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Evolving topography and denudation frame of West Africa over the Cenozoic

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This work aims at reconstructing paleotopographies and mapping the spatial and temporal variations of the local relief of West Africa over the past 50 Ma. The study area extents from the Gulf of Guinea to 17°N and comprises the Guinea-Leo rise and its neighboring lowlands. The study is based on elevation maps of the relicts of three main successive lateritic paleolandsurfaces that developed over West Africa since the Paleocene as a result of punctuated lowering of the base level and long-term climate change. The Bauxite (59-45 Ma) and the Intermediate Surfaces (29-24 Ma) derived from in situ chemical weathering and are capped by alumino-ferriginous duricrusts. The High Glacis formed during a pedimentation-dominated mechanical erosion period (24-18 Ma) of cold/dry tropical climate followed by warmer humid episodes (18-11 Ma), which allowed moderate chemical weathering and subsequent ferricrusting of the pediment (the ages given above are those of the weathering of the surfaces, based on Ar-Ar dating of supergene K-Mn oxides formed in lateritic weathering profiles, [1]). Two types of maps are produced on the basis of more than 380 field stations. Elevation maps of the paleosurfaces (Bauxite, Intermediate Surface and High Glacis) provide paleotopographies at ca. 45, 24 and 11 Ma, respectively. Local relief maps are based on the differential elevation of pairs of successive paleosurfaces (Bauxite-Intermediate Surface, Intermediate Surface-High Glacis, High Glacis-Base level) corresponding to the 45-24, 24-11, and 11-0 Ma erosion intervals, respectively.

At 45 Ma, the bauxite surface defines a 500 km-wavelength and 1500 m-amplitude antiformal upwarp parallel to the coast, extending from today's Niger River delta to Senegal. The upwarp is asymmetrical with a steeper coastal slope. It is flanked to the South East by the inland extensions of the Romanche and Saint Paul fracture zones. The paleotopographic map further suggests that two large North flowing rivers were draining the upwarp at 45 Ma. Between 45 and 24 Ma, the high incision rates (> 10 m/Ma) were confined to the crestal regions of the upwarp and to two portions of its coastal slope, in Sierra Leone and Western Ivory Coast, whereas the highest topographies underwent moderate incision (5-10 m/Ma). The 45-24 Ma period also corresponds to the infilling of the Taoudeni and Iullemmeden intracratonic basins at the foot of the northern slope of the upwarp. The resulting topography at 24 Ma attests to the smoothing out and across-strike widening of the upwarp and the maintenance of high topography in its Western part. Between 24 and 11 Ma, focused denudation continued in coastal areas of Sierra Leone and Ivory Coast and diffuse denudation affected the high/western part of the remaining upwarp. By 11 Ma, the eastern part of the upwarp had been largely dissected and may have been cut by, possibly through-going, North- and/or South-flowing drains, and remains as a skeletal ridge. The relief configuration is concordant with the main actual drainage divides, indicating no significant migration of the main watersheds since 11 Ma. Local relief developed between 11 Ma and today reveals high denudation rates (> 15 m/Ma) focused on isolated topographic massifs that do not necessarily correspond to the highest relict topographies of the relict upwarp. To summarize, the topography of West Africa derives from the punctuated dissection of a marginal upwarp formed essentially before the Late Oligocene. The spatial and temporal variability of the denudation of this upwarp has major implications onto sedimentary and dissolved fluxes to the sedimentary basins and the ocean.

[1] Beauvais, A., G. Ruffet, O. Hénocque and F. Colin (2008), Chemical and physical erosion rhythms of the West African Cenozoic morphogenesis: The 39Ar-40Ar dating of supergene K-Mn oxides, J. Geophys. Res., 113, F04007, doi:10.1029/2008JF000996.