

MINING

THE

MOON

AND

BEYOND

As we use up Earth's supply of minerals that are crucial to our lives, the race is on to extract them from space

Precious metals like gold and platinum are used in everything from cell phones and computers to jewelry. These elements are valuable partly because they're hard to find on Earth. They're often buried deep beneath Earth's surface, and digging them out can be expensive, dangerous, and destructive to the environment.

In fact, we've already used up most of the precious metals that were easy to find. Some companies are setting their sights on hard-to-reach places like the seafloor to find these elements. But with mineral supplies becoming harder to reach on Earth, other entrepreneurs are making plans to leave our planet to find more.

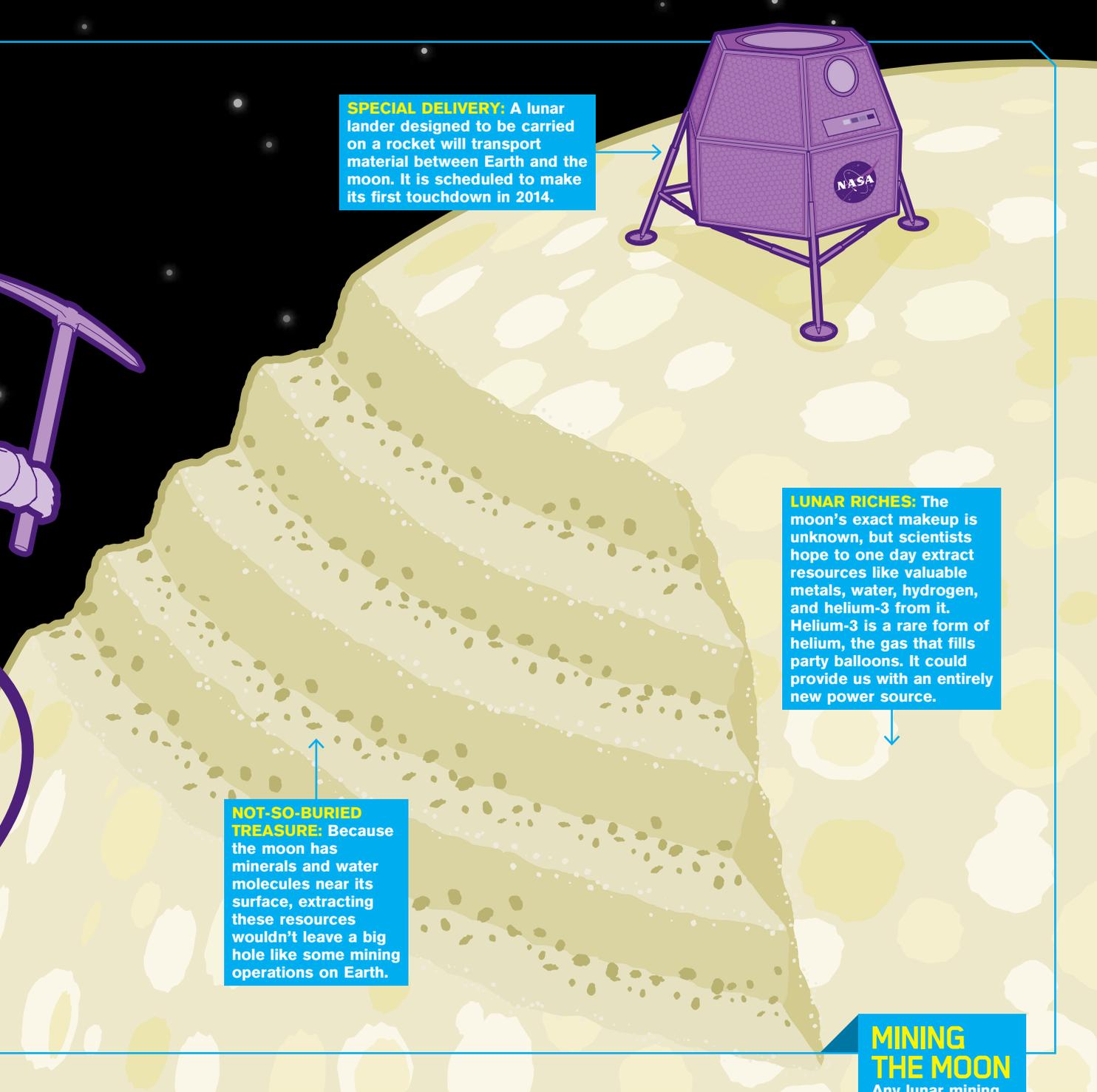
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DESTINATION: THE MOON

Moon Express, a California-based company, wants to hunt for metals like platinum and palladium on the lunar surface. They also want to harvest water, which scientists have recently discovered is much more common on the moon than once thought.

The moon is continually bombarded by asteroids—that's why it's pockmarked with craters. The mineral-rich rocks usually burn up in Earth's atmosphere. But the moon has



SPECIAL DELIVERY: A lunar lander designed to be carried on a rocket will transport material between Earth and the moon. It is scheduled to make its first touchdown in 2014.



LUNAR RICHES: The moon's exact makeup is unknown, but scientists hope to one day extract resources like valuable metals, water, hydrogen, and helium-3 from it. Helium-3 is a rare form of helium, the gas that fills party balloons. It could provide us with an entirely new power source.

NOT-SO-BURIED TREASURE: Because the moon has minerals and water molecules near its surface, extracting these resources wouldn't leave a big hole like some mining operations on Earth.

MINING THE MOON
Any lunar mining in the near future will probably be carried out by robots. But eventually, astronauts on their way to distant regions of space could stop on the moon to gather water and mineral resources.

no atmosphere. Asteroids crash-land, depositing their minerals on the moon's surface.

Moon Express wants to use the moon's resources to aid space missions. Astronauts need water to drink and hydrogen from water could be used as fuel. If a base on the moon could be set up and water and other resources collected, space missions could easily be launched from there, says Moon Express spokesman Brad Kohlenberg (*see Mining the Moon, above*).

The company is working with NASA to develop a lunar lander, which they hope will visit the moon in 2014. But actual mining operations wouldn't begin until many years later. First, says Kohlenberg, "we need to figure out where this stuff is on the moon and the best way we can get to it."

DESTINATION: ASTEROIDS

Planetary Resources, a company based in Washington State, also wants to go hunting

for minerals in space. Earlier this year, it announced plans to send spacecraft right to asteroids to extract precious metals.

Most asteroids in our solar system are found in the *asteroid belt* between Mars and Jupiter. It would take a long time to reach these distant space rocks. But a few thousand asteroids have orbits that bring them closer to Earth. Scientists know about the composition of these rocky objects from fragments that have fallen to Earth as *meteorites*, explains Alfred McEwen, a planetary scientist at the University of Arizona.

Some asteroids are rich in platinum and palladium, another element that's used in electronics. On Earth, these elements separated from lighter elements like calcium and silicon as the planet formed and then they sank toward Earth's center. That's why the highest concentrations are deep underground. But on asteroids, says McEwen, these metals are on the surface.

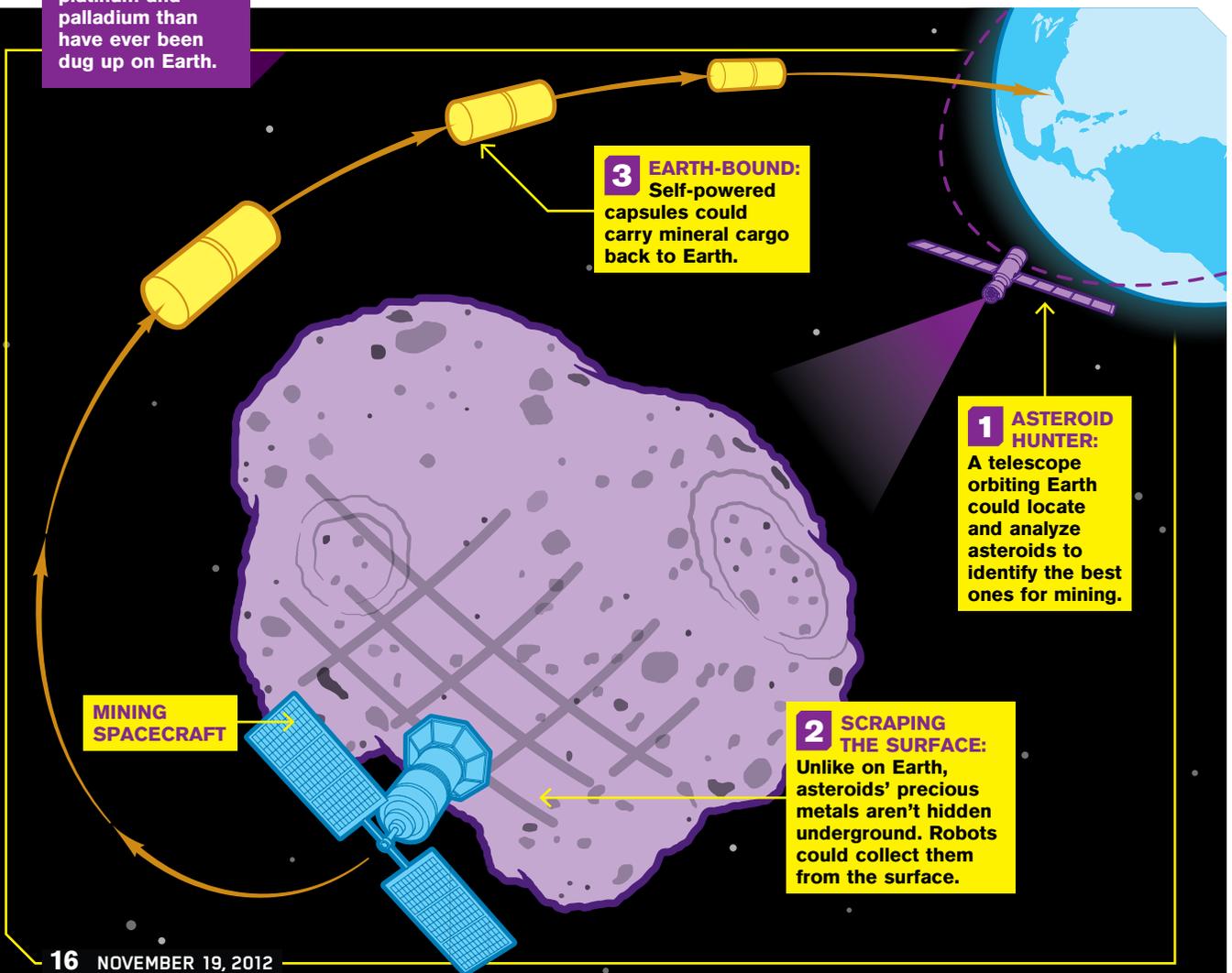
Planetary Resources estimates that a typical asteroid could contain precious metals worth \$100 billion. In the next two years, the company intends to launch a space telescope to spot nearby asteroids and analyze their mineral content from a distance. Once the company identifies the most promising space rocks, it wants to send robotic spacecraft to extract minerals and bring them back to Earth (*see Mining an Asteroid, below*).

The company claims asteroids could provide a practically infinite supply of metals that are scarce on Earth. But space travel is expensive, and McEwen wonders if the asteroids' potential bounty is worth the cost of sending spacecraft all the way there and back.

"I'm skeptical that this will ever be a great way to bring materials back to Earth," he says. "But using them *beyond* Earth is a different scenario." He agrees with

MINING AN ASTEROID

According to Planetary Resources, a company planning to send mining missions to nearby asteroids, just one of the rocky bodies could contain more platinum and palladium than have ever been dug up on Earth.



Kohlenberg of Moon Express that we'd be best served by setting up remote bases in space and using the resources on the spot to fuel space exploration.

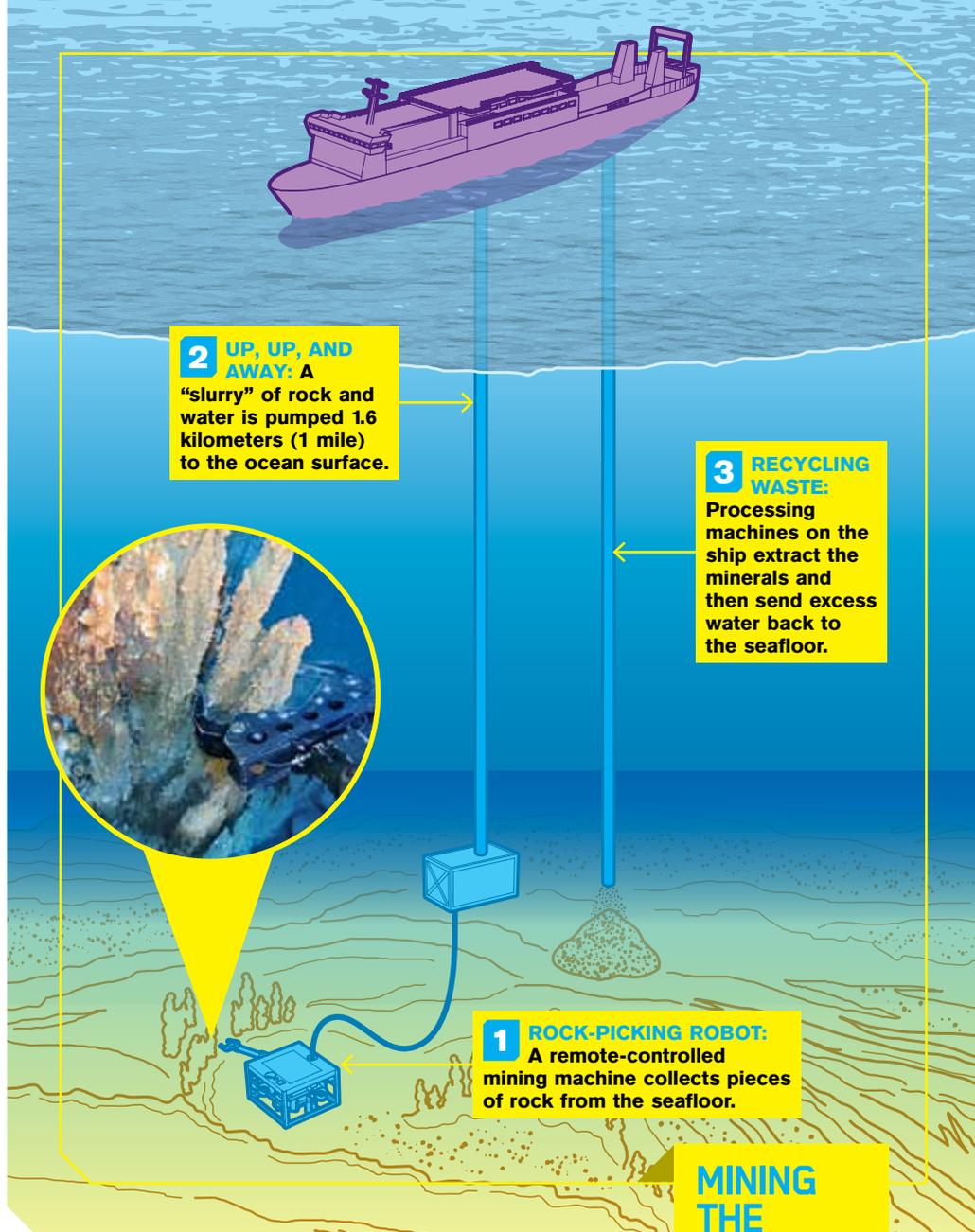
DESTINATION: THE SEA

Space mining is still a long way off. In the meantime, the mining industry has found another new source of precious metals right here on Earth: the bottom of the ocean. A Canadian company called Nautilus Minerals is planning the world's first deep-sea mining project to collect copper and gold on the seafloor.

Nautilus plans to mine in the western Pacific Ocean at a *subduction zone*—an area where a continental plate slips under the plate next to it. This movement creates volcanic activity. *Hydrothermal vents* in the seafloor spew out superheated water full of dissolved minerals from deep within Earth. When the hot water hits cold seawater, those minerals separate out to form rich rock deposits.

The company says it won't harm the deep-sea environment, but some urge caution. Hydrothermal vents are teeming with life, says marine biologist Greg Rouse at the University of California, San Diego. Giant tubeworms, as well as rare shrimp and crabs, adapted to withstand boiling temperatures live around vents. Scientists know little about these species, so it's impossible to ensure that mining won't harm them, says Rouse. "[Mining] might damage the vents, and then the animals would likely die," he says.

Nautilus plans to begin its mining operation about 30 kilometers (19 miles) off the



2 UP, UP, AND AWAY: A "slurry" of rock and water is pumped 1.6 kilometers (1 mile) to the ocean surface.

3 RECYCLING WASTE: Processing machines on the ship extract the minerals and then send excess water back to the seafloor.

1 ROCK-PICKING ROBOT: A remote-controlled mining machine collects pieces of rock from the seafloor.

MINING THE OCEAN

In Nautilus Minerals' deep-sea mining operation, underwater vehicles would send mineral-rich rock to a production ship at the surface. Barges would ferry the minerals from the ship to shore.

shore of Papua New Guinea, next year. The company will use remote-controlled underwater machines, including a large robotic arm, to break off chunks of rock (see *Mining the Ocean*, above). Nautilus hopes to haul up about 1.3 billion kilograms (2.9 billion pounds) of gold and copper a year from the site.

While mining the seafloor or objects in space might seem like far-flung ideas, they're rapidly becoming a reality. In a few years, your cell phone or computer could have a little bit of moon rock inside. ✨

—Mara Grunbaum

WHAT DO YOU THINK?

If companies don't find new sources of rare minerals, what problems might that cause for people?