The Paatusoq Complex and the Spatial and Temporal Evolution of the Gardar Rift, South Greenland

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In partnership with: Durham University, Greenland Rare Earth Projects (London, CASE partner) (Ref: IAP_15_10)

Supervisory Team

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Key Words

Igneous Petrology, Mineralogy, Critical Metals, Economic Geology, Applied Geology.

Overview

The Gardar Province in Southern Greenland is one of the best exposed continental rift provinces in the world, an exceptional natural laboratory to understand mantle and magmatic processes associated with rifting. U-Pb dating has shown that it formed in two rifting episodes at ~1.28 Ga and ~1.17 Ga (Upton et al. 2003 and unpubl data). In the 1990s, a Gardar igneous complex on Greenland’s East Coast was discovered (the Paatusoq Centre). U-Pb dating (1.14 Ga) suggests it is the youngest Gardar centre and preliminary geochemistry shows it has a fluorine-rich, silica-oversaturated composition (Stacey et al. 2014).

Exploration of Paatusoq by Nuna Minerals in 2013 and investment by Greenland Rare Earth Projects (GREP) provide a rare opportunity to place the complex within the big questions of the spatial and temporal evolution of the province. Paatusoq is the youngest and Easternmost centre and hence, by comparisons with other Gardar centres (in the collections of Finch and Humphreys), the development of the sub-continental lithospheric Gardar mantle can be determined as a function of space and time. Gardar centres punch through different basement terranes spanning the Archaean (in the West), Ketilidian granitoid (centre) and Ketilidian metasediments (Paatusoq, East) allowing the nature and extent of interaction with different envelopes to be determined, and thereby how Gardar magma compositions are modified by crustal assimilation.

It is anticipated that this project will include at least one Greenland field season, therefore the applicant must be physically fit.

Methodology

The project comprises fieldwork, petrology and geochemistry leading on to U-Pb, Pb-Pb and Lu-Hf isotope systematics. More precise crystallisation ages will be determined from U-Pb of zircon, and hydrothermal alteration will be dated where possible using combinations of U-Pb on zircon and pyrochlore (McCreath et al. 2012). The timing of melt segregation and source of heavy REE will be determined from Lu-
Hf isotope studies. Crustal assimilation will be examined using Pb-Pb isotopic studies. The project will include training in the field, whole-rock geochemistry by XRF, mineral chemistry by EPMA and mineral trace element geochemistry by LA-ICPMS. The will precede the isotope studies, providing a firm background to understand and interpret the isotope data. The isotope systematics will be performed in the new state-of-the-art isotope suites recently established at St Andrews. All training in these methods will be provided.

This is a CASE studentship with GREP and will involve close links with GREP’s research team on the Paatusoq project. This project is offered alongside a second Gardar project based in Durham led by Humphreys. If both projects are successful, the two students may be asked to work together in the field.

Training & Skills

The project will include one, maybe two, field seasons on the East Coast of Greenland. The applicant needs to be physically fit and unfazed by difficult conditions. Training in arctic geology will be provided by the supervisory team, GREP and their partners Nuna Minerals A/S. The candidate will receive training in the field, in petrology and petrogenesis, and mineral and isotope geochemistry of alkaline rocks and minerals. This will include XRF, EPMA, LA-ICPMS (trace elements) and MC-LA-ICPMS (isotopes). The supervisory team includes experts in alkaline rocks (Finch) and magma chamber processes in both evolved (Humphreys) and basic (Donaldson) magmas.

Timeline

Summer 2016 Fieldwork in Paatusoq (expected, but dependent on funding from GREP)
2016-2017 Petrology and bulk geochemistry, U-Pb, Pb-Pb and Lu-Hf isotope systematics of Paatusoq
Summer 2017 Possibly 2nd field season on Paatusoq
2017-2018 Analysis of second season samples, plus U-Pb and Lu-Hf systematics of other Gardar centres
2018-2019 Comparisons of Paatusoq data with existing data for other Gardar centres. Possible supplementation of data for key Gardar centres if these are unavailable.
End 2019 Submission of thesis for PhD

References & Further Reading


Further Information

Website of GREP: http://greenlandrareearth.com/