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Magnetite Chemistry as Exploration Tool to Constrain Fertility and Hydrothermal Evolution in IOCG and Porphyry Environments. San Matías District, Northern Colombia

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Magnetite structurally incorporates minor and trace elements depending on temperature of formation, thus making it useful for petrogenetic interpretations, as an exploration tool, and to understand the physical-chemical conditions of the ore-forming fluid(s). The San Matías Cu-Au District (SMD) in northwestern Colombia hosts multiple late Cretaceous intrusions and associated mineralization, including Fe-Au±Cu±light REE at the El Alacrán IOCG deposit and porphyry Cu-Au deposits like Montiel E and Costa Azul. Much of the mineralization has abundant magnetite, specularite, and mushketovite, particularly at El Alacrán where magnetite is associated with an early calc-silicate alteration. Copper precipitated with later stage sericite-Mg-chlorite-carbonate.

Six hydrothermal magnetite phases (Mag) are recognized from petrography, SEM and EMPA evaluation: Mag 1-intergrown with chlorite, has patchy zonation, elevated Al, Si, and low V; Mag 2-euhedral, dark-gray and apatite inclusions, highest Al, Mg, Si and Ca; Mag 3-unzoned, euhedral, light-gray, lacks apatite inclusions, highest Fe and lowest Al, Mg, and Ca; Mag 4-pyrite-Au-related, bladed (mushketovite), high Al, Mg, Si, Ca and low V; Mag 5-mushketovite with inherited specularite, lowest Ti and Ca; Mag 6-unzoned and within quartz veinlets in sericite-Mg-chlorite-carbonate alteration.

Mag 6 from the El Alacrán deposit contains Ca-Al-Mn-Ti-V concentrations similar to magnetite from quartz-rich tonalites intrusions and to the hydrothermal magnetite from the associated porphyry deposits. El Alacrán magnetites record an initial heating path from Mag 1 to Mag 2 with a subsequent cooling path to Mag 3, 4 and 5. The changes in the chemistry of magnetite reveal the thermal history related to early calc-silicate alteration (Mag 1 – 5). The similar composition of Mag 6 with the magnetite from the porphyry prospects enhances the prospectivity for a potential concealed porphyry under El Alacrán.