ELASTIC CHANGES OF FLUID INCLUSION VOLUMES IN MODEL AND EXPERIMENT

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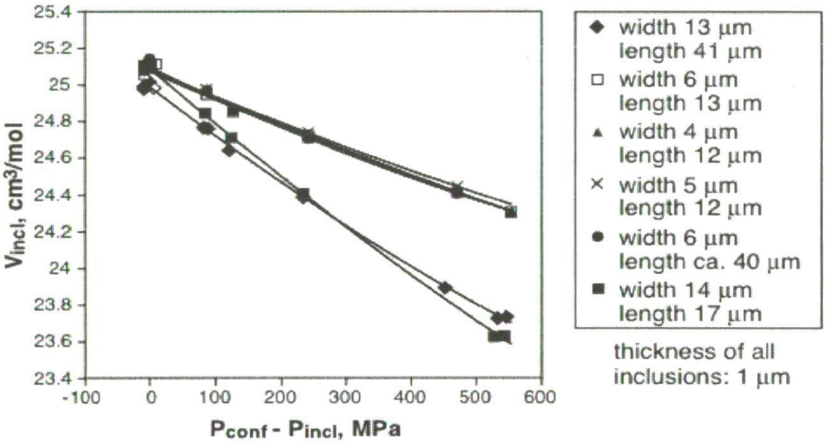
Changes in the volume of fluid inclusions occur when a difference between the confining pressure and the pressure in the inclusion exists. Such pressure differences result in stresses in the host mineral, which can lead to significant elastic or plastic deformation around the inclusion. In this study, elastic volume changes of inclusions in quartz were determined experimentally as functions of the difference of confining and inclusion pressure and inclusion geometry using a hydrothermal diamond-anvil cell (Bassett et al., 1993). The sample chamber of the cell was loaded with an oriented quartz disk containing synthetic pure water inclusions and water, which served as the pressure medium. The sample was heated to the homogenization temperature of the inclusions to determine the inclusion volume. The density of the pressure medium and the confining pressure P_{conf} on the sample were then obtained from the homogenization or the iceI liquidus temperature of the pressure medium. This procedure was repeated for the same inclusions at various confining pressures. The length (the maximum dimension) and width were measured for each inclusion. All inclusions had a thickness of approximately 1 μm.

At all P-T conditions of this study, the deformation of the quartz around the inclusions was elastic, because the inclusion homogenization temperature at 1 atm confining pressure was the same before and after the experiments. The change in inclusion volume with pressure depends strongly on inclusion shape. Sheet-like inclusions (i.e., high width:thickness AND high length:thickness ratios) deform more strongly than elongate inclusions (see figure). For the latter, the length:thickness ratio seems to have no measurable effect on the compressibility.



To quantify stresses from our experimental data, finite element models are used to investigate elastic volume changes of fluid inclusions as a function of shape and distance from the free sample surface. Stresses around an inclusion are proportional to the observed pressure differences, and depend on inclusion shape. All shapes examined are axially symmetric. Of the shapes similar to those of inclusions found in our samples, flat disc-like shapes will experience larger elastic volume changes than those shaped like elongate cylinders. For the latter, changes in aspect ratio do not affect the change in elastic volume with pressure. These results are in good qualitative agreement with our experimental observations. By including elastic anisotropy in the models, we expect an even closer match with the experimentally observed volume changes.

From our experimental observations and modeling results we conclude that the change in volume with pressure has mostly no significant effect on homogenization temperature measurements at 1 atm confining pressure. A notable exception can be large inclusions with a sheet-like geometry, particularly if the internal pressure at homogenization is high, for example in CO_2-bearing inclusions.

References

BASSETT, W.A., SHEN, A.H., BUCKNUM, M., CHOU, I-M. (1993) A new diamond anvil cell for hydrothermal studies to 2.5 GPa and from -190 to 1200 °C. Reviews of Scientific Instruments, **64**, 2340-2345.