Detrital Zircon Indicators of Metallogenic Magma Fertility: A Potential Tool for Exploration Targeting for Porphyry Copper

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Magmatic systems associated with porphyry copper mineralisation typically contain zircons with distinctive trace element patterns indicative of metallogenic magmatic fertility (e.g., relative oxygen fugacity/sulphur-carrying capacity and hydration state). Combining this fertility signature with high-precision U-Pb geochronology provides an opportunity to examine spatial-temporal patterns of magma fertility, offering a powerful tool for reconnaissance-stage exploration. In many instances it is not possible or practical to reach every site of interest for bedrock sampling, so detrital sampling offers an alternative strategy.

Detrital studies can maximise exploration efficiency, minimise costs, and provide material derived from inaccessible areas. However, previous attempts to use detrital zircon fertility studies for exploration have focused on large-scale (<400-km^2) drainage basins, typically analysing ~1 zircon per km^2. While this approach covers a large area quickly, slow sample processing and ambiguous or false negative results have limited its effectiveness.

This project aims to establish a new protocol for detrital fertility analysis guided by a robust geomorphological analysis of the target area prior to sampling. This will ensure that the source region for each sample is well constrained and variations in sediment sourcing due to spatial changes in erosion rate are taken into consideration. To achieve this, we have targeted the porphyry-rich and well-constrained Copper Triangle in Arizona, USA. The primary goals are to constrain optimum basin sizes for sampling, determine the optimum number of zircons required for analysis per basin, and establish whether variability in erosion rate can lead to false negative results.

Samples have been collected from tributaries of the Salt and Gila rivers within the Copper Triangle and zircons separated for analysis. Paired U-Pb dating and trace-element analyses of individual grains via laser-ablation ICP-MS will be carried out to provide a time series representing the age span and variation in chemical fertility of igneous intrusions throughout the study area.