



Chapter 22

Skarn, Porphyry, Vein, and Replacement Mineralization in the Toqui District, Southern Chile

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Abstract

The Toqui district is located in southern Chile, 1,350 km south of Santiago. The total geological resource for the district is 20 million tonnes (Mt) grading 8.2 percent Zn and 1.5 g/t Au, with zones of significantly higher Au grades. All orebodies in the district are being developed by the Toqui mine, an underground room and pillar operation that has an average annual production of 500,000 t per year.

The Toqui district contains a series of skarn and replacement orebodies within a 24 km² area. Oldest rocks include Jurassic andesite and Cretaceous volcanic sandstone and tuff of the Toqui Formation, with a basal 5- to 30-m-thick limestone unit, rich in oyster fossils and forming the main ore host. Above these units is 800 m of black shale of the Katterfeld Formation, overlain by andesite of the Cretaceous lower Divisadero Group, which is then overlain unconformably by rhyolite ignimbrite of the upper Divisadero Group. Intrusive rocks include rhyolite, dacite, and andesite sills emplaced into all the Cretaceous rock units. Multiple periods of magmatic and hydrothermal activity have been documented from 120 to 105 Ma.

At district scale, Fe, As, Au, Bi, and Co are highest in the southeast, associated with garnet, pyroxene, and amphibole alteration, whereas Pb and Ag are highest in the northwest, associated with chlorite and sericite. Zinc grades are fairly uniform across the district, but sphalerite is zoned from high Fe in the southeast to low Fe in the northwest. Economically significant gold mineralization was superimposed on earlier base metal-rich skarn in the southeastern part of the district. Late hydrothermal fluids entered the skarn system along pre-existing northwest-trending structures. Gold occurs as electrum associated with native bismuth, cobaltite, and a variety of sulfosalts. Gold-rich ore generally contains abundant arsenopyrite, but arsenopyrite-rich ores are not necessarily gold rich. Gold and cobaltite deposition was accompanied by extensive retrograde amphibole formation, with clay minerals more abundant at the periphery of the gold zones. Deep drilling has encountered two areas of subeconomic pyrite-chalcopyrite-molybdenite stockworks. One is beneath the skarn orebodies in the southeastern part of the district and the other is beneath mineralization in the northwestern part. The emerging picture is one of a large porphyry-skarn district with multiple pulses of intrusion and alteration, resulting in multiple orebodies and mineralization styles.