Pb isotopes signatures from melt inclusions, host rock, and mineralization in the El Laco magnetite-apatite deposit, Chile

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El Laco is the most pristine example of magnetite-apatite (so-called Kiruna type, or Iron Oxide Apatite) deposits worldwide. The ore body is located on the flanks of the 2 Ma El Laco Volcanic Complex, which is a part of the Pliocene-Pleistocene volcanic arc in northern Chile. Previous studies of the El Laco ore body describe immiscible melt inclusions preserved in plagioclase and clinopyroxene phenocrysts in the andesite hosting the iron mineralization. The immiscible melt inclusions document the presence of unmixed Fe-rich and Si-rich melts in the system. To investigate the relationship between immiscible melt inclusions, iron mineralization and the andesitic host rocks, Pb isotope concentrations were determined in situ in melt inclusions, in plagioclase and clinopyroxene phenocrysts by secondary ion mass spectrometry, and from whole rock analyses of the magnetite-apatite ore body and the andesite hosting melt inclusions by isotope dilution thermal ionization mass spectrometry. The results plotted on Pb evolution diagrams show that melt inclusions and phenocrysts samples are dispersed between the mantle and upper crust reference lines, indicating that the source magma was heterogenous and likely contaminated by interacting with the crust during its ascent. Iron mineralization and host rock samples have different $^{206}Pb/^{204}Pb$ ratios (e.g., 18.22–18.47 and 18.80–18.96 respectively) suggesting that they did not originate from a similar source, or that iron mineralization lost radiogenic lead during its formation. The host rock Pb concentrations occupy a limited field which is located in the middle of the melt inclusions and phenocrysts field, implying that the whole rock Pb data are averages of the Pb isotopes derived from the in situ analyses.

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