SAND AND WATER

CHAPTER
TWO

FOUNDATIONS

Millions of
years to build

The Khaudum Omuramba snaking east towards the Okavango Delta.

As an administrative region with clearly defined borders, Kavango is very new, especially so in relation to the hundreds, thousands and millions of years over which this area has existed. What is to be seen today is largely a product of events and developments over all these years. Indeed, the region's natural features have been millions of years in the making.[1]

Several features dominate Kavango's landscape: its flatness, the mantle of windblown sand, the Okavango River, dry omuramba valleys (dry rivers are known as omurambas in Namibia) and the remains of old sand dunes. One way or another, all of these are associated with the fact that Kavango is part of the Kalahari Basin, a vast depression stretching from the northern Cape in South Africa upwards to close to the Congo River (FIGURE 4). But what formed this huge Basin, how did the region come to be covered by windblown sands, and when did the Okavango River first flow?

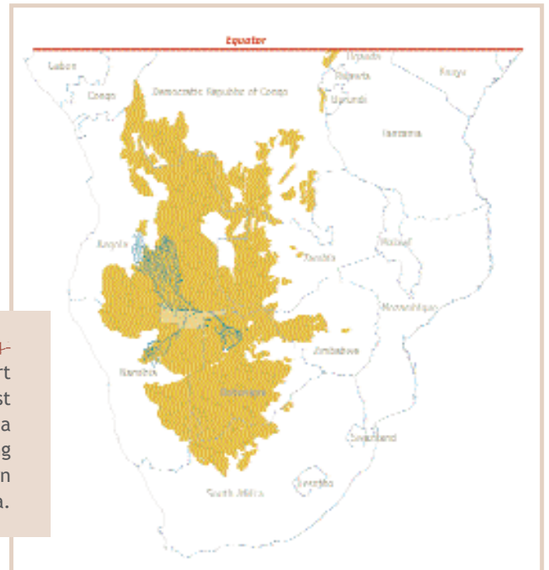


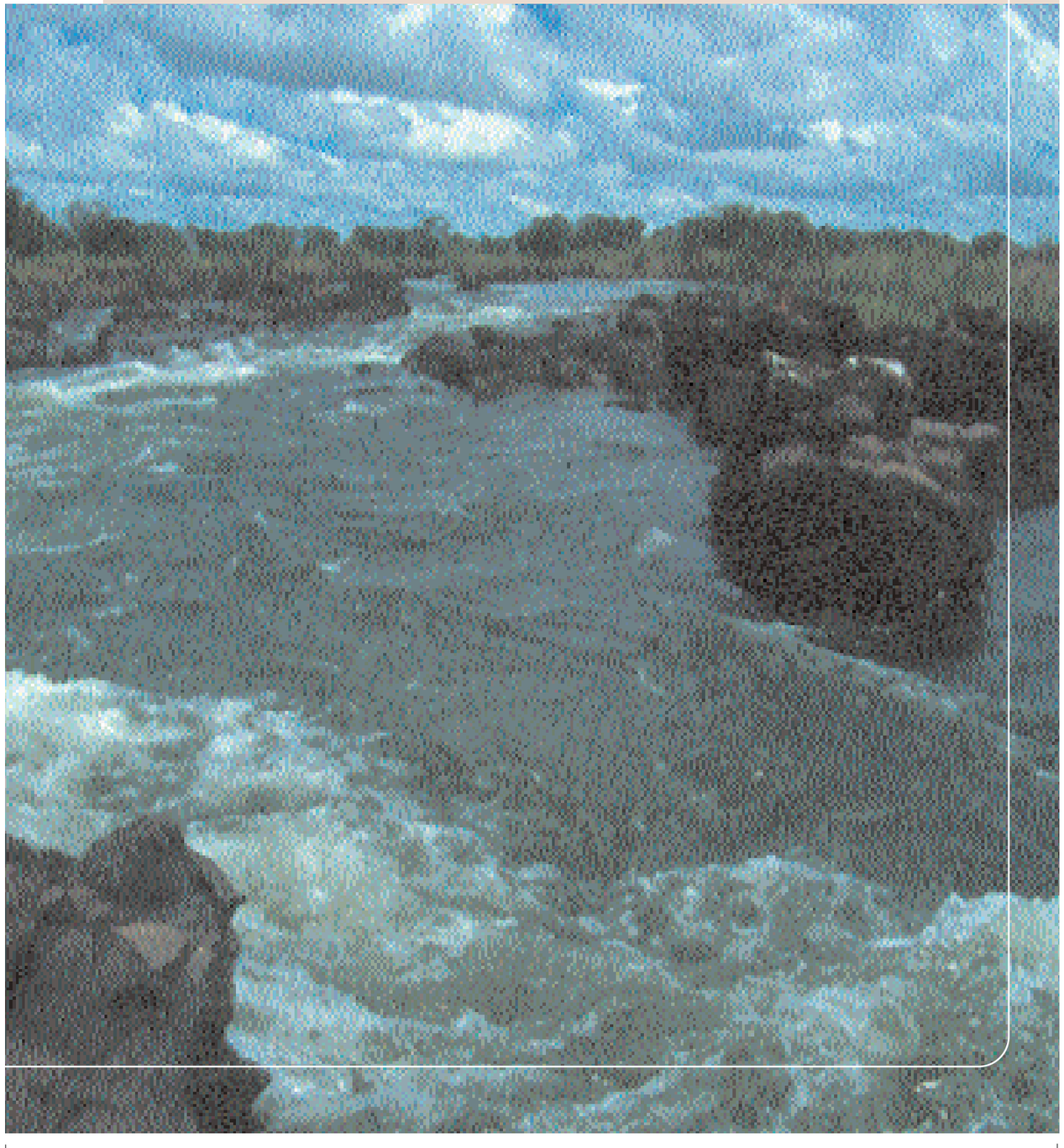
FIGURE 4–
Kavango forms part of the vast Kalahari Basin, a landscape covering much of southern Africa.

Time on Earth goes back to the formation of the planet some 4,600 million years ago, but what Kavango looked like for much of that time is not known. The best place to begin is with the formation of the basement to Kavango, a foundation of rock produced over a period lasting about 350 million years. All of this started some 900 million years ago when an ancient landmass began to split apart into several continental plates. Deep rift valleys formed between the splitting plates, and sediments washed down into lakes lying in the bottoms of the valleys. The splits later widened much further to form distinct continents separated by oceans. One of these is known as the Khomas Ocean, and thick layers of sediments were deposited on its seabed.

The continents then started moving closer about 700 million years ago. Sediments that first accumulated in the rift valley lakes and those later deposited on the ocean floors were squeezed upwards, the great forces of compression heating and moulding them into metamorphic rocks: limestones, quartzites, schists and dolomites. The name of the new landmass created about 550 million years ago by these and other colliding continents was Gondwana, and those metamorphic rocks formed the basement of what is now Kavango. However, the rocks lie at very different depths below the current surface of the region. Those in the south (near Mangetti) and in the east (around Bagani) are closest to the ground because this is where mountain belts had formed when the colliding continents pushed the seabed sediments highest. One belt now forms the hills near Grootfontein, Tsumeb and Otavi while another remains as the hills of the Khomas Hochland, which we now see around Windhoek. The Khomas Hochland belt actually extends in a north-easterly direction, through Botswana and up into Zambia, but most of the original belt in those north-eastern areas was later eroded away. All that remains visible today are small hills, such as the Aha Hills near Tsumkwe and the Tsodilo Hills to the east in Botswana, and rock outcrops in the south-east of Kavango and near Bagani, including those that form the Popa Falls (FIGURE 5). In actual fact, the surface rocks at Bagani and in south-eastern Kavango are thought to have been produced from the earliest deposits of rift valley sediments. They are called Nosib Group rocks, while Damara Supergroup is the name given to the whole assortment of rocks formed from sediments pushed up by the colliding continents.

Basement rocks lie much deeper in western Kavango, and in some places drill rigs must penetrate

Popa Falls, where the river cascades down several metres before resuming its normal slow and leisurely flow.



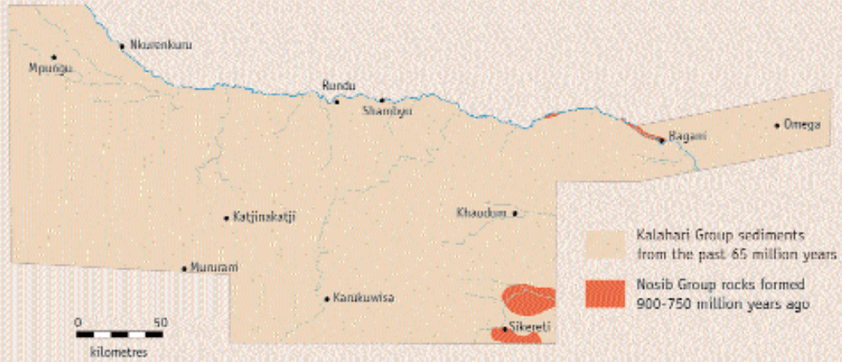
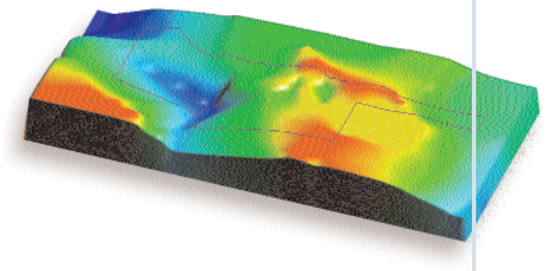


FIGURE 5-
Much of the region is covered by a mantle of Kalahari sand. The only exposed Nosib Group rocks in the east were perhaps formed from sediments deposited in an ancient rift valley between 900 and 750 million years ago.

FIGURE 6-
This is what Kavango would look like if the mantle of Kalahari sediments were stripped away. The surface in the image is thus the bedrock foundation. A deep valley, possibly carved by a glacier, runs from the western border south-eastwards towards and beyond Mururani. Deep areas in the far north-west form part of the Owambo Basin, while the highest areas are in the south-eastern part of Khaudum and along the river between Shambyu and Bagani.



400 metres of younger sediments (FIGURE 6) before reaching the bedrock. This is because the deepest rocks form part of the Owambo Basin, a basin that also formed when the two landmasses collided. Such basins are created when colliding continents push up to form mountain belts in one area but subside in another, the Earth's crust countering uplift in one zone by subsidence behind it.

The events of between 700 and 550 million years ago provided the basement and foundation to the region. A long period of erosion followed during which the Gondwana landscape was smoothed and carved by wind and water erosion. But there was also a good deal of erosion by ice when glaciers covered much of southern Africa between 300 and 280 million years ago. Huge sheets of ice then wore away rocks from the highlands and carried the sediments down to lower areas, including the Owambo Basin. Little is known of the exact distribution and thickness of the glacial deposits, but they possibly cover much of the basement in Kavango.

Massive volcanic eruptions occurred when Gondwana started to break apart about 180 million years ago. The upheavals spewed basalts across much of the southern African landscape, filling in valleys and basins and leaving exposed higher areas of basement, such as those now exposed around Bagani

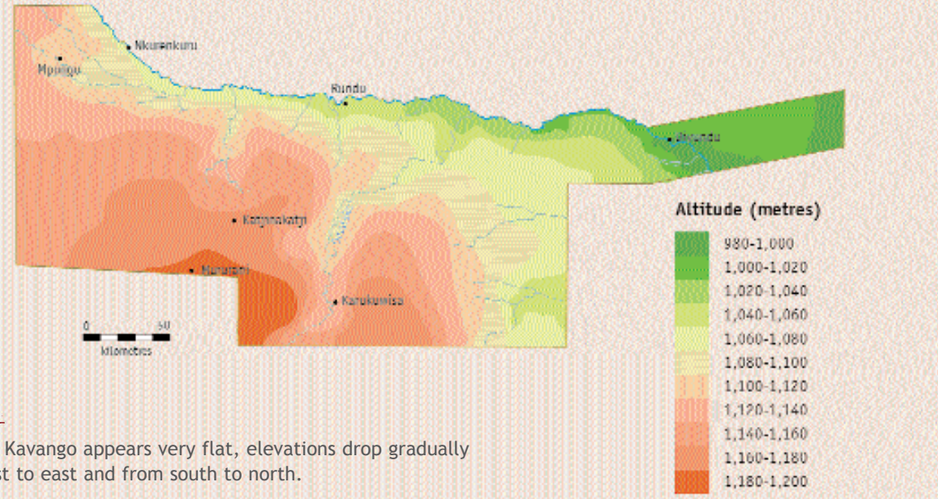


FIGURE 7-
Although Kavango appears very flat, elevations drop gradually from west to east and from south to north.

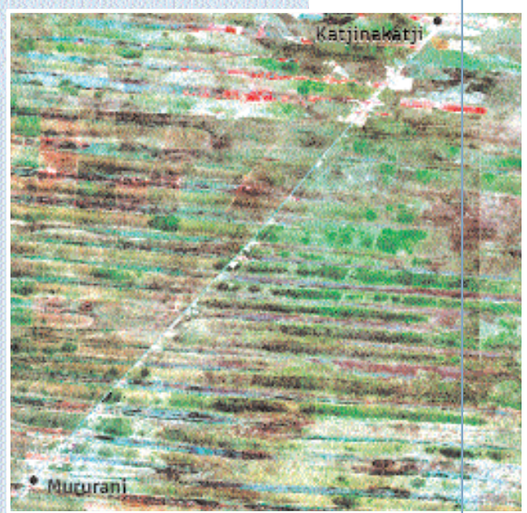


FIGURE 8-
Old sand dunes formed during drier episodes over the past two million years. The last dry period during which dunes were actively moulded probably lasted until about 10,000 years ago. The alignment of the dunes reflects the easterly direction from which prevailing winds blew when the dunes were formed. Dunes to the west of the Omatako were formed from sands carried down this omuramba, while those west of the Okavango Delta were likewise formed from sediments brought down into the Delta by the Okavango River. The small satellite image shows how old dunes cut across the main road between Mururani and Katjinakatji.

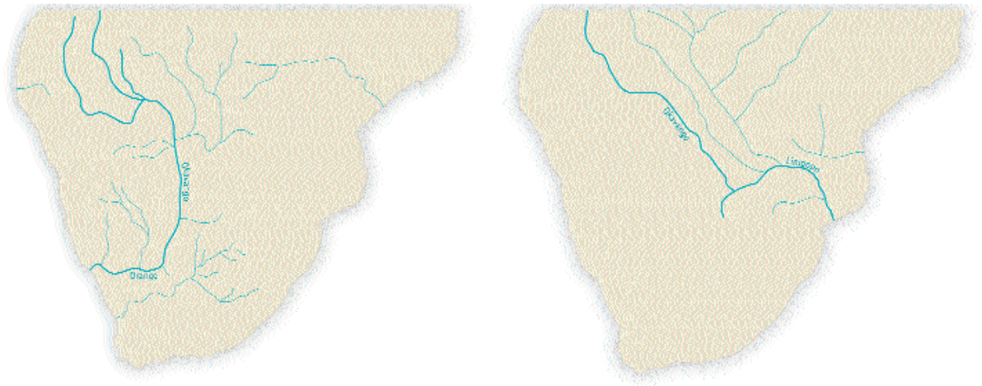


FIGURE 9-
The Okavango quite possibly flowed much further south before the formation of the Kalahari Basin 65 million years ago. The maps show different possible courses of the Okavango either into the Orange (left) or the Limpopo River (right).[2]

and in south-eastern Kavango. Large areas of these volcanic rocks lie hidden beneath the sands, probably as fairly thin layers less than 50 metres in thickness. One small outcrop of basalts can be seen just south of the region at Klein Dobe, north of Tsumkwe. These initial ruptures caused Antarctica and South Africa to part ways, but it was about 132 million years ago that new breaks formed between Namibia and South America. The movements of the earth's crust continue today as South America and Africa drift further apart.

Another important event followed the break-up of Gondwana. The margins of what remained as southern Africa began to lift up, producing a rim of mountains and hills encircling the landmass but also leaving a vast and shallow bowl in its centre. Much of this depression now forms the Kalahari Basin (FIGURE 4) of which the Kavango is part. While earlier processes produced a basement to the region, it is really the sediments that filled the Kalahari Basin over the last 65 million years that characterise the Kavango of today. For example, these deposits give the region its flat surface by blanketing the ancient highlands in the east and lowlands in the west (FIGURE 7). Similarly, the nature of the sandy soil largely determines what animals and plants live here and what kinds of farming can be practised.

The layers of Kalahari sediments can be divided into two broad groups. The first and deepest group is much the thickest, and consists of layers of clays, conglomerates, water-borne sands, silts and calcretes. Most of these older sediments were deposited along rivers and in lakes and swamps, perhaps rather like the present-day Okavango and Cuvelai deltas. The watery character of those deposits make it clear that most of the Kalahari's history over the past 65 million years was very much wetter than the climate we see today.

The second, topmost and youngest group is a relatively thin layer dominated by sand deposited mainly by wind, a fact shown most vividly by the many old dunes in the region (FIGURE 8). The predominance of windblown sand in these layers reflects the generally arid conditions that have persisted over the past two million years, although isolated deposits of clays have been laid down by water flowing along the omurambas and in inter-dune valleys during periodic wetter cycles.

The Okavango River is thought to be about 65 million years old, but it could have had its beginnings as far back as 180 million years ago when Gondwana first started to break apart. It is also possible that the Okavango flowed much further south, and one theory suggests that it could have fed into what is now the Orange River. A different hypothesis suggests the Okavango could have flowed all the way into the Limpopo River (FIGURE 9).

The cycle in which the last two million years were generally drier than the previous 63 million years was part of a long-term change in climate. There have also been many other medium-term changes, such as those occurring in about 23,000 year cycles over the past 200,000 years (FIGURE 10). Rainfall during the wettest of these more recent cycles was often several times higher than the averages of today, and many other rivers must have flowed in the region. This is when water would have carved the Omatako, Ndonga, Khaudum and other omurambas into the landscape. By contrast, other rivers might have been completely covered up by sand during the driest of cycles. Rainfall was then a quarter and less of what it is today, and strong winds would have shifted great volumes of sand to build and mould the sand dunes that are now covered in vegetation. Most of these dunes were probably formed more recently in two very dry periods, one lasting from 23,000 to 21,000 years ago and another from 35,000 to 28,000 years ago.[3] Finally, there are also much shorter cycles of wet and dry periods, such as those occurring at intervals of 10 or 20 years (see page 40).

One unlucky consequence of the thick mantle of Kalahari deposits is the fact that it is very difficult to discover and mine any valuable minerals in the bedrock. However, there has been recent interest in the possibility of finding diamonds associated with four kimberlite pipes near Sikeretti in the south-east. Much more exploration remains to be done before such a possibility is shown to be valid or not.

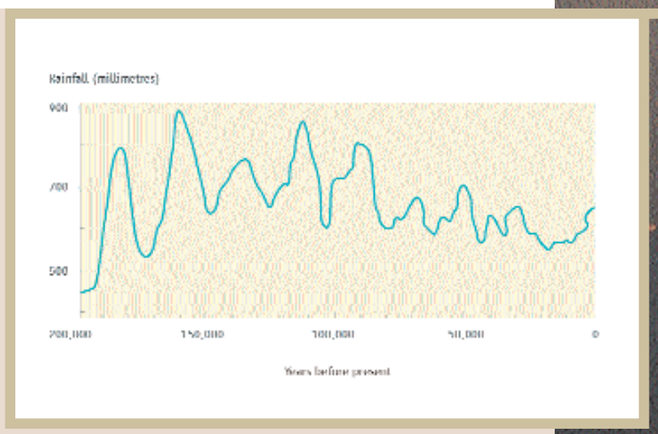
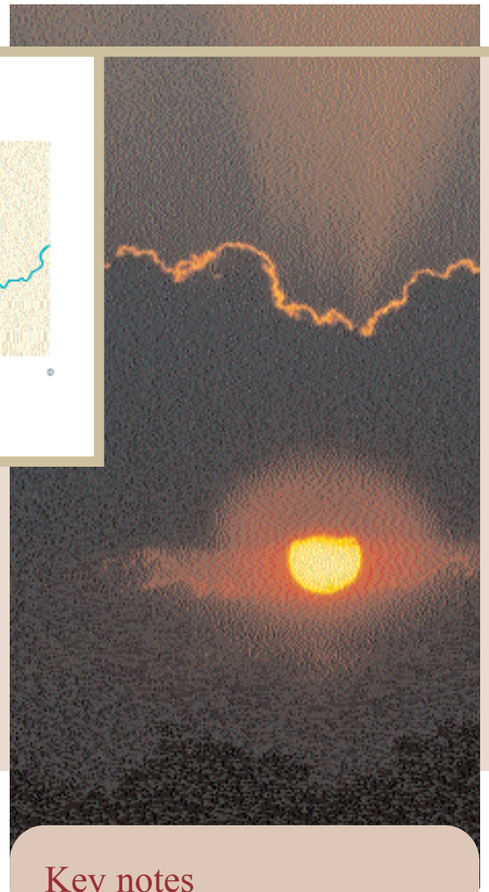


FIGURE 10-
Over time, the climate has fluctuated between wetter and drier periods. Such changes had marked effects on what sediments were deposited in the region, on the flow of rivers, on the types and abundance of plants and animals, and the livelihoods of people. The graph shows probable annual rainfall over the past 200,000 years for an area near Pretoria, South Africa. The figures are probably close to what happened in Kavango at the same time.[4]



Key notes

- The basement of rocks to Kavango was formed during events that occurred between 900 and 550 million years ago.
- Kalahari sediments deposited during the past 65 million years largely cover the basement of rocks, which is much deeper in western Kavango than in the east.
- There are two broad layers of Kalahari sediments: the deepest and thickest consists of material deposited along rivers, and in lakes and swamps, while the top, thinner layer is largely of windblown sand deposited under much drier conditions.
- The Okavango River is at least 65 and possibly 180 million years old.