Application for EMS Centennial Graduate Research Travel Award

Explain the intellectual merit of your work. How is your current research innovative and important to your field?

Mass extinctions and associated environmental change often occurred simultaneously with the emplacement and CO_2 emissions of large igneous provinces (LIPs) – among the largest volcanic events in Earth history. Due to this relationship, a causal mechanism between LIPs and environmental change is often hypothesised, but the quantification of the carbon emission from the LIP and the timing of these emissions relative to the environmental change is required for further investigation. Estimates of the quantity of LIP gas release are often created via measuring volatile content in individual lava flows, and then extrapolating to the entire LIP. There are multiple issues with lava flow estimates: 1, poor precision on dating (e.g. 10^4 - 10^5 years for Jurassic age lava flows); 2, relating these dates to sedimentary records, wherein the timing of climate changes is often hard to correlate to the lava flows; 3, it is difficult to scale up from a few degassing measurements from individual lava flows to an entire LIP, which may be 100s of kilometres wide, multiple kilometres thick, emplaced over 10^4 - 10^5 years, and incomplete due to erosion. Sedimentary mercury concentrations might offer a solution to these issues, as mercury in the environment is dominantly from volcanism and can be globally distributed after a volcanic eruption.

As mercury from volcanic degassing is found in the same sedimentary record as where environmental changes are recorded (via other geochemical proxies), the comparative timing of the two events is not an issue, solving the first two issues of lava flow estimates. <u>The final issue (quantifying CO_2 emissions from LIPs) is where my work is innovative</u>. I use numerical modelling to convert the volcanic signature in the sedimentary rock record to a volcanic degassing history so that I can quantify the amount of degassing through time. **This provides a novel approach to estimating LIP degassing volume and timing**.

Modelling the exogenic mercury cycle and its reaction to a sudden increase in mercury via LIP degassing has only been attempted very recently. There are many unknowns regarding the mercury cycle on timescales relevant to significant environmental change attributed to LIPs (10^3 – 10^5 years) as it has been relatively understudied in the geological past. **My past research on sedimentary mercury places me in a unique position to better understand the mercury cycle and incorporate stronger, more reliable constraints into a mercury model that can resolve LIP gas emission volumes and rates in the past**. Quantifying the amount of gas emissions (specifically CO_2) and the timescales of these in the geological past, where there are clear records of environmental change, is vital to understanding environmental and biotic responses to a sudden climatic event. Without being able to quantify the driver of change, it is difficult to understand the response of the Earth system.

I aim to use these funds to attend the Fall 2024 Goldschmidt Conference (Chicago, IL). I will present my work creating a mercury record from Prees core, U.K. This core record spans the End Triassic Mass Extinction, and the emplacement of the Central Atlantic Magmatic Province (the LIP hypothesised to have caused the extinction), as well as the

Sinemurian–Pliensbachian carbon cycle perturbation. I have collected mercury concentration data through this core record at high resolution, and will present my findings on the geochemical behaviour of mercury, as well as insights about the timing and magnitude of CO_2 emissions.

Explain the broad impacts of your research.

Periods of increased volcanic degassing in the geological past are the best analogue we have to modern climate change, understanding the environmental dynamics during previous climatic perturbations is key to understanding future environmental effects. There may be short-term climatic feedbacks that have not previously been captured due to the poor time resolution of degassing episodes (from lava flow records) that can now be elucidated by my work since the signature of volcanism and the signature of climate change are recorded in the same rock, and so were deposited coevally. If this is the case, these feedbacks can be analysed in the modern environment to see if they are plausible. The feedback can then be incorporated into climate modelling scenarios to give a better understanding of the Earth system effects from large volume CO_2 emissions.

How will this travel award contribute to your graduate research and professional goals?

I hope to present my work at Goldschmidt in August 2024 under the theme of 'Magmatism, Volcanism, and Their Impacts' and Session 'Large Igneous Provinces and Their Impacts Through Earth History'. Goldschmidt is the premier international geochemistry conference. My specific field of study (Hg chemostratigraphy) is a small field with many researchers outside of the USA who do not routinely attend American conferences. Additionally, there is the LIP-specific session which is not typical of US-based conferences. There will be researchers who may be very interested in my work and have recommendations regarding my findings and future directions. **As a first-year graduate student with very limited conference experience (1), this opportunity is essential for me to gain the skills to present work to the international science community and receive feedback on my work**.

Proposed Travel: Goldschmidt Chicago

Dates: 18-23 August 2024

Expenditure	Estimated Cost ($)	Comment
Flight Ticket	500	Round trip from State College to Chicago (as of March)
Abstract Submission	110	
Lodging	1065	$190 Hotel x5 days
Meals and Incidentals	395	$79 per diem x5 days
Conference Registration Fee	325	Early Bird Graduate Member Ticket
Total	2395	

This award will supplement the bulk of my conference expenses. I have also applied to competitive department awards to help reach the required funding. If funds from this award are secured, my supervisor will be able to use her start-up funds to 'top up' the money to reach the required budget, but her funding is not possible to cover the majority of the budget. This conference is only held in the USA every 4 years. The financial situation of my supervisor means this is the only year in the next 4 years that attendance is feasible.

Curriculum Vitae

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EDUCATION

Doctor of Philosophy, Geoscience, Pennsylvania State University
Start Date: Fall 2023

M.EarthSci., Earth Science, University of Oxford (Integrated Masters)
2018 – 2022
Thesis: *Mercury Perturbations During the Early Pliensbachian (Jurassic) and Implications For Its Use as a Volcanic Proxy*
Thesis supervisors: Stuart Robinson, Tamsin Mather, Isabel Fendley

AWARDS

Academic Excellence Award. St. Anne's College, Oxford, 2020
£250 award for exceptional 3rd-year essay on Dansgaard-Oeschger cycles that was used as an example essay for future students

TEACHING EXPERIENCE

Undergraduate Course Teaching Assistant (2023-Present)
Course: Introduction to Geoscience

- Lectured and oversaw laboratory work of 40 students each semester regarding the basics of geoscience
- Developed a 120-minute laboratory session on recreating climate change in Africa from pollen records

Private Tutor, MyTutor, 2021
Courses: A level and GCSE Science

PUBLICATIONS

Manuscripts to be submitted soon:

O. Neilson, I.M. Fendley, G. P. Weedon, J. Frieling, S. A. Robinson, T. A. Mather, H. C. Jenkyns. *Hg signatures include an orbital-forcing component in a Lower Jurassic section (Belemnite Marls, UK)*

CONFERENCE PRESENTATIONS:

O. Neilson, I.M. Fendley, G.P. Weedon, J. Frieling, S. A. Robinson, T.A. Mather, H.C. Jenkyns. *Variable Hg Signatures and Complex Controls in a Lower Jurassic Section.* Geological Society of America Connects, Pittsburg (2023). (Poster Session)

I.M. Fendley, J. Frieling, **O. Neilson**, M. Ruhl, T.A. Mather, S.A. Robinson, H.C. Jenkyns. *Early Jurassic magmatism and environmental change.* Jurassic Congress (2022) (Not present)