

Sedimentology and Stratigraphy Applied to Sediment-hosted Copper Deposits – Insights From the Kalahari Copperbelt, Botswana

Deborah Harlet^{1,2}, Simon Jones^{1,2}, Koen Torremans^{1,2}

¹School of Earth Sciences, University College Dublin, Dublin, Ireland, ²Science Foundation Ireland Research Centre in Applied Geosciences (iCrag), Dublin, Ireland

Sediment-hosted copper mineral systems are controlled by basin architecture and evolution. This combination of structure and sedimentary facies determines subsurface fluid flow pathways, as well as the positions of redox interfaces. The Kalahari Copperbelt in Botswana contains both structurally controlled and stratabound copper-silver ores. These ores are hosted in the Ghanzi-Chobe Belt, a siliciclastic-dominated, late Meso- to early Neoproterozoic basin inverted during the Pan-African Damara Orogeny. Copper-silver minerals occur mainly at the boundary between the Ngwako Pan and overlying D'Kar formations. Key aspects of the basin such as its sedimentary and redox architecture remain enigmatic. In addition, existing interpretations of the sedimentary environment lack detail and the position of evaporitic sequences are poorly defined. This contribution presents new sedimentological and stratigraphic constraints on those sequences based on detailed logging and palaeocurrent analysis of regionally spaced boreholes. The data reveal a shallow marine peritidal environment with (i) sabhka; (ii) mud flat; (iii) mixed flat; (iv) sand flat; and (v) subtidal compound dunes. Interpreted facies associations are laterally continuous over the study area. The lack of abrupt thickness and facies changes indicates accommodation space was generated by thermal subsidence, not faulting. The proposed paleogeographic model for the Ghanzi Basin is a funnel-shaped epeiric embayment open towards the southwest and bound by the Kalahari Suture Zone on its southeast margin. Preliminary LA-ICPMS U-Pb apatite dating reveals a dominant late Mesoproterozoic population with subordinate early Mesoproterozoic, middle Mesoproterozoic and late Paleoproterozoic populations. Importantly, Neoproterozoic apatite ages likely record mineralising fluids. Rare Silurian to Cambrian ages point toward a second fluid event during Damara orogeny. These results provide a new basin-scale framework for understanding sediment dispersal, redox architecture, and fluid migration pathways in the Kalahari Copperbelt. The study also underlines the importance of laterally extensive redbed aquifers for large-scale brine mobilisation in sediment-hosted copper systems.