2024_66_NHM_JW: Detrital mineral records of magmatism and fertility in porphyry copper districts

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The aim of the project is to examine and understand the mineral chemistry of igneous and alteration minerals from the mineralized centres of a major porphyry copper ore district and their transition, dilution and survival in drainage samples in order to develop effective exploration screening tools for porphyry ore systems. Key questions to be addressed in this research include: (1) Can district-scale detrital sampling give us deeper insights into the long-term temporal evolution of arc magmatic systems that generate fertile porphyry ore systems? (2) What are the characteristics of drainage minerals downstream of superior value mineralisation as opposed to smaller and less economic occurrences? (3) Can the effects of anthropogenic and mining related disturbances be compensated for during down-stream sampling? (4) What is an optimised workflow for drainage sampling, preparation and analysis to ensure that representative populations for key indicator minerals are obtained? An initial literature review of igneous accessory mineral and propylitic mineral chemistry in porphyry systems will compile data on the scale, mineralogical zonation, geochronology and spatio-temporal mineral chemistry patterns. Fieldwork will involve mapping and sampling of igneous units and propylitically altered rocks in the selected case study district, and sampling of key drainage catchments. Where necessary, intrusions will be dated using zircon U-Pb LA-ICP-MS in order to pin key geological events. Both in situ and drainage samples collected from across the district will form the basis of subsequent mineralogical, geochemical and geochronological analysis. Samples will be studied using conventional microscopy, hot cathode cathodoluminescence (CL) and electron beam instruments housed at the Natural History Museum (NHM) in order to establish mineral relationships, textures and chemistry. Analysis of minerals by automated (TESCAN TIMA) SEM, analytical SEM, microprobe and LA-ICP-MS methods (including LA-ICP-MS mapping) will determine the residence of major and trace elements. Dating of rock-hosted and detrital zircon, apatite, titanite and epidote will be done using U-Pb geochronology by LA-ICP-MS. The research will provide new insights into the multi-million year and district scale evolution of igneous complexes that produce economic porphyry-copper deposits. The project will be of direct and immediate benefit to the CASE partner's exploration programmes globally. There are currently few case studies that look at the incorporation of mineral chemistry into the assessment of detrital mineral assemblages, and none that look at samples from a holistic perspective (they typically focus on one or a couple of minerals). The study will also provide a template for equivalent work that must be completed for other mineralisation styles where drainage sampling could be used to accelerate the path to discovery