D. DURICRUSTS

Field Note D5a. Pedogenic and non-pedogenic ferricretes

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Ferricrete slab.

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1. Introduction

Ferricrete is a hard, erosion-resistant layer of sedimentary rock, usually conglomerate or breccia, that has been cemented into a duricrust by iron oxides. The iron oxide cements are derived from the oxidation of percolating solutions of iron salts. Ferricretes form at or near the land surface and may contain non-local sediments that have been transported from outside the immediate area of the deposit.

The name is a combination of *ferruginous* and *concrete*. Synonyms include ferruginous duricrust, hardpan and ironpan.[1]

Ferricrete is used widely in South Africa to build roads in rural areas. It is better known in these regions by its Afrikaans name *'Koffieklip'* (coffee stone).

There is very little literature about ferrictere in South Africa and the South Western Cape. The Author is not aware of any study of the ferricretes of the Overberg or alongthe South Coast.

A confusion exists, though, as the terms *ferricrete* ('an iron-rich crust') and *laterite* ('a highly weathered material rich in secondary forms of iron and/or aluminium') have been used interchangeably to describe iron-rich duricrusts of various genetic origins.

To better understand the following discussion, the following are definitions of the terms used below, taken from Wikipedia.

> **Saprolite** is a chemically weathered rock. Saprolites form in the lower zones of soil profiles and represent deep weathering of the bedrock surface. In most outcrops its color comes from ferric compounds. Deeply weathered profiles are widespread on the continental landmasses between latitudes 35°N and 35°S.
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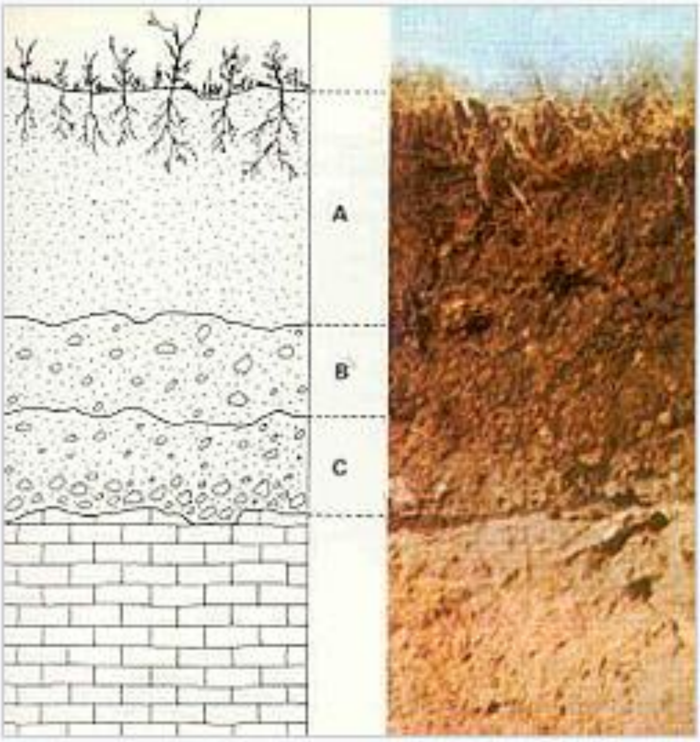
> **Laterite** is both a soil and a rock type rich in iron and aluminium and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterites are of rusty-red coloration, because of high iron oxide content.
>
> **Regolith** (/ˈrɛɡəlɪθ/) is a blanket of unconsolidated, loose, heterogeneous superficial deposits covering solid rock. It includes dust, broken rocks, and other related materials and is present on Earth, the Moon, Mars, some asteroids, and other terrestrial planets and moons.

The diagram below is a graphic depiction of the above terms.



A represents soil; B represents laterite, a regolith; C represents saprolite, a less-weathered regolith; beneath C is bedrock.

Mike Widdowson, from the University of Hull (in: https://www.researchgate.net/publication, 2003) explained the differences in the formation of, and made distinction between, genetically different types of iron-rich duricrust as follows (with the necessary omissions):

> A horizon, at the land surface, made up of the cementation of near surface materials by iron oxides, and often forming a resistant *duricrust. Having varying thicknesses, ferricrete can form laterally extensive sheets which may extend over large areas. Consequently, is perhaps the most widespread of all the duricrust materials. At outcrop it comprises a massive, interlocking fretwork of iron, and often aluminium compounds that bind together other lithological and pedogenic components.
>
> In its broadest sense, the term ferricrete can be used to describe any duricrust material in which the dominant bulk components are iron-rich compounds. However, whilst this may seem a straightforward definition, difficulties arise because the term has been employed to describe a wide range of terrigenous weathering and alteration products resulting from differing processes of formation.
>
> ***Ferricretes*** are those duricrusts which incorporate materials non-indigenous to the immediate locality in which the duricrust formed. In many instances the transported materials can be readily identified as pebbles or clasts derived from adjacent lithological terranes, or as fragments from indurated layers of earlier generations of laterite or ferricrete. Importantly, the term ferricrete should also be extended to those materials whose constituents have been substantially augmented by the precipitation or capture of elements and compounds from allochthonous fluids (i.e. those derived during the

breakdown and mobilisation of materials outside the immediate locality of ferricrete formation). Although it is the allochthony of the constituent materials of the ferricrete, which justify its appellation, determining whether the introduction of such fluids has taken place, and confirming their allochthony is often problematic. However, since ferricretes may develop as ferruginous foot slope accumulations or within topographic depressions, they can often be distinguished by the fact that they display an obvious discordance with the underlying substrate lithologies. In effect, they do not display the progressive weathering profile characteristic of many laterite profiles, and instead the ferricrete horizon sits upon relatively unaltered bed rock.

Laterites are iron-rich duricrusts which have formed directly from the breakdown of materials in their immediate vicinity, and so do not contain any readily identifiable allochthonous (external) component. Lateritic duricrusts are typically manifest as the uppermost layers of in-situ weathering profiles.

To summarise, ferricrete and laterite are not synonymous terms and should, wherever possible, be used to distinguish between fundamentally different types of iron-rich duricrust. This distinction is particularly important since it places constraints upon the type of processes operating during evolution of a duricrust, and the palaeoclimatic and morphological conditions existing at the time of its development. However, although emphasis is put upon establishing whether the iron component is allochthonous or autochthonous, distinguishing these two types of duricrust, both in the field and in hand specimen, can prove problematic. Problems arise because once formed ferricretes can begin to alter and evolve in response to prevailing climatic and groundwater conditions and, over time, begin to exhibit some of the structural and textural features typical of lateritic weathering profiles. In effect these ‘evolved’ ferricretes become modified by a post-depositional weathering and ferralitisation (a leaching process which remove bases and silica). Conversely, the role of allochthonous groundwater fluids, and associated lateral or down slope transport of elements and compounds, cannot always be excluded in the development of otherwise autochthonous laterite weathering profiles.

When documenting ferricrete in the field, one should also be aware of the process of ferrugination, by which shales and silcretes have been, in some places, wholly transformed into ferricretes. Ferricrete slabs, chunks and nodules are very heavy due to the iron content.

Photographs of the various ferricretes found in the Study Area, and maps of their locations are presented in this Field Note.

Other types of ferricrete in the Study Area were found along waterways near shallow lakes and in lacustrine environments. Laurie Wirt et al (in their article Geochemical and Hydrologic Processes Controlling Formation of Ferricrete, in: Professional paper 1651, US Geological Survey, Dep of Interior) explained the formation of this type of ferricrete (with the necessary omissions):

"……Another condition for the formation of ferricrete, is when reduced acid-sulfate ground water mixes with oxygen to drive the precipitation of iron minerals. This condition is found in a variety of hydrologic settings, in which low-pH and low-Eh ground water comes in contact with the atmosphere or with oxygen generated by bacteria or plants or mixes with shallow oxygenated water. Environmental settings where ferricrete typically forms include iron springs, iron bogs (which are also iron fens), and stream terraces of low-pH streams".

The author could not find any study of ‘non-pedogenic’ or ‘hydrological’ ferricrete anywhere in South Africa. They are briefly mentioned by DL Roberts in his 2003 (Memoir 95, which is mostly about silcretes). Photographs of ferricretes near lakes or in lacustrine environment, and maps of their locations in the Study Area are also presented in this Field Note.

2. Ferricretes on erosion surfaces

Ferricretes on erosional surfaces are found in three main consistencies – massive (non-clastic), conglomerate and breccia (Figures 1 to 4).

Figure 1. Massive (non-clastic) ferricrete, heaped by farmers. Top – chunks of tabular ferricrete (see below). Bottom – heap of ferricrete boulders (see below).

Figure 2. Ferricrete conglomerate*.

Figure 3. Ferricrete breccia*.

*A clastic rock made of particles larger than 2 mm in diameter is either a **conglomerate** or **breccia**. A **conglomerate** has rounded clasts while a **breccia** (origin in the Italian language) has angular clasts. Since water transport rapidly rounds large clasts, **breccias** normally indicate minimal transport.

Figure 4. Various colours of ferricrete breccia.

Ferricretes on erosional surfaces are found in several habits – tabular, bouldery, pillowy and nodular (Figures 5 to 8).

Figure 5. Tabular ferricrete. Top – non-clastic ferricrete patch, on a topographic high. Bottom – Ferricrete breccia slabs removed from the field by farmers.

Figure 6. Top and bottom: ferricrete boulders, removed from fields by farmers.

Figure 7. Nodular ferricrete of various sizes and colours.

Figure 8. Ferricrete nodules.

Ferricretes are known to have been formed on river gravel terraces (Figure 9).

Figure 9. Breccia and conglomerate ferricrete on a river gravel terrace. The chunk at the bottom photo contains both angular and rounded clasts.

3. *Non pedogenic ferricretes – drainage-line and pan / lakes*

Ferricretes boulders and nodules are found along drainage lines and rivers (Figures 10 to 15).

Figure 10. Ferricrete boulders in a shallow ravine.

Figure 11. Ferricrete nodules (Upper Potberg Valley, below Verfheuwel Farm).

Figure 12. Top and bottom: Ferricrete on a rise in the Upper Potberg Valley.

Figure 13. Top, middle and bottom: ferricrete boulders in the Upper Potberg Valley.

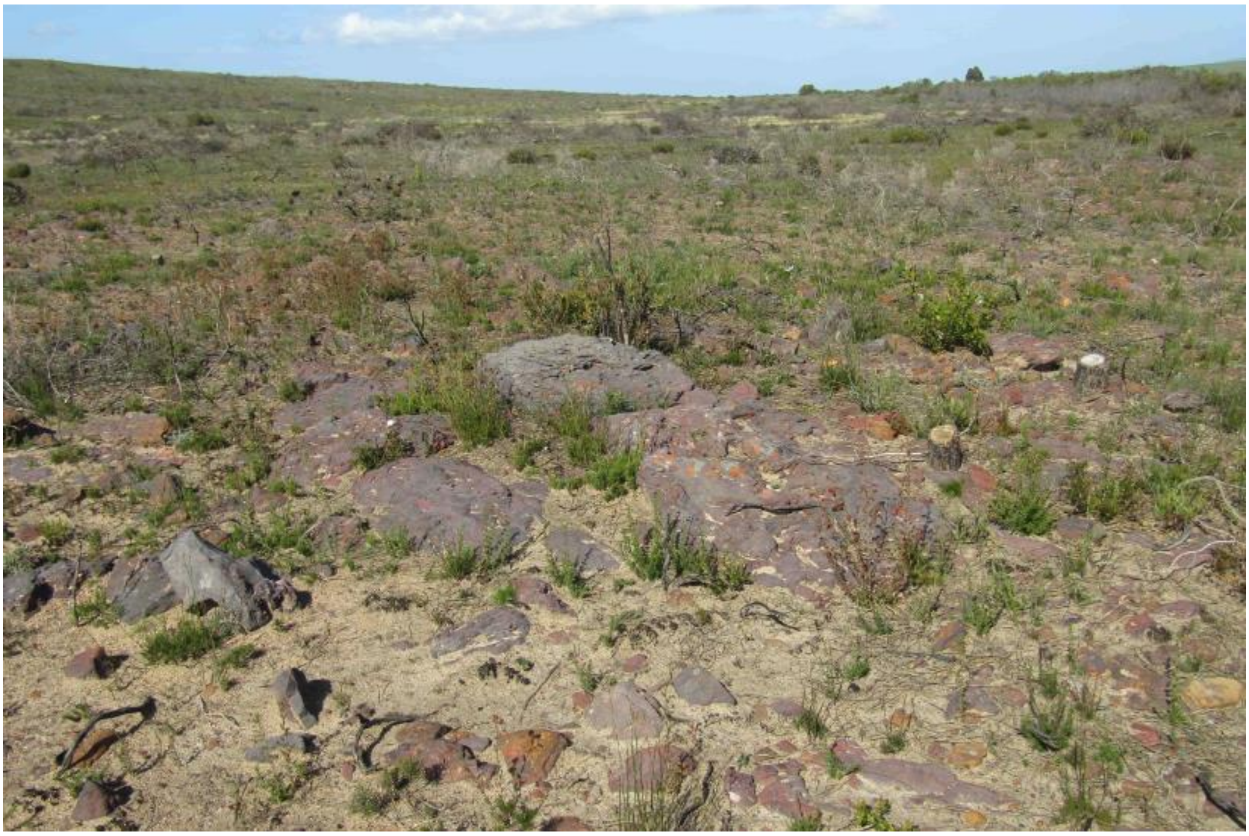


Figure 14. Ferricrete near Elim, along the Nuwejaars River. Top – on a hillslope. Bottom: on an abandoned river terrace.

Figure 15. Ferricrete near Elim, along the Nuwejaars River.

Ferricrete was found around a lake (Figure 16) and on the floors of periodical lakes (Figure 17).

Figure 16. Ferricrete on the south raised shore of Soetendals Vlei.

Figure 17. Lacustrine Ferricrete in periodical lakes. Top - in the West Renoster Valley (arrow). Bottom – in the Ou Werf Valley. (See Field Note about silcretes in lakes and pans).

Ferrugination occurs along, and 10 -15 m above, drainage-lines (Figures 18 and 19).

Figure 18. Top and bottom - ferruginised sandstone outcrops along a stream near Kraaifontein (south of Plaatjieskraal Farm).

Figure 19. Top and bottom - ferruginised sandstone outcrop along a stream near Kraaifontein.