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The iron source in phreatomagmatic pipes in the Tunguska Basin (eastern Siberia): insights into hydrothermal-metasomatic leaching processes from Fe isotopes, microstructures, and mass balances.

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The Siberian iron-bearing phreatomagmatic pipes represent world class Fe-ore deposit, and 5-6 are currently mined in eastern Siberia. The pipes formed within the vast Tunguska Basin, cutting thick accumulations of carbonates (dolostones) and evaporites (anhydrite, halite, dolostone). These sediments were intruded by the sub-volcanic part of the Siberian Traps at 252 Ma, and sills and dykes are abundant throughout the basin. The pipes formed during sediment-magma interactions in the deep parts of the basin, and the degassing is believed to have triggered the end-Permian environmental crisis. A major problem with understanding the pipe formation is related to the source of iron. Available hypotheses state that the iron was leached from a Fe-enriched magmatic melt that incorporated dolostones. It is currently unclear how the magmatic, hydrothermal, and sedimentary processes interacted to form the deposits, as there are no actual constraints to pin down the iron source. We hypothesize two end-member scenarios to account for the magnetite enrichment and deposition, which is testable by analyzing Fe-isotopes of magnetite: 1) Iron sourced from dolerite magma through leaching and metasomatism by chloride brines. 2) Leaching of iron from sedimentary rocks (shale, dolostone) during magma-sediment interactions. We focus on understanding the Fe-isotopic architecture of the pipes in order constrain the source of the Fe and the mechanism that caused this significant Fe redistribution. We further evaluate possible fractionation during fast metasomatic ore-forming process that took place soon after pipe formation.