Tracing the origin of the Brandberg West tungsten-tin deposit, Namibia

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Project Highlights:

- Brandberg West prospective tin-tungsten deposit being actively explored
- Source of metals and genesis of the deposit is poorly understood
- Aim is to apply geochemical and isotopic techniques to constrain its 4D evolution

Overview:

The Brandberg West tin-tungsten mine is situated within the Pan African Damara Belt of central Namibia, hosted by metasediments and surrounded by regional granite intrusions and Sn-Ta-Li pegmatites. The deposit comprises at least three generations of cross-cutting cassiterite (Sn) and wolframite (W)-bearing quartz vein systems. Historically mined in the 1950s, current exploration activity by Andrada Mining is targeting the mineral potential of the district, with a drilling programme underway.

Although Brandberg West lies within the highly prospective Namibian pegmatite belts, it is however considered one of a cluster of magmatic-hydrothermal mineral systems. Such deposits are formed when hydrothermal fluids exsolve from metal-bearing magmas and drive the extraction and precipitation of fluid-mobile metals as vein-hosted ore minerals. The deposit has been studied in the past, however the nature and timing of the Sn-W mineralisation is poorly constrained in terms of the origin of the metals and fluids, its age, and relationship to the regional granitic and pegmatite intrusions, and the paragenetic formation of the different veins and ore minerals.

This PhD will take a geochemical, geochronological, and isotopic study of the Brandberg West region to addresses the source of metals and fluid(s) by systematically characterising the deposit in terms of the nature and timing of the various magmatic and mineralising events and constraining the broader geodynamic evolution. The candidate will undertake extensive digital field mapping of the deposit, sample appropriate examples of mineralization, local and regional magmatic intrusions and the hosting rocks. They will develop and apply novel geochemical, geochronological and isotopic methods to characterize the various generations of magmatism and to trace the origin of the hydrothermal fluids and ultimately the economic metals. The project builds on recent work by the supervisory team and the establishment of new analytical techniques. The candidate will work in partnership with Andrada Mining, who will provide support and assistance for fieldwork, and the University of Oxford, both with whom the successful candidate will work.

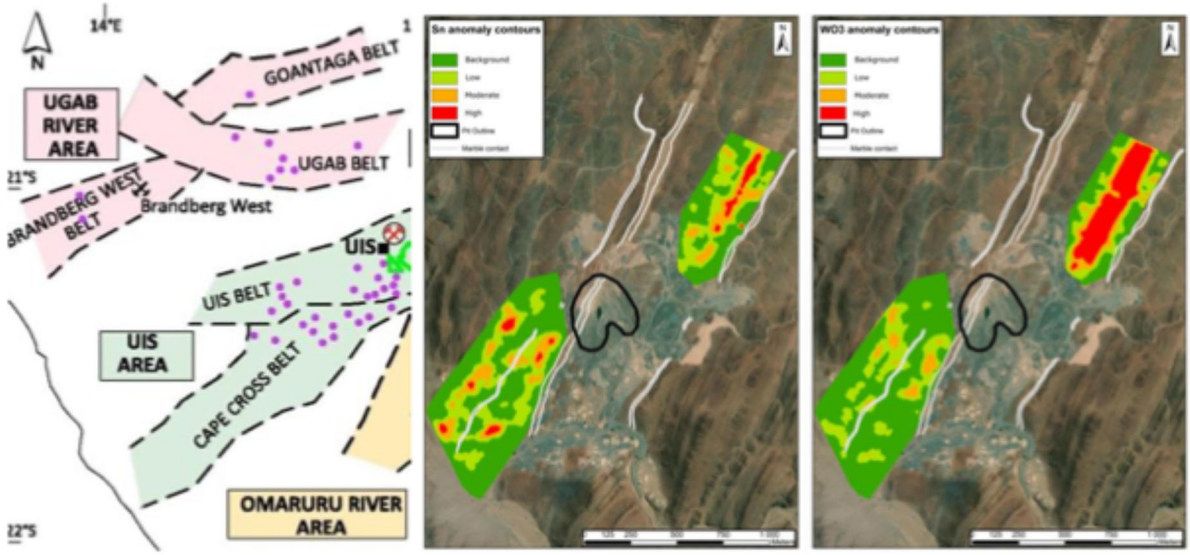

Figure 1: The Brandberg West deposit within the pegmatite belts of Western Namibia; tin and tungsten anomalies around the deposit

Alt text: Outline map locating the Brandberg West deposit within the NE-SW trending pegmatite belts of Namibia; the deposit lies within the "Brandberg West Belt". On the right is *a heatmap of both tin and tungsten anomalies around the deposit, showing a strong tungsten anomaly to the NE of the old pit*

Key research questions:

This project aims to answer the following key research questions:

1) What is the age of the Brandberg West mineral system, and how does that fit into the regional magmatic and orogenic evolution of the Pan African - Damara Orogen?

2) What are the sources of the metals and fluids at Brandberg West, and how did those evolve over time?

3) What are the links (if any) between the deposit and the regional pegmatite deposits?

Methodology:

The student will:

(i) Undertake extensive field mapping in Namibia including sampling of the deposit and associated vein systems and surrounding host rocks, using digital and drone-based mapping and GIS techniques;

(ii) Unravel the paragenesis of the deposit using optical mineralogy and fluid inclusion studies (undertaken at Oxford);

(iii) Apply geochronological methods including LA-QQQ-ICPMS zircon, cassiterite and apatite U-Pb, to provide an accurate chronological framework for ore formation within the context of regional magmatism;

(iv) Undertake S isotope work on the mineralised veins to constrain the nature of source of the fluids (i.e. magmatic vs orogenic);

(v) Apply isotopic tracers vis LA-(MC)-ICPMS of source within the mineralisation and associated magmatism including novel methods such as Hf isotopes in cassiterite, Pb-Pb in feldspar and Sr in apatite.

Possible Timeline

Year 1: Fieldwork, initial sample collection and training

Year 2: Geochronology and radiogenic isotope analysis; possible 2nd field season

Year 3: S isotope analysis; data interpretation, presentation at conferences and paper writing.

Andrada will also host the student for a secondment in their Johannesburg offices during either the 2nd or 3rd year, where they will have the opportunity to work with the active exploration team.

Training and skills:

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.

The student will train in isotope geochemistry and geochronology analysis via LA-ICPMS, gas source mass spectrometry, data reduction and interpretation. They will understand mineralisation paragenesis both in the field and under the microscope. They will become part of a vibrant research culture in the School of Earth and Environmental Sciences, with MSc, PhD and postdocs working on a range of research projects in the PALS (Pegmatites and Laser) and PaStA (Petrology at St Andrews) research groups. It is anticipated a number of publications will arise from this study, and training in scientific manuscript preparation and presentation will be given.

Partners and collaboration (including CASE):

This project is in partnership with the Camborne School of Mines, the University of Oxford, and Andrada Mining. At least one visit a year to CSM is expected, where the student will have a chance to compare Brandberg with mineralisation in the SW England Orefield. Work at Oxford will include use of their fluid inclusion stage. CASE partner Andrada are actively exploring Brandberg West, and will provide logistical support, and host the student to work with their exploration team to share knowledge and experience exploration and mining projects first hand.

Further reading:

Evers, T.J.J.M. and Bowen, M.P. (1989) 'Lithogeochemistry as a tool for extending mineral resources: The Brandberg West Sn-W Deposit, Damaraland, South West Africa/Namibia'. *Journal of Geochemical Exploration,* 34, pp. 47-62.

Macey, M. and Harris, C. (2006) 'Stable isotope and fluid inclusion evidence for the origin of the Brandberg West area Sn–W vein deposits, NW Namibia', *Mineralium Deposita*, 41, pp. 671-690. Doi: 10.1007/s00126-006-0079-1

Pirajno, F. and Jacob, R.E. (1987) 'Hydrothermal tin-tungsten mineralization in the Brandberg West-Goantagab area of the Damara Orogen, South West Africa/Namibia', *Communications of the Geological Survey of Namibia*, 3, pp. 105–110.

Further details:

Please visit https://target.le.ac.uk/ for additional details on how to apply. Informal enquiries regarding this project may be addressed to Nick Gardiner (nick.gardiner@st-andrews.ac.uk).

https://www.st-andrews.ac.uk/earth-sciences/people/njg7