REGOLITH, RESEARCH AND CRC LEME

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One of the reviewers of *Regolith Geology and Geomorphology* by Taylor & Eggleton (2001), Greg Retallack, did not seem to read much past Chapter 1 and the description (definition) of regolith. The *Regolith Glossary* (Eggleton 2001) defines regolith as *'The entire unconsolidated or secondarily recemented cover that overlies more coherent bedrock, that has been formed by weathering, erosion, transport and/or deposition of the older material. The regolith thus includes fractured and weathered basement rocks, saprolites, soils, organic accumulations, volcanic material, glacial deposits, colluvium, alluvium, evaporitic sediments, aeolian deposits and ground water'*, or, *'everything from fresh rock to fresh air'*. When an internationally reputable scientist such as Retallack questions the majority view in Australia I begin to worry.

To me regolith is simply all the material between fresh rock and fresh air. The point of contention that Retallack raises is, I think, whether it should include lithified (a process that converts unconsolidated sediments into rock) or fresh rocks where they are produced by surface or near-surface processes and are sandwiched between softer materials of weathering or sedimentary origin. So, a fresh basalt flow sandwiched between weathered basalt or weathered bedrock and weathered basalt or sedimentary regolith would in my mind be part of the regolith. Equally, one of the hardest rocks we see in Australia, silcrete, is well lithified but in Retallack's mind would not constitute part of the regolith because it is lithified. I think we can agree that this latter example is clearly part of the regolith, but the basalt flow—well, it's up to you, but basalt flows are very useful in reconstructing palaeoslopes and landscape evolution and thus to me an important aspect of regolith and landscape evolution. To most this probably seems a rather pointless argument but then regolith forms in landscapes, and knowledge of former landscapes and drainage are critical in understanding the origin of many regolith features we study. If we are to understand regolith processes then we, at least in part, must study those processes with some knowledge of landscape history.

This brings me to regolith research. For any research to be of value it must either seek to understand process or be empirical and aimed at solving a particular problem in a particular situation. Both are equally valid research endeavours, but the former is better simply because provided we have the correct parameters we can use and understand process to be predictive, and this is of most value ultimately. Empirical research, such as what is a good mineral exploration sampling medium in the Woop Woop area is great for those exploring at Woop Woop, but there is always the problem of the transferability of this research to the Black Stump region. Let me illustrate. In the Broken Hill region work done by Steve Hill and a variety of research students has shown that silcrete may provide an effective sampling medium for various elements. At present I think it fair to say that the reason for this is not known. We do not know where in the silcrete the trace elements are housed, so until we know more about using silcrete as a sampling medium its use is potentially restricted to those areas where its usefulness has been empirically tested.

In the northern Pine Creek of the Northern Territory ferricrete occurs at a variety of levels in the landscape over a relief of some 60 m (Raybone 2002). The ferricretes do not overlie Cretaceous sediments, thought by many to be the source of all 'laterite' in this region, but occur in or over *in situ* weathered Proterozoic bedrock or cement transported regolith of various types from colluvial mantles to alluvium. Clearly these regolith features do not conform to the land surfaces delineated by Hays (1967) nor to the post-Cretaceous surface. Throughout the region iron oxidihydrides are mobile, forming ferrihydrite in creeks and swamps and at springs, both in regions of Proterozoic bedrock and Cretaceous cover. This suggests mobilization and precipitation of Fe is an on-going process. The differences in elevation of ferricrete ('laterite') from hill tops and small plateaux to the base of the present drainage suggests they have formed over an extended period and that they are forming in today's landscape. Because the ferricretes have not been dated it is impossible to determine for how long this process of mobilization and precipitation of Fe has been occurring, but it is a process we understand better in this part of Australia. More research is needed.

What are the areas of research that I think will move regolith studies forward? We must study process. How do silcretes really form? How do various elements disperse in the landscape and where do they precipitate? Where in regolith minerals are trace elements hosted? How do slopes change through time? Do divides move over time? I could go on. To understand these phenomena the processes that form them must be understood. Multidisciplinary teams encompassing such areas as geophysics, mineralogy, geochemistry, microbiology, hydrogeology, geomorphology, and most importantly regolith history must be used to achieve this, in my

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humble opinion. It is by such effort that regolith scientists will become more predictive and less empirical, and that means our science becomes more and more applicable as we learn.

An understanding of the regolith is applicable to a multitude of environmental and economic problems in our society. Perhaps the best example is the salinity problem in Australia. The GILMORE Project (Lawrie *et al.* 2000) and its various off-shoots shows clearly there is no discrepancy between the fundamental data required for the search for economic ores and those needed to understand salinity. This work of CRC LEME and Geoscience Australia in the central west of NSW amply demonstrates the synergies that can be derived from a multidisciplinary study of regolith ranging from mineral exploration to predicting potential salinity problems. Our research should therefore not be tightly focussed but enable sufficient understanding of process and product that it can be applied broadly. Another area worthy of investigation as part of the geochemical and salt research would be medical geology or geohealth. There are many elements deleterious or beneficial to human, stock and crop health, yet we have done little in this area in Australia. Regolith research whether strategic or applied gathers the data necessary for understanding aspects of our community's health. Many people living in Australia suffer potentially from and iodine or selenium deficiency. Others receive higher than WHO recommended levels of radiation from the regolith. Mapping and explaining these anomalies is important to our community's health and economic future.

An important aspect of this research is the encouragement of others to learn our craft, otherwise we are working without a future and that is pointless. We need to get most of our community aware of the importance of the regolith in controlling their earth environment in all its facets from soil fertility to salinity, from national icons like Uluru to the preservation of cultural sites like building stone preservation. We need also to point out the economic significance of the regolith for all Australians. This type of communication will of course need underpinning by a much enhanced awareness of regolith by our university graduates as it is they who will take over the reins in the near future.

Cooperative Research Centres (CRC) are an ideal vehicle for prosecuting such fundamental and applied research. CRC's are ideally about innovation and education. CRC LEME has the opportunity to capitalise on the generous funding provided by the Commonwealth and its core parties to undertake fundamental research into regolith and processes. The applied aspects should flow from and go hand in hand with the fundamental research. CRC LEME has the where-with-all to organise its research priorities to take advantage of the opportunity provided to it. In my view this requires some concentration of effort and a willingness to take the chances that innovative research requires. There are many examples in CRC LEME's history where interesting empirical discoveries made during empirical research have not been followed up with a concerted effort. One example it the presence of gold in regolith carbonates. We know it occurs, but as yet we don't know where in the carbonates it lodges or why it occurs there. My earlier example of silcrete as a potential exploration sampling medium is another example. CRC LEME has enormous research strengths collectively across its staff and this strength must be harnessed to further our understanding of regolith and landscape process so we are better able to serve the stakeholders who finance us.

In terms of education CRC LEME has a very effective PhD scholarship scheme. Regolith education at the undergraduate level is expanding as more univerities have joined LEME, but there is still a long way to go. LEME currently does little to educate our own staff across the disciplines it covers and very little for its major stakeholders let alone the community at large. The Mineral Tertiary Education Council provides an excellent conduit to spread regolith knowledge and learning nationally to Honours and Masters students. Perhaps this model should be used to educate all our stakeholders nationally and internationally.

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