New research in Malawi will help to secure raw materials for green technologies

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Pioneering new insights into why high concentrations of some of the most rare and desirable natural elements - vital for the production of vital environmental, digital and security technologies - have been revealed.

Pivotal new collaborative research, led by the world-famous Camborne School of Mines, based at the University of Exeter's Penryn Campus in Cornwall, provides a ground-breaking explanation of why remarkably high levels of these crucial earth elements are found at the Songwe Hill Rare Earth Project in Malawi, Southeast Africa.

The research team insisted that the new findings could pave the way for mining companies to significantly increase the likelihood of enhancing the global security of the supply of critical, yet rare, earth elements.

The innovative findings are published in the respected journal *Ore Geology Reviews*.

At present, many of the 15 naturally occurring rare earth elements are essential components in the vast majority of green and digital technology production and advances.

These include neodymium, a 'light rare earth' element vital for the production of permanent magnets in electric cars, wind turbines and smartphones; and 'heavy rare earth' elements such as dysprosium, europium and terbium which are used in lighting, anti-fraud and safety technologies.

However, all 15 are considered as "critical raw materials" by the European Union, due to risks of disruption to the supply by the dominant global producer, China.

The new research reveals that the Songwe Hill carbonatite - an igneous rock containing at least 50 per cent carbonate minerals - is composed not just of the relatively common rare earth mineral synchysite, but also the heavy rare earth-enriched variety of the mineral apatite.

This apatite is the key to why Songwe has a higher content of heavy rare earths than most other similar types of carbonatite host rock.

Dr Sam Broom-Fendley, lead author of the study said: "The occurrence of heavy rare earth rich apatite is particularly uncommon in carbonatites. Our work indicates that you need to 'simmer' these rocks in hot fluids to cause heavy rare earth enrichment. This is particularly useful as combined extraction of both light rare earth minerals and the heavy rare earth rich apatite creates a well-balanced deposit potentially suitable to support the growing magnetics industry."

The research team employed a variety of techniques including cathodoluminescence, laser ablation and electron microprobe analysis, to unravel the sequence of events that formed the rare mineral apatite. It was conducted in collaboration with the UK / Canadian exploration company Mkango Resources, who are working predominantly in Malawi.

William Dawes, CEO of Mkango Resources and co-author of the paper adds: "Mkango is very pleased to have collaborated on this pioneering research into heavy rare earth enrichment at Songwe. Our focus is on developing a new sustainable source of light and heavy rare earths outside China. Pushing the boundaries of research into rare earths through collaborations with leaders in the field is a core theme of the company's strategy."

Frances Wall, Professor of Applied Mineralogy at Camborne School of Mines said, 'A better understanding how and where heavy rare earths can be concentrated helps exploration companies improve their deposit models and increases the chances of a new rare earth deposit coming into production."

Provided by University of Exeter