Pioneering study gives new insight into formation of copper deposits

March 17 2021

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A groundbreaking study has given new insights into how copper deposit-forming fluids are transported naturally from their source deep underground towards the Earth's surface.

A team of geologists, led by Lawrence Carter from the University of Exeter's Camborne School of Mines, has published a new theory for how porphyry copper deposits form.

Porphyry deposits provide around 75 percent of the world's copper which is in increasing demand for electric vehicles, power infrastructure and green technologies such as wind turbines. They originally develop several kilometers below the Earth's surface above large magma chambers. Not only are porphyry deposits rare but most large near-surface examples have already been found. Any new model for how and where they form will be of great interest to mining companies.

In the new study, the researchers have shown that vast quantities of mineralising fluids could be extracted and transported from their source magmas and focussed into the ore-forming environment through "crystal mush dykes."

Lawrence Carter, a final year Ph.D. student at Camborne School of Mines, based at the University of Exeter's Penryn Campus said: "Our study addresses the missing link in models for the formation of porphyry-type copper deposits—how vast quantities of mineralising fluids are extracted and transported from their source magmas and focussed into the ore-forming environment.

"In doing so we provide the first field, petrographic and microscale evidence for fluid transport through what we term 'crystal mush dykes." Their recognition is paramount to the development of more reliable porphyry exploration models and has significance for other ore-forming systems and volcanic processes."

Collaborating with scientists from the British Geological Survey (BGS) and University of Surrey, this research involved field studies and micro-textural and geochemical analyzes of samples from the archetypal Yerington porphyry district in Nevada, where an exceptional ~8 km palaeo-vertical cross-section through a number of porphyry copper deposit systems is exposed.

The team were able to identify a wormy interconnected network of quartz within dykes found in rocks that were once beneath the copper deposits. This represents palaeo-porosity in a once permeable magmatic crystal mush of feldspar and quartz. The mush acted as conduits for vast quantities of porphyry-deposit-forming fluids from deep portions of underlying magmas.

It is believed that this breakthrough may provide insights for the discovery of new porphyry copper deposits, and the proposed mechanism key to the formation of other ore deposit types as well as degassing processes in volcanic systems.

The paper, titled "Crystal mush dykes as conduits for mineralising fluids in the Yerington porphyry copper district, Nevada," was published in the leading journal *Nature Communications Earth & Environment* on March 17, 2021.

More information: Lawrence C. Carter et al. Crystal mush dykes as conduits for mineralising fluids in the Yerington porphyry copper district, Nevada, *Communications Earth & Environment* (2021). DOI: 10.1038/s43247-021-00128-4

Provided by University of Exeter