Fe and O isotope systematics of the Los Colorados IOA deposit, Chile

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A genetic model for iron-oxide apatite (IOA) and iron-oxide copper gold deposits (IOCG) remains elusive. Working hypotheses invoke meteoric fluid, magmatic-hydrothermal fluid, and liquid immiscibility [1,2,3]. Here we report new high-precision Fe and O isotope data on magnetite separates from the Los Colorados (LC) IOA deposit, in the Chilean Iron Belt, that allow us to assess whether LC magnetite precipitated from aqueous fluid or crystallized from silicate melt. This avoids tracing the source of Fe and O by indirect means.

LC contains 70 M tonnes Fe [4] in two parallel magnetite-rich (>90 modal %) dykes that measure 1500m strike, 150m wide, and ~500m deep. LC is Cretaceous in age, and hosted in igneous rocks of the Punta del Cobre Formation [5]. The West dyke contains ~63% Fe_{tot} and the East dyke ~55% Fe_{tot}. The dykes are bounded on the west by a fault and the east by a brecciated zone, which contains Fe_{tot} = ~25%.

We measured $\delta^{56}Fe$ for 20 samples from 2 drill cores from the West dyke. Values range from 0.08‰ to 0.26‰, which are within the global range of ~0.06 to 0.5‰ for magnetites crystallized directly from silicate melts [3]. The variation of $\delta^{56}Fe$ outside of the 0.05‰ analytical error accords with evidence of subtle alteration and/or local magnetite dissolution/reprecipitation. High-precision O isotope measurements of magnetite and actinolite are: $\delta^{18}O_{magnetite}$ = 2.04‰; $\delta^{18}O_{actinolite}$ = 6.08‰. The $\delta^{56}Fe$ and $\delta^{18}O$ values are unequivocally magmatic [3,6].

If the LC IOA deposit represents the deeper level of an IOCG system [cf. 1], our new data provide evidence to support a role for liquid immiscibility. The application of $\delta^{56}Fe$ measurements for iron-oxide minerals offers a powerful new tool to fingerprint the source of iron in IOCG deposits.

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