Andrew Whitham CASP Fieldwork Awards 2025 – Winner

Applicant: Daniel Ryczek
Project title: Critical Mineral Enrichment in Natural and Experimental Carbonate Replacement Deposits
Award: £4,000

Scientific question and rationale: As demand for renewable energy transition metals grows, historic and non-traditional ore deposits are being reassessed for their potential to supply critical minerals (CMs) required for the energy transition. Carbonate replacement deposits (CRDs) are dynamic formations that form due to replacement of carbonate minerals with ore minerals through multi-episodic influxes of hydrothermal fluids. Historically mined for base metals (Pb, Zn, Cu), modern analysis and knowledge, indicates that these deposits can host a much wider variety of resources, including CMs [Zheng et al., 2023, Lawley et al., 2021]. CRDs in Ireland have seen continued interest, with some developed into significant base metal mines, where CMs have also been identified during analysis. In contrast, NW England and NE Wales historical base metal districts remain undeveloped and understudied. This project focuses on the Carboniferous carbonates of the UK and Ireland and aims to answer: 1) Are critical minerals significantly concentrated in base metal-bearing CRDs in these regions? And if so, 2) What controls this mineralisation, and can we identify common enrichment processes and trends between regions?

Specific objectives and deliverables: The initial phase of my project has involved compiling geochemical and geophysical survey data (accessed through the BGS, CMIC, NSRI, and UKSO) and analysing >200 historic ore specimens from northern England and NE Wales, housed at the University of Manchester and Manchester Museum using initially handheld XRF. This has been integrated into a GIS dataset to guide targeted fieldwork in each region. Key objectives for the fieldwork phase of this project are to 1) Create high resolution structural maps and sedimentary logs of mineralised localities to determine the relationships between stratigraphic and tectonic features and type and extent of mineralisation, 2) Use field data (i.e. fault kinematics, diagenetic features) to reconstruct the fluid flow and mineralisation history and examine the potential genetic link between basement Caledonian tectonics and carbonate replacement deposits across northern England, Wales, the Isle of Man, and the Irish Midlands. 3) Collect lithological and mineralogical samples for later petrophysical analysis and reaction experiments in UoM's Rock Deformation lab. Key deliverables from fieldwork will include 1) New knowledge on the geological processes and emplacement mechanisms controlling CRD mineralisation 2) A correlative model linking fluid flow and mineralisation to regional tectonics, and 3) updated assessment of CM abundance in NW England and NE Wales.

Proposed work plan: This project proposes a structured fieldwork program targeting CRDs in the UK and Ireland to provide a comprehensive understanding of CRD mineralization, its variability, and its relationship to regional tectonics and stratigraphy.

Fieldwork Locations: The planned fieldwork will include multiple short trips to mineralized areas in Derbyshire and North Wales (local to Manchester base), a one-week expedition to the south of the Isle of Man, and a similar duration trip to the SW Irish Midlands. Potential field sites have been pre-identified using my own GIS database that integrates historical mining records, geological survey data and whole rock geochemistry data. A number of localities have been chosen for mineralization potential (ie. anomalous geochemical signatures) and exposure quality. Reconnaissance during fieldwork will prioritize localities with the best 'along deposit' exposure for assessing the mineralisation characteristics along trend.

Fieldwork Activities: At each locality, we plan to: • Create detailed structural maps and sedimentary logs of mineralized zones • Record mineral types, cement characteristics, and textures related to recrystallization and/or deformation • Analyse deformation features, fracture networks, and their relationship to mineralization • Collect lithological and mineralogical samples for subsequent thin section analysis and laboratory studies.

Post-Fieldwork Analysis: The field data will be synthesized and integrated into my pre-existing GIS database, forming the basis for a correlative model that will link observations from the four field areas, highlighting any shared geological features, mineralization patterns in the context of the regional tectonic and stratigraphic frameworks. Follow-up analysis resulting from field data will include microstructural analysis of thin sections and laboratory petrophysical analysis of hand samples.

Proposed expenditure, including details of any other sources of funding: Proposed budget for travel and subsistence for 2x people during field excursions in N England and Wales (6x 2-day trips) and for 1 person in the Isle of Man (1x week, May) and Irish Midlands (1x week, June), as these excursions will be with some/all supervisors who will pay their own ways.

Flights: Total = £295 (M/c -IoM return - £175), M/c – Dub return - £120), Car Hire and Petrol: Total = £1275 (N England and NE Wales – 12x £50/day, Isle of Man – 5x £85/day, and Ireland – 5x £50/day), Accommodation: Total = £1530 (N England/NE Wales – 6x £90pp, Isle of Man – 6x £75/night, Ireland – 6x £100/night, Subsistence: Total £900 (£25/day pp, 12 days for 2 people, 12 days for 1 person). Full Total = £4000