Across a fire-scarred Panhandle to the woodlands that line its western edge, and to the Tsodilo Hills in the distance.

2

Shaping the Delta

Whereas the great majority of rivers in the world flow to the sea, the Okavango River ends in its Delta, right in the middle of the southern African continental landmass.

The Delta is close to the lowest point and centre of the Kalahari Basin (Figure 5). Most of the basement rocks beneath the Kalahari and the Delta were formed long ago from sediments that were forced and folded upwards from the floor of an ancient ocean about 700–550 million years ago. Extreme pressure and heat turned the marine sediments into metamorphic rocks of the so-called Damara Group. Overlying the Damara Group rocks are more recent fluvial, aeolian and volcanic rocks of the Karoo Group deposited from 300–180 million years ago. All these basement rocks are now hidden beneath the surface, except as isolated landmarks, such as the Khwebe Hills south of Toteng and the Tsodilo Hills west of Sepopa (*see* Figure 3, *page 14*).

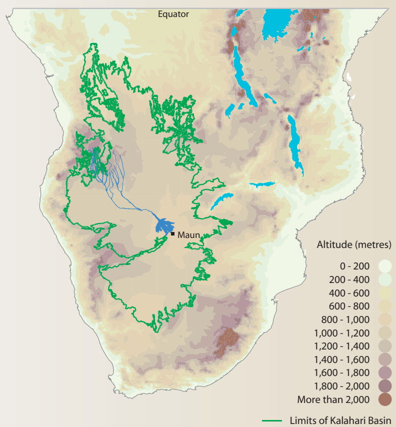


Figure 5 | *The Kalahari Basin is a vast sea of sand extending 3,000 kilometres from the northern Cape, across most of Botswana, through much of Angola and up to the Democratic Republic of Congo. From west to east, the Basin extends 1,500 kilometres at its widest.*

Two sets of faults in the basement have a marked impact on the flow and distribution of surface rivers and the shape of the Delta. Most of the first group are far to the north, where a series of parallel faults direct the flows of the Okavango, Cuito, Kwando and Zambezi rivers south-eastwards (*see* Figure 4, *page 15*). Extensions of these faults probably fix the orientation of the Panhandle, as well as the south-easterly flow of the Kwando River before it kinks into the Linyanti Swamps.

The second set of faults lies perpendicular to the first, and these control the position and shape of the Delta. The faults were formed by tectonic activity along a south-western extension of the East African Rift Valley. About two million years ago, faulting in this extension probably created two sub-basins in northern Botswana. One of these lies beneath the Delta, while the other sub-basin is found below the Makgadikgadi Pans. It is probably that rifting and collapse of the underlying basement that caused this broad trough, which encompasses the Delta and Makgadikgadi to be the lowest in the whole Kalahari Basin.

Other faulting along this extension of the Rift Valley is visible on the surface as the Gumare, Kunyere, Thamalakane, Linyanti and Chobe faults. The Gumare fault divides the Panhandle from the alluvial fan. The Kunyere and Thamalakane faults block water in the Delta from flowing further south-eastwards (Figure 7), forcing it to slow and therefore to spread. These two faults are fundamental in confining the Delta's alluvial fan.

The ridges that form the margins of the Panhandle rise about 20 metres above the swamp (Figure 6), and are sometimes thought to have been formed by faulting. However, it appears likely that the broad valley that confines the Panhandle was caused by erosion as the Okavango cut through, and deeper into the surrounding Kalahari Sands.

The Kwando/Linyanti has been shaped in the same way as the Delta, its flow to the south-east being halted by the Linyanti fault. As a result, the Kwando forms a mini-delta. Flows seep away progressively through the Linyanti Swamps to the

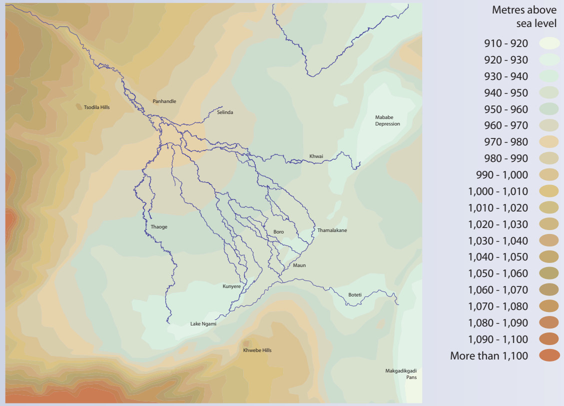


Figure 6 | *Although slopes down and across the Delta are very even, the deposition of sediments bought in by the Okavango River has led to the formation of a fan with a near-perfect conical shape, as shown in this map of elevations above sea level.*

BELOW: Popa Falls marks the real head of the Delta. As water tumbles over the Falls which are a nick-point in the Okavango River, its speed of flow slows and it is there that the river widens into the Panhandle and begins to deposit sandy sediments.

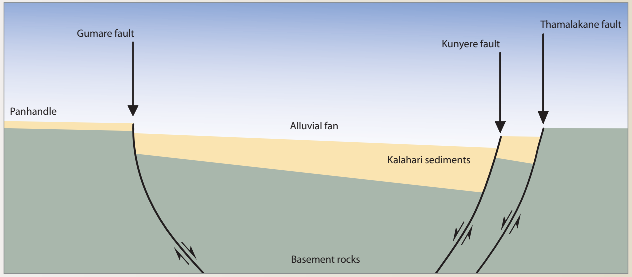
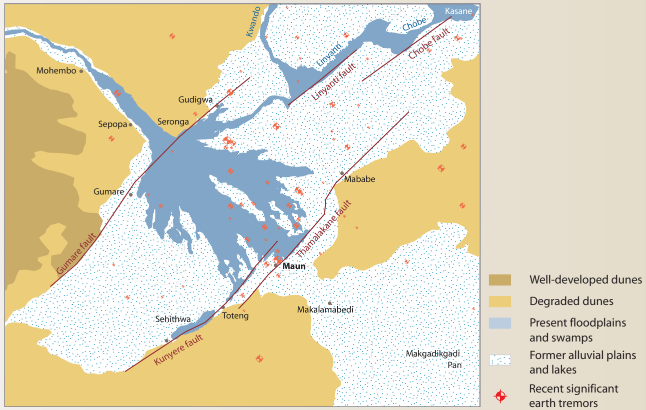
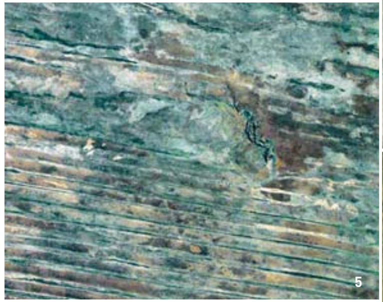
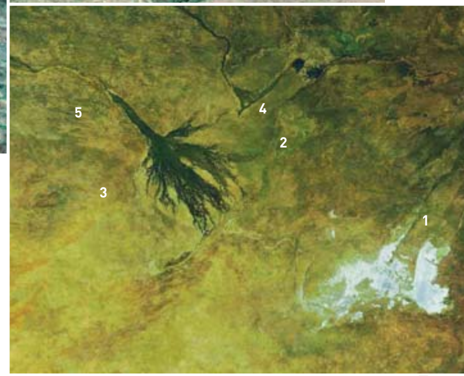


Figure 7 | *Cross-section through the Delta from north-west to south-east, showing the layers of rock and sediments, and the three faults that confine the alluvial fan.[1] Elevations along the Panhandle are extremely gentle, the river dropping only about 5 metres over a distance of about 150 kilometres. Over the next 150 kilometres or so from the Gumare to the Thamalakane Fault at the edge of the alluvial fan, elevations drop about 40 metres.*

Figure 8 | *The surface geology in and around the Delta includes well-developed sand dunes which formed during very arid conditions, as well as massive areas of alluvial sediments deposited during much wetter times by the Okavango, Kwando and Zambezi rivers. Recent earthquakes have ranged in magnitude from 2 (the smallest dots) to 6.7 on the Richter scale.[2]*







Some features around the Delta:[3]

1. The salt works in Sua Pan, which is part of the great Makgadikgadi Pans.
2. Mababe Depression; the colours reflect scars from fires at different times.
3. The sharp interface between the sand dunes and alluvial deposits of the Delta when it was much larger.
4. The Kwando River where it forms a mini-delta with the Linyanti Fault.
5. Tsodilo Hills; note how the linear dunes have packed up against the hills on the east.

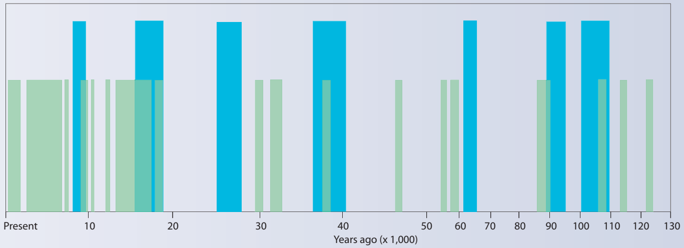
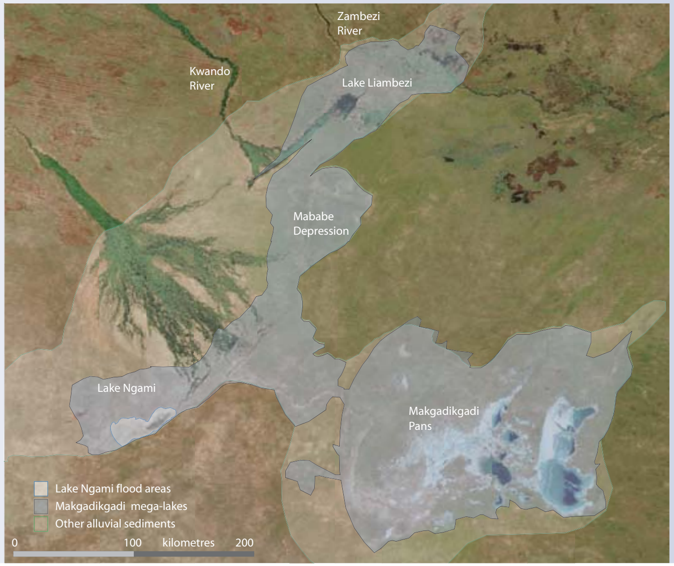


Figure 9 | Top: *Periods (blue bars) during the last 130,000 years ago when mega-lakes extended over Makgadikgadi and the low-lying areas around Lake Ngami, the Mababe Depression and across the eastern Caprivi, and phases (green bars) when Lake Ngami and its immediate surrounds were flooded. The extent of the mega-lakes (which covered some 66,000 square kilometres) and flooded areas around Lake Ngami (covering about 2,600 square kilometres) are shown in the map below. The map also depicts the extent of alluvial sediments deposited during other wet periods and when the flows of the Okavango, Kwando and Zambezi Rivers probably followed different courses.*[4]



north-east and sometimes reach Lake Liambezi. Further east, the Chobe fault controls the position of the Chobe River, which is a backwater of the Zambezi River.

The whole Kalahari Basin now has a remarkably flat surface, which drops gradually from its margins towards the centre. Its flat surface is a consequence of the Basin being filled steadily with sediments over the past 65 million years. Several hundred metres of layered sediments are to be found in places. For example, the Delta lies on top of 100 to 270 metres of deposits.[5] The sediments laid down during the first 63 million years were mainly alluvial, carried into the Basin by large rivers that left their deposits in massive lakes and deltas. The remnants of these now lie deep below the present surface, which, by contrast, was largely shaped by aeolian deposits of wind-blown sand during much more arid conditions over most of the last two million years.

But even during these drier two million years, other rivers bigger than the Okavango have flowed into northern Botswana, leaving behind alluvial sediments over an expanse of about 120,000 square kilometres around the Delta and Makgadikgadi Pan **(Figure 9)**. That area is about ten times bigger than the present Delta. For example, the Zambezi possibly ran here as recently as 50,000 years ago, before being captured by a river that had cut its way back from the east coast.[6] An older course of the Kwando also probably flowed into what is now the Delta.[7]

The Okavango Delta and northern Botswana have therefore looked very different from what we see today. At times dominated by aridity, these areas may have been very similar to the Namib Desert in appearance, while in wetter periods huge expanses of water in lakes, pans and perhaps other deltas have characterized the landscape.

How old is the Delta? This is difficult to answer, given the variety of rivers, courses and volumes of water that have flowed into northern Botswana over millennia. However, if we define the Delta as the fan of water now confined by the Kunyere and Thamalakane faults, it is perhaps relatively young, since those barriers seem to have developed no more than 120,000 years ago. We presume this because extensive older alluvial sediments have been identified to the south and east of the present faults, suggesting that water then flowed beyond the present limits of the alluvial fan.[8]

In the same way that climates change, tiny tectonic movements may cause subtle changes in elevation which result in significant changes in the distribution of flows across the Delta (*see page 51*). Most of the dozens of tremors in the area have been small **(Figure 8)** but one at Maun in 1952 measured 6.7 on the Richter scale.

The repeated flooding and drying of the Delta and its adjacent areas over hundreds, even thousands of years may be considered a matter of academic interest. However, that history and the confinement of flows has led to the accumulation of nutrient resources in and around the Delta. Each flood brought with it more of these chemical constituents of life. Nutrients blown in by wind were trapped in the water, and faecal matter from animals attracted to the water and its associated floodplain pastures likewise enriched the Delta. The key point is that the rich nutrient supplies took a very long time to accumulate here, unlike the fresh supplies of water which arrive to re-flood the Delta year after year. Maintaining the productivity of the Delta thus requires the protection of both the supply of water and the age-old base of nutrients.

KEY POINTS

1. The Delta lies near the lowest part of the vast Kalahari Basin which stretches over 3,000 kilometres from north to south and up to 1,500 kilometres east to west.
2. The Basin is largely filled with aeolian and alluvial sediments that lie on basement rock formations.
3. Faults lying north-west to south-east in the basement rocks control the flow of the Okavango River south-eastwards towards the Delta.
4. Other perpendicular faults – the Gumare, Kunyere and Thamalakane faults – confine the alluvial fan of the Delta.
5. Climates and the extent of the Delta and other bodies of water in northern Botswana have changed radically. There have also been dry periods when the Delta was probably covered by sand dunes.
6. As a result of flooding, nutrients have accu-mulated progressively over a long time in the Delta's sediments and those of adjacent areas flooded by much larger lakes.