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Provenance of the Quaternary Southern Kalahari sediments: A wetland that became dry

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The ca. 140 Ma vast Kalahari basin is characterized by uplifted margins, terrestrial sedimentation within semi endorheic sub-basins, subdued morphology and tectonic quiescence. This intracratonic basin has been subjected to a prolonged period of subsidence affecting its sedimentary fill by changing plate motion and climatic cycles. Provenance studies of Kalahari Group sediments mainly focused on the easily accessible uppermost part that represents only the last phase of sedimentation, leaving unresolved questions for the rest of the strata.

The Southern Kalahari Group succession exposed along the walls of the Mamatwan Mine, Northern Cape, South Africa, reveals three main depositional environments; a bottom pluvial, low-energy water body, a middle fluvial, high-energy environment and an upper aeolian sandy unit. The entire section, which was deposited within the Quaternary, records significant environmental and depositional changes suggesting a highly dynamic landscape.

The fully exposed section (55 m) of the Kalahari Group at Mamatwan Mine was analysed for its mineralogy, elemental composition, Sr, Nd and Pb isotopic ratios and iron species. Mineralogical assemblage imply that a saline and alkaline shallow water-body existed during the early-middle Pleistocene contemporaneous with relative dense hominine occupation of the area.

Isotopic ratios were used to determine the source of the sediments, which was found to be mainly of mafic rocks located to the north-east of Mamatwan. Weathering sensitive indices of both elemental ratios and iron phases show that sediments carried to the basin underwent considerable weathering indicative to a greater availability of surface water than the present.

The lacustrine environment was rapidly filled with clasts that were derived mainly from the surrounding hills and experienced limited degree of chemical weathering during transport, but underwent subsequent groundwater alteration by iron-rich solution and precipitation of celcrete and silcrete duricrusts. The filling of the basin was accompanied with reduced availability of surface water which ultimately resulted in a shift to a mostly aeolian regime in the region supplying pre-eroded sediments. Following the establishment of the modern wind regime sediments were derived from more felsic rocks mainly located in western and north-western source areas.