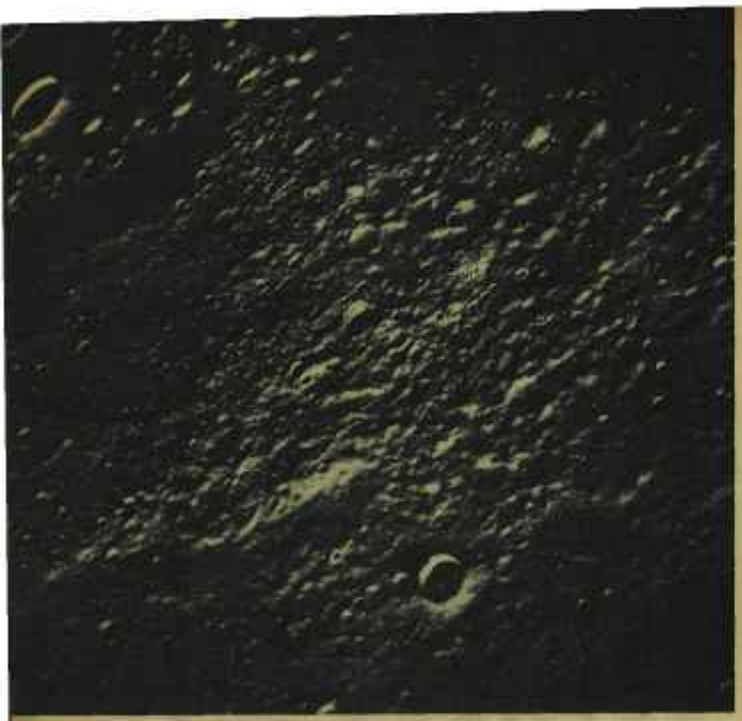
SPACEFLIGHT



First results from the Moon-landings

This photograph of the Fra Mauro walled plain was taken during the Apollo 12 flight. The rugged highland area is heavily overlaid with ejected matter from the splendid crater Copernicus (not shown in the picture) some 250 miles to the north. The view is looking north-west, towards the Apollo 12 site, and with part of the Ocean of Storms visible at the top of the picture. *See news item on next page*

THE FIRST FINDINGS of the scientific exploration made during the first manned landing on the Moon last July were published by NASA last month. In the 203-page *Apollo 11: Preliminary Science Report*, W. N. Ness and A. J. Calio of the Space Agency say: "The most interesting and unexpected surface features discovered and photographed by the astronauts are glassy patches that are described as resembling drops of solder . . . these glassy blobs may be formed by low-velocity molten materials splattering into the craters, or they may be formed from material that has been melted in place."

Examination of the 48lb, 22kg, of rock samples has shown that their chemical composition is unlike that of any known Earth rock. This discovery appears to have disposed of at least one of the three possible hypotheses put forward to explain the origin of the Moon—that it was once a part of the Earth, but was torn off at some period. (The other two theories propose [1] that the Moon was formed separately, but was captured by the Earth's gravitational field, or [2] that it was formed at the same time as the Earth).

There was no evidence in the rocks of life or water, either past or present. The age of some of the samples has been set at not less than 3,500 million years, while the lunar highlands, the sites of future flights, are believed to contain material at least a million years older, which dates them only 200 million years younger than the estimated age of the solar system. In comparison, the oldest known rocks on Earth which have survived the erosive effects of wind and water were formed about 3,500 million years ago. Many of the lunar samples were igneous—they were once in a molten state, either from volcanic eruptions or from the heat generated by meteoric impacts. This appears to confirm the most widely held view that violent events, such as impacts from meteorites or from the debris of volcanic eruptions, have played a major part in shaping the surface of the Moon. All the samples had glass-lined surface pits which may have been caused by showers of small particles. This pitting was found to occur uniformly over the surface, and not just on the upward-facing side, indicating that the rocks had been disturbed from time to time.

Most of the rocks were rounded and fairly smooth, indicating that erosion has been taking place. The process occurs at a very much slower rate than on Earth due to the lack of wind and water, and is due to solar radiation or meteoric impacts. Lunar dust and non-igneous rocks such as breccia—conglomerate rocks—were found to contain large quantities of gases which apparently accumulate as the result of protons from the solar wind being trapped in the rock structure.

Chemical analysis of 23 samples showed that all the rocks and dust were similar in composition, indicating that they were characteristic of a large region of the Sea of Tranquillity. No evidence of organic material has been found. There are, apparently, no life processes taking place, and people and animals exposed to the lunar samples have shown no positive reactions.

The main difference between the chemical composition of Earth and Moon rocks is that the latter exhibit surprisingly large proportions of the metals chromium, titanium, yttrium and zirconium, all of which have very high melting points. In particular the samples were found to contain ten times more chromium than is commonly found in Earth ores, while crystalline igneous rocks contained as much as 12 per cent by weight of titanium oxide, compared with terrestrial occurrences of up to 4.5 per cent. There has been no evidence of gold, silver or platinum. By contrast the scarcity of low-melting-point elements, such as lead, bismuth, sodium and potassium, is noteworthy.

A more thorough examination of the Apollo 11 rocks is still under way by 140 scientists in eight countries, and the results of these will be published later this year.

More recently, some observations on the preliminary scientific results of the Apollo 12 flight were made at a Houston press conference, where it was suggested that the Moon may have been subjected to meteoric bombardment over a period as long as 500 million to 1,000 million years. Dr Oliver Schæffer of New York's State University said that the Apollo 12 rocks were between 500 million and 1,000 million years younger than those of Apollo 11. Dr Carleton Moore of the Arizona State University drew attention to the low carbon content (only 100 parts per million) of the rocks found in the Ocean of Storms, while Dr David Wones of the Massachusetts Institute of Technology said that the 73.15lb, 33kg, of Apollo 12 rocks differed from those brought back by Apollo 11 in their variety in size—the largest weighing 11lb, 4.9kg, and comprising both fine-grained and very coarse-grained specimens. Only two of the 46 rocks were breccias (conglomerations of smaller rocks) com-