CHAPTER 3

The Formation of the Victoria Falls

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The Victoria Falls form the point where the waters of the mighty Zambezi pour off the Southern African Plateau into the chasm of Batoka Gorge and thence to the wide rift valley of the Gwembe Trough. As Professor Bond has shown in Chapter 2, this has not always been so. The river and the Falls have experienced a dramatic evolution since Early Stone Age times, which Stone Age man would have witnessed as he used and discarded his tools.

The story of the developments that led to the formation of today's Victoria Falls can be pieced together from the record preserved in sediments both upstream and downstream. Having left the seasonal swamps of the Barotse Plain, the Zambezi passes over a series of rapids in the underlying basalt before entering the Chobe Swamps at Katima Mulilo (Fig. 1). From there to the Mambova Rapids, the river flows with a very gentle gradient across its own alluvium.

The alluvial sediments of the Chobe Swamps fill a rifted basin, one of several still forming in the southern African interior, at the southern extension of the East African Rift System. These basins are linked by stream lines and contain river and lake sediments, dating from the last few million years, which broadly delineate them in Fig. 1. Whereas today the Okavango and Chobe basins contain swamps, the surface of the Makgadikgadi now forms a series of salt pans that are dry for most of the year. Fossil beach lines around the pans record the former existence of large lakes (Cooke, 1980). Middle and Late Stone Age sites occur on or near these ancient beaches, and dates obtained from associated carbonate and shelly deposits show that lakes have existed at various levels over the Makgadikgadi during periods ex-

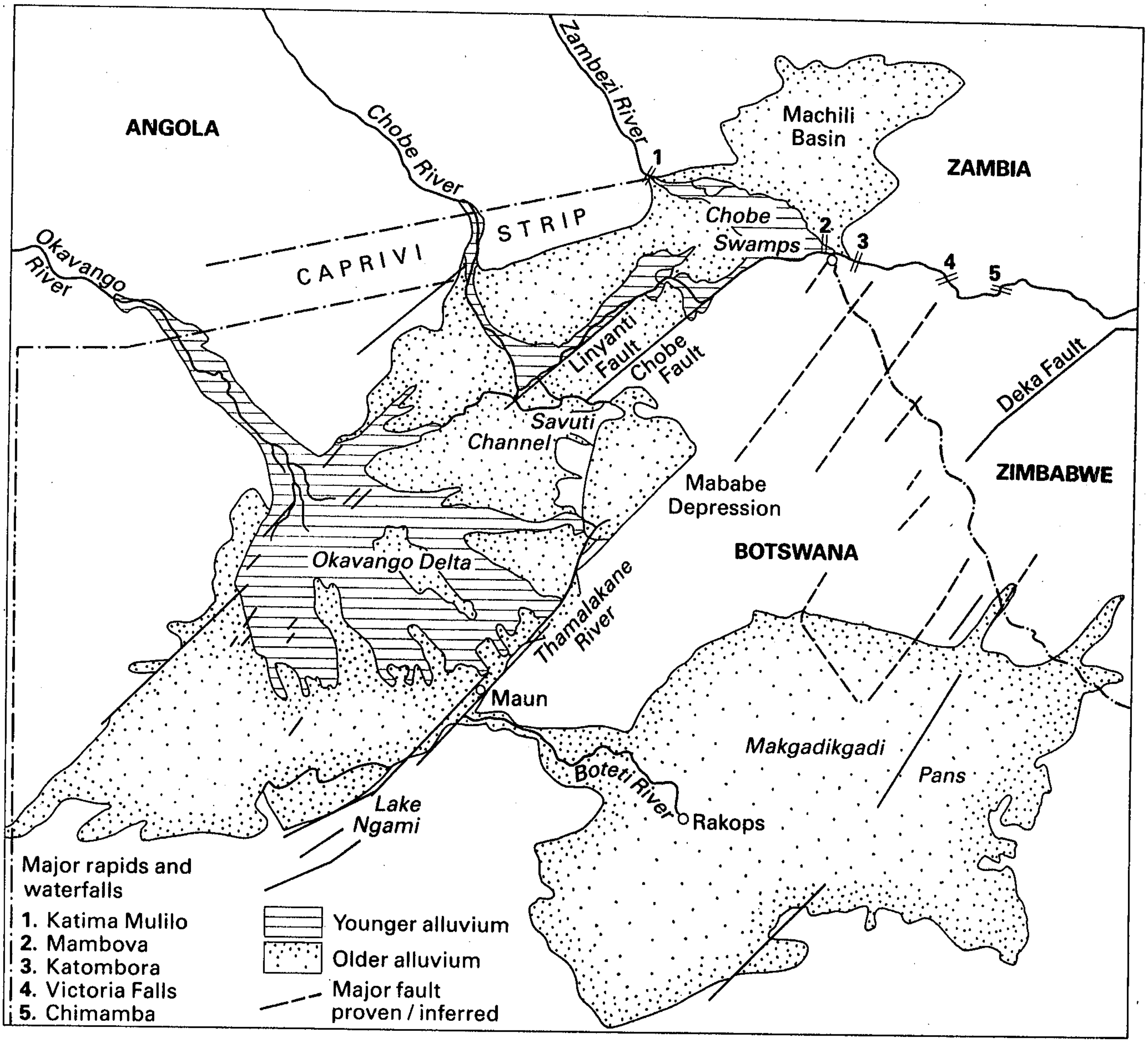

Fig. 1 The distribution of alluvial and lacustrine sediments in Central Southern Africa, the basins of Greater palaeo-lake Makgadikgadi.

tending from at least 50 000 years ago into recent times.

The highest beach lines, at about 945 metres above sea level, lie some 65 metres higher than the lip of the Victoria Falls. They outline a lake which extended over the Makgadikgadi, the southern Okavango and most of the Chobe Swamps, known as Greater palaeo-lake Makgadikgadi. This lake had an area of about 60 000 square kilometres, roughly the size of present-day Lake Victoria. The combined modern inflows of the Okavango and Chobe rivers, together with

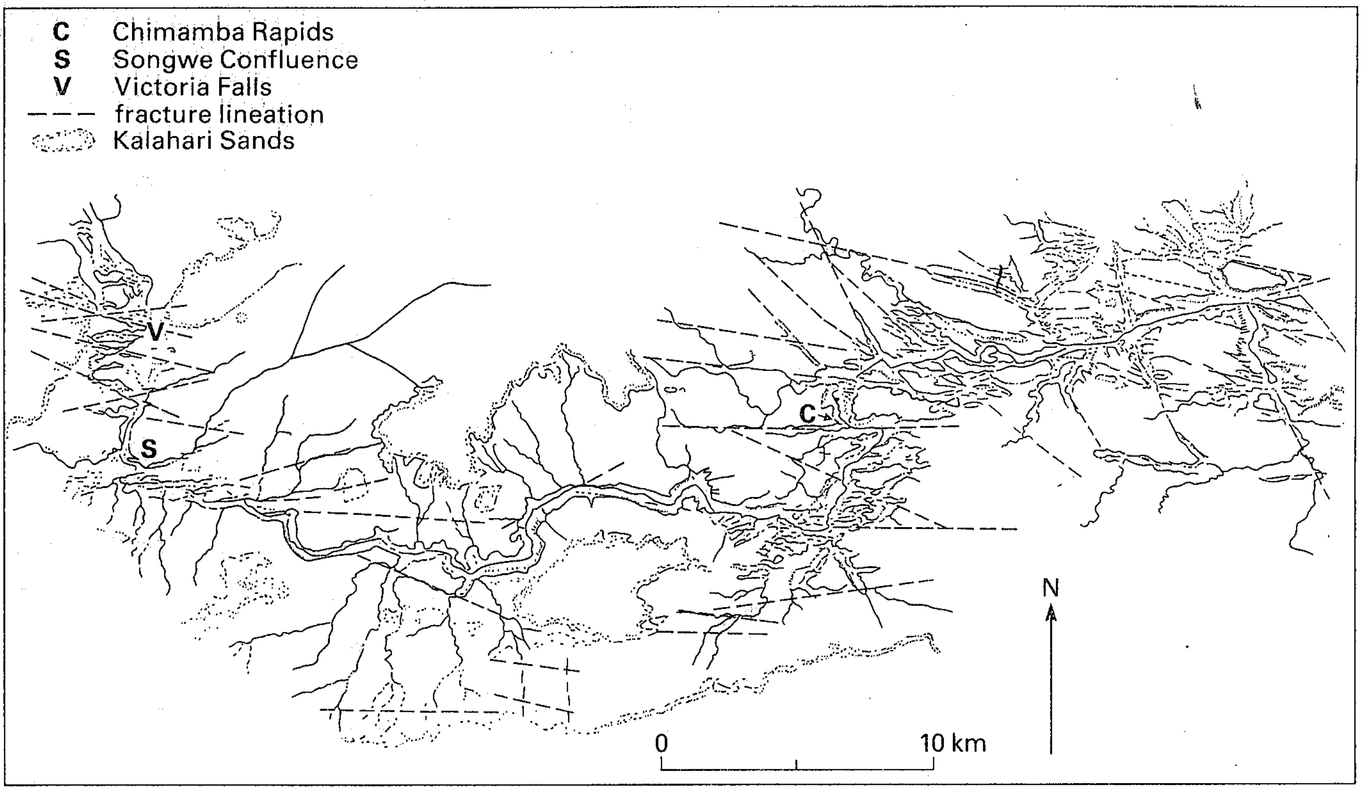

Fig. 2 Sketch map of the upstream end of Batoka Gorge and the local fracture pattern (after Clark, 1950).

local rainfall, supply under modern climatic conditions less than half the water required to balance evaporation from the surface of such a large lake. This implies that the Upper Zambezi must have flowed into the lake, at least at its high stands. Under these circumstances the waters would have been lost in evaporation, without ever reaching the Victoria Falls.

So what caused the flow of the Upper Zambezi to be diverted along its present course and over the Victoria Falls, so that the huge old Makgadikgadi lake dried up? Technically, what happened is known as a river capture: the Middle Zambezi captured its upper catchment. This could have resulted from headwards erosion, caused by the Middle Zambezi cutting upstream into its watershed until it cut back into the river supplying the former lake, or into the lake itself. Alternatively capture could have occurred through overtopping, by the lake rising and overflowing onto the basalt plateau upstream of the Victoria Falls.

Evidence for overtopping comes from downstream of Chirundu, in the Mana Pools National Park. Here a ridge of poorly sorted, unbedded, coarse-grained alluvium known as the Stony Ridge remains as evidence of a cataclysmic flood that swept along the former river channel. The Stony Ridge flood probably lasted only a few weeks, as several years' supply of water poured out of the lake, across the basalt plateau and into the pre-existing river system of the Middle Zambezi. As the waters drained rapidly away, they eroded downwards into the former lake margin at Katombora, some 15 kilometres downstream of Kazungula. This cut the proto-Katombora Gap, establishing the link between the Upper and Middle Zambezi that the river has used in modern times. This inferred cataclysmic flood thus marks the birth of the Victoria Falls and the Zambezi as we know them.

Was there a waterfall before capture? The answer is uncertain. The distribution of fish species within the river system (Chapter 14) suggests that certain species have never been able to move freely between the Upper and Middle Zambezi Rivers; and it may be that a waterfall or waterfalls had already formed on the river by the time the Upper Zambezi was captured. These falls would have formed a comparatively uninteresting spectacle, lying on a minor river supplied by a small catchment. Flow was almost certainly highly seasonal, similar to that of the present day Matetsi River which drains the basalt plateau to the south of the Zambezi and has cut several rapids and waterfalls along its descent into the gorge.

Whether or not the proto-Middle Zambezi once resembled the modern Matetsi, it was changed for ever when palaeo-lake Makgadikgadi overtopped. Such a flood would have eroded rapidly downwards into the stream's bed. Even after the flood had abated and much of the ancient lake had drained away, the Zambezi would have continued to erode downwards until it established a much gentler gradient, in equilibrium with the greater flow. This was the process that created Batoka Gorge, whose walls rise from the river at thirty degrees or more along its whole 110-kilometre length and are almost vertical near the Victoria Falls. The Zambezi loses some 270-metres of height within Batoka Gorge (not counting the drop at the Falls), an average gradient of about 1:400. Within the broad rift valleys downstream the gradient is reduced to 1:4000 and the river is still cutting into its bed, albeit very slowly. We may conclude that the Zambezi is downcutting rather more rapidly within Batoka Gorge, which is thus being progressively deepened.

The tributary streams that flow into Batoka Gorge have cut gorges of their own (Fig. 2), dissecting the plateau on either side of the Zambezi into some of the roughest and least hospitable country in the world. Although no tributaries have developed waterfalls that equal the splendour of the Victoria Falls, many waterfalls and rapids have been created and these generally occur at changes in the hardness of the underlying rock. Where a stream flows onto a fault in the basalt, the soft rock in the fault zone has often been eroded away to form a gorge, and the harder rock upstream of the fault is thus the site of rapids or a waterfall.

As Professor Bond explained in Chapter 2, the Zambezi, downstream of Victoria Falls, crosses several east–west trending faults which mark a series of seven former Falls positions. At each in turn, the soft rock within the fault zone was eroded away to leave the harder bounding rock as the lip of a new waterfall. Flowing off the relatively gentle slope of the basalt plateau, the river eroded downwards into the Falls more slowly than it cut into the steeeper bed of the gorge downstream. This very slow downward erosion characterises most of the modern fall line at the present time. It is only after a part of the sharp lip had been cut back, the process that has started at Devil's Cataract, that erosion becomes more rapid, cutting downwards and backwards to the next fault zone upstream. Each time the process was repeated the Falls experienced a long period of relative stability during which the lip of the Falls was hardly eroded at all, although Batoka Gorge continued to deepen. The first Victoria Falls were created some time after river capture, which can tentatively be dated from the archaeological record preserved in the sediments downstream. The Zambezi's channel between Batoka and Devil's Gorges and beneath the waters of Lake Kariba is bounded by terraces, rising up to 55 metres above the river. The higher terraces contain Early Stone Age tools, which have been rolled and are therefore redeposited. The surfaces of all the higher terraces are littered with fresh, unrolled tools of Sangoan type (Bond and Clark, 1954; see also Chapter 4). The younger terraces, which may correspond in age with the Younger Gravels at the Victoria Falls (see Chapter 2), contain tools made by the first Middle Stone Age people. The youngest alluvium, bounding the channel, is associated with later Middle Stone Age and Late Stone Age remains.

It is believed that the Middle Zambezi River, prior to capturing its Upper Catchment, flowed at the level of the highest terraces, which were isolated, after capture, by the massively increased flow cutting into the river's bed. The archaeological record suggests that this degradation of the channel began around the time that Stone Age tools of Sangoan type were being made.

As Professor Clark indicates in Chapter 4, the date of the Sangoan is only imprecisely known. It probably falls within the general period 150 000–125 000 years ago. This was the time of the last interglacial period, when the world was on average some 2 degrees Centigrade warmer than it is today and rainfall over most of Africa was rather higher. Sangoan remains are overlain by a Middle Stone Age succession, of which the earliest Middle Stone Age stages may belong to a time of global cooling, marking the end of the last interglacial period and the start of the last 'Ice Age'

It seems that global climatic changes at the peak of the last interglacial were responsible for causing Greater palaeo-lake Makgadikgadi to rise to its maximum height and finally to spill onto the basalt plateau and into the Middle Zambezi River system (Nugent, 1990). It is intriguing to imagine the interior of southern Africa at that time, the huge lake (Fig. 1) fringed with dense Okavango-like vegetation: a time of plenty for the Sangoan people. Later, after the lake spilled into the Middle Zambezi and the river established its new course through the Katombora Gap and over the Victoria Falls, the climate began to cool and rainfall was probably reduced. Downstream, Middle Stone Age people lived on the terraces formed as the river cut down to bedrock.

We have seen how successive waterfalls developed relatively rapidly, then became stable for a long period of time. The retrogression of the Victoria Falls has been irregular for another reason. Flow along the Zambezi River and over the Victoria Falls has been much reduced and may have virtually dried up for periods of perhaps hundreds or thousands of years since the time of capture. Shoreline features around the Makgadikgadi Pans, up to and including 945-metre lake stands, have been dated to Middle and Late Stone Age times, long after Sangoan people witnessed capture and the great flood. Fossil beach lines around Lake Ngami and the Mababe Depression (Fig. 1) indicate a series of lakes at 936 metres in the recent geological past and as recently as 1 500 years ago (Shaw, 1985).

These diversions, which have occurred since capture and the cutting of the Katombora Gap, almost certainly resulted from tectonic rifting movements beneath the Chobe Swamps (Nugent, 1990). Rifting creates fault scarps, which divert the flow of water. The

Chobe River itself follows such scarps between the Savuti offtake and Kazungula (Fig. 1). In order to maintain a 945-metre lake over the Makgadikgadi and the Southern Okavango, an inflow more than twice that of the modern Okavango and Chobe Rivers is required. This implies that the lake was also supplied by the Upper Zambezi and that upper catchment waters were diverted away from the Victoria Falls. Shaw and Thomas (1988) show how such a lake (Lake Caprivi) was ponded behind the Mambova Rapids and may have drained, *via* the base of the Chobe Scarp, into a lake over the Okavango.

During the millennia that man has lived on the banks of the Zambezi, the River and the Falls have undergone immense change. From the flood that heralded the birth of the great river, through dry spells when its waters were diverted into lakes over the Kalahari, the Victoria Falls have been slowly and irregularly but inexorably cutting backward, exposing first one then another line of weakness to create the zig-zag gorges described in the previous chapter. It is intriguing to speculate on what exactly early man saw and understood by these early falls. There must have been times when the river was directed over a narrow fall line and perhaps other times when it was wider than it is today. We must remember that each generation lived, as we do, within a mere moment in the life of this great river. They too saw the Falls as being as permanent and immovable as Mosi-oa-Tunya appears today.

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