

Importance of pegmatite and mineral vein segmentation for ore deposits

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Project Highlights:

- Study mineral veins and pegmatites at classic outcrops across the UK
- Be the first to extensively quantify segmentation in mineral veins and pegmatites
- Apply state-of-the-art microscopy and magnetic techniques to unravel fluid flow

Overview:

Mineral veins and pegmatites, igneous rocks with a broadly granitic composition and very coarse crystals, occur in many geological settings and host a variety of crucial ore deposits. Most veins and pegmatites broadly have sheet-like geometries that, regardless of scale or composition, are segmented into discrete elements (Fig. 1). These elements which may be separated by intervening bridges of host rock or connected via 'steps' or 'broken bridges' (Fig. 1) (Magee et al., 2019). The geometry of elements and their connectors influences the overall shape of veins and pegmatites, and may also affect the dynamics of internal fluid flow and thus mineral/metal distributions (e.g., Magee et al. 2016). However, very few studies have quantified the geometry of vein or pegmatite elements and connectors (e.g., aperture, offset; Fig. 1), or their internal fluid flow, making it difficult to predict the subsurface distribution or style of associated ore deposits.

The geometry of mineral veins and pegmatites controls the location of associated mineral and metal deposits crucial to a sustainable energy transition. Key challenges that span structural geology and ore geology disciplines involve: (1) quantitatively analysing the 3D geometry of vein and pegmatite elements and connectors; and (2) reconstructing internal fluid flow patterns. With such information we can build predictive models that forecast the subsurface distribution of mineralising fluids and help identify new mineral/metal deposits. Your findings will therefore be of interest to academics, industries (e.g., mining, geothermal), and policy-makers worldwide. You will communicate findings through scientific papers, presenting at national and international conferences, and other avenues.

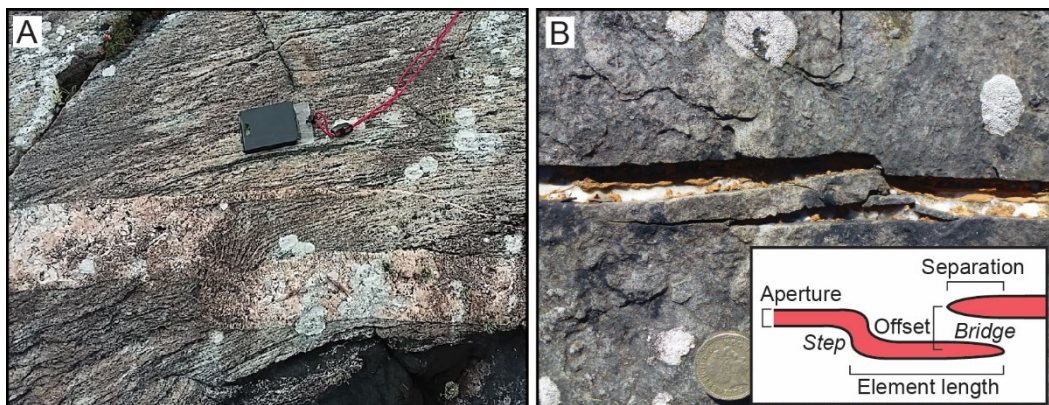


Figure 1: (A) Segmented pegmatite elements separated by a bridge of the Lewisian Gneiss, NW Scotland (B) Mineral vein of quartz and iron-rich carbonate containing a broken bridge of host rock at Wick, N Scotland. Schematic shows terminology describing element and connector geometries.

Methodology:

You will quantify the 3D geometry of mineral vein and pegmatite elements and connectors using a variety of geological and geophysical methods. Specifically, the PhD will involve fieldwork to digitally map a variety of different sheet intrusions, including: (1) pegmatites in the Lewisian Gneiss of NW Scotland (Fig. 1A); (2) pegmatites in Cornwall, SW England; (3) calcite-dolomite veins at Wick, N Scotland (Fig. 1B); and (4) lead-zinc mineral veins in the southern Pennines, England. For selected veins and pegmatites, you will collect samples for detailed rock magnetic analyses that are rarely applied to these structures; these techniques provide information on fluid flow and magnetic mineral evolution, and have been successfully used to understand a wide variety of igneous intrusions. Magnetic techniques will be supported by Scanning Electron Microscopy.

Possible Timeline

Year 1:

- Compile literature data on vein and pegmatite geometries.
- Conduct field campaigns.
- Collect samples for thin section analysis.
- Preparation and analysis of thin sections.
- Present at national conference.

Year 2:

- Complete field campaigns.
- Compile and interpret field data
- Thin section analysis.
- Prepare and analyse rock magnetic samples.
- Present at a national and an international conference.

Year 3:

- Complete thin section and rock magnetic analyses.
- Write-up

Training and skills:

You will be based in the Institute for Geophysics and Tectonics at the University of Leeds and receive training in field skills and/or thin section analysis. Rock magnetic work will be conducted at the University of St Andrews and full training will be provided. Additional training in scientific writing, statistics and data analysis, problem-solving, time management, and developing independent research planning skills will also be provided by us and the TARGET program. Through this training, you will become a confident and independent researcher with transferable skills applicable to both academic and non-academic jobs.

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;
- additional online events and in-person workshops attached to relevant conferences.

Partners and collaboration (including CASE):

You will work with Dr William McCarthy both in the field and during several visits to their M3Ore rock magnetic laboratory at the University of St Andrews, where they will provide full training in all equipment to be used.

Further reading:

Magee, C., Muirhead, J., Schofield, N., Walker, R.J., Galland, O., Holford, S., Spacapan, J., Jackson, C.A. and McCarthy, W., 2019. Structural signatures of igneous sheet intrusion propagation. *Journal of Structural Geology*, 125, pp.148-154.

Magee, C., O'Driscoll, B., Petronis, M.S. and Stevenson, C.T.E., 2016. Three-dimensional magma flow dynamics within subvolcanic sheet intrusions. *Geosphere*, 12(3), pp.842-866.

Bons, P.D., Elburg, M.A. and Gomez-Rivas, E., 2012. A review of the formation of tectonic veins and their microstructures. *Journal of structural geology*, 43, pp.33-62.

Further details:

Please contact Dr Craig Magee (c.magee@leeds.ac.uk) for further information and visit <https://target.le.ac.uk/> for additional details on how to apply.