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Copper: Breakthrough techniques for exploration, processing, and environmental monitoring

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Copper is arguably the most important metal for energy scenarios because it is essential for manufacture and deployment of low-carbon electricity generation, transmission and storage, and vehicle electrification. Copper is also essential for modern economies because it is required for expansion of infrastructure such as wiring for electricity distribution and telecommunications, air conditioning and space heating, plumbing, industrial equipment, rail and public transportation systems, and vehicles. Consider that the built environment of the European Union, United Kingdom, United States and other high-income countries contains 156 kg/capita, whereas in India and other similar lower-middle and low-income countries is 0.5 kg/capita. Hence, business-as-usual global economic development requires an enormous amount of copper, exceeding one billion tonnes of copper for India and countries across Africa.

Our challenge is that this copper demand is significantly greater than projected copper supply. Copper production from existing mines will decrease over the next few decades because due to announced mine closures and decreasing ore grades, and the discovery of new copper occurrences that can be mined continues to decline. The dearth of discovery of new copper occurrences indicates that available exploration methods are no longer successful. Here we describe a novel hydrogeochemical technique that uses the isotopic composition of ground and surface water as a probe for the presence of copper sulfide minerals beneath cover. The technique was developed by collaborating with mining companies around the world. The non-invasive technique can identify and distinguish among chalcopyrite, chalcocite and bornite and whether or not chalcocite is hypogene or supergene. The technique requires 250 mL of water and results, and interpretation are typically available within one to two weeks. The technique can be used for brownfield expansion projects and greenfield exploration. The hydrogeochemical technique can also be used to monitor mineralogy during heap leaching operations, allowing operators to tailor lixiviant chemistry to increase production rates and total recovery. The technique can also be used to quantitatively determine the source(s) of metals in the environment.