one of which, the southern, is generally high, heavily cratered and ancient, while the northern is formed of low-lying, relatively featureless plains which have far less, and generally fresher craters. These plains appear to be predominantly formed of volcanic materials and this general impression was confirmed by Viking Lander 2. The boundary between the two regions is marked by boundary scarps which are remarkably uniform in height at 1–2 km, and areas of the so-called **fretted terrain** where the highlands are being eroded.

Craters in the northern hemisphere only rarely exceed 10 km in diameter, but in the southern they include several multi-ringed structures which range in size up to that of Hellas, which is about 2 000 km across and some 4 km deep. The number of central peaks and peak rings is similar to that of Mercury, as expected from the equal surface gravities. The effect of gravity can also be seen in the fact that Martian craters are shallower than those on the Moon. Distinct blankets of ejecta can be seen around some of the younger impact craters.

Table 5·9 **Mars-Earth comparative data**

	Mars	Earth
equatorial diameter (km)	6 794	12 756
sidereal period of axial rotation	$24_h37_m23_s$	$23_h56_m04_s$
inclination to orbit	24^0 46′	23^0 27′
density (kg per m^3)	3 933	5 517
mass (Earth=1)	0.107	1.0000
surface gravity (Earth=1)	0.38	1.0000
esape velocity (km per s)	5.03	11.2
albedo	0.16	0.36
mean Sun-Mars distance 1.5236915 au		

Volcanism

Although there are no signs of curved mountain chains, a prominent part of the surface is that in the three volcanic regions in the Tharsis, Elysium and Hellas areas. One of these, the Tharsis volcanic province, is especially notable as it contains extensive volcanic plains, four exceptionally large volcanoes and numerous other features. The largest volcano, Olympus Mons, has a diameter of 600 km and a height of 26 km, making it twice as high as the large feature on Venus and much bigger than Hawaii, which forms the largest such volcano on Earth (Fig. 5·14). It has a complex central **caldera** or crater-like depression, gives evidence of extensive lava flows, and a boundary cliff which is up to 4 km high in places.

The other three volcanoes in the same area are very large with diameters of about 400 km and heights of 19 km, but there are also smaller domes which were probably formed by more viscous lava. To the north of the region there is a considerably older, degraded structure, Alba Patera, which seems to have had a diameter of about 1 600 km, making it the largest volcanic feature on the planet.

The Elysium area contains volcanoes and volcanic plains, but the structures in the Hellas region are much less distinct and certainly very much older, being highly degraded. Crater counting and other techniques have enabled the features to be dated and this shows that Mars has been volcanically active practically since its formation until the present. The Hellas features are the oldest, with ages of 3·5–4·0 × 10^9 years, and the Tharsis area the youngest, at perhaps 2·0 × 10^8 years. It is quite possible that a small amount of activity could take place at the present time, although there is no actual evidence for this. The exceptionally long period of activity in just a few regions argues against major horizontal plate tectonic movement having occurred as on Earth, and it may be shown that, as on the Moon, the molten zone has been slowly migrating towards the centre of the planet, with the magma for Olympus Mons now originating at a depth of about 200 km, some four times as deep as on Earth.

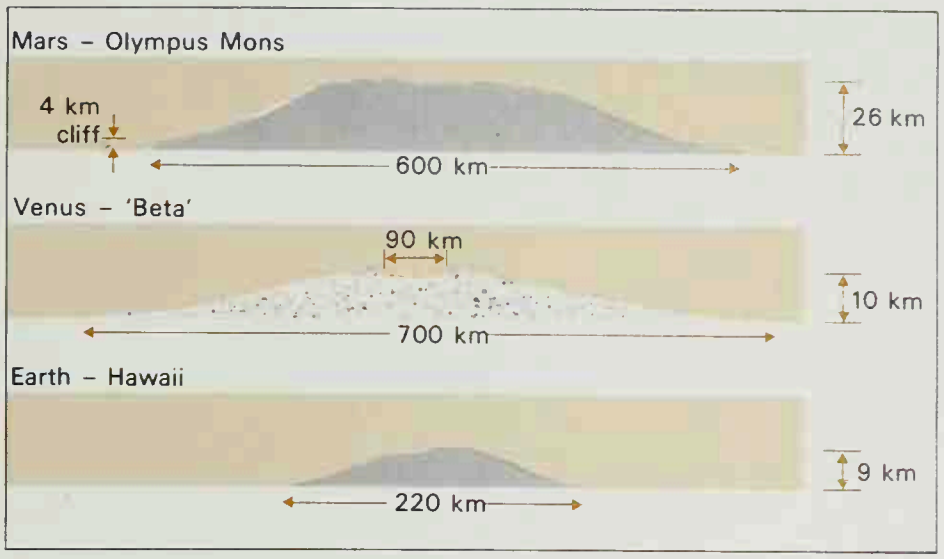
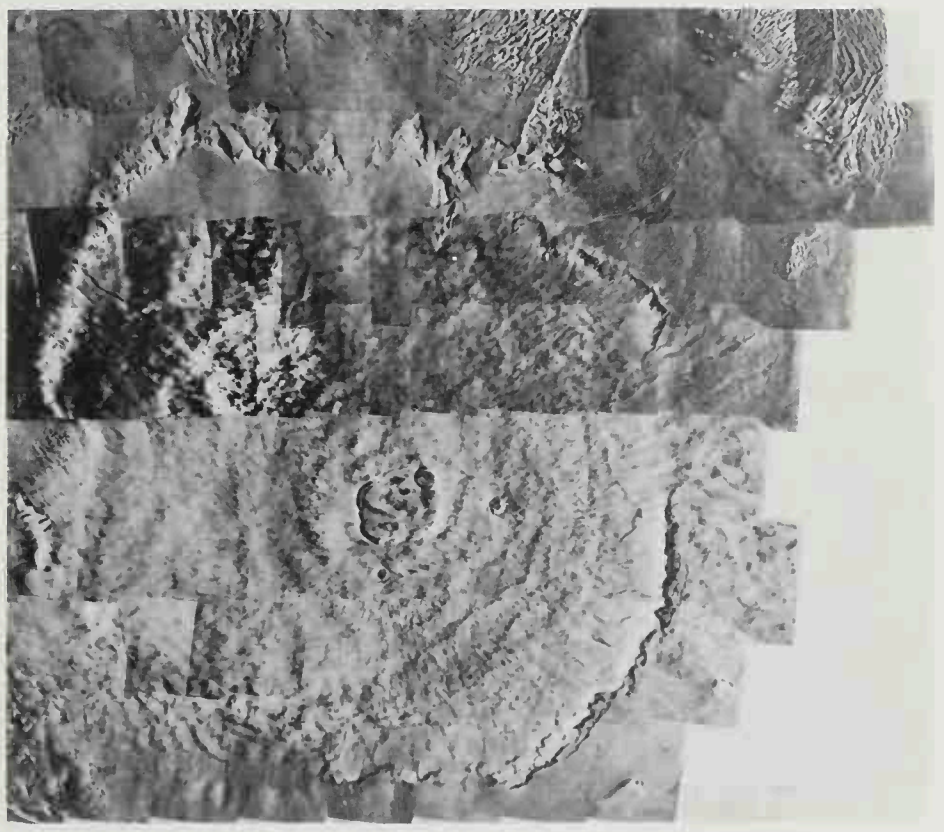


Fig. 5·14 above: A comparison of the largest recent volcanic structures on Earth, Venus and Mars, all of which have central calderas. The highest point on the island of Hawaii is Mauna Kea, but only Mauna Loa is now active. The details of the object on Venus are naturally only tentative.

Rifts, troughs and valleys

The Tharsis volcanoes lie on part of a very large uplifted area, which is about 5 000 km across and 7 km high. The exact causes of this bulge are obscure,



Photomosaic of Olympus Mons, which has a diameter of about 600 km and height of 27 km. The complex central caldera has a diameter of about 70 km.