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The effect of fluid inclusion size on determination of homogenization temperature and density of liquid-rich aqueous inclusions

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ABSTRACT

Homogenization temperature variations of several degrees Celsius or more are often observed within a group of fluid inclusions that appear to have all trapped the same homogeneous fluid at the same time and presumably at the same *PTX* conditions. For inclusions that homogenize at $T \leq \approx 230$ °C, much of the observed variation can be attributed to the size of the inclusions. Larger inclusions homogenize at higher temperatures compared to smaller inclusions with the same density. The relationship between inclusion size and observed homogenization temperature is predicted by the Young-Laplace equation that relates the stability of a vapor bubble to the surface tension and pressure differential across the vapor-liquid interface. Vapor bubbles instantaneously collapse when the vapor bubble radius becomes less than the critical radius. During heating the critical radius of the vapor bubble is achieved at a lower temperature in the smaller inclusions. The critical vapor bubble radius varies from about 0.01 to ~3 μm for low-temperature aqueous fluid inclusions. The Gibbs surface free energy associated with the growth and collapse of vapor bubbles in pure H_2O inclusions with critical radii ranging from 0.01 to 1 μm ranges from about 10^{-18} to 10^{-13} J/m^2 and increases with both increasing critical vapor bubble radius and homogenization temperature. As a result of surface tension effects, the highest measured homogenization temperature, obtained from the largest inclusion in the group of coeval inclusions, most closely approximate the homogenization temperature that would be expected based on the inclusion density. For inclusions ranging from a few to several tens of micrometers in diameter and having densities such that the homogenization temperatures are approximately <230 °C, homogenization temperatures may vary by about 1–3 °C, depending on the inclusion size.

Keywords: Fluid inclusion, homogenization temperature, surface tension, Gibbs surface free energy, isochore, liquid-vapor curve, *PVTX* properties, density