Nuclear Instruments and Methods in Physics Research B 268 (2010) 910–913

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research B

journal homepage: www.elsevier.com/locate/nimb

Comparative AMS radiocarbon dating of pretreated versus non-pretreated tropical wood samples

Adrian Patrut [a], Karl F. von Reden [b,*], Daniel A. Lowy [c], Diana H. Mayne [d], Kathryn E. Elder [b], Mark L. Roberts [b], Ann P. McNichol [b]

[a] Department of Chemistry, Babes-Bolyai University, 400028 Cluj-Napoca, Romania
[b] NOSAMS Facility, Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA
[c] Nova Research Inc., Alexandria, VA 22308, USA
[d] Baobab Trust, P.O. Box 1566, Parklands 2121, Johannesburg, South Africa

ARTICLE INFO

Article history:
Available online 8 October 2009

Keywords:
AMS ^{14}C dating
Tropical trees
Adansonia digitata
Gas ion source
Pretreatment

ABSTRACT

Several wood samples collected from Dorslandboom, a large iconic African baobab (*Adansonia digitata* L.) from Namibia, were investigated by AMS radiocarbon dating subsequent to pretreatment and, alternatively, without pretreatment. The comparative statistical evaluation of results showed that there were no significant differences between fraction modern values and radiocarbon dates of the samples analyzed after pretreatment and without pretreatment, respectively. The radiocarbon date of the oldest sample was 993 ± 20 BP. Dating results also revealed that Dorslandboom is a multi-generation tree, with several stems showing different ages.

1. Introduction

After over 100 years of research, determining the ages and growth rates of tropical trees is still a challenging topic [1]. If trees exhibit annual/seasonal growth rings, ring counting is the most accurate and reproducible method for age and growth rate determination. However, the existence of annual/seasonal rings in tropical trees is very controversial [1–5]. Consequently, for tropical trees with growth rings that are not strictly annual or seasonal, without well defined rings and/or a continuous sequence of rings, due especially to hollow parts, radiocarbon analysis represents the only accurate method for dating [5,6]. According to the usual procedure, wood samples are pretreated prior to radiocarbon dating. Pretreatment is considered necessary to remove non-structural mobile carbon, primarily lignin, in order to isolate for dating exclusively the structural non-mobile carbon components, mainly cellulose [7].

One of the latest AMS developments is the continuous-flow AMS (CFAMS) which uses a genuine gas ion source, allowing for instantaneous analysis of minute amounts of sample [8,9]. Long wood samples can be investigated point-by-point by CFAMS, providing a continuous stream of information on age values and growth rate variations of the whole length of the investigated samples. Unlike standard AMS and other techniques in which wood samples are pretreated prior to dating, CFAMS has the capability of analyzing wood samples instantaneously with a very high accuracy, if pretreatment is not necessary.

The main aim of the research was to establish whether pretreatment is mandatory or not for the accurate radiocarbon dating of wood samples collected from tropical tree species with low non-structural mobile carbon content. As the model species we chose the African baobab (*Adansonia digitata* L.). Species of the genus *Adansonia*, which belongs to the Malvaceae family, are tropical trees whose woody tissue (xylem) contains little non-structural carbon, mainly lignin [10].

Several wood samples collected from Dorslandboom, a large African baobab, were investigated by AMS radiocarbon dating, with and without pretreatment. Other objectives of our study were to determine its age and the history of its multi-stemmed trunk.

2. Materials and methods

2.1. Dorslandboom and its area

"Die Dorslandboom" (The Thirstland tree, in Afrikaans), also called "sewe stam kremetart" (seven-stemmed baobab, in Afrikaans), is located in Eastern Bushmanland, Namibia. Its GPS coordinates are: 19°18.047′ S, 020°39.640′ E and the altitude is

* Corresponding author. Tel.: +1 508 289 3384; fax: +1 508 457 2183.
E-mail address: kvonreden@whoi.edu (K.F. von Reden).

0168-583X/$ - see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.nimb.2009.10.062

1128 m. Mean annual rainfall and temperature in the area are: 451 mm and 21.5 °C. With its toppled or standing knitted stems, some of them broken and a few regenerated with new shoots, Dorslandboom (Fig. 1) can be considered a kind of "Schrödinger's baobab", which is at the same time dead and alive [11]. The largest stem (A) collapsed and died in 2006 and is severely decayed. Two stems (F and G) collapsed before 1880 but their remains are still alive, one leaning stem (E) is alive, while three stems (B, C, and D) toppled but new shoots grew at the ends of broken stems. The largest stem A consisted practically of two fused stems (A1 and A2), so that Dorslandboom could be described more accurately as an eight-stemmed baobab. Its structure was completed recently by two very young stems (X and Y), which sprouted from roots. Measurements indicated a restored circumference at breast height (*cbh*, i.e., at 1.30 m above ground) of 36.30 m, which also includes several empty spaces between stems and a maximum height of 14.0 m.

Several large wood samples were collected from the deep scooped-out holes in the bases of three stems of Dorslandboom (A1, B, and E). Six smaller samples were extracted from determined positions of the larger samples and marked 1–6. Each smaller sample was further divided in two parts, which were radiocarbon dated by AMS. The part of each sample which was analyzed subsequent to pretreatment was labeled by *a*, while the part analyzed without pretreatment was noticed by *b*.

2.2. Sample preparation

For samples 1*a*–6*a*, the acid–base–acid pretreatment method [12] was used to remove soluble and mobile organic components prior to AMS investigation. The wood samples 1*b*–6*b* were investigated by AMS without pretreatment.

2.3. AMS measurements

Radiocarbon measurements were performed at the NOSAMS Facility of the Woods Hole Oceanographic Institution with a 3 MV Tandetron (TM) AMS system.

2.4. Calibration

Fraction modern values were converted to calendar (cal) ages with the OxCal v4.0.3 for Windows [13], by using the IntCal04 atmospheric data set [14].

2.5. Statistical analysis

The comparative analysis of AMS dating results acquired by the two methods, i.e., with and without pretreatment, was performed by using the paired *t*-test and the Statistica 7.0 software [15,16].

3. Results and discussion

3.1. Fraction modern values and radiocarbon dates

Fraction modern (*Fm*) values and radiocarbon dates of samples are listed in Table 1. Radiocarbon dates and errors were rounded to the nearest year. The comparative *Fm* values and radiocarbon dates for the samples analyzed *via* two different methods, i.e., with pre-

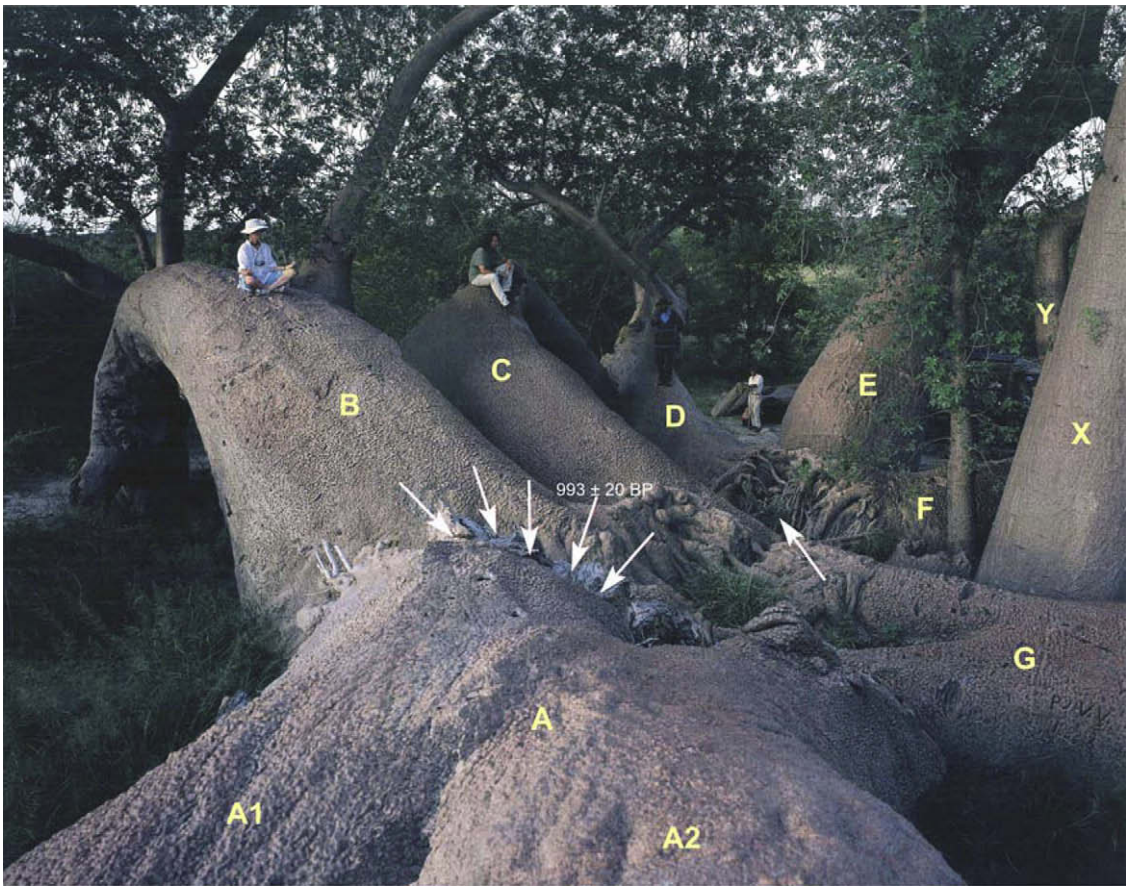

Fig. 1. Top view of Dorslandboom's multi-generation trunk, showing its knitted stems; stem labels: A–G and X, Y. The arrows indicate the approximate position of samples. © Thomas Pakenham.