

Lava flows in the Mare Imbrium which are here about 35 m high and 10–25 km wide. The lava source was off the picture to the lower left and some flows are about 1 200 km long.

Facing page, top right: The Appenines, part of the rim of the Imbrium basin, with a portion of Mare Serenitatis in the distance. Hadley Rille, which is typical of the sinuous type, begins at an elongated fracture, runs approximately parallel to the base of the Appenines and turns at the Apollo 15 landing site through a right angle before gradually fading out into Palus Putredinis.



The Maria

There are good reasons for believing that there were many large impacts in the early part of the Moon's history and some of these excavated basins 20–25 km deep. At a later time these basins were flooded by vast quantities of lava which more or less completely filled them to form the circular maria. The irregular maria, on the other hand, have been produced merely by flooding of low-lying terrain and the lava infill is much thinner. The flooding has been in the form of a series of thin flows, the latest of which can be easily recognized, and which in some cases are known to extend for as much as 1 200 km, showing that the material was very fluid. Similar, although

Part of Mare Serenitatis, showing mare wrinkle ridges and many graben which are generally concentric to the mare basin.



not so extensive flooding is known on Earth, in the Deccan Traps in India and the Columbia River region in North America in particular. The very fluid lava is of the type known as basalt, and is similar on the Earth and the Moon.

In many cases the lunar basalts have more or less completely submerged old craters, sometimes leaving only the faintest ghost rings to be seen. Later craters which have formed in the mare material itself, provide excellent examples of the typical crater shape and deposits.

In the mare areas there are a few domed areas and low arches which have probably been produced by upwelling lavas, but the numerous mare **wrinkle ridges** have almost certainly been caused by compression of the surface layers when the lava flows cooled.

Generally, but not exclusively, associated with the edges of the maria are valley-like **rilles**. The straight and bow-shaped types are troughs or graben due to faulting, which may cut indiscriminately across mare and craters alike. The bow-shaped rilles are usually concentric with the mare basins, and both types are probably caused by movement on ancient underlying lines of weakness. The sinuous and meandering rilles are very different and at first sight look like river valleys. However, unlike water channels they are deepest where they are widest, and in fact they show points of resemblance to collapsed lava tunnels.

Volcanism

Apart from the mare domes which have been mentioned, there are a few other features which are thought to be due to volcanic action. Some domes on the edges of the highlands seem to have been formed before the maria were filled and may be very ancient, while there are a few low cones which resemble cinder cones produced by low-energy eruptions. Moreover, a few dark areas are apparently covered in cinders and ashes from more energetic eruptions. In a number of crater chains the pits greatly resemble the formations known on Earth as volcanic maars, where explosive release of gas has bored a hole in overlying rocks, although there has been no major ejection of volcanic materials. All these features are of minor importance, however, and the few large craters which on the grounds of their positions and associated features may be volcanic, are greatly outnumbered by the impact formations. Indeed, although the Apollo 16 landing site of Descartes was chosen because the surface rocks were possibly volcanic, in the event the astronauts collected large quantities of impact breccias.

The occasional obscurations and glows which are known as **transient lunar phenomena** are most frequently seen around the edges of maria and near to certain relatively fresh craters. These events are more numerous when the Moon is at perigee, suggesting that tidal forces are causing slight movement of the crust which permits gas to escape from the interior. Gas emissions have been detected from Earth, and more reliable observations have been made from orbiting spacecraft, but there are no reasons for supposing that any eruptive volcanic activity is taking place.