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Chapter 19

Oxidized Gold Skarns in the Nambija District, Ecuador

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Abstract

The Nambija gold district, southeastern Ecuador, consists of oxidized skarns developed mainly in volcaniclastic rocks of the Triassic Piuntza unit, which occurs as a 20-km-long, north-trending, contact-metamorphosed lens within the Jurassic Zamora batholith. High gold grades (10–30 g/t) are accompanied in most mines by very low Fe, Cu, Zn, and Pb sulfide contents. The skarn is constituted dominantly by massive brown garnet (mean Ad_{38}). Subordinate pyroxene-epidote skarn developed mainly at the margins of brown garnet skarn bodies. Mostly idiomorphic and more andraditic garnet (mean Ad_{45}) occurs in blue-green skarn formed as a later phase, in places with high porosity, at the transition with vugs and discontinuous dilational type I veins. The last garnet generations are mainly andraditic and occur largely as honey-yellow to red-brown clusters and cross-cutting bands (mean Ad_{84}). As typical for other skarns developed in volcaniclastic rocks, mineral zoning is poorly defined.

The retrograde overprint is weakly developed, commonly fails to alter the prograde minerals, and is mainly recognized in mineral infilling of structurally controlled (N10°–60°E) vugs and up to several-centimeter-wide type I veins, as well as interstices in blue-green skarn. Retrograde minerals are milky quartz, K-feldspar, calcite, chlorite, and hematite, ±plagioclase, ±muscovite, plus minor amounts of pyrite, chalcopyrite, hematite, sphalerite, and gold. Vugs and type I veins are cut by thin (1–2-mm) throughgoing type II veins that show similar orientations and mineralogy. Native gold is associated with retrograde alteration, mainly in the irregular vugs and type I veins, and subordinately in interstitial spaces and throughgoing type II veins. It is not observed in sulfide-rich type III veins, which cut the previous vein generations.

High-temperature (up to 500°C) and high-salinity (up to 60 wt % NaCl equiv) inclusions in pyroxene represent the best approximation of the fluid responsible for a significant part of the prograde skarn stage. Such a highly saline fluid is interpreted as the result of boiling of a moderately saline (~8–10 wt % NaCl equiv) magmatic fluid at temperatures of ~500°C. Moderate- to low-salinity fluid inclusions (20–2 wt % NaCl equiv) in paragenetically later garnet as well as in epidote and quartz from vugs and type I veins may represent later, slightly lower temperature (420°–350°C) trapping of similar moderately saline fluids with or without some degree of boiling and mixing. The similarity of salinities and homogenization temperatures in late garnet, epidote, and quartz fluid inclusions is consistent with the apparent continuum between the prograde and retrograde skarn stages, as illustrated by the general lack of prograde mineral alteration, even at the contacts with retrograde fillings.

Gold deposition, together with that of small amounts of hematite, chalcopyrite, and pyrite, took place during fluid cooling in the retrograde skarn stages but not during the last retrograde alteration, as indicated by the absence of gold in the sulfide-rich type III veins. The abundance of gold-bearing samples with high hematite/sulfide ratios and generally low total sulfide contents suggests high oxygen fugacities during gold deposition. The northeast structural control of vugs and type I veins, compatible with regional northeast-striking structures, in part with a dilational character, suggests that skarn formation, including gold deposition in the retrograde stage, took place under conditions of tectonic stress.

Minimum Re-Os ages of 145.92 ± 0.46 and 145.58 ± 0.45 Ma for molybdenite from type III veins are compatible with skarn formation and gold mineralization during Late Jurassic magmatism. A genetic relationship with felsic porphyry intrusions that cut the Jurassic Zamora batholith and crop out near several gold skarns is suggested by a published hornblende K-Ar age of 141 ± 5 Ma for a felsic porphyry in the northern part of the Nambija district. Furthermore, the minimum Re-Os ages of ~146 Ma are just slightly younger than the published K-Ar ages (154 ± 5, 157 ± 5 Ma) for the Pangui porphyry copper belt about 70 km north of Nambija.

Resumen

El distrito aurífero de Nambija, suroeste de Ecuador, está constituido por skarns oxidados desarrollados en su mayoría en rocas volcanoclásticas de la unidad triásica de Piuntza, que ocurre como una lente de 20 km de largo afectada por metamorfismo de contacto dentro del batolito de Zamora.

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