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A common origin for Thai/Cambodian rubies and blue and violet sapphires from Yogo Gulch, Montana, U.S.A.?

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Abstract

A wide number of genetic models have been proposed for volcanically transported ruby and sapphire deposits around the world. In this contribution we compare the trace element chemistry, mineral and melt inclusions, and oxygen isotope ratios in blue to reddish-violet sapphires from Yogo Gulch, Montana, U.S.A., with rubies from the Chantaburi-Trat region of Thailand and the Pailin region of Cambodia. The similarities between Thai/Cambodian rubies and Yogo sapphires suggest a common origin for gem corundum from both deposits. Specifically, we advance a model whereby sapphires and rubies formed through a peritectic melting reaction when the lamprophyre or basalts that transported the gem corundum to the surface partially melted Al-rich lower crustal rocks. Furthermore, we suggest the protolith of the rubies and sapphires was an anorthosite or, in the case of Thai/Cambodian rubies, an anorthosite subjected to higher pressures and converted into a garnet-clinopyroxenite. In this model the rubies and sapphires are rightfully considered to be xenocrysts in their host basalts or lamprophyre; however, in this scenario they are not "accidental" xenocrysts but their formation is intimately and directly linked to the magmas that transported them to the surface. The similarities in these gem corundum deposits suggests that the partial melting, non-accidental xenocryst model may be more wide-reaching and globally important than previously realized. Importantly, in both cases the gem corundum has an ostensibly "metamorphic" trace element signature, whereas the presence of silicate melt (or magma) inclusions shows they ought to be considered to be "magmatic" rubies and sapphires. This discrepancy suggests that existing trace element discriminant diagrams intended to separate "metamorphic" from "magmatic" gem corundum ought to be used with caution.

Keywords: Sapphire, ruby, Yogo Gulch, melt inclusions, corundum, gemology