Les accumulations ferrugineuses actuelles de bas de versants en zone forestière humide du Sud-Cameroun: évolutions pétrologiques des faciès et des éléments traces en relation avec le cuirassement

Temgoua E.

While iron crusts are widespread in West and Central Africa savannahs, they generally disappear in the tropical rain forest region. Tropical environments are generally characterised by degradation and dismantling of these ferricretes, which seem to have formed under a climate characterised by alternating humid and dry seasons. Under the present humid rainforest conditions typical for tropical zones, iron crusts are in desequilibrium ; they are degrading and dismantling. The dismantling evolves from the top down and from the bottom up the profile or inside the crust. It affects the landscape morphology. The new land surface shows two levels : the first level is higher in altitude, old, represented by large hills with tabular summits and covered by savannah. The second is lower, recent, covered by forest and represented by half-orange shaped hills. This level, characteristic of tropical and equatorial climate, shows actual iron accumulation found on the lower part of hill slopes. Iron crusting is not known as tropical humid zone process. The main goal of this study is to characterise recent ferruginous accumulations which occur on lower part of hill slopes in Southern Cameroon and to identify the iron crust building processes in the humid rainforest zone. This work deals with (micro) morphological, mineralogical and geochemical aspects, based on more than about 70 up to 15 m deep soil profiles on an area of a 250 hectares, situated on a half-orange shaped hill between local rivers at an average altitude of 700 m. The relationship between different soil facies, slope angles and groundwater level fluctuations has been established.

Three types of topographic profiles characterise the study area : in the Northern part, the slopes are short, high in altitude (from 705 to 660 m a.s.l.), and very steep, ranging up to 50% near the entailed zone ; in the southern and eastern part, they are long, low in altitude (from 705 to 635 m a.s.l.) and gentle, less than 5% near the swamping zone. The third down slope type shows an intermediate morphology ; it is observed at the head of W, SW, SE thalwegs and presents the moderate slope. The whole landscape appears to derive from the same undulated surface, that was entailed and eroded leaving behind tabular buttes and half-orange shaped hills.

The Meyomessala study area in particular contains the old thick ferricrete near the top of the plateau part and the present day forming carapace on the lower part of slope. The soil shows fifteen horizons that have been grouped on three types : (I) weathering horizons (isalterite, alloterite and grey clay), (II) ferricrete and ferricrete dismantling horizons (pebbly horizon, ferricrete, spotted nodular horizon, soft nodular horizon, soft clayey horizon) and (III) downslope iron accumulations (yellow grey clay, variegated clay, mottled clay, variegated massive carapace, variegated vesicular carapace, spotted massive carapace). The petrography data and water table fluctuation show that the ferruginous accumulations of the downslope are linked with the hydromorphological process.

On the steep slope, the mottled clay horizon represents the only iron accumulation pattern. These pattern is confined to the extreme part of the slope. It is developed as ferruginous core nodules, becoming more consistent into a clayey soft matrix, without continuous crusting process, despite that the iron is concentrated even more inside the nodules. The mottled clay are overlain by red soft clay of the crust dismantling patterns, on place as relics or transferred by crawling processes.

The moderate slope represents the valley head. Here, from the bottom to the top of the profile, the soil patterns consist of yellow grey clay with a homogenous matrix constituted of the mineral kaolinite. The variegated clay follows on top of the first pattern and consists of large mottled sectors, either purplish red, less hardened with goethite, or yellow and soft with goethite and kaolinite minerals, or whitish grey and flabby with kaolinite. On the variegated clay follows the variegated massive carapace and is distinguished from the latter by its harden mottles with goethite, hematite and kaolinite minerals, and by the increase of the consistency of the yellow and yellow brown mottles. The accumulation of these materials is related to a perched groundwater aquifer that generates permanent humidity due to rising capillary water. At the top of the variegated patterns, a spotted massive carapace shows very reduced yellow and whitish mottles, and abundant red mottles. The latter tend to form a continuous ferruginous frame constituted by hematite and goethite. These massive accumulations are richer in iron (~25% Fe_2O_3). Here, the induration seems to be related to the seasonal humidity conditions.

With the subsidence of the land surface, the slope becomes gentle. Pedological features on the bottom of the profile are essentially whitish grey to greenish grey clay patterns, richer in quartz, kaolinite and cracks. The cracks are filled, either by purplish red and less relatively soft material with goethite, or by yellow soft materials with kaolinite and goethite. The variegated vesicular carapace follows on top of the variegated clay and is distinguished from the latter by harder domains, and by the increase of the consistency and the appearance of vesicles. These domains are filled out by a dark red ferruginous network and the variegated clay-filling vesicles. The mottled clay pattern takes over from the variegated clay zone and the vesicular carapace towards the upper part of the slope. The mean iron content is less here (~15% Fe_2O_3). However, the lateral extension of the iron accumulations has a length of about 400 m and the vesicular carapace represents the hardest downslope patterns. The ferruginous network, developed through the fissures, is due to high groundwater fluctuations between dry and rainy seasons observed in the field. Also here, the iron accumulation is linked to the water table fluctuation zone. These conditions are favourable to mobilise the iron during the humid period and to precipitate it during the dry one and explain why the iron is highly accumulated at the top of the ferruginous patterns.

Iso-element mass balance calculation allows to estimate the chemical transfer of the younger downslope soils. It appears that the ferricrete (group II) and the ferruginous downslope accumulations (group III) show an allochthonous enrichment. This enrichment is significant for the downslope patterns and indicates that iron is transferred from the hill summit to the downslope sequences. The high iron contribution observed on the moderate slope than on the gentle slope indicates that after transfer, the iron is also redistributed during the transformation of the massive carapace to the vesicular carapace when the slope becomes gentle.

The high weathering state of the old ferricrete on the top of the hill is always accompanied by subsidence of land surface and the ground water rising. By subsidence the slope becomes first steep and then gentle. The present study shows that the iron mobilised by ferricrete weathering is an important allochthonous contribution to the downslope of the hill. The carapace crust-building process starts at the spring head where the slope is still steep and remains confined to the slope extremity. These sequence might represent the first stage of the landscape transformation during the Eocene period. When the slope is moderate, the ferruginous accumulation moves upstream and becomes hard in the upper part of the profile, and the massive carapace appears. When by subsidence the slope becomes gentle , the ferruginous accumulations extend more on the slope, while the vesicular carapace replaces the massive carapace. In the present climatic conditions, the carapace crust-building process is able to invade completely the planar landscape.

The ferruginous accumulation here are at their starting stage towards the vesicular crust-building process. There are generalised at the southern Cameroon rain forest zone. Beauvais 1991 has identified the vesicular crust on the low plateau in the Central African Republic. The observed vesicular carapace might be the precursor of these vesicular crust which characterises the actual rain tropical environment.