RADIOCARBON MEASUREMENTS OF TREE RINGS FROM 14 ka HUON PINE

T Lange[1,2] • M Barbetti[3] • D J Donahue[1]

ABSTRACT. We have measured the radiocarbon content of tree rings from a section of Huon pine retrieved from Tasmania. The sample was divided into 39 five-ring sub-samples covering a period of 194 years. Radiocarbon ages of each of these sub-samples was determined by making four measurements of each sub-sample at the Arizona AMS laboratory (Table 1). The resulting 1σ precisions are about 0.5%. A comparison of our data with the appropriate curve in INTCAL98 indicates that the calendar age of our sample is close to 14,000 cal BP. Using this age calibration, we have constructed a plot of $\Delta^{14}C$ versus assumed calendar age. This plot shows an essentially constant value over the youngest 125 rings of our sample. Over the oldest 75 yr of the sample, the $\Delta^{14}C$ curve exhibits three fluctuations, the largest of which is about 65‰. The time of the peaks in the Huon-pine ^{14}C curve corresponds approximately with the European Bølling/Allerød climatic event. Work is in progress to extend the data 100 yr more toward older ages.

INTRODUCTION

Radiocarbon dating can yield important information to a wide variety of fields. Without calendar age calibration, only an approximate date for an event can be determined. Calibration curves, relating ^{14}C ages to calendar ages, are of great importance. There are several different materials that have been found and used which can yield the information needed to create calibration curves. These include corals, varves, and tree rings, to name a few (Stuiver et al. 1998). The focus of this study is tree rings from *Lagarostrobos franklinii*, more commonly known as Huon pine. Huon pine is a conifer found only in the rainforest regions of southern and western Tasmania. Although extremely slow growing, the tree can attain heights of over 40 m. Huon pine increases in diameter at an average rate of a mere 1 mm per year, with ring widths varying from 0.3 mm to 2 mm, depending on meteorological conditions. Huon pine can reach prodigious ages, in excess of 2000 yr, making it one of the longest living organisms on earth, exceeded only by the bristle-cone pine of North America. It is also very resistant to decay due to the presence of a natural oil methyl eugenol. All of these properties make Huon pine an ideal subject for calendar age calibration studies.

METHODS

The logs chosen for this study, labeled SRT 698-1 and SRT 702-1, were excavated by a team of scientists in Tasmania. The excavation site was the Stanley River Valley (41°42′S, 145°17′E), at a depth of about 3.5 m. The logs were then cleaned, cut into sections, transported to the lab, and sanded for ring-width measurements. A portion of each section was then sent to the NSF-Arizona AMS Facility. Upon arrival, SRT 698-1 was re-sanded, to better reveal the ring pattern, and cut into 5 ring samples under a microscope. This yielded 39 samples, covering approximately 194 years of growth. Thin slices of the samples received the following pretreatment to remove any non-native carbon:

1. Soak in 3N HCL overnight to remove inorganic carbons.
2. Rinse to neutral pH with type-1 water.
3. Soak in 2% NaOH overnight to remove mobile carbons (i.e.: humic or fulvic acids).
4. Rinse to neutral pH with type-1 water.
5. Soak in 3N HCL to neutralize any remaining NaOH.
6. Rinse to neutral pH with type-1 water.

[1]NSF-Arizona AMS Facility, University of Arizona, Tucson, Arizona, 85721, USA
[2]Corresponding author. Email: lange@newton.physics.arizona.edu.
[3]NWG Macintosh Centre for Quaternary Dating, University of Sydney, NSW 2006, Australia

RADIOCARBON, Vol 43, Nr 2A, 2001, p 449–452
Proceedings of the 17th International ^{14}C Conference, edited by I Carmi and E Boaretto

https://doi.org/10.1017/S0033822200038315 Published online by Cambridge University Press

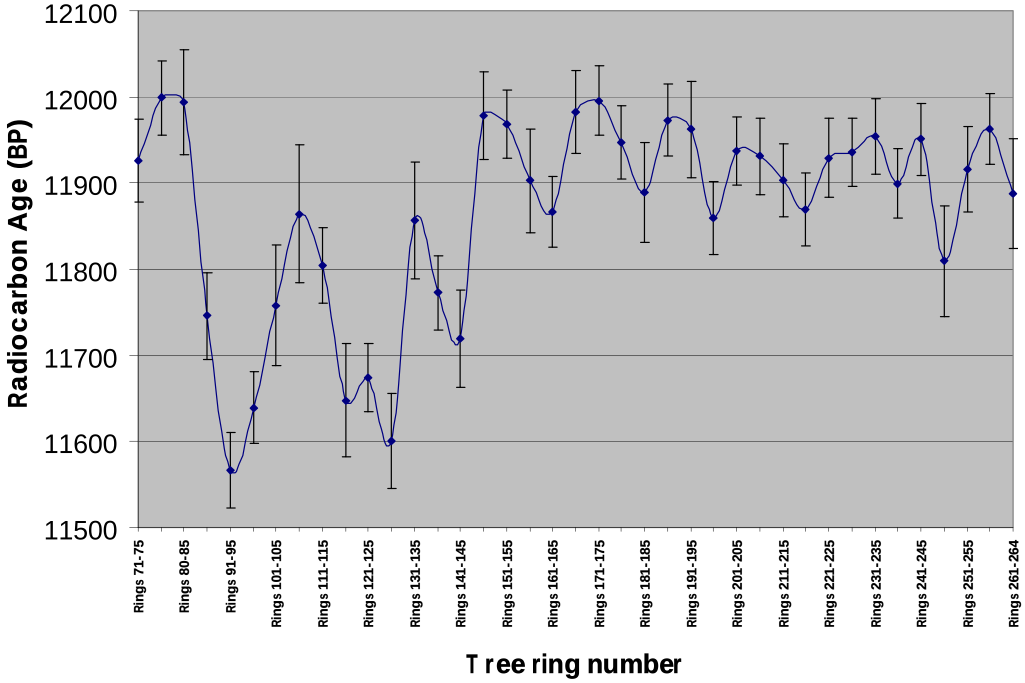

Figure 1 Radiocarbon age versus tree-ring number shows a significant event occurring in the first 75 years of the sample

CO_2 was extracted using standard AMS combustion procedures. The gas was passed through several clean-up traps, measured and reduced to graphite. Each sample was measured four separate times on a General Ionex 2.3 MV Cockroft-Walton Accelerator, yielding a precision of approximately 0.5%.

RESULTS AND DISCUSSION

A plot of ^{14}C age versus tree-ring number is given in Figure 1 (above), where

$$\text{Radiocarbon age} = -\tau_{Libby}\ln(F)$$
$$\text{with } \tau_{Libby} = 8033 \text{ yr}$$

and

$$F = \frac{\left(\frac{14}{13}\right)_{Sample[-25]}}{\left(\frac{14}{13}\right)_{1950[-25]}} \tag{1}$$

(Donahue et al. 1990). Figure 1 shows a substantial peak within the first 75 (oldest) rings. Comparison of the results with the INTCAL98 calibration curve indicates that the oldest of the tree rings illustrated in Figure 1 is about 14,000 cal BP. We assumed a calendar age of 14,000 cal BP for the oldest ring set and then assigned assumed calendar ages to each subsequent 5-yr set of tree rings (see Table 1).

We use these assumed calendar ages to calculate the values of Δ^{14}C, where

$$\Delta^{14}C = 1000\left(Fe^{\frac{t}{\tau}} - 1\right) \quad (2)$$

with τ = 8267 yr, and t = assumed calendar age (BP).

Table 1 Radiocarbon content and assumed calendar age of Huon pine samples

Lab ID	Ring Number	^{14}C AGE	$\sigma_{(14C)}$	Assumed Calendar Age (BP)	Δ^{14}C
AA32795	Rings 71-75	11926	47	14100	247.4
AA32796	Rings 76-80	11999	43	14095	235.3
AA32797	Rings 81-85	11994	61	14090	235.4
AA32798	Rings 86-90	11746	50	14085	273.3
AA32799	Rings 91-95	11566	44	14080	301.3
AA32800	Rings 96-100	11639	42	14075	288.8
AA32801	Rings 101-105	11758	70	14070	269.1
AA32802	Rings 106-110	11864	80	14065	251.7
AA32803	Rings 111-115	11804	44	14060	260.4
AA32804	Rings 116-120	11648	66	14055	284.3
AA32805	Rings 121-125	11674	40	14050	279.3
AA32806	Rings 126-130	11601	55	14045	290.3
AA32807	Rings 131-135	11857	68	14040	249.1
AA32808	Rings 136-140	11773	43	14035	261.4
AA32809	Rings 141-145	11719	57	14030	269.1
AA32810	Rings 146-150	11978	51	14025	228.1
AA32811	Rings 151-155	11969	40	14020	228.8
AA32812	Rings 156-160	11903	60	14015	238.2
AA32813	Rings 161-165	11867	41	14010	243.0
AA32814	Rings 166-170	11982	48	14005	224.5
AA32815	Rings 171-175	11996	40	14000	221.7
AA32816	Rings 176-180	11947	43	13995	228.3
AA32817	Rings 181-185	11889	58	13990	236.5
AA32818	Rings 186-190	11973	42	13985	222.9
AA32819	Rings 191-195	11962	56	13980	223.9
AA32820	Rings 196-200	11859	42	13975	238.9
AA32821	Rings 201-205	11937	40	13970	226.3
AA32822	Rings 206-210	11931	45	13965	226.4
AA32823	Rings 211-215	11903	43	13960	229.9
AA32824	Rings 216-220	11870	43	13955	234.3
AA32825	Rings 221-225	11929	46	13950	224.5
AA32826	Rings 226-230	11936	39	13945	222.7
AA32827	Rings 231-235	11954	43	13940	219.2
AA32828	Rings 236-240	11899	40	13935	226.8
AA32829	Rings 241-245	11951	42	13930	218.2

https://doi.org/10.1017/S0033822200038315 Published online by Cambridge University Press

A plot of $\Delta^{14}C$ versus assumed calendar age is shown in Figure 2. Although the magnitude of the peaks would change, the structure of the data in this curve would not be affected by a change in the assumed calendar age of several hundred years. The curve shows three peaks at approximately the time of the Bølling/Allerød climate event. The oldest of these peaks increases by 65‰, to its maximum, in 10 years. This 6‰ per year increase is about a factor of four greater than the rate that can be produced even by a complete shutdown of ocean circulation (Stuiver et al. 1998). In addition, the geomagnetic field during this period is well known and was essentially constant (Laj et al. 2000). Therefore, the observed high rate of change of $\Delta^{14}C$ suggests that a significant increase in the production rate of ^{14}C must have occurred during this period.

To better define the shape of the curves shown in Figures 1 and 2, and to more accurately fix the time scale, we are currently extending our data back an additional 75 yr, and sampling at an interval of 2.5 yr.

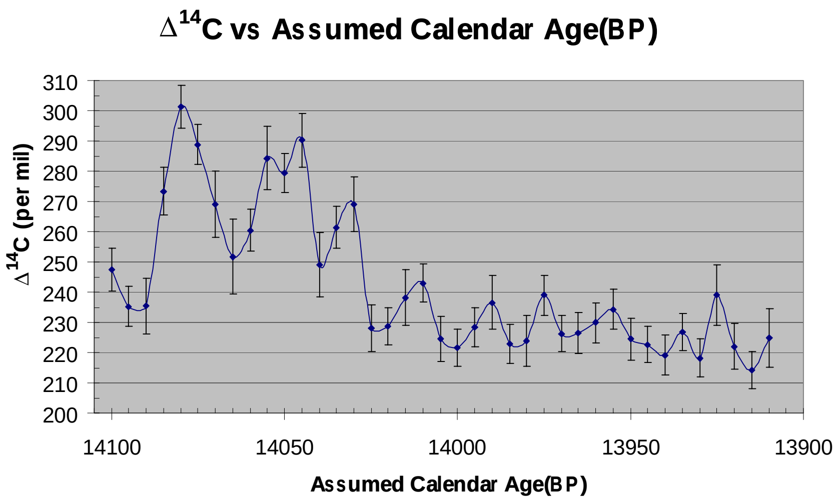

Figure 2 Comparison with INTCAL98 gives an initial "best guess" calendar age, for the event allowing us to calculate $\Delta^{14}C$ values for this sequence of tree rings. We see a 65‰ increase of ^{14}C in 10 years at approximately 14,000 BP.

ACKNOWLEDGMENTS

We acknowledge Dr W Beck, Dr G Burr, Dr A J T Jull, Mr D Biddulph, and Ms L Hewitt at the NSF Arizona AMS Facility, Arizona, USA, Dr E Cook at Lamont-Doherty Earth Observatory, New York, USA, and Mr B Thomson and Ms Y Zhao at the NWG Macintosh Centre for Quaternary Dating, Sydney, Australia for their assistance in this work.

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https://doi.org/10.1017/S0033822200038315 Published online by Cambridge University Press