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SPINELS RENAISSANCE: THE PAST, PRESENT, AND FUTURE OF THOSE UBIQUITOUS MINERALS AND MATERIALS

Magnetite spherules in pyroclastic iron ore at El Laco, Chile

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Abstract

The El Laco iron deposits in northern Chile consist of magnetite (or martite) and minor hematite, pyroxene, and apatite. The orebodies are situated on a volcanic complex and resemble lavas and pyroclastic deposits, but a magmatic origin is rejected by some geologists who regard the ores as products of hydrothermal replacement of volcanic rocks. This study describes spherules of magnetite in the ore at Laco Sur and outlines a previously unrecognized crystallization process for the formation of spherical magnetite crystal aggregates during volcanic eruption.

Mining at Laco Sur, the second largest deposit at El Laco, shows that most of the ore is friable and resembles pyroclastic material; hard ore with vesicle-like cavities occurs subordinately. The friable ore is a porous aggregate of 0.01–0.2 mm magnetite octahedra with only a local stratification defined by millimeter-thin strata of apatite. Films of iron phosphate are common on magnetite crystals, and vertical pipes called gas escape tubes are abundant in the ore. A SEM study reveals that magnetite spherules in the range 0.05–0.2 mm occur in most samples of friable ore from the central-lower part of the deposit. The proportion of spherules in a sample varies from high to nil, but overall the spherule content is low in the ore. The spherules are aggregates of octahedral crystals, or single octahedra, that have been rounded by stepwise, subparallel growth of magnetite with a systematic slight shift in orientation of successive steps. The shape of the spherules demonstrates that they formed unattached to any surface. Growth from hot magmatic gas saturated in iron in a volcanic plume and deposition as ash fall can account for the features of the spherule-bearing friable ore.

Keywords: Crystal growth, Fe, eruption, magmatic gas, plume, volcanic ash