Characterization of magmas associated with porphyry deposits: Petrography and oxidation state of magmas associated with porphyry copper deposit at the Cerro Corona deposit, Peru.

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Introduction

Many Cu-Au porphyry deposits are associated with the intrusion of oxidized intermediate to felsic magmas in subduction zones. A recent study (Shen et al., 2015) suggests a link between the degree of oxidation of magmas and the tonnage of Cu-Au deposits in the Central Asian Orogenic Belt. Our project focuses on the evolution of the oxidation state of the magmatic intrusions at the Cerro Corona porphyry Cu-Au deposit in the Northern Peruvian Cordillera.

We examine the degree of oxidation of magmas and the trend of zircon elements in the Cerro Corona intrusion sequence using petrography and mineral chemistry, notably the trace elements in zircon.

Our objective is then to link these results with petrographic analysis, geochemistry and U-Pb dating in order to understand the evolution of magmatic systems.

Geological Settings

The Cerro Corona Cu-Au deposit is situated in the Huayllay district in northern Peru. It is located 40 km from the north of the very large high sulphidation epithermal Au-Ag Yanacocha deposit of 14.5 to 6.4 Ma (Sung et al., 2010).

The Cerro Corona deposit is hosted in a series of main dioritic intrusions, the only one being biotite, the other phases are hornblende. Similar to other deposits in the district, the intrusion occur at the intersection of Andean-parallel and Andean-normal regional structures.

The magma intruded into the late Cenozoic limestones of the Paratumbó Formation. U-Pb zircon ages indicate the diorite crystallization at 144 ± 1 Ma (James, 1994).

For the present study, a total of 12 samples were examined. Five main intrusion rocks and one post-mineralization dikes from the mine property, and six from the area within ten kilometers of the dike.

Petrography

Porphyry intrusives at Cerro Corona have a typical magmatic assemblage composed of Plagioclase + quartz + hornblende ± magnetite + zircon + apatite. Magmatic, biotite and altered hornblende make up the majority of the phenocrysts, with minor quartz. The fine-grained groundmass is composed of plagioclase, quartz and minor biotite.

Zircon petrography

Zircons in Cerro Corona samples are euhedral, show typical magmatic oscillatory zoning and inherited cores are rare. Zircons commonly show sector zoning and often contain apatite inclusions. Presence of a zircon irregularly-shaped domain in the zircon may suggest short-lived perturbation of the zircon crystallization for which we have no interpretation yet.

Estimation of the oxidation state of the magma is primarily based on the trace element composition of zircon. A lot of care was given to selecting zircon grains suitable for the study. Avoiding grains with many inclusions, inherited cores and sector zoning were the main factors in selecting zircons.

Most zircons have euhedral shapes. Their color is clear to pinkish-orange. Note that many zircons have inclusions. Most clear inclusions are euhedral apatite and irregularly shaped feldspars.Opaque inclusions are magnetite and minor ilmenite.

Zircon trace elements

Zircon trace element compositions of the six samples were obtained via LA-ICP-MS at University of Ottawa.

All zircons from Cerro Corona have typical REE patterns, preferentially enriched in HREE. Among the selected zircons, only one population was identified and shows a homogenous composition.

There are no major differences in zircon REE patterns among the six samples.

Summary and future work

-Cerro Corona provides a good example of an intermediate to large sized Cu-Au porphyry deposit where petrology and age can be linked to the evolution of the oxidation state.

-Preliminary results of trace element compositions of zircons at Cerro Corona are comparable to those for intermediate-sized porphyry deposit in the Central Asian Orogenic Belt and other districts that have been recently developed.

-More detailed analysis of zircons and apatite preliminary results should help in evaluating if there is a variation of the oxidation state of magma within the Cerro Corona Inversion sequence.

Future analytical work on Cerro Corona Samples:
-89MP U-Pb ages in zircons will provide a time frame for the evolution of the oxidation state.
-Analyses of apatite and zircon outside of the mine property will provide background values for comparison.

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References


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SO42-), it can be used as a tracer for the evolution of the magmatic oxidation state.

Cerro Corona samples contain both magmatic and secondary apatite. Most apatites observed are secondary based on the fact that they are often associated with chlorite in the assemblage replacing primary biotite. Those apatites are not considered for this study since they do not reflect the magmatic stage.

Primary apatites were selected based on textual evidences (i.e. euhedral, lack of intergrowth).

Apatite classification in the Cerro Corona samples.

Apatite composition

Apatite is a minor but ubiquitous component of the Cerro Corona mineral assemblages. Apatite can accommodate some sulfur in its structure via a small number of different substitutions (Str€ock and Chen, 1986). Since sulfur can have various valence (+3 or +5) in SO42−, it can be used as a tracer for the evolution of the magmatic oxidation state.

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