Metallogeny of the South West African Craton: a mineral system approach

Nicolas Thebaud[1,*], James Davis[1], John Miller[1], Graham Begg[2], Mark Jessel[1], Kim Hein[3], Cam McCuaig[1], Lenka Baratoux[4]

[1]*Center for Exploration Targeting, University of Western Australia, Crawley, Perth, WA 6009, Australia;* [2]*Minerals Targeting, Suite 26, 17 Prowse Street, West Perth, WA 6005, Australia;* [3]*University of Witswatersrand, 1 Jan Smuts Avenue, Braamfontein, Johannesburg, 2000, South Africa;* [4]*Geosciences Environnement Toulouse, Observatoire Midi Pyrénées, 14 ave E. Belin, 31400, Toulouse, France*

[*]E-mail: nicolas.thebaud@uwa.edu.au

Mineral deposits are a local manifestation of a range of earth processes that take place at different temporal and spatial scales (e.g. McCuaig et al., 2010). At the lithospheric scale geodynamic process and associated lithospheric structure is now commonly proposed to apply a strong control on metal endowment of mineralised provinces (Begg et al., 2014). Increasing high-resolution geochronological constraints on ore deposits further suggest that deposits form during a very narrow time interval during a prolonged geodynamic evolution suggesting a transient regional scale geodynamic setting (i.e. tectonic plate reorganisation), geodynamic transition from long compression period to a period of transcurrent tectonics (Goldfarb et al., 2005). At the regional scale, inferred basement architecture is proposed to apply a multi-scale control on mineralised camp localisation. Often cryptic in the rock record, spatial and temporal mapping of fluid pathways (magmatic and hydrothermal) may be targeted indirectly through deciphering the lithostratigraphic record.

Similar to most Precambrian Terranes, the South West African Craton (SWAC) exhibits a protracted tectonic evolution of which only the latest structural increment is preserved. An insight into the early stages the SWAC formation may however be gathered through careful lithostratigraphic analysis and correlations of its supracrustal cover. Despite numerous studies of the SWAC the regional scale, lithostratigraphic sequence remains largely unconstrained (e.g. Abouchami et al., 1990). The unconstrained lithostratigraphic column has led to uncertainty over the nature and timing of the tectonic processes at play at the time of mineralisation. The lithostratigraphic compilation derived as part of the WAXI2 research project allows for craton wide lithostratigraphic compilation that may be used to assess the tectonic evolution of the SWAC (Davis et al., 2015).

As an outcome of this investigation it is suggested that the lithostratigraphic record deposited between ca. 2300 and 2050 Ma can be correlated and mapped across the entire SWAC. Within this framework it is possible to identify distinct depositional cycles, which allow for further our understanding of the tectonic environment associated with the SWAC development. Within this time period, major breaks in the lithostratigraphy are observed to occur at ca. 2180, 2150, 2115 and 2100 Ma.

The period from ca. 2180 to 2150 Ma represents the first major change, with the cessation of tholeiitic to calc-alkaline volcanism. Basalts are replaced, on a domain wide scale with intermediate-felsic extrusive lavas and pyroclastic deposits; this is indicative of the beginnings of convergent tectonic setting.

The second major event recognised in the stratigraphic record is the caseation of volcanism at ca. 2150 Ma and the onset of large scale/massive sedimentation. This boundary is observed across the domain. Initially reworked volcanic material dominates before grading into thick sequences of greywacke at ca. 2130 Ma. This represents the amalgamation of arc-like domains followed by their uplift and erosion leading to the formation of large sedimentary basins.

The third major event recognised across the craton is the deposition of late basins at ca. 2115- 2097 Ma (e.g. Tarkwa). The deposition narrow elongate basins, and short depositional window are indicative of a change in the regional tectonic over the deposition of the greywacke basins that precede it.

The restart and shift in volcanism to the western Baoule-Mossi domain at ca. 2100-2070 Ma represents a fourth major stratigraphic, and first major diachronous geological event in the Baoule-Mossi domain. Finding its foundation in the concept of mineral system approach and taking examples ranging in scale from craton to deposit scale, this study demonstrates how the development of a unified lithostratigraphic analysis may provide tools for the development of a metallogenic model critical to support mineral exploration strategies.

References

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