Andrew Whitham CASP Fieldwork Award 2022-23 - Winner

Applicant: Emily Madoff
Project title: Layering Mechanisms and Tectonics of Ilímaussaq, South Greenland
Award: £2,920

Scientific question and rationale: Alkaline layered igneous intrusions, like Ilímaussaq, host Rare Earth Element (REE) deposits critical to the energy transition and green economy. However, the genesis and layering mechanisms of alkaline intrusions that are responsible for the concentration of critical metals are hotly debated. Resolving how alkaline intrusions form and evolve, will improve the efficiency of REE exploration and extraction, allowing us to secure the critical metal supply chain to meet the ever-growing global demand for a greener future. I request £2,920 to help cover fieldwork that, with follow-up analyses, will allow me to answer: "What mechanisms were the dominant drivers of layer formation and REE accumulation within Ilímaussaq, and were these affected by contemporaneous tectonic activity?"

Ilímaussaq hosts two world-class REE deposits and provides an ideal natural laboratory to examine layering processes, as it is well-exposed in 3D. A large proportion of previous studies have focussed on the mineralogical and geochemical properties of Ilímaussaq, these data underpin competing models regarding the mechanism of mineral layering. A recent review has highlighted the yet to be realised benefits of a combined structural field mapping and novel textural analysis study using Anisotropy of Magnetic Susceptibility (AMS) which would provide a structural context to interpret the existing geochemical and mineralogical data. If funded this study will be the first modern structural study of Ilímaussaq that is underpinned by quantitative strain analysis including AMS and Anisotropy of Remnant Magnetization (AARM) methods. This analysis will interrogate the origin of textural relationships in these economically important mineral layers. Findings will be applicable to improving the exploration and extraction efficiency of REE from other alkaline layered intrusions.

Specific objectives and deliverables:

1. Map layering within the floor series of Ilímaussaq and along the previously interpreted syn-emplacement Lakseelv Fault using classic geological field mapping methods supported by digital mapping tools and UAV photogrammetry. These maps will detail the structural and textural variation of layering as well as major structural features.
2. Focussed extensive sampling guided by mapping (1) to test cornerstone hypotheses:
    a. sill structures are present within the lujavrite sequence
    b. kakortokite layers formed through a closed system crystal mat formation model
    c. kakortokite layers formed through an open system fluctuation in intensive parameters model
    d. syn-magmatic faulting redistributed crystal mush during the evolution of the igneous complex

Proposed work plan:

April – May 2022: Ship equipment to Greenland, complete wilderness first aid course and risk assessment.
June – July 2022: Complete 5 week field expedition to Ilímaussaq.
Week 1: Recce of field area and identification of sampling sites
Weeks 2-3: Mapping and sampling exercise within kakortokites
Weeks 4-5: Mapping and sampling exercise within lujavrites
August – October 2022: Lab analysis
October – December 2022: Data evaluation
January 2023: Present findings at VMSG and EGU followed by first publication

Proposed expenditure, including details of any other sources of funding: The proposed fieldwork is part of a PhD project funded by The University of St Andrews and IAPETUS studentship, which has a budget that will enable myself and one field assistant to undertake a 5-week field campaign to Ilímaussaq. To maximise the potential of this work, I seek support for the costs of bringing two extra field assistants for two weeks, one of whom has a license for flying UAV, to aid sampling and mapping. Without these additional funds, the maps I will be able to produce and the amount of samples collected will be limited. Specific costs include: (1) transport to field area for two, £2520; (2) food, £200; and (3) shipping of UAV equipment, £200. **Total: £2,920**