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GEOCHEMISTRY OF GOLD CRYSTALS IN EPITHERMAL, GOLD PORPHYRY, AND GOLD-RICH COPPER PORPHYRY DEPOSITS: A DISCRIMINATION MODEL

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INTRODUCTION

The morphology of gold grains in stream sediments evolves during transport, as a function of the distance from the source (e.g. Herail et al., 1999 a,b), being an excellent exploration tool. Additionally the compositional categorization of native Au may be significant for exploration of different types of ore deposits mainly in areas of thick soil and/or dense vegetation. Native gold accepts limited solid solution with Ag, Cu, Fe, As, and Bi among other elements, depending mainly on physico-chemical conditions of transport and crystallization-deposition, and on total element content of the respective system (Rubin and Kyle, 1997; Gammons and Williams-Jones, 1995; Morrison et al., 1991). The chemical composition of gold grains from stream sediments may indicate the type of deposit from which the gold particles were eroded. The deep-seated porphyry type mineralization and shallow epithermal deposits are commonly associated with the evolution of an intrusion-related hydrothermal system (e.g. Far Southeast-Lepanto orebodies, Philippines; Hedenquist and Arribas, 1998). Thermodynamic conditions in which gold precipitate differs in each of these type of deposits. Considering that the core of the gold particles in supergene environment maintain the composition of the precious metal in the primary mineralization source (e.g. Groen et al., 1990; Herail et al, 1990), we compare the chemistry of gold crystals from epithermal, gold porphyry, and gold-rich copper porphyry deposits, in order to attempt a discrimination between these types of mineralization. In this study the epithermal deposits are represented by the Guanaco and Pimenton orebodies in northern and central Chile (21 samples, Ulloa, 1999) and ore deposits from central-south Bolivia (249 samples, Ulloa, 1999). Gold porphyries are represented by the Cerro Casale gold porphyry, Maricunga belt, northern Chile (180 samples, Rivas, 1999, Sepúlveda, 1999), and gold-rich copper porphyries by the Grasberg porphyry. Indonesia (11 samples, Rubin and Kyle, 1997) and the Santo Tomas II porphyry, Philippines (10 samples, Tarkian and Koopman, 1995).

RESULTS

The available data indicate Ag and Cu content in native gold as the most useful elements for discrimination. The Au-Ag-Cu ternary diagrams evidence significant compositional differences in the gold crystals from the studied ore deposits (Fig. 1 to 3). Gold crystals from epithermal deposits are Cu-depleted and tend to be Au-rich. Gold crystals from the gold porphyry orebody are also Cu-depleted and tend to be Ag-richer in comparison to epithermal gold crystals. In addition, gold crystals for gold porphyry exhibit a tendency of increasing Cu-content with the more Au-rich composition. In total contrast, gold crystals from gold-rich copper porphyries show high contents of Cu and variable Ag concentration, defining an area which is well discerned from the other two types of gold-bearing ore deposits.

CONCLUSIONS

The analysis of the available chemical data in gold crystals from different types of hydrothermal ore deposits, allows to delineate that the gold-silver-copper ternary diagram (Fig. 4) seems to be appropriate for the discrimination between epithermal mineralization, gold porphyries and gold-rich copper porphyries. Although more research is needed, it seems that the method may be an appropriate procedure to help in the discrimination between gold-bearing hydrothermal deposits.

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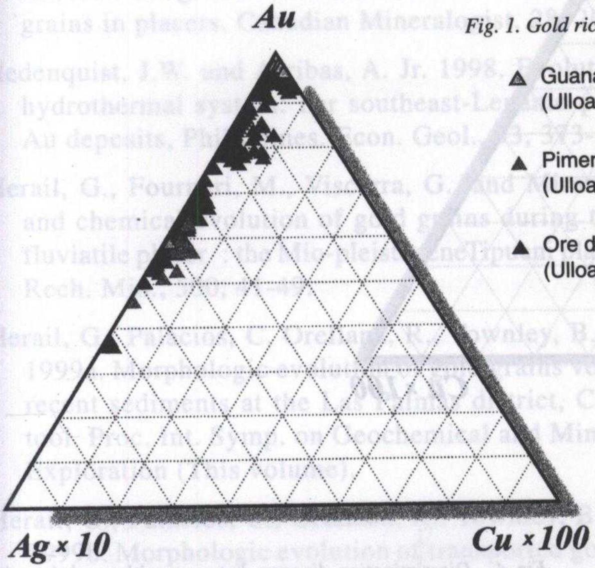

Fig. 1. Gold rich epithermal deposits.

Guanaco orebody, northern Chile (Ulloa, C., 1999; n=9)

Pimentón ore deposit, central Chile (Ulloa, C., 1999; n=11)

Ore deposits from Bolivia (Ulloa, C., 1999; n=249)

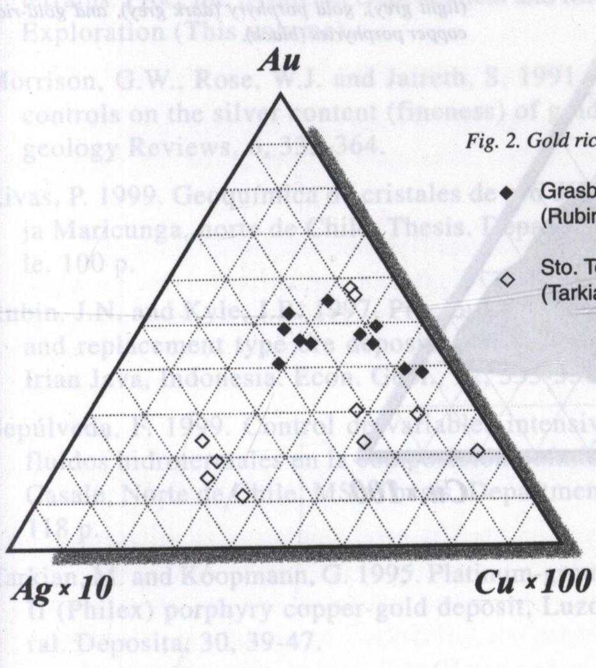

Fig. 2. Gold rich copper porphyries.

◆ Grasberg, Indonesia (Rubin, J. Y Kyle, R., 1997; n=11)

◇ Sto. Tomás II, Philippines (Tarkian, M. & Koopmann, G., 1995; n=10)

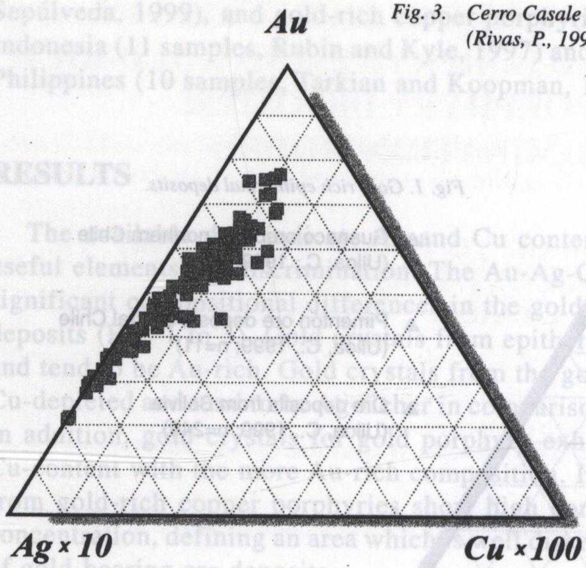

Fig. 3. Cerro Casale gold porphyry, northern Chile (Rivas, P., 1999; Sepúlveda, F., 1999; n = 180).

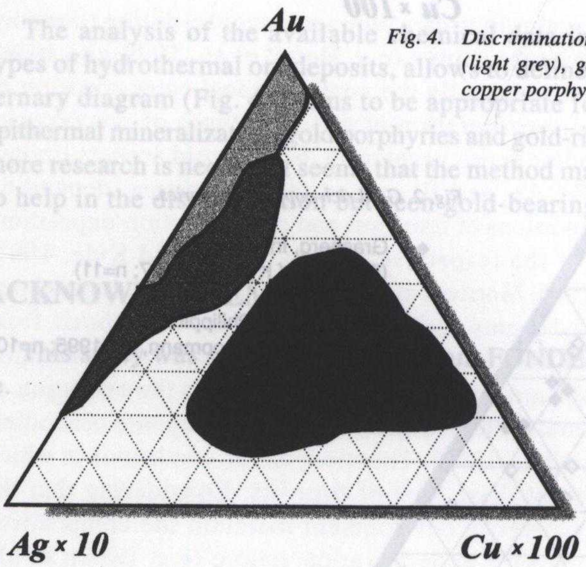

Fig. 4. ***Discrimination diagram between epithermal deposits (light grey), gold porphyry (dark grey), and gold-rich copper porphyries (black).***

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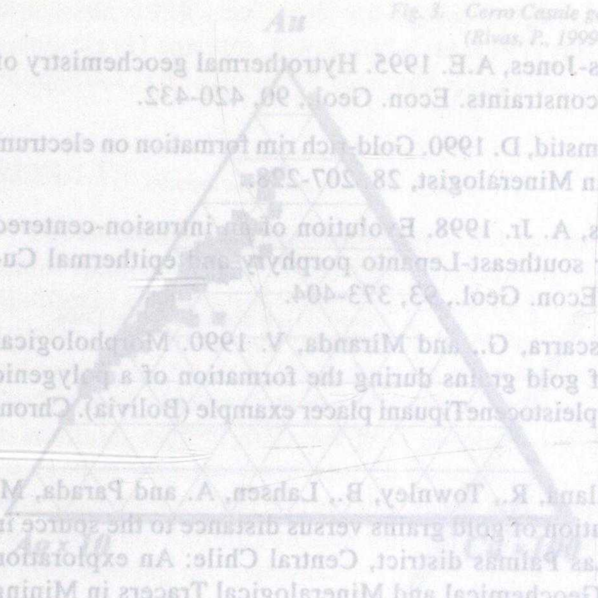
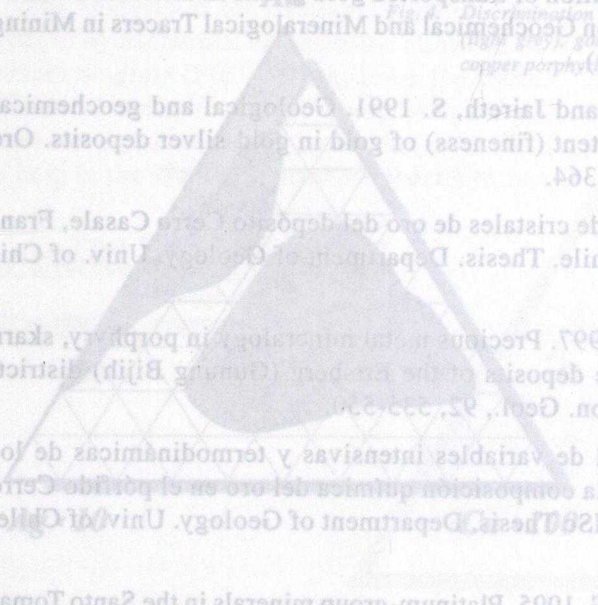


Fig. 3. Cerro Casale gold porphyry. no...
(Rivas, P., 1999; Sepúlveda, F., 1999, n = 186)



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