Beneath the Surface: The Geology of the Magdalena VHMS Deposit, Iberian Pyrite Belt, Spain

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The Magdalena deposit is a volcanic-hosted massive sulfide (VHMS) deposit located in Almonaster la Real, Spain, owned and operated by Sandfire Resources-MATSA. It lies within the northern section of the Iberian Pyrite Belt (IPB), one of the world's most significant metallogenic provinces, known for its numerous massive sulfide ore bodies. Although a relatively recent discovery, Magdalena is part of a broad cluster of significant world-class VHMS deposits in the northern IPB, which includes Aguas Teñidas and Rio Tinto.

Magdalena is a blind deposit, consisting of ore bodies found 160 – 1,000m beneath the surface, and contains 25.4 Mt @ 2.2% Cu, 2.5% Zn, 0.8% Pb, and 37.5 g/t Ag (Sandfire Resources Report, 2024). The deposit is hosted within the Volcanic-Sedimentary Complex (VSC) of the IPB. However, the geology of the deposit remains undocumented and poorly understood.

Detailed core-logging reveals that the stratigraphy of Magdalena includes rhyolites to rhyodacites, and andesites to basalts, interbedded with green to purple shales and slates, characteristic of the middle and upper VSC. The ore-envelope lithology is dominated by volcaniclastic facies, including quartzose clasts, and alteration assemblages containing quartz, feldspar, and layers or aggregates of white mica, with minor chlorite reflecting the hydrothermal alteration associated with the mineralization process.

Mineralization is polymetallic and highly variable, displaying a range of textural and compositional ore types. These include: i) pyrite-rich aggregate layers alternating with quartz–white mica-rich volcaniclastic rocks; ii) massive, laminated sulfide ore with compositional banding between pyrite, sphalerite, galena and chalcopyrite; iii) massive pyrite-dominant ore, with coarse to fine grained pyrite; and iv) brecciated massive sulfide zones. Subordinate veins of chalcopyrite–quartz–carbonate, quartz, and quartz–chlorite–feldspar–pyrite are also observed either within the ore body or distally. This variability suggests a complex depositional and post-depositional history, likely influenced by syn-volcanic and diagenetic processes typical of VHMS systems in the IPB.