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Space

Moon bases may need to be buried underground to avoid radiation

James Woodford


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The surface of the moon is inhospitable despite the great view

IF ASTRONAUTS on the moon are to avoid harmful radiation, long-term lunar bases may need to be shielded by 2 to 3 metres of regolith – the moon's surface layer of rock and dust.

Jingnan Guo and Mikhail Dobynde at the University of Science and Technology of China in Hefei have analysed how the thickness of a lunar base's shielding would affect radiation doses for people living on the moon. Their study includes using the lunar soil as protection as well as using additional artificial shielding.

There are two main kinds of radiation of concern: background levels of galactic cosmic rays, which pose a long-term cancer risk, and solar energetic particles (SEPs) associated with solar eruptions.

The SEPs can lead to acute symptoms of radiation exposure, such as skin injury and damage to areas involved in generating cells for the blood, which include bone marrow. In severe cases, exposure to SEPs can lead to death.

"For short stays on the moon without encountering intensive SEPs, the radiation effect should be small," says Guo. But if a solar eruption happens, the picture changes. At the end of the Apollo programme, for example, Apollo 16 landed astronauts on the moon for a few days in April 1972. This was followed by Apollo 17 in December that year. In between, there was a large radiation storm.

"There was such a big SEP event that happened in between... that it could have caused possible death to astronauts on the moon if they had been there unprotected," says Guo.

"A large radiation storm could have caused death to astronauts who were on the moon unprotected"

The study also found that too little regolith shielding can be worse than none, because lunar soils scatter radiation, generating secondary particles that can include neutrons. This secondary radiation peaks at depths of about half a metre but decreases rapidly lower beneath the surface.

"Neutrons have a large biological effect as they can efficiently interact with the human body to cause radiation effects in the internal organs," says Guo. "They can contribute more than 90 per cent of the total effective radiation when shielding is around 50 centimetres," says Guo.

The study found that bases at a depth of 3 metres would safely accommodate the same crew for more than 20 years without them exceeding lifetime and annual radiation limits set by space agencies (*Nature Astronomy*, doi.org/m9gb).

NASA and the Russian space agency impose different lifetime radiation dose limits – 600 millisieverts and 1000 mSv, respectively – on their astronauts. Both agencies also impose annual exposure limits. Natural background radiation exposure on Earth amounts to about 2.4 mSv a year.

If the lunar stay for a single crew is no more than a few months, 2 metres of total shielding should be enough, says Guo. Crew members could also be rotated back to Earth to avoid exceeding lifetime and annual radiation health limits, she says.

The most practical way to reduce radiation exposure would be to use natural shielding for bases by building them in existing caves or lava tubes or constructing habitats beneath the surface, says Guo.

Better predictions of solar storms will also be important, she says, to keep astronauts safe when they go outside the base for activities on the surface. ▮

Health

Spending time in space speeds up muscle ageing

Karmela Padavic-Callaghan

RADIATION isn't the only danger if you venture beyond Earth. A week in the microgravity of space ages muscle cells so much that their genetic activity looks similar to Earth-bound cells that have been ageing for years. This finding could explain why spending time in space impairs muscle function.

We know astronauts risk losing bone density and muscle mass due to low gravity in space. Now, Ngan Huang at Stanford University in California and her colleagues have analysed the effects of microgravity on muscle cell genetics.

The researchers grew human muscle cells in a scaffold of collagen fibres, which directed the cells to assume the same structure as they would in the body. They then put the cells on a chip that could withstand flight and sent it to the International Space Station (ISS) for a week.

When the cells returned to Earth, they exhibited higher activity in genes associated with fat formation, which is linked to muscle degradation. Gene expression related to the functioning of the muscle cells' mitochondria, which produce energy, was also compromised.

"It seems that microgravity is an environment that is accelerating ageing," says Huang.

These changes are more similar to what happens in sarcopenia, or age-related muscle atrophy, than in muscle loss that occurs due to diminished activity, says Huang. When astronauts on the ISS added drugs that can potentially stimulate muscle growth to some of the cells, the genetic activity of those cells was less affected by microgravity (*Stem Cell Reports*, doi.org/m9nk).

This means astronauts and space tourists could potentially mitigate the effects of microgravity by taking certain drugs. The findings could also be useful for studying ageing more broadly, says Huang. ▮