Resolving the magmatic-hydrothermal signal using iron and oxygen stable isotope pairs at the world class Mantoverde iron oxide – copper – gold deposit, Chile.

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Iron oxide – copper – gold (IOCG) deposits are a globally important source of Fe, Cu, Au, Ag, U, REE, Ba and F. These deposits are homogeneously distributed through time and are most commonly associated spatially and temporally with arc magmatism. Several genetic models for the formation of IOCG deposits have been proposed, including formation by magmatic-hydrothermal fluids, non-magmatic hydrothermal fluids such as basinal brines, a combination of magmatic-hydrothermal fluids and basinal brines, or metamorphic fluids. More recently, models have proposed that iron oxide – apatite (IOA) – derived fluids may continue transporting significant amounts of metals to form IOCG mineralization at more shallow levels in the crust. In this study, we focus on the world class Mantoverde IOCG deposit located within the Chilean Iron Belt. Mantoverde contains hundreds of millions of tonnes (Mt) of iron oxide and copper sulfide ore, and despite several previous studies the source of the ore forming fluids remains elusive. To overcome the extensive hydrothermal overprint at Mantoverde known to disturb most conventional stable isotope systems (e.g., oxygen, etc.), we report the first δ^{56}Fe data for ore-stage magnetite and late-stage hematite that fingerprint the source of the ore fluids for these modally dominant oxide minerals in the Mantoverde system. Stable isotopes of iron have been previously shown to be robust to hydrothermal alteration and remobilization, and are used here in combination with δ^{18}O values to unravel the source reservoir of ore metals. Magnetite δ^{56}Fe values range from 0.37 ± 0.06 ‰ to 0.61 ± 0.04 ‰ and average 0.51 ± 0.16 ‰ (n = 10; 2σ), while the δ^{56}Fe values of three hematite samples were measured to be 0.34 ± 0.10 ‰, 0.42 ± 0.09 ‰, and 0.46 ± 0.06 ‰. Magnetite δ^{18}O values range from 0.69 ± 0.04 ‰ to 4.61 ± 0.05 ‰ and average 2.99 ± 2.70 ‰ (n = 9; 2σ). Hematite δ^{18}O values range from -1.36 ± 0.05 ‰ to 5.57 ± 0.05 ‰ and average 0.10 ± 5.38 ‰ (n = 6; 2σ). These new δ^{56}Fe and δ^{18}O values complement published data for isotopes of C, O, S, Sr, Pb, Ar, Kr, Xe and halogen ratios for samples from hypogene mineralization, and fingerprint a magmatic-hydrothermal fluid as the ore forming fluid responsible for IOCG mineralization in the Mantoverde deposit. The genetic relation between IOCG mineralization and the emplacement of numerous magnetite-apatite orebodies in the Mantoverde district remain to be tested in future studies.