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The Role of Magmas in Forming a Big Skarn System: A Case Study from La Colorada Deposit (Zacatecas, Mexico)

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The La Colorada deposit in Mexico is a large skarn system, containing 299 Moz Ag (34g/t), 7.4 Mt Zn (2.67%), and 3.4 Mt Pb (1.21%; 12/18/2023), and is among the world's top three Zn-Pb skarns. It features skarn, porphyry, and carbonate replacement (CRD) mineralization in deeper carbonate-rich sedimentary sequences, and intermediate sulfidation epithermal mineralization in both overlying volcanic rocks and sedimentary sequence. Exploration is ongoing and the deposit remains open.

Multiple intrusions of andesitic, dacitic and rhyodacitic compositions occur in this deposit as stocks, dikes, and/or sills. Some of them are identified as syn-skarn based on zoning patterns of exoskarns next to the intrusions that include A) garnet color becomes darker; B) pyroxene color changes from brown to green; and C) garnet and pyroxene Mn contents decrease (garnet, from 1.9 to 0.1; pyroxene, from 15.5 to 0.2 MnO wt%), towards the causative intrusions. Additional evidence includes the presence of red garnet endoskarn, with or without porphyry-style alteration/mineralization. Other intrusions are either pre- or post-skarn.

Syn-skarn intrusions include andesite, dacite, and rhyodacite porphyries. Cross-cutting relationships suggest that fertile magmas evolved from intermediate to more felsic compositions, with the latter responsible for more skarn development. Syn-skarn porphyry molybdenite Re-Os (n=3) and zircon U-Pb (20) dating, together with skarn garnet U-Pb (10) dating show a mineralization age of ca. 62 Ma in the east, and ca. 63 Ma in the western side of the deposit.

The plurality of mineralizing intrusions, intruded at close but different locations over ~1 million years, is believed to be critical in the formation of this large system. The intrusions may have stemmed from a deeper batholith and were emplaced in contact with carbonate-rich sequences. Early andesite/dacite intrusions produced only narrow skarns but enhanced wall-rock permeability. Later rhyodacite phases formed wider skarns and significantly increased the deposits' metal endowment.