

PhD research position in Economic Geology

University of Geneva (Switzerland)

Tracing fluid evolution in the Miocene polymetallic Cordilleran deposits of Colquijirca and Cerro de Pasco, central Peru

Applications are invited for a fully funded Ph.D. research position in Economic Geology to commence in June 2012. The project aims to trace the fluid evolution of magmatic-hydrothermal systems at Cerro de Pasco and Colquijirca - two major Cordilleran deposits in the Miocene polymetallic belt of central Peru. It is mainly sponsored by the Swiss National Science Foundation and will be coordinated with the Vólcan Compañía Minera S.A. and the Sociedad Minera El Brocal S.A.A. operating in the studied areas.

The project

Cordilleran or “Butte type” polymetallic mineralization occurs as veins, massive replacement bodies, and sulfide-cemented breccia bodies in the upper parts of porphyry systems. Most of it is largely epithermal, overprinting earlier veins with potassic and phyllic alteration assemblages. A fluid inclusion study of



View of the open pit at the Cerro de Pasco deposit, central Peru

Cordilleran mineralization at Morococha (Catchpole et al., 2011) demonstrated that mineralizing fluids in polymetallic veins directly overprinting barren and mineralized porphyry systems have dominantly magmatic signatures and compositions similar to the fluids forming porphyry mineralization at depth. In contrast, fluids forming

Cordilleran deposits in volcanic setting (e.g., Cerro de Pasco and Colquijirca) have also magmatic signatures but are highly diluted by meteoric waters, as evidenced by stable isotope analyses of gangue minerals. Recent studies on the geological setting, mineralization and alteration assemblages, metal and mineral zonation, stable and radiogenic isotope geochemistry and geochronology of the Cerro de Pasco and Colquijirca deposits (Baumgartner et al., 2008, 2009; Bendezú et al, 2003, 2008, 2009) provide detailed background information that will serve as a basis for the comprehensive fluid geochemistry research project.

The principle objective of the project is to determine intensive parameters (P-T), composition and stable and radiogenic isotope signatures of mineralizing fluids, to test the existing models for the origin of fluids, solutes and metals in magmatic-driven Cordilleran polymetallic hydrothermal systems, studying Cerro de Pasco and Colquijirca as examples.

Methodology and training

Fluid inclusions preserving microsamples of hydrothermal fluids that formed the Cordilleran mineralization at Cerro de Pasco and Colquijirca can be found in transparent gangue (quartz, carbonates) and opaque ore minerals (enargite, sphalerite, and pyrite). These can be analyzed by visible and near-infrared light microscopy and microthermometry. Laser ablation ICP-MS technique can be applied to accurately determine minor and trace element (including S and metals) composition, as well as Cl and Br isotopes in single fluid inclusions. Stable isotopes (O, H, C) and noble gas geochemistry will be applied to trace the origin of fluids. A combination of Sr and Pb isotope determinations in inclusion fluids will be used to trace fluid-rock interactions along pathways of the hydrothermal fluids and possible contribution from different host-rocks.

The successful candidate will join a very active Ore deposits group at University of Geneva and will receive training in large spectrum of analytical methods. The project will involve collaboration with other institutions including the ETH Zurich and the University of Lausanne.

Student profile

Applications are welcome from well-qualified and highly motivated graduates with education in Geology, Geochemistry, Earth Sciences or related fields with a strong interest in geochemistry and hydrothermal ore deposits. Research in this project involves fieldwork in Peru at high altitude (over 4'000 m) and extensive analytical work. Analytical skills in fluid inclusion analyses, isotope geochemistry, and different microscopic and spectroscopic analytical methods, will be considered as an advance.

Applications

The PhD project is fully funded for 3 years, with a possibility of 1 year extension. Interested applicants are requested to send a CV (including details on all third level university courses and grades), with covering letter, two references, (expected) date and abstract of MSc thesis and full contact details. Applications should be sent as a single PDF file by email (see below). Deadline is 15th April 2012.

Contact and further details

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Recent relevant publications

- Baumgartner, R., Fontboté, L., Vennemann, T. (2008) Mineral zoning and geochemistry of epithermal polymetallic Zn-Pb-Ag-Cu-Bi mineralization at Cerro de Pasco, Peru. *Economic Geology*, 103: 493-537.
- Baumgartner, R., Fontboté, L., Spikings, R., Ovtcharova, M., Schaltegger, U., Schneider, J., Page, L., Gutjahr, M. (2009) Bracketing the age of magmatic-hydrothermal activity at the Cerro de Pasco epithermal polymetallic deposit, central Peru: a U-Pb and ⁴⁰Ar/³⁹Ar Study. *Economic Geology*, 104: 479-504.
- Bendezú, R., Fontboté, L., and Cosca, M. (2003) Relative age of Cordilleran base metal lode and replacement deposits and high sulfidation Au-(Ag) epithermal mineralization in the Colquijirca mining district, central Peru. *Mineralium Deposita*, 38: 683—694.
- Bendezú, R., Page, L., Spikings, R., Pecskey, Z., Fontboté, L. (2008) New ⁴⁰Ar/³⁹Ar alunite ages from the Colquijirca District, Peru. Evidence of long period of magmatic SO₂ degassing during formation of epithermal Au-Ag and Cordilleran polymetallic ores. *Mineralium Deposita*, 43: 777-789.
- Bendezú, R., Fontboté, L. (2009) Cordilleran epithermal Cu-Zn-Pb-(Au-Ag) mineralization in the Colquijirca district, central Peru: Deposit-scale mineralogical patterns. *Economic Geology*, 104: 905-944.
- Catchpole, H., Kouzmanov, K., Fontboté, L., Guillong, M., Heinrich, C.A. (2011) Fluid evolution in zoned Cordilleran polymetallic veins – Insights from microthermometry and LA-ICP-MS of fluid inclusions. – *Chemical Geology*, 281: 293-304.