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HERMES Volume 16 Number 4

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The Junior Astronomical Society

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FRONT COVER: In front of the Lunar Module, Apollo 11 astronaut Edwin Aldrin sets up the aluminium foil 'sail' designed to catch particles of the solar wind. The experiment was folded up and brought back to Earth

BACK COVER: Neil Armstrong photographs the imprint of his own boot during the Moon walk on 21 July. He described the lunar surface as fine and powdery. His feet sank into the soil about an eighth of an inch, and the lunar material adhered to the soles and sides of his boots like powdered charcoal

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Comment

I MUST confess that I dozed off for a short while during Armstrong and Aldrin's Moon walk. It was, after all, some unearthly hour in the morning. Out in the growing dawn, early workers were stirring themselves for the day ahead. Others, eyes dark and heavy as charcoal steaks, must have found themselves too long from sleep to remain watching once the two yeti-like lunarnauts had lumbered out of camera shot to spread their experiments on that abominable snowscape.

By the time I awoke, they were huddling back in their little home, a house of cards on a sterile desert. Man's first visit to the lunar candy store had ended after it had hardly begun, but he would go again and pick some more off the shelves. Across a globe united by hope and wonder, electronic images from a world away in space died like sad smiles on their receivers' faces. Into how many homes had come the message of a new continent that for the first time harboured men from the planet Earth? How many watchers had understood what they saw?

To me, the most amazing sensation was the thought that the picture facing me in my own front room had started out life a few seconds before on the surface of the Moon. There never was a more complex outside broadcast than that. But I wonder how long it will be before walking on the Moon is just another news item?

AFTER the glut of Moon magazines and Moon television, we now have a glut of Moon books. Two of them are reviewed in this issue. All of them show the strain of hurried production. And those produced so far have been rushed out so rapidly that they missed Armstrong's correction of the first words on the Moon. It was a small step for a man, he said. Too late, cried publishers as their books hit the shops, documenting the wrong historic phrase.

First off the presses – 72 hours after splashdown – was a book called *We Reach the Moon* by John Noble Wilford of the *New York Times*. It covers the entire history of American manned spaceflight, the national commitment to space, with a mention that the Soviets also ran. A transcript is included of some of the astronauts' remarks while on the Moon, but it's none too reliable – the words on the plaque they unveiled on landing are recorded wrongly, for instance.

Penguin books brought out *Invasion of the Moon 1969* by Peter Ryan at the beginning of August. As its subtitle says, this is the story of the Apollo 11 mission; Ryan's narrative is based mostly on the events of that flight. Peter Fairley's book, *Man on the Moon*, is an

account by a journalist who has written about space since the launching of the first sputnik. Consequently, the story is a balanced look at American and Soviet space achievements. There is one remarkable boob, though. Referring to the Zond 6 lunar photographic mission, Peter Fairley remarks that 'four months later the Russians had still not released these pictures.' In fact, less than two months after the flight a Zond 6 Moon picture was published in *Hermes*.

John Mansfield is the author of a book also called *Man on the Moon*. His is an overall view of man's attempts to climb above the atmosphere. Although far more thorough, it lacks the 'I was there' approach which illuminates Peter Fairley's book. Yet another *Man on the Moon* is by the *Sunday Times* team of Bryan Silcock and Hugo Young, who've been doing some merry fishing in the pool of political intrigue that surrounds the Moon programme. From behind blank names emerge personalities; and from the personalities emerge human strength and human weakness. Not science . . . but eye opening.

But the report to end all reports is written by Norman Mailer, 'the best journalist in America.' Philosophical flowers burst into bloom as the eye, like the summer Sun, scans the deep beds of prose. This is the dawning of the age of Aquarius, the song tells us. Perhaps Mailer finds it significant that this is his birth sign. He writes the book – called, simply, *Moonshot* – in the third person, referring to himself as Aquarius. And we can see that, although Aquarius didn't expect to be impressed with Apollo 11, he was. By all the stars above, he was.

BEFORE long, we should all be able to toss aside our books and walk up to a real bit of Moon in the middle of London. This seeming paradox may well come true when the United States distributes its precious rock samples to world leaders; and London's Geological Museum seems the natural place to display Britain's share of the pickings. Although the official line is still 'No comment,' Geological Museum men privately believe that theirs is the only logical premises on which to showcase the priceless specimen. After all, they point out, what could be better for rounding off the Museum's special lunar exhibit? Maybe then the Moon really will be close enough to touch.

IN the April issue of *Hermes* I announced a competition for both writers and artists. I'm pleased to announce that the prize, a copy of James Muirden's latest book *Astronomy for Amateurs*, has been won by Melvyn Taylor, 21, of Wakefield, Yorkshire, for his essay on the amateur's role in astronomy. Runners up were Michael Foulkes, 15, of Cleethorpes, Lincs.; Paul Haley, 13, of Romford, Essex; and Susan Wakefield, 15, of Grantham, Lincolnshire. Unfortunately, none of the drawings submitted was considered worthy of a prize. For future competitions – and super prizes – watch this column.

IAN RIDPATH

Did Life Once Exist on the Moon?

Although the first lunar samples proved sterile, chemist ALISON BROWN argues that quarantine is still vital for future specimens

NASA's multi-million pound astronaut quarantine facilities, built into the Lunar Receiving Laboratory at Houston, were rendered largely superfluous by an incident that happened thousands of miles away in the Pacific. Minutes after splashdown of Apollo 11, a hulking frogman wearing a Biological Isolation Garment – and hence known as the BIG swimmer – approached the capsule, sprayed it with disinfectant, and opened the hatch.

He handed the astronauts inside three BIGs, and hurriedly shut the hatch again. When the three men had donned the garments, the hatch was opened again while they clambered from their capsule into the waiting raft. The outside of Apollo was treated with germ-killing fluid once more, and then the astronauts and the frogman took turns to scrub each other down. After the three astronauts had been winched up into the recovery helicopter, the raft they had been sitting in was sent to the bottom of the Pacific.

Of course, none of the Apollo 11 crew had actually touched the Moon. Armstrong and Aldrin wore bulky suits for their Moonwalk. These they carefully dusted off before getting back into the lunar module, finally discarding them once safely in their normal pressure suits. But some Moon dust – and presumably also Moon bugs – still could have been carried into the lunar module on the Moon suits or on the outside of the sealed rock sample boxes. And although they cleaned themselves and the equipment before transferring back to join Collins in the command module, either astronaut could already have breathed in some Moon germs and become infected.

The air filter system in both Eagle and Columbia should have accounted for any free-floating nasties, but there was just a chance that it wouldn't. NASA's last line of defence – the disinfectant spray – was designed to catch any remaining bugs that might choose to rush out with the escaping air once the hatch was opened on Earth. But what good terrestrial germ-killer would be against organisms from a totally different environment is anybody's guess. If the

bugs could get out of the capsule, they could get onto the raft. So sinking that was a singularly useless procedure. Not long before splashdown, the captain of the recovery vessel *Hornet* voiced the fears of those who thought that NASA was being lax in its precautions. The good captain asked NASA: 'If I am downwind of the capsule when the hatch is opened, will my ship be contaminated?' The surprised space administration thought deeply before answering with a firm: 'No.'

The original plan (see *Hermes*, October 1968 page 86) had been for the astronauts to wait in the sealed capsule until it was safely on board *Hornet*, when a much safer method of crew transfer could have been effected. NASA commissioned, and rejected, a report that recommended far stricter quarantine procedures than those eventually used. The only reason can be that the space agency simply did not believe that germs of any kind could exist on the Moon.

This belief was based on the Moon's lack of air and surface water, and the ceaseless bombardment by high energy particles from the Sun. Even if the Moon did have a temporary atmosphere that allowed complex molecules to build up, they would almost certainly have been destroyed again by short wave solar radiation and the solar wind once the protective gas layer escaped into space.

There is no mystery as to the origin of life. Wherever conditions are right, it seems, non-living matter will eventually form itself into living matter. The same kinds of atoms are involved; the only difference appears to be in their arrangement.

While the detailed processes by which life originated on Earth are still uncertain, the main outline is at least clear. Several thousand million years ago, well before the time of the oldest known fossil remains (500 million years ago), complex and self-reproducing molecules began to build up in the oceans that condensed on the cooling Earth. The process was slow, the main catalysts being electric storms and small quantities of ultra-violet light from the Sun.



NASA

Lunar rilles near the 16-mile diameter crater Triesnecker in the Sinus Medii. Whether formed by water or not, they will provide a revealing look at the sub-surface layers of the Moon

No free oxygen existed in the primeval atmosphere that formed from volcanic degassing of the Earth's crust. The main constituents were water (H₂O), carbon dioxide (CO₂) and nitrogen (N₂), with some free hydrogen (H₂), hydrogen chloride (HCl), hydrogen sulphide (H₂S) and carbon monoxide (CO), but not ammonia (NH₃) or methane (CH₄) in any quantity. The warm, dilute 'soup' of the newly-formed oceans gave the molecules a chance to collide and aggregate. Some of them were probably as complex as amino acids, the building blocks of proteins; and it is interesting to note that even the simple experiment of passing an electric arc through a mixture of 'primeval atmosphere' constituents will produce such organic molecules with ease.

Those aggregations of molecules which were stable grew at the expense of the ones that were not – a natural selection process. A simple molecule, capable of reproducing itself – a fore-runner of DNA – must have been the next step. This primitive 'cell,' not yet alive but still more than a molecular complex, would begin to feed on the 'organic soup' around it. The compounds would be broken down, assimilated into the cell and CO₂ released into the atmosphere.

Much later, when these early cells could be

termed primitive life forms, the process of photosynthesis evolved as a result of the increase in CO₂ and the depletion of the organic soup. Plants use the process of photo-synthesis to 'inhale' carbon dioxide and 'exhale' oxygen – the opposite of the human breathing cycle. As the number of plant-like creatures increased, oxygen built up in the atmosphere until finally some life forms began to use oxygen for breaking down their food. This was the first step towards animal life.

Although such conditions do not exist on the Moon at present, it is just possible that at some stage in the past life may have had a chance to develop. Opinions differ on whether the Moon ever had an extensive atmosphere, but recent calculations by Menzel indicate that a lunar atmosphere may have lasted for some tens of thousands of years. In this case, the famous 'sinuous rilles', of which Schroeter's Valley near Aristarchus is a prime example, may well be ancient river beds, a possibility which lunar scientists regard quite seriously.

Thus the processes of life may have begun in and around the rilles, and we might expect to find the basis of life – carbon – along the edges of these channels. The report of carbon in the Apollo 11 lunar samples has been dismissed as due to contamination. The largest percentage of carbon found so far amounts to only 10 parts per million, a quantity explicable by handling with rubber gloves. Obviously, to prove or disprove the presence of organic molecules will require ultra-careful handling of samples from other areas, particularly the rilles.

It is still possible, although unlikely, that conditions on the Moon produced life forms which burrowed underground as things got progressively worse on the surface. But more likely, we will find inert complex molecules below the surface, precursors of life that was unable to emerge because of the deteriorating condition. Although this in itself is a slim chance, we should be careful not to take Earth organisms to the Moon and thus destroy the chances of such a nerve-tingling discovery.

Similar arguments can be applied to Mars. Here, it seems likely that early conditions could have led to the formation of complex molecules

and primitive cells before the loss of air and water caused a halt or change in the pattern of evolution. Assuming that Mars is essentially similar to Earth, the processes that may have begun would bear a great resemblance to the chemical and biological evolution of our own planet. But, like the Moon, the conditions on Mars did not stay stable long enough for advanced life forms to develop. Just how far the life processes reached and whether their evolution was halted or merely diverted are questions for the future.

While it is a hostile environment so far as the higher forms of life are concerned, Mars may well have developed and be supporting lower life forms. Experiments have shown that some terrestrial bacteria can survive in near-Martian conditions. How much more chance of survival would an organism have if it actually developed under those same conditions?

Mariner 4 showed Mars to be similar to the Moon. Mariners 6 and 7 confirm this view while raising other questions. Not the least of these is the absence of atmospheric nitrogen, generally supposed to be released on Earth by volcanic activity. Is it locked up in the soil in some way – perhaps as nitrates? If so, does this presuppose organic activity of some kind?

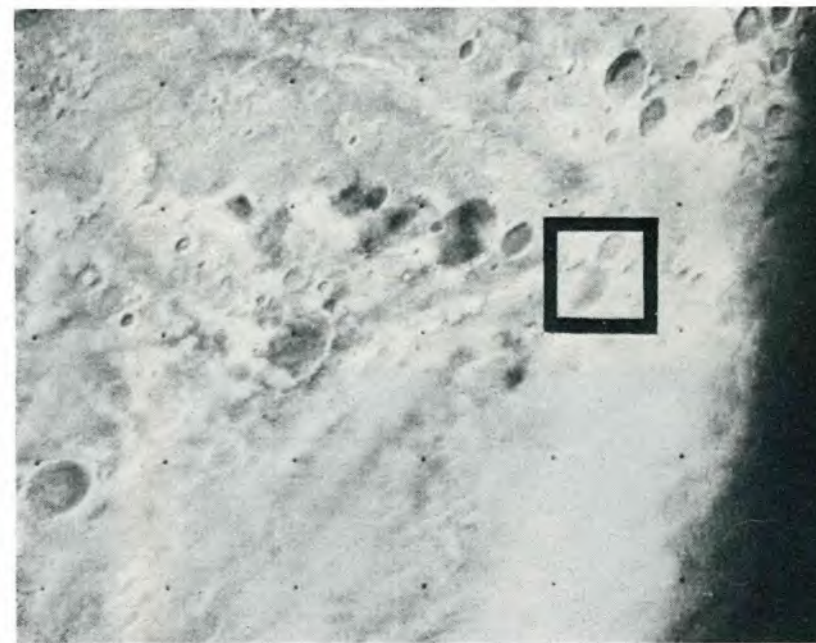
Temperature measurements suggest that the southern polar cap is made of solid CO₂ with

perhaps some ice. Near the dark rim of this receding cap the latest Mariners have found infra-red absorption lines which could be due to NH₃ (ammonia) and CH₄ (methane). CH₄ is only found on Earth as a result of organic decomposition and is not a product of volcanic activity.

The evidence, however, is very tenuous. Even plant life on the large scale envisaged several years ago seems unlikely after the barren landscape shown by the Mariner pictures. The tenuous atmosphere of the planet – what we on Earth would call a vacuum – is no protection against the Sun's death-dealing rays. All we have to go on is the slender hint of the absorption lines seen by Mariner, our theories about the origins of life and an unscientific optimism that is seemingly always applied to this topic. As various authors have said, we *want* to believe that life exists elsewhere in the universe.

We may find life on Mars, life in its lowliest forms. We may find only fossils or carbonaceous material – the remains of life that never had a chance to get started. In either case, it will be no let-down. In fact, it may be of more importance than discovering a whole tribe of Martians. For the discovery of primitive life-forms on Mars may well give us a clue to the solution of the problem that has occupied man for centuries – the problem of the origin of life itself.

'The first sign of life on Mars,' quipped a scientist at the Jet Propulsion Laboratory in Pasadena as the footprint-shaped crater (in square) appeared on this Mariner 7 picture of the Martian south pole. Unfortunately, it may be the only sign . . . for after closer study of the readings sent back by his infra red sensor, Dr George C Pimentel admitted that the spectral 'fingerprint' which Mariner saw was not caused by methane and ammonia after all. Laboratory tests have shown that the same result is obtained from a thick layer of solid carbon dioxide. However, it was confirmed that the Martian atmosphere does contain a minute quantity of water vapour. Also shown on this frame taken from 2500 miles away are snowed-over craters and the dark line of the evening terminator



IAN RIDPATH reports on the preliminary analysis of Moon rock in America and gathers the opinions of British scientists about

What Came Back from Tranquillity

ACCORDING to the analysis of lunar samples brought back by the Apollo 11 astronauts, the surface of the Moon has laid undisturbed for much longer than many scientists imagined. The first dating of Moon rocks shows that in the region of Mare Tranquillitatis where Armstrong and Aldrin landed, no lava flows or giant impacts have disturbed the surface for over 3000 million years. It is now being speculated that rocks due to be brought back from the lunar highlands on later flights may be as old as the solar system itself.

The dating was done by Dr Oliver Schaeffer, a geochemist from the State University of New York. He looked at the amount of potassium in the lunar rocks and compared it with the amount of argon present. Because potassium decays into argon at a known rate, the age of the material can be calculated. The amount of potassium Schaeffer found was one tenth of one per cent by weight – a tiny amount, indicating that the age of the rocks was 3.1 thousand million years, plus or minus 200 million years. If there is an error in this measure, says Schaeffer, it is because some argon may have been lost, causing an underestimate of the sample's age.

Dr Schaeffer also found a large amount of gases, such as hydrogen and helium, which are due to bombardment of the lunar material by the solar wind. Only in the centre of rocks was no evidence of bombardment found. The abundance of elements formed by solar wind and cosmic ray influx leads scientists to the conclusion that the rocks now on the surface of Tranquillity Base have lain there for between 10 and 106 million years. 'Perhaps,' speculated Professor Harold

Urey, 'the rocks we see sticking up above the surface now haven't changed much since they were formed'. This means that the 'churning' effect of the lunar topsoil by micrometeorite impact is not as severe as had been suspected.

The extreme age of the mare material, combined with the relatively large amounts of rare elements like titanium, chromium and zirconium that it contains, seems to close the door on the theory that the Moon and Earth were once part of the same body. Australian scientist Dr Ross Taylor says that, while the lunar composition is just not like that of the Earth, the difference is not as great as we might expect if the Moon had formed separately in some far-off corner of the solar system and since been captured. He therefore believes that the Earth and Moon formed side by side at about the same time.

Dr Taylor performed the first chemical analysis of the lunar samples, identifying about 60 elements ranging from aluminium to magnesium. The overall composition is similar to that given by the relatively crude equipment on board the automatic Surveyor 5 soft lander which came down about 20 miles from the Apollo site. Although Surveyor indicated a chemical make-up similar to types of Earthly volcanic rock, the more accurate measures made by Taylor show that there are great differences in detail. On 4 August, when the second sample box containing 40 lb of specimens was opened, NASA geochemist Dr Jeffrey Warner confirmed that some of the rocks differ completely from types found on Earth. Scientists confessed themselves unable to account for the lunar surface composition.

Moon rock has provided evidence that both volcanic and impact processes have been at work on the surface. All the rocks scooped up by the Apollo 11 astronauts on their July 21 Moon walk were found to be still covered in black dust when the two sample boxes were opened at the Lunar Receiving Laboratory in Houston. The first to be cleaned off was a 43-ounce specimen that was described as being a granular igneous rock. Like most of the other rocks, it is grey-brown in colour. Even the champion of 'cold Moon' theories, 76-year-old Professor Harold Urey, was

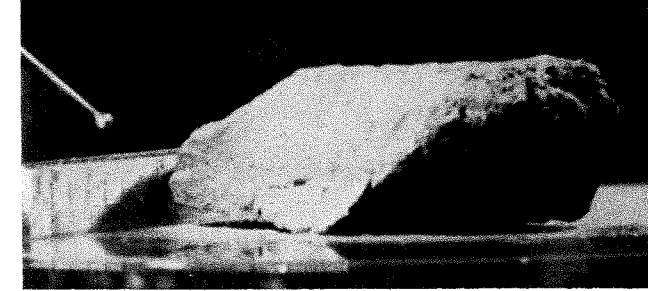
First man on the Moon Neil Armstrong digs for the first rock specimen from another world

Among the first Moon samples to be examined was this 7.5 by 5 by 2.5 centimetre volcanic rock

heard to wonder out loud whether he should change his opinion. Geologist Dr Eugene Shoemaker commented that he felt there was 'overwhelming evidence' of volcanic rock and lava flows on the Moon. It now seems that scientists such as Shoemaker who theorized that the Moon once poured out molten rock from a hot interior were right, even though their time scale was very wrong. Shoemaker, for instance, had believed that the mare surfaces were only about 500 million years old.

Evidence of tiny meteorite impacts abounds on the lunar surface. Formation of the lunar regolith (soil) seen on the Surveyor pictures and sampled by Apollo 11 has long been attributed to such impacts. The countless pits seen on lunar rocks brought back to Earth are rimmed with glassy material. Multicoloured glass beads make up fully 50 per cent of the 'dust' collected on the Moon's surface. 'These microscopic spheres of glass are remarkably lustrous and their surface is smooth,' remarks mineralogist Clifford Frondell of Harvard University. Almost certainly, they are the by-products of meteorite erosion, the heat of impact melting the lunar rock in a fine spray. The varied chemical composition of these spheres, says Frondell, indicates that they originated at differing locations on the Moon.

But some much larger splashes of glassy material were seen and photographed by Armstrong and Aldrin. Indeed, the slipperiness of the surface that the two astronauts reported is thought due to the fact that they were walking not only on the spheres but also on thin crusts of glass several inches across. This is evidence



for impacts on a crater-forming scale. Additionally, many of the lunar rock samples show evidence of shock, indicating that they were blasted out of the lunar surface by meteorite impact.

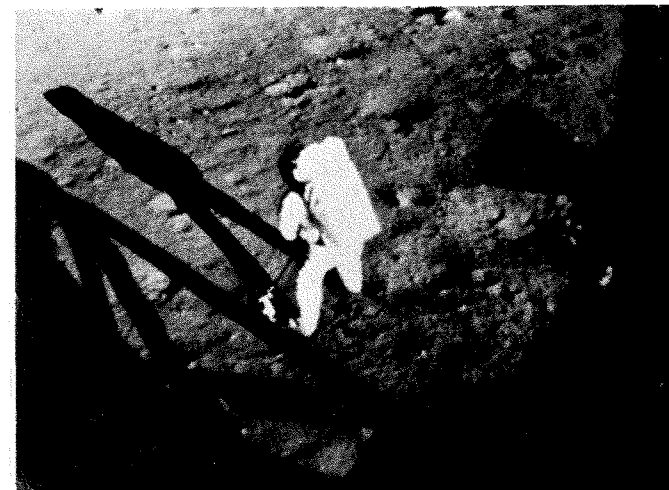
Dr Thomas Gold, the man who scared space agency officials by predicting deep dust drifts on the Moon, amazed the scientific community again at the end of September when he offered an alternative hypothesis for the splashes of glass. They are, he suggested, areas that were scorched when the Sun flared up to 100 times its present brightness, possibly after collision with a comet. The event probably only lasted between 10 and 100 seconds, according to his calculations; and because the mirror-like crusts still maintain their sheen in the face of continual micrometeorite bombardment, the event must have taken place within the last 30 000 years.

He speculates that an entire hemisphere of the planet Mercury will have been seared by the blast, but rather than wait for a probe to that planet he says he will be satisfied that he is right if the Apollo 12 astronauts discover glazing of the same age at their landing site far from Tranquillity. Gold also uses this theory to explain why Saturn's satellite Iapetus appears seven times brighter on one side than the other. The atmosphere of both the Earth and Mars may have been partially swept away by the giant flare, thinks Gold. This could account for the lack of nitrogen in the Martian atmosphere.

What of lunar life? Unfortunately for those who consider the Moon may once have held atmosphere, the preliminary examination team at the Lunar Receiving Laboratory found no evidence of erosion by surface water. Neither was any evidence found of lunar organic matter. The small amounts that have been reported are accounted for by contamination during handling and storing. More significantly, the preliminary examination of the samples included microscopic studies to try to find any living, previously living or fossil material. 'No evidence for any such material has been found,' reported the Lunar Receiving Laboratory team.

However, one fascinating result of tests performed in quarantine at the LRL is that certain terrestrial plants grew greener and hardier in lunar dust than Earth dust. The Earth soil was

Opening the first lunar samples box on 27 July, scientists got this view of Moon rocks





Dr E A King uses tweezers to extract a Moon rock from the first Apollo samples box

made up from various samples mixed to simulate the supposed composition of lunar material. Results from Apollo 11 have enabled a more accurate mix to be prepared for future samples. Such advanced plants as tobacco, lettuce and pine grew vigorously in the presence of Moon rock. Exactly why this should be remains a mystery, but scientists were adamant that no abnormalities had developed during biological testing and thus they felt justified in releasing the lunar samples.

A total of 264 mice, reared in the germ-free conditions of the LRL, were injected with a solution containing crushed lunar soil and then subjected to a rigorous autopsy. As expected, no signs of infection were found. Other biological specimens exposed to Moon dust included tissue cultures from human embryos, which would be expected to react violently to any alien organism. Absolutely no reaction was found to the lunar specimens, and scientists had no hesitation in giving the Apollo 11 rock collection a clean bill of health.

One of the most soul-destroying experimental programmes on lunar rock will be carried out by Dr Vance Oyama of NASA's Ames Research Centre, California. Using hundreds of different environmental conditions, he will incubate lunar material for up to a year in an attempt to grow micro-organisms such as bacteria and molds. Vital though they are, his efforts will almost certainly be in vain.

Interpretation of readings sent back by the seismometer left at Tranquillity Base are open to some dispute at the moment. As soon as it

was set up and switched on it began to radio back to Earth tremors caused by the Moonmen's footsteps. But even after they had blasted off to rejoin Collins in the Command Module above, strange signals continued. These were attributed to degassing of the Lunar Module's engine. Then, over the next few days, came several large surface waves which experimenters Dr Gary Latham and Dr Maurice Ewing of the Lamont Geological Observatory, New York, considered were due to Moonquakes. Early reports quoted Dr Latham as saying that the Moon had a solid crust over a hot interior.

But the signals never repeated themselves. Drs Latham and Ewing now believe that something funny was happening to the seismometer's electronics to cause spurious signals. Despite this, the seismometer recorded over 100 faint rumbles on the lunar surface that could well be due to tiny landslides down crater walls. 'The seismologists,' says a NASA statement, 'may be observing the initial stages of the process by which fresh new craters are transformed into old.'

Latham's latest conclusion, reversing his original speculation, is that 'the interior of the Moon is not like the interior of the Earth.' The tremors that the seismometer has recorded are not at all like the signals seen from terrestrial seismic sources. These more recent recordings are very different from the electrical noise that gave rise to the first cry of 'Moonquake!' Latham explains the strange nature of these signals by supposing that the Moon has a solid, shattered interior. He pictures the Moon as a brittle ball cut by deep fractures, the sub-surface wounds of ancient meteorite strikes.

After receiving their first batch of lunar samples, scientists in Britain were far more guarded than their American counterparts in making comments on the Moon's history. 'Drawing conclusions from one spot is being dotty,' said Professor S Tolansky of London's Royal Holloway College. Dr S O Agrell of Cambridge University agreed. 'This is like telling the history of the Earth from a piece of rock picked up in Cambridge,' he said.

Unlike Ross Taylor in America, physicist Tolansky is encouraged by the great age of the lunar rocks in his belief that the Moon was once a part of the Earth. He also predicts that when astronauts land in impact craters such as Copernicus, they will find not just small glassy splashes but great glazed sheets, miles in diameter. These crusts, he considers, remain invisible from

Britain's Bit

THREE and a half ounces of precious Moon dust were presented to British scientists on 19 September by Dr S O Agrell of Cambridge University and Dr P E Clegg from Queen Mary College, London. They had been to collect the samples from the Lunar Receiving Laboratory at Houston, Texas, as soon as NASA experts had released them from quarantine.

Although this first consignment makes up one-third only of the amount that Britain's scientists have been allocated, no one was taking any chances of a Moon theft. Dr Agrell kept the bag containing the samples at his feet during the flight across the Atlantic, and two policemen were present when the Moon dust was unveiled to the Press in London and given to the scientists NASA has chosen to study it. Two researchers taking their share up to Edinburgh University swapped the precious cargo between them to foil would-be attackers, and finally arrived with the sample wrapped up in a pair of pyjamas.

At Queen Mary College, photographers were escorted blindfold so that no one should know the whereabouts of the room in which the specimens were being examined. And a succession of security guards stood alert at the Geological Museum where 10 grams of Moon stuff were on display. In all, 14 British scientific groups were allocated samples from the first batch. Future consignments will include small rocks and slivers of Moon stuff specially prepared for the experimenters.

Britain has obtained more Moon samples than any country outside the United States. What do the scientists hope to do with their precious cargo? Professor Tolansky is looking at the surface structure of the rock to see if there are any indications of shock patterns, caused by the impact of meteorites. If the Moon ever had an atmosphere, he may also see tell-tale erosion marks. And bearing in mind that tiny diamonds are to be found around impact craters such as in Arizona, he hopes to see traces of diamond in the Moon rock.

At Newcastle University, Professor S K Runcorn's team are to look for traces of a magnetic field that the Moon may have possessed in the past. Iron particles in the Moon samples will still be magnetized in the direction of any long-gone lunar magnetic field.

Trying to solve the problem of past life on

the Moon is a group from the University of Bristol led by Dr G Eglinton. Their sensitive apparatus, carefully sealed to prevent contamination, should show up traces of earthly molecules brought to the Moon by the astronauts and their fiery chariot. But it may also detect the old and battered molecules of life forms that began to shape themselves on the hostile Moon. For this work, they will eventually receive a specially large allocation of Moon dust - 3½ ounces, more than twice as much as anyone else in Britain.

Several experimenters will be looking at tiny chips of the Moon through microscopes to identify the minerals that are present. If the rocks have been heated or strained in the past, this should be apparent from the state of the minerals. And to find out if anything's been missed, other researchers will use various analytical techniques to sift the Moon's composition down to the finest traces.

One researcher determined to discover the exact age of the Moon samples is Dr G Turner at the University of Sheffield, who has perfected an extremely reliable method of dating rocks. His results should be considerably more accurate than the NASA ones - so there may be some surprises to come yet from those lunar samples.

Over 30 000 people queued for up to an hour outside London's Geological Museum one weekend to see this sample of Moon dust. It would fill two or three egg cups, and weighs about ½ oz.



Russia Sets Her Sights on the Moon

Daily Mirror science correspondent ARTHUR SMITH surveys the Soviet lunar programme – and predicts manned flights to the Moon

WITH the successful landing in the Sea of Tranquillity in July by Apollo 11, it can truly be said that a new phase in the exploration of the Moon has begun.

For the Americans, it will be a case of consolidating their success and expanding the scientific content of future missions. This will inevitably lead, I believe, to the establishment of a permanent manned base on the Moon in the second half of the seventies.

But we must not forget that there is another major power engaged in a dynamic, if rather enigmatic, programme of lunar exploration.

The Soviet Union's efforts in this field have naturally been rather overshadowed by the success of Project Apollo. But ever since Lunik, now generally known as Luna 1, was launched in 1959, Russian space scientists have been actively pursuing the study of our natural satellite.

In retrospect, it can now be said that their efforts have obviously been handicapped by primitive guidance concepts and hardware, untrustworthy upper stages, crude photographic techniques and an uncertain tracking network. At the same time, this should not be allowed to detract from their achievements. For it is only by comparison with the fantastically complex and sophisticated US hardware that the Soviet equipment appears outdated, crude and poorly designed.

In any other context the Soviet programme of lunar exploration has been remarkably successful and fruitful. Given an unlimited research and development budget and the same sense of a national goal, it is debatable whether UK science and industry could have accomplished as much in a comparable period.

Before speculating on the future of Soviet Moon exploration, it is instructive to consider the past.

Luna 1 was the first of three probes launched

The setting Earth, taken by Zond 7 on 11 August 1969 as it swung behind the Moon at a height of 1250 miles. Africa is to the left and Australia to the right of the globe

from Tyuratam in 1959, obviously all using the original version of the standard Soviet rocket. This was the period when the Americans were desperately trying to catch up in space, and even the fact that Luna 1 missed the Moon by 3750 miles was no consolation, for it went on to become the first artificial satellite of the Sun.

Luna 2 impacted near the crater Autolycus eight months later – the first direct hit on the Moon. And Luna 3, in October, completed an auspicious treble by photographing the far side of the Moon, somewhat crudely, and returning the picture to the Soviet Union before burning up in the Earth's atmosphere.

These three pioneering craft were all light – between 600 and 860 pounds – and the standard launch vehicle was able to send them to the Moon in under 36 hours. In a sense, they were all propaganda vehicles, for the scientific gain was slight, although the planners must have gained a great deal of operational experience from them.

When it came to the next generation of Luna vehicles, after a gap of over three years, there had to be a 'trade off' between payload weight and flight time.

For any given rocket there is a minimum flight time to the Moon – but in that case the payload is a minimum too. To increase the payload without increasing the overall size of the rocket, it is necessary to arrange burn times in such a way as to maximize the flight time.

In the case of Apollo 11, for instance, it was arranged that the time from translunar injection to lunar orbit insertion was 73 hours 10 minutes. The Saturn IVB can theoretically send an Apollo spacecraft to the Moon in a considerably shorter time, but not if it has the operational Moon-landing weight of 100 000 lb.

The Soviet planners, wanting to put as much instrumentation into their lunar probes as possible, arranged flight times going up to 86 hours for the second generation of Luna craft.

Ignoring the several that failed to leave Earth

A Zond 7 photograph of part of the western limb of the Moon taken from a height of 7000 miles. Craters shown are: 1 Russell. 2 Struve. 3 Eddington. 4 Briggs. 5 Cardan. 6 Cavalerius. 7 Hevelius. 8 Riccioli. 9 Schluter. 10 Hartwig. 11 Vasco da Gama. 12 Einstein (otherwise Caramuel – see Hermes April 1966 p 75). 13 Moseley. 14 Balbao. Mare Orientale (see Hermes October 1967 p 164) is off this picture to the lower left

orbit, and even failed to reach Earth orbit, I include Lunas from 4 to 14 in the second generation. There is a great deal of evidence that they were all based on the same 'bus', as the Americans call it, with a payload package on one end, varied to meet the mission requirements.

In the American case the philosophy has been to design Moon vehicles completely independently so that, for instance, the Lunar Orbiter bore no family resemblance to the Surveyor. On the other hand, by using the 'bus' concept, the Russians were able to save vast development sums and, equally important, several months in time. This, and the possession of a booster large enough to put a ton and a half into the vicinity of the Moon, accounts for the Russian success in achieving 'firsts' in Moon exploration.



Thus, Luna 9 was the first soft landing craft – although I feel the idea of a rugged, well-protected sphere being ejected from the bus just before impact was probably derived by the Soviet Union from the widely publicised, but never successful US plans to put such a sphere into a Ranger.

Luna 10 was the first lunar orbiter, although it did not possess the American capacity to take photographs of the Moon.

All these Lunas can be grouped together by their time of launch as well as by their weight and general configuration. In every case the Moon was between 7.8 and 12 days old at the time of launch, and most were between 8 and 10 days. It is evident from the impact points of those Lunas that have landed that the reason for this is that the Russians have a particular interest in the western hemisphere of the Moon, and choose arrival times that coincide with appropriate illumination of the hemisphere.

But when Luna 15 was launched on 13 July 1969 the Moon was 28 days old – the first Soviet Moon probe ever to be launched at that phase in 10½ years of flights. And, as one might suspect, there was something strange about the probe as well as the launch date. It went into orbit round the Moon, with a low apolune and perilune and an inclination of 126 degrees to the equator. The characteristic long flight of a Luna was even greater in this instance – 102 hours 53 minutes.

However, this was not a typical Luna. It had a propulsion system which enabled it to change plane as well as altitude and it is fairly clear that an attempt was made to soft land it, probably no farther west than the Sea of Tranquillity, on which the Apollo 11 astronauts were resting after their Moon walk.

According to Sir Bernard Lovell, the engine fired for only four minutes before Luna 15 crashed in the Mare Crisium at several hundred miles an hour. Until we get the full story from the Soviet Union, if we ever do, it will be impossible to reconstruct the last few hours of Luna 15.

But it seems at least possible that a very Apollo-like landing was being attempted and failed. That is to say, the engine burn which the Americans call Descent Orbit Insertion, or DOI, was correctly carried out automatically on the far side, the descent orbit with a low perilune began, and the 'powered descent' began, with the engine firing again on the near side of the Moon.

In the Apollo the orbital speed of the lunar module is cancelled out by a burn of the descent

Newsflash: On 23 September 1969 the Soviet Union launched its 300th artificial Earth satellite in the Cosmos series

engine lasting 12 minutes. If my analysis is correct, and a similar manoeuvre was being performed with Luna 15, it is inconceivable that a powered descent as brief as four minutes was planned, and it appears that the descent engine must have shut off prematurely for some obscure reason.

If this is so, the question remains as to the mission of Luna 15. I have come round to the view, after initial doubts, that it probably was an attempt to return lunar samples after all. In the absence of any information about the total craft's weight it is impossible even to guess at the size of the Earth re-entry capsule, but it would probably be extremely small. It may have been that two or three years ago the Russian space planners, realizing that the Apollo project was going to upstage the Soviet Union's own Moon landing plans, decided on a face-saving project to bring back samples automatically. If so, the plan misfired badly – in the very week when Armstrong Aldrin and Collins brought back those expensive rocks from Tranquillity Base.

Further attempts of the Luna 15 kind may be made, but the Soviet Union has not abandoned plans for a manned lunar landing. While the Luna name has been applied to only two craft in the last three years an apparently much more ambitious programme has been running in parallel.

The first three Zonds, launched in 1964-65, should not be confused with the last four. They were evidently planet-oriented, were roughly comparable with the Lunas or with the Venera spacecraft and had no biological bias.

In contrast, it is quite clear that Zond 4, 5, 6 and 7 were related strongly to the Moon programme of the Soviet Union and the last three all contained pressurized compartments for biological specimens.

These three were all launched when the Moon was 22 days old – another new departure – and so arrived at the leading edge of the Moon in a free return trajectory when the Sun was setting over the Ocean of Storms. This would be a reasonably good time for photographic reconnaissance of a landing site there, although not a perfect one, but it would hardly make sense as an unmanned rehearsal for a later landing.

Apollo 8 was a carefully timed rehearsal for Apollo 10 and 11 in the sense that it arrived over Landing Site 2 with the same lighting conditions that were encountered in the two later missions. If, like Apollo 8, the Zond flights have incorporated only command and service modules of a three-module craft, it hardly seems logical to choose sunset as an arrival time. Men landing in the Ocean of Storms at the Moon age suggested by these three circumlunar flights would soon be overtaken by darkness.

However, that the Zond spacecraft is an important part of the Soviet Moon programme is certain, especially as it seems to be in the five or six ton class and must therefore employ the biggest Soviet launcher, the Proton, to get it to the Moon. So far the highest animals reported by the Russians as being passengers in a Zond were the turtles of Zond 6, but I suspect that

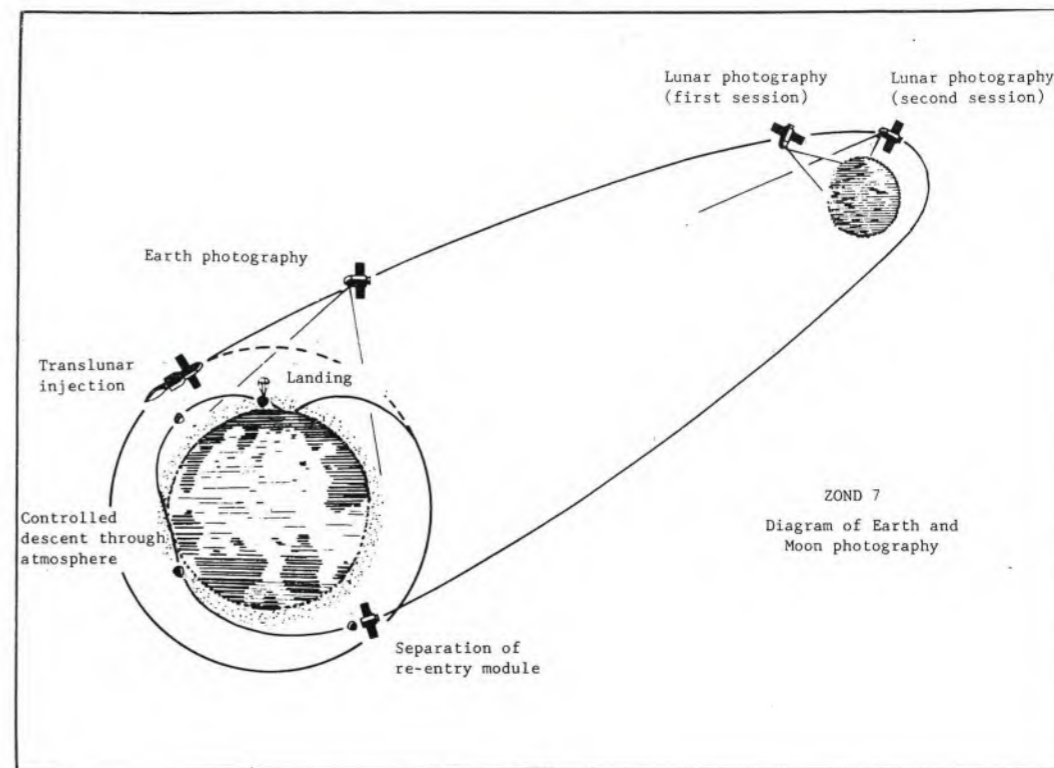
This Soviet drawing of the flight and landing of Zond 7 shows the craft to be similar to the manned Soyuz ships (see Hermes January 1969 p 15) only without the orbital compartment

Zond 7 in August had more important passengers – possibly a pair of dogs.

The silence about the animals on board may simply be another example of Russian taciturnity, or it may have something to do with the landing in Kazakhstan.

Whichever it was, I am sure that further Zond flights round the Moon will be attempted. The number of possible developments from the straightforward free return trajectory is very large – entry into lunar orbit and return is the simplest and a manned landing the most complicated, but there are others.

A manned free return trajectory flight is a distinct possibility, although it would not have quite the same impact that it would have had before Apollo 8, 10 and 11. The days to watch for further Zond launches, if the 22-day Moon is a mission constraint, are 3 October, 3 November, 1 December, 31 December, and so on into 1970, at 29 or 30 day intervals. But these calculations may be nullified if the Russians introduce Earth orbit rendezvous to build up a bigger spacecraft, or the much-forecast giant booster.



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Society Notices

SUBSCRIPTION RENEWAL. Those members who were due to renew in September are reminded that they will cease to be members of the Society and will receive no further benefits of membership if their subscription is still outstanding on 1 December. Rates are 15s for one year, or £1 with Circulars. Make money payable to the JAS and send to the Assistant Secretary. If you wish to pay by GPO Giro, the Society's account number is 58 000 0001. Members due to renew in March are advised that the January issue of *Hermes* is the last covered by their subscription.

JAS MEETING. The next meeting of the Society will be held on Saturday 25 October at Caxton Hall, London SW1. Programme: 14.00 to 14.30 Jim Hysom continues his beginners' talks. 14.45 to 17.00 Noted observer John Isles talks about variable stars; lunar expert Leslie Rae discusses the Moon; and Norman Wright gives the latest news in Sky Diary. Special note: from January onwards, meetings will be held in the Alliance Hall, 12 Caxton Street, London SW1. The entrance to Alliance Hall will be found in Palmer Street, next to Caxton Hall.

PHOTO SCHEME. Man sets foot on the Moon . . .

Continued from page 102

Earth because of a covering of dust. If Professor Tolansky is right, they may provide deadly dangerous skating rinks for unwary lunar explorers of the future.

At the University of London Observatory, geologist Dr John Guest agreed that 'it would be reasonable to say that the Moon rocks are lava from an eruption.' Although the magma outpouring could have been sparked off by a giant impact, Dr Guest thought it unlikely that the rock had been made molten by the heat of impact alone, as Harold Urey has contended. Where did the lava come from? 'In view of the unfamiliar composition, either from a Moon layer unlike the Earth's mantle; or it was produced by a process unknown on Earth,' Guest speculated.

Manchester University's Professor Jack Zussman confessed himself surprised at the lack of meteoric iron and nickel in the samples. In view of the abundant evidence for impact — even if only on the miniature scale — geologist Zussman says he would have expected many more meteoritic particles. One definite conclusion he did put

this historic moment, along with others, brought to you in colour by the JAS photo scheme. Exciting new additions to the slide selection bring JAS members highlights of man's conquest of the Moon. Also: amaze your family and friends by showing them colour slides of David Hardy's world-famous space paintings. For latest lists and prices, send a stamped, addressed envelope to the Photographic Section director, Geoffrey Pearce.

STAFF CHANGES. Keith Hindley, busily engaged in completing his doctor's thesis at Liverpool University, has left the directorate of the Meteor Section in order to concentrate better on his research work. Keith took over the section in early 1968 and steered it through the most successful 18 months since its inception. Robert Mackenzie, winner of the Fred Best award last October, takes over the section, while Martin Ince remains assistant director. An ambitious programme is planned, and with the excellent young observers who have arrived on the scene recently the JAS Meteor Section is quickly establishing itself in the forefront of British observational astronomy. Another section director who has had to leave because of University commitments is variable star man Geoffrey Cowie. After two years in the chair, Geoffrey hands over to John Isles, a respected variable star observer and a mainstay of the influential Binocular Sky Society. Not one to let the dust gather on his own binoculars, John is preparing to completely revise variable star thinking in this country. Join him.

forward was that if the glassy splashes found on Earth known as tektites originate in meteoric impacts on the Moon, then they don't come from the region of Tranquillity Base. He points out that the aluminium content of the Apollo 11 samples is far higher than in tektites.

Bearing in mind the similarity of the lunar rock analyses performed at three widely differing locations by Surveyors 5, 6 and 7, Professor Zussman is willing to speculate that Tranquillity may be typical of most of the Moon. 'The surprising thing,' he says, 'is that the results from the three Surveyors were so alike. However, samples from a crater floor or mountain peak could well be different.' At Cambridge University, Dr Agrell was thinking along similar lines, saying: 'It's quite conceivable that all the mare areas have approximately the same age — give or take 500 million years.'

But when all's said and done, what good will the rocks brought back by the Apollo missions do us? In the words of Nobel Laureate Harold Urey: 'If the Moon only gives us an ancient history of the Earth, then it gives us something that the Earth itself doesn't.'

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Mars Looks More Hostile Than Ever

Lunar scientist JOHN MURRAY comments on the Moon-like surface of Mars revealed by the results from the Mariner 6 and 7 probes

NASA has brought off another superbly successful feat with the Mars probes Mariners 6 and 7. The two hundred pictures returned are all of much higher quality than the Mariner 4 pictures of 1965, and cover a much higher percentage of the planet's surface. As Mariner 6 approached the planet, it sent back successively larger pictures of the whole disk, which in themselves are as interesting as the really close-up views.

In the first place, there is no sign of the 'canals,' which, had they existed, should have been easily visible at this resolution. Most knowledgeable workers on the planet had dismissed canals long ago as optical tricks or illusions, but it is useful to have such definitive evidence for the diehard canalists. Another interesting feature of the early views is the fact that the familiar light and dark markings, such as the Syrtis Major, Sinus Sabaeus and Cerberus, have no clearly defined edges, and as one approaches the planet, the edges of the dark regions become more and more blurred. It

used to be thought that the different colours probably represented mountainous and lowland regions, as on the Moon, but now it seems that highlands and lowlands are found in both light and dark areas.

When the really close-up pictures began to come through, it was no surprise to find craters like those Mariner 4 had photographed, but it was surprising to find them so clear and in such large numbers. The analogy with the Moon is obvious, but it is more interesting to note the differences between Martian and lunar craters. In the first place, the size distribution seems to be different from the Moon. There appear to be far fewer small craters in relation to large ones, perhaps as one would expect, since the smaller ones would tend to be eventually filled in by atmospheric erosion. Secondly, the craters seem to be generally shallower and smoother than on the Moon, with a predominance of flat-floored craters. And thirdly, none of the craters appears

to have rays, all of which again points to blanketing and erosion by dust and the atmosphere.

Apart from this they do not seem to differ at all from the lunar craters, exhibiting similar high circularity, shallow outer slopes and steep inner ones, terracing, high diameter/rim-width ratio, plus a few central peaks. In view of these characteristics, I would suggest that they are mostly of impact origin, though of course this is only a personal view and certainly not supported by all authorities - particularly those in Britain.

The other spectacular pictures taken by Mariner 7 contain close-up views of the polar cap, including the border and the south pole. The extraordinary thing here is that the craters and other topographical features are visible in the middle of the polar cap, indicating that the polar deposit is very thin and discontinuous. At the edge of the polar cap, the sunward facing slopes are dark, whilst those in shadow are filled with the frosty deposit.

The infra-red instruments gave vitally important temperature readings over the south pole, indicating a temperature of -253°F . This is the freezing point of carbon dioxide. As one moves on to the cap there is an extraordinarily rapid drop in temperature in only 10 km. Mariner 6's

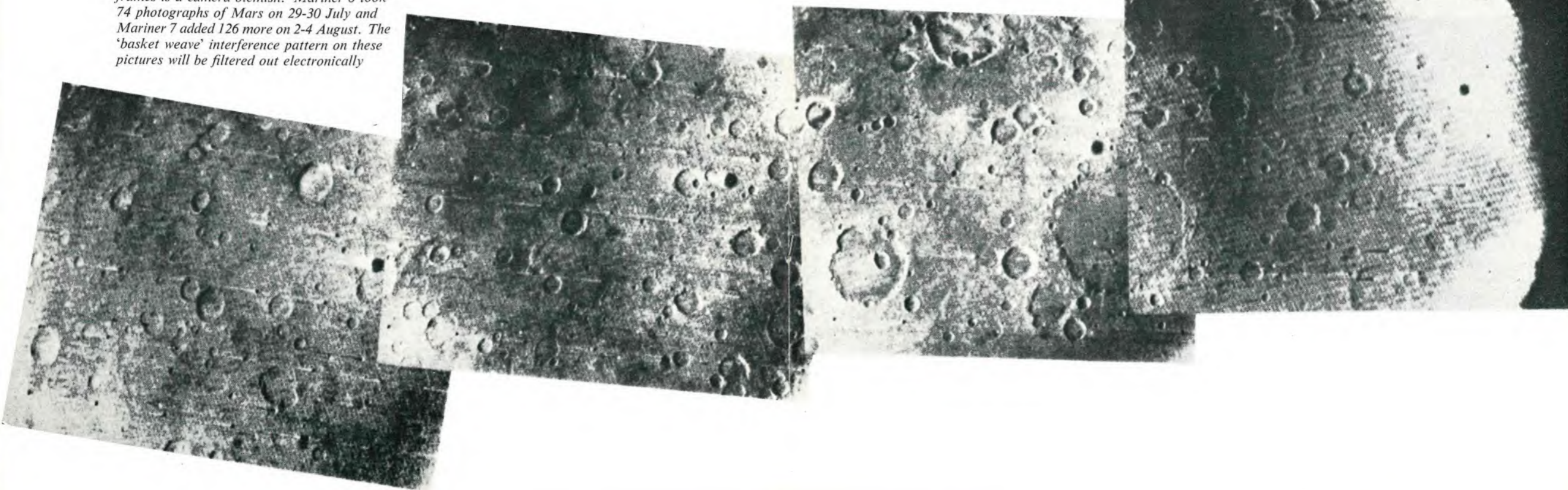
instruments also showed that the Martian atmosphere is composed largely of carbon dioxide, with scarcely any water vapour, so it seems that the polar caps almost certainly consist of frozen carbon dioxide. Though this explanation was first proposed at the turn of the century, it will come as a shock to many popular writers on the planet, not to mention the science fiction market.

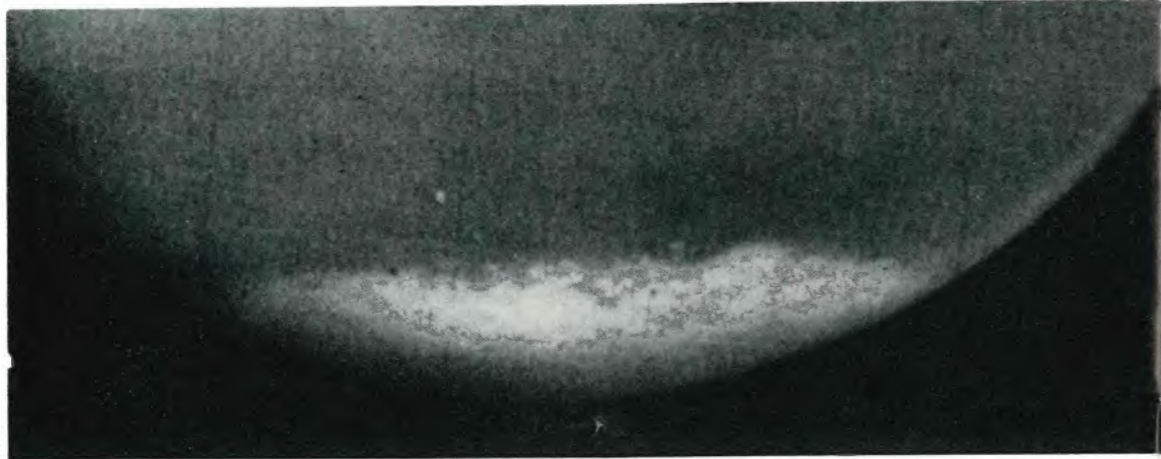
Both Mariners' results failed to detect any free nitrogen, which means that the presence of life forms is highly unlikely. Another factor against any kind of life is the fact that the ultraviolet instruments detected the penetration of lethal solar radiation through the extremely thin Martian atmosphere all the way down to the surface of the planet, which would destroy many of the important molecular bonds of the organic molecules necessary for life as we know it.

The lack of nitrogen also raises one other point.

Four overlapping views of Mars taken by Mariner 6 on 30 July as it swept towards the evening terminator. Taken at 84-second intervals, the pictures cover an area 450 by 2500 miles parallel to and about 15 degrees south of the Martian equator. The Mariner was about 2200 miles above the surface during the sequence

The dark spot that appears on each of these frames is a camera blemish. Mariner 6 took 74 photographs of Mars on 29-30 July and Mariner 7 added 126 more on 2-4 August. The 'basket weave' interference pattern on these pictures will be filtered out electronically





Volcanic processes on Earth are continuously venting nitrogen into the atmosphere, and the lack of nitrogen on Mars therefore points to a lack of volcanic activity. Certainly, this is highly unlikely, even though the huge craters shown are probably not volcanic. We must suppose that the nitrogen erupted was oxidized subsequently by the carbon dioxide into nitrates now in the Martian soil.

Finally, there is one real puzzle spot revealed by the Mariners – the region of Hellas. This is a huge, roughly circular area, about one thousand

When Mariner 6 was 202 000 miles from Mars it took this photograph of the jagged edge of the planet's south polar cap. A number of craters, the largest of them about 20 miles in diameter, appear along the edge of the cap

miles across, which has distinguished itself in the past to telescopic observers by its brightness, often being mistaken for the polar cap. The Mariners have shown it to be devoid of craters within the double scarps that mark its boundary. Either it is some recent asteroidal collision area, swept clean of older craters by one colossal impact, or else frequent lava eruptions obliterate craters soon after they appear. And if Hellas is the Mare Imbrium of Mars, the bright ring-shaped Nix Olympica is the Martian Mare Crisium. Mariner 7 photographs show it to be a giant crater over 300 miles in diameter.

So this is Mars as it really is. Gone are the purple skies at Martian dusk, with delicate Martians gently manoeuvring sandships along the dreamy canals. In its place is a planet retaining almost no atmosphere, water or life, swept by lethal solar radiation, frozen by impossibly low temperatures, and dotted with craters, craters everywhere.

This Mariner 6 picture of Mars was taken from a distance of 503 000 miles. The dark Syrtis Major is seen to the right, with the circular Hellas below it. In the centre of the disk are the dark features Meridiani Sinus and Sabaeus Sinus. The bright area at the top of the planet is the desert called Cydonia

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GREAT ASTRONOMICAL DISCOVERIES.
By SIR JOHN HERSCHEL, LL.D. F.R.S. &c.
At the Cape of Good Hope.

to further discoveries in our solar system. Several years, however, prior to the death of this great astronomer, he conceived it practicable to construct an improved series of parabolic and spherical reflectors, by which all the important points in the Gregorian and Newtonian instruments, with the highly interesting astronomical discovery of Holland, would, in a great degree, remove the formidable obstructions to optical science, and the most desirable property in instruments of observation; but, according to his own voluminous record, the exciting and important application. He was, the present Sir John Herschel, who had been named and created in the observatory, and a practical astronomer both in the field, who fully comprehended the value of the method, who discovered upon finding it at what cost. Within two years of his father's death, he completed his new apparatus and adapted it to the old telescope with nearly perfect success. He would require an ultra-violet speed of four miles an hour to reach the fixed star, to secure him a more favorable impression of the true luminosity of light. The interesting question, however, whether the light of the adjacent forest, of the treeless desert, and of the deep, blue ocean of earth, whether the object at the lofty turret, of the solitary eye, the deserted battle field, and of all the pictures of low and high of misery and despair, that have passed over the hills and valleys of the earth, through the eye of an unassuming being in the quiet solitude, and eventually death, presented any important application. He was, the present Sir John Herschel, who had been named and created in the observatory, and a practical astronomer both in the field, who fully comprehended the value of the method, who discovered upon finding it at what cost. Within two years of his father's death, he completed his new apparatus and adapted it to the old telescope with nearly perfect success. He

GREAT MOON HOAX

BATMEN have been seen on the Moon, read the newspaper report on 28 August. Public and scientists alike were startled but not incredulous. A mathematics professor from the University of Virginia stated publicly that he had no doubts about the truth of the story. For the newspaper involved was not the setting *Sun* of Britain but the thriving *Sun* of New York . . . and the year was 1835.

The man who pulled the wool over the nation's eyes was Richard Adams Locke, a young reporter specially interested in science who had not long previously emigrated to America from England. He joined the New York *Sun*, launched in 1833 with what was then a new style – sensational daily journalism. Locke's series of articles, supposedly reporting astronomical discoveries made by Sir John Herschel, constituted perhaps the greatest scientific hoax of all time. The Great Moon Hoax, as it came to be known afterwards, shot the *Sun* to the top of world newspaper circulation. On the day the story of the batmen appeared, the *Sun* sold 19 360 copies – every paper the presses could turn out in 10 hours' continuous running. The London *Times* was selling 17 000 copies at that time.

How was it that an entire continent could swallow this fantastic tale? Quite simply, because even professional astronomers of the day were very much in the dark about what we would now call fundamental knowledge of stars and planets. It was, for instance, the general opinion that the surfaces of all the planets were much like that of the Earth; in the words of Christian Huyghens: 'They may be stock'd with plants and animals as well as we.' Jupiter, for instance, was thought to have an atmosphere

BY OUR OWN REPORTER

of air and water, similar to our own, rather than the intensely cold hydrogen and helium we analyse spectroscopically today.

But it was not until 1845 that Gustav Kirchhoff discovered that each element emits a distinctive spectral 'fingerprint'. Doppler did not notice the effect now named after him until 1842; and the distance of the nearest stars remained a mystery until Bessel made his pioneer measurements of parallax in 1838. In such a vacuum of information even so great an astronomer as Sir William Herschel could suppose that, while the outer layers of the Sun are hot, the interior is cool. 'We need not hesitate to admit that the Sun is richly stored with inhabitants,' he wrote. Additionally, the famous mathematician Karl Friedrich Gauss strongly backed a plan to build vast geometric figures on the Siberian plains, by way of a signal to the lunar inhabitants that he was sure must exist.

Remarks such as these provided fertile soil for the scientific speculators of the day. One such free-thinking and prolific author was Dr Thomas Dick of Dundee, an influential contri-

butor to such magazines as the Edinburgh *New Philosophical Journal*. Among other amusing philosophies, Dr Dick's logic insisted that all planets were inhabited, otherwise the Creator would not have spawned them; and on this basis, he even went as far as to work out that the population of the solar system was 21 thousand million inhabitants.

One widely reported and genuine astronomical item of 1834 was Sir John Herschel's departure for the Cape of Good Hope to continue the work of his father, Sir William Herschel, in examining double stars and nebulae. This voyage was the cornerstone to Locke's great deception. Having allowed Herschel a respectable length of time to reach South Africa and set up his observatory, the *Sun* carried a short and little noticed report of a supposed article in the Edinburgh *Courant*, telling of the wonderful lunar discoveries that Sir John Herschel had made at the Cape with an entirely new design of telescope. Three days later on 25 August 1835 the bombshell burst. The *Sun* committed itself irrevocably to the Great Moon Hoax by splashing the story over the front page.

The articles came, they explained, from the Supplement to the Edinburgh *Journal of Science*, furnished to them 'by a medical gentleman immediately from Scotland.' One can perhaps see here a satire on the highly imaginative diet served up by Dr Dick of Dundee; certainly Locke's articles are masterpieces of style, laced with a scientific insight sufficient to make them almost credible today. After an ecstatic introduction, the *Journal of Science* explains: 'To render our enthusiasm intelligible, we will state at once that by means of a telescope, of vast dimensions and an entirely new principle, the younger Herschel, at his observatory in the Southern Hemisphere, has already made the most extraordinary discoveries in every planet of our solar system; has obtained a distinct view of objects in the Moon, fully equal to that which the unaided eye commands of terrestrial objects at the distance of a hundred yards; has affirmatively settled the question whether this satellite be inhabited, and by what order of beings; has firmly established a new theory of cometary phenomena; and has solved or corrected nearly every leading problem of mathematical astronomy.'

An amazing breakthrough – if it had been true. But the *Sun's* readers weren't to know for some while that they were being hoaxed; and neither did they realise that the Edinburgh *Journal of Science*, and its Supplement, were nothing more than a fiction of Richard Locke's fertile imagination.

Farther down the page, the story told in vivid

terms how Herschel had stumbled across the principle of his amazing new telescope, overcoming the frustrating limitations in magnifying power experienced by his father's otherwise superlative instruments. 'It is well known,' the article recounted, 'that the great reflecting telescope of the late elder Herschel, with an object glass four feet in diameter, and a tube forty feet in length, possesses a magnifying power of more than six thousand times. But a small portion only of this power was ever advantageously applied to the nearer astronomical objects; for the deficiency of light from objects so highly magnified, rendered them less distinct than when viewed with a power of a third or fourth of this extent. Accordingly the powers which he generally applied when observing the Moon and planets, and with which he made his most interesting discoveries, ranged from 220, 468, 750 and 900 times. . . . The law of optics that an object becomes dim in proportion as it is magnified, seemed, from its exemplification in this powerful telescope, to form an insuperable boundary to further discoveries in our solar system.'

Three years previously, the article continued, Herschel had been musing upon this problem with Sir David Brewster, 'and the conversation became directed to that all-invincible enemy, the paucity of light in powerful magnifiers. After a few moments' silent thought Sir John diffidently enquired whether it would not be possible to effect a *transfusion of artificial light through the focal object of vision!* Sir David, somewhat startled at the originality of the idea, paused awhile, and then hesitatingly referred to the refrangibility of rays, and the angle of incidence. Sir John, grown more confident, adduced the example of the Newtonian Reflector, in which the refrangibility was corrected by the second speculum, and the angle of incidence restored by the third. "And," continued he, "why cannot the illuminated microscope, say the hydro-oxygen, be applied to render distinct, and if necessary, even to magnify the focal object?" Sir David sprang from his chair in an ecstasy of conviction, and leaping halfway to the ceiling, exclaimed "Thou art the man!"

The stunning new principle, therefore, was to introduce extra light into the telescope to intensify the image. Of course, the analogy with the microscope which Locke uses is completely false, and he must have known this. But, having passed that tricky point with great conviction, the way was open to some of the most charming science fiction ever written. We learn immediately of the 'stupendous fabric' that John Herschel conceived for his new telescope – an object glass 24 feet in diameter (that is, 288 inches!). It would be achromatic, but

instead of using two separate lenses, an amalgam of crown and flint glass was to be used. The first casting, we learn, was a failure – the glass cracked badly on cooling. But the second try was immaculately perfect, and the giant lens was ready for shipment to South Africa, where it was mounted at Herschel's singularly complex observatory. This is described in the *Sun* on Wednesday, 26 August 1835.

Interestingly, the telescope was tubeless in design. The giant lens was supported by two pillars 150 feet high, and could be hoisted up or down by a capstan depending on the altitude of the object under scrutiny. The observatory building, a wooden hut 50 feet square with a 4-foot diameter hole to accept the light focused by the giant lens, could move towards or away from the two pillars holding the objective; and levers ensured that the lens was kept squared on to the observing hut as this happened. For tracking in right ascension, the whole assembly rotated on rails. With the instrument thus set up, Locke began a beautifully detailed account of lunar observations supposedly made through this preposterous telescope.

All sorts of vegetation, valleys and lakes on the Moon were described, as well as animals – herds of brown bison-like creatures, tailless beavers and long-legged birds. And then: 'The next animal perceived would be classed on Earth as a monster. It was of a blueish lead colour, about the size of a goat, with a head and beard like him, and a *single horn*, slightly inclined forwards from the perpendicular. The female was destitute of the horn and beard, but had a much longer tail. It was gregarious and chiefly abounded on the acclivitous glades of the woods. In elegance of symmetry it rivalled the antelope, and like him it seemed an agile sprightly creature, running with great speed, and springing from the green turf with all the unaccountable antics of a young lamb or kitten.' Needless to say, this issue of the *Sun* created a great deal of excitement.

Next day, more new types of animals and trees were described. But it was on Friday, August 28 that the batmen flew on to the scene: 'Certainly they *were* like human beings, for their wings had now disappeared, and their attitude in walking was both erect and dignified. They averaged four feet in height, were covered, except on the face, with short and glossy copper-coloured hair, and had wings composed of a thin membrane, without hair, lying snugly upon their backs, from the top of the shoulders to the calves of the legs. The face, which was of a yellowish flesh colour, was a slight improvement upon that of the large orang outang, being more open and intelligent in its expression, and having a much greater expan-

sion of forehead. The mouth, however, was very prominent though somewhat relieved by a thick beard upon the lower jaw, and by lips far more human than those of any species in the simia genus.'

This breathtaking story was interrupted now and again as the reader was informed how it was necessary to change to a higher power eyepiece or turn up the hydro oxygen burners to intensify the faint image. On Monday, 31 August, the *Sun* told how the observations came to an untimely halt when the astronomers, tired from an exciting night's observing, forgot to cover the telescope lens. During the day this acted as an enormous magnifying glass and focused the solar rays on to the observatory, causing it to be incinerated.

Rival newspapers reprinted the story, to satisfy what few of their own readers were left. According to one commentator, the only people who did not believe the story were those who never believed anything. One man claimed that the reprint of the Supplement article by the *Sun* was quite accurate, for he had a copy of the relevant *Journal of Science* himself. Another man reported that he had actually seen the great lens loaded on to Sir John Herschel's ship in England. And a women's club in Springfield, Massachusetts, considered whether it would be possible to communicate with the batmen in order to convert them to Christianity.

Two distinguished American astronomers, Loomis and Olmstead, were sent by Yale University to investigate. On trying to track down the original Supplement, everyone involved claimed to have just lent it to someone else. The two astronomers returned to Yale none the wiser and caught up with their work on Halley's comet. But in Europe, the story was less well received. In a debate on the subject, the French Academy decided that the story, 'tho not perhaps malicious, was utterly incredible'.

A short time later, Richard Locke admitted to a friend that he himself had been the author of the entire series. His friend, a reporter on a rival paper, was not slow to let New York know that the story they had marvelled at was in fact a hoax. Not long after, a traveller to South Africa showed Herschel the story as it had appeared in the *Sun*. Herschel at first charged from his room, wanting to know what it was all about. 'Well,' said the wry traveller, pointing out the uproar the story had caused in New York, 'what everybody says must be true.' After a pause, Herschel broke into laughter, aware that he would have to work very hard indeed to live up to his new-found reputation.

Men Will Land

LANDING sites have been announced for all future missions in the Apollo series. Starting with Apollo 12 on 19 November, astronauts Charles Conrad, Richard Gordon and Alan Bean will touch down in southeastern Oceanus Procellarum. Provisionally, Apollo 13 would follow in early 1970 taking Jim Lovell, Thomas Mattingly and Fred Haise to the region of Fra Mauro crater. Veteran Alan Shepard is named as commander of Apollo 14. With Stuart Roosa and Edgar Mitchell he will aim for the bright crater Censorinus. Apollo 15 is scheduled to look at dark volcanic material in the area of Littrow (Mare Serenitatis). These flights will carry the Apollo Lunar Surface Experiments package, a sophisticated version of the simple Apollo 11 experiments. ALSEP includes a small power generator. Starting with Apollo 16, an advanced ALSEP may be carried, marking the advent of an improved Lunar Module capable of carrying greater loads and allowing longer stays on the Moon. A 400 lb Lunar Roving Vehicle may be included to help the astronauts get around. Apollo 16 will land next to Tycho in the jumbled highlands. Apollo 17 is targeted for the volcanic Marius Hills region, while Apollo 18 will look at Schroeter's Valley near Aristarchus. Another rille - Hyginus - is the object of the Apollo 19 mission. The final flight will be Apollo 20, scheduled for 1972, in which astronauts will examine Copernicus.

Small Ads

Books from Geoffrey Falworth, 11 Wimbledon Avenue, Blackpool FY5 1SA. Specialists in astronomy publications. Free catalogues sent on request. Book tokens accepted in payment.

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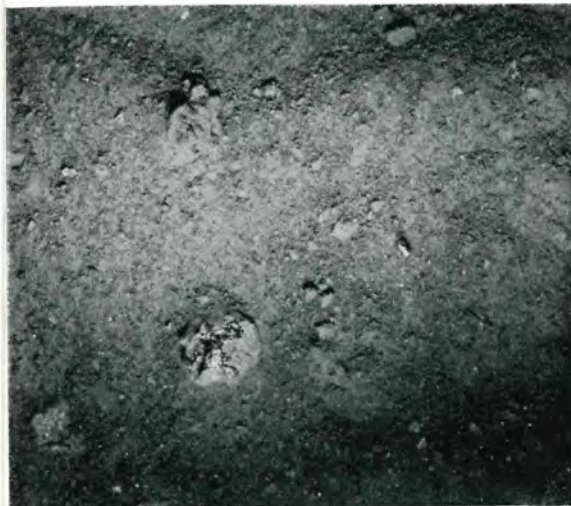
Moon in Stereo

ON the right are three stereo views of the lunar surface taken by the Apollo 11 crew with a specially designed 35mm stereo close-up camera. The camera is mounted on a walking stick, and the astronauts use it by holding it up against the object to be photographed and pulling the trigger. Illumination is by flash, and all the photographs are taken at a fixed distance. Each frame covers a three inch square area of Moon - so that the rocks and dust shown here are reproduced life size. To view the pictures in stereo, hold a small pocket mirror upright between the twin frames. With your right eye look in the mirror at the reflection of the right hand frame; look directly at the left hand frame with your left eye. Move your head and the mirror until the two images fuse, and the large rocks will appear to stand out in relief. For a better effect you may like to cut out the pairs and change their separation; if so, make sure that the frame marked R is always to the right.

TOP PAIR: A clump of lunar surface powder, the pieces appearing as slightly different shades on the colour original. Many small, shiny spherical particles are seen embedded in the material. Note the deep crevices where the clump has split.

CENTRE PAIR: A small lump of lunar surface powder about $\frac{1}{2}$ inch across with a splash of glassy material over it. Scientists believe that a drop of molten material from a meteoric impact fell on the clump, splashed and froze there. This clump, small fragments nearby and the whorl-like clump at the top of the picture stand out well in stereo. The shiny splash appears a brilliant silver on the colour original.

BOTTOM PAIR: A stone, about $2\frac{1}{2}$ inches long, embedded in the powdery lunar surface material. The little pieces closely around it suggest to lunar scientists that it has suffered some erosion. On the surface several small pits are seen, mostly less than one-eighth of an inch in size and with a glazed surface. They have a raised rim, characteristic of pits made by high-velocity micrometeorite impacts. Scientists have christened them 'zap craters' and hope to calculate from them how many tiny meteorites hit a given area of the Moon over a given time. This is a guide to the rate of lunar surface erosion.



It seems pretty certain that the Earth will exist as long as the Sun does. Fortunately, our own star is pretty much a teenager on the stellar time scale – about 5000 million years old. It has been the same size and the same brightness for most of its life. Astronomers once thought that the Sun would just go out with age – die to an icy cinder, leaving the Earth to freeze.

But the end of the world predicted now is scorchingly different. The Earth will be burnt to dust in about 5000 million years' time.

How will this come about? Scientists calculate that about 1500 million years from now the Sun, still looking much the same as at present, will have burnt up all the hydrogen stored in its core, leaving only helium. So the burning process will move out into the surrounding layers, which still contain hydrogen. And it is at this stage, calculations show, that the Sun will be expanding to three times its present diameter, glowing four times as brightly as it does so.

Repercussions throughout the solar system will be horrific. With soaring temperatures, vanishing

water resources and storms of deadly radiation, life should vanish rapidly from our corner of the galaxy.

Even if some lowly, mutant organism manages to maintain a grip on existence, the Sun's next complicated set of manoeuvres will grill it beyond recognition. For astronomers predict that the Sun will spend the ensuing 600 million years or so as a red giant, swelling to 400 times the present diameter and engulfing Mercury, Venus, Earth and Mars.

This distended sphere, 10 000 times brighter than the Sun we know now, will blow away rings of matter into surrounding space, becoming a planetary nebula. But its great expanding act will have taken a heavy toll: all the available fuel will have been exhausted. Fifty thousand million years from now the Sun will have withered and died, its reserves gone.

Where once shone a healthy young star will be left nothing but a fading ember. And there will be no trace around it of the planet that once harboured life.

Sidgwick
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THE OLD MOON AND THE NEW

V A Firsoff

Postscript by Patrick Moore

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Books

Man on the Moon by Peter Fairley. Arthur Barker. 252 pp. 38s. Mayflower Paperback. 5s. PETER FAIRLEY, Science Correspondent for Independent Television News and *TV Times*, is well known for his popular writings and television appearances. He also covered the whole Apollo 11 project for ITV together with Paul Haney, the former head of Public Relations at NASA's Mission Control in Houston.

Although other books have been released quickly to cover man's first steps on the Moon, Mr Fairley's version goes much further and presents a complete coverage of space research. The accomplishments in this field by the USA and the Soviet Union are reviewed from the days of ancient mythology – when men first thought of conquering the Moon – up until the present time.

The author personally knows many of the people engaged on the construction of the gigantic rockets used to launch men beyond the threshold of our planet. He has also met and interviewed scientists, rocket engineers, technicians, administrators and even the astronauts themselves. He presents an enthralling account of his interviews: the dramatic events behind the scenes; the times when disaster has struck; the race between the USA and the Soviet Union in their desperate attempt to master the elements and conquer space.

The final chapter speculates on the future of space travel and the reasons behind it. He considers our Sun, the source of planetary life, and the inescapable fact that in centuries to come it will burn out and die; so man's first steps on the Moon are the beginning of an era leading to further technical and evolutionary development to enable us to travel to worlds orbiting other stars. We have, he concludes, got to find a way out of this solar system in order to survive.

Peter Fairley's book is aimed at the general public who want an exciting, non-technical story about space exploration. It also makes an excellent jumping-off point for deeper delving into facts about the world 'up there.'

SUSANNE STEBBING

Man on the Moon by John M Mansfield. Constable. 256 pp. 45s.

'WITHOUT doubt the most exciting, and above all the most accurate book on the subject. If you want to *know* what happened, read it,' says James Burke on the cover of John Mansfield's *Man on the Moon*. I accepted this endorsement with reservations. Since Mansfield is James Burke's BBC TV producer, and they've covered a lot of the ground together, a certain amount of back-scratching could be expected. But having read the book, I certainly feel that of all the Moon landing commemoratives so far published, this is the one that will best stand the test of time.

Despite what the title would suggest, John Mansfield's book is a history of rocketry from the very earliest days – in fact, from as far back as the dreams of Kepler. Both Tsiolkovsky and Goddard rate useful biographical chapters of their own; but Werner von Braun has to share with Hermann Oberth. And then, after the story of the V-2, comes the myopic plodding of American rocket investment while the Soviet Union, despite some revealing sabre-rattling, leaps ahead on the road to the stars. Here, quite candidly, are the reasons why Russia got into space first; and it wasn't due to the fact that 'their Germans were better than our Germans.'

America's first steps into space – launcher failures, misbehaving probes – make embarrassing reading now that the scene can be surveyed from the final pinnacle . . . the Moon. For a few years, the two greatest nations on Earth rode neck and neck, cramming bold advances into amazingly few flights.

This is living history, and it really does make exciting reading. Error free? Perhaps not quite; but there is certainly no blemish great enough to detract in any measure from the vast amount of facts that John Mansfield has collected. Refreshingly, the publishers chose to wait long enough to have a thorough index compiled before publishing the book. My main grumble is the illustrations. A lot of them are just repeats of the same old pictures we've seen before; although, as a saving grace, there is one riotously amusing photo of a Soviet space meal apparently consisting of swiss roll and iced dainties. Yes, this *Man on the Moon* is one that I shall be looking at again many times in the future.

SUSAN FIENNES

