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Comment

Comment on "Geochronological arguments for a close relationship between surficial formation profiles and environmental crisis (c. 3000–2000 BP) in Gabon (Central Africa)", by D. Thiéblemont et al., 2013 [C.R. Geoscience 345, 272–283]

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1. Introduction

The recent paper in this journal by Thiéblemont et al. (2013) (TH) discusses mainly about the coarse-grained stone lines (S L) in central Africa, particularly the most recent one, and also the fine-grained Cover Horizon (C H) above the S L. This study supplies various interesting precisions on the implementation of S L and C H. So "geochronological data suggest a close relationship between these formations (S L and C H) and the Upper Holocene environmental crisis". "The geological events linked to the S L (ca. 3000 BP) and also to C H (younger than 2000 BP) emplacement are connected with climatic and environmental changes"; and also "the S L event causes the destruction of the soils and the spreading of block as debris flows over the landscape before being collected in torrential fluxes along the river drainages." Then the authors conclude: "Clearly, this could not have taken place in a landscape dominated by equatorial rainforest, therefore suggesting that forests were not present at c. 3000–2000 BP [. . .]. Thus, converging arguments led us to conclude that most (if not all) of the surface of Gabon and western Congo was free of forest c. 4000 to 2000 BP".

2. Comment

We discuss there only the last generation of S L, which intervened probably during the Late Holocene. As S L is an entirely detrital deposit, it is obviously very difficult to date directly using radiocarbon techniques. Moreover, many data, detailed below, lead us to reject the conclusions of TH that the Central African forest would have almost completely disappeared between 3000 and 2000 cal BP, and perhaps even as early as 4000 cal BP. Consequently, and given that the authors indicate that S L is directly connected to climate change and in particular to a Late Holocene crisis in Central Africa, an indirect way of dating precisely this S L is to consider the evidence of this event in lacustrine sediments from several sites of Central Africa. Diverse palynological, sedimentological, geochemical and isotopic data are available from sites in:

- southern Cameroon, including Lakes Barombi Mbo (Maley and Brenac, 1998), Ossa (Giresse et al., 2005; and ref. therein), and the Nyabessan Swamp (Ngomanda et al., 2009);

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- Gabon (Giresse et al., 2009; and ref. therein), Lake Nguène, south of Monts de Cristal, and Lake Maridor;
- Mayombe, western Congo, Lake Kitina (Elenga et al., 1992), and Kakamoéka soil profile (Maley and Giresse, 1998);
- in northern Congo, Mopo swamp (Maley and Willis, 2010; and ref. therein).

First, following a maximum extension of the forest domain during the Early Holocene, a large contraction occurred abruptly around 4000 cal BP, evident as a strong extension of the northern and southern adjacent savannahs. To the north, large savannah extensions intervened in Togo and Benin with the opening of the "Dahomey Gap" (Salzmann and Hoelzmann, 2005) and also in southern Cameroon (Deschamps and Turcq, 2013), and to south of the equator with the extension of the Niari savannahs (western Congo), as seen in the drying of Lake Kitina (Vincens et al., 1998) and in the same time by the expansion of coastal savannahs in Gabon (Lake Maridor: Giresse et al., 2009). From ~4000 to 2600 cal BP, however, the core of the forest persisted, with frequent large expansions of evergreen forests (Giresse et al., 2005; Maley and Brenac, 1998; Ngomanda et al., 2009).

Then, a major perturbation occurred during the third millennium BP (Maley, 2001, 2002). This was marked by an abrupt decrease of many forest taxa, linked in the same time to a significant, rapid extension of pioneer-type forest vegetation. A brief savannah extension occurred in some places such as around the Mopo Swamp (in one level dated ~2500 cal BP) (Maley and Willis, 2010) and around Barombi Mbo, from ~2600 to 2000 cal BP (Maley and Brenac, 1998). Remnants of this formerly extensive savannah still exist today just north of Mount Cameroon.

The S L event described by TH is linked to the major perturbations of the rain forest described above. To date precisely this event, the 5.50 m core OW4 collected in Lake Ossa is particularly well-suited because the abrupt change appears clearly near 1.90 m, and because five radiocarbon dates were obtained near this level (Giresse et al., 2005, Tab. 1). It appears that the 1.90 m level can be bracketed reasonably precisely between ca. 2600 and 2550 (± 50) cal BP. Moreover, this chronology is close to that obtained for the other sites presented here. One can conclude that the major perturbation discussed here, linked with the S L event, almost certainly occurred between ca. 2600 and 2550 (± 50) cal BP. But it is likely that other previous similar events were recurrent through the Pleistocene or although that one deposit was the resultant of several transports, acting as an old palimpsest.

TH considered a very high rate of precipitation required for the S L event "because today, such blocks appear motionless, thus indicating that the power of water flow at the time of emplacement was higher than today". This consideration is inadequate because the competence (transport capacity) of rivers could not allow such a transport, which could be only the result of a torrential regime, improbable here considering the low slopes. It is thus necessary to envisage large landslides (for instance, see the large broken pieces of trees reworked in the upper S L of Kakamoéka, Mayombe: Maley and Giresse, 1998) or huge creeping processes or better debris flows. At the same period such mechanism transported clay clasts in the Lake Assom south of Adamaoua (Giresse and Ngos, 2014). The period with S L emplacement would not be necessary globally rainier, but characterized by several rainy paroxysms acting in the same regions.

Then TH discusses the palaeoclimatic conditions linked to the emplacement of the Cover Horizon that formed above the stone line, i.e. after 2000 cal BP. So TH cites a former paper (Thiéblemont, 2012) which provides precise morphologic, textural and geochemical data indicating that this Horizon is made up mainly by aeolian particles. However, when TH state that "the emplacement of such a layer (i.e. a loess) over large areas is the existence of a denuded surface – where forests were not present – likely to constitute a floor over which the (aeolian) particles will accumulate", this hypothesis is not supported by the available data. Firstly, as shown above, the forest did not disappear. Secondly, according to its own description, the C H "results from the mixing between a fine-grained fraction (clays and silts) and coarser-grained sands"; it thus includes locally derived coarse particles, and cannot be compared to a loess deposit. It could, however, be produced by syn- or post-deposit colluvial processes. It seems that the best explanation would be a final entrainment of the aeolian particles by the rain, and then with variable intensity runoff. This has been already described by Maley (1982, Fig. 4) in relation to the forests of Ivory Coast. Several studies show the importance of the atmospheric transport of dust from Sahara until the equatorial regions of Central Africa (in the present day by Suchel, 1988), wind-blown diatoms from Central Chad being deposited in Lake Ossa during the Late Holocene (Nguetsop et al., 2004), and dust being deposited on the continental slope off Gabon during the Late Quaternary (Bonifay and Giresse, 1992). Moreover, as explained today for Ivory Coast, monsoon can interact with this transport of aeolian material, transforming certain particles into condensation nuclei, which then fall to the ground with the rains, creating conditions for the mixing of fine and coarse particles, as found in the C H.

References

Bonifay, D., Giresse, P., 1992. Middle to Late Quaternary sediment flux and post-depositional processes between the continental slope off Gabon and the Mid-Guinean margin. Mar. Geol. 106, 107–129.

Deschamps, T., Turcq, B., et al., 2013. $\delta^{13}C$ variation of soil organic matter as an indicator of vegetation change during the Holocene in central Cameroon. C. R. Geoscience 345, 266–271.

Elenga, H., Schwartz, D., Vincens, A., 1992. Changements climatiques et action anthropique sur le littoral congolais au cours de l'Holocène. Bull. Soc. geol. France 163 (1), 83–90.

Giresse, P., Ngos III, S., 2014. Palaeoenvironmental observations on a Late Holocene débris-flow process in Lake Assom (Adamawa, Cameroon). Palaeoecol. Afr. 32 (4), 91–122.

Giresse, P., Maley, J., Kossoni, A., 2005. Sedimentary environmental changes and millenial climatic variability in a tropical shallow lake (Lake Ossa, Cameroon) during the Holocene. Palaeogeogr. Palaeoclimatol. Palaeoecol. 218, 257–285.

Giresse, P., Makaya, M., Maley, J., Ngomanda, A., 2009. Late-Holocene equatorial environments inferred from deposition processes, carbon isotopes of organic matter, and pollen in three shallow lakes of Gabon, west-central Africa. J. Paleolimnol. 41, 369–392.

Maley, J., 1982. Dust, Clouds, Rain types, and climatic variations in Tropical N Africa. Quatern. Res. 18, 1–16.
Maley, J., 2001. La destruction catastrophique des forêts d'Afrique centrale survenue il y a environ 2500 ans exerce encore une influence majeure sur la répartition actuelle des formations végétales. In: Robbrecht, E., Degreef, J., Friis, I. (Eds.), Plant systematics and phytogeography for the understanding of African biodiversity. Systematic and Geography of Plants, 71, Meise, pp. 777–796.
Maley, J., 2002. A catastrophic destruction of African forests about 2500 years ago still exerts a major influence on present vegetation formations. Bull. Inst. Dev. Stud., Sussex Univ. 33, 13–30.
Maley, J., Brenac, P., 1998. Vegetation dynamics, Palaeoenvironments and Climatic changes in the Forests of West Cameroon during the last 28,000 years BP. Rev. Palaeobot. Palynol. 99, 157–187.
Maley, J., Giresse, P., 1998. Étude d'un niveau argileux organique du Mayombe (Congo occidental) riche en pollens d'*Elaeis guineensis* et daté d'environ 2800 ans BP. Implications pour les paléoenvironnements de l'Afrique centrale. In: Bilong, P., Vicat, J.-P (Eds.), GéoCam, 1, Presses universitaires du Cameroun, Yaoundé, pp. 77–84.
Maley, J., Willis, K., 2010. Did a savanna corridor open up across the Central African Forests 2500 years ago? CoForChange. Eur. Prog. Letter n° 2, (5 p.).
Ngomanda, K., Neumann, A., Schweizer, Maley, J., 2009. Seasonality change and the third millenium BP rainforest crisis in southern Cameroon (Central Africa). Quatern. Res. 71, 307–318.
Nguetsop, V.F., Servant-Vildary, S., Servant, M., 2004. Late Holocene climatic changes in West Africa, a high resolution diatom record from equatorial Cameroon. Quatern. Sci. Rev. 23, 591–609.
Salzmann, U., Hoelzmann, P., 2005. The Dahomey Gap: an abrupt climatically induced rain forest fragmentation in West Africa during the Late Holocene. The Holocene 15, 190–199.
Suchel, J.-B., 1988. Les climats du Cameroun (thèse d'État). University of Saint-Étienne, France (4 vols.).
Vincens, A., Schwartz, D., Bertaux, J., Elenga, H., De Namur, C., 1998. Late Holocene climatic changes in western Equatorial Africa inferred from pollen from Lake Sinnda, southern Congo. Quatern. Res. 50, 34–45.
Thiéblemont, D., 2012. Evidence for an aeolian origin of the Holocene lateritic surface cover of Gabon (Central Africa). Quatern. Int. 296, 176–197.