AMS date

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26 February 2000

Dr C. P. Rajendran
Centre for Earth Science Studies
Akkulam, Privandrum 695031
India

Dear Dr Rajendran,

Enclosed are the final reports for the sample H/GA/T/1/CP (R26745).

With kindest regards

D.M. Chambers

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory

email: d.chambers@gns.cri.nz
http://www.rafterradiocarbon.co.nz
http://www.14Conference2003.co.nz

Ministry of Agriculture and Forestry, New Zealand
Te Manatu Ahuwhenua, Ngaherehere, Aotearoa

PERMIT TO IMPORT LABORATORY SPECIMENS

This permit is issued under the Biosecurity Act, 1993. Any queries, please contact Import Management Plants, MAF Biosecurity Authority, PO Box 2526, Wellington, (Phone 04 498 9631, Facsimile 04 474 4257)

Authorising Officer : **Dave Nendick** on **09 Oct 2001**

for Chief Technical Officer, Ministry of Agriculture and Forestry, New Zealand, acting under delegated authority.

NOTE: Total number of pages for this permit is 3.
Please ensure all pages (front pages, any appendices and attachments) are included with copies.

Permit for : Rafter Radiocarbon Laboratory
30 Gracefield Road
Seaview
Lower Hutt
New Zealand
Attention : Rodger Sparks
Phone: 04 570 4637
Fax: 04 570 4657

Permit No : 2001013708
Replaces Permit No : N/A
Expiry Date : 09 Oct 2002
No of Consignments : Multiple
Import Purpose : Laboratory Use

Establishment No :

Exporter Name : N/A

Country of Origin : All Countries

Type of Material	Commodity Description	Quantity	Measure
Plant Material	Soil, water, rock, mineral, dried plant material, various freeze dried organic material of animal origin and old bones.	Unlimited	Units

Post Entry Type : Laboratory - aprvd

Transitional Facility : Rafter Radiocarbon Lab
P O Box 30 368
Lower Hutt
30 Gracefield Road.Seaview

Ref : 2580

Operator : Rodger Sparks
Inspector : Nitya Sharma
Min Period : N/A

Special Conditions :

NOTE: Number of pages in this permit is 3, comprising 2 front pages, 1 Appendix 1.

1.FOR GENERAL CONDITIONS SEE APPENDIX 1.

2.The quantity of individual samples imported under this permit may be up to 1 kg.

IMPORTANT INFORMATION FOR PERMIT HOLDERS AND AGENTS

1 You need to ensure that the goods you import comply with the provisions of the relevant import health standard(s) and/or entry conditions.

2 This permit, and compliance with the provisions of the relevant import health standard(s) and/or entry conditions, does not guarantee that the goods you import will be given a biosecurity clearance. There are other restrictions in the Biosecurity Act 1993 which apply to the giving of biosecurity clearance.

3 There are a number of other provisions in the Biosecurity Act 1993 which may affect you. If you commit an offence against the Biosecurity Act 1993, heavy penalties under section 157 of the Act might apply.

4 Apart from the Biosecurity Act 1993, there are other laws relating to or prohibiting the importation of goods. This permit, and compliance with the provisions of the relevant import health standard(s) and/or entry conditions, does not absolve you of the need to comply with these laws.

5 Unless specifically identified in 'Description of Items' or 'Special Conditions' of the permit, NO new organisms, including genetically modified organisms, are permitted entry under this permit.

GENERAL CONDITIONS FOR THE IMPORTATION OF LABORATORY SAMPLES FOR ANALYSIS

Special Conditions :

1. On arrival in New Zealand all documents associated with the consignment will be inspected by an Officer of the New Zealand Ministry of Agriculture and Forestry (MAF) to ensure compliance with the entry conditions.

2. Documentation must include a complete list of scientific names (genus and species) of all viable (propagable) sample types contained in the consignment (e.g. seed). Only plant species listed as approved for entry in the MAF Biosecurity Authority Plants Biosecurity Index shall be allowed entry under this permit to import.

   Note: For new or genetically modified organisms under the Hazardous Substances and New Organisms Act 1996, approval from Environmental Risk Management Authority New Zealand is required.

3. If any conditions of this permit to import cannot be or is not complied with the importer may be required by an Inspector to reship or destroy the plant material.

4. The samples are to be:

   (i) consigned in leakproof packaging;

   (ii) transported under bond (following arrival in New Zealand) to the MAF Biosecurity Authority registered Operator of a MAF Biosecurity Authority registered Transitional Facility;

   (iii) stored and treated at the registered Transitional facility in accordance with a Quality System approved by an Officer of the MAF Quarantine Service.

5. The samples (or material generated from seed) are not to be removed or distributed to any person in NZ or used for other purposes without further authorisation from the MAF Biosecurity Authority.

6. Any material remaining after analysis is to be incinerated/autoclaved for disposal.

7. A record is to be kept by the importer of all samples introduced under this permit (including scientific name/description, country of origin, date of arrival) and the current status of the material generated from any viable seed/sample (i.e. disposal/storage). This record is to be made available to an Officer of the MAF Quarantine Service at all reasonable times.

8. If an import health standard is approved by a Chief Technical Officer prior to the expiry date indicated on this Permit to Import, the conditions on the import health standard, if different, would override the conditions on this Permit to Import.

Gagil/
Himalayan

Delivered-To: rajen@md3.vsnl.net.in
X-Lotus-FromDomain: GNS
From: "Dawn Chambers" <D.Chambers@gns.cri.nz>
Sender: "Dawn Chambers" <D.Chambers@gns.cri.nz>
To: cp_r@vsnl.com
Date: Tue, 26 Feb 2002 16:01:25 +1300
Subject: Rafter Radiocarbon Laboratory

Dear Dr Rajendran,

Here is an AMS result for you. The final reports
will follow by mail.

With kindest regards
Dawn

==========

R 26745
Sample ID H/GA/T/1/CP
Description: Soil
NZA 14688

d13C (o/oo) -23.47
Radiocarbon age 808 +/- 60 BP
delta-14C (o/oo) -98.5 +/- 6.7
DELTA-14C (o/oo) -101.3 +/- 6.6
Per-cent modern 89.87 +/- 0.66

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1)
2 sigma interval is 1047 AD to 1093 AD 903 BP to 857 BP (7.5% of area)
plus 1119 AD to 1292 AD 831 BP to 658 BP (86.3% of area)

1 sigma interval is 1190 AD to 1278 AD 760 BP to 672 BP (65.2% of area)

==========

Age, delta-14C, DELTA-14C and absolute per cent Modern are as defined by Stuiver and Polach Radiocarbon 19: 355-363 (1977)

1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and Spurk,M. 1998, Radiocarbon 40(3):1041-1083

****

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory

****
Institute of Geological and Nuclear Sciences Limited
PO Box 31312 Lower Hutt, New Zealand
Phone +64 5704 671 (Dr Rodger Sparks)
Fax +64 5704 657
****
Email: d.chambers@gns.cri.nz
Email: r.sparks@gns.cri.nz
http://www.rafterradiocarbon.co.nz
****

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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 26745**
Description	Soil
Sample ID	H/GA/T/1/CP
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 14688**
Date measured	25-Feb-02
$\delta^{13}C$	-23.5 ‰
* **Radiocarbon Age**	808 ± 60 BP
$\delta^{14}C$	-98.5 ± 6.7 ‰
$\Delta^{14}C$	-101.3 ± 6.6 ‰
** **Per cent modern**	89.87 ± 0.66

Job No. 22655

Issued 26/02/02

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.4% (= ± 32 radiocarbon years).

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RAFTER RADIOCARBON LABORATORY

R26745

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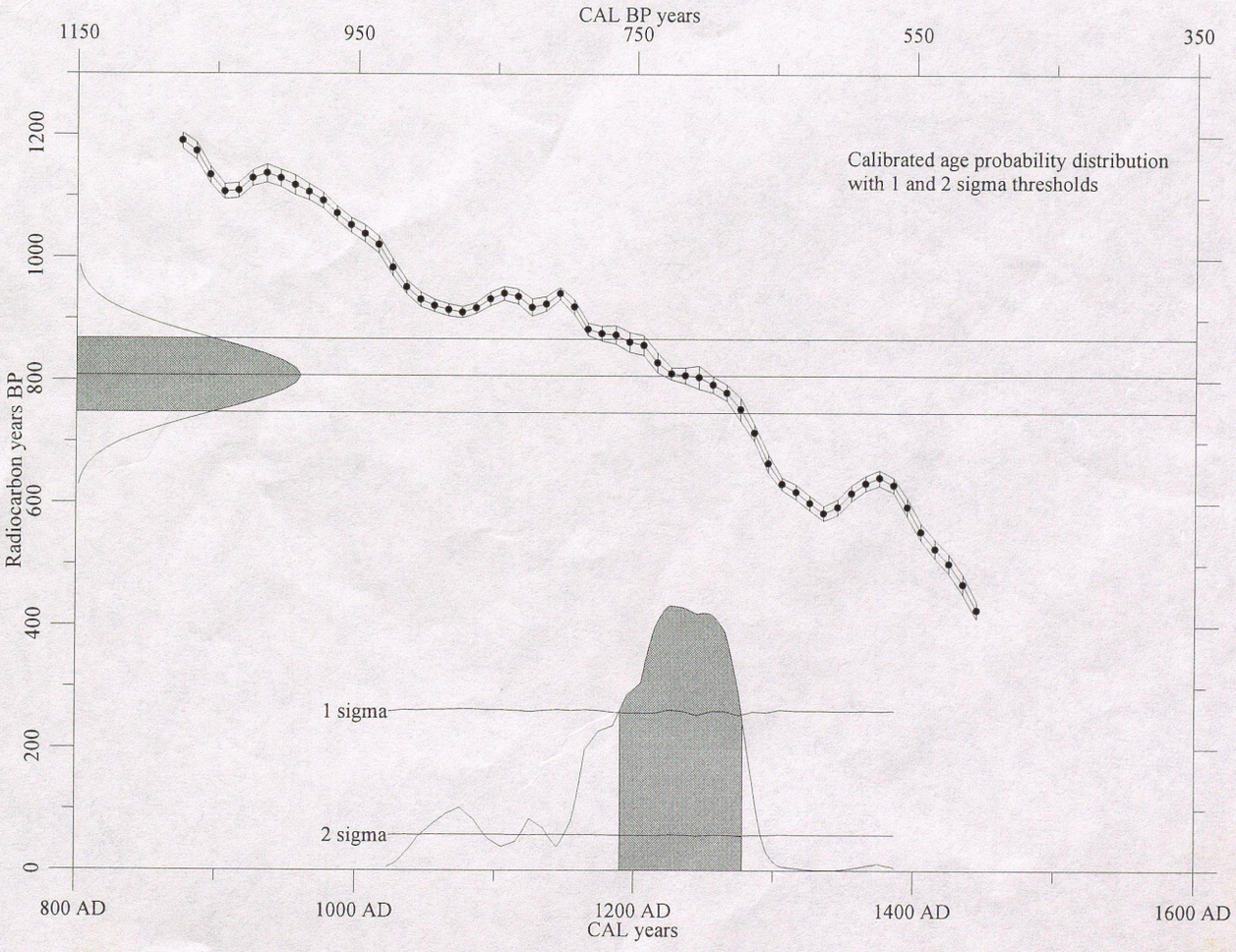
RADIOCARBON CALIBRATION REPORT

NZA14688 CONVENTIONAL RADIOCARBON AGE 808 ± 60 years BP

INTCAL98_14C
1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 1047 AD to 1093 AD	903 BP to 857 BP (7.5% of area)
plus 1119 AD to 1292 AD	831 BP to 658 BP (86.3% of area)
1 sigma interval is 1190 AD to 1278 AD	760 BP to 672 BP (65.2% of area)



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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *26-Feb-02*

R: 26745 **Job:** 22655 **NZA Number:** 14688

Submitter: C. P. (Dr) Rajendran

Sample ID: H/GA/T/1/CP

Description: Soil

Details: Sample consisted of yellowish brown and very dark grey soil. Very hard. Microscopic exam revealed yellow brown is firm sandy material. The black looks very much like charcoal, maybe degraded plant? Small amount of plant. Some of the black is shiny and has vascular structure. Picked out the charcoal/ degraded wood to date. Stored rest of sample. Some small amount of soil attached to charcoal / plant. Crunched in beaker with pestle. Treated with acid / alkali / acid process. Dried in vacuum oven.

Comments:

Fraction dated: treated soil **Stored:** untreated and treated

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Sample Treatment Report

Date Printed: *18-Apr-02*

R: 26805/1 **Job:** 23185 **NZA Number:** 14918

Submitter: C. P. (Dr) Rajendran

Sample ID: BDK-2-L

Description: Peat

Details: Sample consisted of dark grey, sandy-looking soil. Some plant material visible. Broke up lumps, microscopic exam revealed tan clay inside. Fine layer of charcoal on exterior. Loose charcoal fragments are very soft and most appears very degraded - little vascular structure. Picked out charcoal. Treated with acid / alkali / acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated charcoal **Stored:** untreated soil and treated charcoal

---

R: 26805/2 **Job:** 23186 **NZA Number:** 14919

Submitter: C. P. (Dr) Rajendran

Sample ID: D1-1897-1

Description: Charcoal

Details: Sample consisted of large lump of degraded plant material, black in colour along with fine brownish sand. Microscopic exam revealed black shiny degraded wood/ plant material, vascular structure with large holes through out. Covered with a yellow brown sandy soil. Removed lumps of degraded plant material for dating. Cleaned with toothbrush. Crushed with pestle. Treated with acid / alkali / acid process. Dried in vacuum oven

Comments:

Fraction dated: Treated charcoal **Stored:** remainder

Assam 1897

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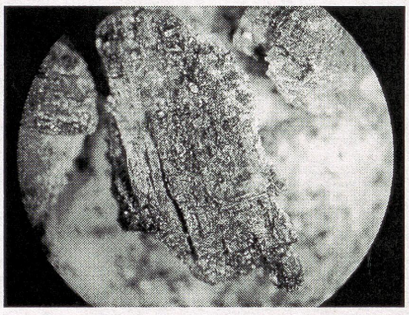
Accelerator Mass Spectrometry Result

Sample	**R 26805/2**
Description	Charcoal
Sample ID	D1-1897-1
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 14919**
Date measured	10-Apr-02
$\delta^{13}C$	-26 ‰
* **Radiocarbon Age**	2501 ± 75 BP
$\delta^{14}C$	-273.7 ± 6.9 ‰
$\Delta^{14}C$	-272.1 ± 6.9 ‰
** **Per cent modern**	72.79 ± 0.69



Job No. 23186

Issued 23/04/02

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.4% (= ± 32 radiocarbon years).

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R26805/2

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RADIOCARBON CALIBRATION REPORT

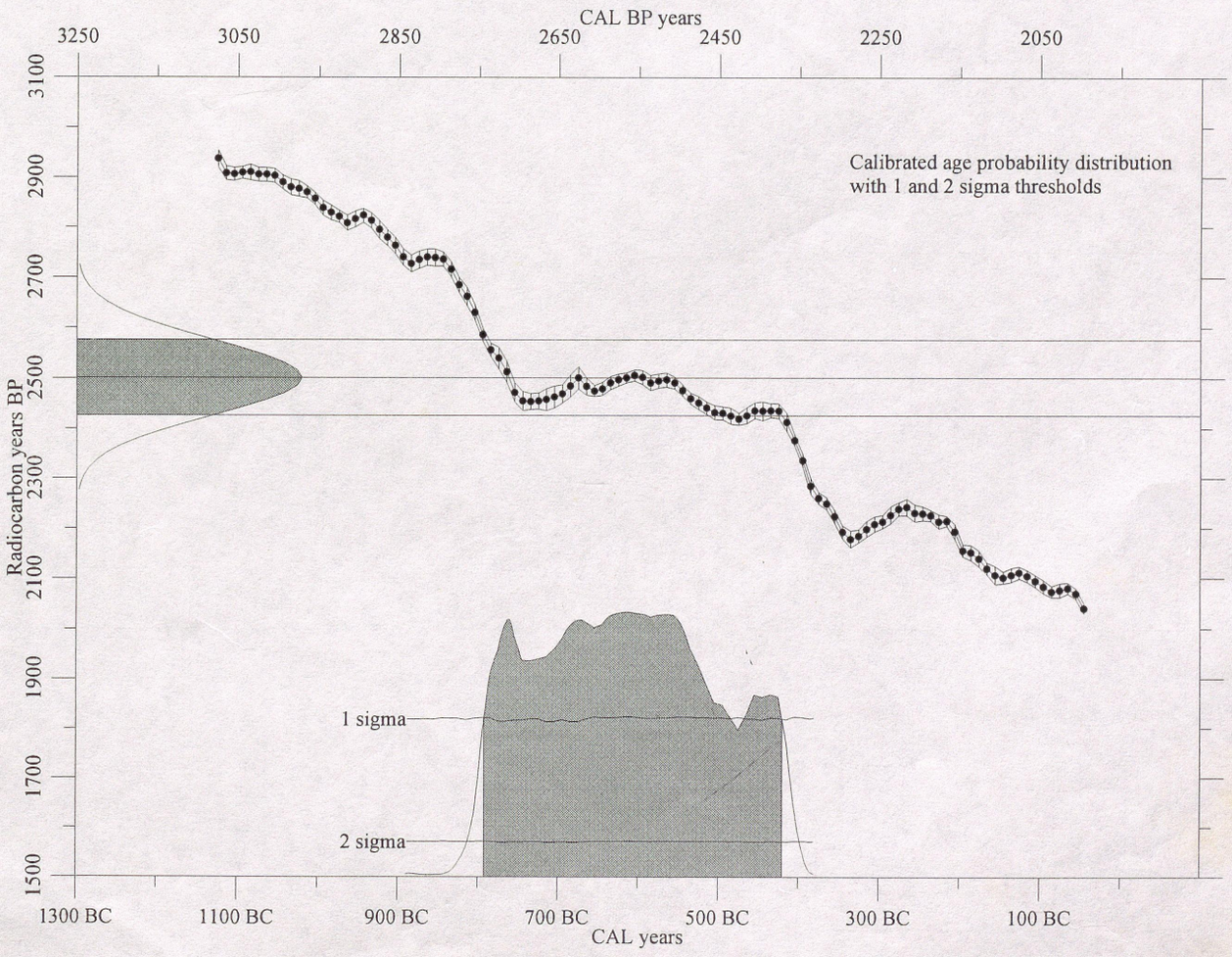
NZA14919 CONVENTIONAL RADIOCARBON AGE 2501 ± 75 years BP

B.C. 810 – 400.

INTCAL98_14C
1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 812 BC to 398 BC	2761 BP to 2347 BP (99.0% of area)
1 sigma interval is 792 BC to 420 BC	2741 BP to 2369 BP (91.8% of area)



Rafter, New Zealand

Sample ID	R Number	NZA	$\delta^{13}C$	Radiocarbon Age	$\delta^{14}C$	$\Delta^{14}C$	Percent Modern
MB/AR/UL } Mahabalipuram	29045/1	23374	-26	955 ± 30 BP	-119.7 ± 3.1 ‰	-117.9 ± 3.1 ‰	88.21 ± 0.31
MB/AR/BL	29045/2	23375	-25.2	1674 ± 30 BP	-193.9 ± 3 ‰	-193.5 ± 3 ‰	80.65 ± 0.3
MB/T1/BL	29045/3	23376	-25.7	1581 ± 35 BP	-185.3 ± 3.7 ‰	-184.1 ± 3.7 ‰	81.59 ± 0.37
Calibration for NZA 23374							
2 sigma interval is 1019 AD to 1161 AD	931 BP to 789 BP (97.7% of area)						
1 sigma interval is 1026 AD to 1052 AD	924 BP to 898 BP (22.5% of area)						
plus 1082 AD to 1152 AD	868 BP to 798 BP (53.9% of area)						
Calibration for NZA 23375							
2 sigma interval is 260 AD to 293 AD	1690 BP to 1657 BP (9.9% of area)						
plus 321 AD to 427 AD	1629 BP to 1523 BP (84.3% of area)						
1 sigma interval is 341 AD to 414 AD	1609 BP to 1536 BP (71.2% of area)						
Calibration for NZA 23376							
2 sigma interval is 405 AD to 564 AD	1545 BP to 1386 BP (96.9% of area)						
1 sigma interval is 423 AD to 540 AD	1527 BP to 1410 BP (86.9% of area)						

Mahalla puram

(1)

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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 26805/1**
Description	Peat
Sample ID	BDK-2-L
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 14918**
Date measured	10-Apr-02
$\delta^{13}C$	-24.6 ‰
* **Radiocarbon Age**	1859 ± 60 BP
$\delta^{14}C$	-210.9 ± 6 ‰
$\Delta^{14}C$	-211.5 ± 6 ‰
** **Per cent modern**	78.85 ± 0.6

Job No. 23185

Issued 23/04/02

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.4% (= ± 32 radiocarbon years).

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R26805/1

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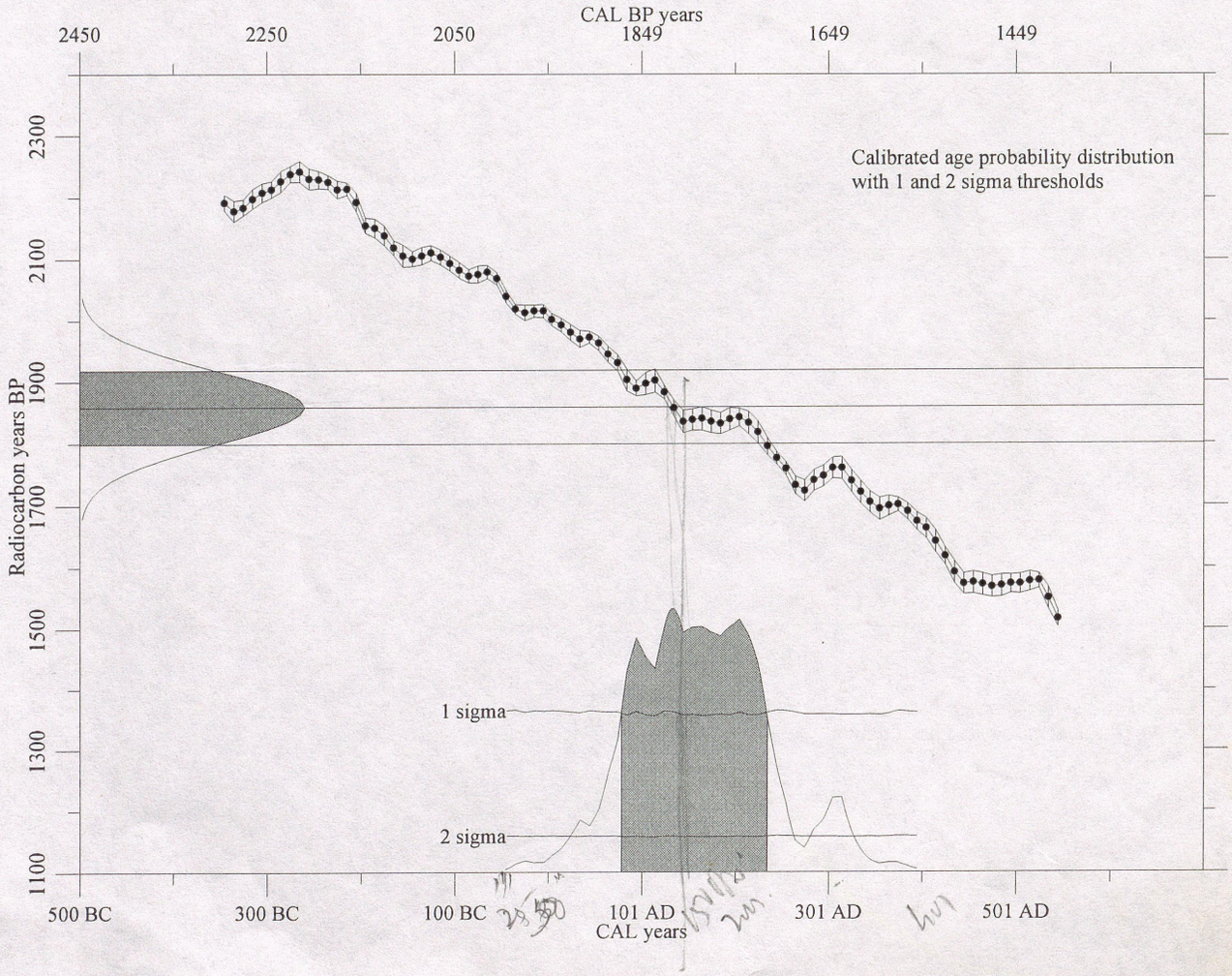
RADIOCARBON CALIBRATION REPORT

NZA14918 CONVENTIONAL RADIOCARBON AGE 1859 ± 60 years BP

INTCAL98_14C
1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 25 AD to 328 AD	1925 BP to 1622 BP (95.1% of area)
1 sigma interval is 79 AD to 235 AD	1871 BP to 1715 BP (75.7% of area)



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24 April 2002

Dr C. P. Rajendran
Centre for Earth Science Studies
Akkulam, Privandrum 695031
India

Dear Dr Rajendran,

Enclosed are the 'new' final reports for BDK-2-L and D1-1897-1 (R26805/1-2 respectively).

With kindest regards

D. M. Chambers

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory

email: d.chambers@gns.cri.nz
http://www.rafterradiocarbon.co.nz
http://www.14Conference2003.co.nz

Rafter

April 7, 2004

Dear Dr. Rodger Sparks:

Enclosed please find five samples of charcoal for AMS dating at your lab. The samples IDs are the following.

Kharsi — 1.	Kh/T_1/CP/2	~~Charcoal~~ plant	16.71 mg	dark brown black pigments & oxidised plant material.
2.	Kh/T_1/CP/3	~~Charcoal~~ material	19.68 mg	
Budarmora — 3.	BD/T1/CP/L3	~~Charcoal~~ tiny black specks.	1.054 gm	— No charcoal. Will withdraw
Budarmora — 4.	BD/T1/CP/L1	Charcoal	4.425 gm	
— 5.	BD/T1/CP/L2	Sediment containing Charcoal	15.74 gm	

I am not sure whether first two samples contain enough carbon for your analysis. I am taking a chance, since I do not have alternate samples. However, let me know if you come across any problem.

Yours sincerely

C.P. Rajendran

To

Dr. Rodger Sparks
Rafter Radiocarbon Laboratory IGNS
PO Box 31312, Lower Hutt
New Zealand

Encl: 5 samples

Date: Mon, 17 May 2004 13:39:25 +1200
From: Kelly Sutton <K.Sutton@gns.cri.nz>
Subject: Samples for AMS dating
To: cp_r@vsnl.com
X-Mailer: Lotus Notes Release 5.0.11 July 24, 2002
X-MIMETrack: S/MIME Sign by Notes Client on Kelly Sutton/GNS(Release 5.0.11 |July 24, 2002) at 17/05/2004 13:39:24,
Serialize by Notes Client on Kelly Sutton/GNS(Release 5.0.11 |July 24, 2002) at 17/05/2004 13:39:24, Serialize complete at 17/05/2004 13:39:24,
S/MIME Sign failed at 17/05/2004 13:39:24: The cryptographic key was not found, Serialize by Router on grfm1.gns.cri.nz/GNS(Release 5.0.11 |July 24, 2002) at 17/05/2004 01:39:27 PM, Serialize complete at 17/05/2004 01:39:27 PM
X-pstn-version: pmps:sps_solaris_1_1_0c0 pase:2.5
X-pstn-levels: (C:78.1961 M:98.5141 P: 0.0000 R:95.9108 S:16.4275)
X-pstn-settings: 3 (0.1000:5.0000) P:14 m:13 C:13 r:14
X-pstn-addresses: from <K.Sutton@gns.cri.nz>
Original-recipient: rfc822;cp_r@vsnl.com

Dear Dr. Rajendran,

We are in the process of treating your samples for AMS dating. Having completed a physical examination of the samples, I require your input regarding the nature of some of these samples.

Firstly, your sample ID: BD/T1/CP/L-3 - charcoal (R28546/3) was examined under microscope and found to have no charcoal. There are some tiny black stones which may have been mistaken with a naked eye, and a great deal of gritty soil. There is no visible plant matter of any kind. How would you like us to proceed with this sample? We can treat the entire sample with our A/A/A process to remove humic acids and other exogenous carbon with a view to obtaining a 14C date from the soil, but would this be of use to you?

No. withdraw & replace this sample.

The other samples that come into question are Kh/T1/CP/2 (R28546/1) , Kh/T1/CP/3 (R28546/2). Both of these samples contain dark brown/black fragments of degraded or oxidised plant material rather than charcoal. Would you like us to proceed with dating this material instead? In the event that it dissolves completely in the alkali stage, (which plant matter of this type is prone to do) we can reprecipitate the humic acid fractions for dating.

Yes - Proceed. 17/5/2004

If you could please contact us regarding how you wish us to proceed, we will place the samples on hold until we hear from you.

The other two samples contain recognisable charcoal and we will proceed with these as normal.

Please do not hesitate to contact us if you have any queries in the meantime.

36		The Machanics of Earthquakes and Faulting	C. H. Scholz	Cambridge University Press, Casmbridge	**2,072.00**
37		Active Tectonics and Alluvial Rivers	S. A. Schumn, Jean F. Dumont and John M. Holbrook	Cambridge University Press, Casmbridge	**3,357.00**
		Total			**139,451.00**

Kind regards

Kelly Sutton (BSc Chemistry)
Rafter Radiocarbon Laboratory
30 Gracefield Road
P.O.Box 31-312
LOWER HUTT

ph: +64 4 5704634
Fax: +64 4 5704657
E-mail: k.sutton@gns.cri.nz

Incoming mail is certified Virus Free.
Checked by AVG anti-virus system (http://www.grisoft.com).
Version: 6.0.561 / Virus Database: 353 - Release Date: 1/13/2004

4. Plate Tectonics and Earthquakes

4.1 The Pattern of Earthquakes around the World
4.2 The Theory of Plate Tectonics
4.3 Earthquake Mechanisms along the Plate Margins
4.4 Intra Plate Earthquakes
4.5 The Deadly Intraplate Killari-Latur Earthquake, India 1993
4.6 Quiet Gaps in Earthquake Zones
4.7 The Hazard from Plate-Edge Earthquakes
4.8 Earthquake Occurrence Statistics
4.9 The Chi Chi Earthquake, Taiwan, 1999
Summary

Box 4.1: Earthquake Statistics

5. Earthquake Effects

5.1 Ground Shaking Intensity
5.2 Landslides and Floods
5.2.1. The 1950 Assam Earthquake
5.3 Tsunamis and Seiches
5.4 Liquefaction
5.5 Evidence on Earthquake Prediction
5.6 Chinese and Japanese Earthquake Prediction Experiences
5.7 Paleoseismology
5.8 Local Site Amplification of Shaking
Summary

Box 5.1: Tsunamis and Seiches

6. Determining Earthquake Hazards

6.1 Specifying Earthquake Motion
6.2 The Beginnings of more Complex Wave Interpretation
6.3 The Factors that Determine Strong Ground Motion
6.4 The baseball "World Series" Earthquake, California
6.5 The Bam Earthquake, Iran 2003
6.6 Action at a Distance: Mexico Earthquake of 1985
6.7 Synthetic Earthquake Records
6.8 Calculating the Odds of an Earthquake
6.9 Simple Steps for Ground Motion Calculation
6.10 Empirical Attenuation Curves
6.11 Hazard Analysis Using Probability (PSHA)
6.12 Near to the Slipping Fault
6.13 Hazard Maps (India, Bangladesh, Pakistan)
Summary

Box 6.1: Calculation of Attenuation

7. Reduction of Earthquake Dangers

7.1 Rapid Response: Shake Maps
7.1.1. Early Warning with Real-Time Recording Systems
7.2 Hazard, Risk and Vulnerability
7.3 *Microzonation
7.4 The Bhuj, India, 2001 Earthquake
7.5 The Needs of Engineering Design
7.5.1. Earthquake Resistant Structures
7.6 Seismic Codes in India
7.6.1. Indian Seismic Codes
7.6.2. Seismic Zone Map
7.6.3. Code Compliance and Safety

Rafter
May 17, 2004

Date: Mon, 17 May 2004 13:39:25 +1200
From: Kelly Sutton <K.Sutton@gns.cri.nz>
Subject: Samples for AMS dating
To: cp_r@vsnl.com
X-Mailer: Lotus Notes Release 5.0.11 July 24, 2002
X-MIMETrack: S/MIME Sign by Notes Client on Kelly Sutton/GNS(Release 5.0.11 |July 24, 2002) at 17/05/2004 13:39:24,
Serialize by Notes Client on Kelly Sutton/GNS(Release 5.0.11 |July 24, 2002) at 17/05/2004 13:39:24, Serialize complete at 17/05/2004 13:39:24,
S/MIME Sign failed at 17/05/2004 13:39:24: The cryptographic key was not found, Serialize by Router on grfm1.gns.cri.nz/GNS(Release 5.0.11 |July 24, 2002) at 17/05/2004 01:39:27 PM, Serialize complete at 17/05/2004 01:39:27 PM
X-pstn-version: pmps:sps_solaris_1_1_0c0 pase:2.5
X-pstn-levels: (C:78.1961 M:98.5141 P: 0.0000 R:95.9108 S:16.4275)
X-pstn-settings: 3 (0.1000:5.0000) P:14 m:13 C:13 r:14
X-pstn-addresses: from <K.Sutton@gns.cri.nz>
Original-recipient: rfc822;cp_r@vsnl.com

Dear Dr. Rajendran,

We are in the process of treating your samples for AMS dating. Having completed a physical examination of the samples, I require your input regarding the nature of some of these samples.

Firstly, your sample ID: BD/T1/CP/L-3 - charcoal (R28546/3) was examined under microscope and found to have no charcoal. There are some tiny black stones which may have been mistaken with a naked eye, and a great deal of gritty soil. There is no visible plant matter of any kind. How would you like us to proceed with this sample? We can treat the entire sample with our A/A/A process to remove humic acids and other exogenous carbon with a view to obtaining a 14C date from the soil, but would this be of use to you?

The other samples that come into question are Kh/T1/CP/2 (R28546/1) , Kh/T1/CP/3 (R28546/2). Both of these samples contain dark brown/black fragments of degraded or oxidised plant material rather than charcoal. Would you like us to proceed with dating this material instead? In the event that it dissolves completely in the alkali stage, (which plant matter of this type is prone to do) we can reprecipitate the humic acid fractions for dating.

If you could please contact us regarding how you wish us to proceed, we will place the samples on hold until we hear from you.

The other two samples contain recognisable charcoal and we will proceed with these as normal.

Please do not hesitate to contact us if you have any queries in the meantime.

Kind regards

Kelly Sutton (BSc Chemistry)
Rafter Radiocarbon Laboratory
30 Gracefield Road
P.O.Box 31-312
LOWER HUTT

ph: +64 4 5704634
Fax: +64 4 5704657
E-mail: k.sutton@gns.cri.nz

Incoming mail is certified Virus Free.
Checked by AVG anti-virus system (http://www.grisoft.com).
Version: 6.0.561 / Virus Database: 353 - Release Date: 1/13/2004

Rajan's Reply
May 18, 2004

Dear Kelly,

Thank you for your message.

I think you shouldn't proceed further on the sample BD/T1/CP/L-3 (R28546/3), as this contained no organic material. I will replace it with a fresh sample, later. Regarding the other two, which you mentioned, please go ahead with your procedures to date them.

CP Rajendran

June 2, 2004

From: Dawn Chambers <D.Chambers@gns.cri.nz>
Subject: Rafter Radiocarbon Laboratory
To: cp_r@vsnl.com

Dear CP Rajendran,

We have received the three carbon sediment samples and they have been assigned the following laboratory references:

U/TR1/L1A	R28575/1
MB/TR1/L1	R28575/2
MB/TR1/L2	R28575/3

If charcoal is found and able to be separated from the sediment is this what you would like dated or would you prefer just the sediment itself? This is just to pre-empt anticipated questions from the technical staff when they come to look at your samples. Results can be anticipated about the first week of August and as indicated in your letter we confirm that payment for these samples has already been received.

With kindest regards
Dawn

****
Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory
****
Institute of Geological and Nuclear Sciences Limited
PO Box 31312 Lower Hutt, New Zealand
Phone +64 4 5704 671 (Dr Rodger Sparks)
Fax +64 4 5704 657
****
email: d.chambers@gns.cri.nz
email: r.sparks@gns.cri.nz
www.RafterRadiocarbon.co.nz
****

Manjare

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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 28546/2**
Description	Charcoal
Sample ID	Kh/T1/CP/3
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 19927**
Date measured	08-Jun-04
$\delta^{13}C$	-25.6 ‰
* **Radiocarbon Age**	-800 ± 35 BP
$\delta^{14}C$	96.1 ± 4.9 ‰
$\Delta^{14}C$	97.5 ± 4.9 ‰
** **Per cent modern**	109.75 ± 0.49

Job No. 29814

Issued 10/06/2004

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

Environment Group, Institute of Geological and Nuclear Sciences Ltd., PO Box 31-312, Lower Hutt, New Zealand
Fax +64 4 570 4657 Phone +64 4 570 4671

Date: Mon, 14 Jun 2004 11:41:13 +1200
From: Dawn Chambers <D.Chambers@gns.cri.nz>
Subject: Rafter Radiocarbon Laboratory
To: cp_r@vsnl.com
Dear Dr Rajendran,

Here is an AMS result for you. More results can be anticipated about the middle of next week.

With kindest regards
Dawn

R 28546/2
Sample ID Kh/T1/CP/3
Description: Charcoal
NZA 19927

d13C (o/oo) -25.64
Radiocarbon age -800 +/- 35 BP
delta-14C (o/oo) 96.1 +/- 4.9
DELTA-14C 97.5 +/- 4.9
Per-cent modern 109.75 +/- 0.49

Age, delta-14C, DELTA-14C and absolute per cent Modern are as defined by Stuiver and Polach Radiocarbon 19: 355-363 (1977)

1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and Spurk,M. 1998, Radiocarbon 40(3):1041-1083

****

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory
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Manjare & Budharmota

Dear Dr Rajendran,

Here are three AMS results for you. The final reports will follow via mail.

With kindest regards
Dawn

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R 28546/1
Sample ID Kh/T1/CP/2
Description: Charcoal
NZA 20028

d13C (o/oo) -26.2
Radiocarbon age -655 +/- 35 BP
delta-14C (o/oo) 75.3 +/- 4.9
DELTA-14C 77.9 +/- 4.9
Per-cent modern 107.79 +/- 0.49

==========

Level-1

R 28546/4
Sample ID BD/T1/CP/L-1
Description: Charcoal
NZA 20029

d13C (o/oo) -33.84
Radiocarbon age 9135 +/- 95 BP
delta-14C (o/oo) -687.1 +/- 3.8
DELTA-14C -681.4 +/- 3.9
Per-cent modern 31.86 +/- 0.39

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1)
2 sigma interval is 8602 BC to 8208 BC 10551 BP to 10157 BP (93.1% of area)

1 sigma interval is 8453 BC to 8260 BC 10402 BP to 10209 BP (64.9% of area)

==========

Level-2

R 28546/5
Sample ID BD/T1/CP/L-2
Description: Sediment containing charcoal
NZA 20030

d13C (o/oo) -35.7
Radiocarbon age 11529 +/- 70 BP
delta-14C (o/oo) -768.6 +/- 2
DELTA-14C -763.5 +/- 2.1
Per-cent modern 23.65 +/- 0.21

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1)
2 sigma interval is 11901 BC to 11656 BC 13850 BP to 13605 BP
(31.9% of area)
plus 11593 BC to 11233 BC 13542 BP to 13182 BP
(61.9% of area)

1 sigma interval is 11829 BC to 11715 BC 13778 BP to 13664 BP
(18.8% of area)
plus 11544 BC to 11457 BC 13493 BP to 13406 BP
(27.7% of area)

==========

Age, delta-14C, DELTA-14C and absolute per cent Modern are as defined by Stuiver and Polach Radiocarbon 19: 355-363 (1977)

1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and Spurk,M. 1998, Radiocarbon 40(3):1041-1083

Date: Fri, 18 Jun 2004 13:52:52 +1200
From: Rodger Sparks <R.Sparks@gns.cri.nz>
Subject: 14C result: Kh/T1/CP/3
To: cp_r@vsnl.com

Dear Dr Rajendran,

I have re-examined the records for the 14C dating of your sample Kh/T1/CP/3 (NZA19927). I believe the result we obtained correctly reflects the amount of radiocarbon in the measured sample, although I see that there was very little identifiable charcoal in the material you sent us. You were contacted about this, and you asked for the processing to proceed, using the humic fractions if necessary. This was done.

It looks as though the sample could be very heterogeneous, and there is no obvious way to extract the appropriate fraction for dating apart from doing several repeats to see how the measured ages are distributed. This would be an expensive and time consuming process. It may be more satisfactory if another sample was collected and 'pre-screened' to make sure that it contained sufficient charcoal for a reliable date before submitting it.

Regards,

Rodger Sparks
//
Rafter Radiocarbon Laboratory,
Institute of Geological and Nuclear Sciences,
30 Gracefield Road,
PO Box 31-312,
Lower Hutt,
New Zealand.
Email: r.sparks@gns.cri.nz Fax: +64 4 570 4657
http://www.RafterRadiocarbon.co.nz
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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 28546/4**
Description	Charcoal
Sample ID	BD/T1/CP/L-1
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 20029**
Date measured	21-Jun-04
$\delta^{13}C$	-33.8 ‰
* **Radiocarbon Age**	9135 ± 95 BP ✓
$\delta^{14}C$	-687.1 ± 3.8 ‰
$\Delta^{14}C$	-681.4 ± 3.9 ‰
** **Per cent modern**	31.86 ± 0.39

Job No. 29816

Issued 22/06/2004

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RAFTER RADIOCARBON LABORATORY

R28546/4

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PO Box 31312, Lower Hutt, New Zealand
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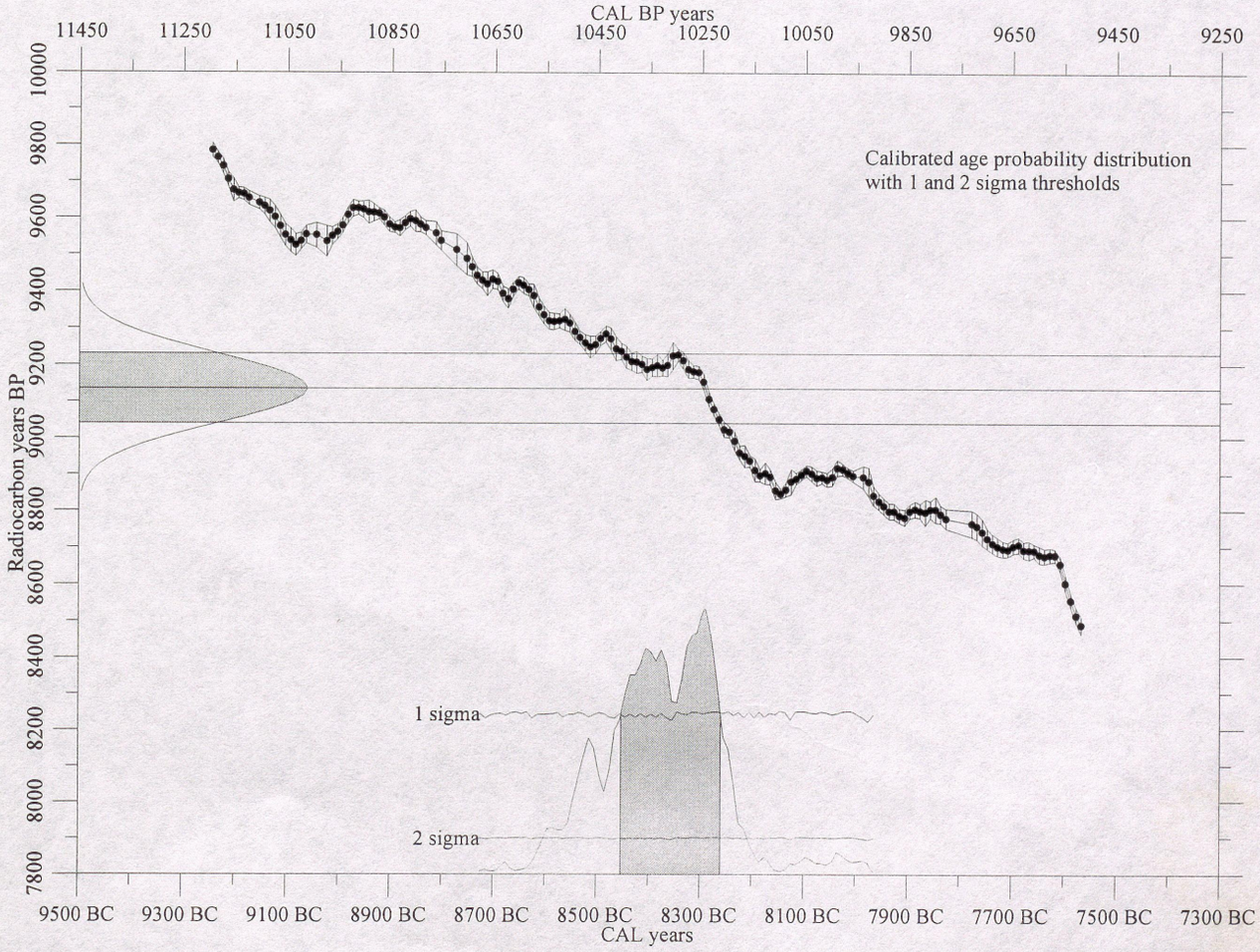
RADIOCARBON CALIBRATION REPORT

NZA20029 CONVENTIONAL RADIOCARBON AGE 9135 ± 95 years BP

INTCAL98_14C
1998 Atmospheric radiocarbon ages. See
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 8602 BC to 8208 BC	10551 BP to 10157 BP (93.1% of area)
1 sigma interval is 8453 BC to 8260 BC	10402 BP to 10209 BP (64.9% of area)



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Accelerator Mass Spectrometry Result

Sample	**R 28546/5**
Description	Sediment containing charcoal
Sample ID	BD/T1/CP/L-2
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 20030**
Date measured	21-Jun-04
$\delta^{13}C$	-35.7 ‰
* **Radiocarbon Age**	11529 ± 70 BP ✓
$\delta^{14}C$	-768.6 ± 2 ‰
$\Delta^{14}C$	-763.5 ± 2.1 ‰
** **Per cent modern**	23.65 ± 0.21

Job No. 29817

Issued 22/06/2004

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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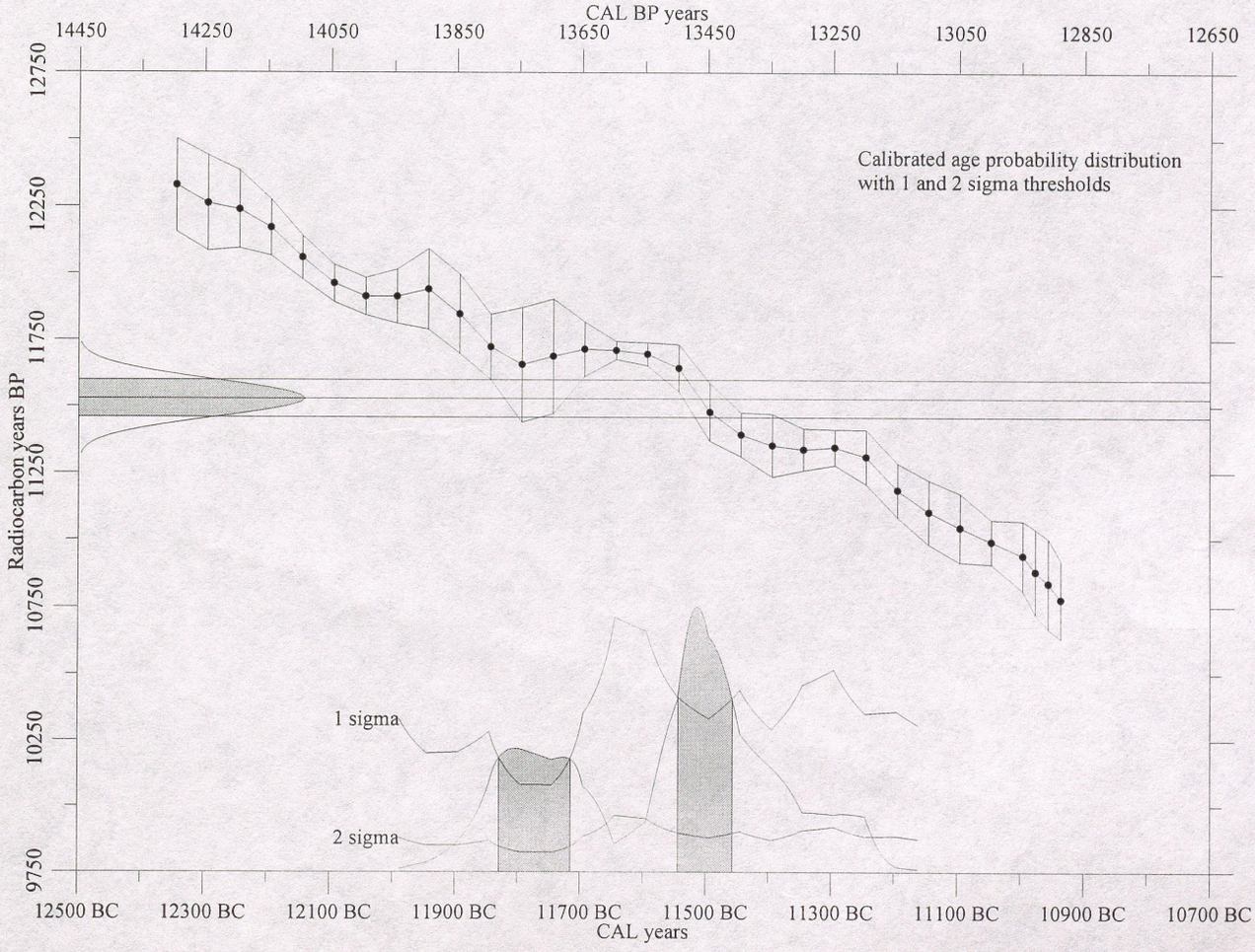
RADIOCARBON CALIBRATION REPORT

NZA20030 CONVENTIONAL RADIOCARBON AGE 11529 ± 70 years BP

INTCAL98_14C
1998 Atmospheric radiocarbon ages. See
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is	11901 BC to 11656 BC	13850 BP to 13605 BP (31.9% of area)
plus	11593 BC to 11233 BC	13542 BP to 13182 BP (61.9% of area)
1 sigma interval is	11829 BC to 11715 BC	13778 BP to 13664 BP (18.8% of area)
plus	11544 BC to 11457 BC	13493 BP to 13406 BP (27.7% of area)



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Accelerator Mass Spectrometry Result

Sample	**R 28546/1**
Description	Charcoal
Sample ID	Kh/T1/CP/2
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 20028**
Date measured	21-Jun-04
$\delta^{13}C$	-26.2 ‰
* **Radiocarbon Age**	-655 ± 35 BP ✓
$\delta^{14}C$	75.3 ± 4.9 ‰
$\Delta^{14}C$	77.9 ± 4.9 ‰
** **Per cent modern**	107.79 ± 0.49

Job No. 29813

Comment: Sample is modern: mid-20th century

Issued 23/06/2004

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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24 June 2004

Dr C. P. Rajendran
Centre for Earth Science Studies
PO Box 7250 Akkulam
Trivandrum 695 031
Kerala
India

Dear Dr Rajendran,

Enclosed are the final reports for the samples Kh/T1/CP/2, Kh/T1/CP/3, BD/T1/CP/L-1 and BD/T1/CP/L-2 (R28546/1-2, 4-5 respectively).

With kindest regards

D. M. Chambers

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory

email: d.chambers@gns.cri.nz
www.RafterRadiocarbon.co.nz

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Sample Treatment Report

Date Printed: *24-Jun-04*

R: 28546/1 **Job:** 29813 **NZA Number:** 20028

Submitter: C. P. (Dr) Rajendran

Sample ID: Kh/T1/CP/2

Description: Charcoal

Details: Sample consisted of small amount of soil - dark brown and mushroom pink-brown. Microscopic exam revealed charcoal is dark brown lumpy fragments with some appearance of bubbles. Picked out all other pale soil. No vascular structure visible. Removed teal thread, light blue thread and tiny quartz pebbles. Contacted submitter, advised to continue and use humics if necessary. Treated dark brown fragments with acid / alkali /acid process. Reprecipitated humic acids. Dried in vacuum oven.

Comments:

Fraction dated: Treated dark soil **Stored:** pale soil and humics

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R: 28546/2 **Job:** 29814 **NZA Number:** 19927

Submitter: C. P. (Dr) Rajendran

Sample ID: Kh/T1/CP/3

Description: Charcoal

Details: Sample consisted of small amount of pale soil and lumps of darker brown/grey material. Microscopic exam revealed many pale quartz grains, pale soil. Darker soil fragments contain grains of dark material. No visible vascular structure, dark brown rather than black, not definate charcoal. One small round charred seed seems only definate charcoal. Picked out dark brown fragments and charred seed. Material seems to be more likely degraded plant material. Contacted submitter who advised to continue anyway, use humics if needed. Treated with acid / alkali / acid process. Reprecipitated humic fractions. Dried in vacuum oven.

Comments:

Fraction dated: Treated degraded plant material **Stored:** humics and pale soil

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Sample Treatment Report

Date Printed: *24-Jun-04*

R: 28546/4 **Job:** 29816 **NZA Number:** 20029

Submitter: C. P. (Dr) Rajendran

Sample ID: BD/T1/CP/L-1

Description: Charcoal

Details: Sample consisted of large lumps of dark material with mid-brown soil on outer surfaces. Microscopic exam revealed lumps of soft puggy, clay soil. Dark lumps are not solid charcoal. Charcoal seems to be a component of the soil - impossible to separate physically. Took lumps with lots of black amterial - resumably charcoal but too small to see vascular structure. Ground in mortar and pestle. Treated with acid / alkali / acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated soil with charcoal **Stored:** remainder

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R: 28546/5 **Job:** 29817 **NZA Number:** 20030

Submitter: C. P. (Dr) Rajendran

Sample ID: BD/T1/CP/L-2

Description: Sediment containing charcoal

Details: Sample consisted of medium brown, possibly damp soil. Dark lumps and quartz pebbles. Microscopic exam revealed black material under clay like soil. Once paler soil removed, charcoal is part of the soil rather than entire lumps. Some lumps of soil seem to have a greater concentration of charcoal - selected these. Ground in mortar and pestle. Treated with acid / alkali / acid process. Dried in vacuum oven

Comments:

Fraction dated: Treated sediment with charcoal **Stored:** remainder

To: Dawn Chambers <D.Chambers@gns.cri.nz>
From: "C.P.Rajendran" <cp_r@vsnl.com>
Subject: Re: Rafter Radiocarbon Laboratory
Cc:
Bcc:
Attached:

Motibaru

Thanks

At 04:31 PM 7/29/2004 +1200, you wrote:

Dear Dr Rajendran,

Here is an AMS result for you. Another two results will be notified next week.

With kindest regards
Dawn

==========

R 28575/2
Sample ID MB/TR1/L1
Description: Carbon Sediment
NZA 20250

d13C (o/oo) -26.69
Radiocarbon age 149 +/- 35 BP
delta-14C (o/oo) -28.1 +/- 4.3
DELTA-14C -24.7 +/- 4.3
Per-cent modern 97.53 +/- 0.43

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1)
2 sigma interval is 1662 AD to 1945 AD 288 BP to 5 BP (99.7% of area)

1 sigma interval is 1672 AD to 1697 AD 278 BP to 253 BP (11.4% of area)
plus 1726 AD to 1779 AD 224 BP to 171 BP (25.2% of area)
plus 1798 AD to 1817 AD 152 BP to 133 BP (8.6% of area)
plus 1840 AD to 1874 AD 110 BP to 76 BP (12.3% of area)
plus 1917 AD to 1944 AD 33 BP to 6 BP (12.6% of area)

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Accelerator Mass Spectrometry Result

Sample	**R 28575/2**
Description	Carbon Sediment
Sample ID	MB/TR1/L1
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 20250**
Date measured	28-Jul-04
$\delta^{13}C$	-26.7 ‰
* **Radiocarbon Age**	149 ± 35 BP
$\delta^{14}C$	-28.1 ± 4.3 ‰
$\Delta^{14}C$	-24.7 ± 4.3 ‰
** **Per cent modern**	97.53 ± 0.43

Job No. 30211

Issued 29/07/2004 D.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

Environment Group, Institute of Geological and Nuclear Sciences Ltd., PO Box 31-312, Lower Hutt, New Zealand
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RAFTER RADIOCARBON LABORATORY

R28575/2

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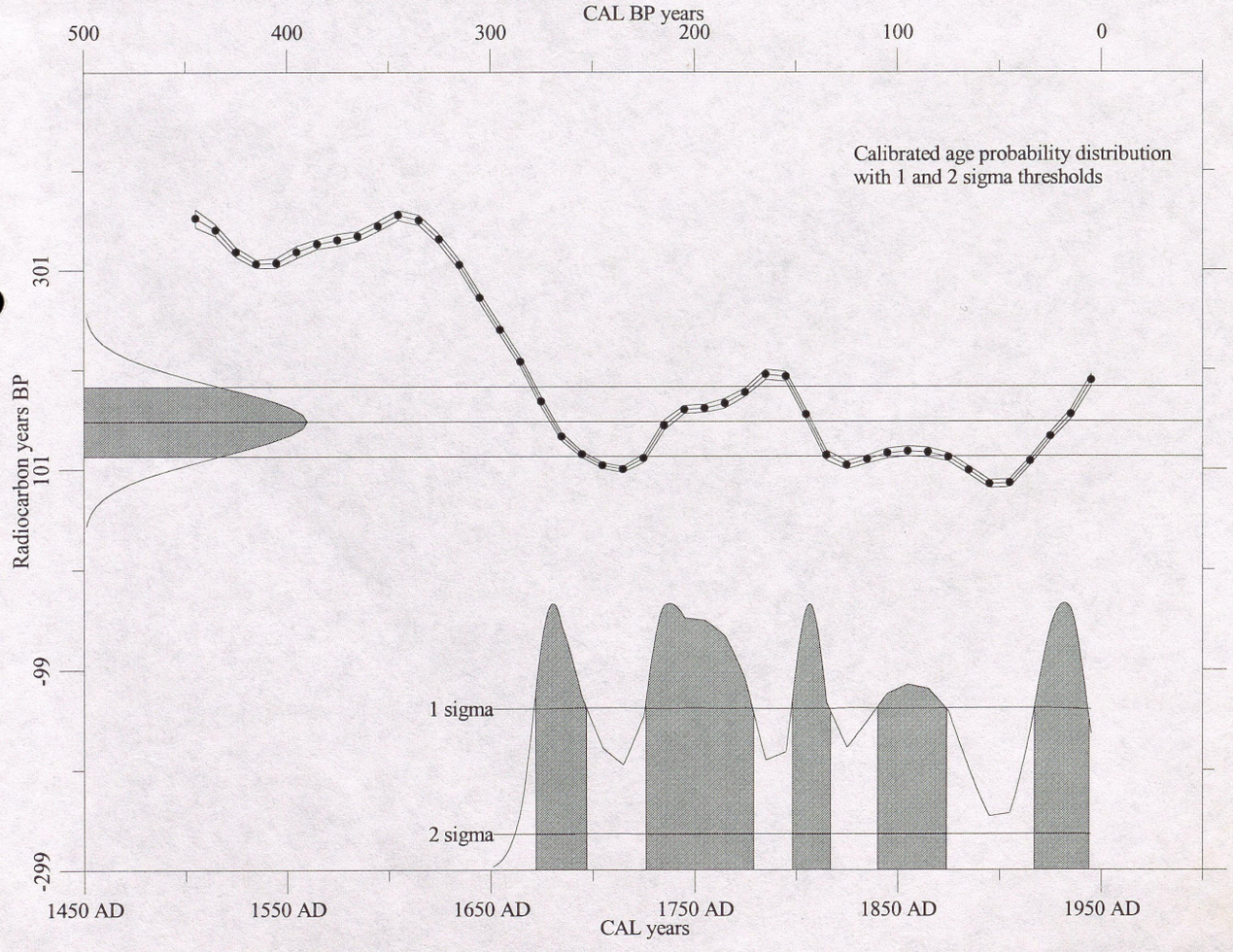
RADIOCARBON CALIBRATION REPORT

NZA 20250 CONVENTIONAL RADIOCARBON AGE 149 ± 35 years BP

INTCAL98_14C
1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 1662 AD to 1945 AD	288 BP to 5 BP (99.7% of area)
1 sigma interval is 1672 AD to 1697 AD	278 BP to 253 BP (11.4% of area)
plus 1726 AD to 1779 AD	224 BP to 171 BP (25.2% of area)
plus 1798 AD to 1817 AD	152 BP to 133 BP (8.6% of area)
plus 1840 AD to 1874 AD	110 BP to 76 BP (12.3% of area)
plus 1917 AD to 1944 AD	33 BP to 6 BP (12.6% of area)



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4 August 2004

Dr C. P. Rajendran
Centre for Earth Science Studies
PO Box 7250 Akkulam
Trivandrum 695 031
Kerala
India

Dear Dr Rajendran,

Enclosed are the final reports for the samples U/TR1/L1A, MB/TR1/L1 and MB/TR1/L2 (R28575/1-3 respectively).

With kindest regards

D.M. Chambers

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory

email: d.chambers@gns.cri.nz
www.RafterRadiocarbon.co.nz

Institute of
Geological &
Nuclear Sciences
Limited

Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 28575/3**
Description	Carbon Sediment
Sample ID	MB/TR1/L2
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 20339**
Date measured	03-Aug-04
$\delta^{13}C$	-25.8 ‰
* **Radiocarbon Age**	370 ± 40 BP
$\delta^{14}C$	-52.9 ± 5 ‰
$\Delta^{14}C$	-51.3 ± 5 ‰
** **Per cent modern**	94.87 ± 0.5

Job No. 30212

Issued 4/08/2004

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

Environment Group, Institute of Geological and Nuclear Sciences Ltd., PO Box 31-312, Lower Hutt, New Zealand
Fax +64 4 570 4657 Phone +64 4 570 4671

RAFTER RADIOCARBON LABORATORY

R28575/3

INSTITUTE OF GEOLOGICAL AND NUCLEAR SCIENCES LTD.
PO Box 31312, Lower Hutt, New Zealand
Phone (+64 4) 570 4671, Fax (+64 4) 570 4657

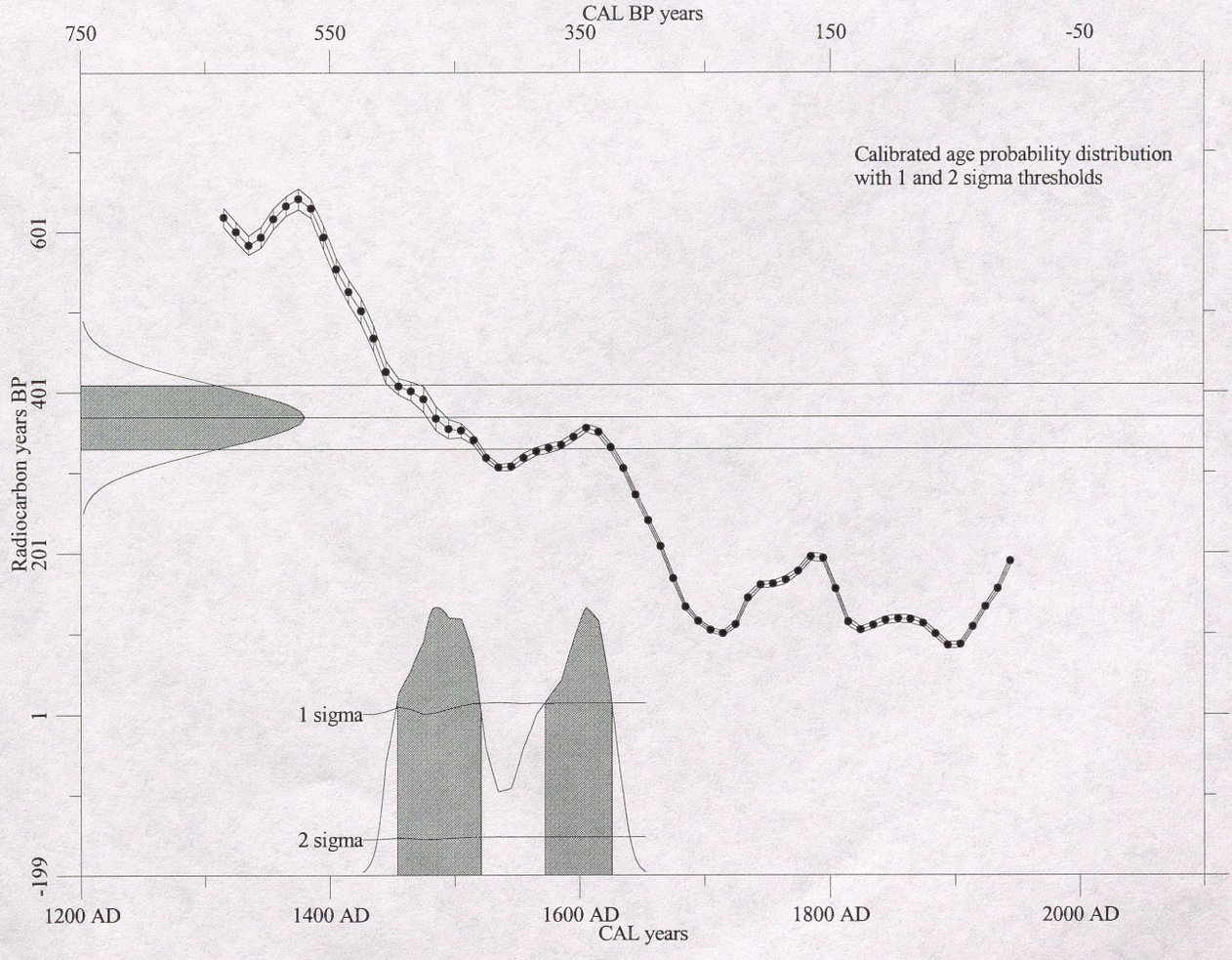
RADIOCARBON CALIBRATION REPORT

NZA 20339 CONVENTIONAL RADIOCARBON AGE 370 ± 40 years BP

INTCAL98_14C
1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 1438 AD to 1641 AD	512 BP to 309 BP (99.1% of area)
1 sigma interval is 1454 AD to 1521 AD	496 BP to 429 BP (41.8% of area)
plus 1572 AD to 1626 AD	378 BP to 324 BP (32.2% of area)



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and Nuclear Sciences
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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *04-Aug-04*

R: 28575/1 **Job:** 30210 **NZA Number:** 20340

Submitter: C. P. (Dr) Rajendran

Sample ID: U/TR1/L1A

Description: Carbon Sediment

Details: Sample consisted of medium brown sediment with sparkly minerals and black specks of charcoal. Microscopic exam revealed very fine flakes of shell and shiny material. Tiny snail shaped shells. Very small balck lumps, selected with tweezers. Very soft and breaks up easily. Shiny colourless flakes tend to be round - possibly fish scales?? Broke up black material with tweezers in beaker. Treated with acid / alkali /acid process and reprecipitated humic acids.

Comments:

Fraction dated: Treated charcoal **Stored:** sediment and humics

---

R: 28575/2 **Job:** 30211 **NZA Number:** 20250

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/TR1/L1

Description: Carbon Sediment

Details: Sample consisted of greyish brown sediment with fragments of charcoal. Microscopic exam revealed greyish brown sediment with few cloudy white spiral shells. Fragments of charcoal with sediment attached. Charcoal is black and shiny with vascular structure, although rather soft. Picked out largest fragments of charcoal, most have sediment attached. Removed as much sediment as possible with scalpel. Crushed in beaker with tweezers. Treated with acid / alkali / acid process. Dried in vacuum oven

Comments:

Fraction dated: Treated charcoal **Stored:** remainder

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and Nuclear Sciences
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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *04-Aug-04*

R: 28575/3 **Job:** 30212 **NZA Number:** 20339

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/TR1/L2

Description: Carbon Sediment

Details: Sample consisted of light olive brown sediment with tiny fragments of black charcoal. Microscopic exam revealed rootlets and threads. Small fragments of balck charcoal. One piece of white/cream shell. Charcoal very fragile and difficutl to remove with tweezers. Charcoal seems more bubbly in apperance than normal. Removed tiny fragments of charcoal from sand with tweezers.Treated with acid /alkali / acid process. Reprecipitated humic acids. Dried in vacuum oven.

Comments:

Fraction dated: Treated charcoal **Stored:** remainder and humics

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Institute of
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Nuclear Sciences
Limited

Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 28575/1**
Description	Carbon Sediment
Sample ID	U/TR1/L1A
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 20340**
Date measured	03-Aug-04
$\delta^{13}C$	-25.2 ‰
* **Radiocarbon Age**	3983 ± 50 BP
$\delta^{14}C$	-395.1 ± 3.9 ‰
$\Delta^{14}C$	-394.9 ± 3.9 ‰
** **Per cent modern**	60.51 ± 0.39

Job No. 30210

Issued 4/08/2004

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RAFTER RADIOCARBON LABORATORY

R28575/1

INSTITUTE OF GEOLOGICAL AND NUCLEAR SCIENCES LTD.
PO Box 31312, Lower Hutt, New Zealand
Phone (+64 4) 570 4671, Fax (+64 4) 570 4657

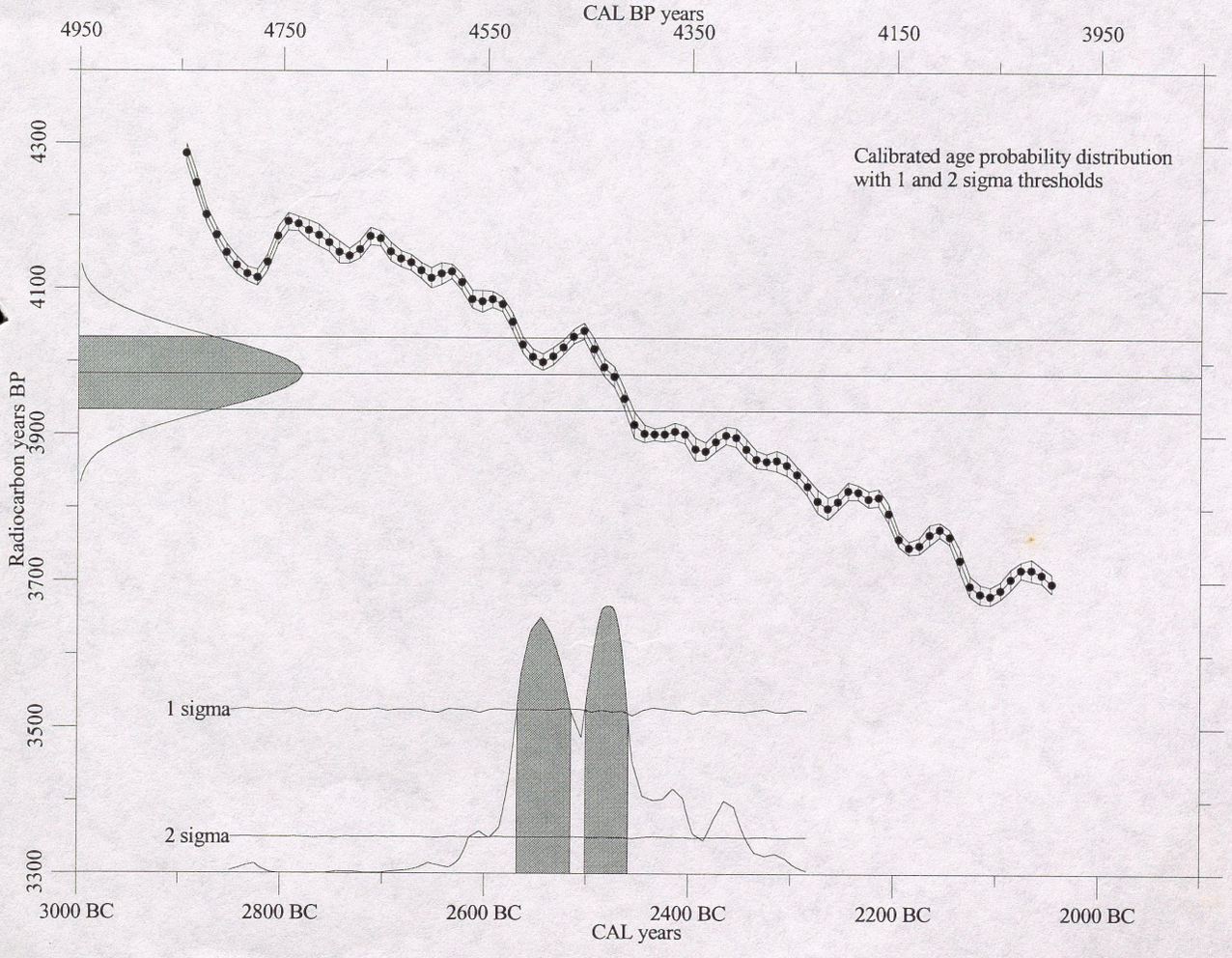
RADIOCARBON CALIBRATION REPORT

NZA 20340 CONVENTIONAL RADIOCARBON AGE 3983 ± 50 years BP

INTCAL98_14C
1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S.,
Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and
Spurk,M. 1998, Radiocarbon 40(3):1041-1083

CALIBRATED AGE in terms of cofidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 2614 BC to 2343 BC	4563 BP to 4292 BP (93.6% of area)
1 sigma interval is 2568 BC to 2515 BC	4517 BP to 4464 BP (32.4% of area)
plus 2501 BC to 2459 BC	4450 BP to 4408 BP (27.0% of area)



Description: Carbon Sediment
NZA 20339

MB/TR1/L2
Mollibare

d13C (o/oo) -25.84
Radiocarbon age 370 +/- 40 BP
delta-14C (o/oo) -52.9 +/- 5
DELTA-14C -51.3 +/- 5
Per-cent modern 94.87 +/- 0.5

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1)
2 sigma interval is 1438 AD to 1641 AD 512 BP to 309 BP (99.1% of area)

1 sigma interval is 1454 AD to 1521 AD 496 BP to 429 BP (41.8% of area)
plus 1572 AD to 1626 AD 378 BP to 324 BP (32.2% of area)

==========

Age, delta-14C, DELTA-14C and absolute per cent Modern are as defined by Stuiver and Polach Radiocarbon 19: 355-363 (1977)

1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and Spurk,M. 1998, Radiocarbon 40(3):1041-1083

****

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory
****
Institute of Geological and Nuclear Sciences Limited
PO Box 31312 Lower Hutt, New Zealand
Phone +64 5704 671 (Dr Rodger Sparks)
Fax +64 5704 657
****
Email: d.chambers@gns.cri.nz
Email: r.sparks@gns.cri.nz
http://www.rafterradiocarbon.co.nz
****

Incoming mail is certified Virus Free.
Checked by AVG anti-virus system (http://www.grisoft.com).
Version: 6.0.561 / Virus Database: 353 - Release Date: 1/13/2004

X-Symantec-TimeoutProtection: 0
X-Symantec-TimeoutProtection: 1
X-Symantec-TimeoutProtection: 2
X-Symantec-TimeoutProtection: 3
X-Symantec-TimeoutProtection: 4
X-Symantec-TimeoutProtection: 5
X-Symantec-TimeoutProtection: 6
Date: Wed, 04 Aug 2004 14:17:23 +1200
From: Dawn Chambers <D.Chambers@gns.cri.nz>
Subject: Rafter Radiocarbon Laboratory
To: cp_r@vsnl.com
X-Mailer: Lotus Notes Release 5.0.11 July 24, 2002
X-MIMETrack: Serialize by Router on grfm1.gns.cri.nz/GNS(Release 5.0.11 |July 24, 2002) at 04/08/2004 02:17:21 PM, Serialize complete at 04/08/2004 02:17:21 PM
X-pstn-version: pmps:sps_solaris_1_1_0c0 pase:2.8
X-pstn-levels: (C:78.1961 M:99.8514 P:95.9108 R:95.9108 S: 5.6928)
X-pstn-settings: 3 (0.1000:0.2000) p:14 m:13 C:13 r:14
X-pstn-addresses: from <D.Chambers@gns.cri.nz>
Original-recipient: rfc822;cp_r@vsnl.com

Dear Dr Rajendran,

Here are the last two results. The final reports will follow by mail.

With kindest regards
Dawn

==========

R 28575/1
Sample ID U/TR1/L1A
Description: Carbon Sediment
NZA 20340

d13C (o/oo) -25.16
Radiocarbon age 3983 +/- 50 BP
delta-14C (o/oo) -395.1 +/- 3.9
DELTA-14C -394.9 +/- 3.9
Per-cent modern 60.51 +/- 0.39

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1)
2 sigma interval is 2614 BC to 2343 BC 4563 BP to 4292 BP (93.6% of area)

1 sigma interval is 2568 BC to 2515 BC 4517 BP to 4464 BP (32.4% of area)
plus 2501 BC to 2459 BC 4450 BP to 4408 BP (27.0% of area)

==========

R 28575/3
Sample ID MB/TR1/L2

Printed for "C.P.Rajendran" <cp_r@vsnl.com> 8/4/2004

==========

Age, delta-14C, DELTA-14C and absolute per cent Modern are as defined by Stuiver and Polach Radiocarbon 19: 355-363 (1977)

1998 Atmospheric delta 14C and radiocarbon ages from:
Stuiver, M., Reimer, P.J., Bard,E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and Spurk,M. 1998, Radiocarbon 40(3):1041-1083

****

Dawn Chambers (Ms)
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Rafter Radiocarbon Laboratory
****
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Phone +64 5704 671 (Dr Rodger Sparks)
Fax +64 5704 657
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Email: d.chambers@gns.cri.nz
Email: r.sparks@gns.cri.nz
http://www.rafterradiocarbon.co.nz
****

Incoming mail is certified Virus Free.
Checked by AVG anti-virus system (http://www.grisoft.com).
Version: 6.0.561 / Virus Database: 353 - Release Date: 1/13/2004

C.P. Rajendran
Centre for Earth Science Studies
P.B.No.7250, Akkulam
Trivandrum 695 031, India
Ph: 91-471-2445803(O); 91-471-2360942 (Res)
Fax : 91-471-2442280

Date: Tue, 30 Aug 2005 11:34:26 +1200
From: Dawn Chambers <D.Chambers@gns.cri.nz>
Subject: Rafter Radiocarbon Laboratory
To: cp_r@vsnl.com
X-Mailer: Lotus Notes Release 5.0.11 July 24, 2002
X-MIMETrack: Serialize by Router on grfm1.gns.cri.nz/GNS(Release 5.0.13a|April 8, 2004) at 30/08/2005 11:34:27 AM
X-imss-version: 2.030
X-imss-result: Passed
X-imss-scores: Clean:71.97639 C:2 M:3 S:5 R:5
X-imss-settings: Baseline:1 C:3 M:3 S:3 R:3 (0.0000 0.0000)
Original-recipient: rfc822;cp_r@vsnl.com

Dear Dr Rajendran,

Thankyou for your email. Attached is a copy of our sample submission form and the import permit. Inclusion of the latter with the sample documentation and writing the permit number on the outside of the package is all that is required. Our records indicate that you have 12 sample credits split over two invoices, PSINV116884 and PSINV116968.

Permit No: 20040237DS

With kindest regards
Dawn

****
Dawn Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory
****
Institute of Geological and Nuclear Sciences Limited
PO Box 31312 Lower Hutt, New Zealand
Phone +64 4 5704 644 (Dr Christine Prior)
Fax +64 4 5704 657
****
email: d.chambers@gns.cri.nz
email: c.prior@gns.cri.nz
www.RafterRadiocarbon.co.nz
****

 Sample Submission Form.pdf

 MAF Import Permit1.pdf

Internal Virus Database is out-of-date.
Checked by AVG Anti-Virus.

CENTRE FOR EARTH SCIENCE STUDIES

P.B. No.7250, Akkulam
Trivandrum 695031
Kerala, INDIA
Tel: 0471-2445803
Fax: 0471-2442280

C.P. Rajendran
Scientist

September 12, 2005

Ref : (1) Invoice No. PSINV116884 dt. 26 January 2005
(2) Invoice No. PSINV116968 dt. 31 January 2005

Dear Dr. Dawn Chambers

Enclosed please find twelve soil, peat and rock samples from India for AMS dating at your lab. The samples IDs are the following. Details of samples are kept within each sample bags.

1. ~~MN/Sill1/SL~~ MN/Sill 1/S1
2. IN/top/A
3. T1/IN/D/P1/A
4. ~~T3/IN/P/P1/A~~ T3/IN/D/P1/A
5. T2/IN/D/P1/A
6. WS/HUT/OT
7. CS/HUT/OT
8. GS/HUT/OT
9. MB/CP-5/D
10. MB/CP-D/B1
11. MB/CP-7/Sh

to be replaced

12. ~~KU/S1/A~~ KU/S1/D

Yours sincerely

C.P. Rajendran

To

Dr. Dawn ~~Champers~~ Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory IGNS
PO Box 31312, Lower Hutt
New Zealand

Encl: 12 samples

Tel (Home): (+471) 2360942; Email: cp_r@vsnl.com

Date: Tue, 20 Sep 2005 11:54:10 +1200
From: Dawn Chambers <D.Chambers@gns.cri.nz>
Subject: Rafter Radiocarbon Laboratory
To: cp_r@vsnl.com
X-Mailer: Lotus Notes Release 5.0.11 July 24, 2002
X-MIMETrack: Serialize by Router on grfm1.gns.cri.nz/GNS(Release 5.0.13a|April 8, 2004) at 20/09/2005 11:54:08 AM,Serialize complete at 20/09/2005 11:54:08 AM
X-imss-version: 2.031
X-imss-result: Passed
X-imss-scores: Clean:99.90000 C:2 M:3 S:5 R:5
X-imss-settings: Baseline:1 C:3 M:3 S:3 R:3 (0.0000 0.0000)
Original-recipient: rfc822;cp_r@vsnl.com

Dear Dr Rajendran,

We have safely received the batch of twelve samples and they have been assigned the following laboratory references:

MN/Sill1/S1 R29033/1
IN/top/A R29033/2
T1/IN/D/P1/A R29033/3
T3/IN/D/P1/A R29033/4
T2/IN/D/P1/A R29033/5
WS/HUT/OT R29033/6
CS/HUT/OT R29033/7
GS/HUT/OT R29033/8
MB/CP-5/D R29033/9
MB/CP-D/B1 R29033/10
MB/CP-7/Sh R29033/11
KU/S1/D R29033/12

For three samples the bag and submission form labels differ from the list provided in the covering letter.

Lab ID	Cover letter	Bag & Submission form
R29033/1	RG/Shell/B	MN/Sill1/S1
R29033/4	T3/IN/P/P1/A	T3/IN/D/P1/A
R29033/12	KU/S1/A	KU/S1/D

Can you confirm which labels you would prefer to appear on the final reports?

Results for most of these samples can be anticipated about mid November with any remaining following shortly thereafter.

With kindest regards and thanks
Dawn

****
Dawn Chambers

Printed for "C.P.Rajendran" <cp_r@vsnl.com> 9/20/2005

Please follow what is given in bag and submission form
MN/Sill 1/S1
T3/IN/D/P1/A
KU/S1/D.
20/9/2005

Sample Coordinator
Rafter Radiocarbon Laboratory
****
Institute of Geological and Nuclear Sciences Limited
PO Box 31312 Lower Hutt, New Zealand
Phone +64 4 5704 644 (Dr Christine Prior)
Fax +64 4 5704 657
****
email: d.chambers@gns.cri.nz
email: c.prior@gns.cri.nz
www.RafterRadiocarbon.co.nz
****

--
Internal Virus Database is out-of-date.
Checked by AVG Anti-Virus.
Version: 7.0.289 / Virus Database: 267.9.7 - Release Date: 7/28/2005

CPR/151/05

September 28, 2005

Dear Dr. Dawn Chambers:

Enclosed please find 3 soil and samples for AMS dating at your lab. The samples Ids are the following. Details of samples are kept within each sample bags. These are replacement samples. The earlier three samples with id starting with MB need not be analyzed.

1. MB/AR/UL
2. MB/AR/BL
3. MB/T1/BL

Yours sincerely

C.P. Rajendran

To

Dr. Dawn Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory
Institute of Geological and Nuclear Sciences Limited
PO Box 31312 Lower Hutt, New Zealand

GEOPHYSICAL RESEARCH LETTERS, VOL. 24, NO. 21, PAGES 2601-2604, NOVEMBER 1, 1997

Geodetic observations of interseismic strain segmentation at the Sumatra subduction zone

L. Prawirodirdjo,[1] Y. Bock,[1] R. McCaffrey,[2] J. Genrich,[1] E. Calais,[1,3] C. Stevens,[2] S.S.O. Puntodewo,[4] C. Subarya,[4] J. Rais,[4] P. Zwick,[2] and Fauzi[2]

Abstract. Deformation above the Sumatra subduction zone, revealed by Global Positioning System (GPS) geodetic surveys, shows nearly complete coupling of the forearc to the subducting plate south of 0.5°S and half as much to the north. The abrupt change in plate coupling coincides with the boundary between the rupture zones of the 1833 and 1861 (Mw>8) thrust earthquakes. The rupture boundary appears as an abrupt change in strain accumulation well into the interseismic cycle, suggesting that seismic segmentation is controlled by properties of the plate interface that persist through more than one earthquake cycle. Structural evidence indicates that differences in basal shear stress may be related to elevated pore pressure in the north.

Introduction

Subduction zones vary dramatically in their ability to store elastic strain energy. Such variation has been explained by differences in convergence rates and subducting plate ages[*Kanamori*, 1983], presence of subducting sediments and seamounts[*Ruff*, 1989; *Clpos*, 1992], upper plate deformation[*McCaffrey*, 1993], motion of the subducted slab through the mantle[*Scholz and Campos*, 1995], and temperature of the plate interface[*Hyndman and Wang*, 1993]. These proposed models all involve large scale properties of subduction zones. Earthquake histories, used to discriminate among these models, are too short compared to the strain accumulation time to resolve small spatial variations on individual subduction zones. Consequently, some conceptual models of earthquake recurrence, such as seismic gaps, time and slip predictability, and the Gutenberg-Richter magnitude-frequency relationship[*Rundle*, 1989] assume uniform long-term slip with no permanent lateral barriers. Clearly, these models do not hold if lateral variations in plate interface properties cause long-term seismic slip rate to vary along a subduction zone.

Geodetic GPS surveys reveal an abrupt change in the velocity field between adjacent sections of the Sumatra subduction zone well into the interseismic cycle (Plate 1) that we interpret as showing variations in plate coupling. Rupture of two 19th century Mw>8 quakes appear to abut at the boundary between these sections. The change occurs where the Investigator Fracture Zone (IFZ) is subducting, but the coupling difference persists far from it, suggesting that the difference is due to properties of the interface rather than a mechanical barrier, as one might expect from a subducted ridge or seamount [*Kelleher and McCann*, 1976]. We suggest that high fluid pore pressures due to sediment subduction cause weaker coupling in the north.

[1]Scripps Institution of Oceanography, UCSD, La Jolla, California.

[2]Rensselaer Polytechnic Institute, Troy, New York.

[3]Now at CNRS-UNSA, Sophia-Antipolis, France.

[4]National Coordination Agency for Surveying and Mapping, Cibinong, Indonesia.

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Paper number 97GL52691.
0094-8534/97/97GL-52691$05.00

GPS Data

A total of 60 sites on Sumatra and the forearc islands were occupied in 1989, 1991, and 1993 (Plate 1). The GPS data comprise dual-frequency (L1 and L2 band) carrier phase and pseudorange measurements. Each site was surveyed for 12 to 22 hours per day over an average of 4 consecutive days. Site coordinates, satellite state vectors, tropospheric zenith delay parameters, and phase ambiguities were estimated for each day by weighted least squares[*King and Bock*, 1995]. We used precise satellite orbits computed at the Scripps Orbit and Permanent Array Center at SIO[*Fang and Bock*, 1996] from data collected by the permanent tracking stations of the International GPS Service for Geodynamics[*Beutler et al.*, 1994]. The daily solutions were then passed to a Kalman filter[*Feigl et al.*, 1993] to estimate site coordinates and velocities.

Interseismic Deformation

The velocity field obtained from the GPS surveys (Plate 1), shows abrupt rotation of the forearc vector azimuths at about 0.5°S, near the Batu islands. South of 0.5°S the forearc vectors are roughly parallel to the convergence direction of the Indian Ocean and Eurasia. In the north, the vectors are more parallel to the Sumatra Fault (SF). This pattern suggests strong coupling of the forearc to the subducted plate in the south and weaker coupling in the north.

To quantify the change in coupling, we calculate the interseismic surface deformation using *Okada's* [1985] formulation, in which locked faults are modeled as dislocations in a half-space. We describe the subduction zone by 3 elastic blocks (Eurasia, forearc, and Australia) separated by two faults: the SF and the thrust fault. The rigid-body motion of each block is specified by a pole of rotation and fault surfaces separating the blocks are specified by nodes. The slip rate v at each node is the difference in the local velocities of the blocks that are in contact across the fault. To model strain accumulation, the slip deficit (locking rate) imposed at each node is $v\chi$[*Savage*, 1983], where χ is defined as the fraction of seismic slip on the fault. Hence, the aseismic slip rate across a node is $v(1\text{-}\chi)$. We model variation in coupling by specifying χ for each node and integrating the slip deficit over the fault surfaces. The SF is modeled as a vertical strike-slip fault, locked to a depth of 15 km, with a dextral, deep slip rate of 30 mm/yr (a geologic estimate for slip rate on the SF at 2°N is 28 mm/yr[*Sieh et al.*, 1991]). The thrust fault comprises three connected surfaces, with dip angles increasing

8

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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

X

Sample	**R 29033/1**
Description	Charcoal
Sample ID	MN/Sill1/S1
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23359**
	Date measured	31-Oct-05
	$\delta^{13}C$	-26.6 ‰
*	**Radiocarbon Age**	-295 ± 30 BP
	$\delta^{14}C$	27.2 ± 3.8 ‰
	$\Delta^{14}C$	30.5 ± 3.8 ‰
**	**Per cent modern**	103.05 ± 0.38

Job No. 34447

Issued 2/11/2005 D.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

Environment Group, Institute of Geological and Nuclear Sciences Ltd., PO Box 31-312, Lower Hutt, New Zealand
Fax +64 4 570 4657 Phone +64 4 570 4671

(7) 9

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Nuclear Sciences
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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 29033/2**
Description	Calcareous rock
Sample ID	IN/TOP/A
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 23360**
Date measured	31-Oct-05
$\delta^{13}C$	-1.9 ‰
* **Radiocarbon Age**	30880 ± 300 BP
$\delta^{14}C$	-977.7 ± 0.8 ‰
$\Delta^{14}C$	-978.7 ± 0.8 ‰
** **Per cent modern**	2.13 ± 0.08

Job No. 34448

Issued 2/11/2005 D.M. Chamberlain

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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Accelerator Mass Spectrometry Result

Sample	**R 29033/3**
Description	Calcareous rock
Sample ID	T1/IN/D/P1/A
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23361**
	Date measured	31-Oct-05
	$\delta^{13}C$	-1.4 ‰
*	**Radiocarbon Age**	22890 ± 120 BP
	$\delta^{14}C$	-939.7 ± 0.9 ‰
	$\Delta^{14}C$	-942.5 ± 0.9 ‰
**	**Per cent modern**	5.75 ± 0.09

Job No. 34449

Issued 2/11/2005 D.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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Accelerator Mass Spectrometry Result

Sample	**R 29033/4**
Description	Calcareous rock
Sample ID	T3/IN/D/P1/A
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23362**
	Date measured	31-Oct-05
	$\delta^{13}C$	-1.9 ‰
*	**Radiocarbon Age**	19894 ± 100 BP
	$\delta^{14}C$	-912.5 ± 1.1 ‰
	$\Delta^{14}C$	-916.5 ± 1 ‰
**	**Per cent modern**	8.35 ± 0.1

Job No. 34450

Issued 2/11/2005 D.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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Accelerator Mass Spectrometry Result

Sample	**R 29033/5**
Description	Calcareous rock
Sample ID	T2/IN/D/P1/A
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23363**
	Date measured	31-Oct-05
	$\delta^{13}C$	-0.3 ‰
*	**Radiocarbon Age**	29130 ± 250 BP
	$\delta^{14}C$	-972.2 ± 0.9 ‰
	$\Delta^{14}C$	-973.6 ± 0.8 ‰
**	**Per cent modern**	2.64 ± 0.08

Job No. 34451

Issued 2/11/2005 *J.M. Chambers*

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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Accelerator Mass Spectrometry Result

Sample	**R 29045/3**
Description	Charcoal in soil
Sample ID	MB/T1/BL
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 23376**
Date measured	31-Oct-05
$\delta^{13}C$	-25.7 ‰
* **Radiocarbon Age**	1581 ± 35 BP
$\delta^{14}C$	-185.3 ± 3.7 ‰
$\Delta^{14}C$	-184.1 ± 3.7 ‰
** **Per cent modern**	81.59 ± 0.37

Job No. 34593

Issued 2/11/2005 O.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

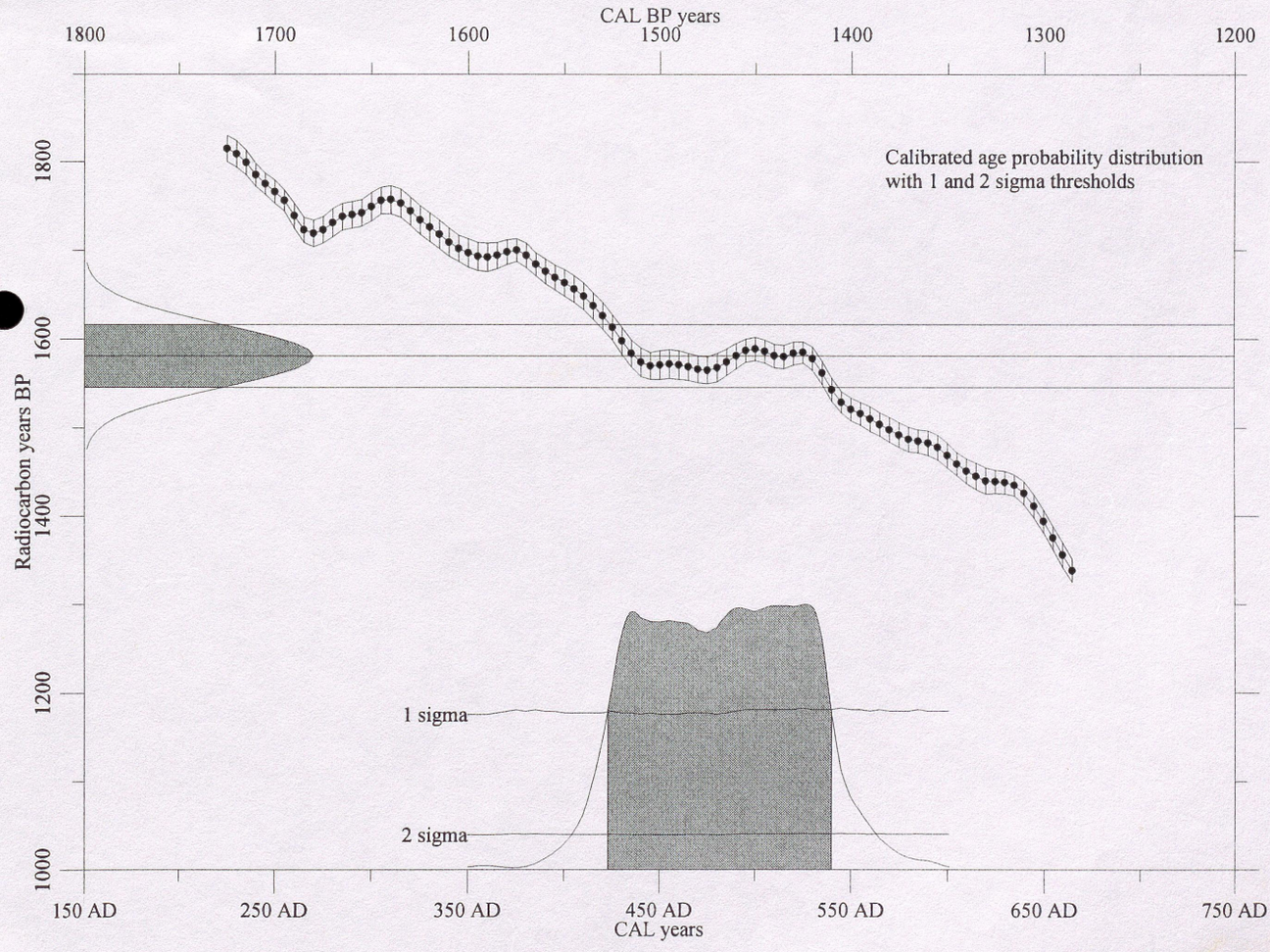
NZA 23376 CONVENTIONAL RADIOCARBON AGE 1581 ± 35 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 405 AD to 564 AD	1545 BP to 1386 BP (96.9% of area)
1 sigma interval is 423 AD to 540 AD	1527 BP to 1410 BP (86.9% of area)



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Accelerator Mass Spectrometry Result

Sample	**R 29045/2**
Description	Charcoal in soil
Sample ID	MB/AR/BL
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 23375**
Date measured	31-Oct-05
$\delta^{13}C$	-25.2 ‰
* **Radiocarbon Age**	1674 ± 30 BP
$\delta^{14}C$	-193.9 ± 3 ‰
$\Delta^{14}C$	-193.5 ± 3 ‰
** **Per cent modern**	80.65 ± 0.3

Job No. 34592

Issued 2/11/2005 S.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

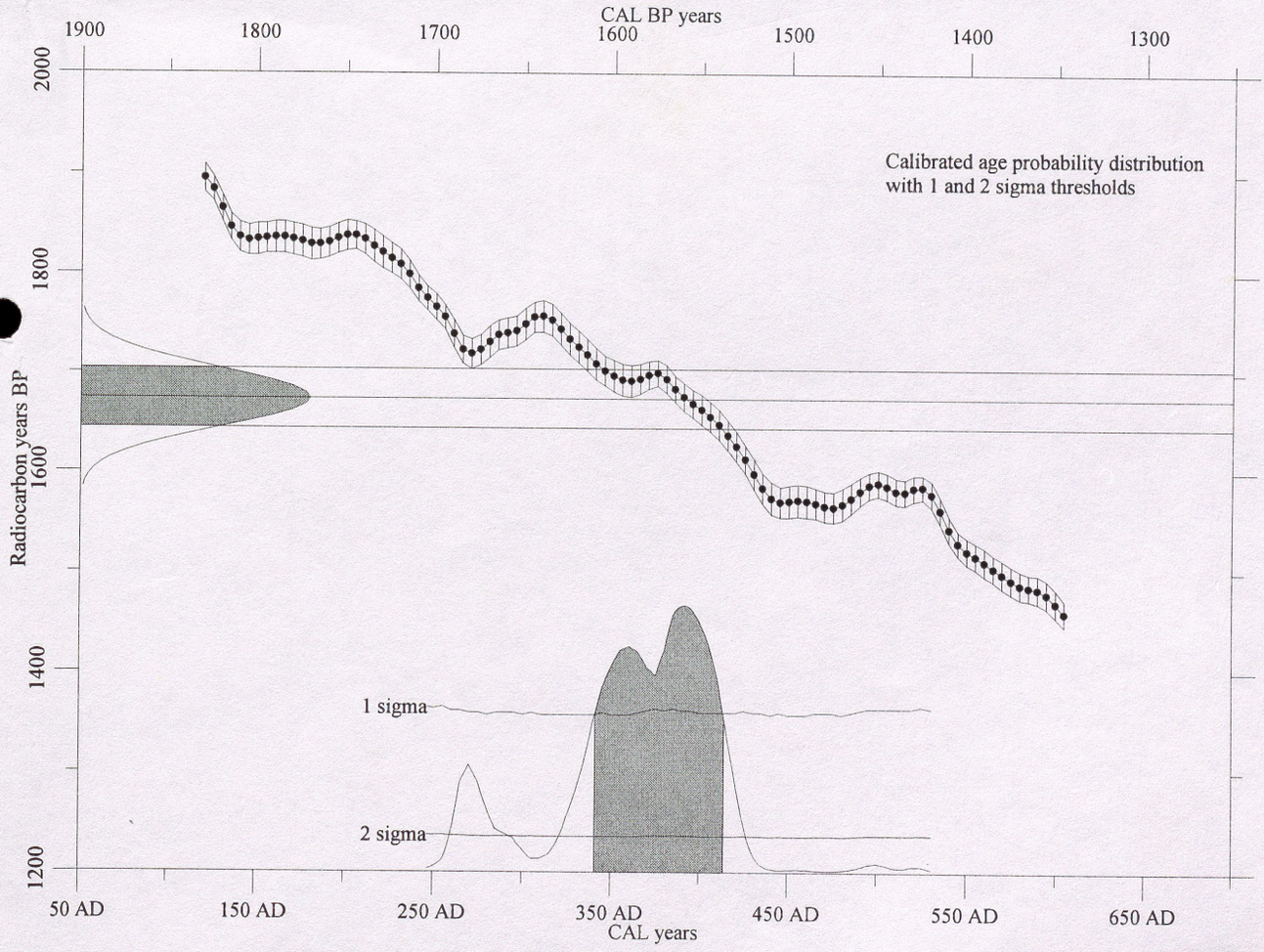
NZA 23375 CONVENTIONAL RADIOCARBON AGE 1674 ± 30 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 260 AD to 293 AD	1690 BP to 1657 BP (9.9% of area)
plus 321 AD to 427 AD	1629 BP to 1523 BP (84.3% of area) ✓
1 sigma interval is 341 AD to 414 AD	1609 BP to 1536 BP (71.2% of area)



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Accelerator Mass Spectrometry Result

Sample	**R 29045/1**
Description	Charcoal in soil
Sample ID	MB/AR/UL
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23374**
	Date measured	31-Oct-05
	$\delta^{13}C$	-26 ‰
*	**Radiocarbon Age**	955 ± 30 BP
	$\delta^{14}C$	-119.7 ± 3.1 ‰
	$\Delta^{14}C$	-117.9 ± 3.1 ‰
**	**Per cent modern**	88.21 ± 0.31

Job No. 34591

Issued 2/11/2005 J.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

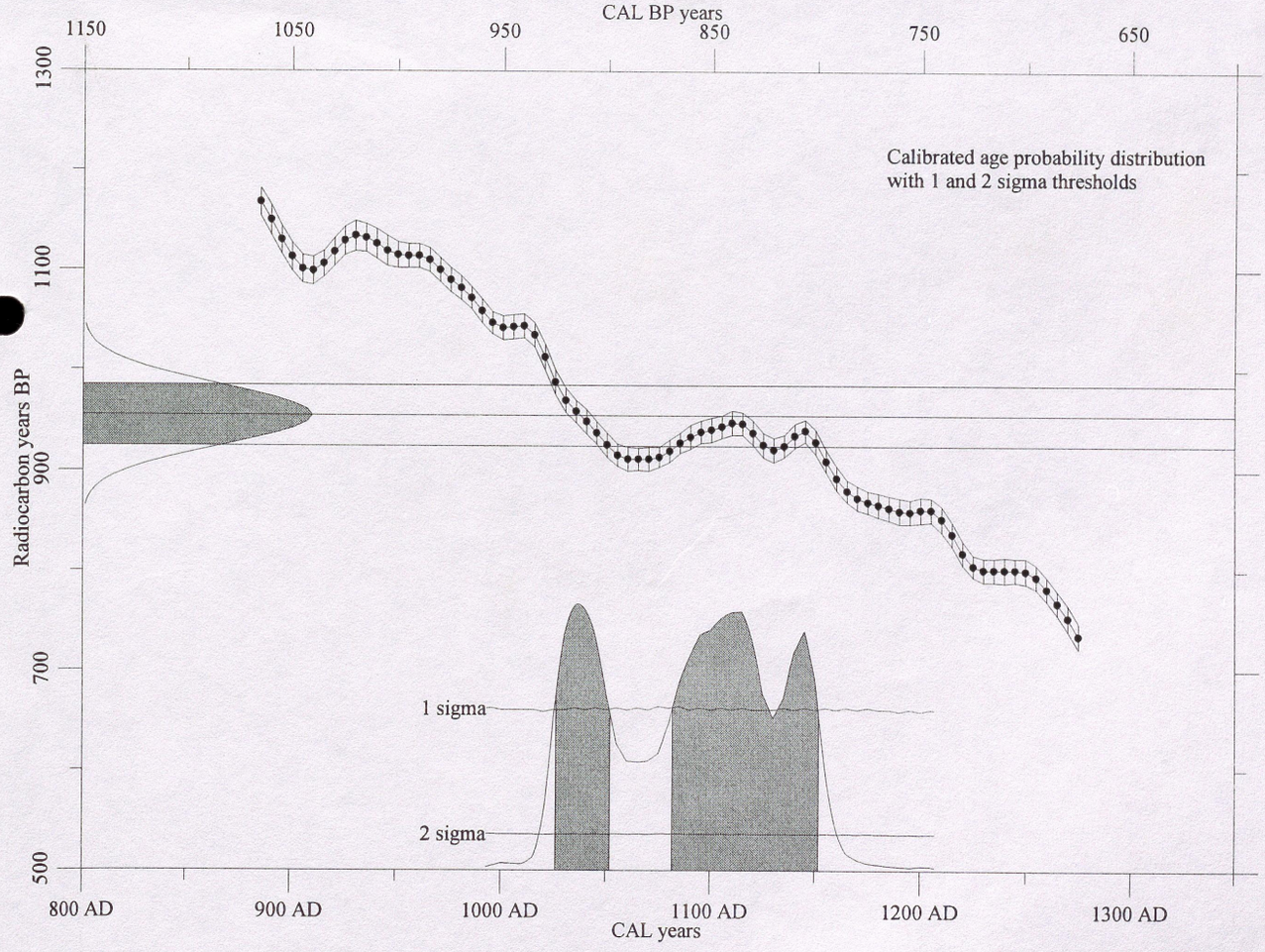
NZA 23374 CONVENTIONAL RADIOCARBON AGE 955 ± 30 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 1019 AD to 1161 AD	931 BP to 789 BP (97.7% of area)
1 sigma interval is 1026 AD to 1052 AD	924 BP to 898 BP (22.5% of area)
plus 1082 AD to 1152 AD	868 BP to 798 BP (53.9% of area)



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Sample Treatment Report

Date Printed: *02-Nov-05*

R: 29045/1 **Job:** 34591 **NZA Number:** 23374

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/AR/UL

Description: Charcoal in soil

Details: Sample consisted of small fragments of black charcoal amongst soil. Microscopic exam revealed tiny fragments of charcoal, with vascular structure. Charcoal amongst gold, brown, quartz. Some charcoal more like coke (bubbly). Fragments very fragile. Picked out better fragments of charcoal with tweezers. Crunched with end of tweezer, treated with acid / alkali /acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated charcoal **Stored:** remainder

R: 29045/2 **Job:** 34592 **NZA Number:** 23375

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/AR/BL

Description: Charcoal in soil

Details: Sample consisted of much charcoal, small - medium fragments amongst brown soil - sample seems damp. Microscopic exam revealed black choarcoal, half with vascular structure, half without. Few coloured fibres, very very fragile. Soil seems to be pale orange-brown quartz. Picked out with tweezers, charcoal with vascular structure. Dried remainder of sample as well as the picked out charcoal in vacuum oven. Ground charcoal in mortar and pestle. Treated with acid / alkali /acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated charcoal **Stored:** remainder

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *02-Nov-05*

R: 29045/3 **Job:** 34593 **NZA Number:** 23376

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/T1/BL

Description: Charcoal in soil

Details: Sample consisted of damp yellow brown mineral soil with charcoal. Microscopic exam revealed black charcoal or oxidised wood. Vascular structure not visible. Most are shaped like small twigs. All charcoal have golden brown minerals attached. Many threads-removed. Picked out charcoal with tweezers and dried in vacuum oven. Once dry can see vascular structure. Crunched in beaker with tweezers and treated with acid / alkali /acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated charcoal **Stored:** remainder

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Accelerator Mass Spectrometry Result

Sample	**R 29033/12**
Description	Charcoal
Sample ID	KU/S1/D
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 23367**
Date measured	31-Oct-05
$\delta^{13}C$	-27.1 ‰
* **Radiocarbon Age**	132 ± 30 BP
$\delta^{14}C$	-27 ± 3.6 ‰
$\Delta^{14}C$	-22.8 ± 3.6 ‰
** **Per cent modern**	97.72 ± 0.36

Job No. 34458

Issued 2/11/2005 D.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

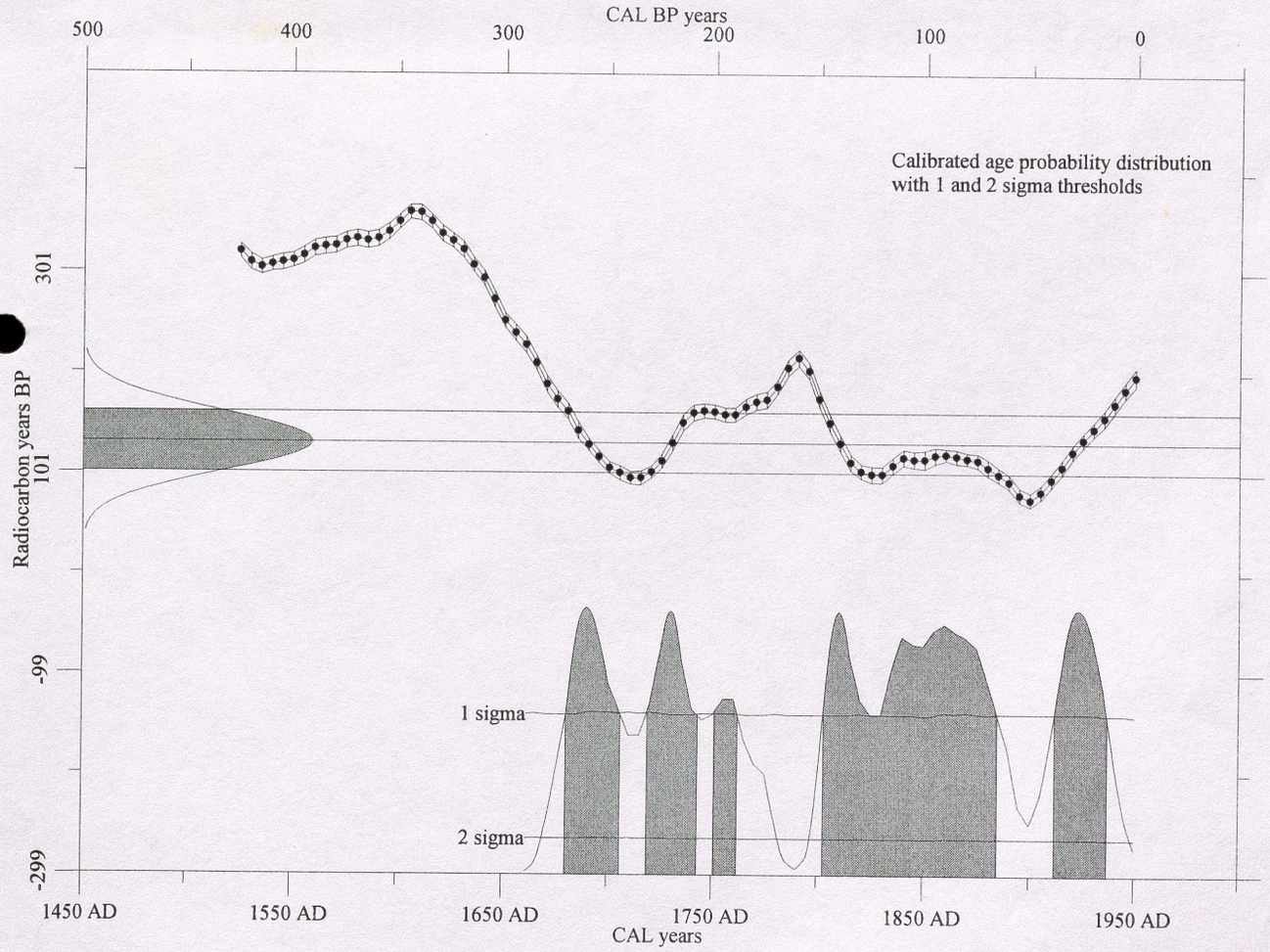
NZA 23367 CONVENTIONAL RADIOCARBON AGE 132 ± 30 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell,
CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich,
TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey,
RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor,
J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 1670 AD to 1949 AD	280 BP to 1 BP (99.1% of area)
1 sigma interval is 1680 AD to 1706 AD	270 BP to 244 BP (12.2% of area)
plus 1719 AD to 1743 AD	231 BP to 207 BP (10.8% of area)
plus 1751 AD to 1762 AD	199 BP to 188 BP (4.0% of area)
plus 1803 AD to 1885 AD	147 BP to 65 BP (37.8% of area)
plus 1912 AD to 1937 AD	38 BP to 13 BP (12.1% of area)



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Accelerator Mass Spectrometry Result

Sample	**R 29033/8**
Description	Shells
Sample ID	GS/HUT/OT
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23366**
	Date measured	31-Oct-05
	$\delta^{13}C$	2.2 ‰
*	**Radiocarbon Age**	753 ± 35 BP
	$\delta^{14}C$	-44.3 ± 4.1 ‰
	$\Delta^{14}C$	-95.5 ± 3.8 ‰
**	**Per cent modern**	90.45 ± 0.38

Job No. 34454

Issued 2/11/2005 J.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

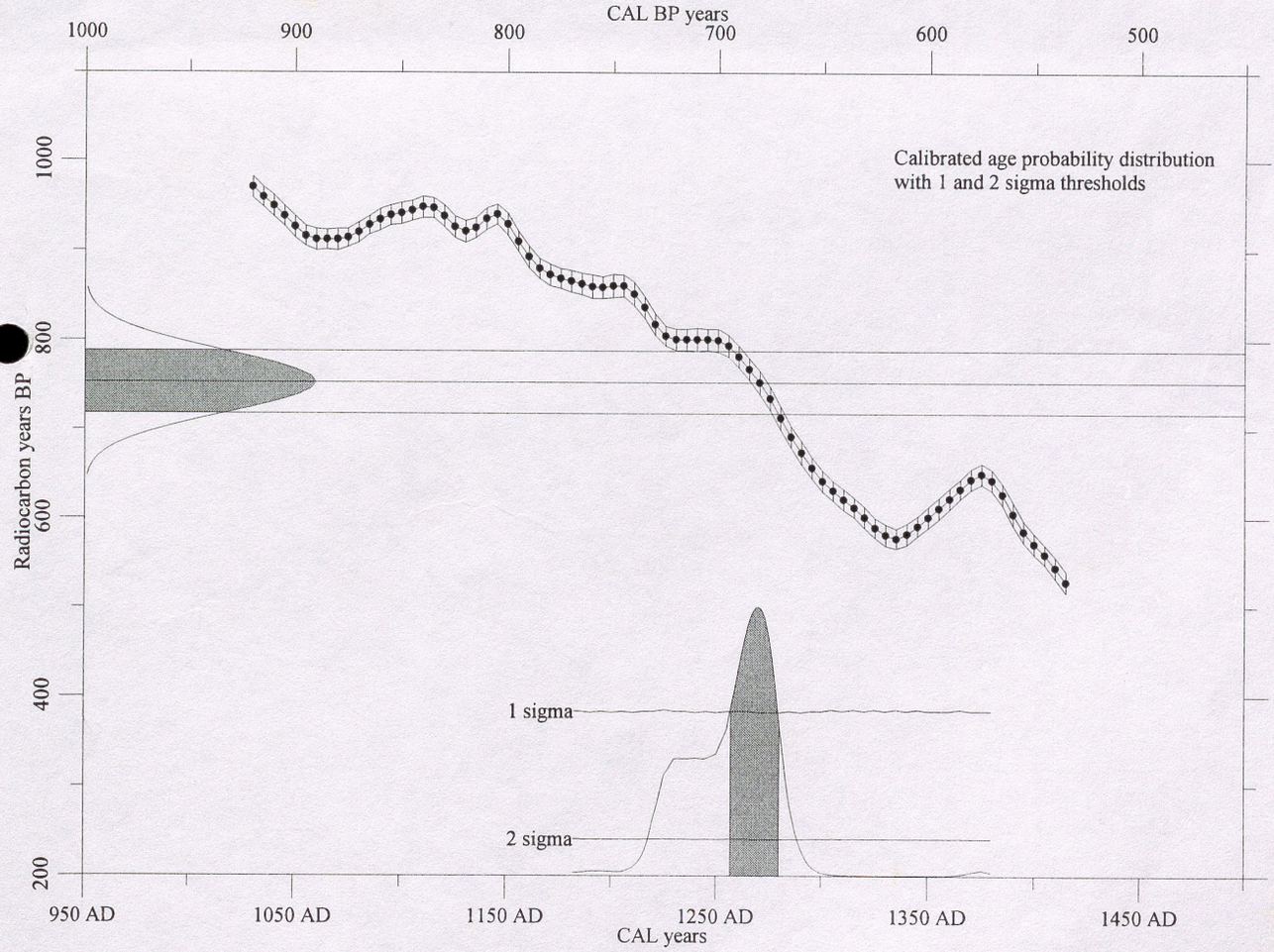
NZA 23366 CONVENTIONAL RADIOCARBON AGE 753 ± 35 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 1218 AD to 1289 AD	732 BP to 661 BP (95.0% of area)
1 sigma interval is 1257 AD to 1280 AD	693 BP to 670 BP (48.3% of area)



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Accelerator Mass Spectrometry Result

Sample	**R 29033/7**
Description	Calcareous rock
Sample ID	CS/HUT/OT
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

Laboratory Code	**NZA 23365**
Date measured	31-Oct-05
$\delta^{13}C$	-1.4 ‰
* **Radiocarbon Age**	5623 ± 35 BP
$\delta^{14}C$	-482.6 ± 2.3 ‰
$\Delta^{14}C$	-506.7 ± 2.2 ‰
** **Per cent modern**	49.33 ± 0.22

Job No. 34453

Issued 2/11/2005 J.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

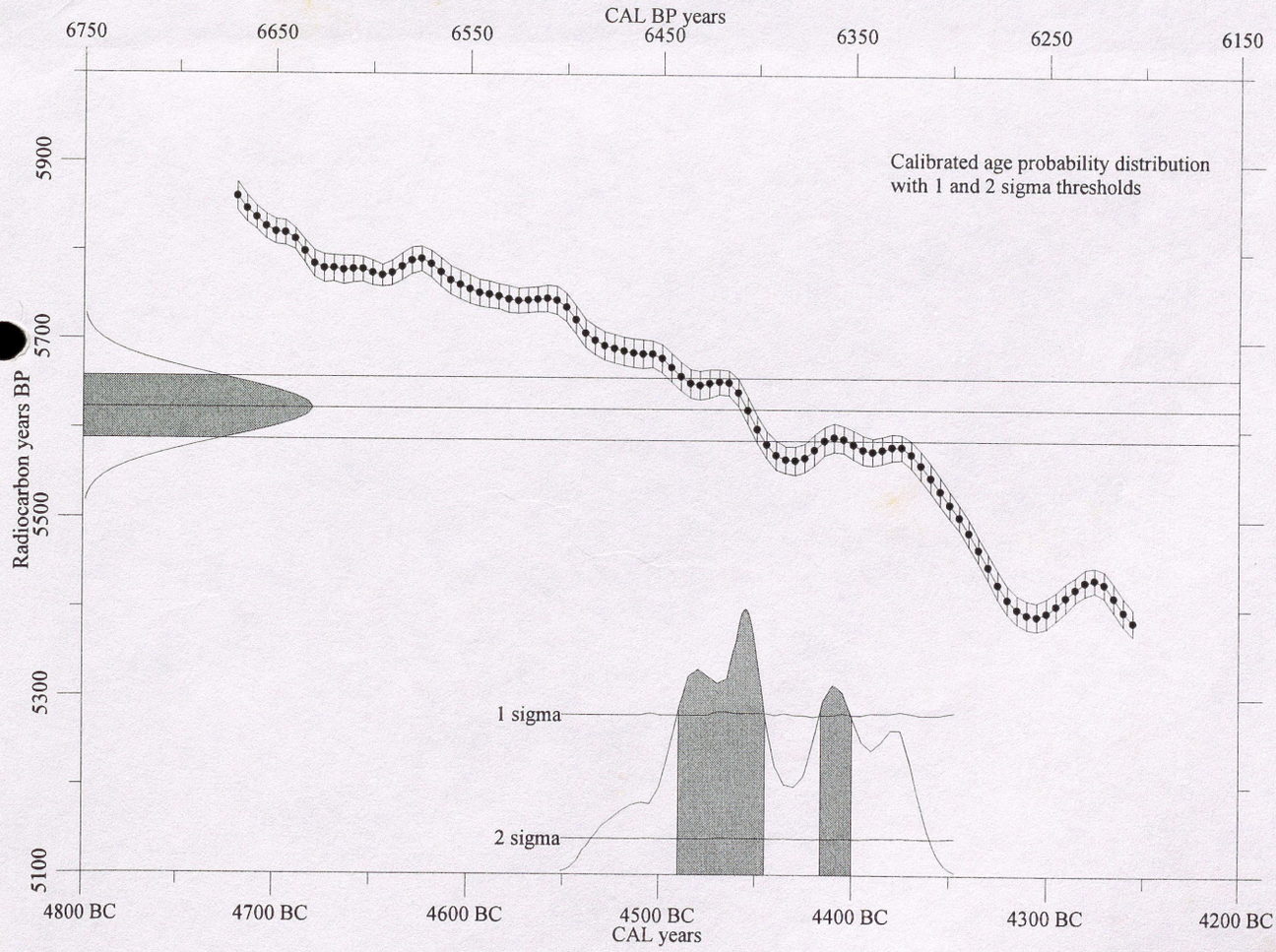
NZA 23365 CONVENTIONAL RADIOCARBON AGE 5623 ± 35 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 4534 BC to 4359 BC	6483 BP to 6308 BP (97.8% of area)
1 sigma interval is 4490 BC to 4445 BC	6439 BP to 6394 BP (38.9% of area)
plus 4416 BC to 4400 BC	6365 BP to 6349 BP (11.8% of area)



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15 November 2005

Dr C. P. Rajendran
Centre for Earth Science Studies
PO Box 7250 Akkulam
Trivandrum 695 031
Kerala
India

Dear Dr Rajendran,

Enclosed are the final reports for the samples R29033/1-8, 12 and R29045/1-3. Also enclosed is a copy of our new import permit.

With kindest regards

D.M. Chambers

Dawn Chambers (Ms)
Sample Coordinator
Rafter Radiocarbon Laboratory

email: d.chambers@gns.cri.nz
http://www.rafterradiocarbon.co.nz

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *15-Nov-05*

R: 29033/1 **Job:** 34447 **NZA Number:** 23359

Submitter: C. P. (Dr) Rajendran

Sample ID: MN/Sill1/S1

Description: Charcoal

Details: Sample consisted of wet charcoal fragments within soil, actually one very large lump of charcoal. Microscopic exam (after drying) revealed black charcoal, fragments and a large lump. Vascular structure, its like part of a large lump has gone to charcoal and the remaining is stiil degraded wood. Charcoal very hard, vascular structure, has holes in it. Picked out fragments of charcoal and large lump. Washed in ultrasonic bath in deionised water. Dried in vacuum oven. Checked under microscope, difficult to tell if charcoal or oxidised wood. Crunched in beaker. Treated with acid / alkali /acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated charcoal/wood **Stored:** remainder

R: 29033/2 **Job:** 34448 **NZA Number:** 23360

Submitter: C. P. (Dr) Rajendran

Sample ID: IN/TOP/A

Description: Calcareous rock

Details: damp ochre yellow brown coloured sediment with lumps of carbonate rich rock present. Plant material and roots also present in sediment. Picked out a couple of lumps and scraped sediment off surface with probe. Brown/white patchy coloured rock material underneath griity sediment. Ultrasonicated lumps then acid etched with 0.5M HCL for a few minutes, filtered rinsed dried, ground with pestle and mortar. Phosphoric acid evolution.

Comments:

Fraction dated: carbonate from rock **Stored:** untreated sample remnant plus some acid etched material

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *15-Nov-05*

R: 29033/3 **Job:** 34449 **NZA Number:** 23361

Submitter: C. P. (Dr) Rajendran

Sample ID: T1/IN/D/P1/A

Description: Calcareous rock

Details: damp ochre yellow brown coloured sediment with lumps of carbonate rich rock present. Plant material in layers on outside of some of the lumps. Picked out a couple of lumps and scraped sediment off surface with probe. Brown/white patchy coloured rock material underneath griity sediment. Ultrasonicated lumps then acid etched with 0.5M HCL for a few minutes, filtered rinsed dried ground with pestle and mortar. Phosphoric acid evolution.

Comments:

Fraction dated: carbonate from rock **Stored:** untreated sample remnant plus some acid etched material

---

R: 29033/4 **Job:** 34450 **NZA Number:** 23362

Submitter: C. P. (Dr) Rajendran

Sample ID: T3/IN/D/P1/A

Description: Calcareous rock

Details: damp ochre yellow brown coloured sediment with lumps of carbonate rich rock present. Picked out a couple of lumps and scraped sediment off surface with probe. Brown/white patchy coloured rock material underneath griity sediment. Ultrasonicated lumps then acid etched with 0.5M HCL for a few minutes, filtered rinsed dried ground with pestle and mortar. Phosphoric acid evolution.

Comments:

Fraction dated: carbonate from rock **Stored:** untreated sample remnant plus some acid etched material

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *15-Nov-05*

R: 29033/5 **Job:** 34451 **NZA Number:** 23363

Submitter: C. P. (Dr) Rajendran

Sample ID: T2/IN/D/P1/A

Description: Calcareous rock

Details: damp ochre yellow brown coloured sediment with lumps of carbonate rich rock present. Some of the lumps have thin layers of black plant material. Picked out a couple of lumps and scraped sediment off surface with probe. Brown/white patchy coloured rock material underneath griity sediment. Ultrasonicated lumps then acid etched with 0.5M HCL for a few minutes, filtered rinsed dried ground with pestle and mortar. Phosphoric acid evolution.

Comments:

Fraction dated: carbonate from rock **Stored:** untreated sample remnant plus some acid etched material

---

R: 29033/6 **Job:** 34452 **NZA Number:** 23364

Submitter: C. P. (Dr) Rajendran

Sample ID: WS/HUT/OT

Description: Wood (peat)

Details: Sample consisted of four large pieces of wood. Submitted wet. Wood has much soil or sediment adhering to it. Washed in ultrasonic bath in deionised water and rinsed well, scraped with spatular to remove soil, rinsed again. Dried in vacuum oven. Microscopic exam revealed large pieces of pale brown wood. There is much white chalky material. Some bluish white minerals, blue threads. Selected a piece, brushed soil off all surfaces, then used scalpel to cut surfaces off. Cut up wood into slithers with scalpel. Treated with cellulose extraction process. Dried in vacuum oven.

Comments:

Fraction dated: Treated wood - cellulose **Stored:** remainder

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *15-Nov-05*

R: 29033/7 **Job:** 34453 **NZA Number:** 23365

Submitter: C. P. (Dr) Rajendran

Sample ID: CS/HUT/OT

Description: Calcareous rock

Details: damp ochre yellow brown coloured sediment with lumps of carbonate rich rock present. Picked out a couple of lumps and scraped sediment off surface with probe. Brown/white patchy coloured rock material underneath griity sediment. Ultrasonicated lumps then acid etched with 0.5M HCL for a few minutes, filtered rinsed dried ground with pestle and mortar. Phosphoric acid evolution.

Comments:

Fraction dated: carbonate from rock **Stored:** untreated sample remnant plus some acid etched material

---

R: 29033/8 **Job:** 34454 **NZA Number:** 23366

Submitter: C. P. (Dr) Rajendran

Sample ID: GS/HUT/OT

Description: Shells

Details: Large chunks of broken shell in loose yellowbrown coloured sediment. Ribbed ridges can be seen on shell fragments also looks like small pieces of plant material in sediment. Selected a few fragments for cleaning. Ultrasonicated then acid etched with 0.5M HCL for 1 minute, filtered rinsed dried ground with pestle and mortar. Phosphoric acid evolution.

Comments:

Fraction dated: shell **Stored:** untreated sample remnant plus some acid etched material

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *15-Nov-05*

R: 29033/9 **Job:** 34455 **NZA Number:**

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/CP-5/D

Description: Charcoal

Details: Sample consisted of brownish sand along with many fragments of blocky charcoal. Microscopic exam revealed many fragments of black charcoal. Some fragments have a smidgeon of brownish sand. Vascular structure, bnlue fibre. Picked out fragments of charcoal with tweezers, removed blue thread. Crushed in beaker with end of tweezers. - no further treatment, sample withdrawn by submitter at this point.

Comments:

Fraction dated: none **Stored:** all

R: 29033/10 **Job:** 34456 **NZA Number:**

Submitter: C. P. (Dr) Rajendran

Sample ID: MB/CP-D/B

Description: Charcoal

Details: Sample consisted of reddish quartzy sand with small fragments of charcoal and some plant materil. Microscopic exam revealed charcoal is tiny wizened stalks of dark brown/black plant material. Not glossy etc, might be degraded or oxidised wood. Ground in mortar and pestle. - not treated further as withdrawn by submitter at this point.

Comments:

Fraction dated: none **Stored:** all

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Rafter Radiocarbon Laboratory

Sample Treatment Report

Date Printed: *15-Nov-05*

R: 29033/12 **Job:** 34458 **NZA Number:** 23367

Submitter: C. P. (Dr) Rajendran

Sample ID: KU/S1/D

Description: Charcoal

Details: Sample consisted of a very large piece of charcoal. Rusty brown in colour, on breaking in half, interior is black to very dark brown - maybe oxidised wood. Microscopic exam revealed reddish brown surfaces, with minerals and mica. Looks more like oxidised wood. If burnt, not fully burnt. However it has vascular structure and dark grey interior. Very soft. Exterior is brown wood, not that thick, going into grey. Removed surfaces of soil and minerals. Left wood on. Ground in mortar and pestle and treated with acid / alkali /acid process. Dried in vacuum oven.

Comments:

Fraction dated: Treated wood/charcoal **Stored:** remainder

Environment Group, Institute of Geological and Nuclear Sciences Ltd., PO Box 31-312, Lower Hutt, New Zealand

Fax +64 4 570 4657 Phone +64 4 570 4671

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Rafter Radiocarbon Laboratory

Accelerator Mass Spectrometry Result

Sample	**R 29033/6**
Description	Wood (peat)
Sample ID	WS/HUT/OT
Submitter	C. P. (Dr) Rajendran
	Centre for Earth Science Studies

	Laboratory Code	**NZA 23432**
	Date measured	14-Nov-05
	$\delta^{13}C$	-27.2 ‰
*	**Radiocarbon Age**	-3566 ± 30 BP
	$\delta^{14}C$	541.4 ± 6.2 ‰
	$\Delta^{14}C$	548.4 ± 6.3 ‰
**	**Per cent modern**	154.84 ± 0.63

Job No. 34746

Issued 15/11/2005 D.M. Chambers

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard, (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver and Polach, Radiocarbon 19:355-363 (1977)

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component that is based on the analysis of an ongoing series of measurements on oxalic acid secondary standard. For the present result the system error component is conservatively estimated as 0.18% (= ± 14 radiocarbon years).

Environment Group, Institute of Geological and Nuclear Sciences Ltd., PO Box 31-312, Lower Hutt, New Zealand
Fax +64 4 570 4657 Phone +64 4 570 4671

o/c

CENTRE FOR EARTH SCIENCE STUDIES

P.B. No.7250, Akkulam
Trivandrum 695031
Kerala, INDIA
Tel: 0471-2445803
Fax: 0471-2442280

C.P. Rajendran
Scientist

CPR/66/06 May 2, 2006

Dear Dr. Dawn Chambers:

Enclosed please find a sample for AMS dating at your lab. The sample ID is GF/MP/D1 (Depth 5m). Details of the sample is kept within the sample bag. A demand draft for processing the sample will be sent to you at the earliest.

Yours sincerely

C.P. Rajendran

To

Dr. Dawn Chambers
Sample Coordiantor
Rafter Radiocarbon Laboratory, IGNS
P.O. Box 31312, Lower Hutt
New Zealand
Phone: +644 704644

GEOLOGICAL & NUCLEAR SCIENCES

RAFTER RADIOCARBON LABORATORY

Accelerator Mass Spectrometry Sample Submission Form

Submitter: Dr. C. P. RAJENDRAN

Address: SCIENTIST, CENTRE FOR EARTH SCIENCE STUDIES, AKKULAM, TRIVANDRUM 695031 INDIA

Facsimile: 91-471-244 2280

Phone: 91-471-2445803

Email address: cp_r@vsnl.com

SAMPLE DETAILS

Submitter's Sample ID Code: GF/MAP/D1

Nature of sample: Sediment

(Eg. bone, charcoal, cotton, forams, peat, plant material, sediment, shell, silk, soil, wood, wool or other)

Estimated sample age: ~1000 yr Estimated carbon content (mg):

Location and date collected: (Map Reference or latitude & longitude) 11.7°N 92.8°E

Describe any treatment the sample has been subjected to. This would include cleaning methods and storage details where detergents, oils, dyes or greases may have been used.

None

Any special instructions:

Return residual material to the submitter?: NO

Unless otherwise stipulated by the submitter, the results of this radiocarbon measurement will be made available to other researchers twelve months after the results have been reported to the submitter of the sample. This work is carried out subject to the Institute's Standard Terms and Conditions of Contract.

30 Gracefield Road, PO Box 31-312, Lower Hutt, New Zealand
Telephone: +64-4-570 4671 Facsimile: +64-4-570 4657
A Crown Research Institute

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Sample Treatment Report

Printed: *21-Jul-06*

R: 29255 **Job:** 36505 **NZA Number:** 25710

Submitter: C. P. (Dr) Rajendran

Submitter ID: GF/MP/D1 (Depth 5m)

Description: sediment

Details: Sample consisted of dark grey brown sediment with little white shells present. There are dark patches which may be the remains of plant material. Microscopic exam revealed sandy looking sediment. Dark patches looks to be plant remains - very degraded. A lot of intact snail like shells as well as fragments. Black plant remains, some look to be leaf amterial and others look like charcoal with a vascular structure seen. Small amount of soil prsent. Shells are a mixture of different types. Some soil present. Picked out shells and plant remains into separate petri dishes. Client wishes plant remains dated - rest stored. Treated plant with acid / alkali / acid process. Dried in vacuum oven.

Comments:

Fraction dated: treated plant material **Stored:** remainder

National Isotope Centre, Institute of Geological and Nuclear Sciences Ltd (GNS Science)
PO Box 31-312 Lower Hutt, New Zealand Fax +64 4 570 4657 Phone +64 4 570 4644
www.RafterRadiocarbon.co.nz

RAFTER RADIOCARBON LABORATORY

R29255

INSTITUTE OF GEOLOGICAL AND NUCLEAR SCIENCES LTD.
PO Box 31312, Lower Hutt, New Zealand
Phone (+64 4) 570 4671, Fax (+64 4) 570 4657

RADIOCARBON CALIBRATION REPORT

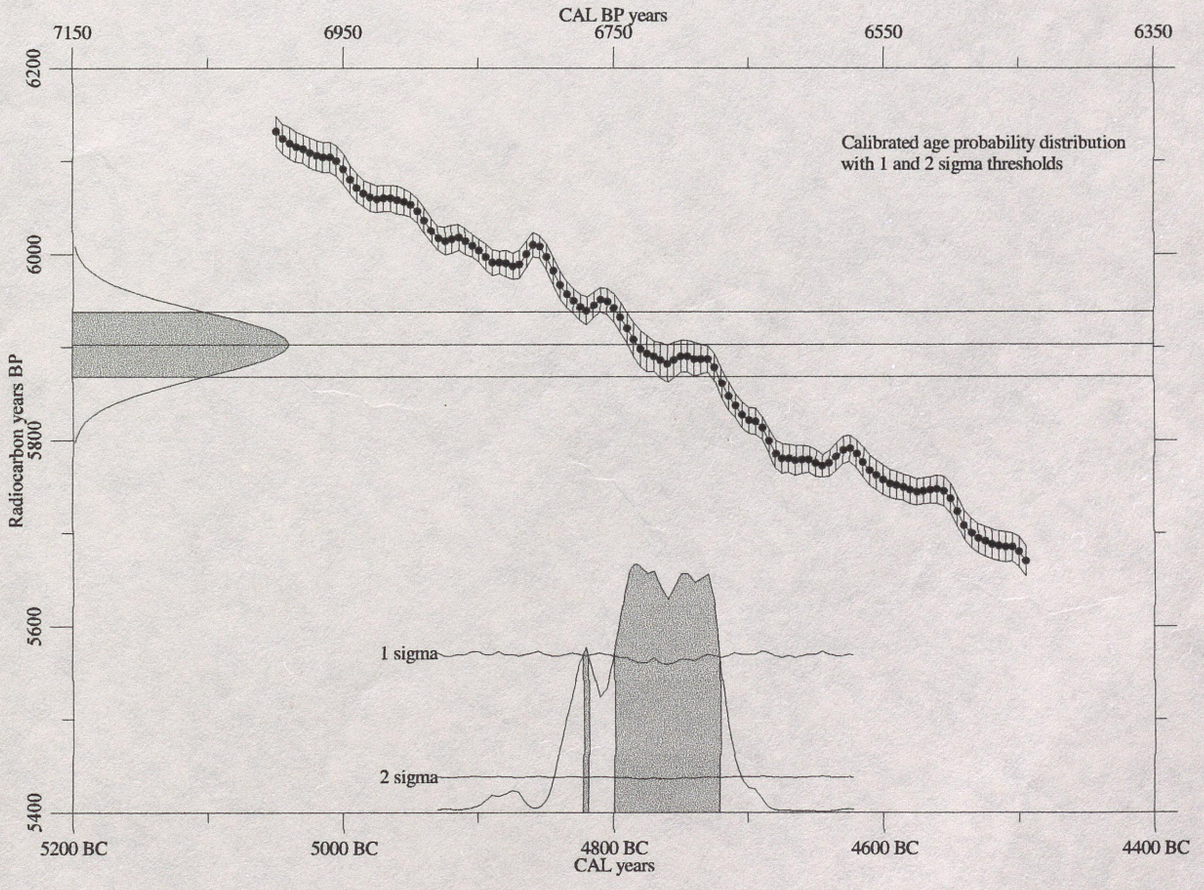
NZA 25710 CONVENTIONAL RADIOCARBON AGE 5903 ± 35 years BP

Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 1, Offset: 0)

2 sigma interval is 4844 BC to 4705 BC	6793 BP to 6654 BP (94.4% of area)
1 sigma interval is 4822 BC to 4818 BC	6771 BP to 6767 BP (2.5% of area)
plus 4799 BC to 4721 BC	6748 BP to 6670 BP (68.5% of area)



-------Original Message-------

From: Dawn Chambers
Date: 3/19/2007 9:00:29 AM
To: cp_r@vsnl.com
Subject: Re: Rafter Radiocarbon Laboratory

Dear Dr Rajendran,

You have a credit of four samples as per the following invoice references:

PSINV128180 1 sample
PSINV134832 1 sample
PSINV138293 2 samples

With kindest regards
Dawn

April 13, 2007

Dear Dawn,

Sending herewith is the soil sample (HUT/B/1) for chemical and physical analysis-radiocarbon dating along with the import permit. Please let me know when receive this.

Regards

Sincerely,

C.P. Rajendran

To:

Ms Dawn Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory
National Isotope Centre
GNS Science
Lower Hutt
New Zealand

+644 5704 644 (Dr. Christine Prior)

CENTRE FOR EARTH SCIENCE STUDIES

P.B. No.7250, Akkulam
Trivandrum 695031
Kerala, INDIA
Tel: 0471-2445803
Fax: 0471-2442280

C.P Rajendran

Tel.(Home): (+471) 2360942; Email:rajendran_cp@yahoo.com

Samples from Manjara
Nov. 20-26, 2007
C.

December 11, 2007

Dear Ms. Dawn Chambers:

I am sending two samples for AMS age dating, along with required papers:

1. Sample id: C2/L/Kh
2. Sample id: C1/U/Kh

Please conduct the analyses of the sample 1 and take up the second sample only we obtain the results of the first sample (C2).

Sincerely,

C.P. Rajendran

To:

Ms. Dawn Chambers
Rafter Radiocarbon Laboratory
Institute of Geological and Nuclear Sciences Ltd.
Lower Hutt
New Zealand

Phone: +644570 4644

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NZA	**30293**
R	29922/6
Job No	65135
Measured	14-Oct-08
TW No	2292
Issued	20-Oct-08
	Page 3 of 3

Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

A.D. 1750.?

Sample ID B4/L2/D
Description Peaty soil
Fraction Dated treated charcoal
Submitter Kusala Rajendran Centre for Earth Sciences, Indian Institute of Science

* **Radiocarbon Age**		**146 ± 30 BP**		$\delta^{13}C$ =	-26 ‰
** **Per cent modern** =	97.51 ± 0.37	$\delta^{14}C$ =	-26.9 ± 3.7 ‰	$\Delta^{14}C$ =	-24.9 ± 3.7 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details
Sample consisted of wet peaty sediment, with black charcoal fragments. Microscopic exam revealed several large black charcoal fragments coated with light brown soil. All have strong vascular structure visible. A lot of minerals present. Picked out charcoal fragments and dried in vacuum oven. Scraped with scalpel to remove soil. Ground in mortar and pestle and treated with acid /alkali /acid process. Dried in vacuum oven.

Stored remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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INDIAN INSTITUTE OF SCIENCE
BANGALORE 560 012, INDIA

C.P. Rajendran
Centre for Earth Sciences
e mail: cprajendran@ceas.iisc.ernet.in
alt.e-mail: cp.rajendran@yahoo.com
Tel: +91-80 2293 3402/09480707044

December 17, 2008

Dear Ms. Chambers,

I am enclosing two soil samples (F-1A and BL-1A) for AMS dating at your laboratory, along with the import permit for laboratory specimens (No. 2008035045). Please arrange to analyze the samples at the earliest and inform me the results.

C.P. Rajendran

Ms Dawn Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory
National Isotope Centre, GNS Science
30 Gracefield Road
Lower Hutt, New Zealand
FAX: +64 4 570 4657; Phone: 6445704644
http://www.RafterRadiocarbon.co.nz/

Makran Freezure trench

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Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

NZA	**30852**
R	32037/1
Job No	66268
Measured	19-Mar-09
TW No	2317
Issued	26-Mar-09

Sample ID F-1A
Description Shell fragments
Fraction Dated Shell
Submitter C. P. (Dr) Rajendran Centre for Earth Science Studies

*** Radiocarbon Age**		**856 ± 20 BP**		**$\delta^{13}C$ =**	-0.5 ‰
**** Per cent modern =**	89.25 ± 0.2	**$\delta^{14}C$ =**	-62 ± 2.1 ‰	**$\Delta^{14}C$ =**	-107.5 ± 2 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details
Cream and grey fragments of shell. Surface cleaning using sieve to remove the sand, then an ultrasonicatic bath to remove sand from shells. Treated as a phosphoric acid evolution.

Stored remainder

Comments

Makran Boulder beds

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Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

NZA	**30858**
R	32037/2
Job No	66269
Measured	19-Mar-09
TW No	2317
Issued	26-Mar-09
	Page 2 of 2

Sample ID	BL-1A
Description	Shell fragments
Fraction Dated	shells
Submitter	C. P. (Dr) Rajendran Centre for Earth Science Studies

* **Radiocarbon Age**	**7361 ± 25 BP**		$\delta^{13}C$ =	0.6 ‰
** **Per cent modern** =	39.71 ± 0.13	$\delta^{14}C$ =	-581.8 ± 1.4 ‰	$\Delta^{14}C$ =	-602.9 ± 1.3 ‰

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Pale cream - dark cream fragments of shell, many orange - brown pebbles. Surface cleaning was carried out using sieve to remove the coloured sand and coloured pebbles, then an ultrasonicated bath to remove sand from the shells. Treated as a phosphoric acid evolution.

Stored remainder

Comments

INDIAN INSTITUTE OF SCIENCE
BANGALORE 560 012, INDIA

C.P. Rajendran
Centre for Earth Sciences
e mail: cprajendran@ceas.iisc.ernet.in
alt.e-mail: cp.rajendran@yahoo.com
Tel: +91-80 2293 3402/09480707044

By DTDC

April 13, 2009

Dear Ms. Dawn Chambers,

I am enclosing six samples for AMS dating at your laboratory, along with the import permit for laboratory specimens (No. 2008035045). Please arrange to analyze the samples at the earliest and inform me the results.

C.P. Rajendran

Car - NIC
March-April, 2009
with Srini

Sample ID:

1. MUS/B2/1
2. MUS/B3/1
3. MUS/B3/1A
4. AR/W/1
5. S/B1
6. S/B2

Ms Dawn Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory
National Isotope Centre, GNS Science
30 Gracefield Road
Lower Hutt, New Zealand
FAX: +64 4 570 4657; Phone: 6445704644
http://www.RafterRadiocarbon.co.nz/

April 27, 2009

Dear Dr Rajendran,

My apologies for the delays in sending an acknowledgement. Your samples
arrived safely on 21 April and have been assigned the following laboratory
references:

MUS/B2/1 (R32136/1)
MUS/B3/1 (R32136/2)
MUS/B3/1A (R32136/3)
AR/W/1 (R32136/4)
S/B1 (R32136/5)
S/B2 (R32136/6)

Results can be anticipated about mid to late June. Also attached is a copy
of the requested invoice. The original will be in the mail and may have
reached you already.

With kindest regards
Dawn

****
Rafter Radiocarbon Laboratory
National Isotope Centre, GNS Science
30 Gracefield Road
Lower Hutt, New Zealand
FAX: +64 4 570 4657
http://www.RafterRadiocarbon.co.nz/
****

Indian Institute of Science
Bangalore 560 012

Kusala Rajendran
Associate Professor
E mail: kusala@ceas.iisc.ernet.in
Tel: 080 22932633

August 5, 2009

Dear Ms. Dawn Chambers,

I am enclosing two soil samples (J3/S1 and J3/S2) for AMS dating at your laboratory, along with the sample submission forms and import permit for laboratory specimens (No. 2008035045).

Please arrange to analyze the samples at the earliest and inform me the results.

Best regards,

Kusala Rajendran

Dr. Kusala Rajendran
Associate Professor
Centre for Earth Sciences

withdrawn the samples – No carbon.
22/9/2009.

Ms. Dawn Chambers
Sample Co-ordinator
Rafter Radiocarbon Laboratory
National Isotope Centre, GNS Science
30 Gracefield Road
Lower Hutt, New Zealand.
Fax: +64 4 570 4657; Phone: 6445704644
http://www.RafterRadiocarbon.co.nz/

Indian Institute of Science

Centre for Earth Sciences

Dr. Kusala Rajendran

Associate Professor, Centre for Earth Sciences
Indian Institute of Science, Bangalore 560 012, India
Tel: +91 80 22932633, email: kusala@ceas.iisc.ernet.in

November 30, 2009

Dear Ms. Dawn Chambers,

I am enclosing two wood samples (**RG/N/OP/01 and RG/N/ST/01**) for AMS dating at your laboratory, along with the import permit for laboratory specimens (No 2009037902). Pease arrange to analyze the samples at the earliest and inform me the results. Amount required for dating these samples is in my credit.

Sincerely,

Kusala Rajendran

Ms. Dawn Chambers
Sample Coordinator
Rafter Radiocarbon Laboratory
National Isotope Centre, GNS Science
30 Gracefield Road
Lower Hutt, New Zealand.
Fax: +64 4 570 4657; Phone: 6445704644
http://www.RafterRadiocarbon.co.nz/

(Post Blair)
Rangachanga treeline

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NZA	**33616**
R	32348/1
Job No	100638
Measured	18-Jan-10
TW No	2395
Issued	22-Jan-10

Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

Sample ID RG/N/OP/01
Description Wood
Fraction Dated cleaned "wood"
Submitter Kusala Rajendran Centre for Earth Sciences, Indian Institute of Science

*** Radiocarbon Age** **1229 ± 20 BP** **$\delta^{13}C$ =** -25.3 ‰
**** Per cent modern =** 85.19 ± 0.23 **$\delta^{14}C$ =** -148.6 ± 2.3 ‰ **$\Delta^{14}C$ =** -148.1 ± 2.3 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Sample consists of 2 large and several small lumps of greyish-black wood plus some fines. There is a light yellowish coating on the large lumps. Under microscopic examination, the sample appears to be more of a coal-like substance rather than wood. No wood structure is discernable; it is more like a black microcrystalline organic matter. A subsample is taken and the outer surfaces are scraped with a scalpel to expose fresh, clean surfaces. The sample is placed in a beaker and crushed with a pestle. Cellulose extraction method is given.

Stored remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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RAFTER RADIOCARBON LABORATORY

R32348/1

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RADIOCARBON CALIBRATION REPORT

NZA 33616 CONVENTIONAL RADIOCARBON AGE 1229 ± 20 years BP

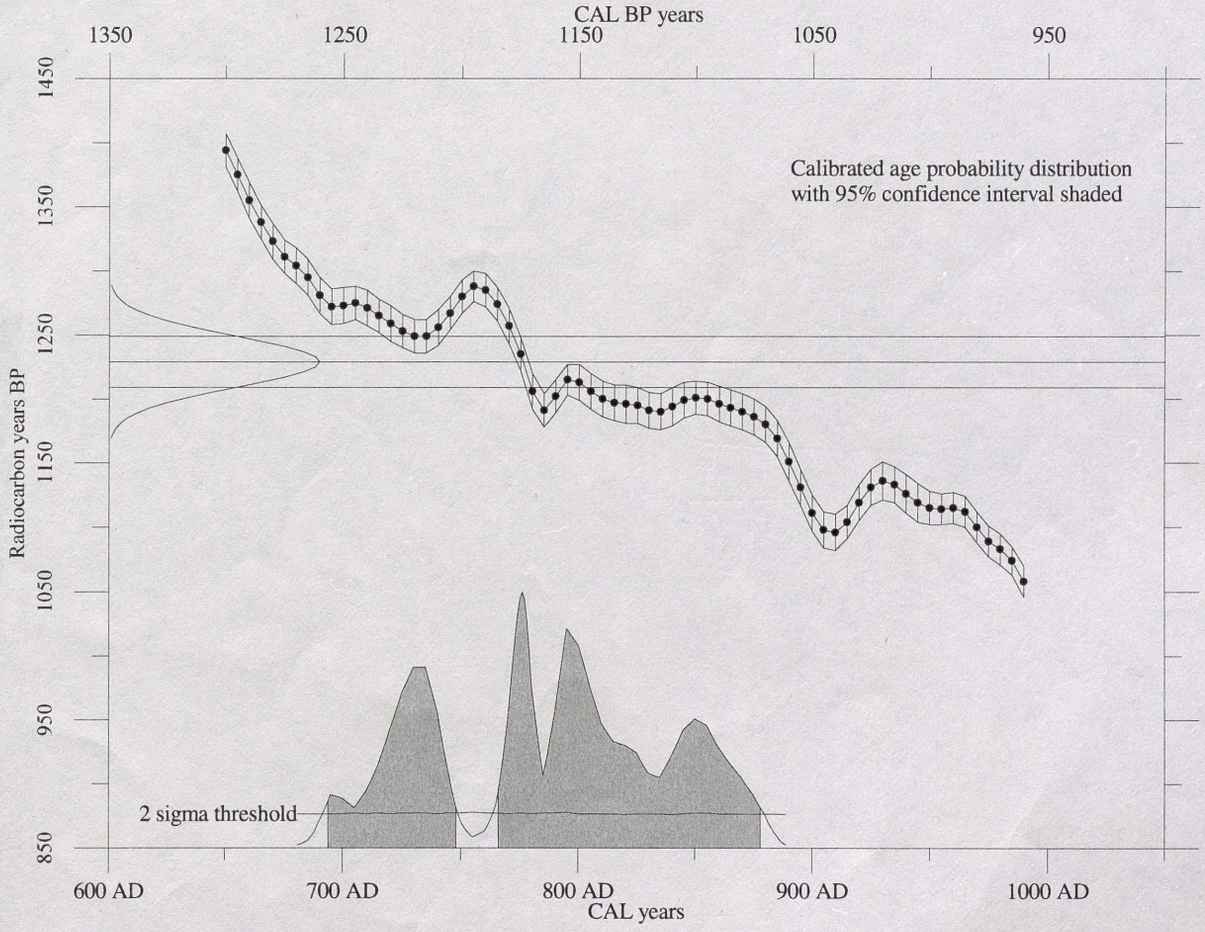
Atmospheric data from Reimer et al (2004);

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 0, Offset: 0)

68% confidence interval is 718 AD to 743 AD	1232 BP to 1207 BP (19.0% of area)
plus 769 AD to 784 AD	1181 BP to 1166 BP (13.7% of area)
plus 788 AD to 821 AD	1162 BP to 1129 BP (25.2% of area)
plus 843 AD to 860 AD	1107 BP to 1090 BP (10.2% of area)
95% confidence interval is 694 AD to 748 AD	1256 BP to 1202 BP (26.9% of area)
plus 766 AD to 878 AD	1184 BP to 1072 BP (68.0% of area)

AD 770 - 880 1180 - 1070



2600
1229
781

March 14, 2010

Samples to be sent to Rafter, New Zealand (Landfall and East Island- March, 2010)

1. E/E/II/1 ✓ 13°37.639'/93°02952' East Island- eastern side ; II terrace. Sample from trench at 50 cm depth near the boulder layer- brachiopod shell. 1291 ± 20

2. E/E/II/2 ✓ 13°37.639'/93°02.952' East Island-eastern coast; II terrace; sample from the trench from within the boulder layer; articulated brachiopod (intact condition with both shells). 1201 ± 20

3. L/II/C/1 ✓ 13°38.672'/92°59.634' Landfall Island; cliff coast; shells embedded on the cliff surface (II terrace?). > 50,000 BP

4. L/III/1 ✓ 13°40.035'/93°01.248' Landfall Island; eastern side; brachiopod shell from the slope leading up to III terrace. 3838 ± 25
3811 ± 20

5. L/~~III~~II/T/2 · 13°38.672'/92°59.634' Landfall Island-eastern side; trench; broken shell collected from the bottom green mud. 4025 ± 20

6. L/II/T/P1 ✓ 13°40.035'/93°01.248' Landfall Island- eastern side. Trench; peat material at the bottom of the reddish-yellowish coarse sand with shells at ~50 cm depth. 132 ± 20 BP

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New Zealand

East Island
Second terrace. just above the building layer

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Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

NZA	**34162**
R	32438/1
Job No	101793
Measured	03-May-10
TW No	2419
Issued	13-May-10

Sample ID E/E/II/1
Description Shell
Fraction Dated shell
Submitter C. P. (Dr) Rajendran Indian Institute of Science

*** Radiocarbon Age**		**1291 ± 20 BP**		**$\delta^{13}C$ =**	2.1 ‰
**** Per cent modern =**	84.54 ± 0.2	**$\delta^{14}C$ =**	-106.9 ± 2.1 ‰	**$\Delta^{14}C$ =**	-154.6 ± 2 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details
Sample consisted of a large bivale shell, about 10cm aross with some surface dirt attached. Put the whole shell into sonicator to lclean surface dirt away, then broke a piece off with hammer. Selected a piece for acid etching in 0.5M HCl, rinsed and dried in vacuum oven. Ground into powder with mortar and pestle. Followed by phosphoric acid evolution. Carbonate content=11%.

Stored Remainder

Comments

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Accelerator Mass Spectrometry Result

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NZA	**34163**
R	32438/2
Job No	101794
Measured	03-May-10
TW No	2419
Issued	13-May-10

Sample ID	E/E/II/2
Description	Shell
Fraction Dated	shell
Submitter	C. P. (Dr) Rajendran Indian Institute of Science

within the boulder layer
East Island II terrace.

*** Radiocarbon Age**		**1201 ± 20 BP**		$\delta^{13}C$ =	2.3 ‰
**** Per cent modern =**	85.5 ± 0.2	$\delta^{14}C$ =	-96.6 ± 2.1 ‰	$\Delta^{14}C$ =	-145 ± 2 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Sample consisted of a large bivale shell, about 8cm aross. Sample has been partially brushed clean by submitter; a shiny lustre can be seen under the soil. Put the whole shell into ultrasonic bath, then broke a piece off with a hammer. Selected a piece for acid etching in 0.5M HCl, rinsed and dried in vacuum oven. Ground into powder with mortar and pestle. Followed by phosphoric acid evolution. Carbonate content=11%.

Stored Remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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East Island, east coast

Lab Code	Sample Code	Radiocarbon age	Calculated ages (years BP)	Calibrated age (years AD)	Calibrated age (years AD) (without considering Δ R)
NZA 34162	E/E/II/1	1291±20	820 ± 90 730 – 910 (1)	1130 ± 90 1040 – 1220 (1)	700 ± 30 670 – 730 (0.62) AD 736-772
NZA 34163	E/E/II/2	1201±20	740 ± 90 650 – 830 (1)	1210 ± 90 1120 – 1300 (1)	830 ± 60 770 – 890 (1) AD 774-887

CALIB RADIOCARBON CALIBRATION PROGRAM*
Copyright 1986-2010 M Stuiver and PJ Reimer

*To be used in conjunction with:
Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.

without marine correction

Before Present	AD	AD without considering Δ R
E/E/II/1 NZA 34162 Marine shell Radiocarbon Age 1291±20 Delta R = 12±34 Calibration data set: marine09.14c # Reimer et al. 2009 One Sigma Ranges: [start:end] relative area [cal BP 778: cal BP 881] 1. Two Sigma Ranges: [start:end] relative area [cal BP 727: cal BP 911] 1.	E/E/II/1 NZA 34162 Marine shell Radiocarbon Age 1291±20 Delta R = 12±34 Calibration data set: marine09.14c # Reimer et al. 2009 One Sigma Ranges: [start:end] relative area [cal AD 1069: cal AD 1172] 1. Two Sigma Ranges: [start:end] relative area [cal AD 1039: cal AD 1223] 1.	NZA 34162 Marine shell no delta R Radiocarbon Age 1291±20 Calibration data set: intcal09.14c # Reimer et al. 2009 One Sigma Ranges: [start:end] relative area [cal AD 675: cal AD 710] 0.628197 [cal AD 746: cal AD 766] 0.371803 Two Sigma Ranges: [start:end] relative area [cal AD 667: cal AD 728] 0.62078 [cal AD 736: cal AD 772] 0.37922
E/E/II/2 NZA 34163 Marine shell Radiocarbon Age 1201±20 Delta R = 12±34 Calibration data set: marine09.14c # Reimer et al. 2009 One Sigma Ranges: [start:end] relative area [cal BP 681: cal BP 765] 1. Two Sigma Ranges: [start:end] relative area [cal BP 652: cal BP 829] 1.	E/E/II/2 NZA 34163 Marine shell Radiocarbon Age 1201±20 Delta R = 12±34 Calibration data set: marine09.14c # Reimer et al. 2009 One Sigma Ranges: [start:end] relative area [cal AD 1185: cal AD 1269] 1. Two Sigma Ranges: [start:end] relative area [cal AD 1121: cal AD 1298] 1.	NZA 34163 Marine shell no delta R Radiocarbon Age 1201±20 Calibration data set: intcal09.14c # Reimer et al. 2009 One Sigma Ranges: [start:end] relative area [cal AD 779: cal AD 794] 0.201889 [cal AD 802: cal AD 830] 0.370726 [cal AD 837: cal AD 868] 0.427385 Two Sigma Ranges: [start:end] relative area [cal AD 774: cal AD 887] 1.

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Accelerator Mass Spectrometry Result

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All liability whatsoever to any third party is excluded.

NZA	**34217**
R	32438/6
Job No	101798
Measured	14-May-10
TW No	2422
Issued	20-May-10

Sample ID	L/II/T/P1
Description	Peat
Fraction Dated	treated peat
Submitter	C. P. (Dr) Rajendran Indian Institute of Science

* **Radiocarbon Age**		**132 ± 20 BP**		$\delta^{13}C$ =	-25.9 ‰
** **Per cent modern** =	97.66 ± 0.26	$\delta^{14}C$ =	-25.1 ± 2.6 ‰	$\Delta^{14}C$ =	-23.4 ± 2.6 ‰

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver .Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Sample consisted of damp peat. Black/brown in color: Munsell2.5YR 2.5/1 with small beige coarse sand/small stones. Microscopic exam revealed fibrous peat, minerals in layers. Took a subsample and scraped off the coarse sand and minerals. Dried in vacuum oven. Ground peat in mortar and pestle, subsampled. Treated with acid / alkali /acid process. Dried in vacuum oven

Stored dried and ground remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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NZA	**34165**
R	32438/4
Job No	101796
Measured	03-May-10
TW No	2419
Issued	25-May-10

Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

Sample ID L/III/1
Description Shell
Fraction Dated shell
Submitter C. P. (Dr) Rajendran Indian Institute of Science

*** Radiocarbon Age**		**3811 ± 20 BP**		**$\delta^{13}C$ =**	-11.5 ‰
**** Per cent modern =**	61.77 ± 0.16	**$\delta^{14}C$ =**	-365.1 ± 1.7 ‰	**$\Delta^{14}C$ =**	-382.3 ± 1.6 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details
Sample consisted of one half of a bivalve shell, white grey in colour, about 7cm across. Shell is weathered-looking with hard coloured deposits and some sediment tightly bound to surfaces of shell. Scraped off hard deposit with tools, then cleaned in ultrasonic bath. Broke piece off with a hammer, then selected one piece for acid etching in 0.5M HCl, rinsed and vacuum dried. Ground into powder with mortar and pestle. Followed by phorsphoric acid evolution, carbonate content= 11%

Stored Remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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NZA	**34164**
R	32438/3
Job No	101795
Measured	03-May-10
TW No	2419
Issued	25-May-10

Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

Sample ID L/II/C/1
Description Shell
Fraction Dated shell
Submitter C. P. (Dr) Rajendran Indian Institute of Science

*** Radiocarbon Age**		**> 50000 BP**		**$\delta^{13}C$ =**	-0.1 ‰
**** Per cent modern =**	0.07 ± 0.05	**$\delta^{14}C$ =**	-999.3 ± 0.5 ‰	**$\Delta^{14}C$ =**	-999.3 ± 0.5 ‰

* Reported age is the conventional radiocarbon age before present (BP)
** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.
Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details
Sample consisted of a fragment of shell with a coating of hard sediment on outer surface. Used chisel to scrape the hardened soil off, then sonicated in deionised water and acid etched in 0.5M HCl twice (still have coloured deposits on the surface). Rinsed and vacuum dried. Ground into powder with mortar and pestle. Followed by phosphoric acid evolution, carbonate content=7.4%.

Stored Remainder
Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

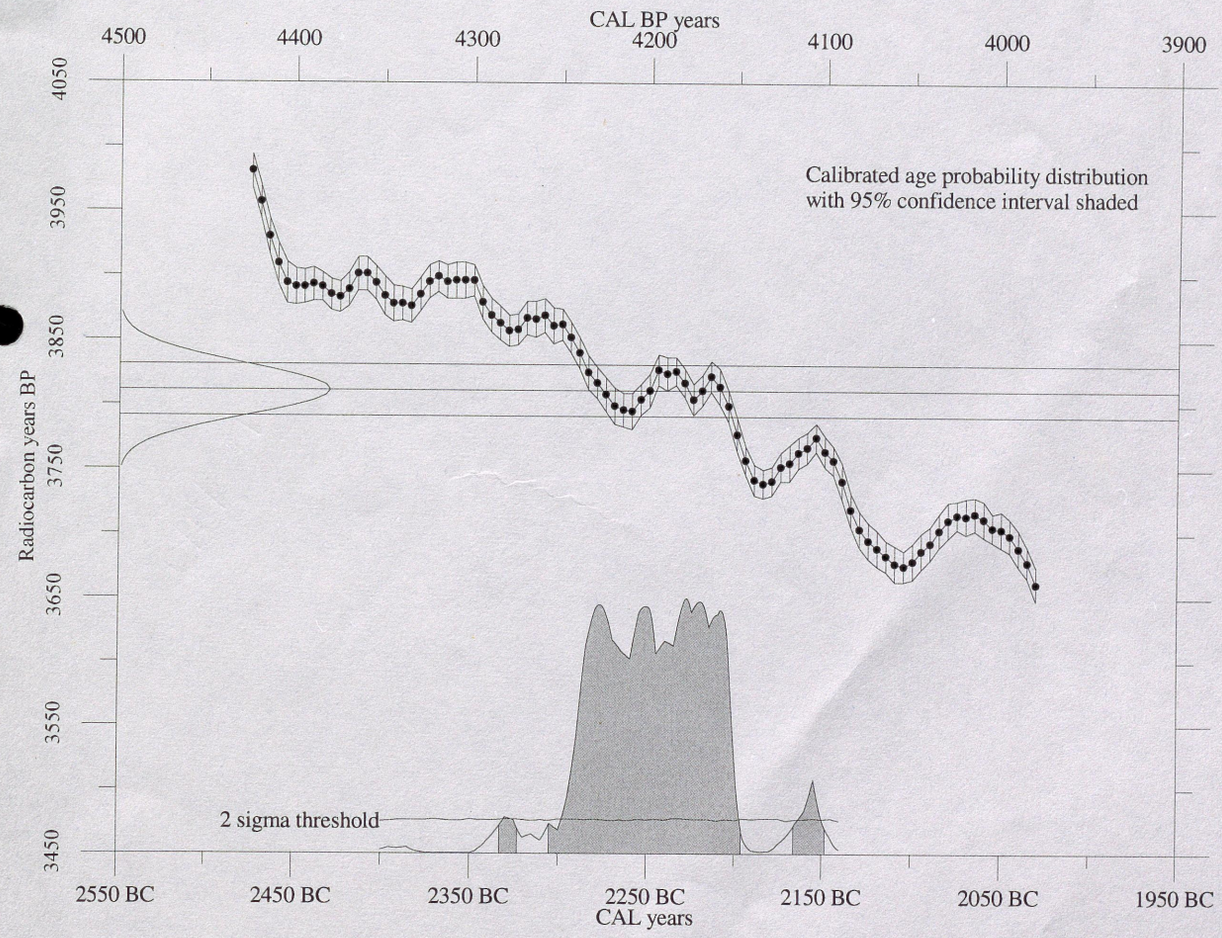
NZA 34165 CONVENTIONAL RADIOCARBON AGE 3811 ± 20 years BP

Atmospheric data from Reimer et al (2009);
PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, PG Blackwell,
C Bronk Ramsey, CE Buck, GS Burr, RL Edwards, M Friedrich, PM Grootes,
TP Guilderson, I Hajdas, TJ Heaton, AG Hogg, KA Hughen, KF Kaiser, B Kromer,
FG McCormac, SW Manning, RW Reimer, DA Richards, JR Southon, S Talamo,
CSM Turney, J van der Plicht, CE Weyhenmeyer (2009) Radiocarbon 51:1111-1150.

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 0, Offset: 0)

68% confidence interval is 2284 BC to 2267 BC 4233 BP to 4216 BP (17.1% of area)
plus 2258 BC to 2245 BC 4207 BP to 4194 BP (13.3% of area)
plus 2241 BC to 2204 BC 4190 BP to 4153 BP (36.8% of area)

95% confidence interval is 2333 BC to 2323 BC 4282 BP to 4272 BP (1.4% of area)
plus 2305 BC to 2196 BC 4254 BP to 4145 BP (90.1% of area)
plus 2166 BC to 2148 BC 4115 BP to 4097 BP (3.5% of area)



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RADIOCARBON CALIBRATION REPORT

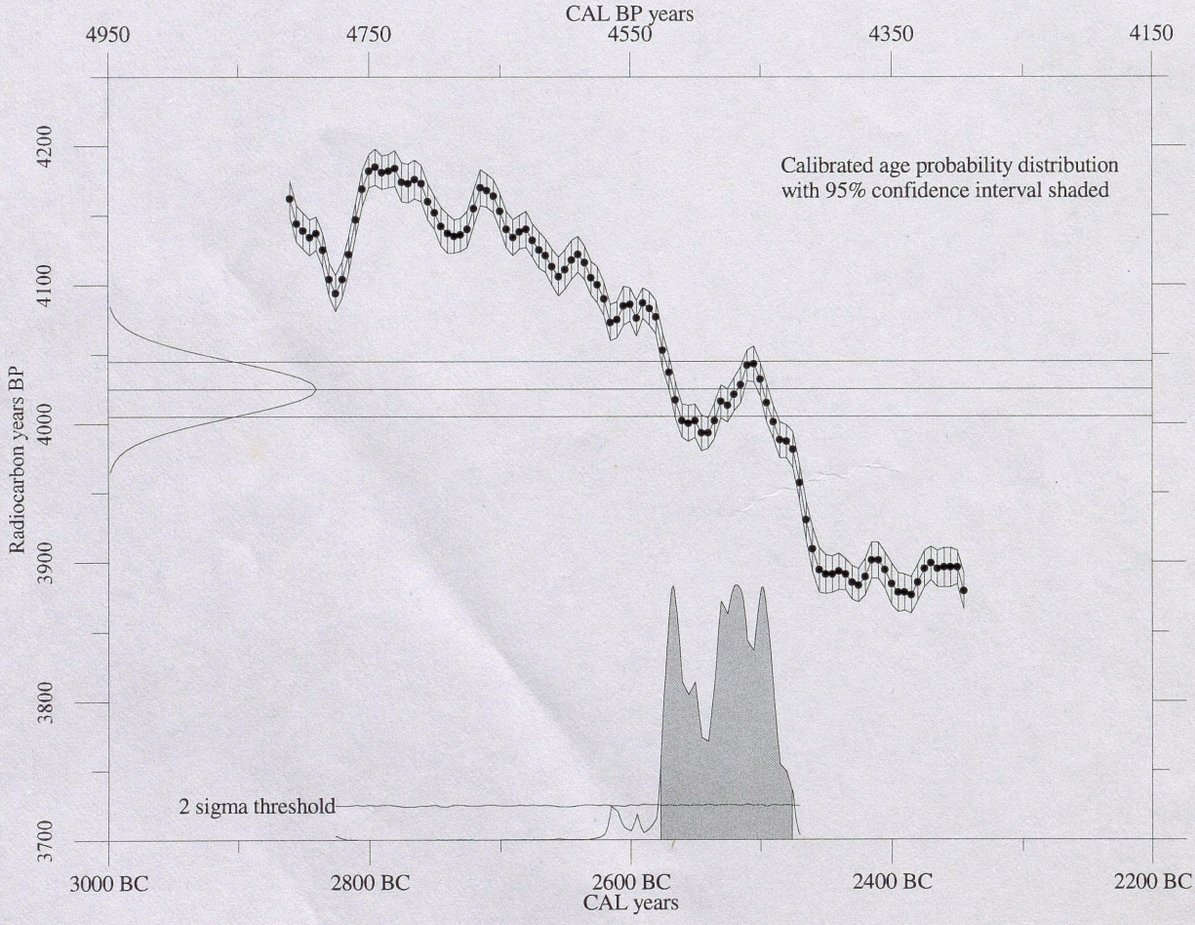
NZA 34166 CONVENTIONAL RADIOCARBON AGE 4025 ± 20 years BP

Atmospheric data from Reimer et al (2009);
PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, PG Blackwell,
C Bronk Ramsey, CE Buck, GS Burr, RL Edwards, M Friedrich, PM Grootes,
TP Guilderson, I Hajdas, TJ Heaton, AG Hogg, KA Hughen, KF Kaiser, B Kromer,
FG McCormac, SW Manning, RW Reimer, DA Richards, JR Southon, S Talamo,
CSM Turney, J van der Plicht, CE Weyhenmeyer (2009) Radiocarbon 51:1111-1150.

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 0, Offset: 0)

68% confidence interval is 2573 BC to 2560 BC 4522 BP to 4509 BP (15.1% of area)
plus 2534 BC to 2490 BC 4483 BP to 4439 BP (52.6% of area)

95% confidence interval is 2577 BC to 2476 BC 4526 BP to 4425 BP (94.8% of area)



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Accelerator Mass Spectrometry Result

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NZA	**34166**
R	32438/5
Job No	101797
Measured	03-May-10
TW No	2419
Issued	25-May-10

Sample ID	L/II/T/2
Description	Shell
Fraction Dated	shell
Submitter	C. P. (Dr) Rajendran Indian Institute of Science

* **Radiocarbon Age**		**4025 ± 20 BP**		$\delta^{13}C$ =	-10 ‰
** **Per cent modern** =	60.15 ± 0.16	$\delta^{14}C$ =	-379.8 ± 1.6 ‰	$\Delta^{14}C$ =	-398.5 ± 1.6 ‰

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Sample consisted of large piece of a bivalve shell split approximately in half through the hinge protion. About 7.4cm as whole, grey-white in colour, with some hard soil deposits on inner surface. Scraped with spatula to remove deposits then ultrasonic bath. Piece broken off with hammer; then selected a fragment for acid etching in 0.5M HCl, rinsed well and vacuum dried. Ground into powder with mortar and pestle. Followed by phosphoric acid evolution, carbonate content=10%.

Stored Remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

NZA	**34244**
R	32438/3
Job No	102077
Measured	20-May-10
TW No	2423
Issued	25-May-10

Sample ID	L/II/C/1
Description	Shell
Fraction Dated	new part of shell
Submitter	C. P. (Dr) Rajendran Indian Institute of Science

* **Radiocarbon Age**		**53100 ± 3100 BP**	$\delta^{13}C$ =		0 ‰
** **Per cent modern** =	0.13 ± 0.05	$\delta^{14}C$ =	-998.6 ± 0.5 ‰	$\Delta^{14}C$ =	-998.7 ± 0.5 ‰

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Sample consisted of a fragment of shell with a coating of hard sediment on outer surface. Used chisel to scrape the hardened soil off, then sonicated in deionised water and acid etched in 0.5M HCl twice (still have coloured deposits on the surface). Rinsed and vacuum dried. Ground into powder with mortar and pestle. Followed by phosphoric acid evolution, carbonate content=11.01%.

Stored remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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Accelerator Mass Spectrometry Result

This result for the sample submitted is for the exclusive use of the submitter.
All liability whatsoever to any third party is excluded.

NZA	**34245**
R	32438/4
Job No	102078
Measured	20-May-10
TW No	2423
Issued	25-May-10

Sample ID	L/III/1
Description	Shell
Fraction Dated	new part of shell
Submitter	C. P. (Dr) Rajendran Indian Institute of Science

* **Radiocarbon Age**		**3838 ± 25 BP**		$\delta^{13}C$ =	-11.5 ‰
** **Per cent modern** =	61.57 ± 0.2	$\delta^{14}C$ =	-367.2 ± 2 ‰	$\Delta^{14}C$ =	-384.3 ± 2 ‰

* Reported age is the conventional radiocarbon age before present (BP)

** Per cent modern means absolute per cent modern relative to the NBS oxalic acid standard (HOxI) corrected for decay since 1950.

Age, $\Delta^{14}C$, $\delta^{14}C$ and absolute per cent modern are as defined by Stuiver Polach, Radiocarbon 19:355-363 (1977)

Sample Treatment Details

Sample consisted of one half of a bivalve shell, white grey in colour, about 7cm across. Shell is weathered-looking with hard coloured deposits and some sediment tightly bound to surfaces of shell. Scraped off hard deposit with tools, then cleaned in ultrasonic bath. Broke piece off with a hammer, then selected one piece for acid etching in 0.5M HCl, rinsed and vacuum dried. Ground into powder with mortar and pestle. Followed by phorsphoric acid evolution, carbonate content= 9.43%

Stored remainder

Comments

The reported errors comprise statistical errors in sample and standard determinations, combined in quadrature with a system error component based on the analysis of an ongoing series of measurements on an oxalic acid standard.
For the present result the system error component is conservatively estimated as 0% (= ± 0 radiocarbon years).

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RADIOCARBON CALIBRATION REPORT

NZA 34245 CONVENTIONAL RADIOCARBON AGE 3838 ± 25 years BP

Atmospheric data from Reimer et al (2009);
PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, PG Blackwell,
C Bronk Ramsey, CE Buck, GS Burr, RL Edwards, M Friedrich, PM Grootes,
TP Guilderson, I Hajdas, TJ Heaton, AG Hogg, KA Hughen, KF Kaiser, B Kromer,
FG McCormac, SW Manning, RW Reimer, DA Richards, JR Southon, S Talamo,
CSM Turney, J van der Plicht, CE Weyhenmeyer (2009) Radiocarbon 51:1111-1150.

CALIBRATED AGE in terms of confidence intervals (Smoothing parameter: 0, Offset: 0)

68% confidence interval is 2340 BC to 2274 BC 4289 BP to 4223 BP (40.9% of area)
plus 2252 BC to 2226 BC 4201 BP to 4175 BP (17.9% of area)
plus 2222 BC to 2207 BC 4171 BP to 4156 BP (9.0% of area)

95% confidence interval is 2456 BC to 2417 BC 4405 BP to 4366 BP (6.2% of area)
plus 2405 BC to 2375 BC 4354 BP to 4324 BP (7.5% of area)
plus 2349 BC to 2200 BC 4298 BP to 4149 BP (81.3% of area)

