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Experimental melt inclusion homogenization in a hydrothermal diamond-anvil cell: Comparison with homogenization at one atmosphere

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Abstract

Melt inclusion (MI) homogenization experiments are essential for determining the pressure-volume-temperature-composition (*P-V-T-X*) parameters of magma systems. The hydrothermal diamond-anvil cell (HDAC) is currently the only equipment that can exert external pressure on MIs while allowing in situ observation of MI phase changes during heating. The HDAC's pressure potentially prevents the MI diffusion that, under heating at one atmosphere, produces artificially elevated measurements of phase transition temperatures. It is important to compare the phase transition temperatures measured using HDAC at elevated external pressure with those obtained using conventional equipment at one atmosphere. Such a comparison not only helps assess the reliability of HDAC phase transition temperatures but also helps determine phase transition temperatures that are naturally occurring in MI during the natural history of cooling.

In this study, we homogenized MIs hosted in quartz from the granitic porphyry in the Yixingzhai Au deposit, China, using HDAC at an elevated pressure of ~(140–230) MPa. We compared our experimental results with published data measured using a Linkam TS1500 stage at one atmosphere. The experiments show that the initial melting temperature (T_{IniM}), total melting temperature (T_{TotM}), and total homogenization temperature (T_{hTot}) of the MIs are 695 ± 20, 780 ± 15, and 833 ± 17 °C, respectively. These phase transition temperatures are as much as 374 °C lower than the corresponding values measured at one atmosphere using the Linkam stage. Moreover, the temperatures measured using HDAC agree with actual values estimated using the linear extrapolation method based on correlations of MI size with phase transition temperatures measured using the Linkam stage. Based on the experimental HDAC results, we estimate that MIs in the Yixingzhai Au deposit were trapped at ~140 Ma and contained ~2 wt% H_2O. These values are consistent with previously estimated emplacement pressures and H_2O contents of granitic magmas in granitic porphyry-type Cu-Au deposits. Our results demonstrate that MI-homogenization experiments using HDAC at suitably elevated pressures can yield reliable naturally occurring phase transition temperatures in MI during the melt cooling process.

Keywords: Melt inclusions, hydrothermal diamond-anvil cell, Linkam heating stage, homogenization experiment, H_2O content; Applications of Fluid, Mineral, and Melt Inclusions