

Moletadikgwa Geomorphology and Geology

Moletadikgwa is a portion of the farm Weltevreden 49KR and is approximately 420 hectares in extent. The farm is situated on high ground separating the catchment areas of the Lephalala River to the east and the Melk River to the west; both rivers flow towards the northwest, and the Melk joins the Lephalala some 17km north of the farm. The Lephalala then flows into the Limpopo a few kilometres upstream from the Groblersbrug/Martins Drift border post between SA and Botswana.

The farm lies at an altitude of about 1400m above sea level, ranging from the lowest point of just over 1300m at the north-eastern corner to 1479m at the beacon on the ridge behind Mokabi Lodge. (By comparison, Johannesburg is at an altitude of 1600-1800m and Pretoria at 1400-1550m). The farm receives an average of about 590mm of rainfall per annum, mainly between November and March.

The geology of the region consists of a sequence of mainly sedimentary rocks varying in total thickness from 1500m to as much as 7000m. Some volcanic units occur at the base of the sequence, near Alma. This impressive succession is known collectively as the Waterberg Group of rocks, and has been dated as being of paleo-Proterozoic age, that is, between 2.0 and 1.6 billion years ago. The characteristic reddish colour of the Waterberg sediments is due to the presence of iron oxides, which in turn could only have been formed in the presence of free oxygen. The Waterberg '*red beds*' therefore reflect the presence, at this early point in the Earth's evolution, of considerable quantities of oxygen in the atmosphere and are the oldest examples known.

The Waterberg Group rests unconformably on top of the rocks of the Transvaal Supergroup (which form the hills around Pretoria and the Magaliesberg) and also above the igneous rocks of the Bushveld Complex, which occupy the area of the Springbok Flats and stretch westwards to Rustenburg and northeast towards Mokopane (Potgietersrus). All of these rock groups in turn are much younger than the sediments of the Witwatersrand Supergroup, which are 2.8-3.0 billion years old and which contain the gold reefs that provided the basis for South Africa's gold mining industry.

This succession of large sedimentary basins, starting with the Witwatersrand 3 billion years ago and progressing upward through the Transvaal, the Bushveld Complex, the Waterberg and finally the Karoo, is a reflection of the remarkable geological stability that has characterised the southern part of the African continent virtually since the beginning of the geological record. This stable region, known as the Kaapvaal *Craton*, is one of only a few in the world – another is the Canadian shield – where very thick sequences of rocks can be found that represent almost the whole geological history of the earth, largely undistorted by the major volcanic or tectonic events that surrounded them.

Moletadikgwa is underlain by sandy and pebbly sediments that lie towards the top (i.e. younger part) of the accumulation of sediments forming the Waterberg Group. They have been mapped as a distinctive unit called the Mogalakwena Formation, after the river of that name, which flows northwards from Naboomspruit towards Mokopane. (It was on the branch of the Mogalakwena River now called the Sterk River that the naturalist and author Eugene Marais lived from 1905 to 1917).

As you walk around the rocky parts of the farm, you will notice that in some areas the outcrop consists of very coarse, pebble conglomerates, whereas elsewhere, the rock becomes more even-grained and sugary in texture. On the Zebra Trail in particular, both rock types can readily be seen. If you look at the conglomerates (or *rudites* as they are called geologically), you will find that the pebbles are all quite small, similarly sized and well rounded, just as you would find along river banks at the base of modern mountain ranges. Another point to note is that the pebbles themselves consist of quite a wide variety of rock types: you may be lucky enough to find some pebbles of chert, jasper or banded ironstone, although most are made of white or grey quartz. This is not surprising, since quartz is one of the hardest minerals, and is able to survive the pounding and erosion along a river better than most other minerals or rocks.

All this suggests that the rudites were formed from the consolidation of well-sorted, pebbly sands that poured onto a plain at the foot of a mountain range. But where were these mountains? The answer is provided from an analysis of the finer-grained, red/grey sugary rocks, which are sandstones (or *arenites*). A quick look at outcrops of the arenites will reveal that unlike the rudites, they are often

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laminated, or layered in appearance; and moreover, the layers are arranged in concave sheets one upon the other, all dipping into the ground in more or less the same direction and at about the same angle. This feature is called *trough cross-bedding* and is the result of the deposition by flowing water of successive layers of sandy sediment in stream beds. Exactly the same structures can be found in any modern sandy streambed – and similar, though usually larger structures would be identified if you were to dig a trench across a desert sand dune, where wind rather than water would have been the depositing agent.

The trough cross-bed *foresets* provide an accurate indication of the direction of stream flow at the time of deposition. Detailed mapping of the whole of the Waterberg has revealed that the sequence exposed on Moletadikgwa –the Mogalakwena Formation - was deposited by a series of braided streams draining a highland to the northeast, and flowing into a large (inland?) basin (or basins) to the southwest. The highland area from which the streams and the sediments now forming the rocks on the farm were derived may have been located as far away as the Tzaneen-Musina area, and the basin(s) into which the streams eventually flowed covered a large area stretching from Thabazimbi westwards into southern Botswana. Further evidence of the transport direction of the Mogalakwena sediments is provided by the size and degree of rounding of the pebbles in the conglomerate layers: to the east of Moletadikgwa, for example on the Blouberg plateau north of Mokopane, pebbles are typically much larger and less well-rounded than those you will see here, implying that those at Blouberg were closer to their source.

Eventual erosion of most of the highland in the north-east, and later, of many of the sediments deposited in the basin, has left only scattered evidence of this ancient geomorphological process – and some of that was later covered by another, even younger sedimentary and volcanic event that gave rise to the huge sequence of Karoo rocks. The Karoo basin still covers most of South Africa, from Calvinia in the southern Cape to Pietermaritzburg, and from Graaff-Reinet to Vereeniging. It overlies all the deep goldfields of the Free State. Another remnant of Karoo rocks lies to the north of the Waterberg in the lowveld that stretches from eastern Botswana, through Lephalale (Ellisras) and on eastwards past Tshipise to the Kruger Park.

The youngest rocks of the Karoo Supergroup were the volcanic lavas that created the Drakensberg Mountains about 160 million years ago. This enormous outflow of lava coincided with the break-up of the continent of Gondwana and its separation into South America, Antarctica, Africa, India and Australia. The lava flows were fed through, or were associated with, an intense network of fissures and cracks through which the molten lava forced its way to the surface. Many of these fissures and cracks became filled with lava as it cooled and froze, to form dark grey-green dykes and sills of *dolerite*.

One such dolerite sill has been found on the farm: it is about 10 metres wide, runs for several hundred metres in a north-northeasterly direction along the base of the escarpment to the east of Mokabi Lodge, dips gently into the hill and is crossed by the vehicle track that follows the valley along the eastern boundary of the farm. This dolerite, however, is *not* of Karoo age: it is much older, and almost certainly is similar to others in the area that have recently been dated at 1.1 billion years. It may even belong to a group of dolerite sills in the Waterberg that have been dated at 1.88 billion years and which have confirmed the age of the Waterberg sediments themselves. If you walk along that track, or along the Leopard Trail, you will easily identify the dolerite outcrop by its smooth, rounded weathered surface, its extreme hardness and metallic sound when struck, and its dark, fine-grained texture when cracked open.

Dolerite dykes and sills are very important to farmers in that they often represent traps for the accumulation of underground water. Also important in this regard are large faults and joints, which are able to channel underground water to places where it can accumulate. One particularly striking fault line can be seen from the view site on the Waterbuck Trail, trending in a northeasterly direction towards neighbouring Emoweni, where a large dam is just visible. This direction is the dominant orientation of macro-fractures in southern Africa, and regionally, often forms lines of weakness along which kimberlite intrusions occur. Although quite a lot of exploration for kimberlites (and the diamonds they might host) has taken place in the area over the years, none has been found yet – but you never know your luck!