GOLD COAST DEPARTMENT OF SOIL AND LAND-USE SURVEY

CONFERENCE PAPER

SOILS DEVELOPED OVER ANCIENT DRIFTS IN THE FOREST ZONE OF THE GOLD COAST WITH PARTICULAR REFERENCE TO THE UPPER TANO DRAINAGE BASIN

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Introduction

Soil surveys conducted in the forest zone of the Gold Coast have revealed the presence of several upland soil associations the component series of which, when fully developed, are deeply weathered, concretionary,* red loams or light clays occurring on summits and upper slopes of rolling hills, and merging into their brown or yellow-brown associates of similar morphology on middle to lower slopes. These soils have developed more or less *in situ* over weathering products of rocks, and the major criterion in their classification is the type of parent rock from which they are derived.

Soils developed over ancient terrestrial drifts were first recognised by Charter (1). Though closely associated with the residual soils described above, they nevertheless represent a distinct pedogenic group. They typically occur on flat to gently undulating hills which represent the remnants of ancient erosion surfaces. Their profile consists of red or brown — the colour depending on drainage — strikingly uniform, non-concretionary loam or light clay of a variable depth, overlying abruptly a highly weathered bedrock. A stone-line which usually forms a layer of ironstone concretions, ironpan boulders and sub-angular to sub-rounded quartz stones, is often present between the uniform transported horizon above and the weathered bedrock. The stone-line marks the lowermost limit of the transported material. Similar occurrences of stone-lines in soils developed over transported materials have been observed in Central Africa (2) and in the Belgian Congo (3).

Another characteristic though not indispensable feature of a drift profile is the presence of bright yellow, brown, rusty and red mottlings at the base of the transported horizon and in the underlying weathered bedrock. The mottling is often associated with induration which may extend above as

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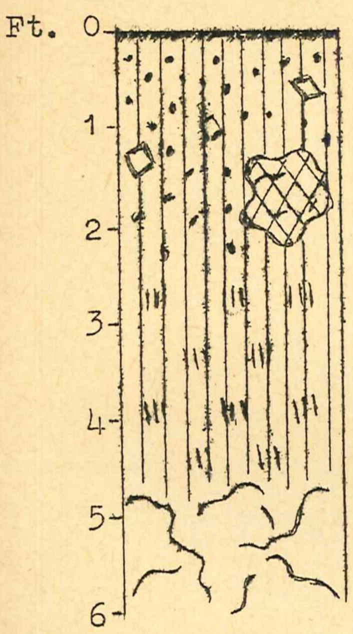
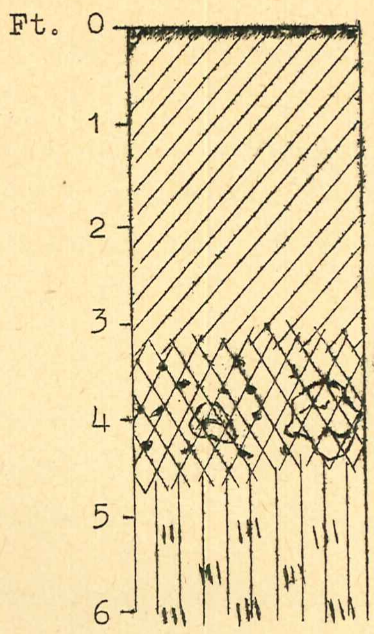
*The term refers to ironstone concretions with a diameter varying from a few millimetres to several centimetres.

well as below the stone-line, thus forming a seemingly uniform but genetically complex horizon of indurated and mottled material. This is more apparent where the stone-line is either weakly developed or virtually absent.

The most important morphological differences between the two types of soils described in the foregoing are diagrammatically summarised below.



(1)



(2)

(1). Typical profile of an upland soil developed more or less <u>in situ</u>. Humic topsoil ± ironstone concretions overlying red or brown subsoil + ironstone concretions, ironpan boulders and typically angular quartz stones. This is followed by the weathered soil substratum which merges into the weathered parent rock.

(2). Typical profile of an upland soil developed from ancient drift material. Uniform non-concretionary red or brown subsoil of a variable depth overlies mottled and indurated material which merges into the weathered bedrock. The stone-line is usually present at the base of the transported material.

Erosion of the drift profile

A number of drift profiles have undergone several morphological changes which have primarily been caused by progressive dissection and erosion of flat-topped hills and a slow uplift. Largely as a result of such processes the superficial drift deposits may be removed and the stone-line with the mottled horizon exposed to the surface.

Several stages of this erosional process have been observed in the upper drainage basin of the river Tano. Shallow drift soils with 2 or 3 feet or less of red or brown transported earth are often encountered on the edges of flat summits. These overlie a considerably indurated and mottled horizon which becomes softer with depth and eventually merges into the weathered and friable bedrock. Further towards the valley the superficial drift deposits disappear completely and this results in the development of a truncated profile consisting of humic, often concretionary, topsoil a few inches thick, overlying hard ferruginous and massive pan.

Thus with the progressive removal of the superficial drift, the mottled and only slightly indurated horizon below it gradually hardens and turns into completely ferruginous hardpan when exposed to the surface.

The process of hardening is, however, extremely slow and it is doubtful if it takes place to any appreciable extent under the present climate with the resulting forest vegetation. On the other hand it may be accelerated by more rapid erosion of the superficial drift when the forest cover is completely removed.

It is not intended in this paper to discuss recent theories regarding the formation of ferruginous crusts. These have been dealt with and summarised by Prescott and Pendleton (4) who conclude that such crusts (commonly referred to as laterite) when found on uplands, are essentially the exposed illuvial horizons of ancient soils. The field evidence presented in this paper supports this view, though there is a need for analytical investigations to determine to what extent the eluvial surface horizons so well preserved in some parts of the basin, have contributed to the formation of the underlying mottled and indurated material.

Occurrence and classification of drift soils

Soils developed over ancient drift material are well represented in the upper drainage basin of the river Tano, where they occur either in large expanses of a few hundred square miles forming upland associations of their own or in 10 to 100 acre patches entering into complex associations with soils of sedentary origin.

Three major soil associations, each comprising deep drift soils as well as their shallow and truncated associates, developed over three distinct erosion surfaces, have been recognised in the region.

1. Soils developed over the oldest erosion surface, the remnants of which form most of the highest hills with summits from 2,400 above sea level in the north to just over 1,000 feet in the south of the region. Though the superficial drift deposits are still found, particularly on inextensive flat summits of hills above 1,500 feet, sheets or broken up boulders of hardpan, occurring just below the surface of such summits and on slopes, are far more common. However, massive ferruginous laterite is often replaced by massive bauxite or bauxitic or manganiferous laterite. These constitute economically important sources of aluminium and manganese.

The remnants of this surface have been recognised elsewhere in the Gold Coast but its age remains uncertain. Junner (5) believed it to be of early to mid-Tertiary age. More recently, Brammer (6) suggested that it might belong to the early Tertiary and as such be correlable with King's African surface (7) which has also been recognised in Nigeria (8). Brammer's explanation of wide differences in height within this surface is that the erosion cycle responsible for its formation may have been two-phased.

2. Soils developed over the succeeding erosion surface which occurs 1,000 to 500 feet below the former. This is believed to be a peneplain of late Tertiary origin. Though considerably dissected in the south, it is still well preserved in the north of the region, where it forms a series of extensive flat-topped hills above 1,000 and up to 1,400 feet above sea level, covered by superficial drift deposits. No bauxite or bauxitic laterite has been found associated with this surface. The horizontal exposures of hardpan which

are quite evident on flat summits below 1,000 feet in the south of the region, where the superficial drift deposits have been completely eroded, consist entirely of ferruginous laterite.

The erosional trends of this surface and the formation of soils associated with it are discussed in another paper*.

3. Soils developed over a piedmont erosion surface which is probably younger than the above though the evidence regarding its exact age is lacking. Extensive flat-topped hills between 1,000 to 750 feet display deep drift deposits underlain by well developed stone-lines consisting of relict ironstone concretions and boulders, ferruginised fragments of rock and large and small quartz stones and gravel. The stone-line layers are commonly thicker (2-4 feet or more) than those found in other drift soils, and there is also a remarkable scarcity of bright mottling and induration at the base of the drift and in the highly weathered bedrock below, which is soft and friable. However, incipient mottling associated with slight induration has been observed in a few cases, and this may well indicate that the process is either taking place at a very slow rate or, more likely, that the topoclimatic conditions favourable for a more rapid formation of the mottled and indurated horizon have ceased to be operative.

Throughout the area occupied by these piedmont drift soils much higher hills, either as isolated peaks or as small ranges, can be found. The difference in height between these hills and the adjacent level of the piedmont surface varies from 1,000 to 500 feet, or in some cases, less. Soils developed on steep slopes and summits of these hills are relatively immature and of sedentary origin with weathered parent rock occurring at 3-4 feet below the surface. Such hills have been referred to as ancient inselbergs, but it is interesting to note that although their summits are rounded, they correspond in height to the remains of the

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*Radwanski, S. A. Soils associated with the late Tertiary peneplain and its erosion in the upper Tano drainage basin of the Gold Coast. (Paper submitted to the Sixth International Congress of Soil Science, Paris, 1956.)

oldest erosion surface. Furthermore, relict boulders of ironpan similar to those which underlie the piedmont drifts, are frequently found on summits and slopes of such hills. These boulders obviously represent the products of an ancient erosion cycle which may possibly be the same as that responsible for the formation of the oldest erosion surface.

Apart from the above occurrences there is evidence of more recent erosion cycles in the region. These are discussed in the paper already quoted.

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Summary

A considerable number of Gold Coast soils are developed not only over the products of weathering that remain in situ (residual soils) and over recently transported material but also over ancient terrestrial drifts of variable origin.

These drift soils have the following structure: a variable depth of uniform earth overlies abruptly the weathered bedrock from which it is usually separated by a stone-line; the latter, if present, consists of a layer of ironstone concretions, ironpan boulders and sub-angular to sub-rounded quartz stones. An indurated and mottled horizon may develop in the weathered rock and below the stone-line and at the base of the drift above.

Erosion of the superficial drift may expose this indurated horizon which in the process hardens into ferruginous pan.

The drift soils are classified according to their relative age as reflected by their present relief. The classification comprises three major erosion surfaces each represented by a distinct association of drift soils including their shallow and truncated associates.

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