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Have humans pushed the Moon into a new geological age?

In our short history of space exploration, humans have already changed the Moon significantly. From the cultural heritage of our first footprints to the damage caused by the crash landings of our spacecraft, our presence is practically frozen in time in the Moon's dusty regolith.

The Moon has been in its current epoch, the Copernican, for the last 1.1 billion years. Now, researchers are arguing for the formalisation of a new epoch: the lunar Anthropocene. This epoch, the researchers argue, began in 1959 when Russia's Luna 2 spacecraft became the first craft from Earth to land on the Moon.

We spoke to one of those researchers, space archaeologist Dr Justin Holcomb at the University of Kansas in the US, to learn more.

WHAT MARKERS SUGGEST THAT A NEW EPOCH HAS STARTED ON THE MOON?

The Anthropocene on Earth is a complex issue because, if humans became the dominant force or agent of change, we need to have a record of that. But the geomorphological systems on Earth are constantly erasing that record. Everything is discarded and then cycled into the environment in various ways, like being buried into the ground and then getting size-sorted and moved around, or having plants growing through it.

The beauty of the Moon is that it has less active systems that are serving to erase the record of human

activity. The main agent of change on the Moon, historically, was just meteoroid bombardment, which is pretty slow. Except now, we have the human variable, which is quite significant. The Moon represents a good laboratory for the experiment of testing the lunar Anthropocene, because of its limited systems and its ability to record the entirety of human history.

WHAT ARE SOME OF THE BIGGEST IMPACTS WE'VE HAD UP THERE?

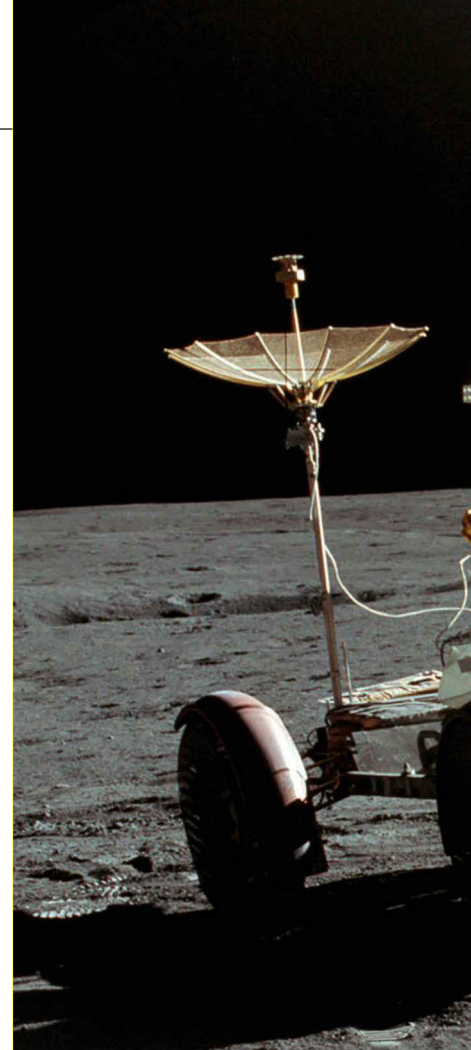
The most significant impact to the Moon is when we land. That's what makes humans different to a natural background of impact: we don't just make an impact – we then walk and drive around and sample things.

The more negative type of impact is accidental crashes – unplanned wrecking into the Moon – and that's a significant risk as we move forward in this era of the new space race.

Since 2019, there have been around six accidental crashes. These pose a real risk to the areas of more planned activity like Tranquility Base, where we have the first footprint. Unplanned crashes could hit those, and once those are gone, they're gone forever.

WHAT ARE SOME OF THE OTHER THINGS WE HAVE LEFT THERE?

There are all kinds of things! [The astronaut] Charles Duke left a photo of his family, which probably instantly turned brown. There are also golf balls, human faeces, urine bags and vomit

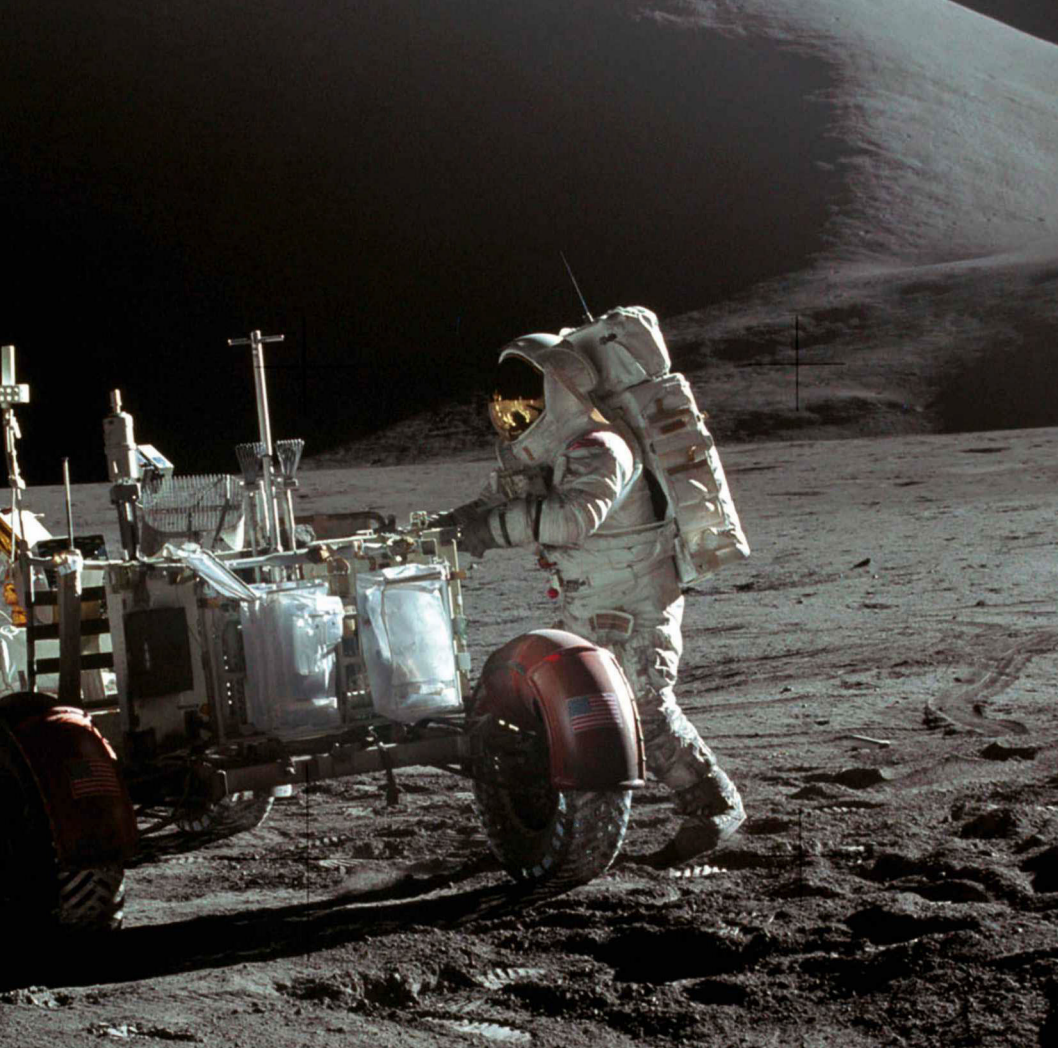


bags. One private company launched a mission that had tardigrades on it that crashed into the Moon. India's rover has its national emblem on its wheels so as it drives around, it leaves this imprint on the Moon.

One of the common narratives is that the Moon has a space trash problem. But it's not trash; it's heritage, and it records our history as a species. So we don't need to solve a space trash problem, we need to solve a space heritage problem – and that means we need completely different solutions that are geared towards protection as opposed to removal.

THE EARTH ANTHROPOCENE IS DEFINED BY HUMAN ACTIVITY CHANGING THE PLANET'S CLIMATE AND ECOSYSTEMS. SO HOW IS HUMAN ACTIVITY CHANGING GEOLOGICAL PROCESSES ON THE MOON? HOW FAR COULD HUMANS THROW THE MOON'S SYSTEMS OUT OF BALANCE?

It's not necessarily that the lunar Anthropocene is going to be defined as a climate change, because there's not a climate on the Moon. Instead, it's going to be defined in the rock record. The significance of humans causing



LEFT Apollo 15 astronaut James Irwin with the lunar rover on the Moon in 1971

BELOW The Duke family photograph laying on the surface of the Moon, left by Apollo 16 astronaut Charles Duke in 1972



“The beauty of the Moon is that it has less active systems serving to erase the record of human activity”

geomorphic change (the movement of lunar regolith around the surface) is threefold. Firstly, we know that rocket fuel can potentially contaminate ice, which tends to be found in the permanently shadowed areas on the Moon. One of the reasons we’re returning to the Moon is because of ice, as it contains hydrogen that can be turned into fuel.

Secondly, humans could have a potential impact on the Moon’s exosphere [its thin, tenuous atmosphere]. This is more speculative, but as we’re also going back to the Moon to mine, what about mining tailings and plumes? How are they going to influence the exosphere – will they produce a big cloud? Will they create a hazy environment on the lunar surface? That’s a problem.

Thirdly, we can’t always predict where our rockets are going to land. So there’s this corpus of important space heritage at risk of being destroyed.

HOW COULD FUTURE SPACE MISSIONS IN 2024 AND BEYOND CHANGE THE MOON EVEN FURTHER?

I think we’re in the middle of a transitional period when it comes to space exploration in our species’ history. Sputnik was the first time we successfully exited our atmosphere. That was in 1957 and now we’re on the cusp of drastically changing our relationship with the Moon.

If we take all the times we’ve impacted the Moon with either an accidental crash or purposeful impact or landing since 1959, it’s around one per year. But there are around

493 launches from Earth planned for this year and, of those, 17 are going to the Moon. That’s 17 times the rate of our historical impact. And this is just the beginning. It’s not the right decision to wait [to formalise the lunar Anthropocene] until that number is something like 100 or 200, which it will be very soon.

With the new focus on mining, there may be a lot of capital to be made on the Moon. The important thing here is that, in the new space race, as compared to the space race of the mid 20th century, private companies are involved. That’s changed the game. **SF**

DR JUSTIN HOLCOMB

Justin is a postdoctoral researcher at the Kansas Geological Survey, University of Kansas.

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