

Woolgoolga to Ballina Pacific Highway Upgrade
Aboriginal Heritage Assessment – Woodburn to Ballina
Volume 2 Appendices

Appendix O Results of radiocarbon and AMS dating

The University of Waikato
Radiocarbon Dating Laboratory



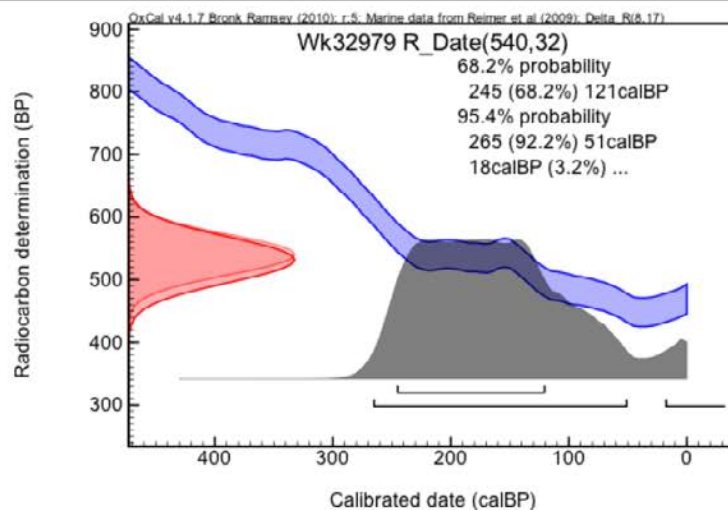
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email c14@waikato.ac.nz
Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 32979

Submitter	Robyn Jenkins
Submitter's Code	E2/2-STP36
Site & Location	Byrnes PAD (E2/2), Australia
Sample Material	Donax
Physical Pretreatment	Surfaces cleaned. Washed in an ultrasonic bath. Tested for recrystallization: aragonite.
Chemical Pretreatment	Sample acid washed using 2 M dil. HCl for 120 seconds, rinsed and dried.

$\delta^{13}\text{C}$	0.9 ± 0.2 ‰
D^{14}C	-65.0 ± 3.7 ‰
$\text{F}^{14}\text{C}\%$	93.5 ± 0.4 %
Result	540 ± 32 BP

Comments



Alan Hogg
25/01/12

- Result is *Conventional Age or Percent Modern Carbon (pMC)* following 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.
- The isotopic fractionation, $\delta^{13}\text{C}$, is expressed as ‰ wrt PDB.
- $\text{F}^{14}\text{C}\%$ is also known as *Percent Modern Carbon (pMC)*

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Radiocarbon Dating Laboratory



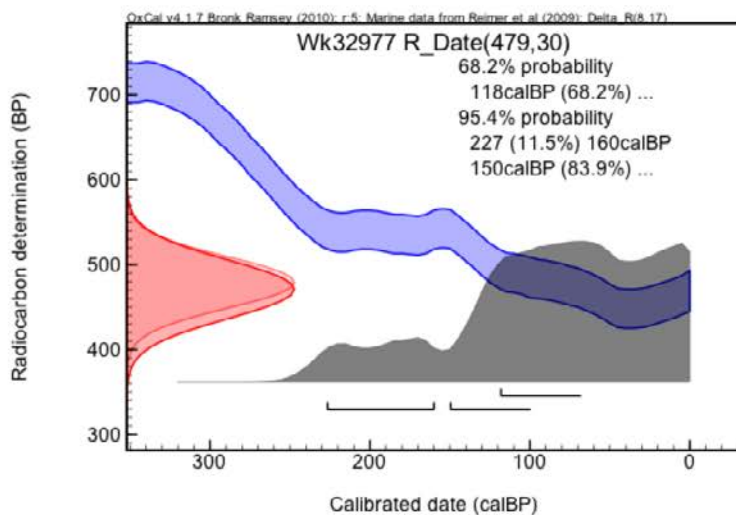
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Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 32977

Submitter	Robyn Jenkins
Submitter's Code	Melino Trench 1 XU3
Site & Location	Melino PAD, Australia
Sample Material	Donax
Physical Pretreatment	Surfaces cleaned. Washed in an ultrasonic bath. Tested for recrystallization: aragonite.
Chemical Pretreatment	Sample acid washed using 2 M dil. HCl for 120 seconds, rinsed and dried.

$\delta^{13}\text{C}$	$0.4 \pm 0.2 \text{ ‰}$
D^{14}C	$-57.9 \pm 3.5 \text{ ‰}$
$\text{F}^{14}\text{C}\%$	$94.2 \pm 0.4 \%$
Result	$479 \pm 30 \text{ BP}$

Comments



Alan Hogg
25/01/12

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- Quoted errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory Error Multiplier.
- The isotopic fractionation, $\delta^{13}\text{C}$, is expressed as ‰ wrt PDB.
- $\text{F}^{14}\text{C}\%$ is also known as *Percent Modern Carbon (pMC)*

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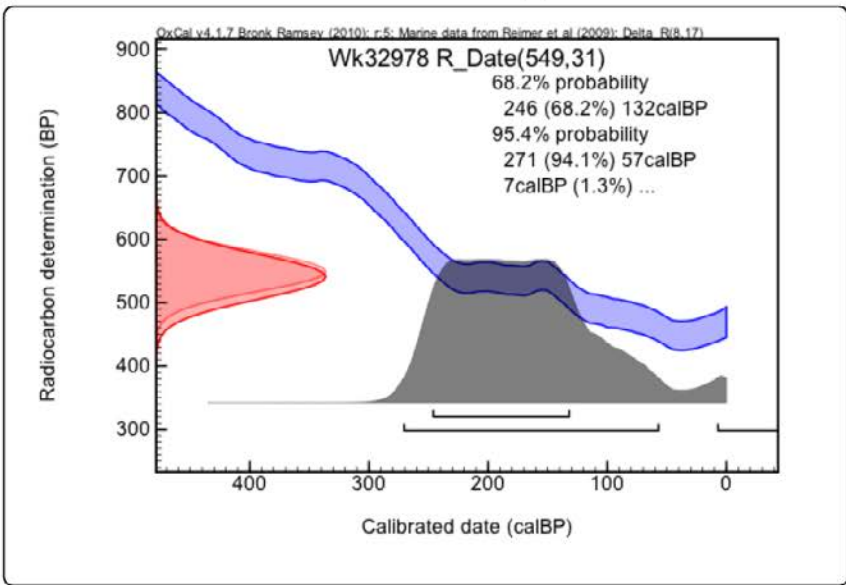
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Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 32978

Submitter	Robyn Jenkins
Submitter's Code	Melino Trench 1 XU4
Site & Location	Melino PAD, Australia
Sample Material	Donax
Physical Pretreatment	Surfaces cleaned. Washed in an ultrasonic bath. Tested for recrystallization: aragonite.
Chemical Pretreatment	Sample acid washed using 2 M dil. HCl for 120 seconds, rinsed and dried.

$\delta^{13}\text{C}$	0.5 ± 0.2 ‰
D^{14}C	-66.1 ± 3.7 ‰
$\text{F}^{14}\text{C}\%$	93.4 ± 0.4 %
Result	549 ± 31 BP

Comments



Alan Hogg
25/01/12

- Result is *Conventional Age or Percent Modern Carbon (pMC)* following 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.
- The isotopic fractionation, $\delta^{13}\text{C}$, is expressed as ‰ wrt PDB.
- $\text{F}^{14}\text{C}\%$ is also known as *Percent Modern Carbon (pMC)*

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Radiocarbon Dating Laboratory



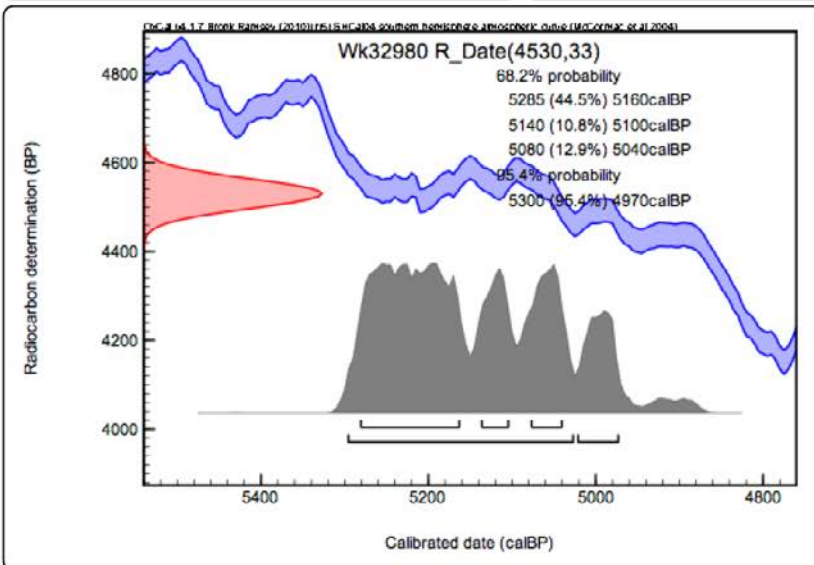
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Report on Radiocarbon Age Determination for Wk- 32980

Submitter	Robyn Jenkins
Submitter's Code	Melino Trench 1 XU12
Site & Location	Melino PAD, Australia
Sample Material	Charcoal
Physical Pretreatment	Sample cleaned.
Chemical Pretreatment	Sample washed in hot HCl, rinsed and treated with multiple hot NaOH washes. The NaOH insoluble fraction was treated with hot HCl, filtered, rinsed and dried.

$\delta^{13}\text{C}$	-25.6 ± 0.2 ‰
D^{14}C	-431.1 ± 2.3 ‰
$\text{F}^{14}\text{C}\%$	56.9 ± 0.2 %
Result	4530 ± 33 BP
	(AMS measurement)

Comments



A. Hogg
13/02/12

- Result is *Conventional Age or Percent Modern Carbon (pMC)* following 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.
- The isotopic fractionation, $\delta^{13}\text{C}$, is expressed as ‰ wrt PDB.
- $\text{F}^{14}\text{C}\%$ is also known as *Percent Modern Carbon (pMC)*

The University of Waikato
Radiocarbon Dating Laboratory



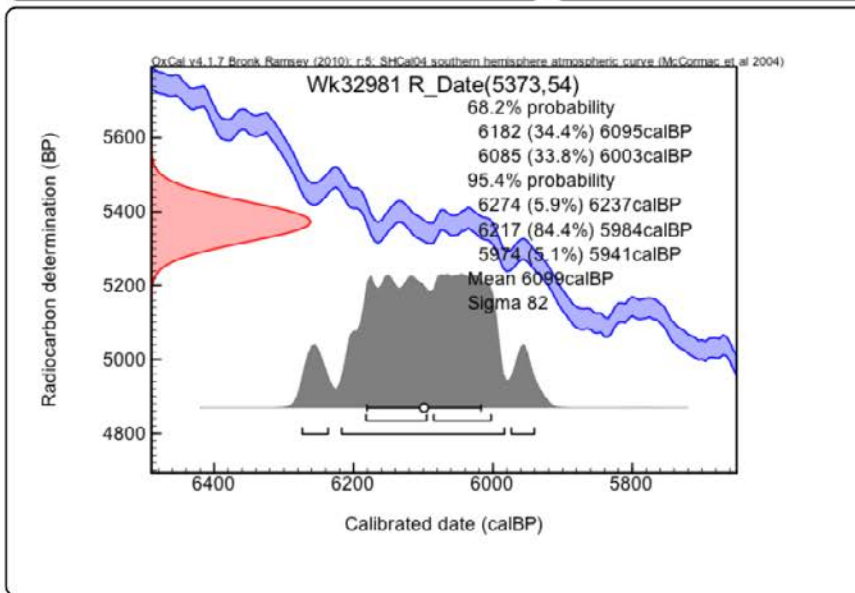
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Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 32981

Submitter	Robyn Jenkins
Submitter's Code	Melino Trench 1 XU13
Site & Location	Melino PAD, Australia
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.

$\delta^{13}\text{C}$	-26.5 ± 0.2 ‰
D ¹⁴ C	-487.7 ± 3.4 ‰
F ¹⁴ C%	51.2 ± 0.3 ‰
Result	5373 ± 54 BP

Comments



- Result is *Conventional Age or Percent Modern Carbon (pMC)* following 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.
- The isotopic fractionation, $\delta^{13}\text{C}$, is expressed as ‰ wrt PDB.
- F¹⁴C% is also known as *Percent Modern Carbon (pMC)*

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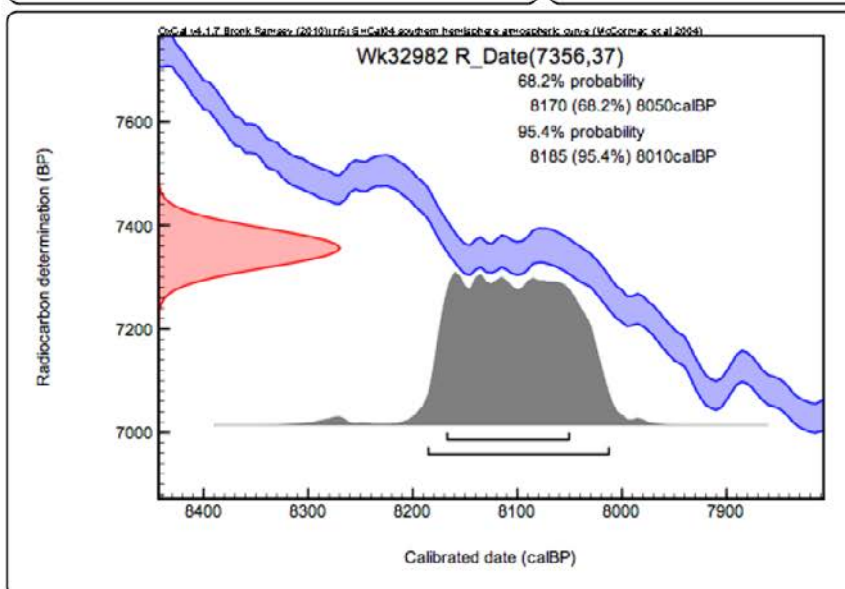


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Report on Radiocarbon Age Determination for Wk- 32982

Submitter	Robyn Jenkins
Submitter's Code	Melino Trench 1 XU16
Site & Location	Melino PAD, Australia
Sample Material	Charcoal
Physical Pretreatment	Sample cleaned.
Chemical Pretreatment	Sample washed in hot HCl, rinsed and treated with multiple hot NaOH washes. The NaOH insoluble fraction was treated with hot HCl, filtered, rinsed and dried.

$\delta^{13}\text{C}$	-26.0 ± 0.2 ‰	Comments
D^{14}C	-599.8 ± 1.8 ‰	
$\text{F}^{14}\text{C}\%$	40.0 ± 0.2 %	
Result	7356 ± 37 BP	
(AMS measurement)		



Y. Patten
13/02/12

- Result is *Conventional Age or Percent Modern Carbon (pMC)* following 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.
- The isotopic fractionation, $\delta^{13}\text{C}$, is expressed as ‰ wrt PDB.
- $\text{F}^{14}\text{C}\%$ is also known as *Percent Modern Carbon (pMC)*

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Appendix P Ground penetrating radar report

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- Geophysical Survey - Possible Aboriginal burial / Stone arrangement site

CLIENT SKM

ADDRESS Level 11 452 Flinders St
Melbourne VIC

CLIENT CONTACT Vanessa Edmonds **TELEPHONE** +61 429 114 188

EMAIL vedmonds@globalskm.com

JOB SITE Melino property - directly north
and adjacent to the Richmond
River, Wardell

PROJECT ID # GNX12046

ONSITE CONTACT Vanessa Edmonds

SURVEY DATE 22/3/12 **METHODS** [x] GPR

COMPILED BY Cameron Young (B.EnvSci) **REPORT DATE** 26/3/12

REVIEWED BY Mads Toft (M.Sci) **REVISED** 23/4/12

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SPECIFICATIONS The undertaking of a geophysical survey to investigate both a possible Aboriginal burial site and possible Aboriginal stone arrangement on a private property located in Wardell, south of Ballina NSW.

The geophysical method utilised was Ground Penetrating Radar (GPR).

SURVEY AREA The survey area was a grassed slope. Vegetation was generally sparse within the area of investigation, the long grass having recently been cut back. The survey area is shown in image 1 below. The area surveyed was 12.3m by 17m. Scans were performed in perpendicular directions, both N-S and E-W approximate orientation, with approx 90 degree intersections.

The slope of the site was quite steep and made manoeuvring the heavy GPR instrument difficult at times, the instrument was pushed and pulled by hand. Scans covered the extent of the site and were performed in both directions (across the slope and up-down the slope) for the highest possible level of data coverage.



Image 1: Survey area outlined in red.

INSTRUMENTS The described area was surveyed using the following system.

- MALA 400Mhz MIRA system

The MIRA system represents the highest level of ground penetrating radar (GPR) technology. The system utilises 16 channels and allows for fast and accurate 3D data acquisition. For more information on the system visit:
<http://www.malagpr.com.au/products/mira/index.html>

The GPR data was collected by manually pushing and the array in a purpose built cart. Line positioning was controlled using coloured pegs on the ground. The data was processed using MALA rSlicer software.



Image 2: MALA MIRA system and Trimble Total Station

POSITIONING Positioning information was provided by a Trimble S8 robotic total station which was 'locked' on to the MIRA array and tracking at all times, this system provides sub-inch accuracy. Control points were taken at trees on site, the total station point and nothing point are marked with steel pickets and pink tape and were left on site for ease of re-positioning if required.

Some minor 'drop-outs' occurred in the data, however in general, positioning accuracy was relatively good.

GROUND PENETRATING RADAR (GPR) Ground-penetrating radar (GPR) is a geophysical method that uses radar pulses to image the subsurface. GPR uses transmitting and receiving antennas. The transmitting antenna radiates short pulses of high-frequency radio waves into the ground/material. When the wave hits a buried object or a boundary with different dielectric constants, the receiving antenna records variations in the reflected return signal.

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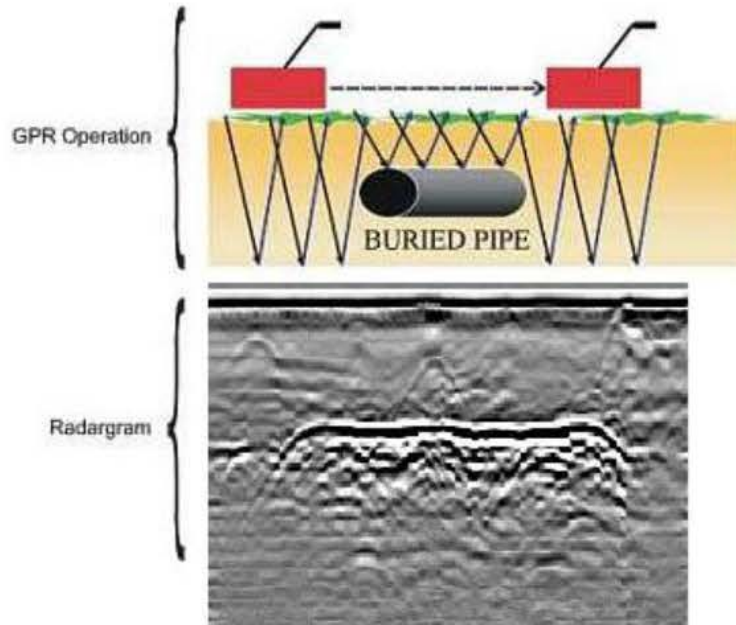


Image 3 : GPR operation and the reflection profile across the length of a buried pipe

The depth range of GPR is limited by the electrical conductivity of the ground. As ground conductivity increases, the signal penetration depth decreases. This is caused by the electromagnetic pulse emitted by a GPR transmitter is more quickly dissipated into heat, causing a loss in signal strength at depth.

- DEPTH PENETRATION AND GROUND CONDITIONS** Soils across the site appeared to be sandy/loam on the surface. Northern NSW had received substantial rainfall in weeks prior to the survey and very light rain was falling on the day of the survey. Depth penetration using the 400Mhz antenna array was approx 2m.
- STAFFING** The data acquisitioning was performed by Geophysicist Cameron Young (B.EnvSci) and Geophysicist Jeremy Hill (B.Sci) of MALA GPR Australia. Data processing and reporting was performed Cameron Young under the supervision of Senior Geophysicist Mads Toft (M.Sci).
- SURVEY SPECIFICATIONS** Data was collected using the MALA MIRA system and 400Mhz antenna array. Data was collected at 4cm intervals along the survey lines (25 samples per meter). Sampling was triggered with an encoder wheel. The table below outlines the collection parameters employed.

Collection Parameters	
Samples	466
Frequency	6990.770020
Frequency Steps	65
Signal Position	53809
Distance Interval	0.039
Antennas	400Mhz Shielded
Antenna Separation	0.180000
Time Window	66.659324
Stacks	4

The antenna array covers a width area of 1.28m. The aim of the survey was to achieve full coverage of the site with zero spacing between lines however due to the terrain (rough in parts) and obstacles such as the sapling trees, total coverage was not possible. Some 'gaps' in the data occur, the largest being 84cm x 93cm around one of the sapling trees.

RESULT OF SURVEY With regards to a possible burial site: The survey has identified two features of interest on the area where a burial is suspected. The features described below are anomalous in the survey area, they do not appear to be related to reflections consistent with geology, tree roots or natural soil conditions.

- a) The data shows a reflection which is consistent with what would be expected from a solid object at .4m to .51m depth. This feature appears to be approx 55cm x 33cm in size. (Images 3 and 4)
- b) A reflection which could be considered consistent with soil disturbance has been identified at .6m to .65m depth. This possible disturbance, approx 1.26m x 76cm in size, is located below (in depth) and to the west of feature A. (Images 5 and 6)

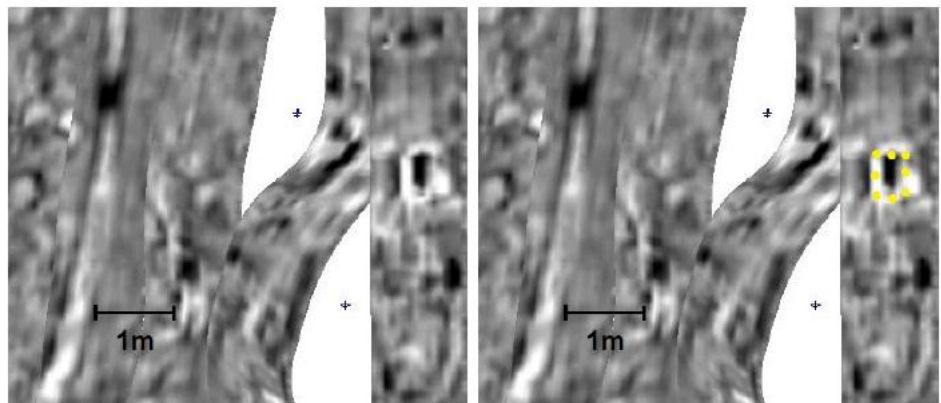


Image 3: Feature A data (the two crosses mark the 2 small trees within the survey area)

Image 4: Feature A outlined in yellow

Notes: These screen shots show data from the N-S scans at .4m depth.

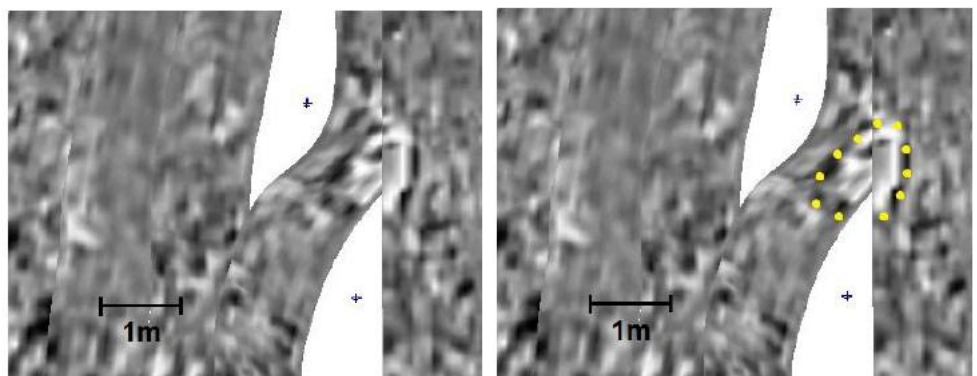


Image 5: Feature B data (the two crosses mark the 2 small trees within the survey area)

Image 6: Feature B outlined in yellow

Notes: These screen shots show data from the N-S scans at .6m depth.

Note: The crosses in the above images mark the position of the sapling trees visible in Image 1. The lenticular blanks are 'gaps' in the data from having to avoid

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these trees. For ease of visualisation these images show data from one direction of scans only. The perpendicular survey lines fill these gaps to some extent, however as mentioned above, gaps in the data do exist around these obstacles.

Images 3 to 6 in plan view show the identified areas of interest most clearly however additional 2D cross sections showing these features are provided in the appendix.



Image 7: The approximate surface locations. Feature (a) outlined red, feature (b) outlined yellow.

With regards to a stone arrangement: There are reflections from rocks which are clearly visible in the data, both from the surface and sub-surface, however there is no clear pattern to suggest that they have been arranged in any sort of order. There is nothing in the data that would suggest a stone arrangement on the site.

ACKNOWLEDGEMENTS Thank-you to Marcus Ferguson and Dean Bolt of the local Aboriginal Land Council for their assistance in the manual work involved in performing this survey.

DISCLAIMER It should be noted that the attached results are the result of an interpretation of the collected data. Whilst state-of-the-art instrumentation and qualified personnel have been utilised for this survey there are circumstances under which the interpreted result can differ from the actual sub surface strata.

The author accepts no responsibility for actions or decisions made on the basis of the presented result. The results are presented for the clients' review only and should not form the sole basis of any decision or action made in relation to this project.

This report has been prepared for the use of the client as listed on page 1 in accordance with general accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report.

This report was prepared on completion of the fieldwork/processing and is based on conditions encountered and reviewed at the time of preparation. MALA GPR Australia disclaims responsibility for any changes that might have occurred after

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this time.

This report should be read in full, no responsibility for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Only qualified legal practitioners can give legal advice.

Whilst to the best of our knowledge, information contained in this report is accurate at the date of issue; conditions on the site can change in a limited time. This should be borne in mind if the report is used after a protracted delay. As with any form of non-destructive testing, our opinions of results do not apply, we rely solely on data collection and criteria conformance.

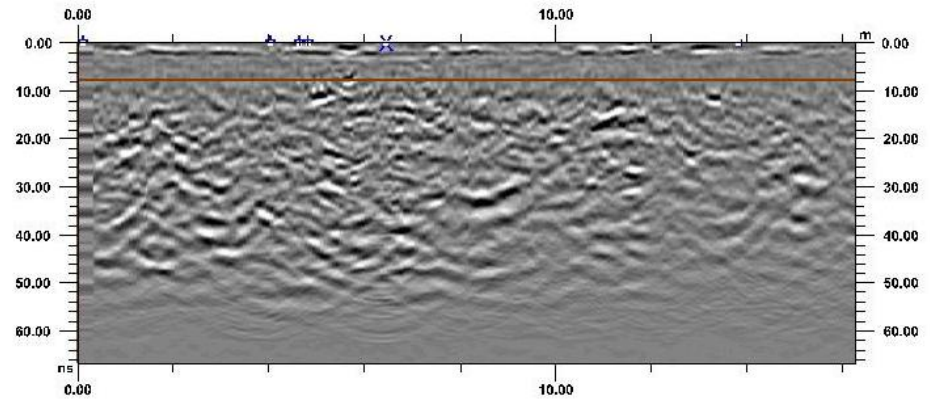
If it is found that the actual locations differ from the interpreted result the author should be contacted immediately.

Your Faithfully

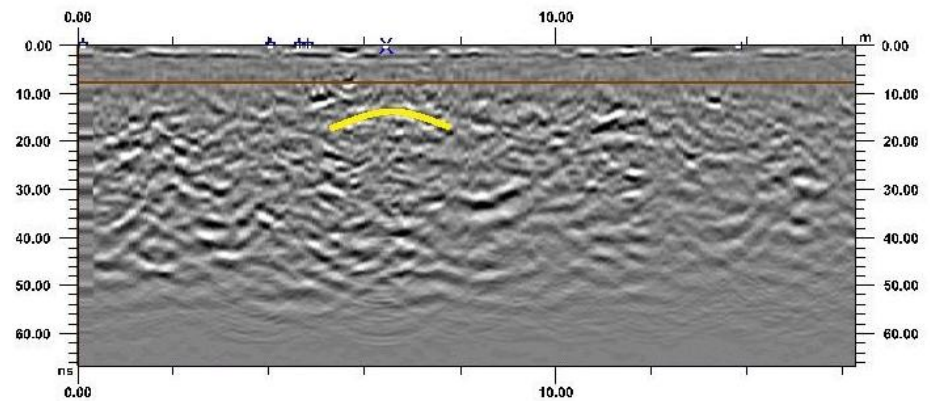
A handwritten signature in blue ink, appearing to read 'Mads Toft', with a long horizontal flourish extending to the right.

Mads Toft (M.Ge)
Senior Geophysicist

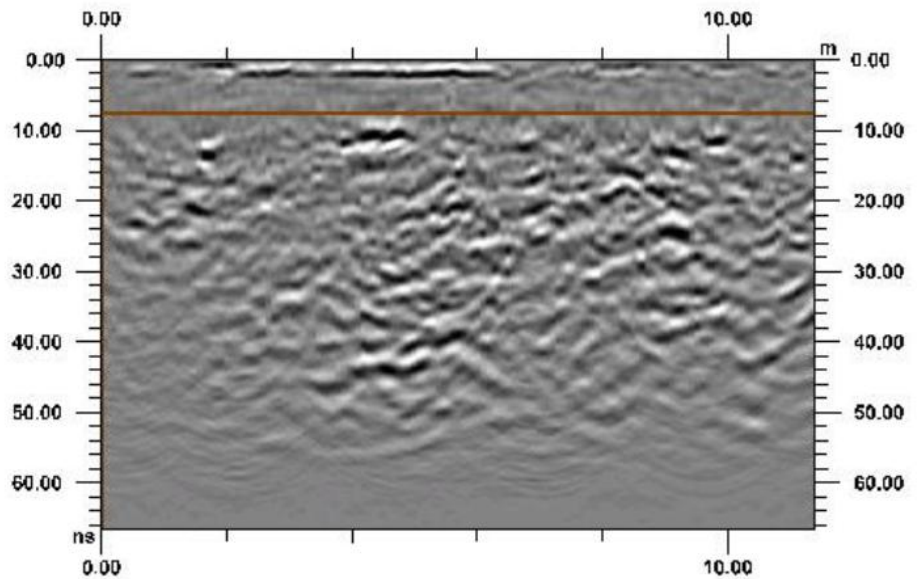
APPENDIX FULL SITE 2D CROSS-SECTIONS



Appendix Image 1: Full site North-South 2D cross-section - unmarked



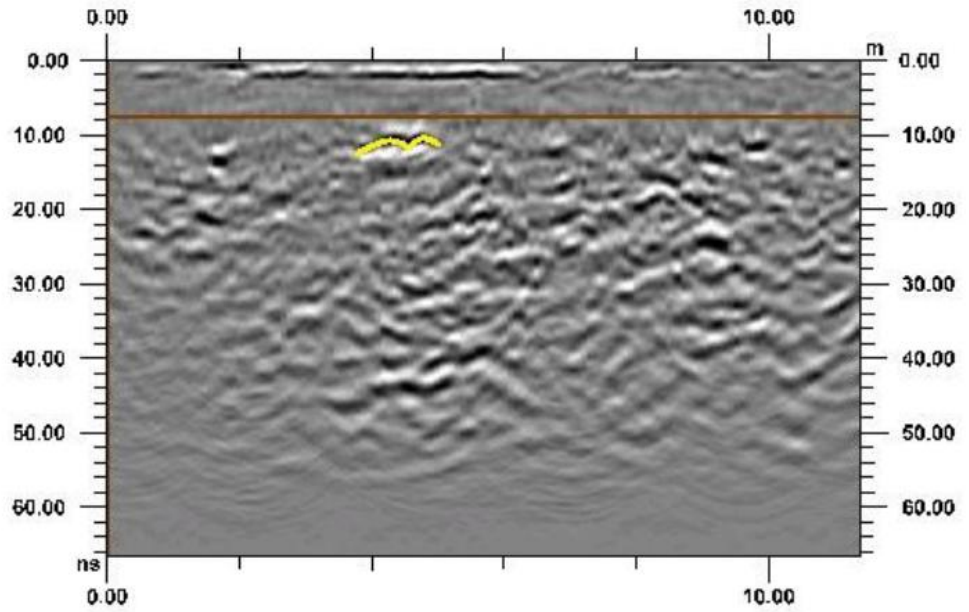
Appendix Image 2: North-South 2D cross-section – reflection marked yellow



Appendix Image 3: East-West 2D cross-section - unmarked

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Appendix Image 4: East-West 2D cross-section – reflections marked yellow