Landforms at constructive plate margins

Constructive plate margins occur where two plates diverge, or move away, from each other and new crust is created at the boundary. This process, known as **sea-floor spreading**, occurs in the mid-Atlantic where the North and South American Plates are being pulled apart from the Eurasian and African Plates by convection cells. As the plates diverge, molten rock or **magma** rises from the mantle to fill any possible gaps between them and, in doing so, creates new oceanic crust. The magma initially forms **submarine volcanoes** which may in time grow above sea-level, e.g. Surtsey, south of Iceland on the Mid-Atlantic Ridge (Places 3) and Easter Island on the East Pacific Rise. The Atlantic Ocean did not exist some 150 million years ago (Figure 1.4) and is still widening by some 2–5 cm annually. Where there is lateral movement along the mid-ocean ridges, large cracks called **transform faults** are produced at right-angles to the plate boundary (Figure 1.8).

The largest visible product of constructive divergent plates is Iceland where one-third of the lava emitted onto the Earth's surface in the last 500 years can be found (Figures 1.10b and 1.26).

Places 3 Iceland: a constructive plate margin

On 14 November 1963, the crew of an Icelandic fishing boat reported an explosion under the sea south-west of the Westman Islands. This was followed by smoke, steam and emissions of pumice stone. Having built up an ash cone of 130 m from the seabed, the island of Surtsey emerged above the waves. On 4 April 1964, a lava flow covered the unconsolidated ash and guaranteed the island's survival.

Just before 0200 hours on 23 January 1973, an earth tremor stopped the clock in the main street of Heimaey, Iceland's main fishing port. Once again the North American and Eurasian Plates were moving apart (Figure 1.10b). Fishermen at sea witnessed the crust of the Earth break open and lava and ash pour out of a fissure 2 km in length (page 25). Eventually the activity became concentrated on the volcanic cone of Helgafell and the inhabitants of Heimaey were evacuated to safety. By the time volcanic activity ceased six months later, many homes nearby had been burned; others farther afield had been buried under 5 m of ash; and the entrance to the harbour had been all but blocked.

A large volcanic eruption in a fissure under the Vatnajökull icecap melted 3000 m^3 of the glacier above it in October 1996. The resultant meltwater collected under the ice in the Grimsvötn volcanic crater (caldera) until, in November, an eruption spewed a 4270 m high column of ash into the air and released the trapped water. The subsequent torrent, which contained house-sized blocks of ice and black sulphurous water, demolished three of Iceland's largest bridges and several kilometres of the south coast ring road (Figure 1.25). A further event in December 1998 resulted in five craters within the caldera becoming active along a 1300 m long fissure and the creation of an eruption plume 10 km in height.

Figure 1.10
A constructive plate margin: Iceland

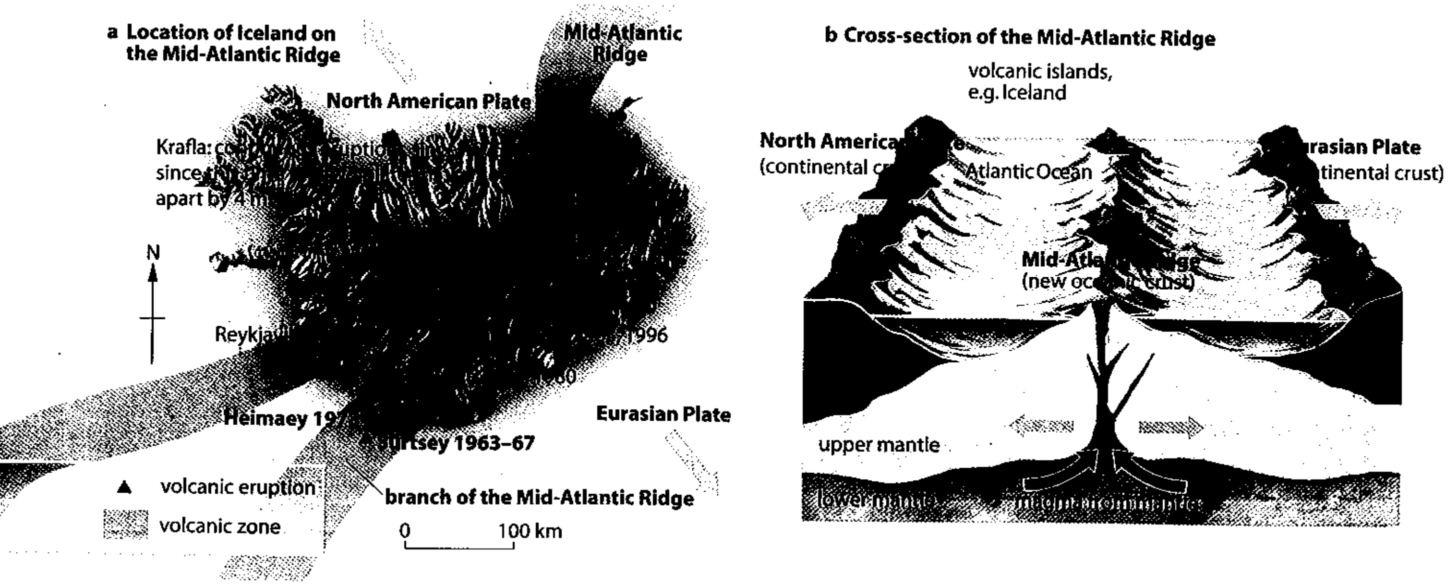
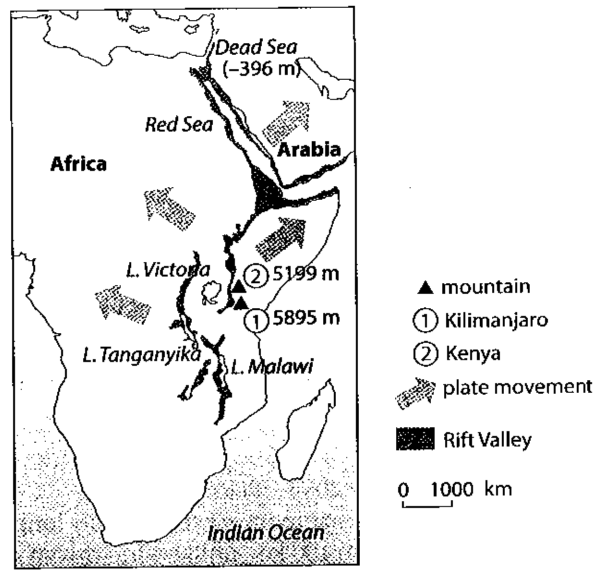
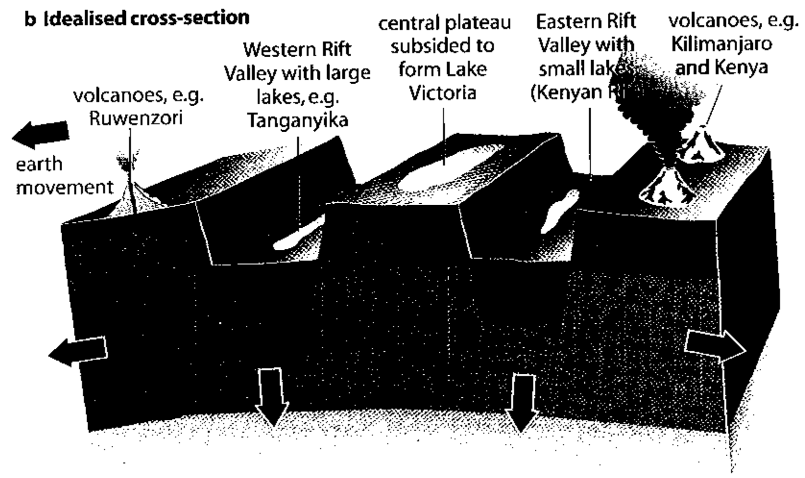


Figure 1.11
The African Rift Valley





The Atlantic Ocean was formed as the continent of Laurasia split into two, a process that may be repeating itself today in East Africa. Here the brittle crust has fractured and, as sections moved apart, the central portion dropped to form the Great African Rift Valley (Figure 1.11) with its associated volcanic activity. In Africa the rift valley extends for 4000 km from Mozambique to the Red Sea. In places its sides are over 600 m in height while its width varies between 10 and 50 km. Where the land has been pulled apart and dropped sufficiently, it has been invaded by the sea. It has been suggested that the Red Sea is a newly forming ocean. Looking 50 million years into the future (Figure 1.4c), it is possible that Africa will have moved further away from Arabia.

Landforms at destructive plate margins

Destructive margins occur where continental and oceanic plates converge. The Pacific Ocean, which extends over five oceanic plates, is surrounded by continental plates (Figure 1.8). The Pacific Plate, the largest of the oceanic plates, and the Philippines Plate move north-west to collide with eastern Asia. In contrast, the smaller Nazca, Cocos and Juan de Fuca Plates travel eastwards towards South America, Central America and North America respectively. Figure 1.12 shows how the Nazca Plate, made of oceanic crust which cannot override continental crust, is forced to dip downwards at an angle to form a **subduction zone** with its associated **deep-sea trench**. As oceanic lithosphere descends, the increase in pressure can trigger major earthquakes, while dehydration of the subducted oceanic crust, caused by the increase in pressure, results in the release of water into the overlying mantle which promotes partial melting and the generation of magma. Being less dense than the mantle, the newly formed magma will try to rise to the Earth's surface. Where it does reach the surface, volcanoes will occur. These volcanoes are likely to form either a long chain of **fold mountains** (e.g. the Andes) or, if the eruptions take place offshore, an **island arc** (e.g. Japan, Caribbean). Estimates claim that 80 per cent of the world's present active volcanoes are located above subduction zones. As the rising magma at destructive margins is more acidic than the lava of constructive margins (page 24), it may solidify within the mountain mass to form large **intrusive** features called **batholiths** (Figure 1.31).

Figure 1.12
A destructive plate margin – the Nazca and South American Plate boundary