



External geophysics, climate and environment (Climate and palaeoclimate)

$\delta^{13}\text{C}$ variation of soil organic matter as an indicator of vegetation change during the Holocene in central Cameroon

Variation du $\delta^{13}\text{C}$ de la matière organique des sols comme marqueur des changements de végétation au cours de l'Holocène au centre du Cameroun

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ABSTRACT

In order to better understand the dynamics of the forest–savanna mosaic from central Cameroon, we analyzed ^{13}C and ^{14}C profiles of six oxisols: two under forests and four under savannas. The $\delta^{13}\text{C}$ soil profiles collected in the forests indicate that these environments are stable at least since the mid-Holocene, whereas the areas currently covered by savannas were formerly occupied by more forested vegetations. The ^{14}C dating of organic matter indicate that the late extension of the savannas in central Cameroon date from the Late Holocene, starting from 4000–3500 ^{14}C yr BP.

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RÉSUMÉ

Afin de mieux comprendre la dynamique de la mosaïque forêt–savane du centre du Cameroun, nous avons analysé les profils isotopiques ^{13}C et ^{14}C de six oxisols: deux sous forêt et quatre sous savane. Les profils de $\delta^{13}\text{C}$ des sols sous forêts indiquent la permanence de ce couvert végétal depuis au moins le milieu de l'Holocène, alors que les sols couverts actuellement par de la savane étaient auparavant occupés par une végétation plus boisée. La datation ^{14}C de la matière organique montre que l'extension des savanes du centre du Cameroun date de l'Holocène supérieur et n'a débuté que vers 4000–3500 ^{14}C an BP.

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1. Introduction

In Equatorial Africa, the edge of the evergreen forest massif consists of a mosaic of semi-deciduous forests

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and savannas. Savannas also occur within the forest massif in small patches but also, as in the Bateke plateaus in Congo, over wide areas. The origins of these open landscapes, which occur under present-day equatorial climate mostly suitable for forest presence, are still a matter of debate (Bayon et al., 2012). Isotope analyses on soil organic matter are widely used to discriminate between C3 (mostly forests) and C4 (mostly savannas) vegetation through $\delta^{13}\text{C}$ measurements and thus are powerful tools to reconstruct the history of these former landscapes (Boutton, 1996). Although based on a few sites, the soil profiles from Congo (Schwartz, 1997; Schwartz et al., 1992) and Gabon (Delègue et al., 2001) recorded large-scale environmental changes in relation with the Late Quaternary climatic succession in specific areas of the Atlantic Coast and the Bateke Plateaus.

As soon as the late fifties, Bachelier et al. (1957) studied soils from the savanna–forest mosaic from the lowlands of central Cameroon. They concluded that the anthropogenic activities and mainly repeated burnings were responsible for the recent opening up of the forest. However, Youta Happi (1998) and Guillet et al. (2001) showed that the forest has been currently expanding since, at least, the last decades.

In this article, we present isotope analyses on six soil profiles recovered in central Cameroon along a south–north transect from Abong Mbang to the southeast ($3^{\circ}50'\text{N}$ – $13^{\circ}20'\text{E}$) and Ngambe Tikar to the north–west ($5^{\circ}40'\text{N}$ – $11^{\circ}40'\text{E}$), in an area where the lack of lacustrine or swamp deposits hampers our understanding of past environmental changes. The goal of our study is to discuss the changes in forest extents during the recent past, particularly at the age of the Late Holocene forest crisis evidenced throughout central Africa (Vincens et al., 1999). These changes are thought to have strongly influenced the local populations (Bayon et al., 2012; Verdu et al., 2009).

2. Materials and methods

2.1. Soil profile location

Two soil profiles were taken in semi-deciduous Sterculiaceae/Ulmaceae forests (at Abong Mbang and Ngambe Tikar) and four profiles were taken in savannas (at Ndjolé, Sangbé, Maboén, and Nditam) (Fig. 1). The savannas are of Guineo–Congolian phytogeographical type (White, 1983) and are characterized by tall grasses, mainly *Hyparrhenia* sp. with shrubs and trees. (*Lophira lanceolata*, *Annona senegalensis*, *Bridelia ferruginea*, *Bauhinia thonningii*, *Terminalia* sp.). All the studied soils were located in the highest part of the relief, and classified as oxisols, with texture varying from clayey to sandy-loamy.

2.2. Soil sampling

Soils were sampled using a 6-cm-diameter auger, to a depth of 390 cm, at 10-cm intervals between the surface and 50 cm, and at 20-cm intervals from 50 cm to the bottom. The soil samples were air-dried, sieved with a 2-mm mesh, homogenized and ground to $< 200\ \mu\text{m}$. The forest and savanna core sites were chosen in low declivity zones, within undisturbed vegetation apart from the present savanna–forest boundary.

2.3. Stable isotope analyses

Since C3 plants (the dominant plants in forests) and C4 plants (the dominant plants in savannas) are isotopically distinct, it is possible to detect shifts from tropical forests to grasslands (or vice versa) from the $\delta^{13}\text{C}$ signature of organic matter in soils (Desjardins et al., 1996; Mariotti, 1991; Runge, 2002; Sanaiotti et al., 2002; Schwartz et al., 1996).

The isotopic ratio ($R = {}^{13}\text{C}/{}^{12}\text{C}$) is reported in standard delta notation ($\delta^{13}\text{C}$), defined as parts per thousand (‰)

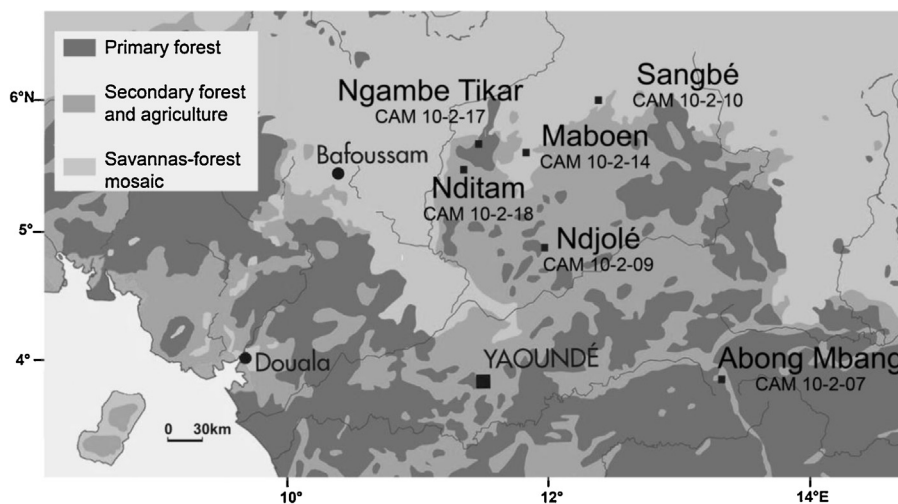


Fig. 1. Location map of the study sites. The simplified vegetation map is from Guillaumet et al. (2009).

Fig. 1. Carte de localisation des sites étudiés. La carte de végétation simplifiée est reprise de Guillaumet et al. (2009).

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