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# IFAN RADIOCARBON LABORATORY MEASUREMENTS I

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**ABSTRACT.** Results obtained from a liquid scintillation counter using BGO ($Bi_4Ge_30_{12}$) tubes have produced more precise radiocarbon dates in our laboratory. Duplicate analyses confirm the electronic stability of the counter with a background of 0.1 cpm. Our $^{14}C$ dates agree well with those from another laboratory (Paris 6-LOCEAN). Most of the $^{14}C$ dates in this study were obtained on samples taken from different archaeological sites. Calibration of the various dates with the appropriate software (CALIB 5.0 in our case) allows better interpretation of the results and their importance in this understudied region. In this paper, we investigate the performance of the counter by analyzing samples from archaeological and marine sites in Senegal and Mauritania, and report the results in our first laboratory date list.

## INTRODUCTION

Since 2003, we have operated a new dating system in the Institut Francophone d'Afrique Noire (IFAN) Radiocarbon Laboratory in Dakar, Senegal. Counting was carried out using a Tri-Carb® 3170TR/SL liquid scintillation analyzer from Packard provided with BGO ($Bi_4Ge_30_{12}$) tubes driven by the Quanta Smart software under a Windows® NT operating system. In "super low level" mode, the background noise is very low (Cook et al. 1990). The liquid scintillation counter is housed in an underground room, thus eliminating more background of atmospheric $^{14}C$. Assessment of the performance of the dating system (background and factor of merit) is done using the known samples from Paris 6 and international standards from the International Atomic Energy Agency (IAEA). In the 13–85 kV energy range at an efficiency of 68% and a background of 0.2 cpm, the figure of merit is 23.400.

With the change in methods, the laboratory took on a new lab code, DK, replacing the previous one of DAK (Diop 1974) used in the 1970s by Prof Cheikh Anta Diop (former head of the laboratory). Physical and chemical pretreatments depend on the nature of the samples, but the classic acid-base-acid (ABA) procedure is usually adopted. The acid treatment is done with HCL 8%, and the base with NaOH 5%.

The liquid scintillation counter uses benzene as a scintillation solvent. For each sample, 2 g of benzene was placed in a standard (20 mL) pico glass vial. The scintillators employed were a bis MSB + Buthyl PBD mixture (6 mg + 6 mg) (Horrocks 1974). Age calculations are based on the Libby half-life of 5568 yr and dates are expressed in yr BP with AD 1950 as the reference year. Ages and standard deviations (2 $\sigma$) of samples are adjusted for stable isotope fractionation to a normalized concentration ratio ($\delta^{13}C = 25\%$), according to Stuiver and Polach (1977). Calibration was done using the program CALIB 5.0 (Reimer and Reimer 2001; www.calib.org). In the list that follows, new dates are given along with their location coordinates and sample descriptions.

## ARCHAEOLOGICAL SAMPLES

### *Khant Series*

Shell samples (*Anadara sensilis*) were collected from the Khant site in northern Senegal (Figure 1). This site is a depression discovered by A Ravisé in 1969 (Ravisé 1970). The samples were submitted 13 January 2003 by H Bocoum of the IFAN laboratory, Université Cheikh Anta Diop de Dakar.

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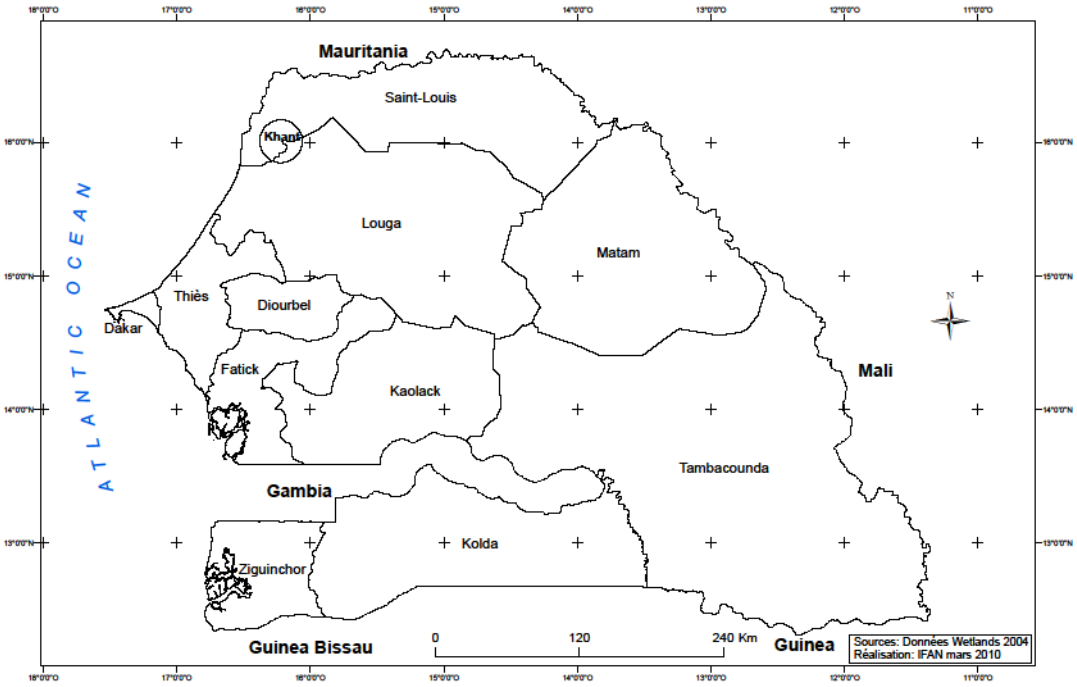


Figure 1 Location of the Khant site, 22 km N-NE of St. Louis (north of the Senegal River delta).

**DK-1. Khant, northern Senegal** **2448 ± 34 BP**
**409–598 BC**

Bolé zone at 0.3 m depth.

**DK-4. Khant, northern Senegal** **2633 ± 29 BP**
**777–837 BC**

Xoor Nook zone at 0.2 m depth.

**DK-5. Khant, northern Senegal** **2663 ± 49 BP**
**775–916 BC**

Bolé zone at 2 m depth.

**DK-6. Khant, northern Senegal** **2946 ± 86 BP**
**968–1393 BC**

Bolé zone at 1 m depth.

**DK-7. Khant, northern Senegal** **2912 ± 29 BP**
**1010–1212 BC**

Bolé zone at 3.2 m depth.

*Comment*: These dates (DK-4 and DK-6) could incite new investigations to confirm the initial level of the cluster above 4 m, which could date to the 2nd millennium. This period may be a time of transition that would mark the end of the Neolithic and the introduction of the Iron Age in the valley of the River Senegal (Bocoum et al. 1992). The sequence obtained with DK-1, DK-5, and DK-7 is coherent with regard to the respective calibrations. These results allow us to study the chronological sequence of a small entropic valley in this zone called Bolé.

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### Samples from IAEA, Vienna

Carbonate sample and cellulose samples were sent from the IAEA. We compare the pMC of the samples given by the IAEA to those calculated in our lab. The aim of this analysis is for calibration of the counter and intercomparison exercises (Rozanski et al. 1990).

**DK-2, DK-3. IAEA, Vienna** **IAEA = 129.46 pMC**
**LC14 DK = 129.36 pMC**

Sample of cellulose supplied by the IAEA. It is a series of cellulose (C3) that was produced in 1989 from a harvest during that season.

**DK-8. IAEA, Vienna** **IAEA = 0.02 pMC**
**LC14 DK = 0.04 pMC**

Sample of carbonate (C1) supplied by the IAEA.

*Comment*: The 2 values of pMC are almost the same (difference of 0.08%) and show good calibration with the scintillation counter. Sample C1 is used to measure the background noise of the machine by the low pMC (0.02), which is twice as low as the one calculated by our lab. Taking into account the uncertainty, one can say that the values belong in the same range (Ndeye et al. 2003).

### *Mauritania Series*

Shell samples collected from sites in Mauritania (Figure 2). The samples were submitted in 2003 by Mr Robert Vernet, the head of the Khant Project (SCAC, Ambassade de France, Rabat, Morocco). The aim of the project is to date the consumption of shellfish in order to determine the Nouakchottan transgression.

**DK-9. Dakhlet, Nouadibou, Mauritania** **6150 ± 86 BP**
**4894–5305 BC**

Shell samples (*Anadara senilis*) collected in March 2003 from the Dakhlet site on the surface of the shell midden (20°51′N, 17°02′W).

**DK-10. Dhraina, Mauritania** **5142 ± 49 BP**
**3966–4175 BC**

Shell samples (*A. senilis*) collected in May 2003 from the Dhraina site in Mauritania at the shell midden (18°48′N, 15°29′W).

**DK-11. Grandes dunes Nouakchott, Mauritania** **6000 ± 115 BP**
**4651–5215 BC**

Shell samples (*Lopha stentina*) collected in May 2003 from site 32 in Mauritania.

**DK-12. Targueguit, Keur masséne, Rosso, Mauritania** **5030 ± 80 BP**
**3660–3967 BC**

Shell samples (*A. senilis*) collected 29 January 2004 from the Bantar After Saheli site (Rosso in Mauritania).

**DK-13. Akchar, Mauritania** **6090 ± 85 BP**
**4791–5224 BC**

Shell samples (*L. stantina*) collected 30 January 2004 from site 28 of Bantar After Saheli (Akchar in Mauritania).

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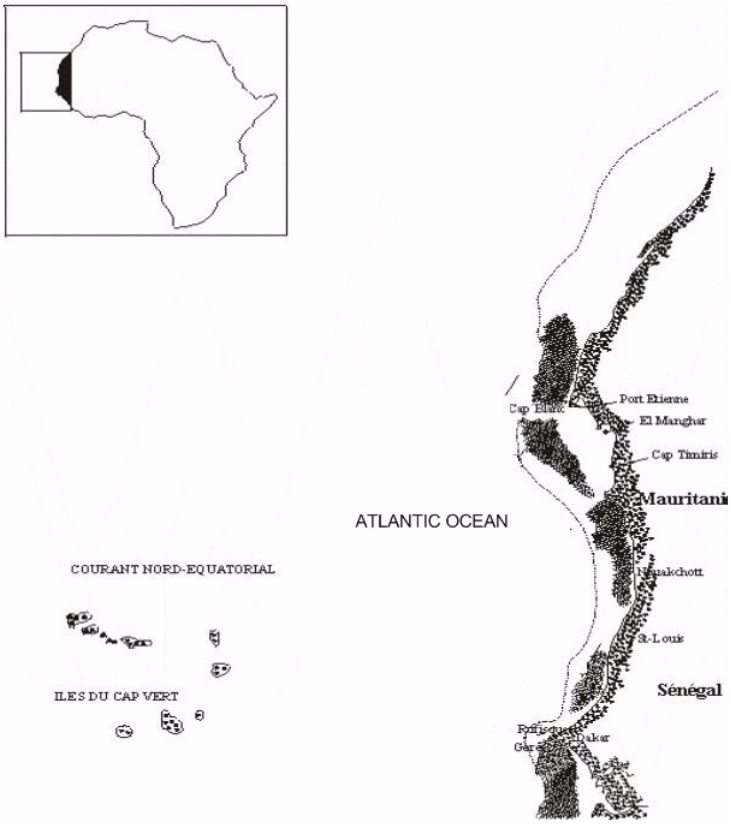


Figure 2 Senegal and Mauritania coastal sites

**DK-14. Akchar, Mauritania** **4340 ± 40 BP**
**2890–3029 BC**

Shell samples (*Donax rugosus*) collected 31 May 1996 from the site of Bantar After Saheli (Akchar in Mauritania). Samples collected from the shell midden situated at 18°59′N, 16°15′W.

**DK-15. Goula (Aftout es Saheli), Mauritania** **6485 ± 64 BP**
**5321–5557 BC**

Shell samples (*A. senilis*) collected 31 May 1996 from the site of Goula in Mauritania. Samples collected from the shell midden situated at 16°55′N, 16°14′W.

**DK-16. Foum Arguin, Mauritania** **5147 ± 76 BP**
**3763–4079 BC**

Shell samples (*A. senilis*) collected 31 May 1996 from the site of Foum Arguin in Mauritania.

*Comment*: The sequence DK-9 to DK-16 are coherent with regards to their respective calibrations and allow the determination of the Nouakchottan transgression (Vernet 1993) climatic phase.

### *Ngayene Series*

Samples of charcoal from wood collected and presented by A Holl from the Museum of Anthropology at the University of Michigan (USA) during archaeological excavations made at the Megalithic sites of the rural community of Ngayene in the Falémé region (northern Senegal) in June 2005.

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**DK-17. Ngayene, Nioro du Rip, central-west Senegal** **305 ± 35 BP**
**AD 1482–1654**

Sample collected at 1.6–1.7 m depth.

**DK-18. Ngayene, Nioro du Rip, central-west, Senegal** **3075 ± 30 BP**
**1268–1415 BC**

Sample collected at 1.7 m depth.

**DK-19. Ngayene, Nioro du Rip, central-west Senegal** **820 ± 25 BP**
**AD 1173–1264**

Sample collected at 0.6 m depth.

**DK-28. Ngayene, Nioro du Rip, central-west Senegal** **926 ± 32 BP**
**AD 1025–1180**

Sample collected at 20–40 m depth.

**DK-29. Ngayene, Nioro du Rip, central-west Senegal** **960 ± 27 BP**
**AD 1064–1155**

Sample collected at 61–80 m depth.

**DK-32. Ngayene, Nioro du Rip, central-west Senegal** **3823 ± 60 BP**
**1075–1155 BC**

Sample collected at 190–200 cm depth.

*Comment*: The purpose of this sequence of dates (DK-17, -18, -19, -28, -29, and -32) is the construction of a chronological timeframe of the Megalithic cemetery of Ngayene. These dates were made in a cooperative study between the $^{14}C$ laboratory of IFAN (Dakar) and the LOCEAN laboratory (University Paris VI, France).

### *Grande Côte Series*

These samples were collected by Hamady Bocoum, archaeologist at the Laboratory of Protohistory and Prehistory of the IFAN, and Cheikh Anta Diop of Dakar. Dates below are made at the Grande côte, Senegal (Figure 3) for small stations behind the offshore bar of the big coast, which had not been studied prior.

**DK-20. Grande côte, Senegal** **3657 ± 81 BP**
**1871–2235 BC**

Charcoal from wood collected at 1.5 m depth, 1600 m north of Mbanar 1 (18°48′N, 15°29′W).

**DK-21. Grande côte, Senegal** **2005 ± 50 BP**
**121 BC–AD 85**

Charcoal from wood collected between 190 and 200 cm depth, 1600 m north of Mbanar 1.

**DK-22. Grande côte, Senegal** **2014 ± 75 BP**
**206 BC–AD 137**

Charcoal from wood collected at 1.3 m depth at Mbanar 1. The tumulus is located near the village school (15°15′N, 16°20′W).

**DK-23. Grande côte, Senegal** **1970 ± 35 BP**
**45 BC–AD 87**

Charcoal from wood collected at 1.55 m depth, 1600 m north of Mbanar 1. The tumulus is situated near the village school (15°15′N, 16°20′W).

**DK-24. Grande côte, Senegal** **1643 ± 49 BP**
**AD 322–539**
Charcoal from wood collected at the village of Keur Abdou Ndoye, Kayar (15°15′N, 16°20′W).

**DK-25. Grande côte, Senegal** **5900 ± 66 BP**
**4601–4944 BC**
Shell samples collected at an ocean station connecting Kayar and Mboro.

**DK-25a. Grande côte, Senegal** **1324 ±70 BP**
**AD 602–878**
Shell samples collected on the road leading to Lac Rose.

**DK-25b. Grande côte, Senegal** **3823 ± 60 BP**
**2133–2467 BC**
Shell samples collected at Yallay-Mbanar-Mbow site VII.

*Comment*: Sequence DK-20, DK-21: Analysis of the progress of the excavation allows us to construct a relatively coherent succession of the early sequences of the tumulus. Two dates obtained at approximately the same depth are very close (1970 ± 35 and 2014 ± 37 BP) and place us at the beginning of the Christian era.

## GEOLOGICAL SAMPLES

The following samples were collected in eastern Senegal by Alain Pearson, researcher at the University Paris VI (France).

**DK-30. East Senegal** **5033 ± 33 BP**
**3760–3947 BC**
Concretion samples of lakeside limestone collected in Ferlo, a site in eastern Senegal (15°27′97″N, 13°39′32″W).

**DK-31. East Senegal** **4517 ± 47 BP**
**3089–3365 BC**
Pedological carbonated concretion samples brought out by the dismantling of a wind turbine in Falémé (14°22′78″N, 12°13′99″W).

## MARINE SAMPLES

The following samples were analyzed to determine $\Delta^{14}C$ (Stuiver and Polach 1977; Mook and van der Plicht 1999) and time variation for the Senegalese coastal region. The samples were collected by Mr Marchad and processed by the Marine Biology Laboratory of IFAN.

**DK-26, DK-27. Dakar (Senegal)** **$\Delta^{14}C$ = 44‰**
Shell sample collected in 1951.

**DK-33. Dakar (Senegal)** **$\Delta^{14}C$ = 43‰**
Shell sample collected in 1951.

**DK-34. Dakar (Senegal)** **$\Delta^{14}C$ = 45‰**
Shell sample collected in 1956.

**DK-35. Iles du saloum (Senegal)** **$\Delta^{14}C$ = 44‰**
Coral sample collected in 1950.

**DK-36. Dakar, Senegal** **$\Delta^{14}C = 65‰$**

Coral sample collected in 1974.

*Comment*: These $^{14}C$ values correspond with the predicted values according to their collection dates (Broecker et al. 1978).

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