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Sunken Treasure: The Deep Sea Mining Renaissance

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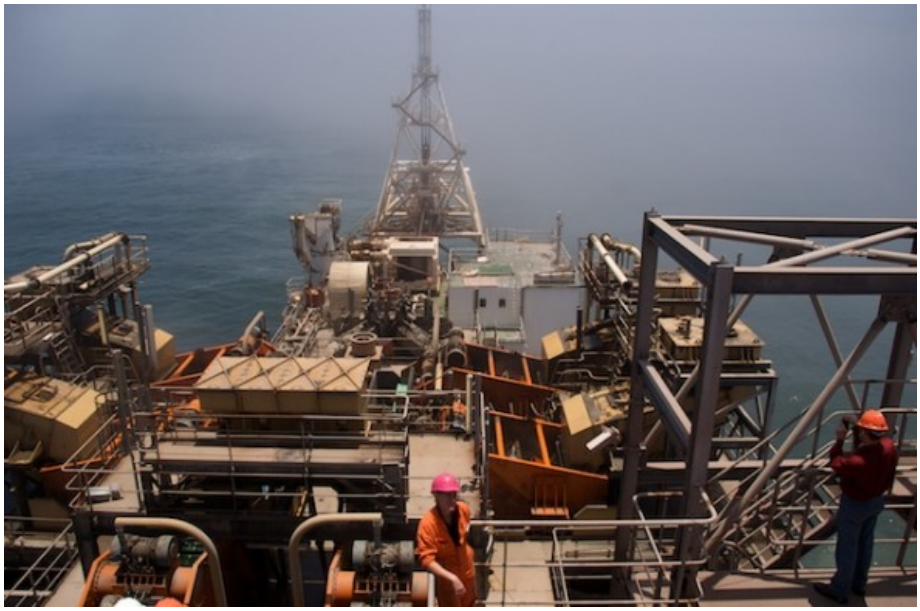
Mining the ocean floor is an idea that sounds at first like quaintly retro science fiction— like something from a Tintin comic replete with jetpacks and moon colonies. Partly that's because, until recently, drilling precious metals out from under thousands of feet of solid rock would have been unquestionably easier than working a claim the same distance beneath the waves.

Thanks to steady improvements in submarine robotics and some surprising geological discoveries on the seafloor, however, the fantasy is becoming real. Within two years, mining interests may start satisfying the growing global hunger for industrial raw materials by hauling up treasure from almost a mile underwater.

Critics insist that more independent evaluation of the environmental risks is needed. "There is much more that we do not know about the deep sea than we do know, so we must employ the precautionary principle widely and be conservative as we move forward," said Charles Fisher, a professor of biology at Pennsylvania State University and expert on hydrothermal vent fauna, during his address (PDF) at the International Workshop on Environmental Management Needs for Exploration and Exploitation of Deep Seabed Minerals held in Fiji Nov. 29 – Dec. 2.

Mining industry officials counter that it will be minimally disruptive — far less so than terrestrial mining. More to the point, the techniques are several orders of magnitude more cost effective than terrestrial mining, requiring a

tiny fraction of the workers at traditional mines and exposing them to far less risk. It's hard to overstate the potential that mining companies see in the deep blue sea. Consider: South Africa's De Beers, the world's dominant diamond mining company, considers an area just off of the West African coast to be its prize. "De Beers' most important mining area is, in fact, the Namdeb concessions off the Namibian coast," De Beers executive Mike Brown told the trade publication Mining Weekly in 2009.



De Beers diamond mining ship Peace in Africa. Courtesy Flickr user Oso

Enthusiasm for sea mining ran high in the 1960s, '70s and early '80s, fueled by a combination of moon shot-era technological optimism and the successful precedent of offshore oilfields. Those efforts targeted the recovery of small metallic nodules from the vast abyssal plains three miles deep. Those nodules consist of manganese, copper, nickel and other metals that slowly precipitate out of seawater over millions of years. The formidable depth and scattered distribution of the nodules made mining challenging, however. Mining companies and governments spent an estimated $650 million on the project over the years, and billions more would probably have been needed to make it commercially feasible. When the price of nickel collapsed in the 1980s, interest in the manganese nodules went with it.

The idea of undersea mining never went away completely, however, particularly for valuables at shallower depths. The most lucrative such effort today is the diamond mining along the coast of Namibia by Namdeb Diamond Corp., a joint venture between De Beers Centenary AG, and the government of Namibia. The diamonds in those waters originated in South African geological formations but washed out to sea through the Orange River. According to De Beers, the Namibian marine deposits may total 80 million carats. (By comparison, the Rio Tinto-owned Argyle diamond mine in Australia has produced 670 million carats of rough diamonds over the last 30 years.)

The deposits are only about 150 meters beneath the surface. De Beers operates five mining vessels that work the Namibian waters, in addition to a sixth that takes samples of the seafloor for evaluation. Some of the ships use a robotic device that crawls across the seabed, inhaling diamond-bearing gravel and sending it to the ships through hoses. Others use a large-diameter pipe drill, which the ship tows over a mining site to vacuum up the stones.

Now, a new set of ambitious deep sea miners are hoping to open up much deeper and more novel resources near the submarine volcanic vents called, ominously, "black smokers."

In 1977, oceanographers discovered this type of vent near the Galapagos Rift in the Pacific. Water seeping into these cracks in the seafloor heats up to more than 300 degrees Celsius, picks up sulfur and becomes acidic. Minerals in the exposed rocks dissolve into the acid, then flow out of the smoker vent in a dark plume.

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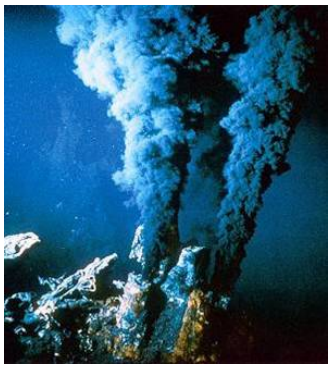
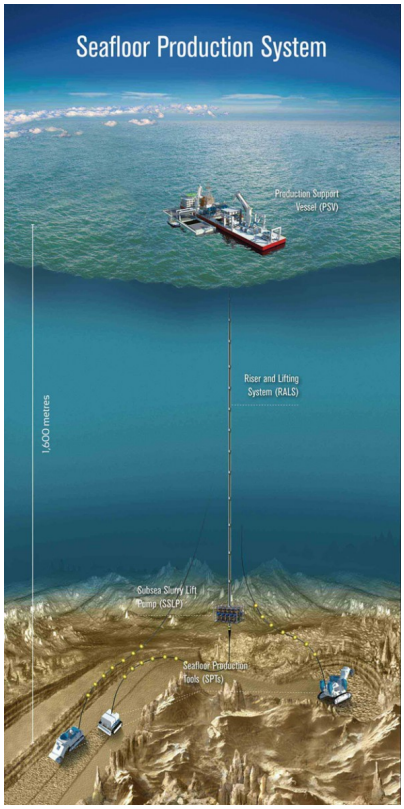
As the plume exits the vent, it almost instantly cools and the minerals drop out, forming tall chimneys around the vent and potato-sized lumps on the surrounding seabed.



A black smoker at work.

What excites mining companies is that these materials are rich in gold, silver, zinc, copper, and even rare earth metals in heavy industrial demand. Moreover, the concentration of the metals can be dozens of times higher than in the ores from terrestrial mines, according to Nautilus Minerals, the Toronto-based company leading the pursuit of the resource.

This past January, Nautilus signed a 20-year lease with Papua New Guinea to develop a vent area 30 miles off its coast, 1,600 meters deep in the Bismarck Sea. That area includes a number of potentially workable black smoker sites, including a 0.11 square-kilometer patch designated Solwara 1, where Nautilus intends to start mining late in 2013.



Nautilus Minerals' extraction system. Courtesy Nautilus Minerals.

Three large robotic devices being built for Nautilus by Soil Machine Dynamics in the U.K. will perform the mining. The Auxiliary Cutter's primary job is to flatten the volcanic chimney while the Bulk Cutter grinds up the metallic chunks. The Collection Machine would then transfer the material to lifting pumps and send it to a support ship on the surface. Other transport ships would eventually ferry the material ashore for further processing.

"We aim to move 1.3 million tons of material per year," says Joe J. Dowling, vice president for investor relations and communications at Nautilus. At that rate, he says, the Solwara 1 resource should last at least two or three years. Hundreds of hydrothermal vent fields have been identified and thousands more may exist, but Dowling says that relatively few of them may be feasible or economical for mining.

Beyond Solwara 1, the company is looking at another site 25 kilometers to the northwest, "and we expect to find other deposits in the Bismarck Sea in the coming years," Dowling says. Nautilus also has rights to areas near Tonga and Fiji, and applications pending with New Zealand and other countries.

Neptune Minerals, a company with offices in Florida and Australia that formed early this year, has reportedly applied for licenses to explore black smoker sites near New Zealand, Japan, Palau and elsewhere. Nations such as China, South Korea, and Russia are also looking into mining the vents. Company officials declined interview requests.

All these exploration plans could yet run afoul of worries about the environmental impact of mining the smokers. The World Wildlife Foundation and the Marine Conservation Society, for example, have expressed concern that mining could kill the vent fields' unique life forms and that pumping could stir nutrients into surface waters and create algal blooms deadly to marine life. Dowling counters that Solwara 1 represents only a small part of the local vent fields and the company plans to create a set-aside area five times larger for preserving vent life that can recolonize Solwara 1 when mining is done. He also says that the mining processes are designed to prevent sediments and water from near the seafloor from being released higher up.

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Diamonds and metallic nuggets are only the beginning of the resources that developers may soon draw from the ocean floor. Mining interests are also looking, for example, at crusts rich in cobalt and ferromanganese on higher elevation seamounts and at methane hydrate formations that could yield vast amounts of natural gas. Expect the environmental controversies to persist long after the technological challenges succumb.

Top image: Rough diamonds. Courtesy De Beers

John Rennie is an editor at large for Txchnologist. He served as editor in chief of Scientific American between 1994 and 2009 and is an adjunct instructor in New York University's Science, Health and Environmental Reporting Program. His last story for Txchnologist was about Google's driverless cars. John blogs at The Gleaming Retort can be found on Twitter @tvjrennie.

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