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# VAPOR-PHASE GARNET AT YUCCA MOUNTAIN, NEVADA: GEOCHEMISTRY AND OXYGEN-ISOTOPE THERMOMETRY

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## ABSTRACT

About 20 vapor-phase garnets were studied in two samples of the Topopah Spring Tuff from Yucca Mountain, in southern Nevada. The Miocene-age Topopah Spring Tuff is a 350-m-thick, devitrified, moderately to densely welded ash flow that is compositionally zoned from high-silica rhyolite to quartz latite. During cooling of the tuff, escaping vapor produced lithophysae (former gas cavities) lined with an assemblage of tridymite, cristobalite, alkali feldspar, and locally, hematite and/or garnet. Vapor-phase topaz and economic deposits (such as porphyry molybdenum-tungsten) commonly associated with topaz-bearing rhyolites (characteristically enriched in fluorine) were not found in the Topopah Spring Tuff at Yucca Mountain. The garnets are not primary igneous phenocrysts, but rather crystals that grew from a fluorine-poor magma-derived vapor trapped during emplacement of the tuff. The garnets are euhedral, vitreous, reddish brown, trapezohedral, as large as 2 mm in diameter, and fractured. The garnets also contain inclusions of tridymite. Electron-microprobe analyses of the garnets reveal that they are almandine-spessartine (48.0 and 47.9 mol percent, respectively), have an average chemical formula of ($Fe_{1.46}$, $Mn_{1.45}$,

$Mg_{0.03}$, $Ca_{0.10}$) ($Al_{1.93}$, $Ti_{0.02}$) $Si_{3.01}O_{12}$, and are homogeneous in Fe and Mn concentrations from core to rim. Composited garnets from each sample site have $\delta^{18}O$ values of 7.2 and 7.4‰. The coexisting tridymite, however, has $\delta^{18}O$ values of 17.4 and 17.6‰, values indicative of reaction with later, low-temperature water. Unaltered tridymite from higher in the stratigraphic section has a $\delta^{18}O$ of 11.1‰ which, when coupled with the garnet $\delta^{18}O$ values in a quartz-garnet fractionation equation, indicates vapor-phase crystallization at temperatures of almost 600°C. This high-temperature mineralization, formed during cooling of the tuffs, is distinct from the later and commonly recognized low-temperature stage (generally 50-70°C) of calcite, quartz, and opal secondary mineralization, formed from percolating meteoric water, that locally coats fracture footwalls and lithophysal floors.