CHAPTER 1

Understanding the landscape

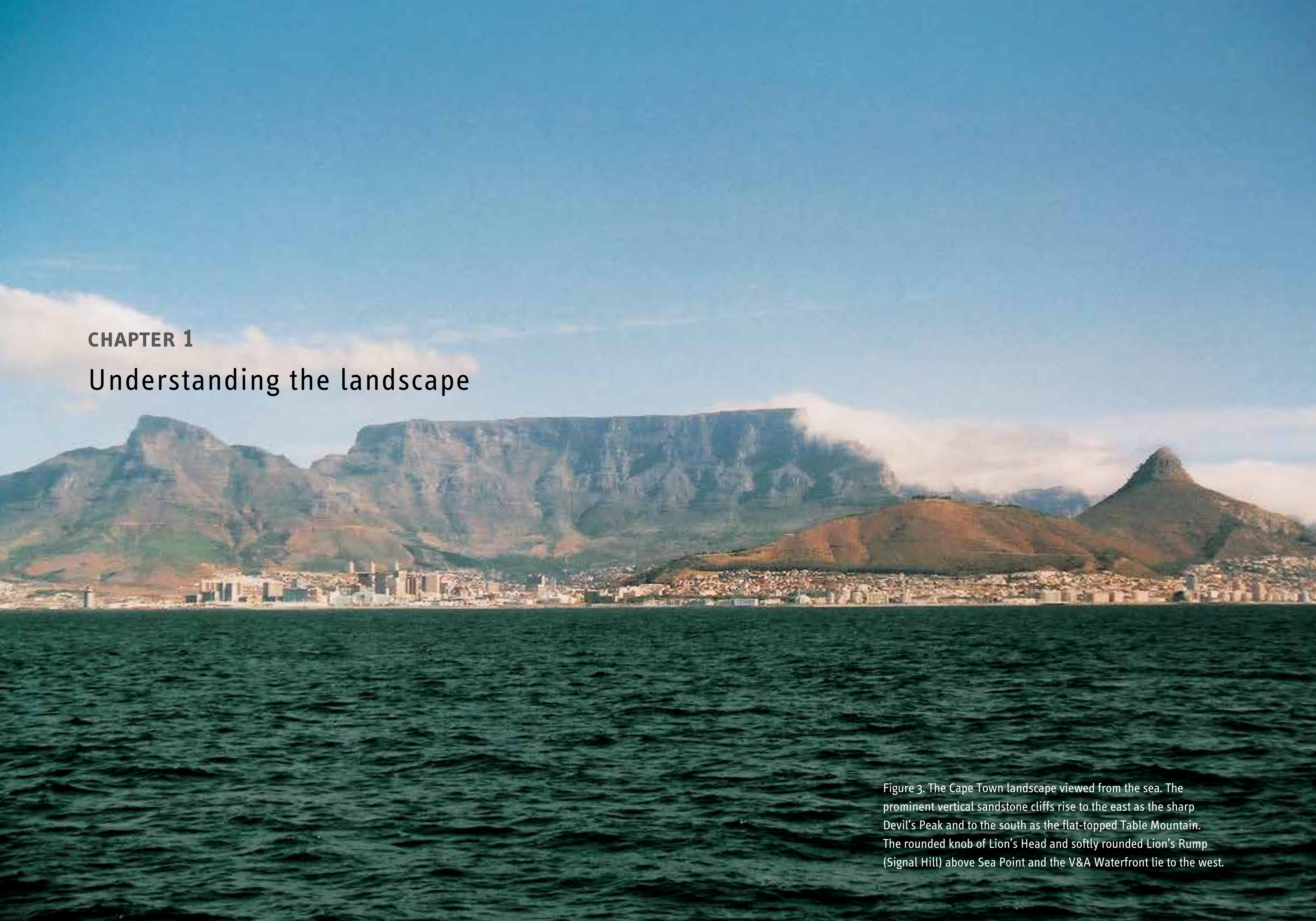


Figure 3. The Cape Town landscape viewed from the sea. The prominent vertical sandstone cliffs rise to the east as the sharp Devil's Peak and to the south as the flat-topped Table Mountain. The rounded knob of Lion's Head and softly rounded Lion's Rump (Signal Hill) above Sea Point and the V&A Waterfront lie to the west.

Whether you are approaching Cape Town from a ship at sea, descending to land in an aircraft or driving in along one of the national motor routes, Table Mountain makes the first and most striking announcement of your arrival. What makes Table Mountain so impressive is the near-vertical relief of over 1 000 m as it rises from the sea to a top that from most approaches looks nearly flat, as if a large block of Earth had popped up from below (Fig. 3). In strong contrast, and emphasising the flat mountain top, are the nearby Devil's Peak to the east and the rounded knob of Lion's Head, separated from Table Mountain by the deep Kloofnek saddle.

Once you are in Cape Town, there are many good vantage points for viewing the surrounding landforms (Fig. 4). Most of these viewpoints are easily reached by car, such as the top of Signal Hill, Tafelberg Road beyond the cableway station, Rhodes Memorial above Rondebosch, or Bloubergstrand with its overviews of Table Mountain across Table Bay. But the best views are to be had from outside the car, and there are many hiking trails at all levels of altitude and difficulty within easy reach of Cape Town, from which to take in the scenery. You can reach the top of Table Mountain by following any number of trails in a vigorous and steep three- to four-hour hike or by taking a quick trip up the cableway. And the one- to two-hour hike to the top of Lion's Head is popular for watching the sunset, followed by a moonlit descent after a full moon has risen over the mountains to the east (Fig. 5).

From many of these viewing sites, you can see more distant but equally striking features. On a clear day the view to the east of Cape Town out across the Cape Flats reveals the Hottentots Holland as well as other mountain ranges (Fig. 6), whose highest peaks of 2 200 m are occasionally powdered with snow after a winter front. Lying east-northeast from Cape Town, in the foreground of the distant mountains, are the gently rolling hills of Tygerberg and Bottelaryberg, with the more distant but notable hills of Koeberg and Blouberg situated to the west (Fig. 1). Hills similar to the Tygerberg also form the foothills that butt up against many of the cliff-faced mountains: Signal Hill and Mowbray Ridge surrounding the City Bowl, for example, as well as many of the vineyards surrounding Stellenbosch. Looking south from the top of Table Mountain, you can see spectacular rock-cliff exposures stretching down the length of the Cape

Figure 4. Cape Town road map and topography, showing the location of good viewing sites.

1 Cableway
2 Tafelberg Road
3 Lion's Head
4 CBD
5 V&A Waterfront
6 Signal Hill
7 Green Point
8 Devil's Peak
9 Platteklip Gorge
10 Camps Bay
11 Kloofnek
12 Maclear's Beacon
13 Mowbray Ridge / King's Blockhouse
14 Twelve Apostles
15 Newlands Forest
16 Bantry Bay / Sea Point Contact
17 Sea Point Promenade

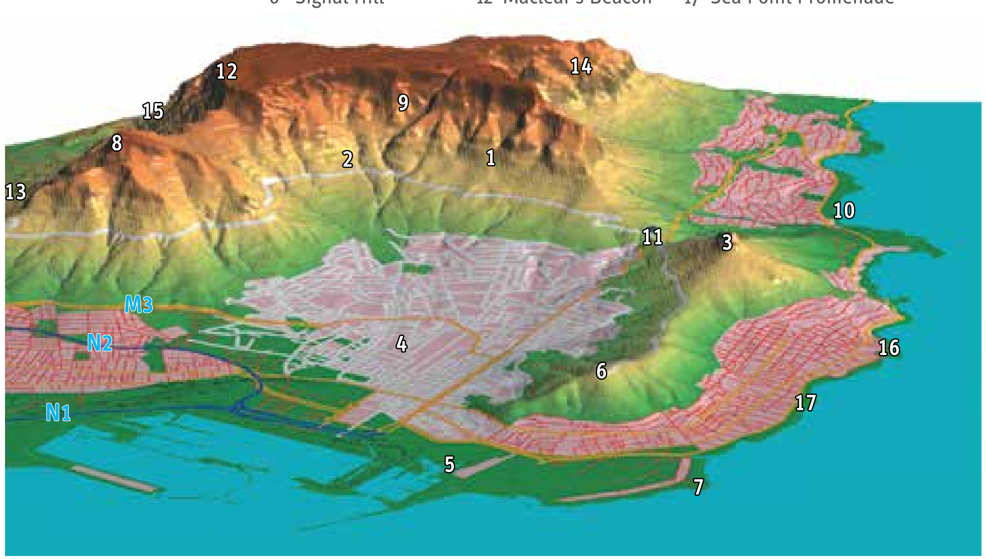


Figure 5. Moonrise over Devil's Peak as seen from the top of Lion's Head. The lower slopes of Mowbray Ridge rise gently to the rugged cliff faces above. The lights of the City Bowl are in the foreground and of the Cape Flats in the background.

Figure 6. Sunrise over the still-illuminated Cape Flats as seen from Rhodes Memorial, with the rounded hills of the Bottelaryberg silhouetted against the Hottentots Holland and other mountains along the distant skyline.

Peninsula. These mountain cliff-face exposures, impressive even at a distance, can be viewed up close along the roads that encircle the Cape Peninsula or on the wine routes of Stellenbosch and Franschhoek to the northeast.

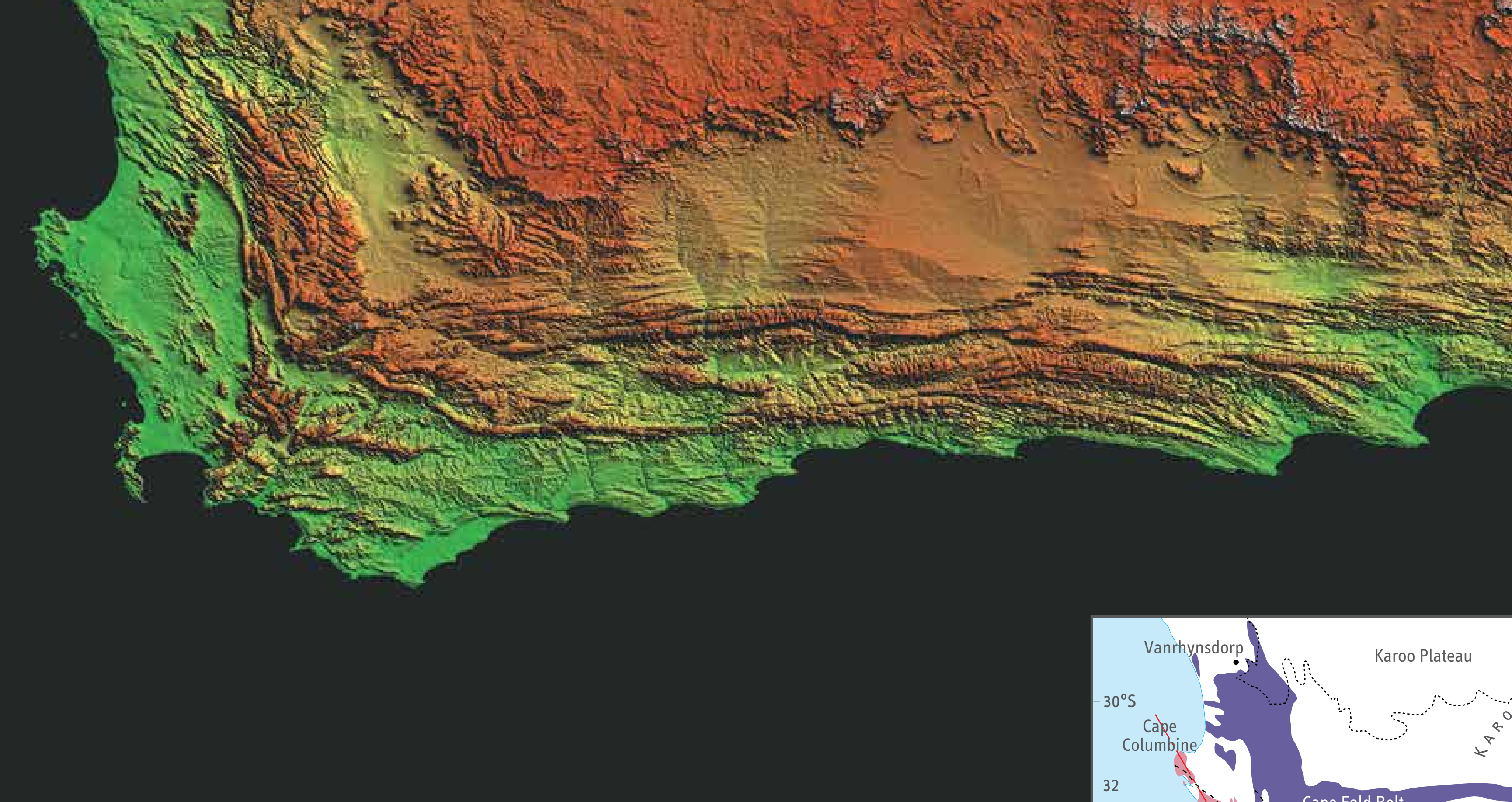
In contrast to and accentuating the steep mountain terrains are the Cape Flats, the low-lying expanse of land that stretches between the mountains of the Cape Peninsula and the mountains to the east. And if you look north to the white arch of the beach of Table Bay, you can see Robben Island looking precariously flat as it rises only 30 m above the sea. The sea can also be seen further to the south at False Bay. It is easy to imagine the sea flooding the Cape Flats and cutting off the Cape Peninsula from the rest of Africa to form a large offshore island, as it did during periods of higher sea level in the past.

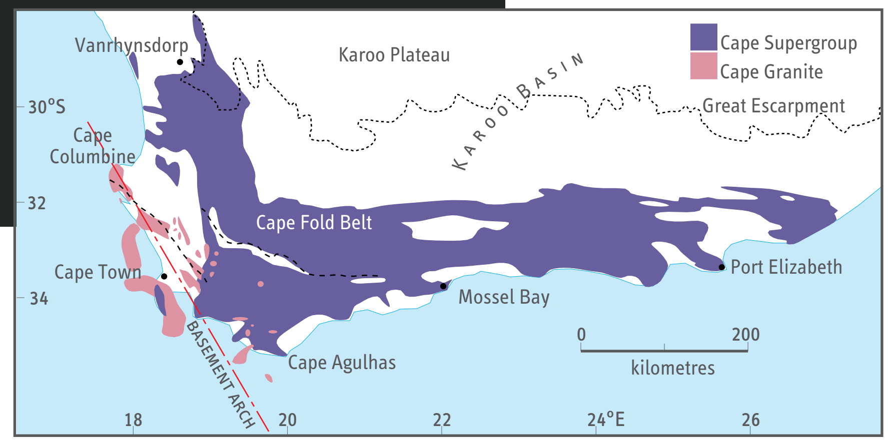
How did this diverse landscape of rocky, cliff-faced mountains, large, gently rolling hills and extensive flat lands come to be, and why do the landforms differ so strikingly one from the other? Did Table Mountain pop up from below or is it a resistant remnant that persisted after the surrounding rocks were worn away?

The view from space

To answer these questions, it helps to step back and place the landscape of the Cape Town area within the large-scale framework of the geological features of southern Africa. If we take a big step back and observe southern Africa from space (Fig. 7), Table Mountain and the Hottentots Holland Mountains turn out to be part of a much larger mountain chain that extends 700 km from Port Elizabeth running parallel to the coast to Cape Town, where it takes a sharp 90 degree turn to continue 150 km north of Cape Town as the Cederberg. This long mountain chain is referred to as the Cape Fold Belt (Fig. 8) and is made up of sandstone rocks similar to those exposed on the cliff faces of Table Mountain.

Figure 7. A true-colour composite image of southern Africa from space, acquired by NASA's Aqua and Terra satellites on 7 November 2002.





The distinct features of the South African coastline are also clearly visible when viewed from space and reveal that the Cape Peninsula is a pronounced but small part of a much larger, broader peninsula at the southwest tip of Africa. This larger peninsula coincides with the elbow-like kink in the Cape Fold Belt and contains, in addition to the mountains of the Cape Fold Belt, a series of granite hills scattered along a line that runs from Cape Agulhas in the southeast to St Helena Bay in the northwest (Fig. 8b).

An unusual feature of South Africa is that as you journey further inland and cross the mountains of the Cape Fold Belt, the land rises abruptly again onto the flat but elevated Karoo Plateau (Fig. 9). The Karoo Plateau sits 1 100 to 1 600 m above sea level and extends from the Great Escarpment (Fig. 10) across the country, with the highest elevations of 3 500 m being reached in the Drakensberg mountains of Lesotho.

Figure 8.(a) (Above) An elevation map of southern Africa showing the land features captured in the satellite image.
(b) (Below) The Great Escarpment, the Cape Fold Belt and the linear array of granite hills that defines the Agulhas–Columbine Arch. This resistant feature forms the large peninsula on the southwest tip of Africa.

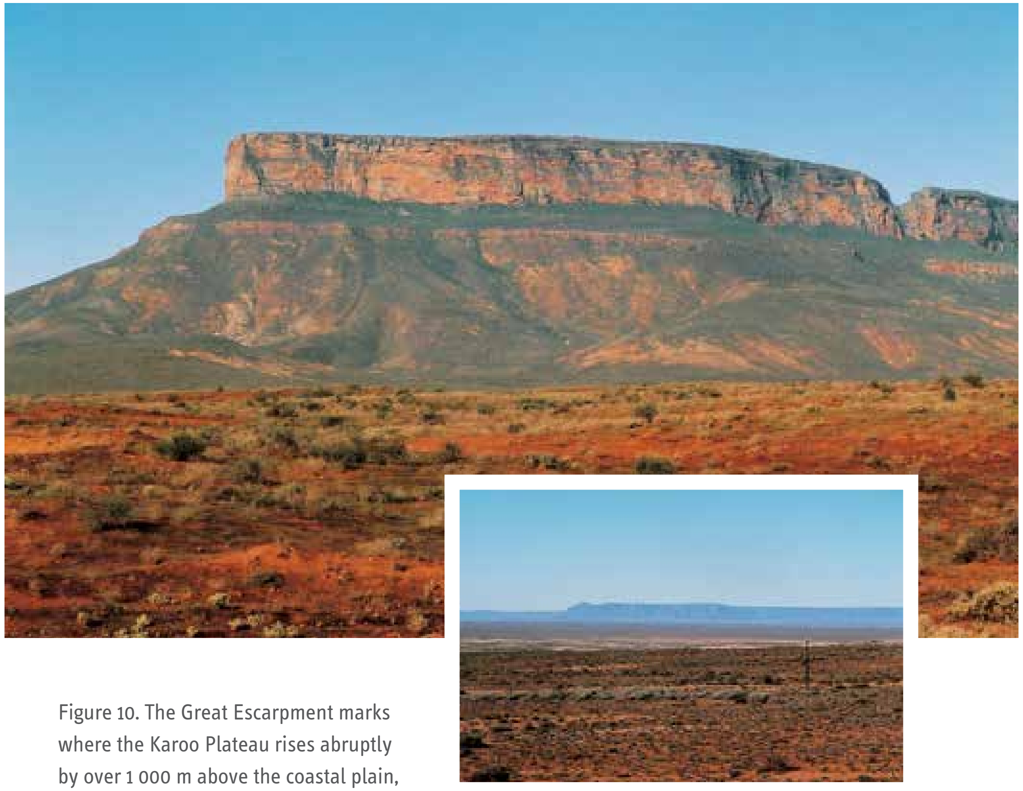


Figure 9. Cape Town sits on the edge of the African continent. (Above) Features (vertically exaggerated) of the Cape Town area, looking east into the Cape Fold Belt Mountains, taken from the Landsat and Shuttle Radar Topography Mission.
(Below) The deep sea floor rises gradually and then rapidly up onto the continental shelf. The shelf is the relatively flat offshore feature that extends onto land as the coastal plain. The Cape Peninsula mountains and granite hills rise abruptly from the coastal plain before the spectacular rise of the Cape Fold Belt Mountains. The elevated Karoo Plateau extends inland.

Figure 10. The Great Escarpment marks where the Karoo Plateau rises abruptly by over 1 000 m above the coastal plain, seen here at the town of Klawer and looking east from the N7, 20 km north of Vanrhynsdorp (inset).

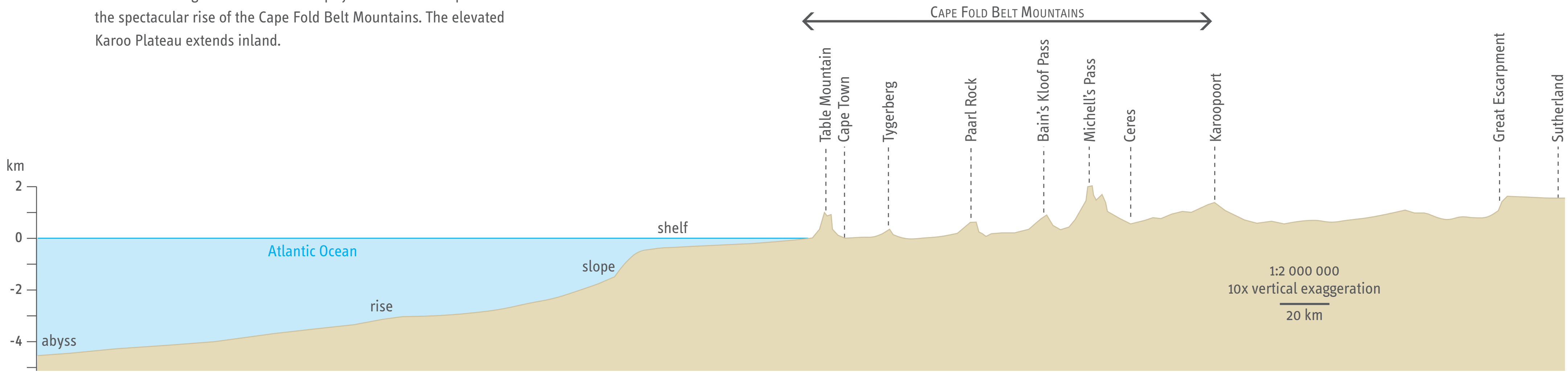
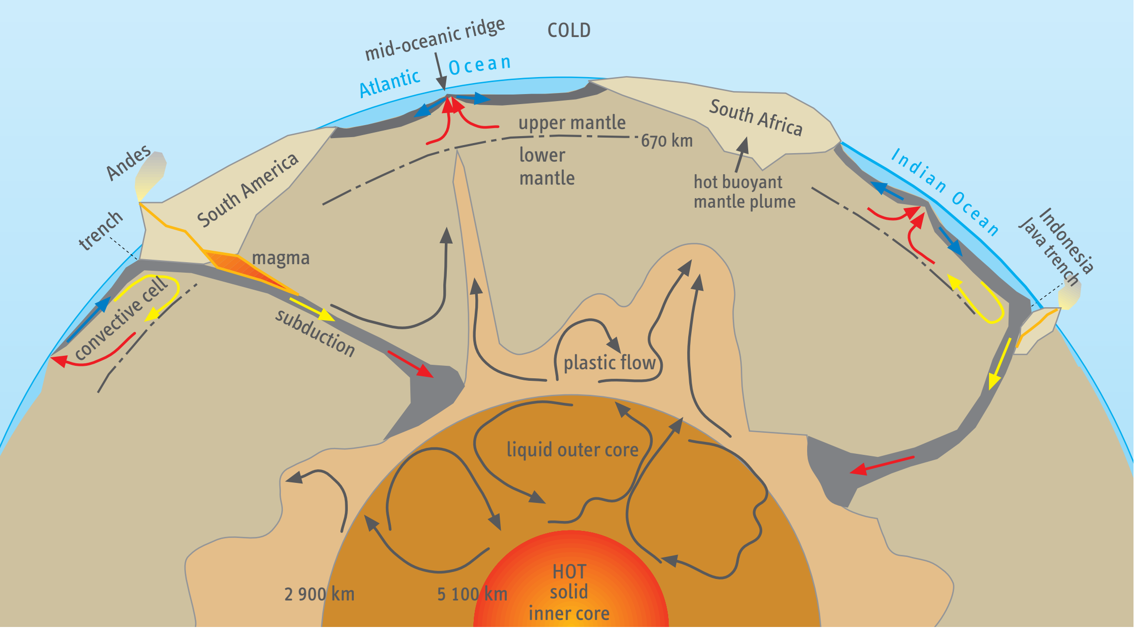


Plate tectonics

Plate tectonics is a general theory that explains many of Earth's dynamic features. Earth's crust – its thin, apple-skin outermost layer – can be divided into about a dozen large, rigid plates. These plates move in relation to one another in response to the plastic flow of rocks deep in Earth as heat is transferred from the hot interior to the surface (Fig. 11). Oceanic crust is continually being produced along the mid-oceanic ridge – a large mountain chain that runs for 80 000 km like a suture down the middle of the ocean basins. Magma rises up from the mantle as the ridge is pulled apart at a rate similar to that at which human fingernails grow. Because Earth is not expanding, the production of new crust at mid-ocean ridges requires destruction of old oceanic crust elsewhere. Old, cold and hence dense oceanic crust is destroyed by sinking back into the mantle along what are called subduction zones, demarcated on the surface by deep oceanic trenches and volcanoes. Continental crust consists of generally old, relatively thick accumulations of lighter rocks that ride on this conveyor-belt-like, convective motion of continually cycled oceanic crust. However, continental crust is too light to be returned to the mantle and remains at the surface as the 'scum of Earth', sometimes colliding and sticking together to form supercontinents or splitting apart into the separate continents of the present day. Earthquakes, volcanoes and mountain building are common features along new or collisional plate boundaries. Billions of years in the future, Earth will have cooled to a point when plate tectonics will come to a grinding halt.



Ancient continental collisions and the African superswell

How did the extensive Cape Fold Belt, which includes the steep mountains surrounding Cape Town, form, and why is southern Africa so high? Mountains are created through powerful earth movements and are just one of many features that can be explained by plate tectonics (Fig. 11). Mountains represent areas of uplift, where enormous forces push large masses of rock upward against the force of gravity. One way in which such forces are generated is when two continents collide. The largest mountain range in the world, the Himalayas of Asia, formed when the Indian continent collided into the Asian continent – a collision that has been ongoing for the past 55 million years. A similar but ancient continental collision formed the Cape Fold Belt Mountains.

The collision ended over 200 million years ago and one would therefore expect southern Africa to have an old, low-lying, weathered surface similar to that of Australia. Why the mountains around Cape Town are so steep and the Karoo so high remain big and largely unanswered questions for earth scientists. One possible explanation is that deep below the surface a large plume of hot mantle rock – the African superswell – is ascending (Fig. 12). This plume is thought to have buoyed Africa up to make it the continent with the highest mean elevation (Fig. 13). In the south, the plume sustains the high elevations of the Karoo Plateau as well as the steep mountains of the Cape Fold Belt. To the north the plume expresses itself at the surface as the East African Rift Valley, floored by active volcanoes. As this plume continues its ascent, the East African Rift may extend into southern Africa and slowly, over many millions of years, split the African continent in two.

Figure 11. An idealised cut-away of the interior of Earth showing the 'lava-lamp' model of plate tectonics. At the centre of Earth is a solid iron-nickel core surrounded by a liquid outer core whose convection currents transfer heat to the core–mantle boundary (and produce Earth's magnetic field). Heated mantle rock rises plastically toward the surface and can cause continents to rise up and eventually split, as is believed to be happening under Africa currently. Relatively cold oceanic crust sinks back into the mantle at subduction zones to produce magma that ascends to form mountain belts like the Andes. Subduction also allows magma to ascend at the mid-oceanic ridges, where new oceanic crust is continually being produced. The lighter rocks of the continents forever ride on the surface, pushed apart or forced to collide with one another as oceanic crust is continually created and destroyed around them. Note that the crustal features are greatly exaggerated here.