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Mining a Mile Down: 175 Degrees, 600 Gallons of Water a Minute

Rio Tinto plans to deploy tens of thousands of electronic sensors to help operate its deepest underground mine to date



Rio's Resolution copper mine, more than a mile below ground, contends with constantly dripping water and temperatures nearing 175 degrees. PHOTO: MARK PETERMAN FOR THE WALL STREET JOURNAL

By **STEVEN NORTON**

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SUPERIOR, Ariz.—One of the world's largest untapped copper deposits sits 7,000 feet below the Earth's surface. It is something operator Rio Tinto PLC wouldn't have touched—until now.

Not that long ago, an abundance of high-grade copper could be mined out of shallower open pits. But as those deposits are depleted and high-grade copper becomes tougher to find, firms such as Rio have been compelled to mine deeper underground.

Advances in mining technology are making that possible—just as developments in oil and gas drilling heralded the fracking revolution. Now, using everything from sensors and data analytics to autonomous vehicles and climate-control systems, Rio aims to pull ore from more than a mile below ground, where temperatures can reach nearly 175 degrees Fahrenheit.

“Copper has just become a lot harder to get, and we're relying on technology to keep dealing with that decline in grade,” said Craig Stegman, Rio's vice president for operational and technical support for copper and diamonds.

The company bets the Resolution Copper Mining project, a joint venture in Superior, Ariz., between Rio and BHP Billiton Ltd., could one day supply a quarter of U.S. demand for the metal each year. It plans to spend \$6 billion to \$8 billion on the mine, which the company hopes to bring into operation in the mid-2020s, when a lengthy approval process is expected to end. That includes completion of an environmental-impact statement, a process managed by the U.S. Forest Service.



Pumps remove 600 gallons of water a minute from Resolution's No. 10 mine shaft. PHOTO: MARK PETERMAN FOR THE WALL STREET JOURNAL

Rio expects Resolution will be one of its most advanced projects because the company can design the mine with the latest technology in mind, rather than retrofitting it after the mine begins operating.

Most of the world's copper is extracted from open pits at the Earth's surface, according to the International Copper Study Group. Some mines are deeper than the Resolution mine, but this is Rio's deepest underground mining project to date. While a deep underground block-cave mine costs much more to develop, Rio says it can match the operating costs per ton of ore of a surface mine, partly because it's so mechanized.

"Because Resolution is so deep and so hot, it's really going to push the envelope of technology," said Mary Poulton, professor emerita of mining and geological engineering at the University of Arizona.

As with the development of new hydraulic-fracturing and horizontal-drilling techniques to extract oil from shale-rock deposits, locating and extracting the copper successfully requires deployment of new technologies such as cheaper, more powerful sensors and breakthroughs in the use of data.

"Whoever gets underground and figures out technology for underground is going to be ahead," said Theophile Yameogo, a partner with Ernst & Young LLP's mining and metals practice.

A 15-minute elevator ride 6,943 feet down Resolution's No. 10 mine shaft leads to a dimly lighted cavern where warm water falls from the rocks like rain. Electrical gear buzzes constantly, and a network of pipes pumps water out of the shaft at the rate of 600 gallons a minute. A ventilation system cools the area to 77 degrees.

Over the next few years, Rio plans to deploy tens of thousands of electronic sensors, as well as autonomous vehicles and complex ventilation systems, to help it bring 1.6 billion tons of ore to the surface over the more than 40-year projected life of the mine.

Data coming from those sensors will be fed into analytics engines that will help monitor tasks ranging from underground blasts to the movement of autonomous vehicles.

To operate the mine, Rio's systems will juggle terabytes of data from extra-durable sensors and other sources in the mine. When monitoring safety, for example, it has to track rock movements during the mining process, keep vehicles from running into each other and ensure human employees aren't overheating or inhaling too much dust.



To monitor safety, sensors juggle many different kinds of data. PHOTO: MARK PETERMAN FOR THE WALL STREET JOURNAL

Rio hopes analytics will help to break down organizational silos. Rather than one person viewing data about a specific part of the mining process, information from across the mine can be sent to a single place where experts can obtain a more holistic view of operations.

“It is taking a lot of the decision-making out of the hands of the operator and putting it into a group of specialists who can manage the whole system,” Mr. Stegman said. Rio will test some of these systems at other mines before deploying them at Resolution, but the company doesn’t have another project operating at Resolution’s depth and temperature.

Rio is working with manufacturers including Caterpillar Inc. and Komatsu Mining Corp. to build battery-powered electric loaders and other equipment than can operate in the mine’s underground tunnels.

Sensor data will travel wirelessly to a central database on Rio’s network. That data exists in a number of systems, including CaveCAD, Rio’s proprietary underground-mining information-management system. Equipment information is housed in a system underpinned by SAP SE, and third-party software tools manage ventilation and water information.

“The challenge is how we integrate all of this data,” Mr. Stegman said.

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