Two Senior Soil Scientists discuss African Soils

Introduction

The following letter is a reply to an earlier communication from Hugh Brammer from Harry Vine, an interesting and productive soil surveyor, whose main field work was in the cocoa soils of Southern Nigeria. Charter advised him on setting up the survey, and Vine adapted Charter's Gold Coast methodology (Borden *et al.*, 2020). Vine had a particular interest in the unexpectedly fine textures of many Nigerian topsoils, and attributed them to harmattan dust blown out of the Saharan and Sahel regions to the north (Vine 1987).

Vine spent the latter part of his career in academia, firstly in Trinidad, then in the fledgling University of Ibadan in Nigeria, and finally in then University of Leicester in the UK. His family retained the Caribbean and agricultural connections.

Harry Vine was a careful field worker and tended to be cautious in his written work. Because he was not a prolific author, this detailed letter is valuable background to his work and thinking.

R. Wayne Borden, Hugh Brammer, Ian Baillie & Stephen Hallett. 2020. The contributions of C.F. Charter to tropical soil survey and classification. *Catena* **19,** 104957. https://doi.org/10.1016/j.catena.2020.104957

Vine, H., 1987. Wind-blown materials and W African soils: an explanation of the 'ferrallitic' soil over loose sandy sediments' profile. In: Frostick, L., Reid, I. (Eds), Desert Sediments: Ancient and Modern. Publication No. 35. Geological Society, London, pp 171–183. (also at: http://www.wossac.com/search/wossac_detail.cfm?ID=45781)

[redacted]

4 August 1997

Dear Hugh

I am sorry. It is very bad of me not to have sent some reply before now to your letter of 17 April, before spending time thinking about it and many relevant papers, and then writing back.

I went away from 13 December to 19 March, and then visited my daughter and grand-daughter in Devon for 10 days. There is quite a lot of letter-writing that I have not caught up with yet, and I am rather lacking in energy;tend to doze off during the day instead of getting down to things.

I retired from 16 years in the Geography Department at Leicester University in 1981. Soon after that I began to try to write up something on soils of the Sedimentary regions of southern Nigeria, but then the main thing about them came to be that I thought I at last had evidence for an explanation of the anomalous content of clay (and iron oxide), compared with the underlying geological material. Somehow I got on to looking at early (1970's) Reports of the great Deep Sea Drilling Project, and found mention of the recognition of wind-blown mineral grains in some layers of deposit of various ages (which are known from their micro-fossils). A main problem was that silt-size particles are known to be predominant in desert dusts and loess deposits, but my soils contained only small percentages of silt (and fine sand); the answer seemed to be that quartz grains of these sizes would dissolve fairly rapidly when dust fell on the soil surface, in high-rainfall tropical areas, leaving clay and iron oxide to accumulate. So I returned to my lab to examine some soil samples that I happened to have. I produced a paper in 1987, of which I enclose a copy. I was fortunate to have encouragement from Lynn Frostick and Ian Reid, organisers of the meeting on Desert Sediments - Ancient and Modern, at which I had belatedly put up a poster, to make it into a paper; but it was disappointing that they made a lot of alterations and finally did not accept all my consequent corrections in the page proofs, so in places the printed paper did not make sense, so I have made some alterations in ink On page 181 I mentioned unpublished Scanning Electron Microscope studies. These needed to be continued to produce photos of a quality suitable for publication, and I began work on this, as well as examining silt and fine sand extracted from some soils of "Eluvial Mottled Earth" or "Ilepa" type. However, it got interrupted as my wife suffered increasing pain and disability and I became chief housekeeper, and later carer, until her death in April 1994. I was anxious to get the SEM work done, and made a fresh start in 1996, but that again has been interrupted by my going off on a long trip to South Africa.

I intended to get back to the SEM work soon after my return to Leicester.Tha means booking some sessions on the equipment, which is in the Geology Department, the Geography Department being entitled to use it just occasionally. But I have got preoccupied with trying to get information and to clarify my ideas about African landscapes and soils, reading things acquired in South Africa and during 5 days in Zambia 10 days in Zimbabwe and other things from the University Library.

Thank you for the comments in your letter and the pages which you photocopied for me. I was a bit puzzled until I realised that what you sent me were the front cover of "1m E262 1/76" Soils of Zambia, by you,

and secondly the cover of your Soil Survey Report No 11 - "Soils of Zambia 1971-1973", dated 1973, and pages 16 to 31. This latter is highly informative and very interesting; it is a pity that Dr. Hampwaye in Geography and Dr. Yerokun in Soil Science at the University did not have it nor apparently know of it. Dr. Yerokun tried to get for me from Mount Makulu Clayton's 1975 Report, No. 32 in the series, which I asked for because of its being referred to by R.A. Pullan in his paper in Catena 1979 on Termite Hills in Africa (which had interested me very much, so that I arranged a trip 40-50 km north from Lusaka to see the main area of his observations - where he wrote that the soil was typical Sandveldt "at the heart of the Mid-Tertiary (Miocene) peneplain described by Dixey (1955) and attributed to the Late-Cainozoic surface by King (1962)"). But that seems to have been mislaid and could not be sent in time for me to see it.

I have not yet looked up the 1977 Geoderma paper on Ferrolysis. Previously I guessed it was something peculiar to Bangladesh. The full title of your 1973 paper includes "an Account of Soil Genesis and Classification", which would interest me a lot; but perhaps that is not a separate section, as you deal with these aspects, for Central Province soils, in the pages that you sent me. However, I would quite like to read about other Provinces. I could photocopy more of the Report if you brought it when calling here (as you said would be possible - when on a visit to Derby or Yorkshire).

Your shorter report on Soils of Zambia marked 1m E262 1/76 is what Dr. Yerokun was able to lend me. I copied from it the material on Sandveldt Soils on pages 20-25. I also made a partial tracing of the 1965 soil map of Zambia which was inserted in the report, roughly copied the legends (one according to the Zambian system, the other according to the CCTA Soils Map of Africa), and most of the profile descriptions and data in small print on the back of the map.

One thing that I noticed was a divide across that map running between Kabwe and Ndola and north-eastwards towards Lake Tanganyika: north of this there is the symbol LcBc (for Dominantly Yellowish Brown Ferrallitic Soils + Lithosols on Ferruginous Crusts); to the South there is Lc, LcKc, or KcLc (Kc being Ferrisols). On page 23 of "1m E262 1/76" you wrote, describing Sandveldt Soils "Laterite often occurs in a narrow strip bordering dambos" (as in Gambari Series in Nigeria) "and more erratically on upland sites". This seems to suggest the remains of an erosion surface, and by a plausible extrapolation from Southern Africa (south of the Limpopo) that would be the "African Surface" - as commonly understood but precisely defined by the present-day authorities T.C.Partridge and R.R.Maud as the product of planation from LateJurassic/Early Cretaceous toEnd of Early Miocene - at two levels:above and below the Great Escarpment.

De Swardt discussed laterite as a landscape feature in West Africa, Uganda and Zambia; but remarks about Zambia were very brief and did not specify whereabouts the higher-level laterite was observed (Zeitschrift fur Geomorphologie N.F.8 1964 pp 813-833). Webster (J. Soil Sci. 1965 16 31-43) appears to have had some appreciation of the surrounding landscape when choosing a particular slope for a line of pits to be representative of the catenary association, 25 miles SW of Ndola, and his remarks do not indicate that there was any hill-top laterite in adjoining areas.

21 August
With regard to pedogenesis, Webster was very feeble, writing that morphology below "the concretionary horizon" and the formation of soil material by rock weathering might reasonably be expected to be similar to what Nye had reported for Ibadan profiles, so it was OK to have pits dug only to 65-76 inches, and the study of these really does not contribute much towards his discussion of Penck and L.C.King, pediplains, etc. There is the significant point that a well shaft nearby on a lowerslope had rock (biotite gneiss) partially weathered to a soft friable mass, with few remaining hard lumps of rock, at 30 ft.

I had quite a long phone conversation with Barry Clayton. [redacted] seems to be for his Ansafone, and [redacted] is the number to call for speaking. He has sent me on loan his copy of Soil Survey Report No 32 - The Sandveldt Soils of Central Province (102 pages). It gives very clear descriptions of the six main soil series which made up the Sandveldt Catena (in seven particular areas surveyed in 1973-74), in three Associations - Mushemi-Choma, Chongwe-Kalomo, and Luano-Muchanga, plus two Land Types - Dambos and (very stony) Nsato Shallow Land which occurred sometimes at the crest or elsewhere, and a few other "associated soils" which did not seem to be part of the general catena. There is also full reference to vegetation, geology and geomorphology of the whole country. No doubt all the material went into his Ph.D. thesis, and I will get round to studying that fairly soon; he offered to lend me his copy, and I said I would like to have it but needed to give priority to resuming the SEM work which I explained briefly, and would ask for the thesis later.

I went to South Africa to visit my sister and her husband in Pietermaritzburg. I had contacted Dr Chris MacVicar there, as he had had a paper in Journ Soil Sc on the "red sands" (so-called) of the Natal coastal belt, which seemed to be similar to the soils over Benin Sands, etc. I found that he had been top man in soil classification, Chairman of a group that had worked out very thoroughly a "Taxonomic System for South Africa". He took me out and demonstrated L.C.King's several post-Gondwana surfaces andhow the Sugar-Belt soils, mapping of which had been the life's work of B.E.Beater, were related to these. He put me right about lithology, about which Beater had been misinformed. I then had a day out with Dr. Rodney Maud, who became a Consultant on geotechnology, etc., after being one of L.C.King's bright young men and then an assistant of B.E.Beater.

I had to discard my idea that there were anomalous amounts of clay and iron oxide in the coastal "red sands" and in some of the soil over Table Mountain Sandstone that might be explained by additions of wind-blown material during episodes in the Pleistocene.

13 September
As I was going to visit Zimbabwe on the way back to England I was very pleased to meet, near Pietermaritzburg, Dr.J.G.(Dickie) Thompson, who had been chief soil survey man in S.Rhodesia (Zimbabwe) for nearly 20 years (and then worked on environmental damage, including effects of subsidence, due to coal-mining, in South Africa). I was able to photocopy his copy of Thompson J.G. and Purves W.D. 1978. A Guide to the Soils of Rhodesia. - Rhod Agric J Tech Handbook No 3 (64 pages plus small-scale version of soil map). In this account the expression "sandveldt soils" was not used, but the corresponding plateau expanses have the same sort of soil profiles, which are classified as Fersiallitic (greatest area), Paraferrallitic (second), and Orthoferrallitic (least extensive).

Rodney Maud had given me a copy of his paper with T.C.Partridge: Geomorphic evolution of southern Africa since the Mesozoic, S.Afr.J.Geol.1987,90(2),179 208, which he said had been awarded some special mark of appreciation. There is so much in this paper that I did not manage to study it adequately before departing to Zimbabwe, and I missed important points of detail. I was, and still am, rather sceptical as to the extent and prominence of "massive laterite ...duricrusts" marking (as well as silcretes) the remains of the late Mesozoic-to-end-of-early Miocene surface; both MacVicar in Natal and another leading man whom I met in Cape Town expressed such doubts, too. Moreover "southern Africa" ended at the Limpopo, in this paper.

Now after studying Partridge and Maud much more thoroughly I think I may have quite a good picture of the geomorphology of Zambia and Zimbabwe. Crucially, it appears that the biggest and most rapid event since the Mesozoic was a "major uplift (up to 900m in eastern marginal areas)" of age "Late Pliocene (around 2.5 million years)". Partridge and Maud give many important and interesting references, but also an Appendix of abstracts of "some major landmarks in the literature on the geomorphic evolution of southern Africa". I really need to avoid spending too much time on this literature; but one topic that I should catch up on is that of (passive) continental margins and their uplifts (particularly Plio Pleistocene).

The plateau surface of central Zimbabwe, and the generally featureless soils - as in Zambia - perplexed me, the more so because of the lack of cuttings and PWD borrow pits such as are common in Nigeria and Ghana. I was reminded of the concept of the stripped etch surface, and some resemblance to the northern plains of Sri Lanka which seemed to me to fit that bill (when I was on a short visit there in 1975 - carrying with me the relatively short 1974 book "Tropical Geomorphology" by my friend Michael F.Thomas).

I was made to realise that I had never got to grips with the etch-plain business when I read your letter. Even with Thomas' translations I had not understood Budel's Rand Spulpedimente, Spul Oberflache, etc, and not really much interested in the subtle differences between pediplanation and etchplanation. Mainly, I rather liked the scheme of types of etchplain and etchsurfaces on pages 236-238 of the 1974 book (photocopies enclosed) except the way that the laterite is shown. Now I have struggled to read and re read much of Thomas' bigger 1994 book "Geomorphology in the Tropics", and I do not find his main original area in SW Nigeria supposedly having this set of land-forms to be validly described in this way; I remember the soil of certain localities in the area, and I am sure he was wrong about them. In a 1969 book he repeated his account of that type area: "This (surface) morphology records a sequence of events leading to the dissection and partial stripping of a deep rego-lith, and may be the result of both tectonic and climatic changes. But the widespread occurrence of this sequence suggests that it is climatically induced". This climatic explanation is what De Swardt held to, from his note on Kaduna in 1947 onwards. I think he implied Quaternary climate changes. It now seems clear that the sequence of surfaces resulted from planations on a time scale 10 to 40 times as long as that - tectonically induced. Moreover neither De Swardt nor Thomas was interested in examining and explaining the soil profiles.

In Harare, the one or two members of the University with interests in pedology were away. I was lent a well produced book "The Soils of Zimbabwe", 1991, 180 pages, by Kingston Nyamampfene, Ph.D.(Aberdeen-1982), Senior Lecturer in Harare with considerable research output in a few years before leaving to become Professor at Fort Hare University in South Africa. I managed to buy a copy in a small office in the town. His account does not depart much from Thompson & Purves 1978, but includes more detailed descriptions and analytical details.

I do not think it is clear whether much of a distinction can be made between the soil profiles of the catenas of the central plateau area of Zimbabwe and those of Central Province of Zambia. I note that Clayton's account, resultin from a lot of soil survey in the field, shows about 25% of the area of the Sandveldt Catena to be the lower-slope Luano-Muchanga, with strongly mottled material (which must mean restriction of growth of tree roots) at about 70cm in Luano and much greater depth in Muchanga; these soils may occupy quite a wide belt above the dambo. Detailed surveying, which may not have been done in Zimbabwe, also made it possible to draw cross-sections showing the real (rapidly changing) varied depth to the stone-line, at Kabwe and at Zamic Chisamba Farms.

One thing I would like very much to know is whether there is an association between the huge domed termite "hills" (Pullan's term), described by David Livingston as of the size of an English cottage, which are recognised as definitely "fossil", and a soil profile with drainage impedance in the saprolith or clayey material above it, particularly in the almost flat interfluve area which I saw along the road about 40-50 km north of Lusaka. I do not think these occurred in more undulating land where we went back to about 30 km from Lusaka and off to the East along a side-road.

Very large such domed termite hills may have been what led some (mainly Francophone) people to write of "Macrotermes goliath". They contrast with towering termitaria of some places in West and East Africa, particularly the Cretaceous sandy plain in the Mokwa area, just beyond where the railway crosses the Niger - described by David Attenborough in a noted TV programme, in which he crawled along a trench underneath, to comment on the amazing structure (and air-conditioning system) of the mound and the huge cave below with termite shafts going down through the floor for getting moist soil. Yangambi reports definitely record the great number of very large termite mounds there, but unfortunately not their shape; I just vaguely have a memory of their being of the tower type - from the International Congress in 1954; that would fit with a hypothesis that phases of such activity during the past 1-2 million years explains the great depth of uniform subsoil in the "ferrallitic soils over loose sandy sediments".

I am enclosing a photocopy of Owens & Watson 1979, on soils of two small catchments in eastern Zimbabwe; very interesting on pedogenesis and also giving the clearest details of granite soils in Zimbabwe that I have found. Whilst I was there, perhaps the most significant remark I heard was from Dr Penelope Grant, who took me on a trip to the Marandellas area, that she always knew that the absence of Brachystegia spiciformis (the big msasa tree was an indication of relatively shallow depth of favourable soil.
At the end, I went south to the Great Zimbabwe ruins, which are on the Plateau edge. On the way there it did seem to me that there was a lot of patchiness in vegetation that might be a matter of B.spiciformis and depth of soil or regolith - upon a stripped etch-surface; also, wide rock-pediments noticeably occurred adjacent to some granite kopjies. (I saw no laterite/ferricrete).

According to Thompson and Purves, and also Nyamaphene, three main types of laterite are distinguishable in Zimbabwe:
(i) Laterites of relative accumulation ("true laterites" since they are produced only under conditions of intense weathering, as where orthoferrallitic soils occur) in minor localities in Zimbabwe.
(ii) Laterites of absolute accumulation ("ferricretes") of younger sites, apparently associated with varying oxidising and reducing conditions.
(iii) Laterites of absolute accumulation of much older sites, often associated with remnants of previous erosion surfaces, mainly in the central plateau area, occurring as a capping on hill tops.

You referred to a Geol Soc/British Geomorph Research Group meeting on "Uplift, Erosion and Stability: Geological and Geomorphological Perspectives on Landscape Evolution". You will see from the photocopy of the notice in Geophemera (the BGRG Newsletter) which I enclose that I expected there to be much of great interest to me. I did not find it coming up to such expectations. I tried to listen to most of the first day's papers, but with most speakers I found I missed too much though I have an NHS hearing aid; and all but the first three papers were hopelessly poor and uninteresting - including one by C.D.Ollier on high planation surfaces in Ecuador. I decided to cut the second day and come home.

Ollier did soil surveying with Chenery in Uganda and wrote a paper "A two cycle theory of tropical pedology" in J.Soil Sci.1959, which has been cited many times, but always left me somewhat doubtful of his abilities as a field observer, but he has gone on to make a name, in Australasia, and produced books and many papers. Now I find a fairly favourable review in (European) J.Soil Sci Sept 1996 of Ollier C & Pain C "Regoliths, Soils and Landforms" J.Wiley & Sons, 1995, £65. I will get this through the University Library. But perhaps I should remark here that the soils and landscapes of Nigeria are the focus of my interests which I expect to continue during further years of retirement and I am aware that what may be established in Southern Africa cannot be directly extrapolated to West Africa.

The first paper at the London meeting was "Resurfacing Geomorphology: an overwiew of pre-Quaternary landscape evolution with reference to southern Britain" by David K.C.Jones (Professor at London School of Economics). He referred to Wooldridge and Linton's work, which you probably have been quite familiar with, as the classic basis for explaining the geomorphology of southern Britain, but"criticisms led to alternate models (Jones 1980; Small 1980) which placed greater emphasis on Palaeogene denudation and pulsed deformation." However, he says since 1980 the picture has changed, as the result of further work, and was reviewing this in his presentation. I have borrowed Jones' book Southeast andSouthern England, 1981, of the series "The Geomorphology of the British Isles", pub. Methuen, and expect I will buy a copy, if still in print; you probably know it otherwise I can recommend that you would find it interesting. Some time I might also look up publications of the post 1980 developments.

Finally, it occurred to me that you might like copies of the first page of the long paper by Partridge and Maud and their Table 1 summarising geomorphic events since the Mesozoic.
I hope all has been well with you since you wrote. Best wishes, and I look forward to seeing you.

Harry