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A cold-sealing capsule design for synthesis of fluid inclusions and other hydrothermal experiments in a piston-cylinder apparatus

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ABSTRACT

Here we report on a newly developed, large-volume, cold-sealed capsule design for hydrothermal synthesis experiments in a piston-cylinder apparatus that should be useful for the production of synthetic fluid inclusions at pressures and temperatures not previously attained in gas- or fluid-pressurized reaction vessels. The design is adapted for large-volume experiments using a 30 mm internal-diameter pressure vessel, but can be scaled down to suit smaller pressure vessels, e.g., 15.9 mm (5/8") internal diameter, if required. Calibration experiments show that temperature varies ±5 °C over the length of a 30 mm (length) × 15 mm (diameter) Cu capsule. The design incorporates the thermocouple within the capsule mass to optimize temperature control. Quartz-hosted H_2O inclusions were synthesized over a range of conditions. Fluid-inclusion densities are consistent with the nominal experimental conditions, suggesting a friction correction is not required. This approach has several advantages over conventional hydrothermal experimental methods: (1) substantially higher pressures are attainable in piston-cylinder than hydrothermal and gas-media apparatus; (2) cold-sealing capsules avoid potential problems associated with welded capsules, such as solution modification; (3) capsule fluids are readily sampled ex situ; (4) the use of relatively thick-walled capsules minimizes H_2-losses during experiments; (5) synthetic fluid inclusions can be used to derive fluid *PVTX* properties by combining conventional thermometry with analyses of individual fluid inclusions or independent mineral solubility data.

Keywords: Piston-cylinder apparatus, synthetic fluid inclusions, hydrothermal studies, fluid *PVTX* properties, high-pressure and -temperature fluids, cold-sealed capsule, isochore