

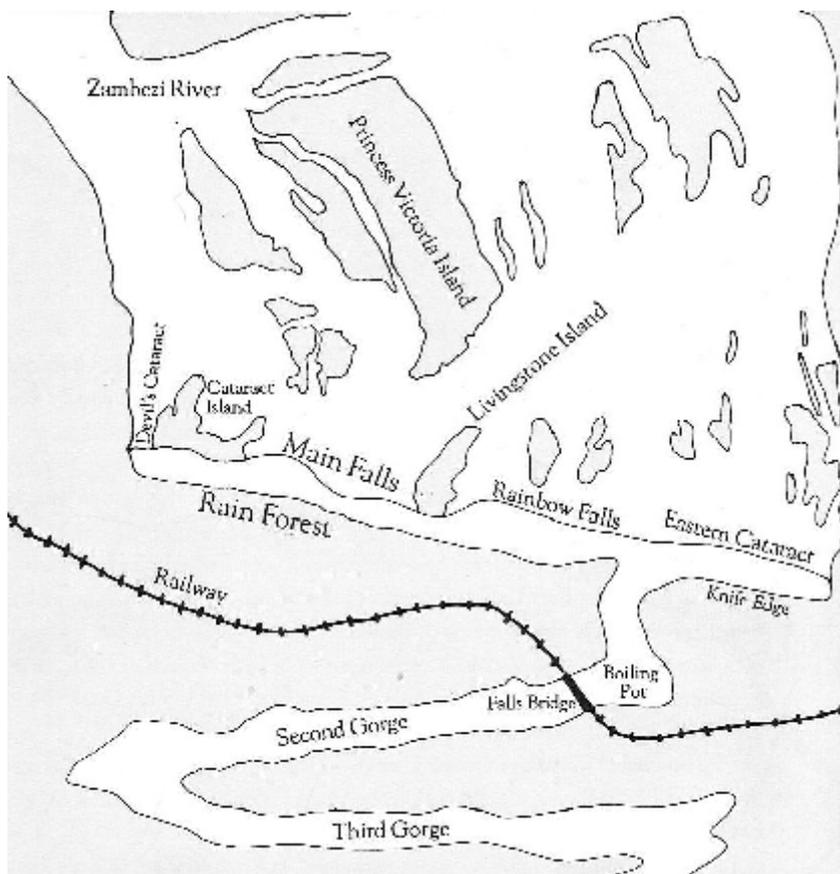
## Victoria Falls

### Formation of the Falls (from Zambezi: River of the Gods)

Some 150 million years ago, molten lava oozed out of the cracks in the earth's surface, in a series of giant flows, each settling and cooling on the last. Bubbles of water vapour escaped from the surface of the solidifying deposit, creating red, reticulated bands of basalt, sandwiched between blue fine-grained layers. The rock hardened and contracted, leaving a network of deep fissures. The larger of those cracks from a series of major east-west 'joints', linked together by smaller north-south clefts. With the passage of time these faults were filled with soft limestone deposits.

Many geologists believe that the upper Zambezi was once an entirely separate river, flowing south-east through the Makgadikgadi depression in northern Botswana and possibly joining the Limpopo system on the southern border of Zimbabwe. Gentle movements in the earth's crust, about two million years ago, are thought to have cut off the Zambezi's access to the sea, resulting in a huge inland lake, the remains of which include the Okavango Delta, the Chobe Swamps and the Makgadikgadi salt pans. Spillage from those wetlands ran over onto the low-lying area to the east, carving a new river valley through the wind-blown Kalahari sands deposited on the basalt sediments. The headwaters of the middle and the lower Zambezi were thought to have been the Matetsi river, approximately 100 kilometres downstream from the Falls of today. The Matetsi ran in a deep valley, the western scarp formed by the edge of the basalt 'plate'. The upper river, following its new course, tumbled over this 250 metre drop, creating the first "Victoria Falls". It joined the waters of the middle Zambezi, so forming the river system as we know it today.

The pounding water found a weakness in one of the large east-west fissures in the basalt. The erosive process began, washing away the soft limestone deposits and cleaving out the Batoka Gorge. About eight kilometres downstream from the Falls the river swings north. With the change in direction of the waterflow, the erosion also altered, digging back along a north-south fissure. This linked with another east-west cleft. Gradually a broad waterfall was excavated across the river. The process was repeated, resulting in a zigzag pattern of the gorges, eight in all. Today's fall line, in the first of those gorges, is probably some 2500 years old. The lip of the Falls is showing two points of recession, the larger on the western side of Cataract Island, the second through Livingstone Island.





Map 1 - The Zambezi River

## Geomorphological Formation (from the Info Centre at the falls)

A unique geological/geomorphological process formed the Victoria Falls and its gorges. About a hundred and fifty million years ago, a volcanic eruption produced great sheets of lava covering the entire area from the Chobe (Cuando) confluence at Kazungula 70 km upstream to a point about 130 km downstream of the present falls (Fig. 1). The molten rock or lava was poured out in quick succession to form layer upon layer (Fig. 2). The molten rock gradually cooled and solidified resulting into a hard, dense rock called basalt.

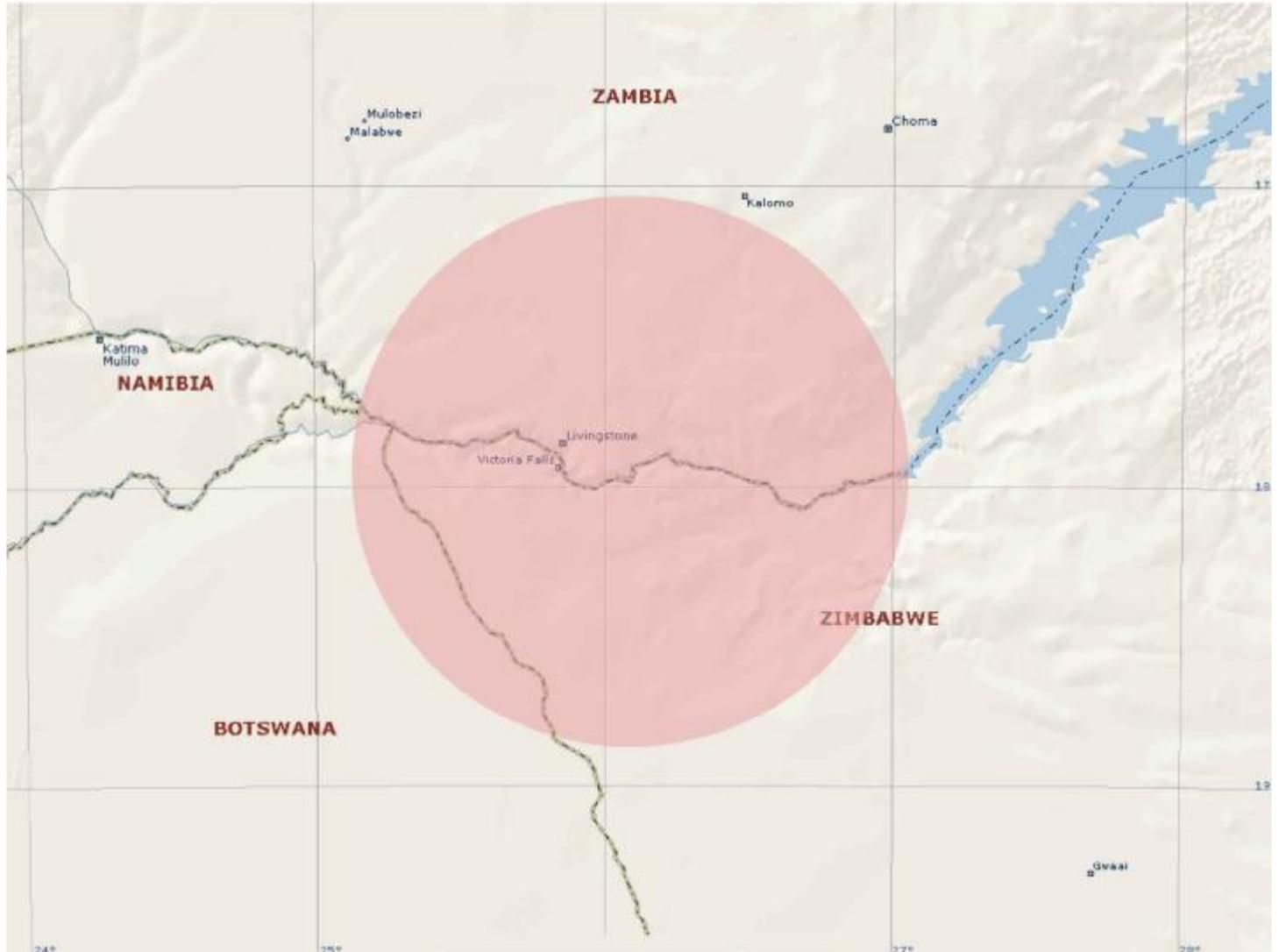


Figure 1

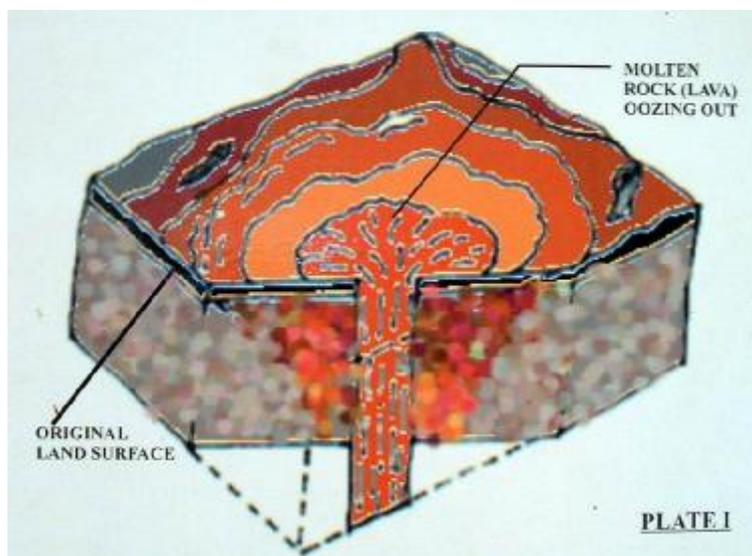
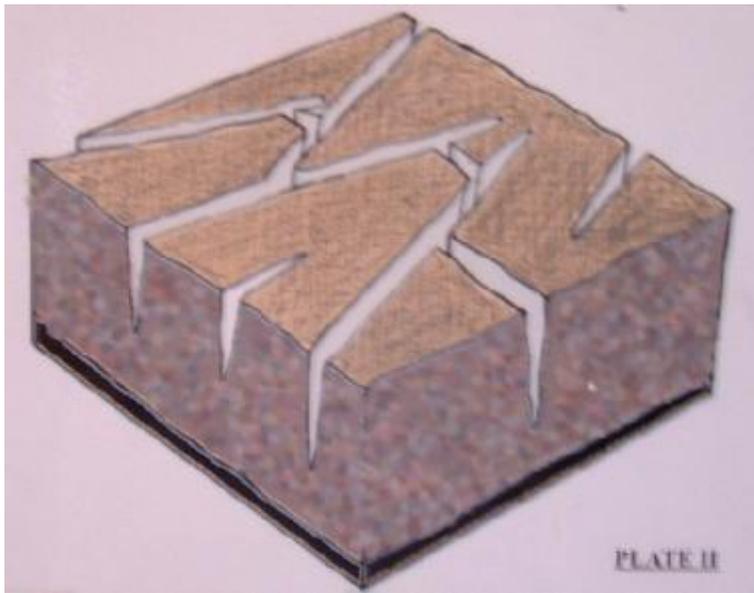


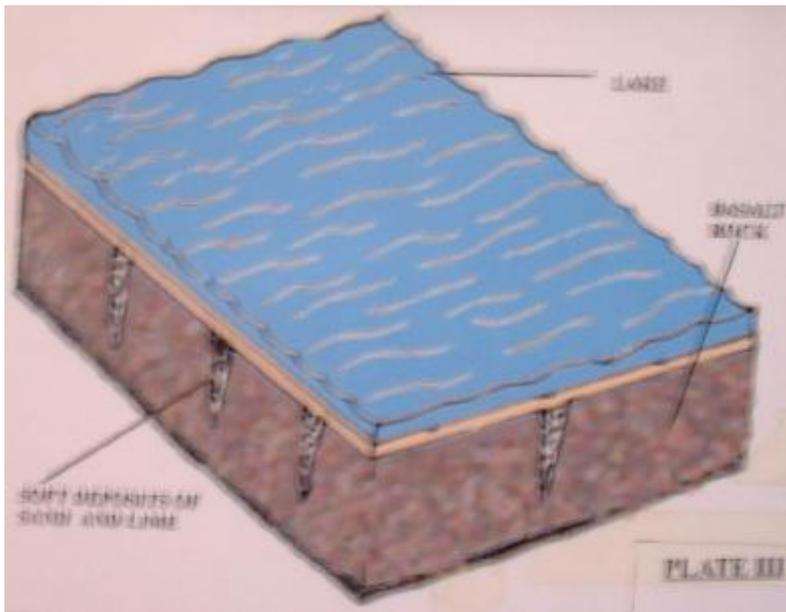
Figure 2

As the molten lava cooled down, its solidification into basalt gave rise to cracks, or fissures, known as “shrinkage cracks” (Fig. 3). These cracks run in an east-west direction, with smaller, less extensive ones running from north-south. Through erosion and earth movements these cracks were widened and are the ones we see today as gorges.



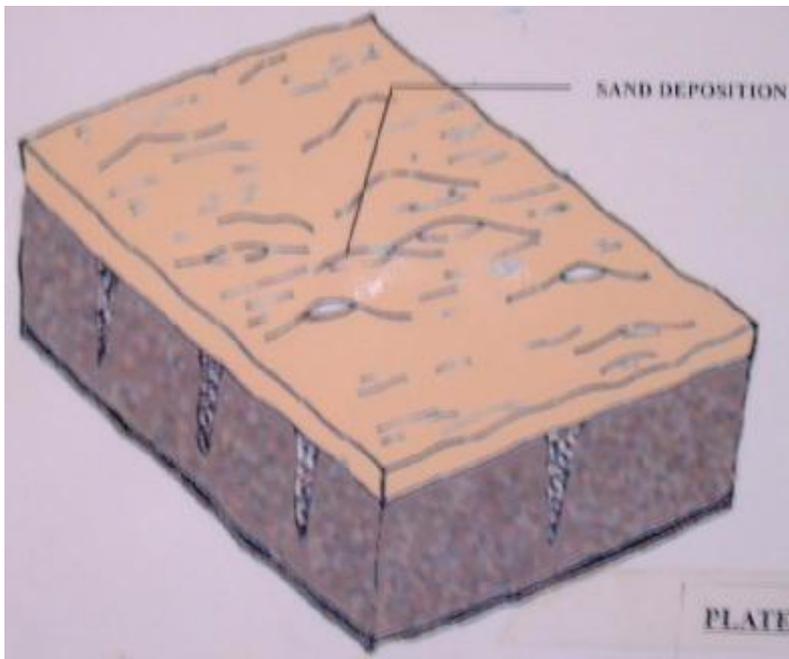
**Figure 3**

After a prolonged period of erosion of those fissures, a lake formed over the area and deposits of clay and lime were deposited into the shrinkage cracks and onto the basalt (Fig. 4).



**Figure 4**

With the onset of drier conditions, the lake dried up and desert conditions prevailed. The soft material on top of the basalt was mostly eroded away from the surface by wind and occasional rains but those in the fissures remained and gradually consolidated to form limestone (Fig. 5).



**Figure 5**

During this period, wind blown sands accumulated on the surface, which forms the Kalahari sand today.



**Kalahari Desert**

The Kalahari Desert covers most of Botswana and portions of northern South Africa and eastern Namibia. The desert is part of a much larger semi-desert sand basin that stretches into Angola, Zambia, and Zimbabwe. The desert's name is derived from the Tswana word *Kgalagadi*, meaning "the great thirst."

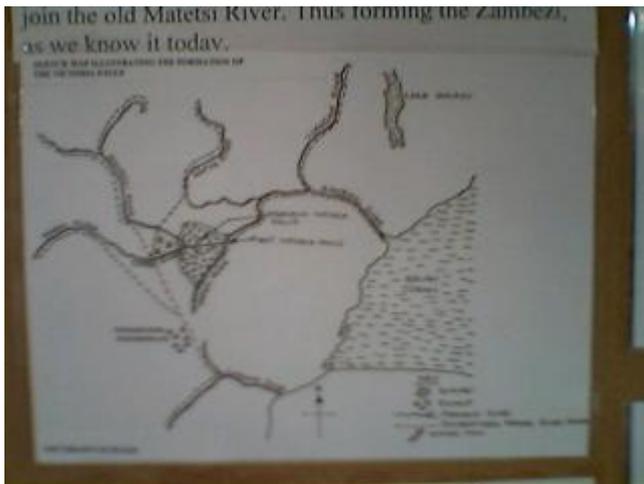
The next stage was the formation of two separate river systems. What are now the Chobe and the Upper Zambezi used to flow south through the present Makgadikgadi depression and into the Limpopo valley.

*Note: Scientists believe the Okavango was once a much larger river that flowed southeast into the Limpopo River and then into the Indian Ocean. After regional earth movements severed the connection to the Limpopo, the Okavango's waters collected to form Makgadikgadi Pan. Further earth*

*movements and a long-term decline in rainfall reduced the river's flow, causing Makgadikgadi Pan to dry up and creating the present delta.*

The Middle and Lower Zambezi formed a completely separate river system with its headwaters somewhere near Panda Ma Tenga. The present north flowing Matetsi River was the source of the lower Zambezi. Due to uplifting of the land south of the Makgadikgadi depression, through which the old course ran, the river was divided into two, the Limpopo to the south, which continued down into the Indian Ocean, and to the north, a strongly flowing, well fed river whose access to the sea had been cut off.

Due to lack of access to the sea, a huge lake formed in Makgadikgadi area in Botswana. The water level rose so high that it spilled over on the low-lying area. The water that spilled found its way over the sand covered basalt to join the old Matetsi River, thus forming the Zambezi, as we know it today (Fig. 6 and 7).



**Figure 6**



**Figure 7**

As the Zambezi joined the Matetsi, it plunged over the basalt into the 250 metres deep Matetsi valley creating the first waterfall over 100 kilometres downstream from the present falls. The water flowing over the drift slowly began to erode into the east-west limestone filled fissures running along the bed through the basalt. This process of eroding the soft limestone in the cracks continued up to the present falls. The east-west fissures formed broad waterfalls compared to the north-south fissures and these gave rise to the zigzag pattern (Fig 8 to 13)

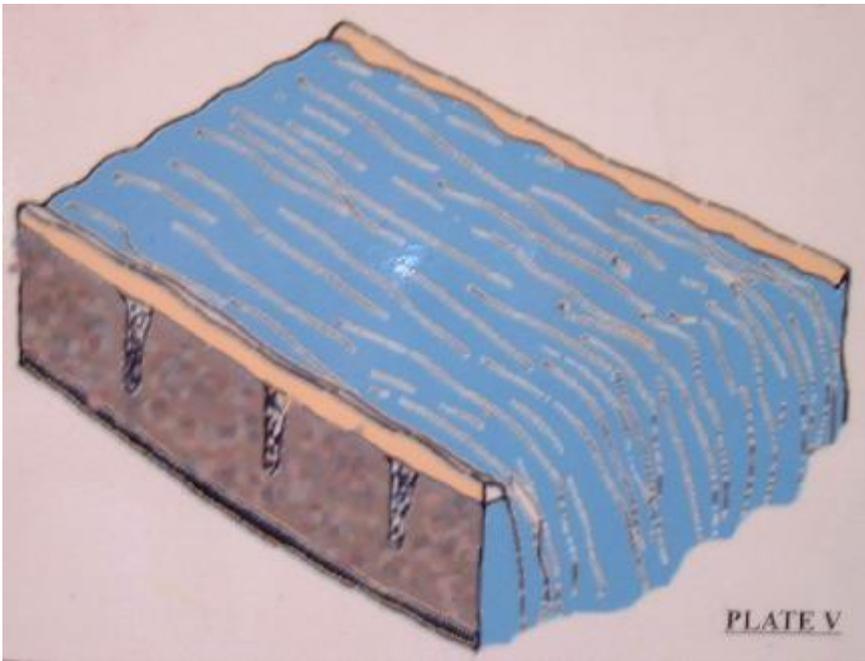


Figure 8

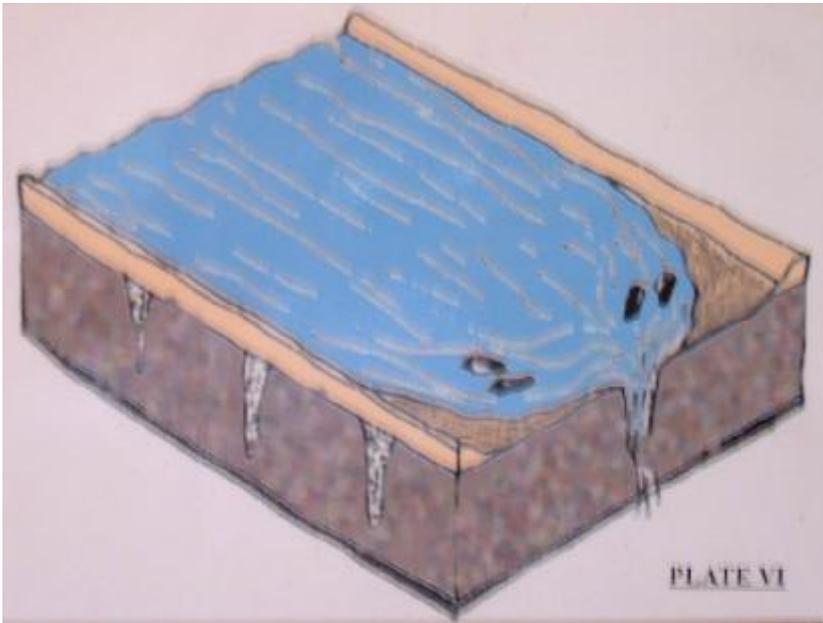


Figure 9

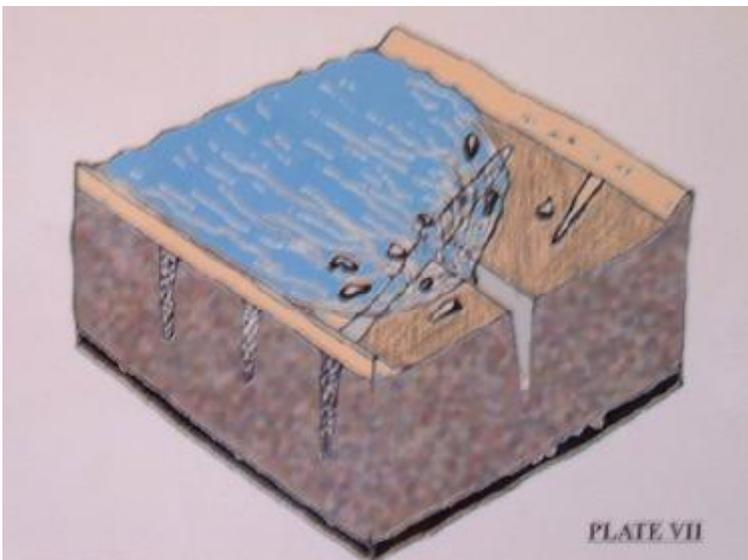


Figure 10

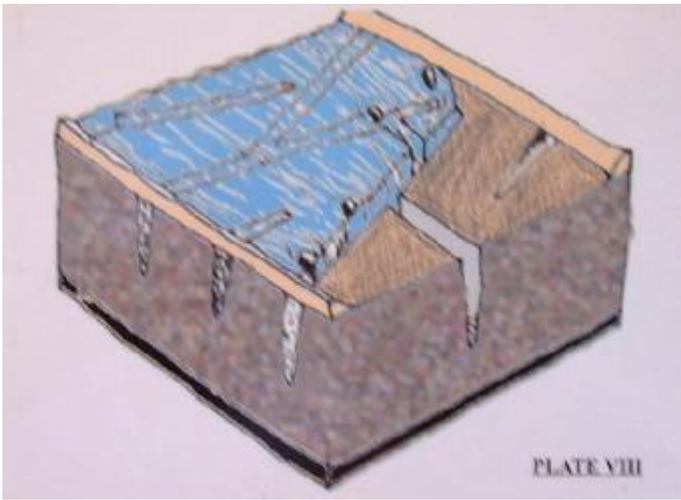


Figure 11

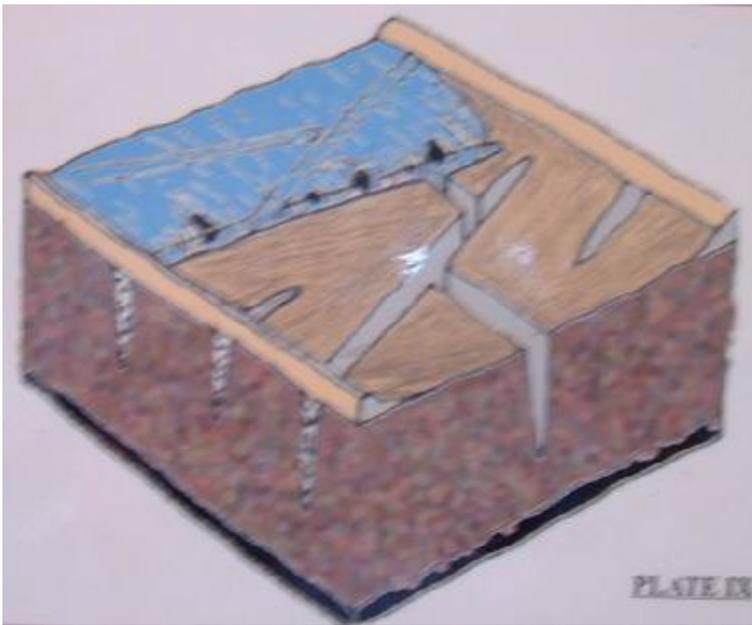


Figure 12

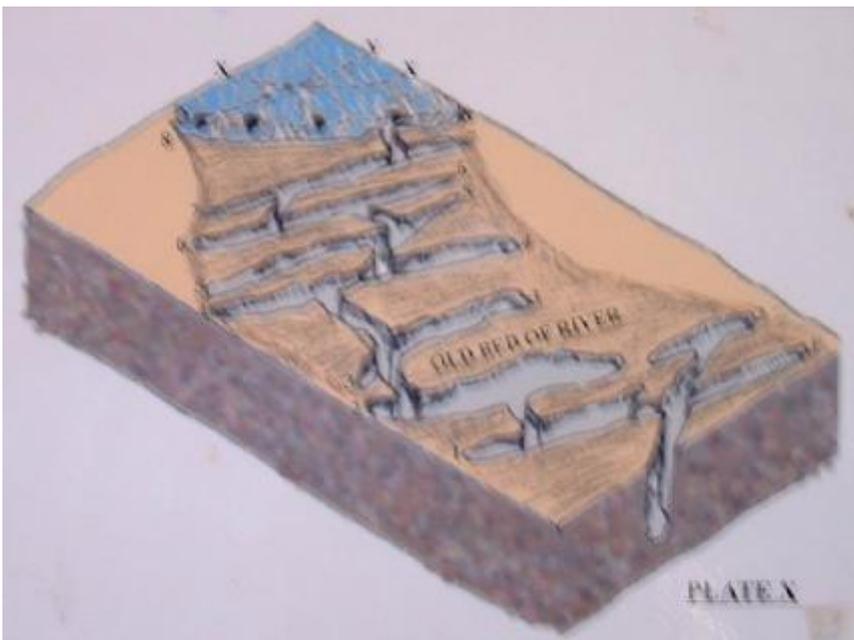


Figure 13



### The Main Falls At Peak Flow

The Victoria Falls reach their peak flow between the months of March and May when the average volume of water rolling over the lip of the cataract is approximately 550'000 cubic **litres (?)** /minute. The highest flow ever recorded was 770'000 cubic **litres (?)** /minute during the record flood of 1958.

During the peak flow period, this water spray is so dense that everything is hidden in the mist, the thunder of the falling water can be heard for miles, and the only complete view of the falls is from the air.

### The Main Falls At Low Flow

The seasonal variation in the water flow is so great that the falls produce wide-ranging impressions on the visitor. The flow during the dry season can be as low as 20'000 cubic **litres (?)** /minute. Normally this happens in late November or early December but in the years of poor rainfall, the rocks become visible as early as September or October.

All the features of the falls including the knife-edge bridge can be seen during this period and the visitor can peer to the bottom, at least on the eastern side.

### The Eastern Cataract

The Eastern Cataract (Zambia) forms the largest part of the falls and is 100 metres high, 38 higher than the westerly Devils Cataract (Zimbabwe). A lower volume of water is carried by this section of the falls and a double rainbow can be seen when the sun is shining through the spray. At low season, very little water passes over this section and the geological formation of the chasm can clearly be seen.

### Danger Point

The unique physical formation of the Victoria Falls enables the visitor to obtain all views of the narrow strip of land, which runs opposite the chasm of the falls. The Danger Point, the furthest point that can be reached and marks the border between Zambia and Zimbabwe. It is a rocky promontory above the narrow gorge, which carries the water from the falls into the first gorge. Danger Point gives the visitor a bird's view of the main falls during the dry season, with the Rainbow Falls and Livingstone Island easily visible.

## The Boiling Pot

According to available scientific evidence, the Victoria Falls have moved upstream eight times leaving a series of gorges on the way to the present site. The first of these gorges lies about two thirds of the way from the chasms' western end at which the point two kilometres wide river is compressed into a 60 meter wide channel. Because of this lateral squeeze, the speed of the water is ferocious and the depth great (*what depth?*). No accurate figures are available but the speed is estimated at 40 kilometres per hour during periods of low flow. A rise of one metre in the river above the falls produces a rise of five metres below, a 1 to 5 ratio. The gorge runs for a very short distance and opens into a wide pool known as the Boiling Pot.

## The Second Gorge

From the Boiling Pot, the Zambezi flows into the second gorge, which is the site of the rail and road bridge linking Zambia and Zimbabwe. The bridge was opened in 1905.

## The Third And Fourth Gorge

Below the point where those two gorges meet is the Silent Pool. The pool is the only point at which the valley widens and allows the water to slow down before continuing its headlong journey into the inhospitable Batoka gorge.

## Vital Statistics

Width: 1.7 km. Niagara is 998 m.

Height: 108 m drop. Angel Falls in Venezuela is the highest at 979 m; Niagara is 58 m.

Water flow: 100 million litres per second at the height of the rainy season. Niagara is 6.8 million.

Mean Maximum flow of water over the Falls during flood season: 794'062'000 litres/minute.

Lowest known flow of water over the Falls, 7<sup>th</sup> November 1959: 10'500'000 litres/minute.

Mean annual flow of water over the Falls: 60'000'000 litres/minute.

Mean height of the Devil's Cataract (Zimbabwe): 60.72 metres.

Mean height of the Rainbow Falls (Zimbabwe): 82.88 metres

Mean height of the Eastern Cataract (Zambia): 98.05 metres.

Mean height of the bridge above gorge (high water): 94.11 metres.

Mean height of the bridge above gorge (low water): 110.5 metres.

Highest known rise of water in the Gorge: 16.5 metres.

Greatest depth of water in the Gorge at low water in October 1906: 17 metres.

Altitude of Victoria Falls Station above seal level: 906.19 metres.

Altitude of Victoria Falls Bridge above seal level: 894.92 metres.

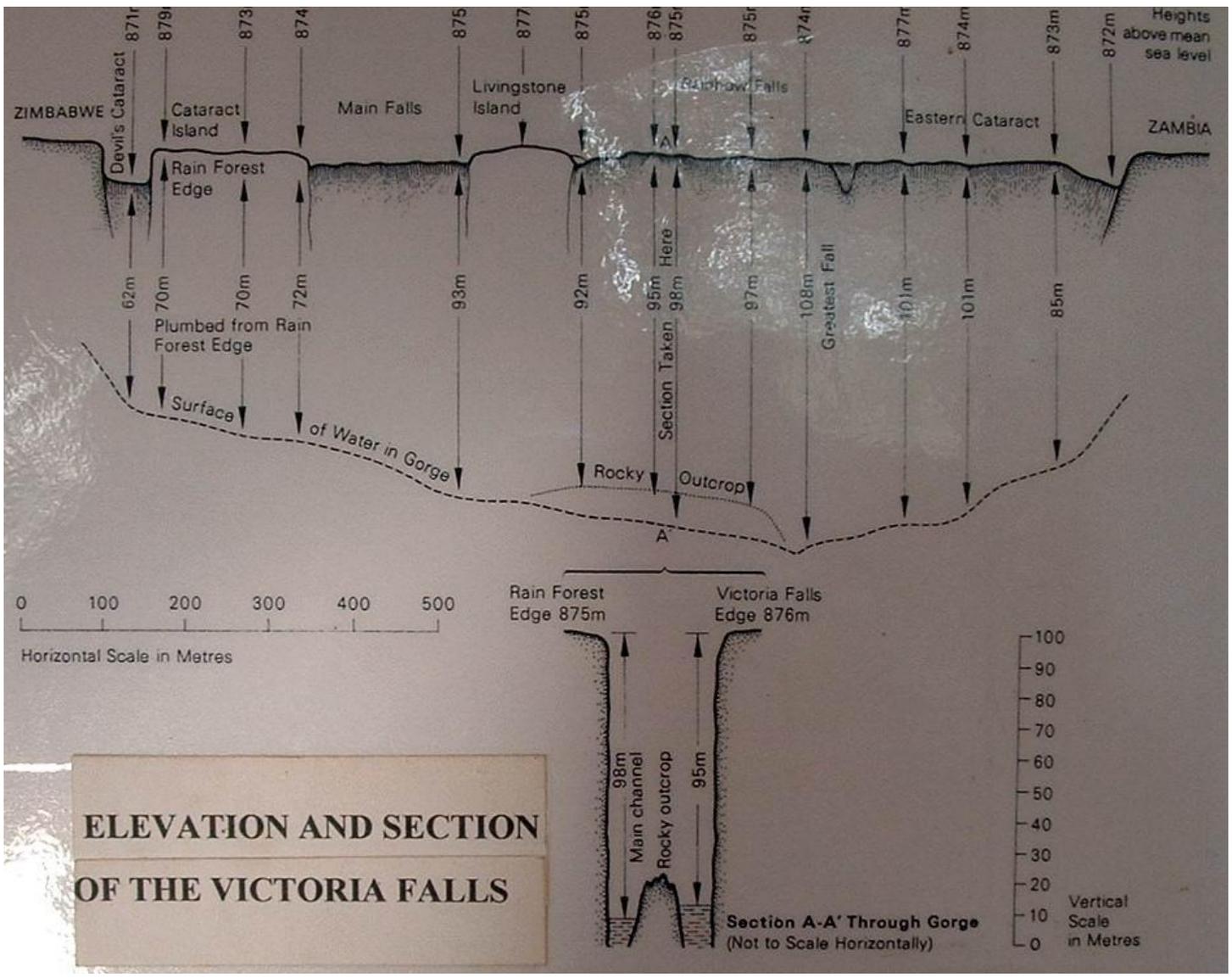
Mean temperature in Summer (September to February): 26° Celsius

Mean temperature in Winter (March to August): 20° Celsius

Mean annual rainfall: 760 mm.

Mean daily sunshine: 8.7 hours.

Geographical position: Latitude South 17°54 – Longitude East 025°51



**Lava**, molten or partially molten rock that erupts at the earth's surface. When lava comes to the surface, it is red-hot, reaching temperatures as high as 1200° C (2200° F). Some lava can be as thick and viscous as toothpaste, while other lava can be as thin and fluid as warm syrup and flow rapidly down the sides of a volcano. Molten rock that has not yet erupted is called magma. Once lava hardens it forms *igneous rock*.

**Igneous Rock**, rock formed when molten or partially molten material, called magma, cools and solidifies. Igneous rocks are one of the three main types of rocks; the other types are sedimentary rocks and metamorphic rocks. Of the three types of rocks, only igneous rocks are formed from melted material. The two most common types of igneous rocks are granite and *basalt*. Granite is light coloured and is composed of large crystals of the minerals quartz, feldspar, and mica. *Basalt is dark and contains minute crystals of the minerals olivine, pyroxene, and feldspar*.

**Basalt**, the most common variety of volcanic rock, composed almost entirely of dark, fine-grained silicate minerals, chiefly plagioclase feldspar and pyroxene, and magnetite. The extrusive equivalent of gabbro, it forms by the outpouring of lava all along the world's mid-ocean ridges, where sea-floor spreading continually adds new crust to counterbalance that lost by subduction (see Plate Tectonics). Usually dark-grey in colour, basalt often has a vesicular texture, preserving vestiges of bubbles produced by expanding steam as lava cools and solidifies. Also characteristic are pillow-shaped masses caused by rapid cooling of lava erupted on the sea floor. In addition to lava flows, basalt is also found in the form of dikes and sills. Columnar jointing, as exhibited by Devils Tower in Wyoming and the Giant's Causeway in Ireland, is a common feature of these shallow intrusive bodies.