SC6: Petrological modelling as a tool to assess magma fertility in porphyry systems

Massimo Chiaradia (UNIGE)

Pre-conference short course 27 August 2023, University of Geneva

Porphyry Cu-Au deposits are the major global source of copper, an essential metal for the green transition, and a significant source of gold. They occur both in thick continental and thin oceanic arcs at depths between ~1 and ~6 km above parental magma chambers situated at ~5-15 km depth. Although it is believed that the metal precipitation processes for these deposits are the same, it is not clear why porphyry deposits encompass more than 4 orders of magnitude differences in metal endowments and why they also have broadly different Au/Cu ratios.

Because it is widely accepted that the major source of fluids and metals in porphyry Cu-Au deposits are the temporally and spatially associated magmas, investigating the role that magmatic processes play in the formation of these deposits is of primary importance to understand their genesis.

This course will investigate, first through a qualitative approach and subsequently through quantitative modelling, the controls that magma evolution at convergent margins exert not only on the formation of porphyry Cu-Au deposits, but also on their size.

In the first part of the course the roles of parameters considered to be critical to the formation of porphyry Cu-Au deposits, like metal and volatile (e.g., H_2O, S) contents of magmas, oxygen fugacity and magma chemistry will be discussed.

In the second part a quantitative, mass-balance based model will be developed on the basis of available petrological, geological, and geochemical information, and model results will be compared with data from real porphyry Cu-Au deposits to test the model validity. Implications for the exploration of porphyry Cu-Au deposits using bulk rock and mineral (e.g., zircon, apatite) chemistry will be also discussed.

Massimo Chiaradia is Senior Lecturer at the Department of Earth Sciences, University of Geneva (Switzerland), where he is also responsible for the isotope tracing laboratory facility. His research mostly focuses on the relationships among geodynamic setting, petrogenesis of magmas and formation of porphyry-type deposits at convergent margins, using field work, bulk rock and mineral geochemistry, high-precision dating and modelling.