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Healing experiments on magmatic fractures: implications for mechanism of volcanic seismicity

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Repetitive seismic events are often observed during emplacement of silicic lavas. Geological observations on fractured magmatic rocks suggest that such events are caused by repetitive fracturing and healing (RHF) cycle (Tuffen et al., 2003; Tuffen and Dingwell, 2005). While the process of fracturing is well investigated in experimental studies (e.g., Tuffen et al., 2008), mechanism of healing is scarcely understood. To estimate the healing time of magmatic fractures, which is important for understanding of seismicity interval, we performed healing experiments on rhyolitic melts at 850-1000 degrees C and 1.6-3.2 MPa for 0.5-94 hours. Two cylindrical obsidian cores were juxtaposed on surfaces prepared by cutting the cores both with and without polishing. These were annealed in an open-system cell. The contact interface became coherent and finally disappeared. The water content across the contact initially decreased toward the interface via diffusive dehydration, but was later homogenised. This change was interpreted to reflect atomic-scale closure of the interface, probably by chemical bonding. We defined this closure interval as microscopic healing time and determined this by fitting the measured profiles with a diffusion model. The microscopic healing time was strongly dependent on temperature and roughness of the interface; it was 70, 4.6, and 0.37 hours at 850, 900, and 950 degrees C for the nonpolished interfaces,, respectively, whereas for the polished examples, 1-3 and 0.5-0.6 hours at 850 and 900 degrees C, respectively. These timescales are a few orders magnitude longer than the viscoelastic relaxation time of melts that has been used as a proxy of healing time. This microscopic healing time is consistent with the period of actual seismicity.

Keywords: magma, fracture, healing, seismicity, degassing