

THE

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# Mint

*fresh thinking in economics*

## COMMUNITY AND BEYOND

Scanning the frontiers  
of commons

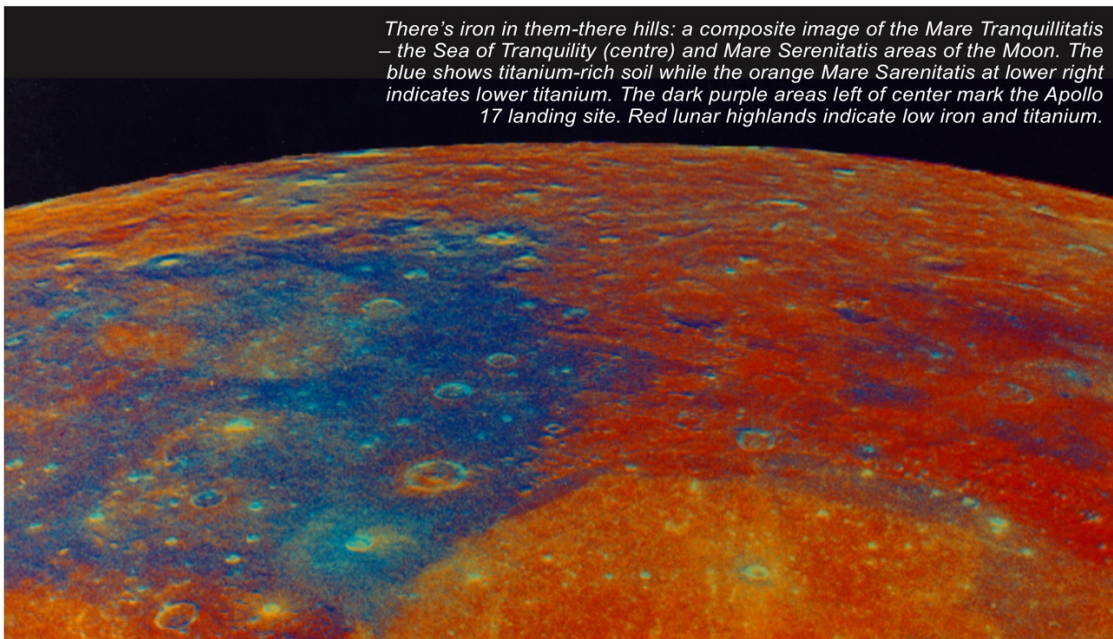
### IN THIS ISSUE

Ann Pettifor  
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Tessy Britton  
Victoria Chick



# The space between us

Could the next gold rush be a plunge into outer space – a lunar landing of robots to mine trillions of dollars worth of helium isotope or rare earth elements? Yes, says [Angela Dennis](#), but asks: who will reap the spoils?



*There's iron in them-there hills: a composite image of the Mare Tranquillitatis – the Sea of Tranquility (centre) and Mare Serenitatis areas of the Moon. The blue shows titanium-rich soil while the orange Mare Serenitatis at lower right indicates lower titanium. The dark purple areas left of center mark the Apollo 17 landing site. Red lunar highlands indicate low iron and titanium.*

In July this year, a rare and beautiful event captured worldwide attention, leading people across four continents to gather together and turn their eyes to the night sky. This was the appearance of a Blood Moon, which occurs when the Moon is in the shadow of the Earth, and on this night, the eclipse was expected to be the longest of the century.

Your writer, along with many others, traipsed up a high hill to witness the spectacle. Though we were ultimately thwarted by the arrival of clouds, as we quietly watched and waited, we who had trekked to the high point felt a kinship – as fellow humans, sharing a sense of the smallness of ourselves amid the unreachable vastness of space. This feeling has perhaps been shared by humans since time immemorial.

Few in the crowd will have been aware that the innocent awe with which we viewed the heavens may come to seem quaint before long. Space technologies are emerging that are likely to dramatically alter the relationship that we have to our moon and to outer space. In particular, mining operations on outer space bodies are becoming a real possibility in the foreseeable future and with them the reverence for outer space could be replaced with an altogether more mercenary perspective.

Plans to mine on the moon and asteroids are underway, and are confronting scholars with challenging legal, economic, scientific, philosophical and ethical questions. Some of these questions are deceptively simple to express, yet their answers may have wide-reaching consequences. They are:

- Who (if anyone) owns the Moon and outer space?
- Who (if anyone) has the right to make economic use and derive economic benefit from them? And
- Who gets to decide?

The moon contains metals including iron, titanium and aluminium. Its surface has been found to be abundant in ice, which could, using solar power, be broken down by electrolysis into hydrogen and oxygen, for use as rocket fuel and to support life. It also contains helium-3, a stable isotope of helium that is not found on Earth and which could be used in nuclear fusion – a theoretically safe source of nuclear energy that produces no harmful by-products.

Asteroids – rocks that orbit the sun but are too small to be considered planets – can likewise host an array of valuable materials. Some contain water, organic carbon and phosphorous, which could support deep space exploration. Some also carry valuable metals such as platinum and gold, and rare-earth metals, that are

highly sought after for electronics manufacturing. The asteroid currently ranked most valuable is 511 Davida. It has a diameter close to 200 miles and has an estimated value greater than US \$100 trillion.

“The Earth is the cradle of humanity, but mankind cannot stay in the cradle forever.

Konstantin Tsiolkovsky

With such eye-watering sums apparently up for grabs, it is no wonder that several private US companies already have clear, costed plans to establish mining operations in outer space, already set in motion (see box, *All aboard*).

On the Moon Express Inc. website, two children point with awe at a Moon covered in twinkling lights. Above them, the following words appear: “Our mission is to redefine possible by returning to the Moon and unlocking its mysteries and resources for the benefit of humanity”.

Moon Express, based in Cape Canaveral, is the first private company given permission by the US government to travel beyond the Earth’s orbit and land on the Moon. As of October 2018, it has raised US \$12.5 million for its plan for lunar exploration and development. This plan includes sending a small spacecraft to the Moon (which they call the Earth’s eighth continent), followed by the establishment of a lunar outpost at the lunar South Pole. And for 2020, it is planning a mission to harvest samples from the lunar surface. Moon Express is clear about who it believes will own the samples harvested: “The lunar samples brought back to Earth will be the

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only privately owned Moon materials on Earth.”

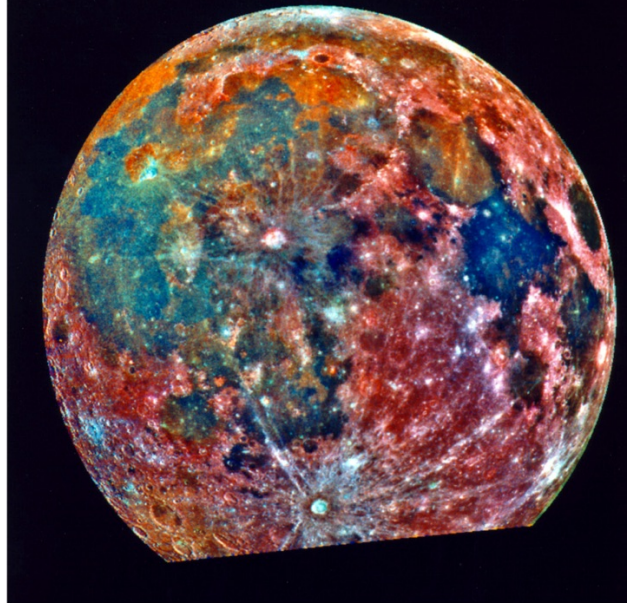
Another private US company with outer space mining ambitions is Planetary Resources, whose investors include Larry Page, Richard Branson and Warren Buffet. Rather than the Moon, Planetary Resources has its sights set firmly on Near-Earth Asteroids, which pass within about 30 million miles (50 million km) of the Earth’s orbit.

Like Moon Express, its website features a dramatic short film detailing a proposed programme of missions. Firstly, a rocket would launch multiple small spacecraft, each directed to a different target asteroid. Each spacecraft would map the surface of its target asteroid, searching in particular for evidence of water, and would then probe the asteroid to extract material samples. Data collected would be used to design and construct a mine or several mines in space.

Crucially, the purpose of these missions is not to locate resources for use on Earth. Rather, Planetary Resources view asteroids as akin to “outer space petrol stations”, whose vast water reserves could provide propellant for rockets and supply water for human crew. By stopping on an asteroid to refuel, space missions could depart the Earth with much less fuel than they currently carry. The chief executive officer of Moon Express, Robert Richards, puts it vividly: “Water is the oil of the solar system and those companies who are able to harvest and harness extra-terrestrial deposits of water will make Exxon look like a lemonade stand”.<sup>1</sup>

Planetary Resources’ plans are clearly ambitious, but it will face competition. Several other companies, including Deep Space Industries, Kepler Energy & Space Engineering and the UK-based Asteroid Mining Corporation have similar plans to prospect and ultimately establish outer space mining operations.

*Helium balloon: the Moon contains a form of helium that could be used to produce safe nuclear power.*



It is not just private companies who are interested in commercialising space – there are government-funded projects making progress. The Japanese Space Agency has already reached the asteroid, Ryugu, after a three-and-a-half-year journey. Chinese and EU agencies have plans for the early 2020s. Unsurprisingly, one of the most ambitious projects has been conceived by NASA, which plans to send a robotic mission to a near-earth asteroid, retrieve a huge boulder from it and direct the boulder into a stable orbit around the Moon. Once in orbit, NASA astronauts will explore the boulder, and bring samples to Earth.

These government projects are promoted as having value for scientific knowledge and international security, but many of the technologies developed will also be of great value to space mining concerns. As noted by Dr Deganit Paikowsky of Tel Aviv University: “Private companies who wish to commercialise space can rely on a subtle, indirect subsidy in research and development stemming from government agencies.”

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Though technology is developing rapidly, mining the moon and asteroids will be an extremely expensive undertaking, bearing significant risks. According to Trade Finance lawyer, Priyank Doshi, “Even though the potential profits are massive, the initial risks of asteroid mining come close to swallowing the benefits. While both Planetary Resources and Deep-Space Industries have been very tight-lipped about their costs, the list of big-name investors and the ambitious plans insinuate investments in the hundreds of millions of dollars, at minimum.”<sup>2</sup>

**“As with past frontiers, it is those who show up, not those who stay home, who create the rules and establish the norms in new areas of human activity.”** Dr Scott Pace, US National Space Council

With such huge sums required in investment, companies are lobbying for an international legal and regulatory framework that would ensure that they would be able to extract, keep and sell, all materials they mine in outer space.

This is far from assured. Outer Space is not a lawless domain in which anything goes. Rather, it is governed by international treaties, the cornerstone of which is the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, also known as the Outer Space Treaty (OST).

The OST has been called an “ideological charter for the Space Age”<sup>3</sup>, having come into force in 1967, amidst the tense atmosphere of the Cold War. According to lawyer and scholar, Carol R. Buxton, “The former Soviet Union emerged as a pioneering leader when it launched the first satellite (Sputnik) into orbit in 1957, and landed the Luna IX on the Moon in 1966, sending waves of alarm through the United States which feared that the Soviets would stake a property claim on the Moon. This prompted the United States to initiate treaties limiting activities in outer space to peaceful purposes and preventing any state from exercising ownership.”<sup>4</sup>

Most legal scholars agree that the Outer Space Treaty has been remarkably successful. Ratified by 105 nations, including all current spacefaring nations, and never having been directly violated, it enshrines into law several key principles, including:<sup>5</sup>

- the exploration and use of outer space shall be carried out for the benefit and in the interest of all countries and shall be the province of all mankind;
- outer space shall be free for exploitation and use by all states; and
- outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation or by any other means.

Notably, the OST bars appropriation of outer space by nation states, but is silent as to appropriation by individuals or private companies. According to Frans von der Dunk, Professor of Space Law at the University of Nebraska, this simply was not envisaged as a possibility at the time. According to von der Dunk: “In 1967, for sure nobody thought something like [space mining] was possible, certainly not with private money”<sup>6</sup>. This oversight may now have significant consequences.

Later treaties attempted to expand on or accentuate OST principles. The most significant is the *Agreement Governing the Activities of States on the Moon & Other Celestial Bodies*, also known as *The Moon Agreement (1979)*<sup>7</sup>. This treaty attempted to close the loophole concerning appropriation by private companies, by prohibiting any ownership of any extra-terrestrial property by any organisation or private person, unless that organisation is international and governmental.<sup>8</sup>

Possibly the most controversial provision of *The Moon Agreement* is Article 11, which provides that the Moon and its natural resources are the “common heritage of mankind”. It also proposes the establishment of an international regime to govern the exploitation of such resources when it becomes feasible. This would seem to tie up any loose ends overlooked by the OST and prohibit unilateral space mining.

“Plans to mine on the moon and asteroids are underway, and are confronting scholars with challenging legal, economic, scientific, philosophical and ethical questions.”

However *The Moon Agreement* has a problem; unlike the OST, no space faring nations have ratified the treaty and only 18 nations are parties to it. Under international law, this is not completely fatal to a treaty, as a treaty’s provisions may become binding as “customary law” over time if countries behave in accordance

with them, even when those countries are not signatories.

Nevertheless, without “the big three” space faring nations: the United States, the Russian Federation, and the People’s Republic of China, the legal force of the *Moon Agreement* is greatly weakened, leading some legal scholars to refer to it as a failed treaty.

The *Moon Agreement* describes outer space as the common heritage of mankind. The *Outer Space Treaty* calls it “the province of mankind”. These are the so-called mankind provisions and oceans of ink have been deployed in attempts to clarify the difference between them.

One broadly accepted distinction is that the “province of all mankind” provision contained in the OST refers to *activities* (exploration and use) of outer space while the “common heritage” provision as contained in the *Moon Agreement* refers to “material objects”. This offers a hint as to why so few space faring nations signed the *Moon Agreement*.

According to Buxton, under the common heritage principle, resources would be “for the benefit of humankind, to serve the common interest of peoples everywhere.”<sup>9</sup> If such a principle is applied to outer space, Planetary Resources, Moon Express and others may be compelled to share their intellectual property and the rewards of their endeavours. Not unsurprisingly developing countries support this outcome, while developed countries are not so keen.

Understandably, the phrase, “common heritage of mankind” strikes fear into the hearts of space mining companies, who argue that they could not possibly attract sufficient investment into space mining if compelled to share the rewards. The question of the correct interpretation of “the mankind provisions” has thus reached an impasse, and according to former Editor-in-Chief of the *Journal of Space Law*,

Professor Joanne Gabrynowitz, it is “now primarily a political problem... and therefore, only subject to a political solution. Without supportive political action to develop the law of space, space lawyers are reduced to the twentieth century version of arguing the number of angels that can sit on the head of a pin.”<sup>10</sup>

The US government has firmly set out its political position. At the 2017 Space Law Symposium in Washington DC, the executive secretary of the National Space Council, Dr Scott Pace, said, “It bears repeating: outer space is not a “global commons,” not the “common heritage of mankind,” not “*res communis*,” nor is it a public good. These concepts are not part of the *Outer Space Treaty*, and the US has consistently taken the position that these ideas do not describe the legal status of outer space.”<sup>11</sup>

Along with firm words, the US has taken decisive action to create a domestic legal environment that facilitates space mining. In 2015, after extensive lobbying, Congress passed the Commercial Space Launch and Competitiveness Act. The act purports to grant US companies ownership of anything they bring back from space, whilst maintaining that the US does not assert sovereignty over or ownership of the celestial bodies themselves. The US thus appears to be walking a fine line between asserting property rights for US space entrepreneurs and respecting US obligations under international law.

This approach appears to be influencing others. Luxembourg has adopted similar legislation, hoping to establish itself as a hub for space mining in Europe, while the one UK-based mining company, the Asteroid Mining Corporation, is actively lobbying the UK government for a UK equivalent.

With the US leading the way, we thus appear to be moving towards a piecemeal regime, in which nations assert outer space

property rights for their own citizens and companies, without attempting to achieve any kind of international consensus. Numerous space law experts believe that this approach is at the very least unwise, and at most, a blatant violation of established international law. US space lawyer, Michael Listner, has warned, “China and Russia will want in. If you have conflicts of law, things start getting dicey and that could lead to legal and political conflict”<sup>12</sup>.

“Those companies who are able to harvest and harness extra-terrestrial deposits of water will make Exxon look like a lemonade stand.”

It is also hard to see how such an approach would satisfy the clear intent of the OST Article 1, which provides that “The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development”.

So far, the response of space mining companies and their nations to this question has sounded rather like “trickle-down” economics. The benefit to humanity as a whole, they argue, will be in the form of technological breakthroughs which eventually will be enjoyed by everyone, as well as in opportunities to participate in Earth-based sections of the space-mining industry, such as the processing of imported space minerals.

They argue further that the benefit to humanity will be in the removal of

environmentally polluting mining operations from the biosphere. These indirect kinds of benefit would certainly be welcome, but one wonders whether this is what was intended when the OST was drafted. Moreover, will these benefits sufficiently counter the real risk that space mining will exacerbate existing worldwide inequalities, leaving less developed countries far behind?

Dr Morgan Saletta and Dr Kevin Orrman-Rossiter from the University of Melbourne have proposed a resource fund model, based on Alaska's sovereign wealth fund, The Alaska Permanent Fund. This was established in 1976 after oil was discovered on Alaska's North Slope.

Alaskans wanted to build the wealth for future generations, and voted for its creation, with an initial investment of 25% of oil revenue. The principal is constitutionally protected, and since 1982, each Alaskan has received a yearly dividend from the fund's earnings. So Alaskans have a strong personal stake in Alaska's oil resources, and receive a direct financial benefit.

Saletta and Orrman-Rossiter imagine that something very similar could be created from the wealth derived from outer space resources. They propose the establishment of an international organisation which has the right to lease extra-terrestrial sites of resource extraction and impose royalties on production. This is totally in keeping with current established terrestrial practice in oil mining, logging and other areas.

Royalties collected would then go into an International Space Resource Fund, whose dividends could be distributed in some form, to all the people of the world.

There are many ways in which this apportionment could occur. For example, monies could be distributed to national governments based on population size.

Dividends could include a mix of monetary and non-monetary benefits. Or, following the example of the Alaska Permanent Fund, dividends could be distributed simply as individual payments to every person in the world – a worldwide citizens dividend.

Another model that appears to have not yet been proposed, might be to take an approach following the ideas of 19th Century economist and land reformer Henry George. He taught that when natural resources are abundant, people should be able to help themselves. We all, for example, can help ourselves to as much air as we want to breathe.

When a natural resource is scarce, he argued, all have an equal claim to it, or in practice, to the value or cash proceeds of the resource. This is because desirable natural resources have a value that no one created, so it is right that they be shared. Land is an example of a scarce resource on Earth.

**“There are twenty-trillion-dollar cheques up there, waiting to be cashed!” Peter Diamondis, Planetary Resources**

In the outer space context, the outer space bodies and resources that are realistically accessible and attractive for mining are limited, or scarce. Therefore, according to George, we should all have a right to the resources or a share of their value. That value is the “natural rent” as determined by the market. Since the value is market-based, it is only generated when more than one company seeks to obtain the same resource.



Again, in the outer space context, competing companies would bid over the right to mine in a particular area, for example, some locality on a particular asteroid. This would perhaps be overseen by an international body such as the UN. After the auction, the amount raised could then be distributed in some form to all the nations of the world, or possibly to all the individuals of the world.

The appeal of this approach is that unlike a resource fund, it would be guaranteed not to discourage investment into space mining. Since the natural rent is determined by how much the market itself is willing to pay, there can be no argument that the framework would discourage enterprise. This cannot necessarily be said of a licensing regime, since the license amount will be an arbitrary fee, not set by the market and which would have to be factored into project costings.

The Saletta and Orrman-Rossiter proposal and the approach based on George's teaching are just two proposals that could allow for the orderly and fair usage of the riches to be found in outer space. There may be many more.

**“Mining the moon and asteroids will be an extremely expensive undertaking, bearing significant risks.”**

Both proposals would bring direct benefit to humankind, in accordance with Article 1 of the OST and would reflect the communitarian ethos of the “mankind” phrases in the OST and *Moon Agreement*. And both would enable and possibly encourage investors to enter the space

mining industry, by providing an orderly and internationally agreed framework by which companies may access space resources and be said to “own” them. Neither model would disrupt or prevent companies from making the stratospheric profits they are hoping for.

Possibly most importantly, both proposals anticipate and “see off” future international conflicts over space resources. This is no idle concern. Human history has taught us that where there are no agreed-upon norms of behaviour, wars over territory and resources are probable. Scholar Carol Buxton, warns: “Man, like the universe, follows a pattern – one of acquisitive need and selfish procurement.... ancient man first fought over earth’s resources – and then the land itself when occupation became feasible. To the dismay of less-developed nations, this cycle will continue in space, as man exploits celestial resources and later develops the ability to occupy celestial bodies<sup>13</sup>.”

Recalling that night under the stars, waiting for the Blood Moon to emerge, I wonder what we might have said, had someone asked us, who owned the moon, and the resources it contains. Our first response might have been bemusement at the very idea that the Moon could ever be owned. After all, this space rock, circling the Earth, existed before humankind began, and will be there long after we have perished.

Still, if pressed, perhaps we would have said that if anyone could be said to own the Moon, it should be all humankind together, past, present and future; a kind of traditional custodianship. It is this gut feeling that is reflected in the “province of mankind” and “common heritage of mankind” provisions in our space treaties. And it could be reflected in our use of outer space resources, if we choose a framework that acknowledges that all humankind has a stake in outer space bodies, not just those who get to them first. Yes, those who do the

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difficult work should be handsomely rewarded, but a slice of that reward should go to humanity as a whole.

And if all this seems impossibly idealistic, we would do well to remember that outer space has always been the site of the idealistic. Long before Jules Verne's stories, humans looked up at the night sky and imagined cities on the moon, journeys between planets and untold riches. We were impossibly idealistic when Yuri Gagarin orbited the earth and Neil Armstrong took his steps.

Space mining itself, until very recently, seemed an impossible dream. Yet it is becoming a reality. So why should we not reach higher than a free-for-all framework for space mining, which may benefit a few but leaves others far behind? Why not adopt a model that reflects the way humans feel about the Moon and near-Earth objects – that they are ours? We could achieve in space what we have not yet managed on Earth: a model that could tangibly benefit humankind as a whole is within our reach.

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