**PROJECT TITLE:** Reconstructing the regional stress field during porphyry copper formation in the western USA

**University of Bristol Research Theme:** Climate/Environment

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**3rd & 4th Co-Supervisors:** Dr Simon Tapster & Dr Nick Roberts, British Geological Survey

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**Project keywords:** Tectonics, Structural Geology, Paleomagnetism, Geochronology, Ore deposits

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**Project Background:**

Porphyry copper deposits (PCDs) supply most of the world’s copper, a critical metal in efforts to transition to a greener low-carbon economy, and yet finding PCDs is becoming increasingly difficult. Therefore, understanding what controls where and when they form will be essential to future exploration efforts as global demand intensifies. Most PCDs in the western USA relate to the Laramide Orogeny, a phase of crustal thickening and magmatism associated with subduction of the Farallon plate beneath North America. During this time, progressive flattening of the downgoing slab caused the location of convergence and magmatism to sweep SW to NE across western North America, reaching Arizona in the Late Cretaceous-Palaeocene. At this time, numerous PCDs formed in Arizona along the margin of the Colorado Plateau, a cratonic block that is thought to have acted as a rigid backstop to deformation. Generally, the position and age of the PCDs overlap with the end of peak compression along the margin of both the Colorado Plateau and another rigid cratonic block, the Wyoming Craton, further north (Fig. 1). These relationships suggest a potential link between the orientation of compressional deviatoric stress, the subsequent relaxation of compressional stress against a rigid craton backstop, and PCD genesis.

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**Figure 1.** Tectonic map of the western USA with porphyry copper deposits (PCDs). [1].

**Figure 2.** Frances drilling a mafic dyke for paleomagnetic analysis in the northern Snake Range metamorphic core complex, Nevada [2].
**Project Aims and Methods:**

This project will combine structural and paleomagnetic analysis of dykes along the margins of the Colorado Plateau and Wyoming Craton to discern temporal or spatial patterns in the orientation of the regional stress field prior to and during PCD formation. A critical focus will be on whether there is a link between the maximum principal stress direction, the orientation of the craton margin, and PCD formation. The student will combine field mapping, structural analysis, and sampling of dykes with paleomagnetic analysis and U-Pb dating. There are two main objectives:

1. **Constrain spatial variations in the paleostress field along the margins of the rigid cratonic blocks**

   The long azimuths of dyke swarms located along the margins of the Colorado Plateau and Wyoming Craton will be used to resolve the maximum principal stress orientation at each location at the time the dykes were intruded. Post-intrusion rotation of the dykes due to Miocene Basin and Range extension or strike-slip faulting will be resolved using paleomagnetic analysis.

2. **Constrain the timing of dyke intrusion to highlight temporal changes in the stress field**

   U-Pb zircon or baddeleyite geochronology [e.g. 2] will be used to constrain the timing of dyke emplacement in order to investigate temporal changes in the paleostress field and to compare with the timing of PCD formation. Other datable structures that reflect the paleostress field will also be targeted where possible, e.g. calcite-filled extensional veins will be collected for U-Pb dating.

**Candidate requirements:**

This project would suit a quantitative geoscientist keen to develop field and laboratory skills who has an interest in tectonics and structural geology and how they can be applied to ore deposits. The student will work in rugged and desert terrain so independence, physical fitness, and an ability to drive would be important. We welcome and encourage student applications from underrepresented groups. We value a diverse research environment.

**Project partners:**

The project is cross-institutional and international between the University of Bristol, the British Geological Survey, and the global mining company BHP. BHP has a long-standing relationship with Bristol through its sponsorship of the Bristol PCD Group (bristolpcd.org), which the student will join. The BGS will provide expertise covering a wide array of geochronological techniques and data interpretation.

**Training:**

The student will receive training in structural field analysis, paleomagnetic sampling, and laboratory analytical techniques. Dr Cooper and Dr Lamont will support the student in field work, sample preparation and petrography, geochemical analysis and geothermobarometry. Prof Mac Niocaill will train the student in paleomagnetic analysis and researchers at the BGS Geochronology and Tracers Facility will provide training in U-Pb analysis.

**Background reading and references:**


**Useful links**

http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

**How to apply to the University of Bristol:** http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is Monday 14 February, 2022 at 2359 GMT. Interviews will take place during the period 10 March – 18 March 2022.

**General Enquiries:** Email: earth-postgrad@bristol.ac.uk