

THE QUATERNARY GEOMORPHOLOGY OF THE KALAHARI

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Interpretation of the Kalahari Group sediments, first attempted by Passarge at the end of the nineteenth century, has proved to be a difficult task. The sediments show a high degree of homogeneity, particularly the Kalahari Sand, lack fossils and have low rates of organic preservation. They are frequently highly altered, and there has been much confusion in distinguishing the products of post-depositional modification from true stratigraphy.

Geomorphological studies carried out in the Kalahari south of the Zambezi River over the past twenty years have contributed greatly to the understanding of processes active in the Kalahari Basin, and, through a suite of approximately 300 radiocarbon dates, of the environmental conditions prevailing in the Late Quaternary. This, in turn, has allowed greater insight into the nature and relationships of the Kalahari sediments.

The oldest Kalahari landforms appear to be the networks of dry valleys (megacha) which drain towards the centre of the basin, or southwards towards the Orange River. Although there is limited evidence for sporadic surface flow in these valleys, particularly in the Kuruman-Auob-Nossob system, their formation can be largely attributed to groundwater activity along selected flow paths. Pans are also formed by groundwater activity, rather than aeolian action as previously thought.

The complex suites of duricrusts associated with these two landform types are evidence of this groundwater activity.

Studies of the Okavango Delta and the associated Makgadikgadi-Mababe-Ngami palaeolakes has provided evidence for episodes of wetter climates in the Late Quaternary, although hydrological patterns have been much modified by tectonic activity in the Kalahari Rift and Gwembe Trough. Two major palaeo-lake levels, the Lake Palaeo-Makgadikgadi stage at 945 m asl. and the Lake Thamalakane stage at 936 m asl. indicate major changes in the Middle Kalahari region. Evidence from Drotsky's Cave in Ngamiland has been used to differentiate local from regional climatic signals.

The dominant dune form is the linear dune, which occurs in three major fields in the Southern and Middle Kalahari. These fields have previously been assumed to be fossil features activated during periods when precipitation has decreased below c.150 mm p.a. This hypothesis is difficult to sustain given the latitudinal extent of the dunes, and the lack of chronological data currently available for the existence of episodes drier than present. Recent research suggests that linear dunes are sand transporting dunes with little bedform movement, and are capable of functioning at higher precipitation levels and a vegetation cover up to 30%. As such they are persistent and probably ancient features in the landscape.

Radiometric dating has provided good chronological control of environmental changes over the past 20,000 years, with strong evidence for a major wet phase throughout the region at 16,000-13,000 BP, followed by lowering of groundwater tables and accompanying duricrust formation to 10,000 BP. The early Holocene experienced conditions similar to the present, while minor wet episodes have occurred throughout the last 5,000 years, notably around 2,000 BP. The radiocarbon chronology has been extended back to 50,000 years, but the period before the Last Glacial Maximum (c. 18,000 BP) has provided less certain results.

An interesting feature of the Quaternary climatic chronology is that it is out of phase with Africa north of the Equator, and with other arid and semi arid regions of the tropics. This divergence from global patterns has not yet been satisfactorily explained, but is likely to arise from the northward movement of the monsoonal belt during periods of hemispheric forcing.

Present research is concentrating on the extension of the palaeoclimatic record to 300,000 BP through the use of Th/U dating on cave speleothems, and the dating of 'drier' episodes using thermoluminescence and optical luminescence on dune sediments.

PALYGORSKITE AND DOLOMITE IN LATE NEOGENE PALUSTRINE SEDIMENTS, NORTHWESTERN TRANSSVAAL, SOUTH AFRICA

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The fluvial sediments of the Rooibokkraal Formation and associated lacustrine argillites comprising the Zuurverdiend Member accumulated in parts of the northwestern Transvaal on the margin of the Kalahari region, probably during the late Neogene period. The accumulation of thin, yet widespread sedimentary cover and formation of diverse duricrusts associated with the Rooibokkraal Formation is discussed in the context of regional calcretization in response to changing environmental conditions.

Landscape processes in the area changed from active fluvial channel and distal ephemeral lacustrine processes to those dominated by pedogenic calcretization. The development of thick calcrete profiles within gravelly and sandy sediments and weathered granitoid bedrock occurred initially in areas surrounding poorly-drained depressions. Preferential removal of Ca during a long period of calcrete formation in these areas concentrated Mg in groundwater-feeding poorly-drained areas. Further evaporative concentration of magnesium during periodic emergence of the palustrine margins of ephemeral lakes resulted in breakdown of smectitic clays and neof ormation of palygorskite. Permanent desiccation of palustrine mudflats led to development of replacive, pedogenic powder dolcrete within the palygorskite/smectite clay deposits.

Although accumulation of the Rooibokkraal Formation was probably contemporaneous with part of the Kalahari Group succession, no lithostratigraphic correlation has been attempted. It is suggested that a broader lithostratigraphic grouping is needed before attempting to correlate Cainozoic sediments in the region.