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Hydrothermal Laboratory

GFZ German Research Centre for Geosciences *

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Abstract: The hydrothermal laboratory is equipped with horizontal and vertical cold-seal pressure vessels for the synthesis of crystals or glasses or to study interactions between minerals/rocks, melts, and fluids at hydrostatic conditions. An advantage is that long-term runs can be done to investigate equilibria between solid phases. This facility, operated by the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, is open to all academic applicants, both national and international. There is no external steering board. Requests to use the laboratory are evaluated based on scientific quality and feasibility of the project.

1 Introduction

Hydrothermal experiments provide essential information to understand geologic processes at the conditions in the Earth's crust, and are also an important tool for the synthesis of materials of interest in chemistry and physics. For this purpose, the GFZ operates a hydrothermal laboratory, which is equipped with vertical rapid quench and horizontal cold-seal pressure vessels (Figure 1). This facility is used for academic research, largely for experiments from numerous German and international collaborations, but also for in-house projects and for education of students including Master's and doctoral theses.
The collaborations are mostly with geoscientists, but also with physicists. Consequently, the experiments span a large range of topics from fluid–rock or aqueous fluid–silicate melt interaction to crystal growth rates in hydrous melts or reaction rims to tuning of crystal compositions for nonlinear optics.

The hydrothermal laboratory belongs to the infrastructure of the section "Chemistry and Physics of Earth Materials" and is not part of the "Modular Earth Science Infrastructure" (MESI) of the GFZ. Requests to use the facility are possible as collaboration projects and are evaluated by the scientist in charge or the collaborating scientist based on the scientific quality and feasibility of the project. The experiments are scheduled depending on autoclave availability and required maintenance work. External users are expected to provide the metal tubing (mostly Au or Pt) for the capsules to seal the samples.

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2 Typical Applications

- geosciences (metamorphic and igneous petrology, aqueous geochemistry)
- chemistry
- physics
- phase equilibria
- phase diagrams
- solubility
- element partitioning
- reaction kinetics
- crystal growth rates
- texture development
- synthesis of hydrous silicate glasses
- melt immiscibility
- synthetic fluid inclusions
- melt inclusion homogenization

Figure 1: a) 200 MPa line and rapid quench line, b) 500 MPa line.

3 Technical data – specifications

200 MPa line:
6 externally heated cold-seal autoclaves (steel: ATS). T-P limits: 800 °C at 200 MPa or 900 °C at 100 MPa. Pressure medium: H_2O. The temperature can be controlled via internal or external thermocouples, depending on capsule length. Maximum capsule diameter: 5 mm.

500 MPa line:
12 cold-seal autoclaves (steel: ATS or RENE41). T-P limits: 750 °C at 500 MPa or 900 °C at 100 MPa. Pressure media: H_2O (up to 10 autoclaves), or CO_2 (2 autoclaves, separate pressure generation unit, to about 400 MPa). The temperature can be controlled via internal or external thermocouples, depending on capsule length. Maximum capsule diameter: 5 mm.

Rapid quench line:
6 rapid quench autoclaves (steel: ATS). T-P limits: 800 °C at 200 MPa or 900 °C at 100 MPa. Pressure medium: H_2O. The temperature is controlled via external thermocouples.

Miscellaneous equipment for capsule preparation and welding (fine welding machine Lampert PUK U3) and sample loading, drying, and weighing.

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