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Petrogenesis of the Rio Blanco epithermal Au-Ag mineralization in the Cordillera Occidental of southwestern Ecuador: Assessment from host rocks petrochemistry and ore constituents isotopic (O, S, H, and Pb) compositions

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ABSTRACT

The petrogenesis of the Rio Blanco Au-Ag mineralization in the Cordillera Occidental (Western Cordillera), southwest Ecuador, was assessed using magmatic host rocks and ore constituents geochemical and isotopic (S, O, H, Pb and Sr) composition. The magmatic rocks spatially associated with the Rio Blanco Au-Ag mineralization are of arc affinity and mostly include lava flows of andesitic composition, as well as plutons and pyroclastic falls that range from dioritic (andesitic) to granodioritic (dacitic) compositions. These arc rocks as evidenced by their initial Sr isotope compositions ($^{87}Sr/^{86}Sr_i$: 0.70443–070694), which are symptomatic of crustal contamination, are of two contrasting magmatic suites (transitional and calc-alkaline), and typically display enrichment in LREE with respect to HREE, with resulting moderately elevated La/Yb ratios of 5.75–8.79.

Unlike parental melts of most Miocene intrusions associated with porphyry-related mineralization from the Cordillera Occidental of Ecuador, which differentiated at a deep crustal level, the Rio Blanco parental magma, which was generated in a relatively thin crustal setting (as suggested by Sr/Y ratios) differentiated in the upper crust (as supported by the relatively low Sr/Y) at < 0.4 GPa, where significant plagioclase fractionation took place as evidenced by their consistent negative Eu anomaly (Eu/Eu* ranges from 0.065 to 0.102), as well as the positive correlation between Sr/Y and Eu/Eu*. Important plagioclase fractionation was accompanied by minor amphibole and pyroxene fractionation as evidenced by their sporadic occurrence as phenocrysts in Rio Blanco magmatic rocks under investigation.

Magmatic rocks spatially associated with the Rio Blanco Au-Ag mineralization also show a significant radiogenic signature, which was acquired through assimilation of various basement rocks within the upper crust, thus leading to heterogeneous and wide Pb isotopic composition ranges ($^{206}Pb/^{204}Pbi$ = 18.605–19.174; 207Pb/204Pbi = 15.621–15701; $^{208}Pb/^{204}Pbi$ = 38.442–39.043). Sulfides and electrum are radiogenic as well ($^{206}Pb/^{204}Pb$ ratios are between 19.002 and 19.143, whereas $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ ratios span from 15.644 to 15.697 and from 38.827 to 38.998, respectively) and overlap the compositions of the highly radiogenic magmatic rocks, indicating Pb and by inference, the other metals such as Au and Ag are of magmatic origin like S, which $\delta^{34}S$ (V-CDT) values range between −3 and 4.9‰. Unlike S and metals of magmatic origin, the degased (as indicted by δD (V-SMOW) values range between −92.54 and −78.89‰) mineralizing H_2O is a mixture between magmatic and meteoric fluids as supported by their $\delta^{18}O$ (V-SMOW) values ranging from −0.959–4.21‰.

1. Introduction

The Rio Blanco Au-Ag low sulfidation Prospect (Bineli Betsi, 2007; Bineli Betsi et al., 2007; Ponce, 2011) previously called Beroen, is located in the western side of the Cordillera Occidental (Western Cordillera), southwestern Ecuador (Fig. 1). It is part of the Miocene metallogenic belt that extends from northern Peru into southern Ecuador (Schütte, 2010; Schütte et al., 2010a) and which hosts in its Ecuadorian portion numerous types of deposits including: (i) the Gañarín low sulfidation epithermal deposit; (ii) the Quimsacocha high sulfidation epithermal deposit; (iii) the Zaruma-Portovelo intermediate sulfidation deposit; (iv) the Chaucha, Gaby, and Cangrejos porphyry

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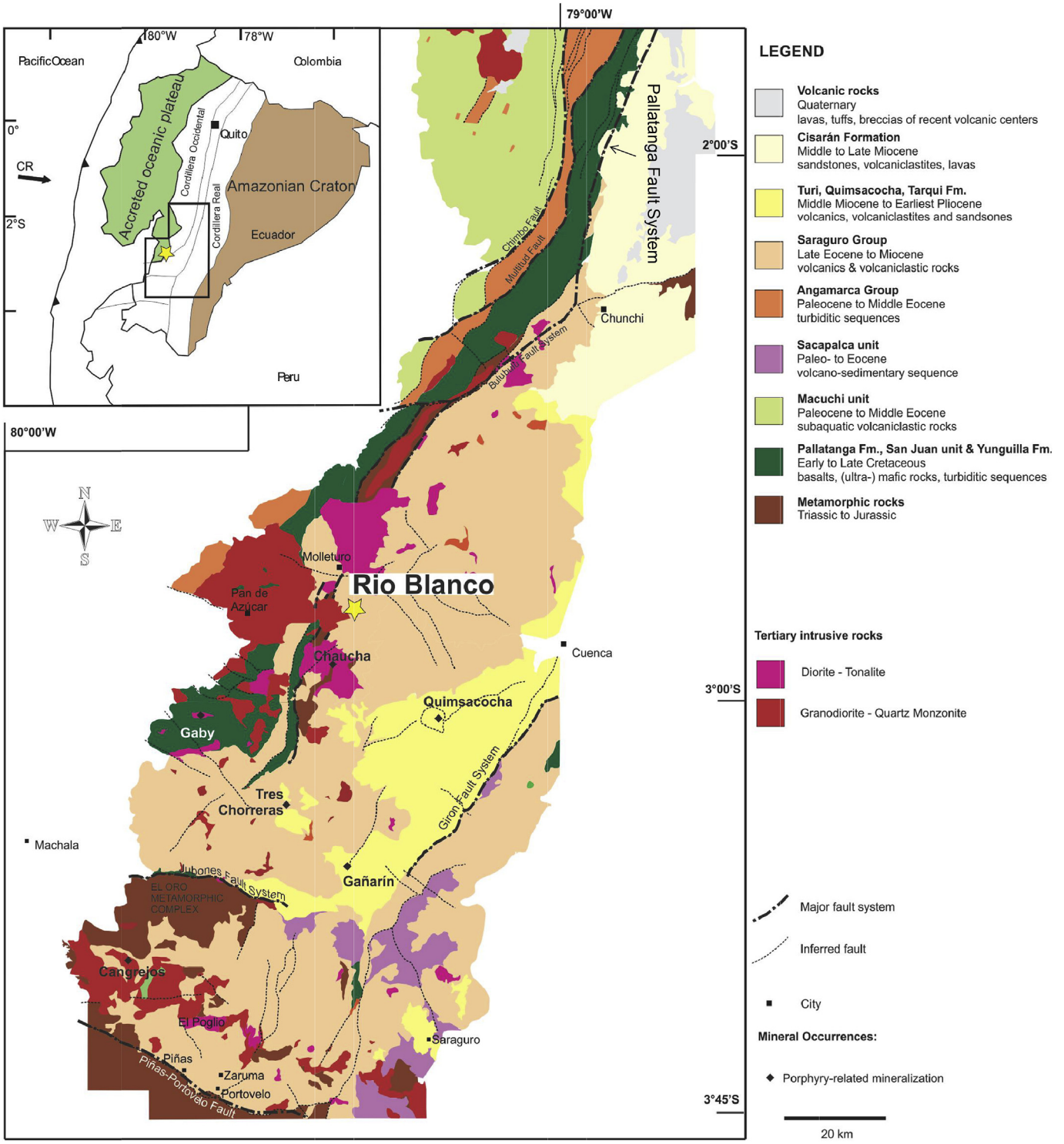

Fig. 1. Generalized Regional map showing the location of the Rio Blanco Au-Ag Project. Geology shown corresponds to the domains of the Western Cordillera (Cordillera Occidental). The locations of major porphyry-related mineralization of the Western Cordillera of southwest of Ecuador are also shown. Note the predominance of volcanic rocks from the Saraguro Group, which is the host the Rio Blanco Formation, which in turn is host of the NE-NNE trending Rio Blanco vein systems. Modified from Bineli Betsi et al. (2017).

Cu-Au-(Mo) deposits, and (v) the Tres Chorreras polymetallic deposit (Fig. 1) to name a few.

The Rio Blanco Au-Ag Project is an 86 km^2 land subdivided into several Au-Ag target areas (comprising from north to south: Loma Larga, Arco Iris, Bolivar, San Luis, Alejandra, Lourdes, Esperanza, Orquidea, Dorada, and Cachimachay). Of these Au-Ag target zones, the Alejandra zone is the most important one, in respect to size, grade, and tonnage [605,000 ounces of gold and 4.3 million ounces of silver contained within 2.15 million tons at an average grade of 8.8 g per ton (g/t) gold and 62 g/t silver, using a 3 g/t Au cut-off grade (International Minerals Corporation (IMC) news release October 12, 2006]. "Bonanza" grades (at least 1 Oz/t Au) as defined by Sillitoe (2002) are locally encountered through Alejandra vein and reach 600–800 g/t Au (PRODEMINCA BGS, 2000).