New path to rare earth mineral formation has implications for green energy and smart tech

December 17 2020

First author Adrienn Maria Szucs with Professor Juan Diego Rodriguez-Blanco in Trinity's Museum Building. Credit: Trinity College Dublin

Researchers from Trinity College Dublin have shed new light on the formation mechanisms of a rare earth-bearing mineral that is in increasingly high demand across the globe for its use in the green energy and tech industries.

Their discovery has important economic implications because there are no substitute alternatives to these rare earth elements (REEs), which are indispensable due to their ability to form small and very powerful magnets essential for smart devices and low-carbon energy generation (e.g., electronics, wind turbines, hybrid cars).

Most REEs are exploited in carbonatite deposits (the largest known carbonatite is the Bayan Obo in China), but scientists still debate how and why they form due to their complicated mineralogy, element composition and geologic history.

There are more than 250 known REE-bearing minerals, but only three are economically viable and exploited commercially. Bastnäsite is likely the primary valuable mineral for REES in the world and was the focus of the Trinity team's study.

By considering how water containing REEs interacted with calcite, a mineral that is ubiquitous in nature and often present in hydrothermal environments, the team discovered a new pathway by which bastnäsite formed.

Adrienn Maria Szucs, Ph.D. Candidate, Trinity, is the first author of the study, which has just been published by the international journal *Crystal Growth & Design*. She said:

"The fact that we need more REEs urges us to find out more about the geochemical behavior of these precious elements. Simply, we need to know a lot more about REEs, and how and why they form, if we want more of them.

"The crystallization pathway we discovered reveals that in some rare earth-bearing deposits the origin of bastnäsite could be simply a consequence of the interaction of calcite with rare earth-rich fluids. This

is not the only reaction that forms bastnäsite but the discovery is particularly important because calcite is found everywhere and is also the most stable calcium carbonate in nature. As a result, it suggests it should be possible to support the formation of bastnäsite under the right conditions."

Juan Diego Rodriguez-Blanco, Ussher Assistant Professor in Nanomineralogy at Trinity, and funded investigator in the Irish Centre for Research in Applied Geosciences (iCRAG), is the Principal Investigator. He said:

"The use of REEs for high-tech products is continually increasing over the years, and therefore the demand for them is also shooting up. This has generated significant geopolitical competition because many REEs have become very valuable.

"Unfortunately, extracting and refining REEs is both financially and environmentally expensive, so work like this is important for bettering our understanding of formation mechanisms of bastnäsite, which in turn helps us improve existing extraction and refinement methods."

More information: *Crystal Growth & Design*, DOI: 10.1021/acs.cgd.0c01313

Provided by Trinity College Dublin