

## Thermal diffusivity of pyrope-composition glass at high pressure

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The thermal properties of silicate minerals and melts are very important for understanding heat and material transport in planetary interiors. In particular, the thermal diffusivity of silicate melt is required for evaluating the dynamics of magma convection, because this term appears in the Plandtl and Rayleigh numbers. However, measurements of the thermal diffusivity of silicate melts are rare especially at high pressure, because of technical difficulties. Such difficulties are greatly reduced when measurements are made on glass (i.e. quench melt). In the present study we have measured the thermal diffusivity of pyrope-composition glass up to 11 GPa in a multianvil apparatus using the periodic temperature wave method (Ångström method). This method is suitable for in-situ measurements in a high-pressure apparatus on a sample under static compression. A heating system with a cylindrical geometry was used. A cylindrical sample of  $Mg_3Al_2Si_3O_{12}$  glass was loaded in a cylindrical resistance heater in an octahedral multianvil pressure cell. The electric power supply to the heater was cycled periodically (sine wave function) and temperature was measured simultaneously at both the center and the outer surface of the sample as a function of time. Thermal diffusivity was calculated from the phase shift of the two sinusoidal temperature curves and the distance between the two thermocouples. The frequency was varied at each pressure and temperature in order to investigate any possible frequency dependence of thermal diffusivity. The distances between two thermocouple wires at high pressures and high temperatures were corrected using the results of molecular dynamics (MD) simulations at the experimental conditions. Experiments were performed from 400 to 1000 K from 3 to 11 GPa. The recovered glass samples remained transparent and did not crystallize during the experiments at these conditions. The thermal diffusivity and its pressure derivative for  $Mg_3Al_2Si_3O_{12}$  glass are  $5.16(5) \times 10^{-7} \text{ m}^2/\text{s}$  and  $5(1) \times 10^{-9} \text{ m}^2/\text{s/GPa}$ , respectively, at 3 GPa and 400 K. The contribution of the radiative heat-transfer mechanism appears above 750K. MD simulations show that the coordination number of silicon increases gradually with increasing pressure and changes from 4.0 at ambient pressure to 4.3 at 11 GPa. The results of thermal diffusivity measurement indicate little variation in thermal diffusivity with pressure and temperature over the range of experimental conditions. In the pressure and temperature range of the experiment, the structural change of glass is continuous but not significant.

## The oceanic CO<sub>2</sub> system and biogeochemical processes in the Great Barrier Reef, Australia

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The carbon cycle of coral reefs and its effect on the surrounding ocean have drawn much attention. The seawater CO<sub>2</sub> system in the Great Barrier Reef (GBR) of Australia, the world largest reef system, was examined during both the winter/dry and summer/wet seasons. While the increase of CO<sub>2</sub> fugacity in the lagoon water relative to the offshore during winter time was already reported (Kawahata et al., 2000a; Suzuki et al., 2002), the same trend was also found in summer. Because total alkalinity in the GBR lagoon was low compared to the offshore, higher CO<sub>2</sub> fugacity in the lagoon water can be primarily attributed to reef calcification. Other than calcification, some biogeochemical processes including oxidation of organic matter, river discharge and oceanic exchange were identified from the latitudinal and cross-shelf distributions of carbon related parameters in the GBR shelf system. However, net system-level organic carbon fixation could not be detected. Calcification and river discharge were dominant processes among them and the GBR shelf system served as a comprehensive alkalinity sink. These results are consistent with those from some coral reefs of wide variety with respect to topographic types and oceanographic settings in the Indo-Pacific Oceans (Kawahata et al., 2000b; Suzuki and Kawahata, 2003). The effect of freshwater runoff on the lagoon water can be seen as an increase of surface particulate and dissolved organic carbon concentrations in narrow nearshore bands of the northern section of the GBR lagoon. However, the difference of particulate and dissolved organic carbon concentrations between the lagoon and offshore were relatively small, suggesting the limited contribution of particulate and dissolved forms in the carbon transport from the lagoon to the offshore.

### References

- Kawahata H., Yukino I. and Suzuki A. (2000b), *Coral Reefs*, 19, 172-178.  
 Kawahata H., Suzuki A., Ayukai T. and Goto K. (2000a), *Mar. Chem.*, 72, 257-272.  
 Suzuki A. and Kawahata H. (2003), *Tellus B*, 55, 428-444.  
 Suzuki A., Kawahata H., Ayukai T. and Goto K. (2001), *Geophys. Res. Lett.*, 28, 1243-1246.