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How Fluids Make or Break Critical Metal Deposits: The Ivigtut Cryolite Body, SW Greenland

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In this time of the green energy transition, the attempt to reduce fossil fuel consumption is inseparable from increasing demand for critical metals, including REEs. Currently, most REEs are mined and processed solely in China, although some deposits exist elsewhere in the world, including the north Atlantic region.

A key target area is Greenland, where igneous complexes associated with mid-Proterozoic continental rifting (termed “the Gardar Province”) host several potential REE deposits. In these complexes, magmatic fluids redistribute the elements of interest, often decreasing concentration but in some cases focussing the resources into a restricted area.

In this research, the Ivigtut cryolite deposit in southwest Greenland is examined. Ivigtut was the world’s largest cryolite deposit (before its complete extraction in the 20th century), and its structure comprises an orebody on top of a small granite cupola. We will present novel stable isotope studies (δ^{7}Li, δ^{34}S) to provide new insight into the origin of the fluid (i.e., meteoric vs. magmatic) and its relationship to the petrogenesis of the granite. At the same time, the atomic-scale processes are recorded by spectroscopy of the minerals crystallised from the fluid, including cryolite (in three colour variations: black, purple, and white), other aluminofluorides, and sulphides.

Lifetime luminescence and UV-Vis spectra of cryolites vary significantly. A few sharp, narrow peaks can be interpreted as lanthanide substitution in the structure, while broad peaks derive from structural defects. Both possibilities, and most importantly their petrological significance, are explored by a combination of spectroscopic methods, geochemical analysis, and thermal treatment.