

Statement of research interests

Summary

My research interests are centred around the formation and exploration of magmatic and magmatic-hydrothermal ore deposits. My primary ongoing research projects include: (1) formation of igneous layering and stratiform ores (e.g., Merensky Reef, Pseudoreef, and Flatreef of the Bushveld, the Stella and Koitelainen PGE-magnetitites); (2) the formation and exploration of magmatic sulphide deposits in the Labrador Trough; (3) the paragenesis of granite-related polymetallic vein systems (e.g., Hemerdon and Redmoor of the Cornubian Batholith). Published, in-press, in-review, and few in-preparation publications are listed at the end of this document.

Previous and current research

Layered igneous intrusions

My primary research interest is layered igneous intrusions and their ore deposits, in particularly, stratiform PGE-sulphides and chromitites. Over the last year, I have compiled physical and chemical characteristics of several hundred layered igneous and alkaline intrusions, which is discussed in a currently in-press publication in *Earth Science Reviews* (listed below). I am particularly interested in the combination of layer-forming and ore-forming processes and am currently studying the Bushveld Complex, Stella, Koitelainen, and Skaergaard. In a series of published and in-preparation publications, collaborators and myself combine SEM-EDS and microXRF element mapping, computed tomography, whole-rock and mineral geochemistry, EBSD microstructural analysis, and CA-ID-TIMS zircon geochronology to produce petrogenetic models for these layered intrusions and their economically-important horizons.

Magmatic Ni-Cu-PGE sulphide deposits

My PhD project at Cardiff University was focussed on the formation of magmatic Ni-Cu-(PGE) and PGE-Cu sulphide prospects in the Labrador Trough, northeast Canada, in collaboration with Northern Shield Resources. The aim of the project is to evaluate the formation for different styles of magmatic sulphide mineralisation in the Montagnais Sill Complex through a holistic approach including petrography, whole-rock and PGE geochemistry, EDS-WDS-LA-ICP-MS mineral chemistry, MC-ICP-MS and SIMS isotope geochemistry, and thermodynamic modelling (MELTS, PELE, COMAGMAT, and MCS). In a series of published, in-press, in-review, and in-prep manuscripts (listed below), we characterise the nature and formation of the newly discovered Idefix and Huckleberry prospects to constrain petrogenetic processes favourable and detrimental to ore formation operating in the Labrador Trough. We argue that crustal contamination led to sulphide segregation prior to the final emplacement of the parent magmas. Contrasting styles and grades of mineralisation reflect several processes including the timing of sulphide segregation, the composition of parent magmas, the mass ratio of silicate to sulphide melt, and the thermal histories of the host sills.

Granites and granite-related ore deposits

My research masters (MRes) at the University of Portsmouth in 2016-2017 was a petrological, geochemical, and geochronological (LA-ICP-MS and CA-ID-TIMS) study of evolved and mineralised S-type granites of the Cornubian Batholith in southwest England in collaboration with the British Geological Survey and several local mining companies. Our aim was to constrain diachronous granite magmatism in the batholith and outline implications this had on the formation of W-Sn-Cu-Zn orebodies. In a 2019 publication (listed below), we argued that two-stage granite magmatism was evident in zircon antecrysts hosted in younger granites and that the decoupling of W-As and Sn-Cu-Zn ores across the batholith reflects two separate ore-forming events.

Despite academically moving away from granites and granite-related ore systems, I retain strong ties with exploration companies working in southwest England. In 2017, I supervised a Masters project focussed on the formation of the sheeted vein system at the active Redmoor W-Sn-Cu-Zn-As prospect in collaboration with Cornwall Resources Limited. Research is currently ongoing whereby we intend to constrain the complex paragenetic sequence of the lodes and investigate the partitioning of chalcophile and siderophile elements in granite-related ore fluids using detailed optical and electron microscopy alongside trace elements and Pb isotopes.

Future outlook

For the future, my aim is to integrate petrological, geochemical, and geochronological data of layered igneous intrusions and the ore deposits to improve our understanding of their formation. Through combining high-resolution 2D and 3D petrological data with precise geochronological data, we can address unresolved aspects of igneous intrusions, including the nature, composition, and mode of emplacement of magmas parental to economically significant layered intrusions, formation of magmatic and/or hydromagmatic igneous layering, and the mechanisms for sulphide segregation, transportation, and concentration.

List of publications

Published

W.D. Smith, J.R. Darling, D.S. Bullen, S. Lasalle, I. Pereira, H.S. Moreira, C.J. Allen, and S. Tapster. (2019). Zircon perspectives on the age and origin of evolved S-type granites from the Cornubian Batholith, Southwest England. *Lithos*, 336, pp.14-26.

W.D. Smith, W.D. Maier, and I. Bliss. (2020). Contact-style magmatic sulphide mineralization in the Labrador Trough, northern Quebec, Canada: implications for regional prospectivity. *Canadian Journal of Earth Sciences*, 57(7), 867-883.

W.D. Smith, W. D. Maier, and I. Bliss. (2020). The geology, geochemistry, and petrogenesis of the Huckleberry Cu-Ni-PGE prospect in the Labrador Trough, Canada: Perspectives for regional prospectivity. *Ore Geology Reviews*, 103905.

W.D. Smith, W.D. Maier, S.J. Barnes, G. Moorhead, D. Reid, and B. Karykowski. (2020). Element mapping the Merensky Reef of the Bushveld Complex. *Geoscience Frontiers*. 12(3), 101101.

W.D. Maier, S.-J Barnes., D. Muir, D. Savard, Y. Lahaye, and W.D. Smith. (2021). Formation of Bushveld anorthosite by reactive porous flow. *Contributions to Mineralogy and Petrology*, 176(1), 1-12.

In-press

W.D. Smith, W.D. Maier, I. Bliss, and L. Martin. (in-press). In situ multiple sulfur isotope and S/Se composition of magmatic sulfide occurrences in the Labrador Trough, northern Québec. *Economic Geology*.

W.D. Smith and W.D. Maier. (in-press). The geotectonic setting, age and mineral deposit inventory of global layered intrusions. *Earth Science Reviews*.

In-review

W.D. Smith, W.D. Maier, and I. Bliss. (in-review). Distribution of noble metals in magmatic sulfide occurrences of the Montagnais Sill Complex, Labrador Trough, Canada. *Canadian Mineralogist*.

Selected in-preparation manuscripts

W.D. Smith, W.D. Maier, J.Ø. Anderson, D.D. Muir, E.T. Mansur, and I. Bliss. (in-prep). Accessory phase perspectives for ore-forming processes and magmatic sulphide exploration in the Labrador Trough.

W.D. Smith, W.D. Maier, D.D. Muir, J.Ø. Anderson, C. Tully, and B. Williams (in-prep). New perspectives for the formation of the Boulder Bed in the western Bushveld Complex, South Africa.

W.D. Smith, W.D. Maier, D.D. Muir, J. Heinonen, J.Ø. Anderson, C. Tully, and B. Williams. (in-prep) The Merensky Reef at the Rustenburg Platinum Mine of the Bushveld Complex: new constraints from element mapping, mineral chemistry, microstructures, and thermodynamic simulations.

W.D. Smith, G.A. Lawson, J.R. Darling, D.S. Bullen, and J. Blight. (in-prep). The Sheeted Vein System of the Redmoor W-Sn-Cu prospect in the Cornubian Batholith, southwest England: mineral paragenesis, chemistry and Pb isotopes.