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Landscape evolution mapping in the south of Western Australia: a proxy to assist mineral exploration under cover

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Landscape evolution is the result of the interaction of climatic conditions, geological characteristics and sedimentary dynamics through time. In regolith-dominated terrains (RDTs), landscape morphologies and their stratigraphy record the 4D architecture of the overburden. The geochemical relation of surface, cover and basement geology is captured by the landscape stratigraphy.

Remote sensing datasets such as Digital Elevation Models (DEMs) can be used to analyse the geomorphological features of the land surface. Combining different surface geometrical features can be used to classify landscape types. Therefore, DEMs can be employed to classify landscapes over large geographic areas (e.g., geological province, country or continental scale).

In this study we tested the concept of classifying the variability of landscape types within the Albany-Fraser Orogen and southern Yilgarn Craton in Western Australia (WA). We used supervised machine learning algorithms based on DEM data and DEM-derived products (e.g., Hillshade and Flatness Map), Google Earth and Bing satellite imageries as well as field observations. We assessed how landscapes can be classified based upon their specific surface geometric features. From this we generated a map showing six conceptually different landscape types.

The south of WA is subdivided into three main geological provinces: the Archean granite, gneiss and greenstone belts of the Yilgarn Craton trending SE-NW; the Mesoproterozoic Albany-Fraser Orogen in a SW-NE trend; and the Mesozoic Bremer Region. Outcrops in these regions are rare ($<\sim$20% total surface) due to intense weathering and the presence of widespread transported (regolith) cover increasing in thickness from the coast towards the interior.

In this geological context, a total of 3000 km W-E-traverses were surveyed to verify the computer-generated landscape classifications with field observations. Further three traverses were surveyed along and across the main palaeovalleys. Google Earth imagery and the recording of stratigraphic sequences associated with the diverse landscape types were also used to verify the landscape classifications.

The approach implemented in this project can be generalised to assist landscape mapping in RDTs by the use of DEM surface geometry. This is a quick and low-cost technique for creating a first-pass landscape type map on a large scale. However, ground truthing is essential. Landscape classification using this technique could be a useful tool to map and classify landscape types in similar geological contexts such as West Africa, India, Brazil and large parts of China. Landscape mapping can provide a reference in mineral exploration for a better understanding of geochemical dispersion of the basement geochemical signatures through cover, by linking stratigraphic units to dispersion processes and surface geometries. This can be of significant assistance for mineral exploration programs in areas of transported cover or deeply weathered stratigraphy, by assisting the interpretation of geochemical anomalies detected at the surface.