NONSULFIDE AND SULFIDE-RICH ZINC MINERALIZATION OF THE VAZANTE GROUP, MINAS GERAIS: ISOTOPIC GEOCHEMISTRY AND IMPLICATIONS FOR REGIONAL EXPLORATION

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The Vazante–Paracatu region hosts the Vazante hypogene nonsulfide zinc deposit, which is the major zinc deposit in Brazil. Several carbonate-hosted sulfide-rich zinc–(lead) deposits and occurrences (e.g. Morro Agudo, Ambrósia, Fagundes, Poções, Bento Carmelo) also occur in the region. All these present different mineralization styles attributed to diagenetic or epigenetic-hydrothermal processes involving fluids tectonically expelled during the Brasiliano Orogeny.

The Vazante ore is epigenetic, structurally controlled and comprises mainly willemite (Zn_2SiO_4). Subordinated sphalerite and galena occur in small bodies tectonically imbricate with the willemitic ore, dolostone, slate, and metabasite within a shear zone. Strong hydrothermal alteration is associated with hydraulic and net veined breccias with hematite, siderite, dolomite, and Zn-chlorite.

The sulfide-rich deposits are stratabound or fault-controlled. The zinc ore is composed of sphalerite, pyrite, galena, white dolomite, and quartz. The ore textures are represented by early sulfide cementation of inconsolidated allochemical grains (syndiagenetic stage), rhythmically-banded, colloform or zoned sulfides (late-diagenetic stages) and by coarse-grained granular sphalerite and veinlets (epigenetic stages). Focused hydrologic outflow, typically along faults, resulted in hydrothermal alteration involving silicification and

precipitation of coarse-grained dolomite. Brittle–ductile and brittle deformation and late mineralization events occur in all deposits.

Stable isotopic studies indicate remarkably distinct signatures for sulfides and associated carbonates from Vazante deposit and sulfide-rich deposits. In the Vazante deposit, sulfides show a narrow range of $\delta^{34}S$ values (+11.8 to +14.4‰), whereas the sulfide-rich deposits display a wide sulfur isotopic variation (–8.7‰ to +40.0‰) and a complex isotopic distribution. The carbon and oxygen signature of the carbonates related to Vazante sphalerite ($\delta^{18}O$ = +21.58 to +31.85‰; $\delta^{13}C$ = –5.94 to +1.66‰) are also different of those of sulfide-rich deposits ($\delta^{18}O$ = +12.4 to +20.3‰; $\delta^{13}C$ = –2.3 to +0.3‰).

The main sulfur source for the Vazante sulfides could be related to the reduced sulfur content transported by the relatively ^{18}O-enriched (~+10‰), high-temperature (>250^{o}C), moderate salinity (~15 wt.% NaCl) metalliferous fluids. The progressive consumption of sulfur from this fluid would yield early sphalerite precipitation followed by bulk willemite deposition. The genesis of the high-grade sulfide-rich deposits involved progressive mixing with an additional important sulfur source, related with high-salinity, strongly radiogenic tectonic brines, possibly derived from shale units, which are scarce at the Vazante area.

Additionally, topographically-driven flow of ^{18}O-depleted, low salinity, low-temperature (~100^{o}C) meteoric water was fundamental for the Vazante willemite stability. In the other areas, its predominance resulted in ^{18}O-shifts in the host dolostone, white dolomite formation, and low-grade zinc mineralization.

The use of stable isotopes could trace the degrees of fluid mixing involving different proportions of fluid components (meteoric, metalliferous, and sulfur-rich fluids) in the system, and consequently, of metals and reduced sulfur, and would be useful for mineral exploration of the distinc mineralization styles in the district.

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