

pared with 75 per cent which comprised the Apollo 11 samples; a difference "which may or may not be significant."

Most of the rocks, like those from Tranquillity Base, were of igneous origin, born in the melting process caused by volcanic or meteoric impacts. They were generally lower in titanium content but richer in iron, and were mostly crystalline. The amount of glass was less than that contained in the Apollo 11 samples, but this was because less dust (which contained as much as 50 per cent of minute glass beads) had been brought back.

The deliberate crashing of the Apollo 12 ascent stage, to prevent it from hazarding future flights using the same orbit, and to exercise the seismometer, paid a major and completely unexpected scientific dividend in revealing the nature of the Moon. Disturbances caused by the impact were recorded by the Apollo 12 seismometer for half-an-hour, instead of tailing-off rapidly to zero as had been expected. Three tentative explanations have been offered: first, that the Moon is an unstable structure, in which the impact was sufficient to trigger a cascade of avalanches and collapses over a wide area of the

surface; secondly, that a single disturbance is propagated without significant attenuation, and circulates through the Moon's crust and is thus continuously re-recorded; and thirdly, that the effect was caused by the fallback of debris and dust which must have been flung to great heights by the impacting spacecraft.

The velocities of the signals were very low, and until further seismometers can be placed on the Moon to allow normal triangulation techniques to be employed, it was not possible to reach a positive conclusion about their origin. It does seem however, that the Moon's crust may be cracked or shattered to a depth of several hundred miles.

Meanwhile, to follow up this observation, it is planned to impact the S-IVB stage during the flight of Apollo 13 to the Moon next March. Travelling at about 5,700 m.p.h., 9,100km/hr, the spent stage and instrument unit will crash inside a 440-mile, 700km, diameter area (which includes the Apollo 12 landing site) with an impact equivalent to 10 tons of TNT. There will be no explosion as such because the propellants will have been vented from the stage.

### AND SO TO APOLLO 13

At 9.38 p.m. BST on March 12 the third manned expedition to the Moon will pull away from Cape Kennedy, bound for the rugged foothills of the Fra Mauro. Apollo 13 will be the first to land in an area other than the smooth, level plains chosen for Apollos 11 and 12. Fra Mauro is a crater of some 50 miles, 80km, diameter, with low and discontinuous walls, and is named after the 17th-century Venetian geographer. This vast, flat highland area is traversed by a large number of ridges, and is 110 miles, 170km, east of the Apollo 12 landing site. The scientific interest in these regions stems from the belief that it is an outcrop of rock which has been thrust up from deep within the Moon's interior.

Based on the demonstration of a pin-point landing with Apollo 12 and large-scale photographs of the area taken during that flight, the chosen aiming point lies just outside the Fra Mauro. It is here that James E. Lovell, commander of the Apollo 13 flight (and veteran of Gemini 7 and 12 and Apollo 8, with more time in space than any other astronaut), and lunar-module pilot Fred W. Haise, will explore the area near the lip of the crater for as long as 5hr during one of the two planned excursions from the spacecraft. They will collect samples from deep inside the Moon, while Thomas K. Mattingly will orbit the Moon in the command module.

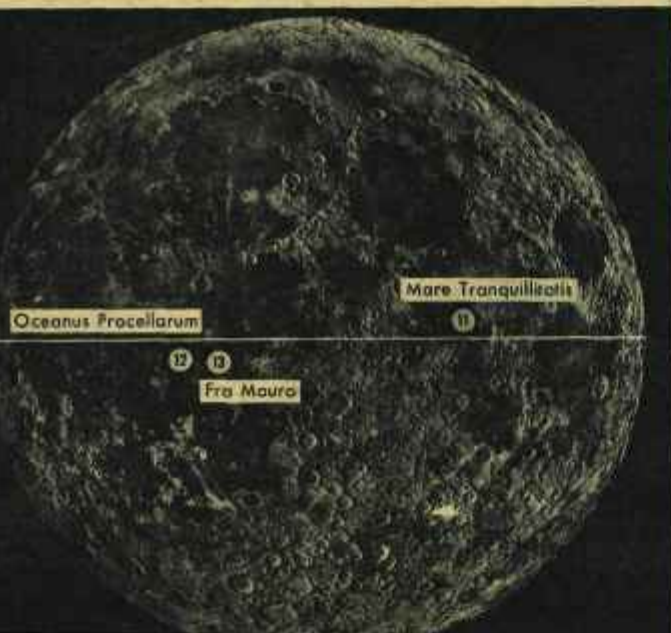
The Apollo launch vehicle and spacecraft was moved from

the vehicle assembly building to the launch pad on December 15, and the three-month checkout procedure began immediately. Launch director Walter Kapryan has stated that the rules which define weather limits in which a flight may take place have been reviewed and modified: launches under the conditions experienced by Apollo 12 are definitely "out."

The duration of the excursions have again been increased, as a result of the very encouraging reports by the Apollo 12 moonwalkers, Conrad and Bean: "You can work as hard as you can, but you don't seem to get tired," commented Bean, during a press conference last month. Conrad has suggested that the backpacks might be modified for longer excursions on the Moon, and that the suit itself might be redesigned to allow the knees to bend to facilitate working on the Moon. But he was otherwise pleased with it. "The sun was beautiful. I never gave it a second thought." Of the pack, he said: "After 10min you don't even know its there." He visualised future crews being able to work continuously on the Moon for a normal working day, stopping only for an hour's break.

### A NEW MILITARY COSMOS?

The launch of Cosmos 316 on December 23 provides a direct link between the sub-set of Cosmos satellites with orbits inclined at 62° to the equator and FOBS (fractional orbital bombardment system) tests. All FOBS from Cosmos 139 up to Cosmos



Left, the site chosen for Apollo 13 is near the Moon's equator (as are all the early landing sites) for ease of access. Above, the crew: left to right, James A. Lovell, 41, USN; Thomas K. Mattingly, 33, USN; and Fred W. Haise, 35, a civilian. Neither of the two last-named astronauts have flown in space before.