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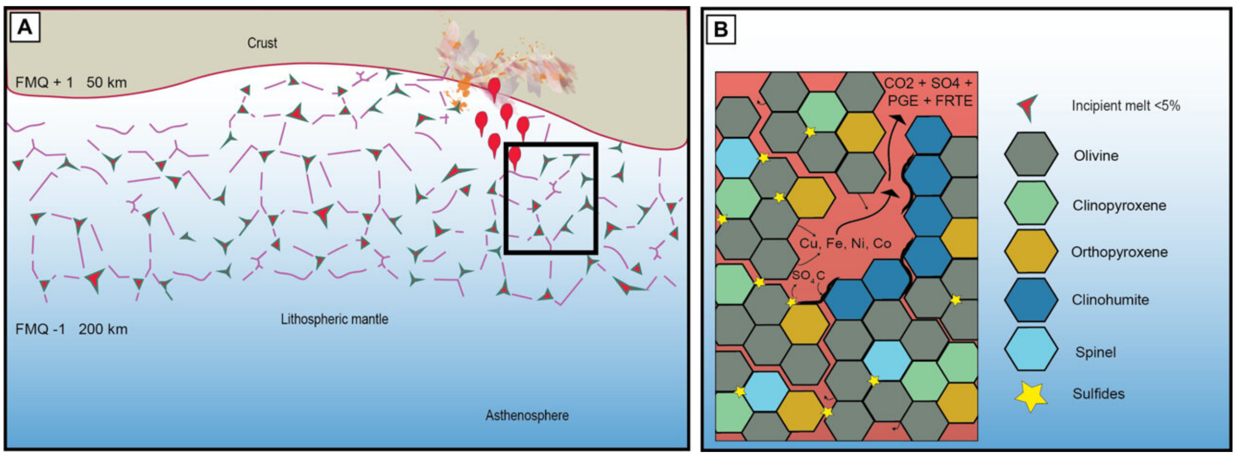

Credit: *Science Advances* (2024). DOI: 10.1126/sciadv.adk5979

Research led by Macquarie University sheds new light on how concentrations of metals used in renewable energy technologies can be transported from deep within the Earth's interior mantle by low temperature, carbon-rich melts.

The findings published this week in the journal *Science Advances* may assist global efforts to find these valuable raw materials.

An international team led by Dr. Isra Ezad, a postdoctoral research fellow from Macquarie University's School of Natural Sciences, carried out high pressure and high temperature experiments creating small amounts of molten carbonate material at conditions similar to those around 90 kilometers depth in the mantle, below the Earth's crust.

Their experiments showed carbonate melts can dissolve and carry a range of critical metals and compounds from surrounding rocks in the mantle—new information that will inform future metal prospecting.

"We knew that carbonate melts carried rare earth elements, but this research goes further," says Dr. Ezad.

"We show this molten rock containing carbon takes up sulfur in its oxidized form, while also dissolving precious and base metals—'green' metals of the future—extracted from the mantle."

Most of the rock that lies deep in the Earth's crust and below in the mantle is silicate in composition, like the lava that comes out of volcanoes.

However a tiny proportion (a fraction of a percent) of these deep rocks contain small amounts of carbon and water that causes them to melt at lower temperatures than other portions of the mantle.

These carbonate melts effectively dissolve and transport base metals (including nickel, copper and cobalt), precious metals (including gold and silver), and oxidized sulfur, distilling these metals into potential deposits.

"Our findings suggest carbonate melts enriched in sulfur may be more widespread than previously thought, and can play an important role in concentrating metal deposits," says Dr. Ezad.

The researchers used two natural mantle compositions: a mica pyroxenite from western Uganda and a fertile spinel lherzolite from Cameroon.

Thicker continental crust regions tend to form in older inland regions of continents, where they can act as a sponge, sucking up carbon and water, Dr. Ezad says.

"Carbon-sulfur melts appear to dissolve and concentrate these metals within discrete mantle regions, moving them into shallower crustal depths, where dynamic chemical processes can lead to ore deposit formation," Dr. Ezad says.

Dr. Ezad says that this study indicates that tracking carbonate melts could give us a better understanding of large-scale metal redistribution and ore formation processes over Earth's history.

"As the world transitions away from fossil fuels to battery, wind and solar technology, demand for these essential metals is skyrocketing, and it's becoming harder to find reliable sources," says Dr. Ezad.

"This new data provides us with a mineral exploration space previously not considered for base and precious metals—deposits from carbonate melts," she says.

More information: Isra S. Ezad et al, Incipient carbonate melting drives metal and sulfur mobilization in the mantle, *Science Advances* (2024). DOI: 10.1126/sciadv.adk5979

Provided by Macquarie University