absorption by sulphur dioxide. The clouds exhibit a strongly layered structure, the densest layers occurring between about 70 and 47·5 km, with hazes both above this (extending to about 90 km) and below (down to about 31 km). The lower atmosphere is essentially clear, which is one of the reasons why conventional lightning processes are unlikely to occur.

There are various sizes of cloud particle present, but the majority appear to be droplets of sulphuric acid (H_2SO_4), some tiny and some larger, the latter probably accumulating on nuclei of small particles. The very largest cloud particles are quite possibly fairly large crystals, most likely to be some form of chloride, although this is still uncertain. A number of other components must be present to account for the optical properties of the clouds.

The atmospheric circulation of the planet is unusual. There is a very high-speed circulation of the upper and middle layers around the planet, in the opposite direction to the axial rotation. The velocities are very high at about 100 m per second, giving rise to an apparent rotation period of about 4 days for the cloud tops.

At high levels the night-side temperature is very low (unlike on Earth, where both day and night sides have high temperatures). The steep temperature gradient and consequent pressure difference is the cause of the high-speed winds.

Superimposed upon this rotation of the cloud around the planet is slower motion between the equator and poles. Most of the absorption of solar heat occurs at fairly high levels in the cloud layer, and this drives a fairly slow circulation in a layer of restricted depth. By friction this layer drives a circulation in the stratosphere above it, and one in the lower atmosphere (down to about 40 km from the surface), so that the circulation is rather like three counter-rotating conveyor belts running between equator and poles. Yet another circulation cell appears to exist at the surface, driven by the small amount of heat which penetrates to such a low level, and there may also be smaller intermediate eddies contributing to the overall stack of counter-rotating layers.

At the poles the general circulation of the layers appears to form a pair of very large counter-rotating eddies which allow the lower, hotter layers of the atmosphere to be seen through holes in the cloud layer. The general atmospheric circulation is quite unlike that of the Earth, which essentially consists of three circulation cells between equator and poles, driven by heat absorbed at the surface.

The Venera landers and the four Venus Pioneer probes (one of which, although not designed to survive impact with the surface, did return 67 minutes of data) show that information can be gained slowly about the nature of the surface, as well as about the atmosphere through which they descend. Further advances in understanding should come with the proposed orbiting vehicle carrying a radar experiment, as well as the balloon probes now under development, which would remain in the atmospheric layers for some considerable time.

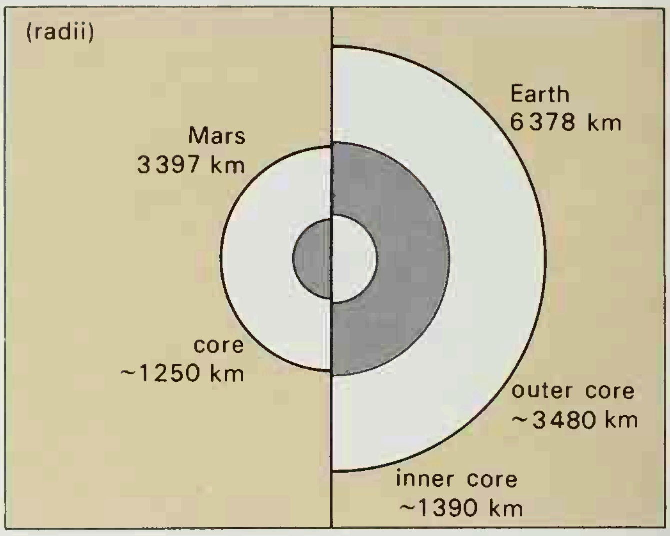

Fig. 5·13 far right: Comparative sizes of Mars and the Earth. The planet's total mass is about 11 per cent of the Earth's (about twice that of Mercury).

Mars

Mars, unlike Venus, has only a thin atmosphere and the planet has long been extensively studied from Earth. Detailed maps have been drawn of its surface markings which were thought probably to be related to high and low areas, perhaps somewhat similar to the division on the Moon. Apart from these features it shows clouds, brilliant polar caps which alter in size with the seasons, similar seasonal changes in some of the surface markings and occasional vast dust storms which may obscure the whole planet. Rather ironically, the markings which were thought to indicate the nature of the surface have now been shown by spacecraft pictures to bear little relation to the actual features, whereas the other characteristics have been fully confirmed.

Mars has an equatorial diameter of 6 794 km, an axial period of $24_h37_m23_s$ and is inclined to its orbit by 24° 46′, the last two factors being very similar to those of the Earth (Table 5·9). It has a lower density than any of the other inner planets (although higher than the Moon) and has a surface gravity almost exactly equal to that of Mercury, despite being more than 3 800 km greater in diameter. The crustal and mantle materials of the inner planets appear to be very similar and this, together with spacecraft tracking results, suggests that the core of Mars is smaller (Fig. 5·13) and less dense than those of the other planets, with the most probable material being iron sulphide (FeS). The nature of the core may be clarified by future information about the planet's magnetic field. Results from the Soviet Mars probes and Viking spacecraft appear to indicate the presence of a weak magnetic field, although nothing had been detected by the three Mariner missions.

Craters

Both the Mariner 4 and 7 spacecraft showed that the surface of Mars was cratered, but it was Mariner 9 which revealed the true distribution of the craters and discovered numerous other interesting features. The Soviet Mars 5 probe also returned high resolution pictures, but the highest quality images have naturally been obtained by the later Viking Orbiters. The most striking fact which has been revealed is that the surface is divided into two approximate hemispheres,