



A fresh look at the regolith of the central Gascoyne region with implications for mineral exploration

by

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A major challenge facing mineral exploration in many parts of Western Australia is exploring effectively and efficiently through commonly thick and extensive regolith cover. Mapping regolith and understanding its genesis is crucial in terms of developing a landscape evolution model, which is critical for mineral exploration in regolith-dominated terrains.

The Gascoyne region has an extensive regolith cover including regolith that is genetically related to the underlying bedrock or transported. There are few actual age determinations for regolith, so the age of regolith units is invariably based on their position in the landscape, degree of induration, extent to which they have been dissected by more-recent processes, or the extent of overlying material. This study is the first attempt to gain a more-detailed insight into the regolith and therefore the landscape evolution of the central Gascoyne region, and has a strong emphasis on identifying both residual and relict regolith units, some of which represent remnants of previous landforms. A variety of regolith exposures in the central Gascoyne were investigated and several stratigraphic sections were measured, providing detailed information about different regolith types and successions.

Regional setting

The study area comprises most of the MOUNT PHILLIPS 1:250 000 map sheet, located in the central Gascoyne region. It encompasses rocks of the Paleoproterozoic Gascoyne Province, the Mesoproterozoic Edmund Basin (Bangemall Supergroup), and the Phanerozoic Southern Carnarvon Basin, all of which are overlain by various regolith units of variable thickness up to 150 m.

Regolith distribution and occurrence

A wide variety of regolith types is present in the study area, some of which are closely related to the underlying bedrock. Most of the transported relict regolith units and some of the older alluvial and colluvial regolith units were cemented and lithified under alternating wet and dry conditions. They are now preserved as elevated erosional remnants within

paleovalleys, or as topographically inverted paleochannels. Differential erosion rates and weathering during the Cenozoic formed a variety of regolith profiles over Archean to Phanerozoic bedrock. Ferruginization, calcretization, and silicification of these regolith successions led to the formation of resistant rises, hills, and mesas. Relief inversion is found in many places over partly silicified paleochannel deposits. In situ regolith profiles are retained where the rate of weathering is greater than the rate of erosion especially along old drainage systems, resulting in their preservation.

Landscape evolution model

Several episodes of weathering, ferruginization, calcretization, silicification, and erosion occurred in the central Gascoyne region leading to the complex regolith distribution of the current landscape (Fig. 1). With the exception of the rocks of the Southern Carnarvon Basin, most of the bedrock on MOUNT PHILLIPS has been periodically subaerially exposed since at least the Precambrian (Pillans, 2005). This resulted in continuous weathering and the formation of extensive in situ regolith profiles over Gascoyne Province and Edmund Basin rocks. In the southwestern part of the study area, where Upper Carboniferous and Lower Permian sedimentary rocks of the Southern Carnarvon Basin are exposed, land surface exposure started during the Permian (Pillans, 2005).

Ferruginization and development of deep-weathering profiles over bedrock was common in Australia during the Early Cretaceous to early Paleogene (McGowran, 1979). Williams et al. (1983) and Elias and Williams (1980) reported a 'Tertiary' land surface, which, due to active erosion, is only preserved as 'laterite' remnants along watersheds. Williams et al. (1983) also included calcrete and silcrete as part of this 'old duricrust surface'. The current study has shown that two distinct types of ferruginous duricrust (in situ and transported) are found on MOUNT PHILLIPS. In situ ferruginous duricrust is part of the in situ regolith profiles developed over bedrock mainly within the Gascoyne Province, whereas transported ferruginous duricrust is the result of widespread ferruginization of alluvial sediments in ancestral river valleys and alluvial plains. There is no conclusive evidence that they are either relative age equivalents or genetically related.

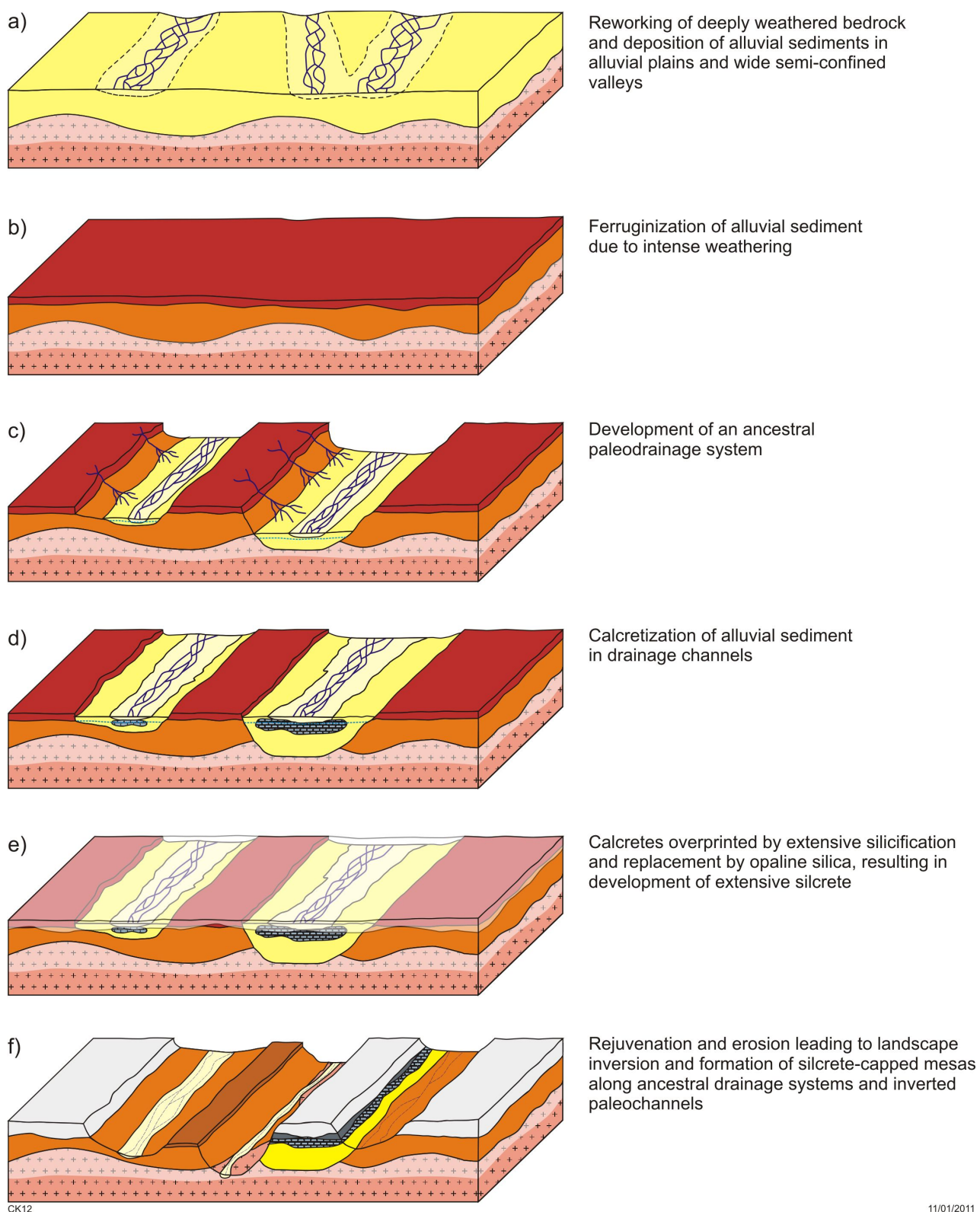


Figure 1. Landscape evolution model on MOUNT PHILLIPS

The transported ferruginous duricrust, overlain in many areas by calcrete and silcrete, is the result of intense post-depositional ferruginization and reworking of sediments that were originally deposited on alluvial plains and in wide semi-confined valleys (Fig. 1a). After deposition these sediments were intensely bioturbated and overprinted by soil development, cementation, weathering and erosion.

These alluvial deposits underwent extensive ferruginization and resulting in a more subdued landscape (Fig. 1b). Erosion of this landscape led to the development of an ancestral paleodrainage system followed by the development of calcrete mainly within and along the ancestral river courses (Fig. 1c). Calcretization partly continued into the underlying transported ferruginous duricrust (Fig. 1d). The calcretes in turn were overprinted by extensive silicification and replacement by opaline silica, resulting in development of an extensive siliceous duricrust (Fig. 1e).

Following development of the silcrete, the landscape experienced rejuvenation and erosion leading to landscape inversion and the formation of silcrete-capped mesas mainly along the valleys of the ancestral drainage systems and inverted paleochannels that are unrelated to any present drainage pattern (Fig. 1f).

In areas adjacent to the Gascoyne River, silicified calcretes are exposed up to 35 m above the present river level. Therefore, uplift must have rejuvenated the river systems after extensive calcrete development and subsequent silicification, a process that has also been discussed by Butt et al. (1977). As a result of rejuvenation, the sediments have been eroded and elevated in the form of mesas or inverted paleochannels.

Implications for mineral exploration

Understanding the landscape evolution of a region can assist in finding new exploration targets and in developing efficient exploration strategies. In the case of the central Gascoyne region, a new paleochannel 15 km long, up to 2 km wide, and elevated 10 to 15 m, has been identified in the northwestern part of MOUNT PHILLIPS during this study. Here, transported ferruginous duricrust is overlain by groundwater calcrete. The calcrete is partly silicified or replaced by opaline silica and overlain by silcrete to form the elevated and inverted areas of the paleochannel. The calcrete areas of the paleochannel show an elevated response in the uranium band of the Ternary Radiometric Image (TRI) and two surface calcrete samples from the paleochannel have increased uranium values compared to other regolith samples from MOUNT PHILLIPS (Sanders et al., 1997).

References

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