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Textural and Ore Mineralogical Studies on Laterites of the Sukinda Valley of the Singhbhum Craton, Odisha (India)

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Abstract

The present paper is an attempt to evaluate the chromium ore assemblages with special reference to their behavior of distribution through the lateritic cover. The mafic and ultramafic rock in this area are highly weathered and converted into lateritic soil cover up to the depth of more than 20 mt and exposed in most of the Sukinda area. Laterite is broadly classified based on nature and basement, color of soil, abundance and nature of laterite, abundance of transported boulders in the weathered profile and nature of vegetation. Low level laterite, Disintegrated laterite, Cavernous laterite, Pisolitic and concretionary laterite are mostly found in the study area. The laterite is brown to brickred, orange and spongy, metallic lusture sometimes show pisolitic and concretionary texturelaterite and illustrates probably reconstituent forms of rthymic and colloform bandings.Hematite is the dominant mineral followed by goethite with subordinate amount of limonite, quartz, traces of magnetite.Cavities are more common of various sizes in the Sukinda laterite.The main litho-units of Sukinda ultramafic complex are Serpentinised peridotite, orthopyroxenite, laterite (limonitic at places) and silicified rocks. The maximum area of the Sukinda region is covered by thick laterite, soil and weathered profile of saprolite and limonitic rocks. The lateriteis exposed in most of the Sukinda area. Laterite is broadly classified based on nature and basement, color of soil, abundance and nature of laterite, abundance of transported boulders in the weathered profile and nature of vegetation.

Key words: Sukinda Ultramafic, rethymic coloform banding, Hematite, saprolite, limonitic rocks.

Introduction

Mafic-ultramafic complex of Sukinda Valley is the one of the largest igneous complex of Precambrian age which has been underlain by banded iron formation and chromite bearing ultramafic rocks. It comprises primarily of highly sepentinisedperidotite, orthopyroxenite with lateritic cappingsand secondary limonitised rocks.

The area under investigation is 175 km away from Bhuwneshwar near the tri-junction of Jajpur, Denkanal and Keonjhar district in northern Orissa. It is located within E-W trending valley flanked on the north by Daitari hill range and Mahagiri hill range in south over an area covering approximately 200 sq. km. The geographical co-ordinates of this area are 20° 58’ to 21° 05’ (N) 85° 42' to 85° 53' (E) and evaluation ranging between 166mt and 208mt MSL while the hill ranges rise to over 690mt MSL. [12]. It is falls in survey of India toposheet No. 73 G/12 and 73 G/16.

The terms “laterite” and “lateralization” have been used in so many ways that much confusion has arisen regarding their meaning. Laterite is defined here as the product of tropical weathering resulting from an accumulation of iron, aluminum, and certain other elements. Laterite term was first suggested by Buchanan,[1] as a name for ferruginous deposit observed in Malabar in the India and derived the term from the Latin later. The interesting study of laterite developed because of possible uses of laterite as an ore of aluminum[6], iron and in some cases for manganese[4]. Wadia,[14] classified laterite as high and low level laterite. High level laterite never occur on situation below approximately 2000 feet whereas low level laterite are in most cases secondary origin, they are derived from high level laterite and recombined after deposition in the valley or plane and they are mainly detrital origin. Kellong,[8] defined a latsol as a term to comprehend all the zonal soils in tropical and equatorial region having their dominant characteristics associated with low silica-sesquioxide ratios of clay fractions, low base exchange capacity, low activity of the clay, low content of primary minerals and high degree of aggregate stability. It is collectively term for zonal soil called lateritic soil and it is divisible in to ferruginous soil, ferrallitic soil, humiclatasol and basisols (a group of soil derived from basic rocks). Tertiary period presented congenial condition favorable to lateralization. Quaternary glaciers which remove the altered crust might have obliterated certain influence but did not affect intertropical region[5,11,12].

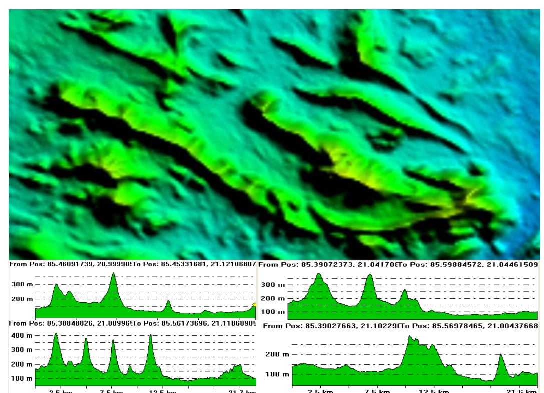

Fig. 1. Elevation model of the Sukinda valley

Geological Setup :

Sukinda mafic and ultramafic complex makes a part of Precambrian un-fossilliferous metamorphosed Peninsular India located at southernmost border of the Singhbhum Craton. Tectonically, the Sukinda complex represents a segment of plat formal part of the Singhbhum Craton. The small plate during ~0.85 Ga back possibly caused deep rifting in the platform[13]. Subsequent to the rifting, an ultramafic body was emplaced as a fault controlled intrusion. In study area, ultramafic are intruded within Iron Ore Group in 2.95 Ga-3.00 Ga. [10], then weathered and converted into laterite. Sukinda valley extends an about 20 km from Kansa town (21^0 04' N: 85^0 57' E) in the east to Maruabil town (21^0 02'N: 85^0 43'E) to the west. Ultramafic field is confined by east-west trending Tomaka (782.42mt)–Daitari (847.77mt) hill and Mahagiri (707.69 mt) hill range[2]. Iyenger[7] correlates the banded iron formation of the Daitari- Tomka basin to the older Gorumahishani group of the Mayurbhanj. Sukinda massif is the largest ultramafic body in the Singhbhum Craton (approximately ~25 X ~400 mt., [9]. The main rock types of Sukinda ultramafic complex are Serpentinisedperidotite, orthopyroxenite, laterite (limonitic at places) and silicified rocks. Laterite, soil and weathered profile of saprolite and limonitic rocks cover the maximum area of the Sukinda valley. The chromite bands occur within serpentinisedp-eridotite. The orthpyroxinites are unaltered having sharp contact with serpentinisedperidotite. Generalized stratigraphic succession of the Sukinda Valley is given in Table 1. Geological map of the area is shown in Fig. 2.

The M-UM rock in this area are highly weathered and metamorphosed at places giving lateritic soil cover up to the depth of more than 20 mt [3]. Weathered part and alluvium of the Sukinda field are divided in to two kinds; i) Latsol, (Megascopicallylatsol appear to be decomposed remnant of laterite) low amount of bases, low humus and high Fe. (Roy Chaudhari et al 1963). At some places thickness of the latsol ranges up to five meter. ii) Chernozem like soil which is high clay content grey to dark gray in color. A freshly exposed profile is divisible into its componential A and B horizon. Horizon A_0 and A_1 are generally absent. The A_2 horizon represented by a dry, granular soil of a lighter shade than

Table 1. The generalized stratigraphic succession of Sukinda valley
(after Chakarborty, et al., 1980)

Alluvium
Laterites (Nickeliferous at places)
Dolerite
Granite and granitic gneiss
Orthopyroxenite (Enstatotite)
Ultramafic intrusion with chromitite
Sandstone (Quartz-arenite) :Kolhan Group ?
Conglomerate
~~~~~~~~~~~~~~~~~~~~Unconformity~~~~~~~~~~~~~~~~~~~~~~
Banded Iron Formation with interbaded volcanic tuff and alteration product
Quartzite with intraformational conglomerate
Basement no exposed
~~~~~~~~~~~~~~~~~~~~

the B horizon lying beneath. (A_0, A_1, A terminology as given in Hawkes and Webb[5].

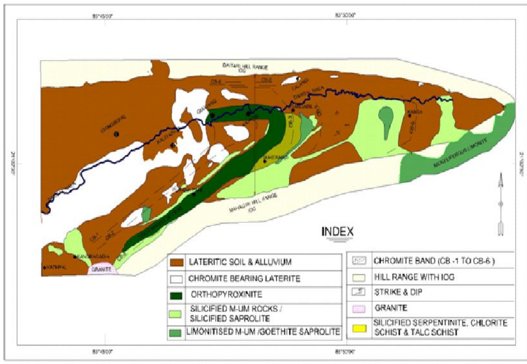

Figure 2.Geological map of the Sukinda Valley.

Laterite: These occur as weathering residues through the removal of silica, and the alkali as well as calc alkali elements. Laterite are usually reddish brown, moderately high density 2.5-3.6, usually contains secondary alumina. According to Roychaudhari[11], the types of laterite and its sub-divisions are classified.

a) **Massive laterite:** It possesses a continuous hard fabric and it is divided into cellular and vesicular laterite. Cavities of cellular laterite are approximately rounded.

b) **Nodular laterite:** In consist of rounded concretions, it is also called as pisolitic laterite and again subdivided into cemented nodular laterite, partly cemented nodular laterite, non cemented nodular laterite and iron concretions.

c) **Recemented laterite:** It contains fragments of massive laterite or ferruginous laterite.

d) **Ferruginized rock**: Rock structure is still visible but with substantial isomorphous replacement by iron.

e) **Soft laterite:** Mottled rich-clay which hardens irreversibly on exposure to air or to repeated wetting and drying.

The laterites are exposed in most of the Sukinda area. Laterite is broadly classified based on nature and basement, color of soil, abundance and nature of laterite, abundance of transported boulders in the weathered profile and nature of vegetation (Fig. 4). These are divisibleintothe two types:

Low level laterite: At places the thickness of low level laterite crust is up to 12 mt. It occurs as flat, gently sloping pavements and supports a very thin (less than 6 cm thick) and discontinuous layer of top soil. The laterite is brown to brick red in colour and is made of hematite, and goethite with subordinate amount of magnetite with few amount of limonite. This type of laterite includes both transported and residual components.

Disintegrated laterite: It is confined in out crop to the slopes. In the plains, it lies concealed beneath latsol. It is made up of angular pebbles of vesicular laterite and partly lateralized ultramafites set in a silty matrix. (fig. 3.a, b).

Pisolitic and concretionary laterite: It is made up of loosely bound, pale to reddish brown iron oxides, pisolites with 1-5% silty matrix. Individual concentrations are made up of a hard outer shell of hematite and goethite (fig.3.c).

Cavernous laterite: It is characterized by large (up to 10 cm or more in length and around 2 cm in diameter) tabular voids, interconnected by tortuous passages. Parts of these voids are filled up with granular soil. An interesting feature of the process of laterali-zation is the conversion of the grey chromite down to a depth of about 3 mt from the surface into a lumpy brownish ore, poorer in chrome content and richer in iron oxides (fig.3.d).

Laterite capping on the hillocks: This type is mostly developed on a basement of the limonitised rocks. It is orange, brown, brick red, or steel grey in colour. The orange and brown shades are composed of dominantly of goethite and keolinite with variable unit of hematite and quartz, minute traces of magnetite and localized concentrations of flaky illite, while the brick red and steel grey shades are mostly made up of hematite and goethite.

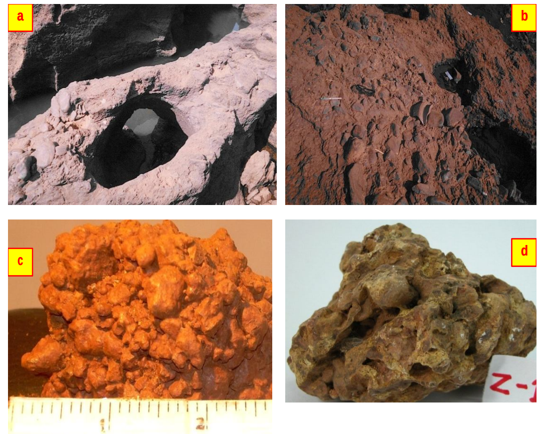

Fig.3 Lateritic terrain, a and b) Disintegrated laterite c) Pisolitic and concretionary and d) Cavernous

Table 2 The geological setup of the laterite can be represented by following profile

Profile I	Profile II	Profile III
Soil aproximatly 5 meter	Soil aproximatly 3 meter	Massive and hard laterite
Concretionary laterite 60cm	Concretionary laterite 50 cm	Cavernous laterite
Silicified ultramafic	Disintegrated laterite having boulders of massive laterite	Lateritised bed rock
	Concretionary laterite 40 cm	Limonitised and silicified rock
	Aproximate 2 meter soft clay rich layer	
	Limonitised, silicified and serpeninised rock	

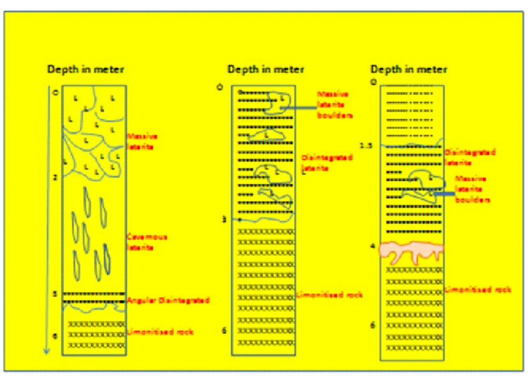

Fig.4 Vertical distribution Pattern of Laterite

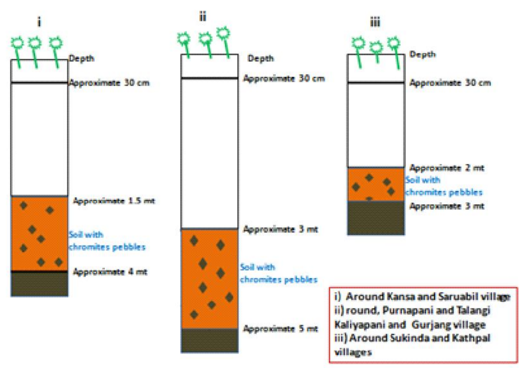

Fig.5 Vertical distribution of Chromite in latasol.

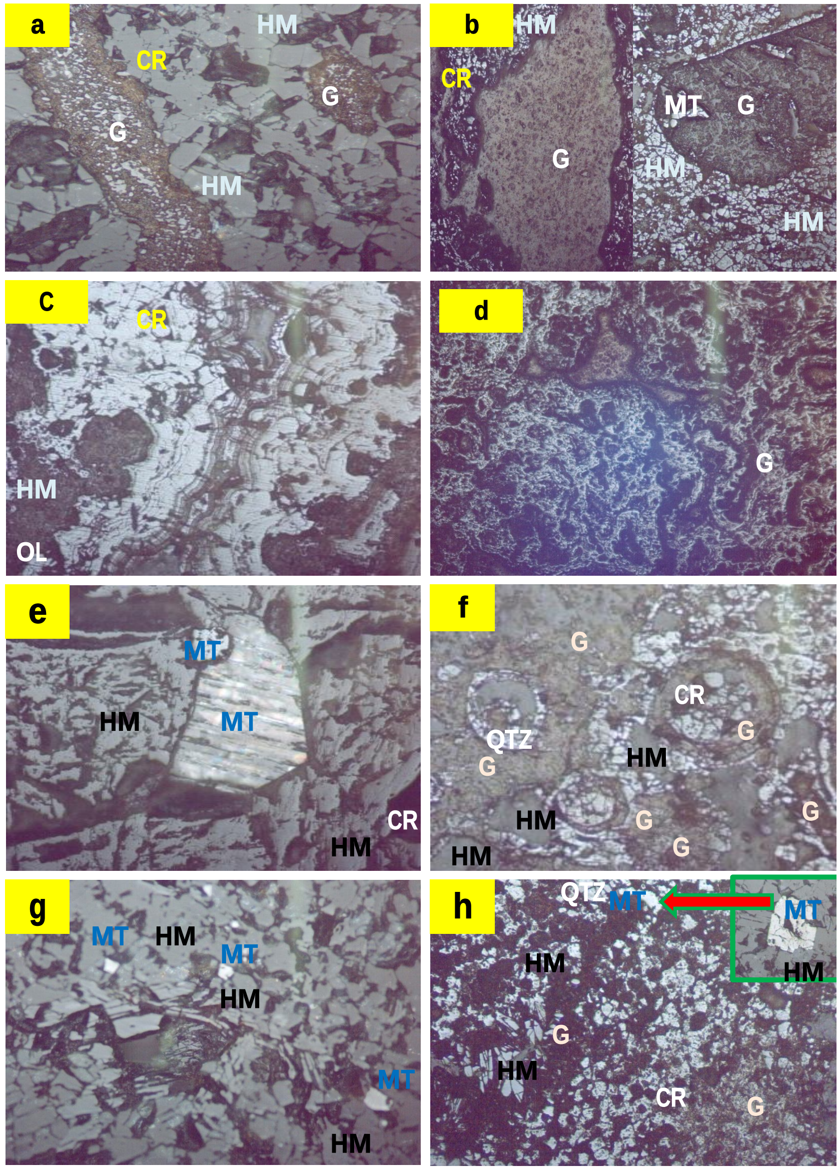

Fig. 6 Photomicrograph of laterite showing a)Vein of goethite traverse through the hematite and its margin show replacement, b) Goethite balls, gel structure mass of earthy goethite replaced hematite and lobade pattern of goethite found in the laterite with inclusion of magnetite and also in figure d, c) laterite illustrates probably reconstituent forms of rthymic bandings called colloform texture, e) Phenocryst of magnetite embedded in the hematite and goethetic matrix and show internal refraction, f) Pisolitic grain of goethite illustrate orbicular texture which is surrounded by hematite, g) Light grey gray shades are mostly made by hematite and goethite, h) granular texture having hematite (gray), goethite (earthy gray) magnetite

Ore Petrography :

The lateriteis brown to brickred, orange and steel grey in color.Fe and Al hydroxide are evident by the color. It is spongy, metallic lusturesometimesshow pisolitic and concretionary texture. Theorange and brown shades are composed of dominantly of goethite and keolinite. Hematite is the dominant mineral followed by goethite with subordinate amount of limonite, quartz, traces of magnetite. Goethite balls, gel structure seen along with typical laterite texture (fig.6, b). Goethite crystals are rounded in shape and occur in pisoids (Fig. 6, .f). The light grey gray shades are mostly made by hematite and goethite (Fig. 6.a and g). Laterite shows granular texture having hematite (gray), goethite (earthy gray) accessory magnetite (fig 6, e) (white color) with traces in quartz and chromite (brown color). Pisolitic grains of goethite illustrate orbicular texture which is surrounded by hematite (Fig.6, .f). Phenocryst of magnetite embedded in the hematite and goethitematrix show internal refraction (fig 6, .e). Mass of earthy goethite replaced hematite and lobade pattern of goethite found in the laterite with inclusion of magnetite (fig 6, .b). Vein of goethite traverse through the hematite and its margin show replacement also (fig 6, .d). In the fig. 6, b and c of laterite illustrates probably reconstituent forms of rthymic bandings called colloform texture. Cavities are more common of various sizes in the Sukinda laterite.

Conclusion

Mineralogical and chemical studies indicate that an area of laterite developed on ultramafic rocks. The serpentine alters to montmorillonite, aluminous goethite, and quartz. Chromiferous chlorite, a stable component, becomes concentrated in the weathering profile. No bauxite groups were identified, and the alumina occurs chiefly in solid solution with the goethite. In the upper levels of the profile serpentine and montmorillonite disappear completely, and the amount of alumina substituting in the goethite increases.

The mineralogical investigations reveal that nickel is released from serpentine by chemical weathering and has partly been residually enriched in goethite along the supergene enrichment in goethite and Mn oxides. The lateriteis brown to brickred, orange and steel grey in color. Fe and Al hydroxide are evident by the color. It is spongy, metallic lusture sometimes show pisolitic and concretionary texture. Theorange and brown shades are composed of dominantly of goethite and keolinite. Hematite is the dominant mineral followed by goethite with subordinate amount of limonite, quartz, traces of magnetite. Goethite balls, gel structure seen along with typical laterite texture. Laterite exhibits the excellent reconstituent forms of rthymic bandings called colloform texture. Cavities are more common of various sizes in the Sukinda laterite.

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