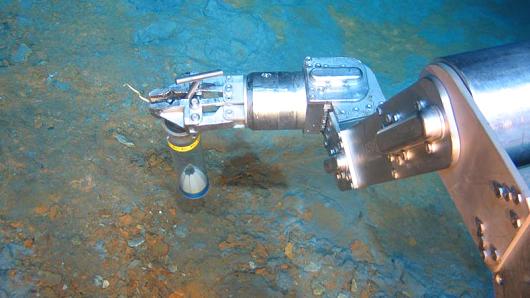
**Future of mining may be on the ocean floor**

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Mining for minerals such as [copper](http://data.cnbc.com/quotes/%40HG15M) could become more efficient and cause fewer environmental problems if miners look for their minerals at the bottom of the ocean rather than on land, according to a study—but some scientists say deep-sea mining may have harmful consequences that we still do not fully understand.



Source: Nautilus Minerals

Underwater operations by Nautilus Minerals

[Nautilus Minerals](http://data.cnbc.com/quotes/NUS-CA) is a company based in Australia and listed on the Toronto Stock Exchange that wants to harvest copper from the hot vents at the bottom of the ocean that spew sulfur and other minerals rising from the earth's mantle—the layer of earth directly below the planet's crust. The company commissioned Tacoma, Washington-based consultancy [Earth Economics](http://www.eartheconomics.org/) to compare the environmental impacts of their own mining methods with land-based mining operations now in use around the world.

Nautilus is in its construction phase and plans to begin production off the coast of Papua New Guinea at a site called Solwara 1 in the first quarter of 2018.

The report says demand for copper, one of the most commonly used metals on earth, will continue to climb, with everything from infrastructure to medical technology and electronics requiring the metal.

Executives from Nautilus are also betting that existing, terrestrial sources of copper are becoming scarce and more socially and environmentally dangerous to mine, but that the seafloor holds abundant reserves of copper and other minerals.

"I think it is important to apply the precautionary principle here. And if you don't know very much about the potential effects on an ecosystem, you have to sort of assume the worst." -Craig Smith, professor of oceanography, University of Hawaii, Manoa

"We double the amount of copper we use every 10 years or so. The global market uses 20 million tons now, we will need 40 million tons in 2030. The question is: Where is that going to come from?" said Mike Johnston, CEO of Nautilus.

Nautilus' proposed operation would be unique among mining companies. The area it wants to mine is a patch of ocean floor roughly 1,600 meters below the ocean surface. The company is building a ship that hosts an on-board refinery and a control center where crew members operate giant machinery that cuts the rock around the vents. Rock and seawater are then pumped up to theship, where the copper is processed and then sent to factories on land for further manufacture.

Earth Economics compared the potential effects of the Papua New Guinea site with three major land-based mines around the world—one each in Utah, Australia and Ecuador.

The Earth Economics report concludes that mining on the ocean floor would have little impact on the environment or on people, compared with the copper mines the group studied on land.

Terrestrial mining companies flush massive amounts of freshwater to collect the mineral-rich dirt and rock in mines, which are then filtered back out as minerals are extracted. Because they use salt water instead, a deep-sea mining operation would not waste valuable freshwater.

And deep sea mines would not displace communities that might be living on rich deposits or near processing facilities, the report said.

"With few exceptions, people inhabit or directly use the landscapes where copper mines are established," the report said. "There is a long history of conflict between mine operators and people living within, around and downstream of copper mines, tailings and smelter sites."

Nautilus' methods for managing waste water and debris are also less risky to the environment than terrestrial methods, the report says. The seawater and unneeded debris that are left over once Nautilus extracts the copper are separated and pumped back down to the ocean floor. That's different from most land-based mining operations, which usually pump their waste water and unwanted debris into large holding pools, or into disposal heaps.

Earth Economics received a fee from Nautilus "on the order of $60,000" for its work, said Earth Economics Executive Director David Batker, and there are no other financial relationships, such as investments, between the two companies. The group had performed a previous impact report for an outside investor in Nautilus, but Batker said that report is confidential.

**Possible risks**

Craig Smith, a professor of oceanography at the University of Hawaii, Manoa, said that the report does not fully account for the potential effects of something called the "plume"—clouds of debristhat float in the water near the bottom of the ocean at the mining site, and possibly carried further by currents.

A nearby underwater volcano already creates a plume made of particles of rock that hangs in the water several meters above the floor.

Earth Economics did not try to estimate the impact of a mining plume from Solwara 1, saying that its impact would be smaller than that already produced by the volcano.

"We considered including damage from the plume," said Batker. "However, we decided not to include the plume area because in the particular case of Solwara 1 the close proximity and deposition area of the volcano's plume overshadows the mine site plume. The volcano's plume dwarfs the plume of the mine site in volume, and it appears that the volcanic plume will continue long after the mining is complete."

But Smith said that alone is not enough to dismiss the potential impact of the plume. The mining plume may behave differently than the volcano's plume, which is buoyed by the heat from the volcano, for example.

"I think there needs to be a study that discounts the impact of the mining plume," he said. "That could double or triple the size of the impact, or more. The fact is we just don't know."

Smith said that the premise of the study—that seabed mining may have fewer environmental impacts than terrestrial mining, is a "valid perspective." But caution is the best policy, he said.

"I think it is important to apply the precautionary principle here," Smith said. "And if you don't know very much about the potential effects on an ecosystem, you have to sort of assume the worst."

Nautilus' Johnston said his company hired consultants to examine the potential effect of a miningplume. They found that it would sit not more than 300 meters above the ocean floor, and that most of the mine's plume would settle within a hundred meters from the mine site.

"We have been working with the Papua New Guinea regulator playing around with mine plume variables to come up with a preferred plume outcome," Johnston said. "In all the cases we have run, the mine plume is orders of magnitude smaller than the natural plume."

**Analysis Questions**

1. **What effects can ocean floor mining have on the environment?**

**Claim:**

**Evidence:**

**Reasoning:**

1. **What will happen to the price of copper as a result of increased mining of the ocean floor?**

**Claim:**

**Evidence:**

**Reasoning:**