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ESTIMATION OF VOLUME FRACTIONS OF LIQUID AND VAPOUR PHASES IN FLUID INCLUSIONS AND INCLUSION-SHAPE DEFINITIONS

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The molar volume (V_m) and chemical composition (x) of several types of fluid inclusions can be analysed by combining microthermometric and other analytical data. For complex gas-bearing aqueous inclusions, however, the calculation of bulk V_m–x properties still requires as input an optical estimate of the volume-fractions (φ) of phases in the inclusion. Such estimates are based on projected area fractions, as observed through the microscope. Unfortunately, the accurate conversion of area fractions to volume fractions is problematic for non-spherical inclusions, and although φ estimates are widely recognised as being uncertain, the magnitude of the uncertainty is essentially unknown. In order to quantify the uncertainties we have conducted optical analyses of synthetic inclusions that contain liquid + vapour (LV) at room temperature, for which the true φ values are known. We have also calculated the theoretical relationships between area fractions and volume fractions for a range of 3-dimensional geometries of LV inclusions. *Overestimates* of φ_{vap} values are obtained if the amount of liquid above and below the bubble cannot be seen and accounted for in the microscope. In contrast, *underestimates* of the true φ_{vap} values are obtained from the inclination of the inclusion walls, which is not obvious in the projection, so the apparent amount of liquid is exaggerated. The area fractions of regularly-shaped fluid inclusions *equal* the volume fractions when the inclusion is rotated such that its largest dimensions become visible. In irregularly-shaped inclusions, area fractions are always *underestimates* of φ_{vap}. Assemblages of synthetic fluid inclusions with known properties reveal both overestimates and underestimates values of φ_{vap} when based on area fractions, but the statistical distribution of values is centered on the true φ_{vap} value. As an aid in classifying the shape-dependency of uncertainties in φ we propose an objective image-processing method to describe the projected 2-dimensional shapes of fluid inclusions using two parameters: (1) the perimeter/area ratio and (2) the major/minor ratio of the axes of a best-fit ellipse. Combining these results yields systematic predictions of the uncertainties in φ estimates, which can then be propagated through calculations of bulk V_m–x properties of individual inclusions.