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An experimental study on the mechanism of fracture healing in a rhyolitic glass using a spring pressure device

YOSHIMURA, Shumpei[1*]

[1]Department of Natural History Sciences, Hokkaido University

Introduction

I have carried out a series of fracture healing experiments on a rhyolitic glass at 920 degC and 5-100 bars in order to determine the fracture healing time in a shallow silicic magma. Two cylindrical obsidian cores were inserted in a magnesia container, juxtaposed on the base flats and pressurised by a newly developed spring pressure device. The base flats of the obsidian cores are nominally flat, but have fine-scale irregularity of ~10^-6 m. The pressurised sample was then heated in a furnace for 3 or 6 hours. The fracture healing time was determined by using the water-diffusion profile method (Yoshimura and Nakamura, 2010 JGR).

Results

The contact interface became coherent and disappeared in all experiments. Two types of pressure dependence were observed in the fracture healing time. When the pressure is greater than 30 bars, the healing time decreased monotonically with increasing pressure, from 50 to 4 minutes at 30 to 100 bars. When the pressure is smaller than 30 bars, on the other hand, no clear pressure dependence was observed. The healing time was 42 minutes at 10 bars.

Discussion

The fracture healing requires the viscous flow of the glass driven by the load pressure and capillarity. The difference in the pressure dependence may reflect the switching of the driving force. When the load pressure is greater than the capillary pressure, the load is the dominant driving force and thus significant pressure dependence is expected. When the load pressure is lower than the capillary pressure, on the other hand, the capillary pressure is the dominant driving force. In this case no load-pressure dependence is expected. Because the scale of the irregularity is ~10^-6 m and the surface tension is ~10^-1 N/m, the capillary pressure is ~10 bars. Thus the switching may have occurred at about 30 bars.

Keywords: fracture healing, magma, rhyolitic glass