Using modern field mapping techniques to characterize magmatic-hydrothermal IOCG deposit alteration zones in a Lower Cretaceous Peruvian pluton

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Introduction:
The Cerro Media Luna Pluton (CMLP) is part of the Mesoarchean Peruvian Coastal Batholith (PCB) near Pisco in Western Peru (Fig. 1). The CMLP has been considered a Cu porphyry (CP) system based on rock sample description of reddish or pinkish rocks. However, the PCB includes part of the 180-100 Ma Araruta batholith (Oxide-Copper-Gold (IOCG) belt). Though the mineralizations of CP and IOCG systems are very distinct, they have some similarities between the alteration assemblages. Potassic, sericitic, and propylitic alteration are common features of both, but sodic-calcic alteration, U content, and iron oxides (especially hematite and magnetite) are specific characteristics of IOCG deposits. The attempt of this research is to characterize the hydrothermal system using modern mapping and analytical techniques. This approach allows for quicker preliminary conclusions and will impact the way we look for mineral resources.

Table 1: Preliminary alteration zones based on petrographic description.

<table>
<thead>
<tr>
<th>Alteration Type</th>
<th>% Fe2O3</th>
<th>% K2O</th>
<th>% SiO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh rock</td>
<td>0.5</td>
<td>0.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Low alteration</td>
<td>0.7</td>
<td>0.3</td>
<td>3.5</td>
</tr>
<tr>
<td>High alteration</td>
<td>0.9</td>
<td>0.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Field observations:

Gamma spectrometry shows low and constant values of K across the pluton's units irrespective of the type of sample analyzed (veins or host rock), whereas U content was moderately high and the highest values are representing some of the collected vein samples. The values of MS show no correlation concerning sample type. Data is reported in Fig. 3.

Laboratory work:

Whole rock analyses by ICP-MS and XRF (major and trace elements). CaO and Na2O plots show trends very similar to the ones of magma undergoing the differentiation process, as shown in Fig. 5.

Discussion:
The GS results show very low values of K, including among the veins, which suggests that potassic alteration is not one of CMLP's strongest alteration assemblages. Along with it, some of the veins are enriched in U content, that is one of the possible features of an IOCG deposit. The oxidation of MS also suggests zones of enrichment of magnetite, which is expected from an IOCG due to the zones rich in magnetite (where MS values are higher) and hematite (where MS values are lower), as Table 1, Fig. 3 (c) and Fig. 6 show. As shown in the Harker diagrams (Fe2O3), the concentrations don't form a linear trend, which suggests hydrothermal alteration. Apart from that, the samples that plot above normal concentration values for CaO suggest the calcite alteration; most samples plot below normal concentration values for K2O, which corroborates the mineralogy results and suggests low importance of major element in the pluton; and all samples, but one, plot above normal concentrations for Na2O, which suggests sodium alteration. Within the silica range of 53-58%, sodium and calcium are suggested alteration type, which is expected from an IOCG deposit, as shown in Fig. 6. Also, IR and XRD show insignificant Kspar, which corroborates that the mineralization is not similar to a copper porphyry type.

Conclusions:

This study validates the proposal made by correlating in situ and laboratory measurements. The method is precise in assigning chemical signatures to in situ informed decision making on alteration zones and potential ore bodies within a batholith. Future steps involve method amalgamation through repeated applications to discern ore bodies. Results suggest the studied area resembles an IOCG type deposit rather than a CP deposit based on the following:

- Low % K, high U, and Na2O alteration presence.
- Magnetic and non-magnetic zones associated to the Fe2O3 concentration.
- Low percentage of K-ore and presence of reddish or pinkish color due to iron carbonates.

References:


Sillitoe, R. H., 1981, Copper mineralization and magmatic hydrothermal brines in the Rio Pisco section of the Peruvian Coastal Batholith: Economic Geology, v. 76, no. 1, p. 89-100

