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Plans to Strip Mine the Moon May Soon be More Than Just Science-Fiction

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It may not be long before we start mining the moon for its resources, particularly the rare Helium-3 for its use in nuclear fusion.

Billions of tonnes of resources, ranging from water to gases to metals, have been detected on the Moon and further out into space, and both governments and private companies are navigating the ambiguous legal parlance to determine how to reach, extract and distribute it all.

Vast quantities of the isotope Helium-3 are known to exist on the Moon, as well as in the atmospheres of planets like Jupiter, and could come into high demand as the essential fuel for the so-called 'golden dream' of nuclear fusion power.

While existing nuclear fission plants break apart atoms and harvest the excess energy, nuclear fusion combines atoms of hydrogen to create helium, a process that releases vast amounts of energy.

According to Matthew Genge, lecturer in the Faculty of Engineering at Imperial College London, the Moon's lack of atmosphere means it has been bombarded by high-energy particles for billions of years, some of which have embedded on its surface.

Many of these particles, including Helium-3, can be extracted through heating Moon rock and collecting the gas.

'Millions to hundreds of millions of tonnes, I should think, is readily accessible,' says Genge. 'You can strip mine the Moon and you can cook out the Helium-3.'

What's more, he says, nuclear fusion using Helium-3 would be cleaner, as it doesn't produce any spare neutrons. 'It should produce vastly more energy than fission reactions without the problem of excessive amounts of radioactive waste.'

Scientists have so far only been able to sustain a fusion reaction for a few seconds, but with nothing near the scale or energy yield necessary to be replicated for commercial use. With billions invested into its potential, many scientists believe it will eventually be perfected – at which point demand for Helium-3 is likely to 'explode'.

Helium-3 is available in such low quantities on earth that even though nuclear fusion doesn't even work properly yet, it is still worth US$16 million per kilo

'We're going to have to go somewhere else to get it,' continues Genge, 'and the easiest

place to go is the Moon.'

Cost of strip-mining the moon

According to Genge it costs US$25,000 per kilo to lift things into space on a shuttle. Thus, whatever is mined in space in the future, it will have to be in high-enough demand to subsidise the cost of launching it.

This is especially true for prospecting missions beyond the Moon. A mission to retrieve Helium-3 from Jupiter's atmosphere, for example, would take ten years, and businesses will likely be reluctant to wait a decade for a return on such a pricy investment, says Genge.

Another potential lunar resource – water – could fuel these future missions into deep space. Orbital scans suggest there are at least a billion tonnes of water frozen on the Moon after impacting in craters of the Moon's surface – usually in the darker areas where temperatures can be as low as 35 degrees Kelvin.

Texas-based Shackleton Energy Company has already begun operations aimed at mining the Moon within the next few years. The company's plans for mining and refining operations would involve melting the ice and purifying the water, converting the water into gaseous hydrogen and oxygen, and then condensing the gases into liquid hydrogen, liquid oxygen and hydrogen peroxide, all potential rocket fuels.

Shackleton CEO Dale Tietz says the water extracted would be used almost exclusively as rocket fuel to power operations both within Low Earth Orbit (LEO) – such as space tourism and the removal of space-debris – on the Moon, and further out into space.

'We are a for-profit business enterprise moving forward, and so we are only going there really for one reason and that is to mine, prospect mine and harvest water for rocket propellant production,' says Tietz.

Private investors interested in the moon

Shackleton plans to set up several refuelling service stations in LEO that would free exploratory, commercial and tourist shuttles from lifting all their fuel from Earth. Shackleton believes the stations would also enable an entirely new category of space vehicle shuttles that operate only at or beyond LEO.

Tietz says Shackleton is currently in phase one of a four-phase operation to mine water on the Moon. Phase one involves gathering teams for the mission and investors to fund it, as well as detailed mission planning.

Phase two would involve launching two unmanned rover vehicles to prospect areas of the Moon for water deposits. The Shackleton crater at the south pole on the dark side of the Moon, among many others, is believed to retain a significant portion of the Moon's water.

Tietz says 'there's a great deal of interest out there' from potential investors.

'This will not be funded by any government or any federal agency like NASA. This is all going to be – if it ever happens – it will all be private investment,' continues Tietz.

In a June 2009 article in the Institute of Electrical and Electronics Engineers magazine Spectrum, Shackleton founder Bill Stone wrote that lunar prospecting could cost as much as $20 billion over a decade.

‘At the moment, no country seems eager to foot the bill,’ writes Stone. ‘Where governments fail to act on a vitally important opportunity, the private sector can and should step in.’

Stone outlined that, to save $1 billion during the initial staging of the lunar mining base, the first human team would only take enough fuel to land and establish the base—not enough for a return trip to Earth.

‘This may sound radical, but the human crew who will undertake this mission will do so knowing that their success and survival depend on in situ fuel generation for the return. Should they fail, theirs will be a one-way trip; the risk is theirs to take,’ writes Stone.

‘For government-sponsored space agencies, such a concept is unthinkable; they cannot tolerate the political risk of failure. Yet it is the only viable business choice. Centuries of explorers made the same hard choice in pushing the limits on land, sea, and air. It’s time to carry it forward into space.’

According to Tietz, governments are at present neither politically inclined nor financially able to carry out prospecting missions in space. Tietz says governments have different priorities – most research-oriented – they have to fund with limited budgets.

‘Private enterprise, we believe, can move very quickly – almost like our internet companies – if they have the right funding and the right regulatory environment to go do what they want to do they can go do it very fast and effectively, privately, and are basically only beholden to their Board of Directors and investors,’ continues Tietz.

‘Governments would then be the beneficiaries of the products that we would produce if we were then successful,’ says Tietz. ‘It’s openly sourced to all of humanity, first-come-first-serve.’

Corporate ‘takeover’ of space exploration

According to Tietz, the extent of Shackleton’s dealings with government are focused on securing Plutonium-238 – a highly scarce commodity on Earth – for low-power nuclear reactors to power their rovers. Tietz says Shackleton are working at ‘the White House level’ to secure Plutonium-238.

‘Where we’re going is probably one of the coldest places that we know of in our solar system, and in order to do that, where there’s extreme cold and no light,’ continues Tietz, ‘we need to have power systems that can tolerate those extreme conditions.’

Jill Stuart, fellow in global politics in the London School of Economics’ Department of Government, believes the role of government in space resource exploration is underestimated, however.

‘There’s a lot of military subtext to everything that happens in outer space,’ says Stuart. ‘Essentially, being able to launch something into outer space demonstrates long-range

missile capabilities.'

'So much of what's up there is private – satellites and that sort of thing – but the international community continues to sort of insist that these objects be tied to a state,' says Stuart.

Stuart noted several ways a government could regulate the private space industry. Objects launched into space from US territory, for example, have to be registered as an export. Also, governments can control access to space through their ownership of most launch pads.

'The thing is, any country that has launch capabilities is the type of country that would have a strong enough government to continue to assert that authority,' continues Stuart.

'Outer space has always been a way for countries to compete in a cold manner,' continues Stuart. 'In the Cold War context it was a way to demonstrate economic, political and technological capabilities, and also ideological stuff – essentially, you know: "If our country can put a man on the moon then we're the leaders of mankind."'

Chinese plans for moon mining

Genge expects there won't be mining operations on the Moon until there is a Moon base which mining operations can then attach themselves to.

'It's going to be a government that sets up a Moon base, whether it be the Americans—who are going to have to plan this from scratch. Probably more likely the Chinese,' he says.

In January 2004, Chinese Premier Wen Jiabao officially launched phase one of the Chinese Lunar Exploration Programme (CLEP), a three-phase programme aiming to send rovers to the Moon to collect lunar soil by 2017.

In 2002, CLEP chief scientist Ouyang Ziyuan said: 'Our long-term goal is to set up a base on the moon and mine its riches for the benefit of humanity.'

Regulation over resource extraction in space remains ambiguous, however. The UN's 1967 Outer Space Treaty (OST) doesn't ban the extraction of resources from space so long as mining stations don't constitute de facto 'occupation' of a part of outer space. The OST, however, doesn't mention who would own any resources retrieved in space.

Tietz says that Shackleton's operation will not attempt to 'claim land' on the Moon, and that the OST 'does appear on the surface to give private enterprise an opportunity to go to the moon and do mineral extraction.' Once they are finished mining, Shackleton say the land will be regraded to near-original condition.

The UN's 1984 Moon Treaty sought to clarify space mining rights, stating: 'The Moon and its natural resources are the common heritage of mankind' and that use of the moon 'shall be carried out for the benefit and in the interests of all countries.' The Moon Treaty was not ratified – the only outer space treaty to fail to be – with the US and Russia both voting against it, and the OST's clause on space resource extraction remains unclarified.

Resource war still 'decades away'

Stuart makes the point that commons like outer space are maintained because no individual

state feels they can control it, thus it's in their interests to share.

'However, as technology has developed,' says Stuart, 'law has adjusted to give countries more ownership control.'

Stuart alluded to the Arctic, a formerly unclaimed territory hostile to industrial development that is now accessible for mineral extraction as a result of melting ice. For the past few years states have been claiming swathes of Arctic ice and resources based on their continental shelf beneath the ice.

And as a possible resource war brews in the Arctic, Genge says there is the possibility of a similar competition over the Moon.

'I could imagine what would happen. You know, the first fusion reactors kick off and you need all this Helium-3. China launches a mission to Moon to come back with as much Helium-3 as it can so the US does the same and the Russians do the same, and then they start squabbling over what's the best bit. And then the Russians will claim half the north pole of the Moon and the Chinese the south pole and the Americans the equator, and then the British will go: 'We want to build a spaceship as well.' And you can just see how it's going to work out,' says Genge.

'I'm sure it will be quite interesting. I don't think we have to worry about it for the next twenty years.'

The Moon has been geologically dead for two and a half billion years and supports no organic life, thus there would appear to be no ecological hazards associated with mining the Moon. Genge speculates that strip mining could ruin the face of the Moon, however.

'If you're mining enough of the Moon in the end the Man on the Moon disappears,' says Genge. 'I can imagine that being an issue if it really got going.'

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