REGOLITH GEOCHRONOLOGY AND MINERAL EXPLORATION

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Geological evidence suggests that many parts of the Australian continent have experienced subaerial exposure over hundreds of millions of years (Fig.1). Consequently, there has been a long and complex history of weathering and landscape evolution, some of which occurred under climates quite different from the present. Given the long history of subaerial weathering in many regions, polygenetic weathering profiles are likely to be the rule rather than the exception. As a result one should expect a range of ages from a single profile, whether determined by a single method, or by more than one method. Furthermore, different ages should be expected from different mineral phases because each can form under differing environmental conditions.

The LEME Geochronology project is applying regolith dating methods at sites across Australia (Fig. 2) to provide the chronologic framework for this long history of weathering and landscape evolution. Many sites are located in open pit mines, where results have implications for the age and genesis of supergene mineral deposits and associated geochemical haloes.

Reliable numerical estimates of regolith age, using isotopic dating techniques, are often difficult to obtain. Typical problems include the lack of suitable minerals and uncertainties regarding closed system assumptions. Furthermore, the generally unfossiliferous nature of much of the Australian regolith means that traditional methods of biostratigraphic dating cannot always be employed. Despite these problems, a number of dating methods have been successfully applied. On timescales of less than 10^5 years, radiocarbon and thermoluminescence have been extensively used to provide a robust chronology for late Pleistocene regolith. On timescales beyond 10^5 years, paleomagnetism, oxygen isotopes, K/Ar (including $^{40}Ar/^{39}Ar$) and stratigraphic dating have been employed. Recently, U-series, (U-Th)/He and U/Pb dating methods have been investigated, with promising results. Cosmogenic isotopes are also increasingly important for measuring erosion rates on 10^5-10^6 year timescales (Bierman & Caffee 2002), while apatite fission-track ages constrain regional denudation rates on longer timescales (see Kohn et al. 2002). The age ranges over which various regolith dating techniques can be applied, are summarised in Fig. 3. See also Pillans (in press) for an overview of regolith geochronology in Australia – available for downloading from http://leme.anu.edu.au/Pubs/Monographs/RegLandEvol.html

In this talk I will illustrate some ways in which regolith geochronology can be significant in the context of mineral exploration.

REFERENCES

BIERMAN, P. R. &CAFFEE, M. 2002. Cosmogenic exposure and erosion history of Australian bedrock landforms. *Geological Society of America Bulletin* **114,** 787-803.

BMR PALAEOGEOGRAPHIC GROUP. 1990. *Australia: Evolution of a continent.* Bureau of Mineral Resources, Canberra, 97pp.

KOHN, B.P., GLEADOW, A.J.W., BROWN, R.W., GALLAGHER, K., O'SULLIVAN, P.B. & FOSTER, D.A., 2002. Shaping the Australian crust over the last 300 million years: insights from fission track thermotectonic imaging and denudation studies of key terranes. *Australian Journal of Earth Sciences* **49**, 697-717.

PILLANS, B. 1998. *Regolith Dating Methods. A Guide to Numerical Dating Techniques*. Perth, Cooperative Research Centre for Landscape Evolution and Mineral Exploration, Perth, 30pp.

PILLANS, B. (in press). Geochronology of the Australian regolith. In: Anand, R.R. & de Broekert, P (Eds.). *Regolith-Landscape Evolution Across Australia.* CRC LEME Monograph.

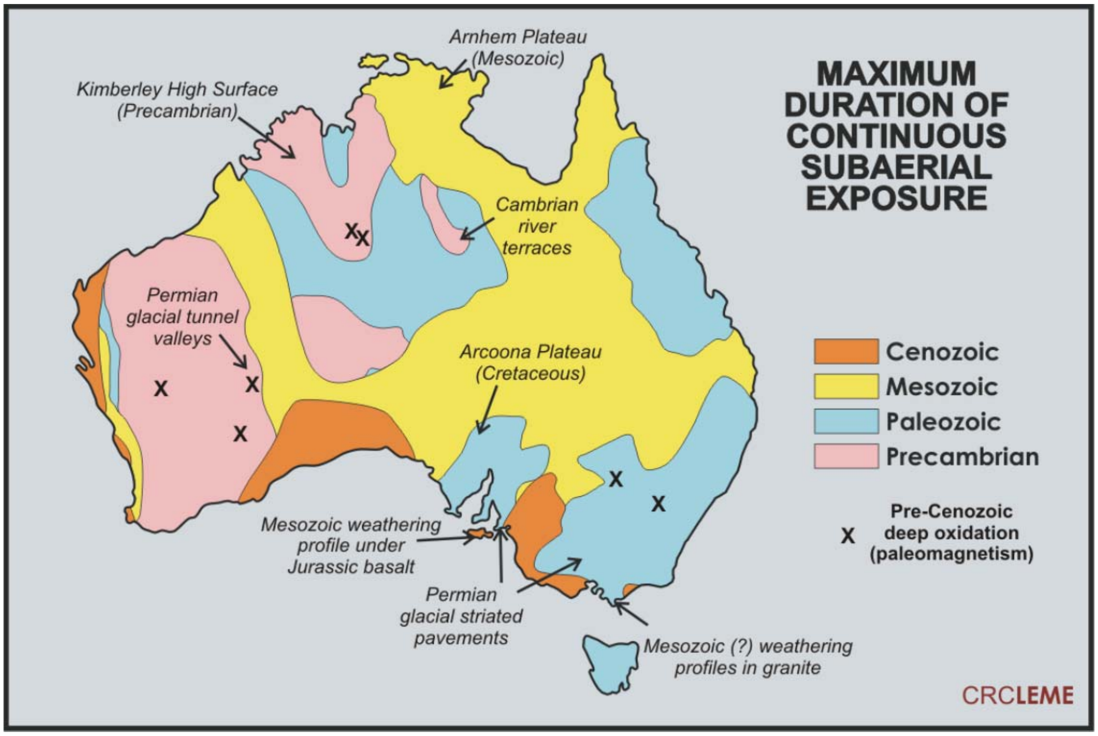

Figure 1. Duration of continuous subaerial exposure from paleogeographic reconstructions by BMR Palaeogeographic Group (1990) and locations of selected sites with pre-Cenozoic regolith and landforms.

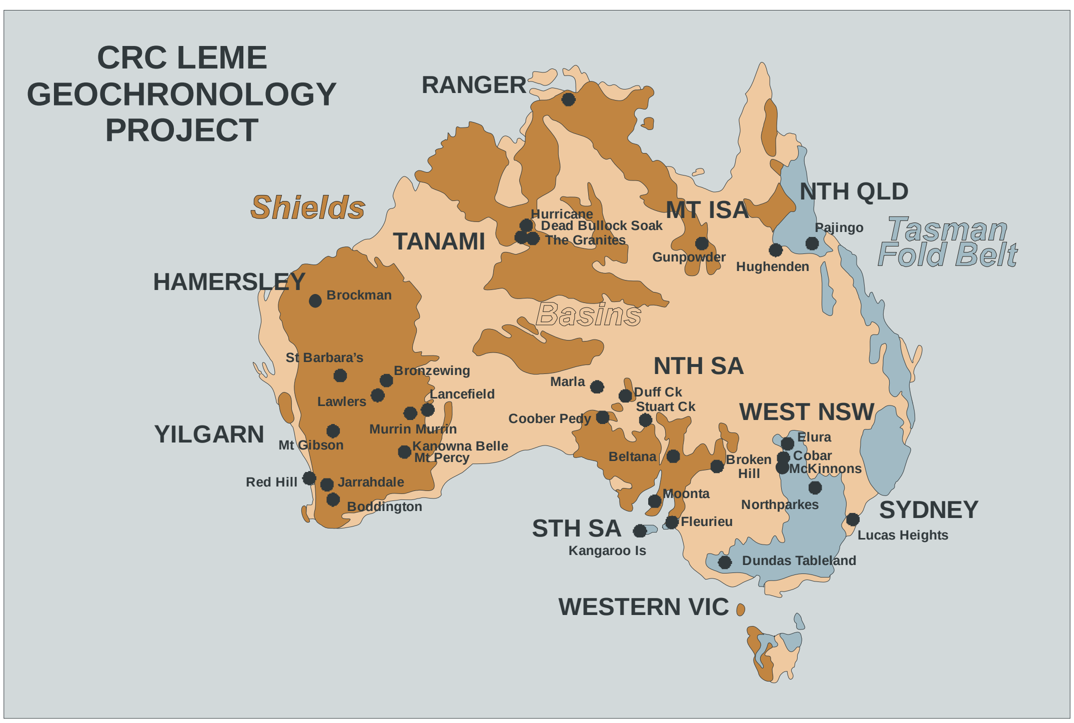

Figure 2. Location of sites where regolith ages have been obtained or which are currently being studied.

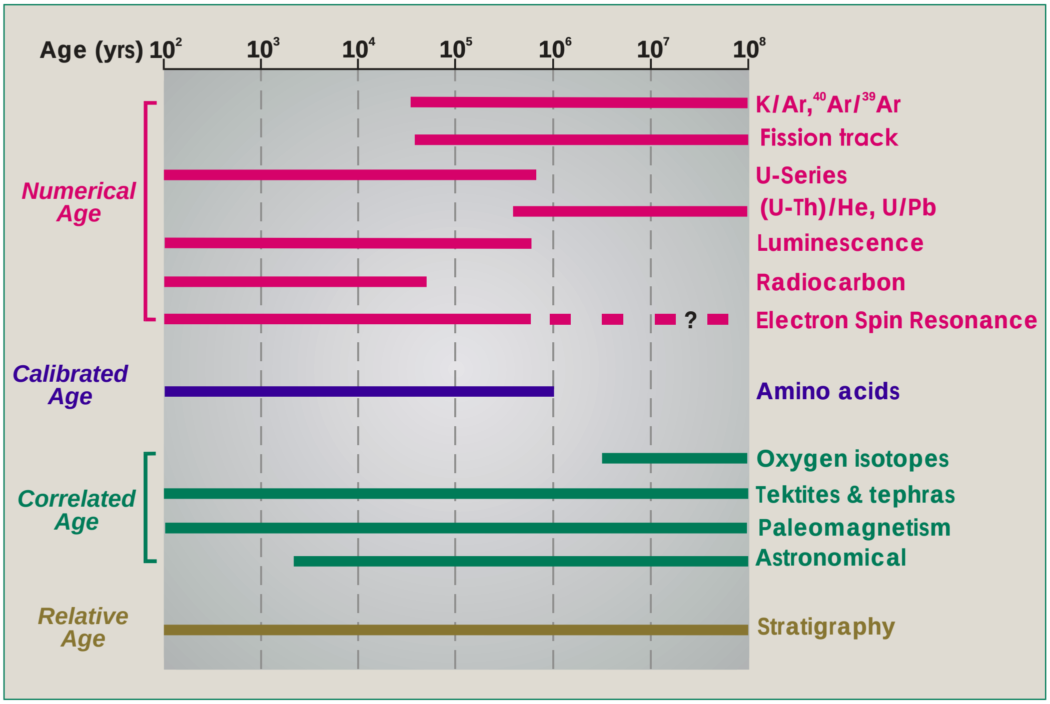

Figure 3. Age ranges over which regolith dating methods can be applied. Methods are grouped according to type of age result produced (after Pillans 1998).