Regolith geochemistry in sand-dominated terrain: a case study of the Ajana 1:250 000 sheet

by

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The Geological Survey of Western Australia (GSWA) regolith geochemical mapping program provides information on the distribution and composition of regolith to assist bedrock mapping, and to stimulate mineral exploration. This program, which has largely focused on the Yilgarn Craton and adjacent Proterozoic basins, has established a simple relationship between bedrock composition and regolith geochemistry. Recently, the program has included Phanerozoic basins, where limited outcrop and extensive sand and vegetation cover create new challenges in interpreting regolith geochemistry. Despite this, some encouraging results were obtained that are applicable to sampling in sand-dominated terrains elsewhere in Western Australia.

The AJANA 1:250 000 sheet (Fig. 1) includes parts of the Archaean Yilgarn Craton, Proterozoic rocks of Badgeradda Group, Nilling Formation and Northampton Complex, and Phanerozoic rocks of the Coolcalalaya Sub-basin and Southern Carnarvon Basin (Myers and Hocking, 1998). Regolith and regolith geochemical mapping of AJANA was based on regolith characteristics and sampling of regolith at 820 sites at a nominal density of one sample per 16 km^2. The <2mm fraction of the sample was subsequently analysed for 48 elements by a commercial laboratory.

A regolith-materials map was produced using Landsat imagery, aerial photography, synthetic Landsat stereopairs, and sample-site descriptions. Sand-dominated regolith, which accounts for 65% of all regolith on AJANA, was divided into eleven types, based on lithology and geomorphology. Vegetation patterns, in conjunction with periodic fire scarring (resulting in soil destabilization) and recent faulting may have influenced the morphology of some of these sandplain units. In some coastal areas, the sandplain types reflect coastal processes, with significant dune development. Many sandplain subdivisions can be distinguished by subtle chemical variations, suggesting that sandplain chemistry is controlled by several factors, including sand stability, coastal and eolian processes, and the nature of the underlying lithology (Sanders and McGuinness, in press). A simplified version of the regolith-materials map is produced in Figure 2.

Owing to the predominance of quartz sand, many analytes are diluted by SiO_2 and variations in the chemistry of the sandplain are subtle. In the northwest of AJANA, P_2O_5 values in regolith are higher over areas of relatively stable undulating sandplain, whereas lower values are encountered over adjoining depressions and drainage areas, typically dominated by net-like dune systems. The higher P_2O_5 values in the more stable sandplain probably relate to the presence and reworking of underlying carbonates. This area also contains some of the highest Zr values in regolith for the map sheet. As samples containing high Zr are found in zones parallel to the coast, are continuous across numerous regolith types, and are progressively depleted in an easterly direction, it is proposed that the high Zr values represent concentrations of heavy mineral sands enriched by coastal processes (Sanders and McGuinness, in press).

To test the hypothesis that many of the sandplain units on AJANA are chemically different, k-means cluster analysis was undertaken to divide the samples into several chemically distinct groups (Rock, 1988). This approach shows that most of the map sheet is covered with quartz-rich sandplain, although along the coast, the higher SiO_2 concentrations have given way to more carbonate-rich material (Fig. 1). Some of these coastal areas include the highest levels of resistate phases in regolith, including such detrital minerals as rutile, ilmenite, monazite, sphene and zircon. Heavy mineral concentrates constitute up to 4% in some samples. These have probably been derived from the Northampton Complex and Yilgarn Craton and transported by the Murchison River and concentrated by eolian processes, along palaeoshorelines, or in the mouth of a proto-Murchison River (Sanders and McGuinness, in press; Harrison, 1985).

There may be evidence of base metal mineralization in the sand-dominated environment but this requires more detailed work involving low-level detection of pathfinder elements.

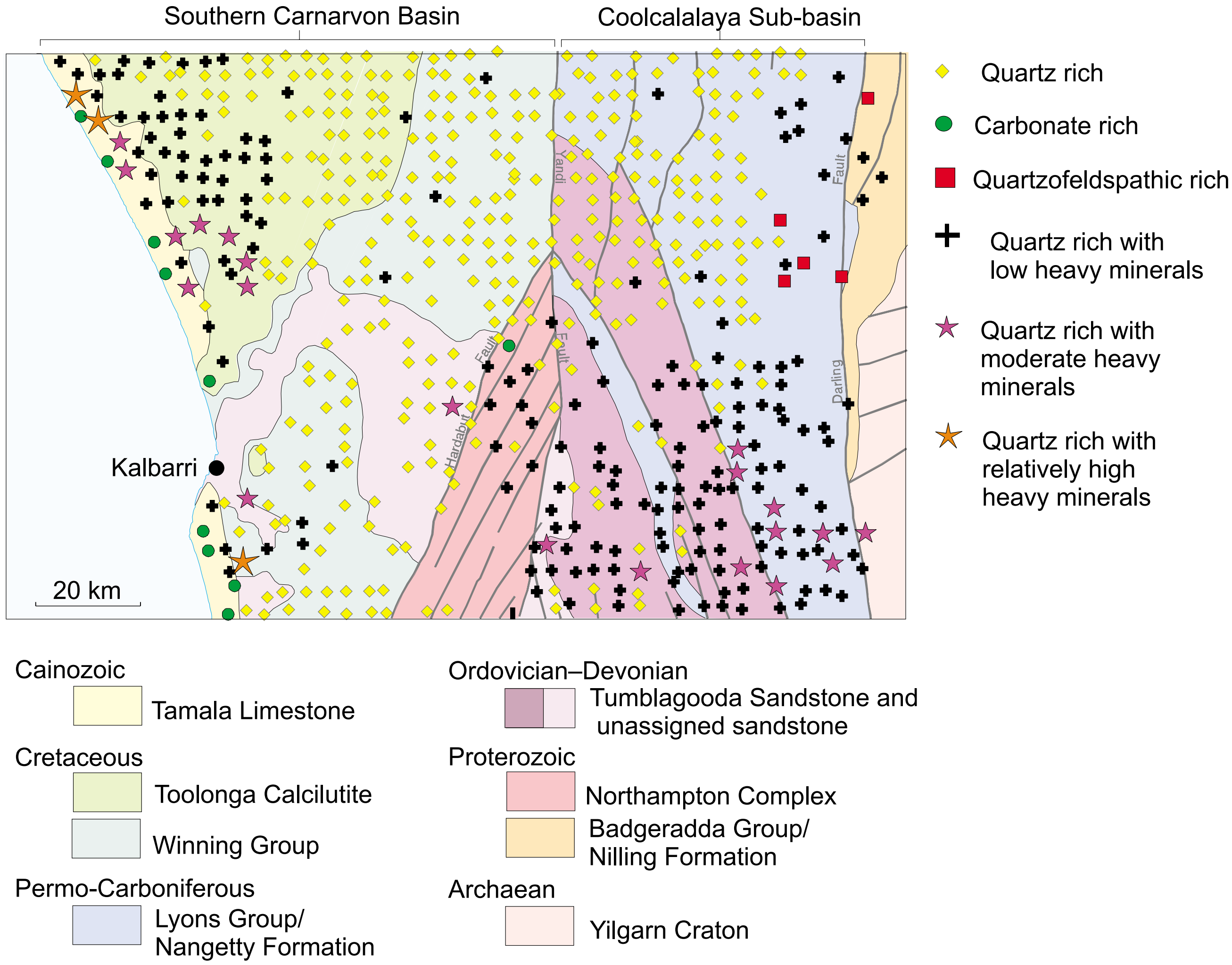

Figure 1. Simplified geology and classification of sand composition after k-means cluster analysis

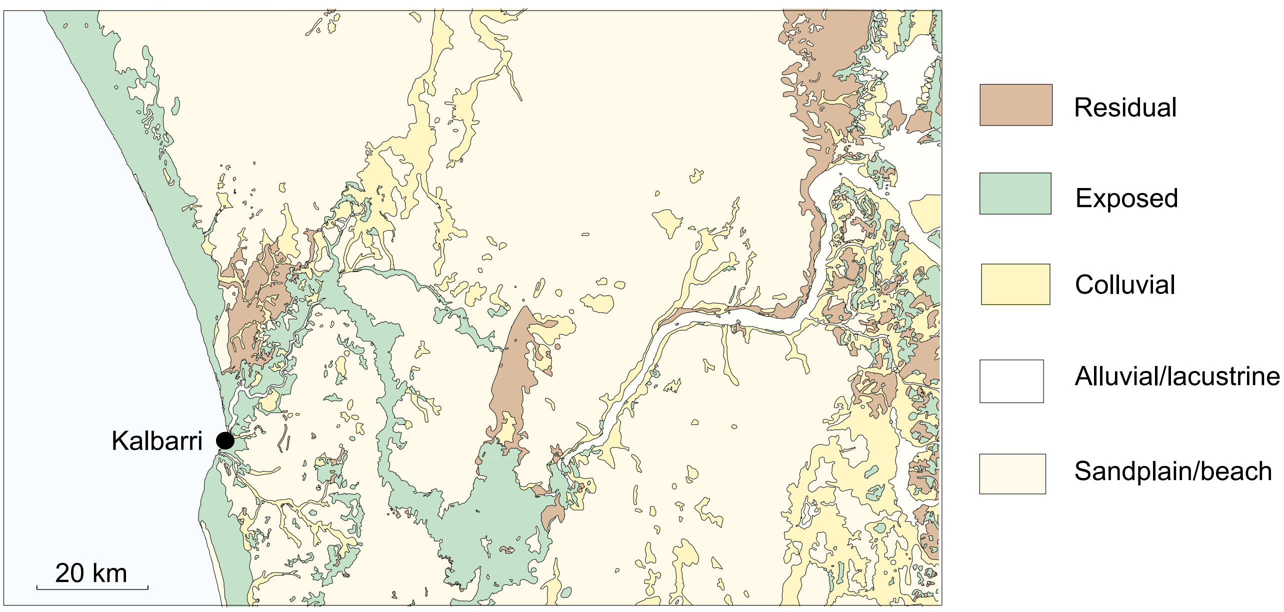

Figure 2. Simplified regolith highlighting the dominance of sandplain on AJANA

References

HARRISON, P. H., 1985, An evaluation of the mineral potential of the onshore Carnarvon Basin: Western Australia Geological Survey, Record 1984/8, p. 55–63.

MYERS, J. S., and HOCKING, R. M., 1998, Geological map of Western Australia, 1:2 500 000 (13th edition): Western Australia Geological Survey.

ROCK, N. M. S., 1988, Numerical geology: Berlin, Springer-Verlag, 427p.

SANDERS, A. J., and McGUINNESS, S. A., in press, Ajana, W.A.: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series Explanatory Notes.