Correlation between Metallic Oxides (Fe_2O_3, Cr_2O_3, NiO) Platinum and Palladium in the Laterites from Southeast Cameroon (Central Africa): Perspectives of Platinoids Survey in Weathering Mantles

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Abstract

Southeastern cameroonian laterites, in the equatorial wet region, develope on serpentinites. They form a thick weathering mantle made up of a saprolithe, a glaebular mass and a red sandy-clay horizon.

The amount of iron (Fe_2O_3) fluctuates between 44.32 % in the saprolithe and 22.84 % in the red sandy-clay horizon. The content in Cr_2O_3 vary between 1.1 % in the saprolithe and 0.5 % in the red sandy-clay horizon. NiO vary between 0.41 % in the saprolithe and 0.11 % in the red sandy-clay horizon. The contents of the three oxides diminish from the saprolithe to the red sandy-clay horizon.

The contents in platinum are, 20 ppb in the saprolithe and glaebular mass and 10 ppb in the red sandy-clay horizon. That of palladium is 12 ppb in the saprolithe and 8 ppb from the glaebular mass to the red sandy-clay horizon. These results show that these two elements concentrate in the saprolithic areas of the weathering mantle of ultrabasic rocks at the same level like metallic oxides (Bowles, 1986, 1990; Ndjigui, 2000). Their content diminishes from the saprolithe to the red sandy-clay horizon. The mobility of platinum and palladium in the superior part could be linked to the solubilisation of metallic oxides due to the intense soil biological activity (Travis et *al*., 1976). The metallic oxides would probably be carrier minerals of platinum and palladium in the weathering mantle and may be considered as tracers in platinoids survey.

Introduction

Most of the reseach works that have been carried out on elements of the platinum group (platinum, palladium, iridium, osmium, ruthenium and rhodium) are based on the inventory of the species of minerals from the platinum group in the ultrabasic rocks, as well as in the stream sediments originating from ultrabasic districts (Cabri et Laflamme, 1976 ; Barnes et Naldrett, 1986 ; Gueddari et *al.,* 1994 ; Auge et *al.,* 1995). Very few works have been based on the fate of these elements in the weathering mantles of ultra basic rocks ; amongst these, are the works carried out in Western Australia (Travis *et al.*, 1976; Bowles, 1986) and in brazil (Varajao *et al.,* 1999). This very reduced number of studies can be explained by the scarcity and the very low quantity of platinoïds in the weathering mantles as well as the high cost of their analysis. However, considering the high economic value of platinoïds, all research works that can improve their survey in surface formations should be developed. In this respect, on the bases of correlations established between metallic oxides and platinoïds (Travis *et al.,* 1976; Bowles, 1986), this work re-precises these correlation in the weathering mantle and attemps to bring out their significance in the search for platinoïds in the lateritic weathering mantle on ultrabasic rocks.

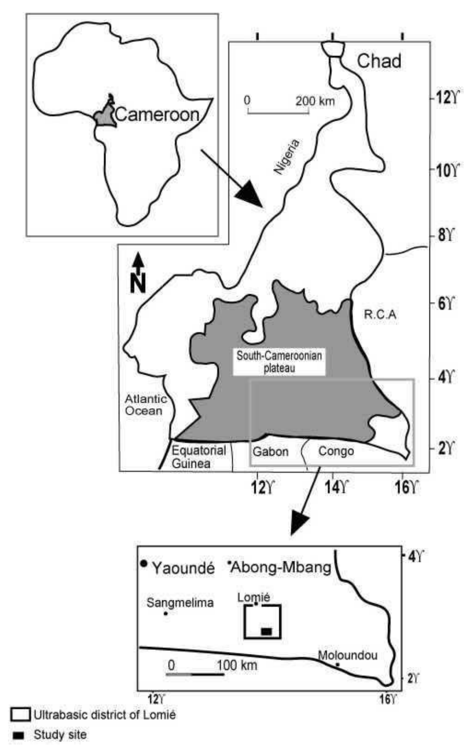

Figure 1. *Location map.*

Material and method

This study is located at Lomié in the wet forest region (1655 mm of rainfall) of South-East Cameroon (fig. 1), on the largest (240 km^2) of the four ultrabasic districts in the country.

The ultrabasic rocks of Lomié district are serpentinites resulting from the hydrothermal weathering of harzburgites (Seme Mouangué, 1998). They are crossed by beddings schist and quartzite and are made up of antigorite, magnetite, magnesite and talc. The weathering profile studied is situated on the slope of an interfluve 550 m high. It is an 11 m deep profile that is made up of; from bottom to top, a ferruginous saprolithe, a glaebular mass and a red sandy-clay horizon (fig. 2). Entire fractions of the parental rock (serpentinite), the ferruginous saprolithe, the glaebular mass and the red sandy clay horizon where submitted for global chemical analysis carried out at the Centre Européen de Recherche et d'Enseignements en Géosciences de l'Environnement (CEREGE (Marseille), France) and to specific analysis of platinum and palladium at the laboratoire Chemex (Canada). Platinum and palladium were analysed on an ICP-EAS and their respective detection limits are 5 and 2 ppb.

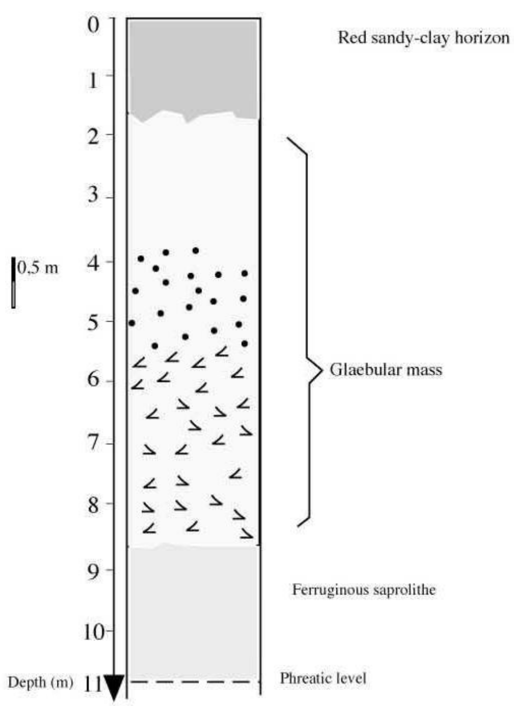

Figure 2. Macroscopic organization of the weathering profile on serpentinite.

Results

Contents in metallic oxides and platinoids. The parental rock is mostly made up of silica (39.38 % SiO_2) and magnesium (39.44 % MgO). The content in Fe_2O_3 is 7.13 % and, among the trace elements, the presence of considerable quantities of nickel (0.29 % NiO) and chromium (0.31 % Cr_2O_3) are observed. The contents in platinum and palladium remain lower than the detection limit (table 1).

From the parental rock to the base of the profile, in the ferruginous saprolithe, an increase in contents is observed for :

- iron, from 7.13 to 42.58 % Fe_2O_3, that is 600 %,
- chromium from 0.31 to 1.04 % Cr_2O_3, that is 340 %,
- and nickel from 0.29 to 0.41 %, that is 140 %.

As for the platinoids, their contents, just like in the case of metallic oxides greatly increase from the parental rock to the saprolithe (Table 1).

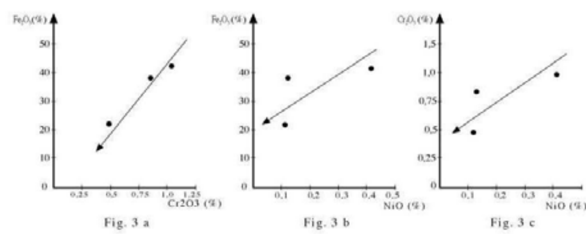

Fig. 3. Correlations between Fe_2O_3/Cr_2O_3, Fe_2O_3/NiO and Cr_2O_3/NiO.

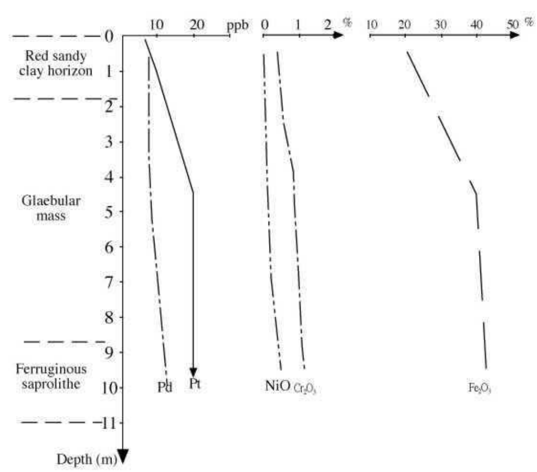

***Fig. 4** . Evolution of the content of metallic oxides and platinum and palladium in the weathering profile of serpentinite.*

In the weathering profile, the content in oxides and in platinoids generally reduces from the base to the top (fig. 3). For iron, the reduction is low, of the order of 6 %, from the saprolithe (42.58 % Fe_2O_3) to the glaebular mass (39.88 % Fe_2O_3), and higher, about 42 %, in the surface red sandy-clay horizon (22.84 % Fe_2O_3) (tab. 1). Chromium presents an identical evolution to iron at all points (fig. 3). As for nickel, it's content reduces by more than 60 % from the saprolithe (0.41 % NiO) to the glaebular mass (0.12 % NiO), and nearly remains stable at the red sandy-clay horizon at the top (0.11 % NiO) (tab. 1 and fig. 3). For platinum and palladium, the detail of the evolution of their contents permits the identification of two groups according to the similarity in the nature of the curves. One group is made up of nickel and palladium (fig. 3) and another is made up of iron, chromium and platinum, these 3 elements decreasing by about 50 % from the base to the top of the profile (Table 1)

The content in platinum varies between 10 and 20 ppb in the weathering profile. It is lower than the detected limit in the parental rock , equal to 20 ppb in the ferruginous saprolithe and in the glaebular mass (fig. 3). In the red sandy-clay horizon, the content in platinum drops by 10 ppb (table 1). Palladium shows a similar evolution to that of platinum. The content in platinum is equally lower than the detected limit in the mother rock. Meanwhile, it is of the order of 12 ppb in the ferruginous saprolithe, 8 ppb in the glaebular mass and the red sandy-clay horizon (table 1).

Correlation between metallic oxides. Figure 4, shows a very marked correlation between iron and chromium (fig. 4a) and an unmarked correlation between these two elements and nickel (fig 4b and 4c).

Correlations between metallic oxides and platinoids. From the six correlations established (fig. 5), it follows that:

- For platinum, the correlation is very marked with iron (fig. 5a) and with chromium (fig. 5b), but is average with nickel (fig. 5c).
- On the contrary, for palladium, the correlations are more marked with nickel (fig.5d) than with iron and chromium (fig. 5e and 5f).

Discussion

The very important increase in the contents of metallic oxides (140 % for NiO, 340 % for Cr_2O_3 and 600 % for Fe_2O_3) is therefore observed when passing from the parental rock to bottom of the weathering profile. Such a phenomenon, attributed to surface weathering concerning metallic oxides in weathering mantles, is frequently observed in lateritic areas (Trescases, 1975 ; Edou-Minko, 1988 ; Ouangrawa *et al.,* 1996 ; Ndjigui, 2000). Likewise, with Travis et al (1976), it can be noted that, this weathering that concentrates metallic oxides at the base of profiles equally seems to concentrate platinoids. Within the lateritic weathering mantle, platinoids and metallic oxides have an identical mobility; their contents, high at the base of the mantle, generally reduce towards the top (Travis et *al.,* 1976, Bowles, 1986). According to Travis et *al.*(1976), the great reduction in iron oxides at the top of profiles is linked to the biological activity in the soil. The same reason could explain the reduction in the contents of all the other elements studied. To be more specific, platinum is associated to the couple iron/chromium, while palladium is associated to nickel.

Conclusion and perspectives

Generally, metallic oxides (Fe_2O_3, Cr_2O_3, NiO) show a very marked correlation with platinoids. In detail, this correlation is much more marked between iron, chromium and platinum on one hand and between nickel and palladium on the other hand. These very marked correlations confirm that metallic oxides are carriers of platinoids in lateritic weathering mantles, at the same time, revealing that these oxides that are abundant and common in lateritic areas are excellent "tracers" in view of platinoids survey within the lateritic weathering mantle. It would be interesting to envisage a mineralogical study in order to identify the forms of the mineral oxides that are carriers of platinoids, and a study, using the Scanning Electron Microscope in view of determining the morphology of elements of the platinum group, and on the other hand to bring out the relationships between the carrier minerals and platinoids.

Table 1: *Contents in metallic oxides and in platinoïds in the parental rock and in the weathering profile.*

		Fe_2O_3 (%)	Cr_2O_3 (%)	NiO (%)	Platinum (ppm)	Palladium (ppm)
Weathering profile	Red sandy -clay horizon	22.84	0.50	0.11	10	8
	Glaebular mass	39.88	0.85	0.12	20	8
	Ferruginous saprolithe	42.58	1.04	0.41	20	12
Parental rock		7.13	0.31	0.29	< 5	< 2

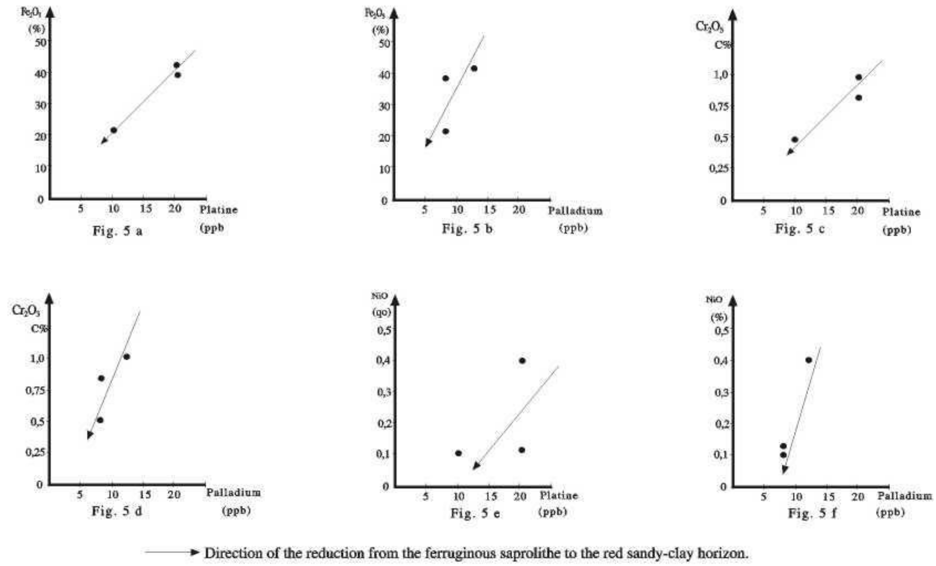

Fig. 5. *Correlations between metallic oxides (Fe_2O_3, Cr_2O_3,NiO) and platinum and palladium.*

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