## Carbonatite Melt as a Travel Agent for Magmatic Sulfide Liquid: Nature vs. Experiments

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The transport of dense sulfide liquid in mafic-ultramafic magma across the lithosphere has been a long-standing challenge in the studies of magmatic sulfide systems. Solving this issue is crucial for understanding the metal and sulfur cycles and for developing effective exploration strategies for valuable magmatic Ni-Cu-PGE deposits. Recently, it has been observed that sulfide mineralization is commonly found in intimate association with volatile-rich minerals, leading to a hypothesis that sulfide liquid transportation could be facilitated by water- and carbon dioxide-bearing fluids or gas bubbles coupled with sulfide droplets. However, this association with volatile-rich phases alone cannot explain the mineralogy, as minerals enriched in elements incompatible with mafic magma, such as Ti or Zr, are also present in close proximity to sulfide globules. The explanation of mineralogy by a pressure-derived infiltration of late, highly fractionated melt into the hollow spaces that left behind the bubbles presents similar problems, as some minerals cannot form in this manner. Additionally, this association has been found in both shallow and lower-crustal intrusions, where gas bubbles or fluid exsolution from the magma are unlikely due to high-pressure conditions. Therefore, a new model for sulfide liquid transport is needed, which we propose here based on mineralogy and textural variability. We suggest that the haloes enveloping sulfide globules are the product of crystallization of primary relatively buoyant and low-viscosity carbonatite liquid exsolved from the mafic magma, wherein the carbonatite globules will be immiscible with both sulfide and silicate melts. High-temperature, high-pressure experiments confirm that three immiscible liquids can coexist together, with carbonatite globules enveloping sulfide droplets in a coupled pair. The average density of these paired globules would be lower than that of the silicate melt, indicating that carbonatite liquid can be an effective transportation agent for sulfide globules in their journey from the mantle to the crust.