Origin, geodynamic significance and mineralization potential of Archaean ultramafic complexes in the Kaapvaal and North Atlantic Cratons.

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Introduction

Ultramafic rocks (comprising dunite, harzburgite, wehrlite or serpentinite) are an important but poorly understood component of Archaean greenstone belts and tonalite-tronjhemite-granodiorite (TTG) basement terranes. These ultramafic bodies may be intruded into primitive komatiite lava sequences within greenstone belts, or be present as low strain zones or inliers within TTG gneisses that may predate the major deformation events recorded in the felsic rocks. Anhauesser (2004; 2006) reviewed occurrences of these ultramafic bodies across the Kaapvaal Craton of South Africa and speculated on the origin and significance of these bodies for the reconstruction of terrane boundaries and as potential sources of Au (e.g., for the world-class gold deposits of the 2.97-2.78 Ga Witwatersrand Supergroup) and platinum-group elements (PGE) as speculated in the Barberton area. In the North Atlantic Craton, ultramafic bodies are also important components of Archaean basement rocks – for example in the 3.1-3.0 Ga Fiskefjord terrane (hosting subeconomic Ni-PGE mineralization and the major olivine deposit at Seqi; Windley and Garde 2009); and in the 3.0-2.8 Ga Lewisian Gneiss Complex of NW Scotland (Park and Tarney 1987).

While many of these ultramafic bodies have been mapped and undergone limited petrographic studies, modern geochemical methods have not been widely applied to these rocks, in such a way as to constrain their origin(s) and the implications regarding Archaean geodynamic settings. Anhauesser (2006) proposed that poorly known ultramafic belts associated with the Murchison greenstone belt and the Johannesburg Dome could represent slivers of Archaean oceanic crust or mantle lithosphere preserved in suture zones between crustal blocks assembled during accretion processes akin to early plate tectonics (c.f. de Wit et al 1992). Recent evidence from pilot studies in the Scottish portion of the North Atlantic Craton, combining major element, trace element and PGE geochemistry on two spatially related ultramafic bodies near Scourie suggest that they are unrelated to one another, originated in different geodynamic settings and were

subsequently juxtaposed during the development of the Lewisian Complex. pertaining to different geodynamic environments.

The aim of the PhD project is to generate a series of geochemical tools that will constrain the origin(s) of suites of Archaean ultramafic bodies from two contrasting cratonic regions – the Kaapvaal Craton and the North Atlantic Craton. This will reveal the extent to which ultramafic units of apparently different origin(s) became dismembered and juxtaposed against one another, thereby shedding light on the possible 'tectonic' and geodynamic controls of the Archaean-Palaeoproterozoic. In essence, what were the processes governing 'cratonisation' itself? The project will also allow for more confident reconstruction of ultramafic belts according to a common geochemistry (and potential origin). An associated aim of the project will be to examine the relationship between Archaean igneous ultramafic processes and mineralization potential (i.e., craton-specific mineralization).

Layering in ultramafic body at Camas nam Buth, Scourie (Drs Hughes and Faithfull for scale). Hand held XRF analysis of ultramafic layers and garnet granulite country rocks.

Training Opportunities

The student will carry out fieldwork in Scotland and South Africa and receive training using digital field equipment and portable XRF for rapid non-destructive analysis at sensitive sites where sample collection may be restricted. This will be followed by bulk analyses by ICP-OES and ICP-MS and complimentary SEM and LA-ICPMS mineralogical analysis, in addition to modelling of magmatic and metamorphic processes. This project will equip the student with the skills necessary for a successful high-level career in the mineral exploration industry or in academia.

Wider Opportunities

Cardiff University is part of the Great Western Four (GW4) NERC Doctoral Training Partnership along with Bristol, Bath and Exeter universities. During the course of their project the student will have access to the

various training programmes organised by GW4 research themes relating to the Solid Earth and Natural Hazards and Resources, as well as any in-house training for Cardiff analytical facilities. It is anticipated that the student will attend one or more NERC Advanced Training short courses relating to fieldwork and/or advanced data analysis and statistics over the course of the project. The PhD student will attend UK and European workshops and conferences, and will be encouraged to publish their results, where possible, over the course of the project to gain experience of writing for publication and the peer-review process at an appropriately early stage.

References

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Applications

The project is funded by the College of Physical Sciences and Engineering and is open to UK or European Union applicants. Applicants should hold or expect at least an upper second class honours degree. **The deadline for applications is Monday 22nd of June 2015**. The student will be expected to start their studies in late September 2015.

Applications should be made online at: http://www.cardiff.ac.uk/for/prospective/postgraduate.html