Radiocarbon age** (ka BP)	**Brief description**
3.2	0–1.00	Fine scree (colluvium)		Brownish yellow (10YR6/6) very gravelly silty loam (high silt content); 90% angular gravels (siltstone) <10 mm diameter; moist; very weak strength; many fine macropores.
3.1	1.00–1.96	Fine scree (colluvium)		Brownish yellow (10YR6/6) very gravelly silty clay loam (30% clay estimated); 5% light yellowish brown (2.5Y6/4) mottles 30 mm diameter (forming silty bands 30 mm thick, mostly in lower half of layer) and 7% strong brown (7.5YR5/6) mottles 50 mm diameter; 75% angular gravels (siltstone) 10–20 mm diameter with few gravels to 40 mm diameter; moist; weak strength.
2.2	1.96–2.30	Colluvium	Wk26705 (AMS) **30.612±0.508***	Pale yellow (5Y8/2) slightly gravelly silty clay loam; 5% subangular gravels (chert and quartz) 20–200 mm diameter; moist; firm strength; abundant **charcoal** fragments in top 100 mm of layer.
2.1	2.30–2.52			Pale yellow (2.5Y7/4) slightly gravelly silty loam (20% clay estimated); 5% subangular gravels (chert and quartz) 20 mm diameter; 45% brownish yellow (10YR6/6) mottles 10-20 mm diameter; moist; firm strength.
1.0	2.52–3.50	Colluvium		Brownish yellow (10YR6/4) very gravelly silty clay loam; 75% angular gravels (siltstone and sandstone) 20–50 mm diameter; 30% strong brown (7.5YR5/6) mottles 5 mm diameter; moist; weak strength.

*Calibrated age (CalPal) = 34.9±0.5 cal ka



The prominent white palaeosol containing charcoal (Layer 2) at the Styx Road site.

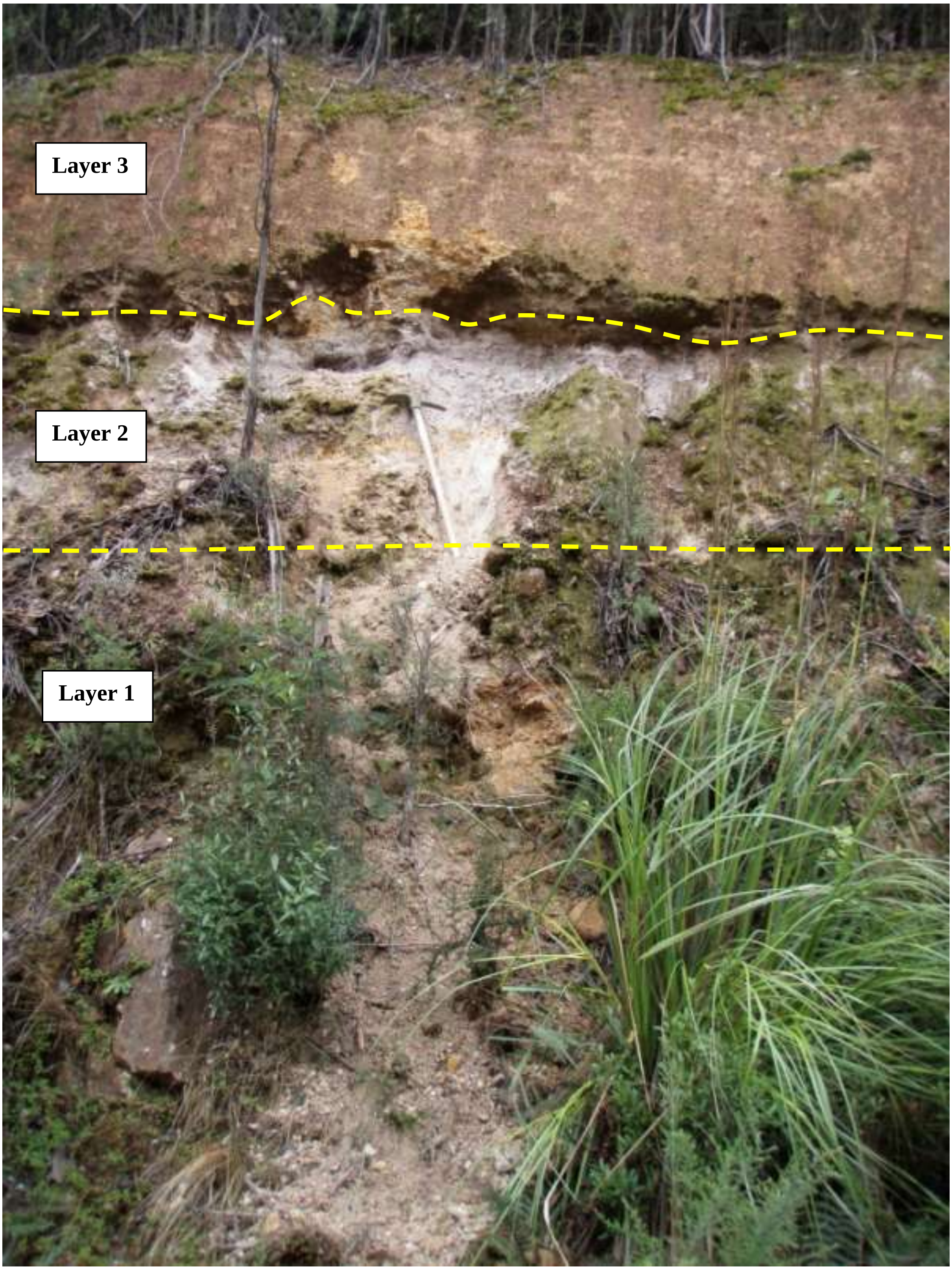
3. STYX BRIDGE TERRACE AND FAN DEPOSITS

Statement of significance. (1) The deposits demonstrate three different depositional styles at the site: terrace gravels of the Styx River, probably glacial outwash; fine alluvial floodplain deposits containing a palaeosol and charcoal; fan alluvium derived from the Diogenes Stream, a tributary of the Styx River; (2) The minimum age for the terrace below the palaeosol is 50 ka BP.

Date: 16 June 2010
Location: Road cutting north of Styx bridge, on western side, GDA 481305 5263819
Described by: P. McIntosh and D. White
Slope: 15^{o} to east
Altitude: 230 m
Geology: Underlying rock is mapped as Permian (siltstone and sandstone) on the 1:250000 digital map
References: McIntosh et al. (2012)

Layer	**Depth** (m)	**Interpretation**	**Radiocarbon age** (ka BP)	**Brief description**
3.2	0–1.20	Fan alluvium from Diogenes Steam		Yellowish brown (10YR5/4) clay loam; weak consistence; 60% angular gravels (fine sandstone) 50 mm diameter.
3.1	1.20-2.75			Light yellowish brown (10YR6/4) silty clay; weak consistence; 40% angular gravels (fine sandstone) 2-20 mm diameter.
2.6	2.75–3.05	Fine alluvium from Styx River)		White (5Y8/1) silty loam; 20% yellow mottles 10 mm diameter; 10% subangular moderately weathered flat subrounded gravels (fine sandstone) firm consistence.
2.5	3.05-3.20			White (5Y8/1) silty loam (est. 90% silt); strong consistence; few charcoal flecks 3 mm diameter.
2.4	3.20-3.30		Wk 28930 (AMS) **>50.0**	Grey (5Y6/1) silty loam (est. 80% silt); 10% pale yellow (2.5Y8/2) mottles forming 1 mm diameter veins; strong consistence; abundant **charcoal** flecks. (Buried A1 horizon.)
2.3	3.30–3.65			Grey (5Y6/1) silt (est. 100% silt); strong consistence; few charcoal flecks.
2.2[1]	3.65–4.00			Pale yellow (2.5Y7/3) silty clay loam; 5% light brownish grey (2.5Y6/2) veins (clay skins and infillings after roots) 3 mm diameter and 5% dark yellowish brown (10YR4/4) veins (after roots) 3 mm diameter; weak consistence.
2.1	4.00–4.50			Light grey (5Y7/2) silty loam; 5% pale yellow (2.5Y8/4) mottles 10 mm diameter; strong consistence.
1.0	4.50-6.50+	Coarse alluvium from Styx River (Terrace gravels)		Light yellowish brown (10YR6/4) clay loam; 30% light brownish grey (10YR6/2) mottles 5 mm diameter; 10% dark yellowish brown (10YR4/6) mottles 5 mm diameter (around stones); 70% rounded gravels (Permian sandstone and siltstone and dolerite) 20–100 mm diameter; weak consistence.

[1]Layer 2.2 could be interpreted as the clay-rich B horizon of the palaeosol developed in the layer with abundant charcoal (layer 2.4); on the other hand the clay-rich layer may be alluvial.



Site showing layers 1–3. The charcoal-rich horizon is in layer 2, above the pick blade.

4. WARRA DUNE

Significance of the site: The dune represents a period of increased sand supply, or a period of dry climate favouring aeolian deposition, or both. The age of the dune provides a minimum age for the underlying coarse (bouldery) terrace deposits of the Huon River, which are likely to be glacial outwash. The absence of charcoal or other evidence of forest cover such as wood or palaeosols in the dune suggests that the site was unforested at the time of dune accumulation.

Date: 29 February 2012
Location: Low dune 30 m north of the Huon River, on river terrace, accessed along track to in-river generator. 2.0 m pit adjacent to track at GDA 472059 5228338
Described by: P. McIntosh
Slope: Flat crest of dune 10 m wide
Altitude: 80 m
Geology: Quaternary alluvial gravel, sand and clay on Picton 1:25000 sheet 4622
References: McIntosh (2012); McIntosh et al. (2012). Aeolian deposits at Slees cutting, approximately 1 km upstream, were described by McIntosh et al. (2009)

Layer	Depth (m)	Interpretation	TL age (ka)	Brief description
2	0–2.55	Dunesand	W4553 **40.6±4.2** at 2.05 m depth	White sand with wavy iron pan at c. 40 cm depth; no roots below iron pan.
1	2.55+	River gravels		Rounded quartzite river gravels 10–40 cm diameter

Top 1.5 m of the dune deposit, showing iron pan at c. 40 cm depth; the dune was sampled for TL dating at 2.05 m depth

5. FOURFOOT ROAD SPUR 4 COLLUVIUM

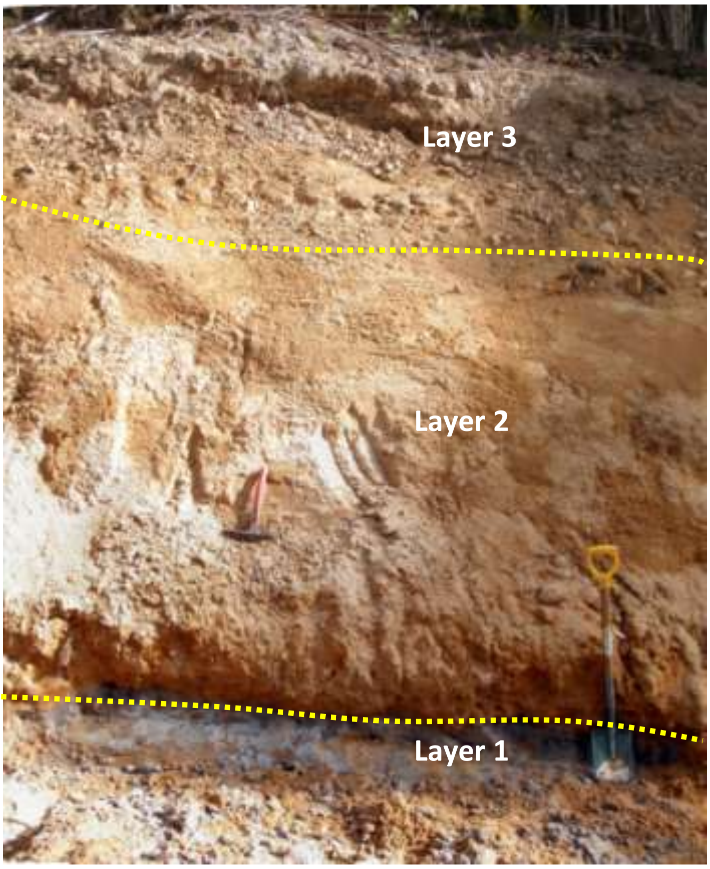
Statement of significance: The dated palaeosol overlain by 4 m of sandy sediments without palaeosols indicates that there was massive hillside erosion at this mid-altitude location about 30 cal ka BP.

Date: 23 April 2010
Location: GDA 490405 5224872
Described by: P.D. McIntosh
Slope: 20^o to north
Altitude: 355 m
Geology: Underlying rock mapped as Triassic sandstone on 1:250 000 digital geological map
References: McIntosh et al. (2012)

Layer	**Depth** (m)	**Interpretation**	**Radiocarbon age** (ka BP)	**Brief description**
3.4	0–0.05	Colluvium		Very dark grey (10YR3/2) silty loam; loose consistence; strongly developed 5 mm granular peds; 5% angular gravels (micaceous siltstone) 10 mm diameter.
3.3	0.05–0.70			Dark yellowish brown (10YR4/4) silty loam; weak consistence; 20% angular gravels (micaceous siltstone) 10–100 mm diameter.
3.2	0.70–1.40			Yellowish brown (10YR5/6) silty clay loam; weakly developed subangular blocky peds 30 mm diameter; 50% angular gravels (micaceous siltstone) 10–400 mm diameter.
3.1	1.40–2.20			Yellowish brown (10YR5/8) silty loam; massive; 20% angular gravels (micaceous siltstone) 5–50 mm diameter.
2.0	2.20–4.15	Colluvium		Yellow (10YR7/8) medium sand; massive; 10% subrounded gravels 3 mm diameter; 2% subrounded gravels 100 mm diameter (micaceous sandstone).
1.0	4.15–4.35	Colluvium with palaeosol	Wk 28031 (Standard) **24.720±0.155***	Light grey (5Y7/1) sand; loose; many **charcoal** flecks. (Palaeosol)
	4.35–4.55			Light greenish grey (10Y7/1) silty loam (60% silt estimated); firm consistence.
	4.55–4.90			Light greenish grey (10Y7/1) silty loam (60% silt estimated) with 70% yellowish red (5YR5/6) mottles; firm consistence.
	4.90–5.00+			Reddish yellow (7.5YR6/8) silty clay (40% clay estimated). Firm consistence.

Note: Charcoal sampled 23 March 2010; section described 23 April 2010; top of layer 1 including palaeosol subsequently obscured by road works; description from 4.15 m downwards was from auger samples.

*Calibrated age (CalPal) = 29.764±0.343 cal ka



The palaeosol containing charcoal is the grey layer (layer 1) at the level of the spade blade. This layer is laterally persistent and occurs (with charcoal) about 100 m further north on the same spur road.

6. MARY ANN BAY AEOLIAN SANDS

Statement of significance: The Mary Ann Bay deposits are Last Glacial aeolian sands containing inclusions of older reworked shells and shelly fragments, and not beach deposits formed during Last Interglacial high sea levels, as suggested by earlier authors. The shells were probably translocated to the site by high winds and have been concentrated into layers as lag gravels.

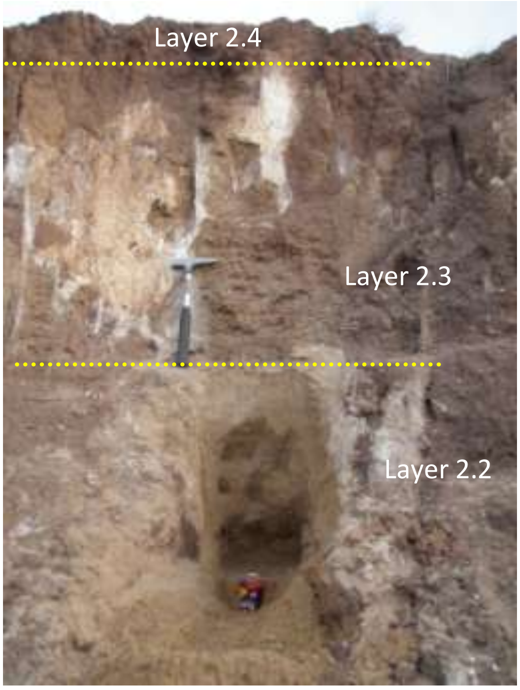
Date: 2 July 2011
Location: GDA 532447 5241936 (bottom); 532452 5241918 (top)
Described by: P. McIntosh and A. Slee
Slope: near-vertical sections in backwall of slump in strongly rolling dune landscape
Altitude: top of section is c. 20 m above sea level.
Geology: Underlying rock is dolerite; samples are in Quaternary aeolian sediments, previously mapped as Mary Ann Sandstone (Leaman 1972)
References: Colhoun (1982); Murray-Wallace et al. (1990); Murray-Wallace and Goede (1991, 1995); Lewis and Quilty (2009); Slee et al. (2012)

The description below is a composite profile, combining descriptions for the upper and lower sampling sites.

Layer	**Depth** (m)	**Soil horizon**	**Interpretation**	**TL age** (ka)	**Brief description**
2.5	0–0.80	A1	Dunesand		Dark brown (7.5YR3/2) medium sand
2.4	0.80–1.00	AB			Brown (10YR4/3) medium sand
2.3	1.00–2.30	Bk			Yellowish brown (10YR5/4) medium sand; columnar structure (columns 0.20-0.60 m diameter); columns coated with calcite c. 10 mm thick, and some with organic matter coatings; shells (mostly angular, thin, weathered and fragmental) up to 60 mm diameter concentrated in bottom half of horizon, where they form layers.
2.2	2.30–7.00	C1		W4475 **30.7±1.9** at 2.90 m W4476 **30.3±3.7** at 6.70 m	Light yellowish brown (2.5Y6/4) medium sand; many coarse shell fragments 2 mm diameter; few fragments >2 mm; carbonate flecks; sediment is banded with coarse sands (c. 25% of total thickness) and fine sands (c. 25% of total thickness)
2.1	7.00–10.00 m	C2			Light yellowish brown (2.5Y6/4) fine sand with bands of coarse and medium sand including shelly fragments
1.2	10.00–10.50	2Bg	Strongly weathered dolerite		Greyish brown (10YR3/2) clay; water-saturated
1.1	10.50–18.00	R	Weakly weathered dolerite		Rock; wave-cut bench at 0.5 m above high tide mark

Note: The top of layer 1.2 forms a slump plane; the dune deposits above the slump plane have collapsed and debris from the collapse obscures most of layer 2.1. The exposed face is the backwall of the slump – see photographs.

Bottom sample site at 6.70 m total depth in layer 2.2



Top sample site at 2.90 m total depth in layer 2.2; hammer is 0.33 m long; 1 m of soil has been deflated from the top of this section; shells are concentrated in layers in the yellowish brown Bk horizon of the soil, at the level of the hammer. Note that layer 2.5 (the Ah horizon of the soil) is not visible in this photograph.

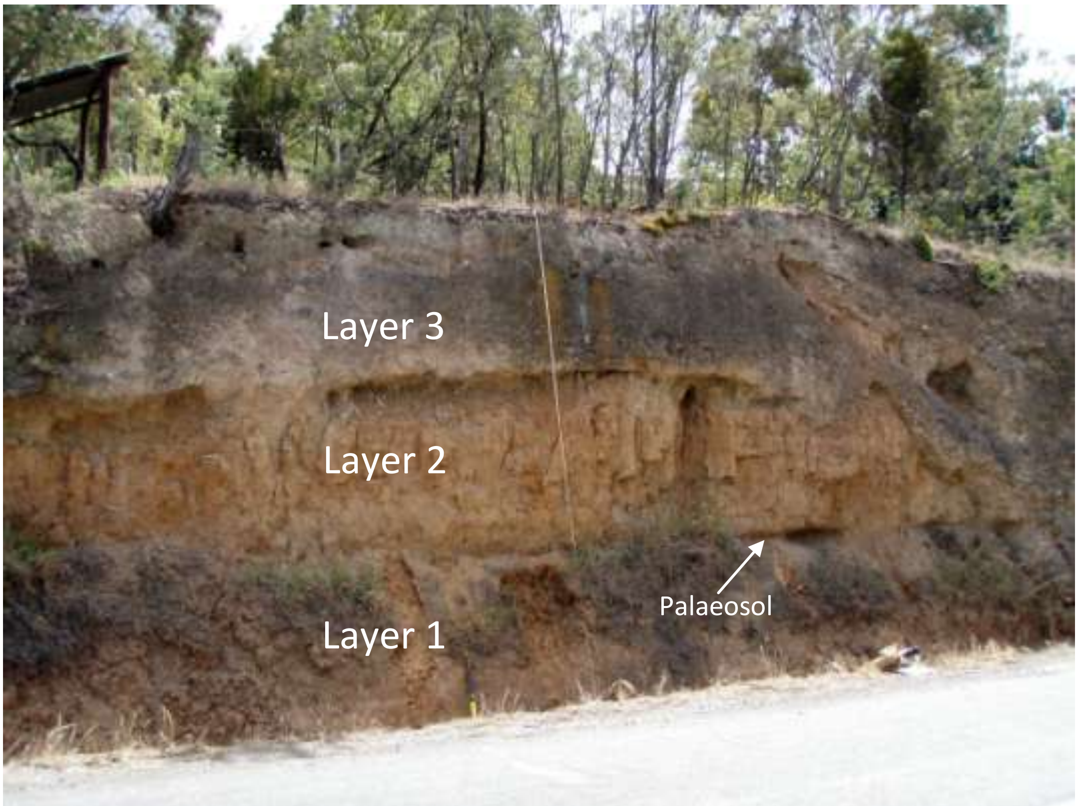
7. NEW NORFOLK FAN AND DUNES

Statement of significance: The described section has provided the first dates (maximum ages) for lower Derwent River slope deposits first described by Wasson (1977). The weakly cemented gravels overlying the dated dunes are provisionally assigned to OIS4, i.e. they are estimated to have been deposited about 65 ka BP.

Date: 18 December 2008.
Location: Road cutting, c. 30 m west of overhead bridge; GDA 506792 5264003
Described by: P. McIntosh and A. Slee
Slope: 10^o to south
Altitude: 5 m
Geology: Quaternary fan alluvium and intercalated aeolian deposits at margin of Derwent River floodplain.
Reference: Wasson (1977); McIntosh et al. (2012)

Layer	**Depth** (m)	**Interpretation**	**TL age** (ka)	**Brief description**
3.4	0–0.20	Fan alluvium		Dark brown (10YR3/3) peaty gravelly silty loam; loose consistence; strong granular peds; 70% angular sandstone gravels 20–100 mm diameter. (A1 horizon.)
3.3	0.20–0.60			Brown (10YR5/3) gravelly sandy loam; 70% angular sandstone gravels 20–100 mm diameter; weak consistence; single grain. (A2 horizon.)
3.2	0.60–1.60			Greyish brown (2.5Y5/2) gravelly sandy clay loam; 85% angular gravels 20–100 mm diameter; weak consistence; single grain. (B2g horizon.)
3.1	1.60–1.85			Greyish brown (2.5Y5/2) gravelly sandy clay loam; 85% angular gravels 20–100 mm diameter; very firm consistence (weakly cemented); single grain. (C2g horizon.)
2.2	1.85–2.20	Dunesand (moderately weathered)		Light olive brown (2.5Y5/3) sandy clay loam; 40% dark yellowish brown (10YR4/6) mottles 10 mm diameter; light olive brown (2.5Y5/3) grey veins 100 diameter. (2Bgb horizon.)
2.1	2.20–3.40		W4231 **74.1±9.1** at 2.65 m	Dark yellowish brown (10YR4/6) loamy sand; weak blocky peds 50–150 mm diameter; fine carbonate strands (after roots); relict faunal burrows 2–3 mm diameter. (2BCgb horizon.)
1.3	3.40–3.65	Dunesand (strongly weathered)		Greyish brown (10YR5/2) silty loam; 35% yellowish brown mottles 10 mm diameter; firm consistence; weak blocky peds 20–30 mm diameter; wood fragments 1–2 cm at top of horizon (buried litter layer); carbonate coatings on peds, concentrated at base of horizon. (3Bgb horizon.)
1.2	3.65–3.90			Yellowish brown (10YR5/4) clay loam; 30% strong brown (7.5YR5/8) mottles 5–10 mm diameter; firm consistence; moderate blocky peds 50 mm diameter; carbonate flecks on peds. (3BCg1b horizon.)
1.1	3.90–5.00+		W4232 **>87.5±7.4** at 4.65 m	Dark yellowish brown (10YR4/4) loam; 20% very dark grey (10YR3/1) mottles 5 mm diameter; 30% yellowish brown (10YR5/8) mottles 8 mm diameter; very firm consistence; massive. (3BCg2b horizon.)

Notes: Layer 3 (fan alluvium) has cut into and eroded layer 2 (weathered dune) in places (see photographs below); in places Layers 1 and 2 are separated by a thin 0.1–0.2 m thick) layer of angular gravel; the woody fragments at the top of Layer 1 are soft and fragile; TL samples were taken (as blocks) from approximately the line of the tape visible in the upper photograph.


Layer 3
Layer 2
Palaeosol
Layer 1


74.1+/-9.1
>87.5+/-7.4

8. JUBILEE ROAD FAN

Statement of significance: The dated fan deposits indicate that slope instability in this area occurred around 50 ka BP and not during the Last Glacial maximum. However, if the age is considered to be infinite rather than absolute, the deposits are older.

Date: 13 January 2011
Location: Road cutting on Jubilee Road spur 0.5 km south of Styx River; GDA 468091 5258997
Described by: P. McIntosh and A. Slee
Slope: 15^{o} to north
Altitude: 390 m
Geology: Quaternary fan alluvium derived from Permian siltstone
References: McIntosh et al. (2012)

Layer	**Depth** (m)	**Interpretation**	**Radiocarbon age** (ka BP)	**Brief description**
2.4	0–0.10	Fan alluvium		Dark grey (10YR4/1) silty loam; strongly developed granular peds. (A1 horizon.)
2.3	0.10–0.25			Light brownish grey (10YR6/2) silt; massive. (A2 horizon.)
2.2	0.25–0.50			Yellowish brown (10YR5/6) silty clay loam; weakly developed blocky peds 5 cm diameter. (B2 horizon.)
2.1	0.50–1.50			Yellowish brown (10YR5/8) slightly gravelly silty clay; 4% angular quartz gravels to 1 cm diameter; strongly developed blocky peds 5 cm diameter; dark greyish brown (10YR4/2) clay coats on ped surfaces. (Bt horizon.)
1.3	1.50–1.65	Fan alluvium	Wk28929 (AMS) **47.219±2.311**	Light grey (2.5Y7/2) gravelly silt loam; 10% angular gravels 2 cm diameter; **charcoal** flecks. (A2b horizon.)
1.2	1.65–2.00			Light yellowish brown (10YR6/4) gravelly silty clay loam; 30% light brownish grey (2.5Y6/2) veins and brownish yellow (10YR6/8) mottles 5 cm diameter; 5% angular quartz gravels 4 cm diameter; weakly developed blocky peds 4 cm diameter. (B2gb horizon.)
1.1	2.00–2.50+			Pale olive (5Y6/4) gravelly silty clay loam; 40% brownish yellow (10YR6/6) mottles 8 mm diameter; 5% quartz gravels; massive. (B3 horizon.)

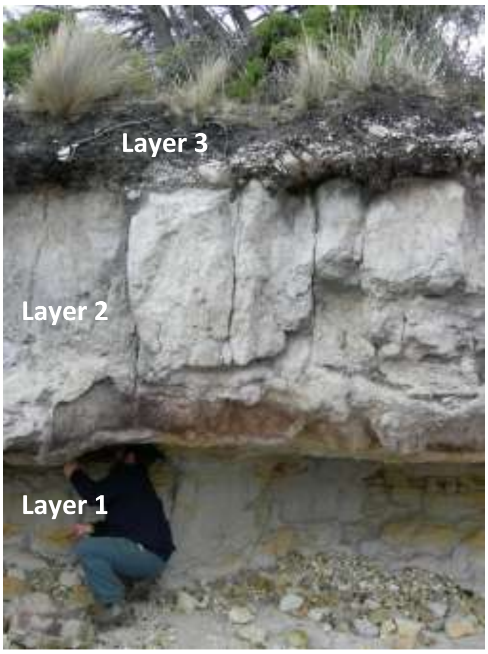
Arrow indicates top of layer 1.3.

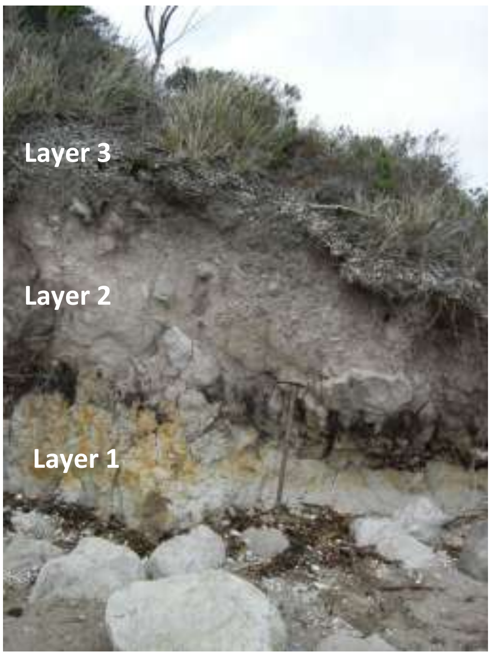
9. BRUNY ISLAND SILCRETE

Statement of significance: The dated silty deposits and the gravelly fan deposits above them indicate slope instability and little vegetation cover down to present-day sea level during the Last Glacial.

Date: Sampled 31 August 2008
Location: On Great Bay at the white cliffs visible when travelling north from The Neck, north of steps and beach access; GDA: 531182 5216395
Described by: P. McIntosh and C. Spencer; redescribed by A. Hammond and P. McIntosh on 19 December 2008
Slope: 3^{o} to west
Altitude: At sea level
Geology: Lacustrine silty and proximal (gravelly) Quaternary fan alluvium derived from Permian siltstone
Reference: Burns (1977); McIntosh et al. (2012); McIntosh and Ranson (2012) (unpublished report, appended to this site description)

Layer	Depth (m)	Interpretation	TL age (ka)	Detailed description
3	0–0.60	Colluvium		Black medium sand with c. 80% white angular sandstone stones 1–20 cm diameter.
2	0.60–2.00	Fan or lakeshore (beach) deposit		Cemented white sand with 5% subangular and subrounded sandstone gravels 1–2 cm diameter, concentrated in bands.
1	2.00–3.00	Alluvial (lake deposit)	W4202 **48.1±6.5** at 2.5 m	White and yellow mottled silt; massive.





Left: the sampling site; sample taken from layer 1. *Right*: the exposure near the beach access.

1 June 2012; TRIM 2012/65956

A NOTE ON THE QUATERNARY STRATIGRAPHY OF ABORIGINAL AND SILCRETE SITES, GREAT BAY, BRUNY ISLAND

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D. Ranson, DPIPWE, Hobart

INTRODUCTION

On 26 May 2012 we visited the Great Bay Aboriginal site described by Ranson (2011) and a Tasmanian Geoconservation Database site (TGD site 2197: White Cliffs Silcrete) (TGD 2011) further south (Figure 1). The purpose of the visit was to determination stratigraphic relationships between the two sites.

Figure 1. Location of the Aboriginal site and the Silcrete site discussed in this report. The Aboriginal site is at GDA 531246 5218976 and the Silcrete site is at GDA 531182 5216395. Grid squares are 1 km^2.

PREVIOUS WORK: SITE DESCRIPTIONS

Aboriginal site

The Aboriginal site was described and interpreted by Ranson (2011). Ransome interpreted the dark layer at the Aboriginal site (which contains profuse silcrete fragments including flakes made by humans) to be a peat deposit, formed in a low lying swampy depression, bounded on its eastern side by slightly higher land and on its western side by a dune at the edge of a shallow coastal bench. Ranson (2011) proposed that the enclosing dune was broken through by high sea levels possibly 6000 years ago, causing the sea to inundate the peat. In this interpretation the dark layer is considered to be the remnant of a more extensive Last Glacial deposit. Figure 2, from Ranson (2011), provides a reconstruction of the ancient landscape.

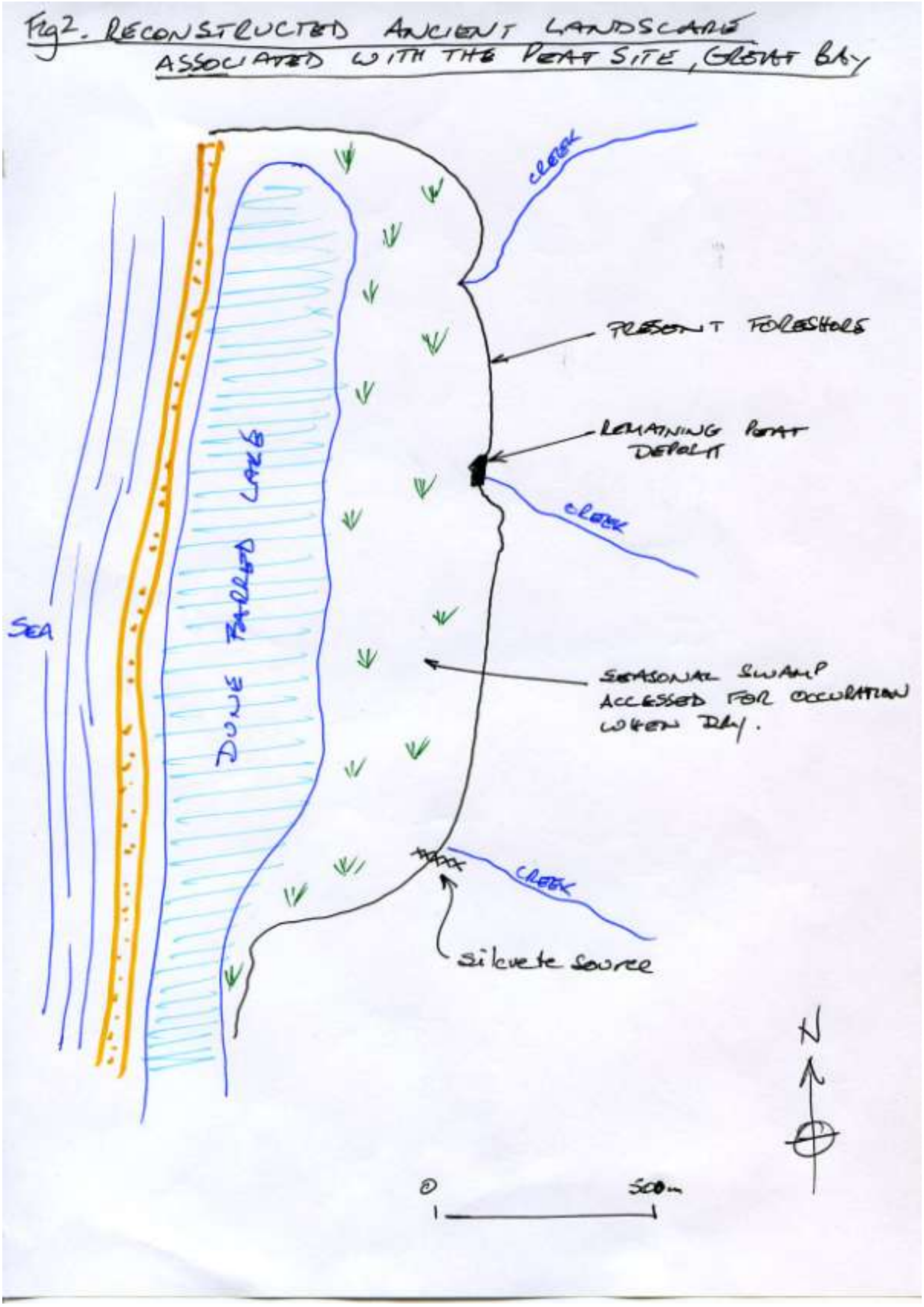

Figure 2. Reconstruction of likely palaeogeography around the Aboriginal site by Ranson (2011).

The peat deposit abuts large silcrete boulders resting on mottled silty clays. The silcrete has been broken up and flaked by humans, and fragments of silcrete, many of them shaped, litter the beach at present and are also found within the peat deposit.

Silcrete site

The White Cliffs silcrete was originally considered to be Tertiary (Burns 1977). The Silcrete site was redescribed by P. McIntosh and A. Hammond in 2008 and their description is reproduced below. The description refers to the site shown in the left hand photograph in Figure 3. The thermoluminescence (TL) age was obtained by David Price at the University of Wollongong.

Map reference: GDA 531182 5216395
Described by: P. McIntosh and C. Spencer; revisited and reinterpreted by A. Hammond and P. McIntosh on 19 December 2008.
Date of sampling: 31 August 2008.

Layer	**Depth** (m)	**Interpretation**	**TL Date** (ka BP)	**Detailed description**
3	0–0.60	Colluvium		Black medium sand with c. 80% white angular sandstone stones 1–20 cm dimeter
2	0.60–2.00 m	Fan or lakeshore (beach) deposit		Cemented white sand (silcrete) with 5% subangular and subrounded sandstone gravels 1–2 cm diameter, concentrated in bands
1	2.00–3.00 m	Alluvial (lake deposit)	At 2.5 m **W4202** 48.1±6.5	White and yellow mottled silt; massive.

Figure 3. The Silcrete site. The photograph on the left shows the described site. The photograph on the right shows the exposure about 50 m further south. The overall stratigraphy at both locations is similar, but the massive silcrete layer is more gravelly at the southern site, and the overlying gravelly black topsoil (also partly silicified and cemented in its lower portion) is thicker.

Layers 1 and 2 are interpreted to be fan alluvium derived from Permian siltstone which occurs in the 500 ha catchment east of the site. Layer 1, having a silty field texture, actually contains 65% clay, 34% silt and 1% sand (analyses by Ralph Bottrill, Mineral Resources Tasmania), i.e. it is a silty clay and was TL dated 48.1±6.5 ka BP (BP = before present, i.e. before 1950), which may be an overestimate, as aggregates were noticed in hand specimens and quartz grains may not have been fully 'reset' prior to deposition. These aggregates may be responsible for the silty (rather than clayey) hand texture of the deposit. It is most likely that the silty deposit formed in a seasonally dry freshwater lake when sea levels were lower, and that as the fan advanced into the lake, or as the climate deteriorated and frosts became more severe and erosion increased, gravelly sands covered the originally distal deposits of clays and silts (Figure 4). The site's significance is that it shows that there was extensive erosion in a small low-altitude catchment (maximum altitude 180 m) during the Last Glacial. Analyses by Patrick Moss, University of Queensland, showed that the silty deposits have a very low pollen count (c. 2500 pollen grains/cm^3) and the pollen types present suggest an arid and sparsely vegetated landscape dominated by very open dry eucalypt forest with a heathy understorey, an interpretation supported by the absence of traces of vegetation (e.g. leaf impressions) or charcoal in the silty clay, which appears to be an ideal preservation medium.

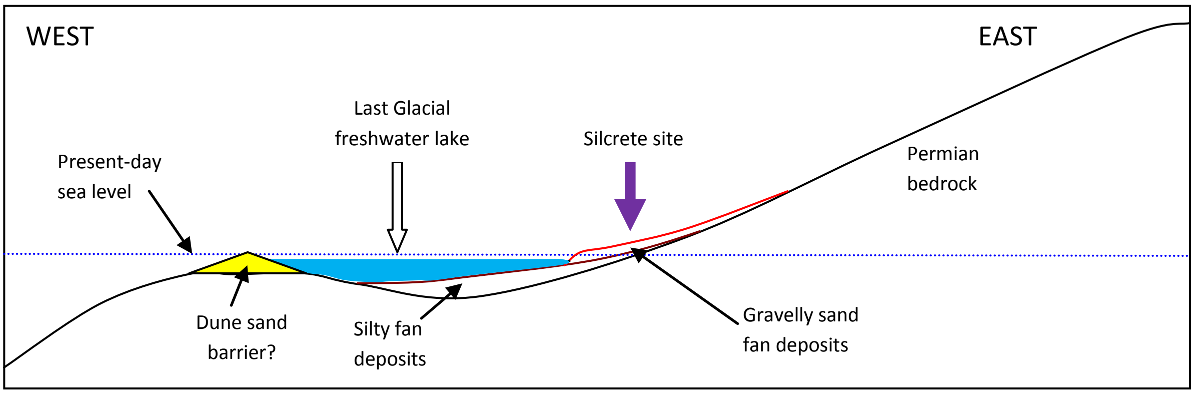

Figure 4. Cross section of inferred palaeogeography c. 40 ka BP at the Silcrete site.

NEW OBSERVATIONS

The peat deposit

At the aboriginal site we observed modern shelly deposits in organic-rich dark sands (Figure 5), clearly formed at high water mark in stormy conditions. On close examination the nearby 'peat' deposits proved to have a loamy sand rather than a peaty texture, and contained trace fossils of shells, now dissolved (Figure 6). We concluded that the 'peat' deposits originated in a similar way to the modern shelly beach deposits, i.e. formed as storm beach deposits rather than in a wet depression.

Figure 5. Modern storm deposits of shelly sands, at high water mark. Intervals on pole are 25 cm.

Figure 6. Trace fossils of shells in the 'peat' deposit. The texture of the deposit is a loamy sand. The presence of shells and the loamy sand texture indicate that the 'peat' is also a beach deposit and has probably formed by a similar process to that which formed the recent shelly beach deposits (Figure 5). Scale is 13 cm long.

At the Aboriginal site silcrete boulders overlie mottled silty clays – the same stratigraphy as shown at the Silcrete site. We conclude that the silcrete boulders (and the mottled silty clays below them, which are poorly exposed at the Aboriginal site) are the remnants of a much more widespread silcrete deposit which followed the present Great Bay shoreline northwards from the Silcrete site.

The modern and the older shelly deposits butt against the silcrete boulders and mottled silty clays. They are therefore younger, and clearly related to high (Holocene) sea levels. We suggest that the older deposit with dissolved shells may be several thousand years old, and because it forms a bench between high water and low water mark (though now extensively eroded), may have formed during storms in a period of declining sea levels after the 6 ka BP sea level high stand. As the sea receded the landward sandy deposits would have been invaded by coastal vegetation and in time the acid vegetation litter would have dissolved the shells in the deposit. Sea-level rise post 6 ka BP has eroded the deposit and also formed the present-day storm deposits with abundant intact shells.

CONCLUSION

The earlier conclusion (Ranson 2011; TGD 2011) that a freshwater lake existed of the coast of Great bay, and was probably dune-bound on its western edge, is supported by the field observations, but the lake is not as young as supposed by Ransom (2011); it probably dates to around 40 ka BP. The 'peat' deposit containing Aboriginal-worked silcrete flakes is reinterpreted to be a fossil storm deposit probably formed about 6 ka BP. The silty clay deposit and the formation which later became cemented, forming silcrete, are interpreted to be distal and proximal fan deposits respectively, dating to about 40 ka BP, and their formation in an eroding and sparsely vegetated landscape is supported by pollen analysis. Mineralogical analysis of the silcrete could establish whether it formed under arid alkaline (high pH) or wet acid (low pH) conditions (Wopfner 1983). The former conditions are considered more likely, given the palynological data.

ACKNOWLEDGEMENTS

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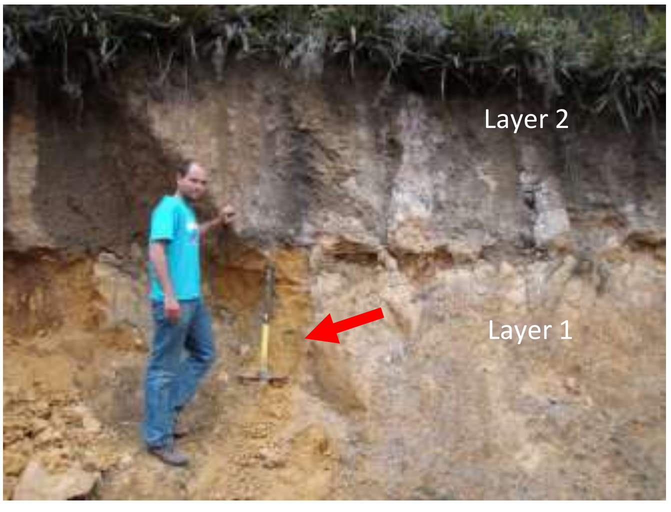
10. FLORENTINE ROAD FAN

Statement of significance:
The age of the silty clay loam layer (38.7±2.5 ka) places this deposit in OIS 3. The overlying gravelly layer was possibly deposited soon afterwards. The fact that these fan deposits are now remnant implies that widespread erosion has occurred in the Florentine valley during the late Last Glacial.

Date: 18 December 2008
Location: Road cutting on west side of Florentine Road at GDA 455979 5279165
Described by: P. McIntosh and A. Slee
Slope: 7^{o} to northeast
Altitude: 405 m
Geology: Underlying rock mapped as cherty Ordovician limestone; no Quaternary deposits mapped here by Sharples (2008)
Reference: Sharples (2002, 2008); McIntosh et al. (2012)

Layer	Depth (m)	Interpretation	TL age (ka)	Brief description
2.3	0–0.20	Fan alluvium		Dark greyish brown (10YR4/2) silty loam; loose consistence; strong granular peds. (A1 horizon.)
2.2	0.20–0.50			Light grey (10YR7/1) gravelly silty loam (high silt content); loose consistence; 75% angular quartz and chert gravels 2–10 mm diameter. (A2 horizon.)
2.1	0.50–1.70			Very pale brown (10YR8/2) gravelly silty loam (high silt content); light yellowish brown (10YR6/4) mottles in bands c. 50 mm thick; 65% angular gravels 2–10 mm diameter; massive; weakly cemented; few gravels to 50 mm diameter; wavy discontinuous Fe pan 3 mm thick at base. (B2g horizon.)
1.1	1.70–4.00	Floodplain alluvium[1]	W4233 **38.7±2.5** at 2.3 m	Brownish yellow (10YR6/8) silty clay loam; 50% yellow (10YR6/8) mottles 10–20 mm diameter; massive; firm consistence; 2% angular gravels 10–20 mm diameter in lenses. (2B2 horizon.)

[1] The absence of faunal mixing, low porosity and the presence of gravels in Layer 1.1 indicates that it is alluvial rather than aeolian. The Layer 1/Layer 2 transition may mark a change from distal fan alluvium to proximal (gravelly) fan alluvium as the fan prograded.



TL sampling position arrowed

11. HUSKISSON FAN

Statement of significance:
The slight weathering of the deposits (low clay content and lack of cementation) suggests a Last Glacial age but ages obtained were considerably older and not in stratigraphic order. It is concluded that the ages obtained result from incomplete resetting of quartz grains, i.e. are a consequence of rapid deposition with insufficient exposure to sunlight prior to burial. This would be consistent with the alluvial origin of the sediment and the steepness of the small catchment from which the sediments are derived.

Date: 20 January 2009
Location: Road cutting on north side of Pieman Road at GDA 372118 5378510
Described by: P. McIntosh and A. Slee
Slope: Surface slope at top of section c. 12^{o}S. Slope of section is 52^o from horizontal.
Altitude: 170 m
Geology: Mapped as Quaternary fluvioglacial deposits. This 12 m deep deposit 1 km east of the Huskisson River is derived from erosion of a 300 m hill of Siluro-Devonian rocks to the northwest by minor streams. Presently a stream flows c. 60 m west of the section. The fan deposits probably overlie terrace gravels visible on the south side of the Pieman Road opposite the section but the actual contact of the two formations has not been observed.
Reference: McIntosh et al. (2012)

Layer	Depth[1] (m)	Interpretation	TL age (ka)	Brief description
2	0–8.6	Fan alluvium		Brownish yellow (10YR6/8) loamy sand with bands of rounded quartz and sandstone gravels up to 4 cm diameter. Bedding dips southeastwards.
1	8.6–11.8	Fan alluvium	W4250 (9.1 m) **>165±14** W4249 (11.4 m) **125±8**	Brownish yellow (10YR6/8) loamy sand with bands of greyish brown (10YR5/2) loamy sand (faint palaeosols); slumping indicated by a 'faultline' immediately east of lower sample location.

[1]Depths have been corrected for the slope of the section

Left: Site photo (section is 11.8 m high); *right*: positions of TL dating tins prior to their removal.

12. HOME HILL

Statement of significance: The site shows that during the LGM there was little vegetation at altitudes close to sea level in southern Tasmania and deep fine screes accumulated, probably by freeze-thaw processes, where siltstones outcrop upslope.

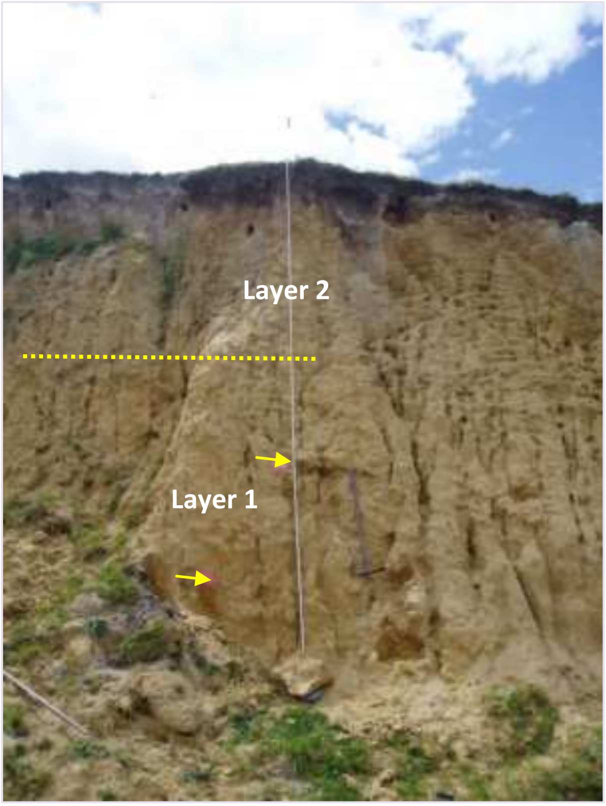
Home Hill: the main section

Date: 8 November 2007
Location: GDA 503499 5239402
Described by: P.D. McIntosh
Slope: 12^{o}S
Altitude: 70 m
Geology: Slope colluvium from Permian sediments
Reference: McIntosh et al. (2009) summarised and interpreted features in the main section

Layer[1]	**Depth** (m)	**Interpretation**	**Radiocarbon age** (ka BP)	**Horizon description**[2]
3.6	0–0.26	Colluvium		Very dark grey (10YR3/1) fine sand.
3.5	0.26–0.39			Greyish brown (10YR5/2) medium sand sand.
3.4	0.39–0.89			Yellowish brown (10YR5/8) gravelly silty clay; 30% fine gravels 2–4 mm diameter.
3.3	0.89–1.19			Yellowish brown (10YR5/8) loamy coarse sand.
3.2	1.19–1.55			Brownish yellow (10YR6/8) slightly gravelly sandy loam; 5% gravels 2–4 mm diameter.
3.1	1.55–2.25			Brownish yellow (10YR6/8) coarse loamy sand.
2.5	2.25–3.60	Colluvium		Brownish yellow (10YR6/6) gravelly sandy clay loam with 10% gravels 2–5 mm diameter.
2.4	3.60–3.70		Wk22695 (Standard) **18.060±0.109**	Brownish yellow (10YR6/6) gravelly sandy clay loam with 10% gravels 2–5 mm diameter and abundant **charcoal** fragments up to 200 mm diameter.
2.3	3.70–4.70			Brownish yellow (10YR6/6) gravelly sandy clay loam with 10% gravels 2–5 mm diameter.
2.2	4.70–4.80		Wk22696 (AMS) **20.765±0.120**	Brownish yellow (10YR6/6) gravelly sandy clay loam with 10% gravels 2–5 mm diameter and abundant **charcoal** fragments up to 100 mm diameter.
2.1	4.80–5.30+			Brownish yellow (10YR6/6) slightly gravelly sandy clay loam.

[1]Layer 1 (firm colluvium) is obscured by debris at the section described here but is visible further east and west. The section described on pages 28–29 is the western site showing 3 layers.

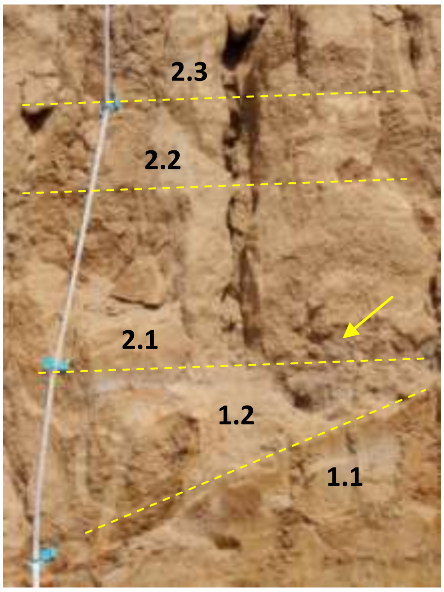
[2] Below 0.4 m depth clay-rich bands occur at approximately 150 mm intervals. These bands bifurcate and are deduced to be pedogenetic rather than depositional in origin.



The Home Hill main section showing layers 1 and 2 and the sampling sites for charcoal (arrowed)

Home Hill: the western section

Date: 3 December 2008
Location: GDA 503484 5239385
Described by: P.D. McIntosh and A. Slee
Slope: 12^{o}S
Altitude: 70 m
Geology: Slope colluvium from Permian sediments
Reference: McIntosh et al. (2012)



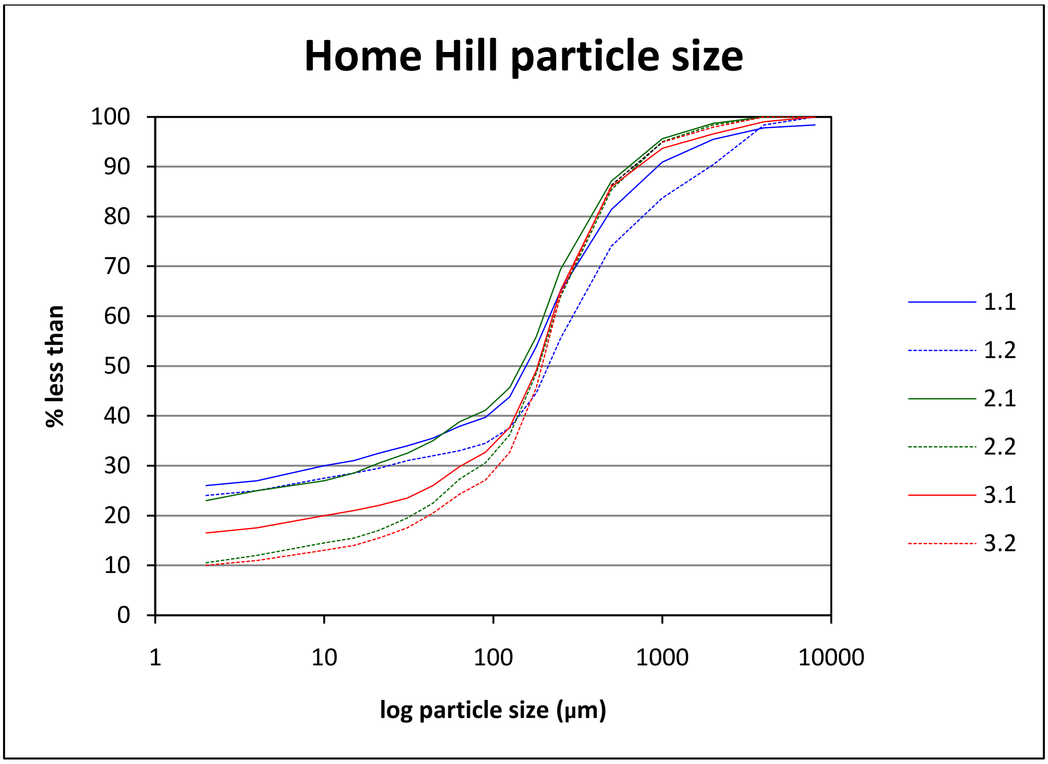
The lower part of the western profile at Home Hill, showing the charcoal-containing zone (arrowed) at base of layer 2.1.

Layer	Depth[1] (m)	Interpretation	Radiocarbon age (ka BP)	Horizon description
3.4	0–0.10	Colluvium		Very dark grey (10YR3/1) fine sand; very weak consistence
3.3	0.10–0.20			Greyish brown (10YR5/2) medium sand; very weak consistence.
3.2	0.20–1.10			Yellow (10YR7/6) sandy loam; weak consistence.
3.1	1.10–2.30			Brownish yellow (10YR6/8) silty loam; 10% angular gravels 2-3 mm diameter; firm consistence.
2.2	2.30–4.20	Colluvium		Yellow (2.5Y7/6) silty loam; 30% yellowish brown (10YR5/4) mottles 10 mm diameter (indistinct clay-enriched bands); weak consistence.
2.1	4.20–4.90		Wk24895 (AMS) 4.80–4.90 m **21.596±0.114**	Brownish yellow (10YR6/6) silty loam; 30% yellow (10YR7/4) mottles 10 mm diameter; 2% angular gravels 2–5 mm diameter; 10% gravels in bottom 100 mm of horizon; firm consistence; very firm in bottom 100 mm, with **charcoal**
1.2	4.90–5.35	Colluvium		Brownish yellow (10YR6/6) sandy clay loam; 15% light grey (5Y7/2) mottles 3 mm diameter; 1% angular gravels 10 mm diameter; firm consistence; layer thins to nil thickness at right of section.
1.1	5.35–5.85+			Light olive brown (2.5Y5/6) sandy clay loam; 10% yellowish brown (10YR5/6) mottles 20 mm diameter and 2% light brownish grey (10Y7/1) mottles 50–100 mm diameter (at top of horizon only); 1% angular gravels 4 mm diameter; soft charcoal flecks present; firm consistence; flat rounded stone 40 mm diameter.

Size analysis

Sieve mesh (μm)	Layer 1.1	1.2	2.1	2.2	3.1	3.2
	% passing sieve (by wt.)					
8000	98.4	100	100	100	100	100
4000	97.8	98.4	100	100	99	100
2000	95.5	90.4	98.7	98.4	96.6	97.9
1000	90.9	83.7	95.6	95	93.7	94.9
500	81.4	74.1	87.1	85.4	86	86.3
250	65.1	55.6	69.4	63.9	65.2	64.4
180	53.9	44.6	55.9	48.5	49.1	45.7
125	43.8	37.6	45.7	36.2	37.7	32.7
90	39.7	34.5	41.1	30.6	32.7	27.1
63	37.9	33	38.8	27.3	29.8	24.3
44	35.5	32	35	22.5	26	20.5
31	34	31	32.5	19.5	23.5	17.5
21	32.5	29.5	30.5	17	22	15.5
15	31	28.5	28.5	15.5	21	14
10	30	27.5	27	14.5	20	13
4	27	25	25	12	17.5	11
2	26	24	23	10.5	16.5	10

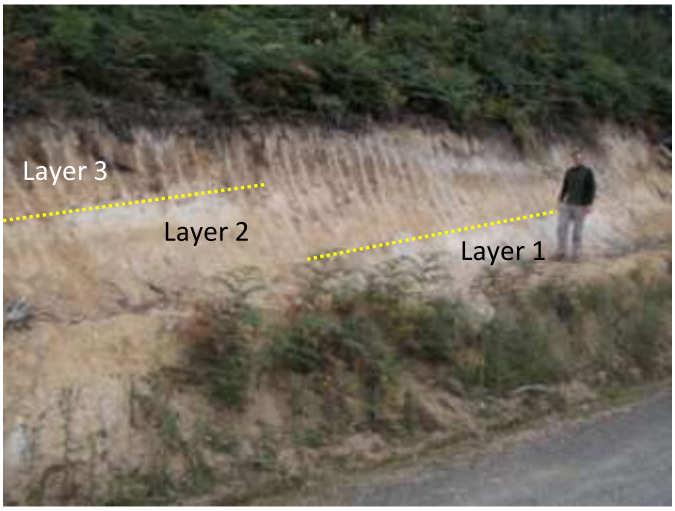
Note: figures for 4 and 2 μm categories estimated by extrapolation.


Home Hill particle size
% less than
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
10000
log particle size (µm)
1.1
1.2
2.1
2.2
3.1
3.2

13. MAYNES JUNCTION

Date: 23 July 2009
Location: On Styx Road, immediately opposite turnoff to Maynes Road at GDA 466537 5263680
Described by: P. McIntosh and A. Slee
Slope: 7^{o} to south
Altitude: 410 m
Geology: Underlying rock mapped as Permian/Carboniferous mudstone with boulders ("tillite"). No Quaternary deposits mapped here.

Layer	Depth (m)	Interpretation	Radiocarbon age (ka BP)	Brief description
3.4	0–0.10	Fan alluvium		Very dark greyish brown (10YR3/2) silty loam. (A1 horizon.)
3.3	0.10–0.35			Dark yellowish brown (10YR3/4) silty loam. (A2 horizon.)
.2	0.35–0.75			Brownish yellow clay loam with 40% dark yellowish brown (10YR4/4) mottles.
3.1	0.75–0.95			Yellow (10YR7.6) clay loam with 30% very pale brown (2.5Y7/4) mottles. (B3 horizon.)
2.2	0.95–1.25	Fan alluvium	Wk26704 (AMS) **26.931±0.351**	White (5Y8/1) silt with 10% yellow (2.5Y7/6) mottles 20 mm diameter; 2% angular stones 30 mm diameter; abundant **charcoal** fragments. (A2b horizon)
2.1	1.25–2.20			Yellow (10YR7/6) clay loam with 20% light grey (5Y7/2) mottles and 20% angular quartz stones 10-100 mm diameter. (B2b horizon.)
1.2	2.20–2.77	Fan alluvium	Wk26703 (AMS) **>52.8***	White (5Y8/1) fine sand; 10% quartz and siltstone gravels 10-30 mm diameter; **charcoal** fragments concentrated in top 150 mm (A2b horizon)
1.1	2.77–3.17			Brownish yellow (10YR6/8) fine sandy loam/silty loam with 30% light yellowish brown ((2.5Y6/4) mottles and 10% yellowish red (5YR4/6) mottles (discontinuous iron pan). (B3b horizon.)



The two palaeosols at Maynes Junction. Note the texture-contrast soils (A2 horizons) in each layer, similar to the present-day texture-contrast soil visible close to the figure.

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Version 1.0; 5 September 2012; TRIM 2012/111365

Appendix 1. Laboratory analytical details for thermoluminescence ages.

Laboratory No.	W4231	W4232	W4233	W4249	W4250	W4452	W4453	W4475	W4476
Field reference	**New Norfolk** 2.65 m	**New Norfolk** 4.65 m	**Florentine Rd** 2.30 m	**Huskisson lower** 11.4 m	**Huskisson upper** 9.1 m	**Strahan Dune** 2.40 m	**Warra Dune** 2.05 m	**Mary Ann Bay** 2.90 m	**Mary Ann Bay** 6.70 m
Plateau region (^{o}C)	275–500	275–500	275–500	275–500	275–500	275–500	275–500	300–500	300–500
Analysis temperature (^{o}C)	375	375	375	375	375	375	375	375	375
Palaeodose (Grays)	195±24	>229±19	131±8	303±19	303±31	4.3±0.5	80.1±7.9	41.2±2.3	39.6±4.8
K content (% by AES)	1.36±0.05	1.41±0.05	2.23±0.05	1.10±0.05	0.90±0.05	0.135±0.005	1.06±0.005	0.590±0.005	0.585±0.005
Rb content (ppm assumed)	100±25	100±25	100±25	100±25	100±25	50±25	100±25	50±25	50±25
Moisture content (% by weight)	3.9±3	9.7±3	27.3±3	17.1±3	10.3±3	2.6±3	14.5±3	3.4±3	8.4±3
Specific gravity (Bq/kg U + Th)	54.7 ±1.6	61.0 ±1.74	91.9 ±2.4	75.4 ±2.4	70.6 ±2.4	76.9 ±0.2	48.8 ±1.5	29.8 ±0.9	34.0 ±0.9
Cosmic contribution (µGy/year)	143±25	125±25	147±25	150±25	150±25	147±25	150±25	141±25	99±25
Annual radiation dose (µGy/year)	2631±59	2618±58	3375±54	2417±58	2309±58	430±25	1972±58	1344±28	1307±27
TL age (ka)	74.1±9.1	>87.5±7.4	38.7±2.5	125±8	>165±8	10.1±1.2	40.6±4.2	30.7±1.9	30.3±3.7