GEOCHEMISTRY AND MINERALOGY OF SOILS COVERING LATERITES AND THEIR USE FOR GOLD EXPLORATION

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In West Africa, lateritic profiles and mainly ferricretes are very often capped by a silty-clay soil cover. In topographic depressions of the morphology, such soils can reach several meters thick and constitute flat deposits on several kilometer square. Thus, the geochemical signal of these soils is of considerable importance for mining exploration (FARREL, 1984; CARVER *et al*, 1987; SCHELLMANN, 1989). Geochemical and mineralogical aspects of these soils where examined in detail, as well as the lateral and vertical distribution of gold. The study area is localised in the Kangaba area (South Mali).

MORPHOLOGY

The morphology of the Kangaba area is slightly undulated. Ferricrete plateaus are capped by gravelly soils mostly made of lateritic nodules derived from the dismantling layer of the ferricrete. In depressions of lateritic plateaus and mainly on thalweg flats, grey silty soils are well developed. These soils consist of an accumulation of fine quartzic and kaolinitic material (ROQUIN *et al.*, 1990).

SOIL PROFILES

In cross section, soils of flat are composed of several horizons.

1- At the base, the fresh ferricrete made of hematitic nodules included in an indurated ferruginous matrix.

2- An horizon of 30 to 100 cm of weathered ferricrete. The degradation of ferricrete is progressive and results from a transformation of the hematitic matrix into goethite. Tubules in the ferricrete are filled with a silty material coming from the upper horizons.

3- The weathered ferricrete is covered by a nodular horizon of 50 to 120 cm thick. The ferruginous matrix is totally dissolved and hematitic nodules, more resistant, appear then isolated within the silty material. At the top, hematite of nodules is also dissolved or transformed into a pulverulent goethite forming yellow iron stains.

4- The nodular horizon is finally capped by a grey-yellow layer, where iron stains are diffuse. That horizon can reach 100 to 300 cm thick. The soils surface submitted to rainfall and lateral runoff is washed and depleted in clay fraction producing a relative enrichment of quartz in the top 30 cm.

The petrographic studies show a weathering process of the ferricrete by a progressive dissolution of the ferruginous material at the contact with the silty material. The ferricrete degradation process occurs in situ. The presence of thick soils creates hydromorphic conditions at their base, where ferricretes are strongly weathered. Iron oxihydroxides are dissolved and large voids are invaded by the silty material coming from the upper horizon.

ORIGIN OF THE SILTY MATERIAL

The average composition of the silty material is 62% quartz, 33 % kaolinite and 2% iron oxyhydroxides. Muscovite and heavy minerals are also frequently observed (ROQUIN *et al.*, 1990).

The quartz morphology showed that quartz grains are primary and little or not transported.

No eolian impacts were observed on grain surfaces. Most of quartz grains don't show corrosion features on their faces. These observations lead to conclude that quartz grains of the silty material were not mechanically transported on long distances. The relative lack of corrosion figures on the grain surfaces indicates that most of the soil material don't derive from the dismantling ferricrete upper-layer.

Spheric micro-aggregates of kaolinite and quartz were also observed in the soil surface layer and in tubules of the ferricrete. Such aggregates are characteristic of termite activity (ESCHENBRENNER, 1986). There are also good correlations between the geochemistry of soils and the saprolite located at 10-15 m depth below the ferricrete.

The termite activity results in an upward motion of clays, silts or even sand particles deposited on termitaria. Termitaria are submitted to mechanical erosion, their material is washed out, and finally deposited in low laying areas. Commonly, the uptake source of the silty material corresponds to the mottle zone or to the top of the saprolite of the lateritic profile (BOYER, 1973).

GOLD BEHAVIOUR IN FLAT

Geochemical soil surveys in the area showed important differences between gold signal in ferricretes and in flat. Strong gold anomalies were detected in flats even if gold contents in the underlying ferricrete are often below the detection limit. There is no strict vertical dependence between the gold grades in flat soils and in the underlying ferricretes. In fact, there are local enrichments in flat close to the mineralization, but gold anomalies in flats are shifted in regard to gold anomalies in ferricretes around the mineralization.

In the Kangaba area, gold is strongly dissolved in the laterite profile, particularly in the ferricrete, where 90% of visible gold shows corrosion features (FREYSSINET *et al.*, 1989). The same statistics applied to gold grains in flats indicate that gold is generally much less corroded than in the ferricrete. Morphological characteristics of gold in flat are very similar to those of grains observed in the mottled zone. It seems that most of the gold contents in flats are included in the termite material which was uptaken in the mottled zone or in the saprolite close to the mineralization (Fig. 1).

The vertical distribution of gold shows a strong depletion in the top 20 cm of the soil, where the fine fraction is removed by runnof. High gold grades are generally observed in the silty horizon between 30 and 150 cm depth. Gold more concentrated in the fine fraction (<125um) whereas coarse fraction composed of nodules is low graded. Correlation diagramms show a good affinity between gold and the clay fraction like kaolinite or weathered muscovite.

CONCLUSION

In conclusion, pedological, petrographical and geochemical studies applied to soils of flat bring several informations on the origin of the material, and also on the gold behavior in these soils.

1 - Thick soils on laterites, particularly in thalwegs, constitute a favorable environment for hydromorphic processes and then for ferricrete degradation.

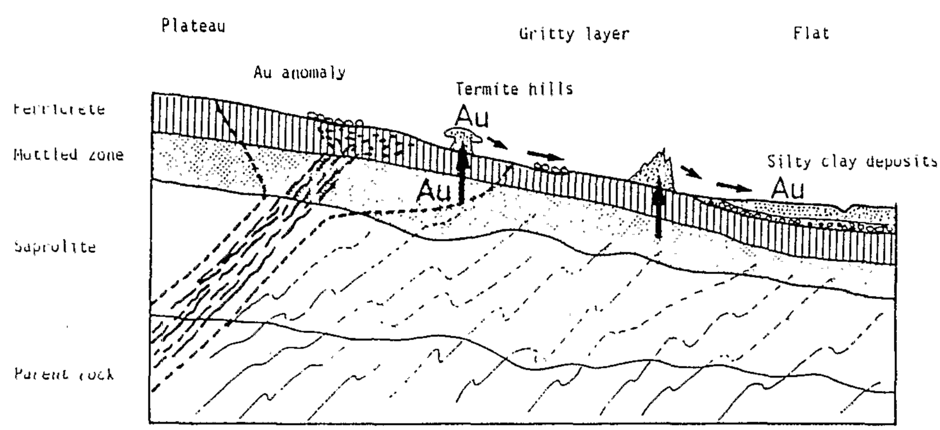

Figure 1 : Lateral mouvement of material reworked by termite activity.

2- The silty material of flat derives essentially from the termite activity. According to quartz grain morphology, the proportion of eolian material is negligible in this area.
3- The termitic origin of the soils of flat are of primordial interest for exploration geochemistry because of their chemical relationship with the underlying horizon (mottle zone or saprolite). However these soils are eroded and the material can be transported for several hundreds of meters on plateaus or in thalweg flats. That's why in the case of a regional survey, soils of flat represent a good sampling media, but for follow-up exploration studies at a local scale, the gold signal in ferricretes or in gravelly soils should be more precisely located than in silty soils.

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