
CAMILLA ELVIS

Let's mine asteroids — for science and profit

The commercial dream of trawling space for valuable minerals could bring enormous benefits to a wide range of sciences, argues **Martin Elvis**.

Two events in quick succession have transformed the prospects for commercial space activities: the successful rendezvous last week of California-based SpaceX's privately developed Dragon capsule with the International Space Station; and the bold announcement last month of a new asteroid-mining company, Planetary Resources in Bellevue, Washington, backed by deep-pocketed billionaires.

Trawling space for valuable resources may seem an unlikely concept, especially when discussed in the pages of this serious journal, but suspend your disbelief for a moment. We scientists should take the idea seriously, for it could offer two benefits: a burgeoning of planetary sciences, including the discovery of exotic new cosmic materials, and much cheaper space missions to explore the Solar System and the distant Universe. And government agencies, not least NASA, should pay attention too. Asteroid mining could give them a renewed purpose.

It is often overlooked that one of the formal goals of the US space programme, in addition to its scientific and strategic goals, is to advance the country's economic interests. The economic appeal of asteroid mining is clear: precious metals such as gold and platinum sell for around US$50,000 per kilogram. A smallish asteroid, about 200 metres across and rich in platinum, could be worth $30 billion.

There is, of course, more to it than just identifying such an asteroid, not least digging the material out with the help of robots and bringing it back to Earth (it is worth nothing in space). But greed is a powerful motivator to get things done.

Asteroids are directly useful in a wide variety of sciences. The least-altered asteroids, the 'carbonaceous' ones, carry 4.5-billion-year-old messages from the period, lasting just a few million years, during which the pre-solar nebula condensed into planets.

Asteroid material can tell us about this process, and why there are ores in Earth's crust, given that gold and other heavy metals should have sunk to the core when Earth was molten. And it can show us whether the water in our oceans came from asteroids and comets that hit Earth soon after the crust had formed.

Some meteorites — pieces of asteroids that reach Earth's surface — contain scores of different amino acids. Did these seed the early Earth and enable life to develop? And are exotic materials such as quasicrystals, with new and perhaps useful properties, to be found in asteroids? An extreme possibility is that a few 'quark nuggets', left over from the Big Bang, are masquerading as small asteroids but have the density of atomic nuclei.

Samples from meteorites are useful, but asteroid material with known provenance in the Solar System is limited to the few milligrams of dust retrieved from the surface of the stony asteroid Itokawa, and the lucky retrieval of 4 kilograms of meteorites from the small asteroid 2008 TC3, which was detected and hurriedly tracked just 19 hours before it crashed into the Sahara desert. This meagre hoard will not increase quickly. NASA's OSIRIS-REx mission will bring back the first sample from a carbonaceous asteroid, 1999 RQ36, in 2023 — but this will be only 60 grams. Commercial asteroid mining would return not grams of material, but tonnes. Just a fraction of this would expand planetary science immeasurably.

Most importantly, the pressure to make a profit should drive down launch and mission costs by a factor of ten or more. Powerful new observatories and planetary probes that are not now affordable will become so. When seeking profit, time is money, and spending a year bringing back valuable ores is expensive. Known technologies will be developed to speed delivery times. That will accelerate outer Solar System exploration, and get people safely to Mars.

Scientists can help to make this dream a reality. Asteroid mining is a capitalist exercise, but the financial and technical barriers to entry are high. Just as the US government encouraged the development of the American West in the nineteenth century, so NASA and space scientists can help to tame the frontier of space, and make it ripe for harnessing, to the mutual benefit of all involved. The mining companies could gain from surveys by scientist-explorers, just as both the American pioneers and science gained from government-sponsored expeditions. In that era, for example, valuable sources of ores were discovered, as well as abundant dinosaur fossils.

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Astronomers will have to map out the new territory — finding easy-to-reach asteroids in the vastness of space is not easy. The carbonaceous asteroids, in particular, are dim and easily missed. And even when they are found, it is hard to determine their size and composition accurately, which directly affects the likely profit. Just 13 meteorites out of the 1,200 or so that have been analysed in detail contain high levels of platinum, for example.

Mining engineers will have to work out ways to anchor, drill into and recover material from what in the trade is known as an 'uncooperative body'. The rocks and dust of 'rubble pile' asteroids are held together almost entirely by their own microgravity, so a mining robot would have nothing to anchor itself to. Cracking this problem will need input from materials scientists and physicists.

To promote such research, NASA's new goal should not be exploration, but enablement of the commercial development of space resources. Exploration will follow naturally. And once profits from asteroid mining start to flow, scientific exploration will be the winner. ■

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