Chemical Geology, 107 (1993) 323-326
Elsevier Science Publishers B.V., Amsterdam

Gold: a useful tracer in sub-Sahelian laterites

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(Received April 6, 1993; revised and accepted April 15, 1993)

1. Introduction

Sequential and connected lateritic sequences from the Tertiary to present day can be observed in sub-Sahelian conditions in northern Burkina Faso (Michel, 1973; Grandin, 1975). Here, complex iron auriferous crust systems have developed on the stable West African Craton from Proterozoic auriferous greenstone belts and volcanic tuff. In order to distinguish between chemical and physical processes which have led to the development of the lateritic systems, we propose to use visible gold particles as pathfinders.

In this paper, we focused on the lowland lateritic system (profile of pit P4) located downslope to the middle land lateritic system, where gold is associated with hydrothermally altered quartz veins and pebbles (Fig. 1).

2. Weathering pattern and distribution of visible gold

The P4 weathering profile can be divided from top to base into three main layers (Fig. 2):

The H1 sandy–clayey layer, 0.1–2 m thick, consists of a gray-greenish sandy–clayey matrix. The minus 500 μm fraction is nearly 80% by weight of the total sample. The mineralogical composition is homogeneous and consists mainly of blunted quartz grains and kaolinite, with minor illite and smectite.

The H2 nodular layer, 1.5–1.8 m thick, is friable and consists of a red and yellow sandy–clayey matrix (25–30% of the total weight), with mainly quartz and kaolinite. Illite and smectite are less abundant at the base. In the matrix, elements above 500 μm ($\sim$75% by weight) are composed of angular and blunted quartz pebbles and blocs, debris of indurated iron crust, ferruginous small plates of schist and diffuse Fe nodules. The base of the layer consists of a 20 cm thick sublayer rich in angular quartz blocs.

The H3 saprolite is 20 cm thick and consists of smectite and illite. A successive thin bed structure is clearly recognizable and expresses the in situ weathering of schist.

Gold grain sizes range from 800 to 80 μm. Visible gold contents decrease progressively downwards from the sandy–clayey layer to the saprolite, respectively from 0.15 to 0.01 g t^{-1}. In addition, gold grain sizes clearly discriminate between the two upper layers: in the nodular layer, most of the grains exhibit sizes up to 800 μm, while in the sandy–clayey layer, the 500–160 fraction predominates.

3. Morphological features and chemical composition of gold particles

More than 1000 gold particles were collected from profile P4.

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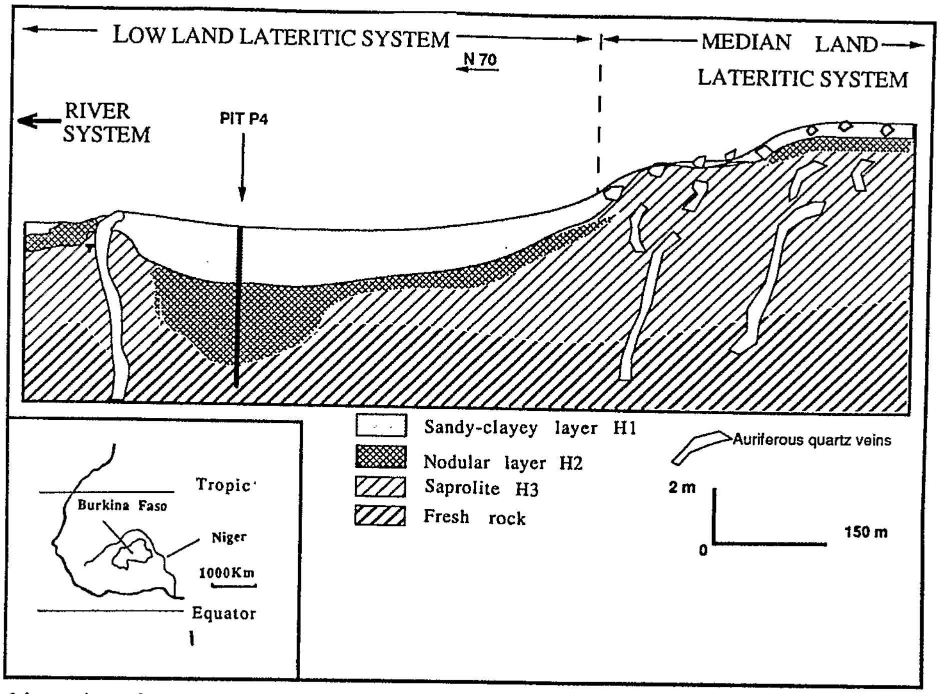

Fig. 1. Geographic setting of Aribinda gold deposit and cross-section of weathering mantle showing the location of pits used in the study.

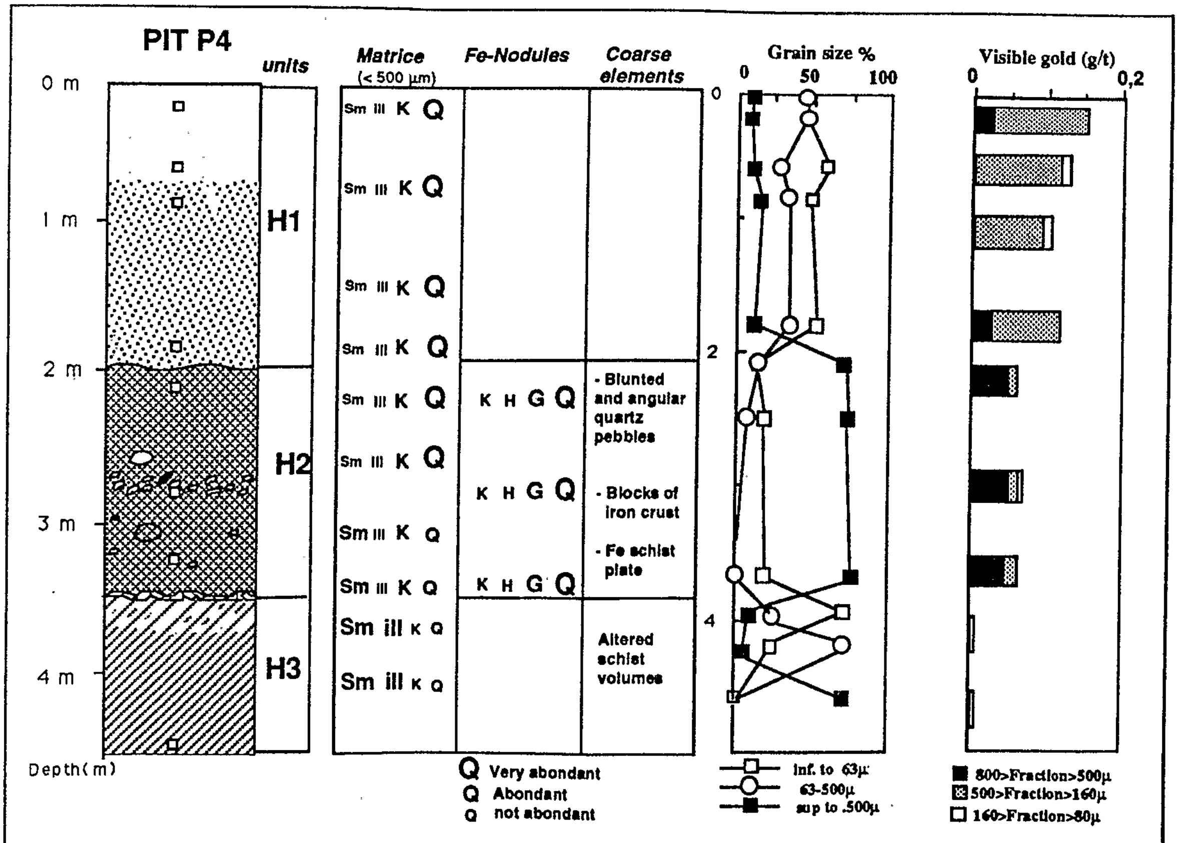

Fig. 2. Sketch showing the principal features of the profile P4 (Q=quartz; K=kaolinite; G=goethite; H=hematite; ill=illite; Sm=smectite). The size of the letter is proportional to the abundance of the mineral (X-ray diffraction).

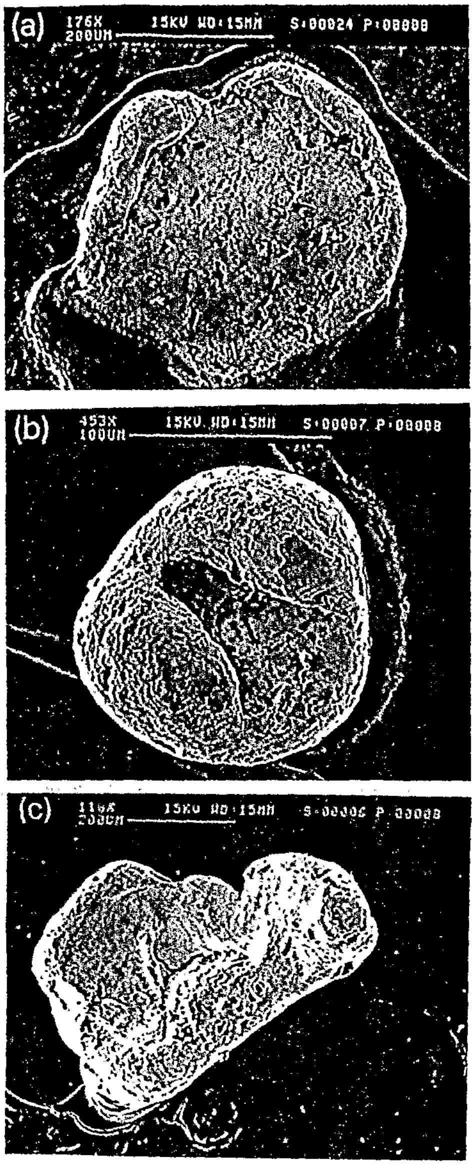

Fig. 3. a and b. Sandy–clayey layer: very rounded particle with (a) turned over features; and (b) scratch features, both covered by numerous micrometric dissolution pits. c. Nodular layer: particle with visible primary euhedral faces and surfaces affected by dissolution pits.

400 gold particles have been studied in detail under SEM and extensive microprobe analyses were performed to study their chemical composition. Within the sandy–clayey layer (H1) particles have homogeneous sizes and develop extremely rounded rims. The primary euhedral crystal faces are not recognizable and particle surfaces are covered by numerous micrometric pits of dissolution associated with scratch and turned over features (Fig. 3a and b).

Within the nodular layer, particles are much less rounded. Primary euhedral crystal faces are still recognizable under SEM. Surfaces are covered by dissolution pits, without any marks of physical strain.

Within the saprolite, particles are similar to those of the overlying layer.

Ag, S, Al and Cu have been found by microprobe above the detection limit (Table 1).

To feature the distribution of silver, we use a depletion index D_i defined as:

$$D_i = (Ag_{rim}/Ag_{core})(Au_{core}/Au_{rim})$$

If D_i is close to 1 the Ag distribution is homogeneous within the particle. When D_i tends to 0^+, Ag is depleted in the rims.

Gold particles from median lateritic land quartz veins have a mean Ag content of 7.012% and a mean D_i-value 0.932.

Within the P4 profile, there is a notable difference between the H1 and H2 units.

Within the sandy–clayey layer, the mean D_i-value declines strongly to 0.449, while within the nodular layer, the mean D_i-value (0.8) is close to the mean D_i-value of the gold particles issued from the upslope system.

4. Conclusions

The distribution of gold contents, decreasing from the surface to the saprolite is clearly related to translocation patterns. The source of imported gold grains is the quartz veins of the median lateritic system. However, granulometry, morphology and chemical composition discriminate between the nodular and the sandy–clayey layer. Gold particles which originated from the nodular layer are much less weathered than those issued from the upper one: this is expressed by the coarser granulometry, by the less pronounced bluntness and by

TABLE 1

Mean chemical composition of gold particles extracted from the P4 profile (H1 and H2 layers) and from the quartz veins of the median land lateritic system (S1)

	Au	Ag	S	Al	Cu	$D_{i(Ag)}$	
P4 H1	m	94.86	5.051	0.037	0.027	0.021	0.449
	S.D.	1.455	1.171	0.008	0.012	0.01	0.23
P4 H2	m	93.413	6.435	0.068	0.061	0.0147	0.8
	S.D.	2.064	2.085	0.026	0.016	0.01	0.33
S1	m	92.32	7.012	0.0128	0.043	0.0113	0.932
	S.D.	5.516	4.84	0.0085	0.021	0.0089	0.219

m = median; S.D. = standard deviation.

the rather homogeneous distribution of silver compared to the very Ag-depleted rims. In addition, mechanical strain features differentiate the two populations of gold particles.

Taking the weathering patterns into account, we conclude that the nodular layer results from paleo-colluvial-like processes which have drained auriferous quartz blocks. In situ lateritic weathering released the gold particles and made it moderately marked by dissolution. The surficial sandy–clayey layer develops from sub-recent to recent alluvial processes

Thus, gold behavior enables us to demonstrate that the lowland lateritic systems from northern Burkina Faso have evolved from colluvial to alluvial-like processes combined with superimposed in situ lateritic weathering.

References

Grandin, G., 1976. Aplanissements cuirassés et enrichissement des gisements de manganèse dans quelques régions d'Afrique de l'Ouest. Mém. ORSTOM (Off. Rech. Sci. Tech. Outre-mer), No. 82, 275 pp.

Michel, P., 1973. Les bassins des fleuves Sénégal et Gambie —Étude géomorphologique. Mém. ORSTOM (Off. Rech. Sci. Tech. Outre-mer), No. 63, 3 vols., 752 pp.