Weak Velocity Weakening of Augite with Concomitant Intergranular Pressure Solution under Hydrothermal Conditions

Ping Tian and Changrong He* (crhe@ies.ac.cn)

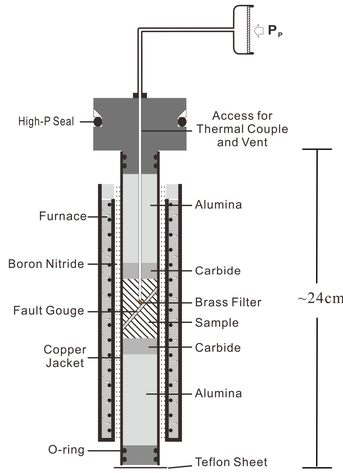
State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, Beijing, China

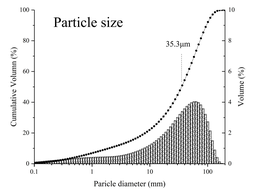
AGU 100 FALL MEETING Washington, D.C. | 10-14 Dec 2018

Abstract Reference Number: T11E-0201

1. Introduction

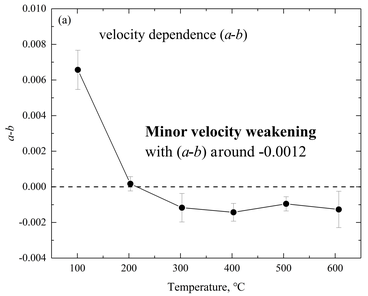
To fully understand the frictional sliding behavior of pyroxene and the relevant deformation mechanism, especially the mechanism responsible for frictional healing and velocity-weakening behavior, we employed augite (clinopyroxene) as simulated gouge sample material to run velocity stepping sliding tests at temperatures of **101—607 °C** and **~200 MPa effective normal stress** (confining pressure of 127 MPa with 30 MPa pore pressure) and axial loading rates of **0.1-1.0 μm/s**.

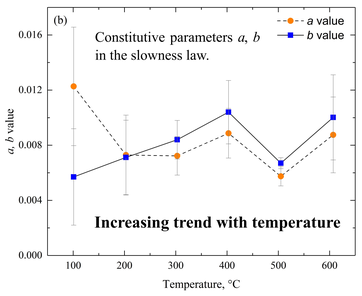


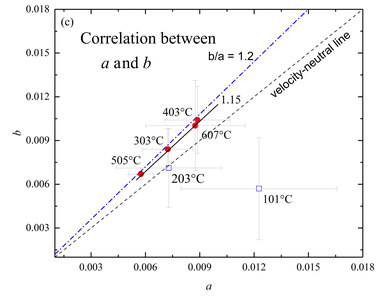


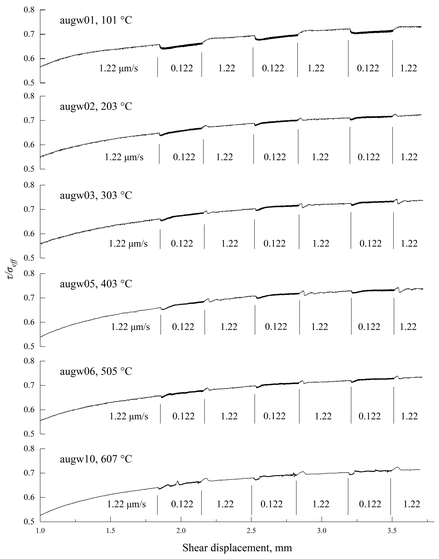
Schematic sample and furnace assembly and augite sample.

2. Result

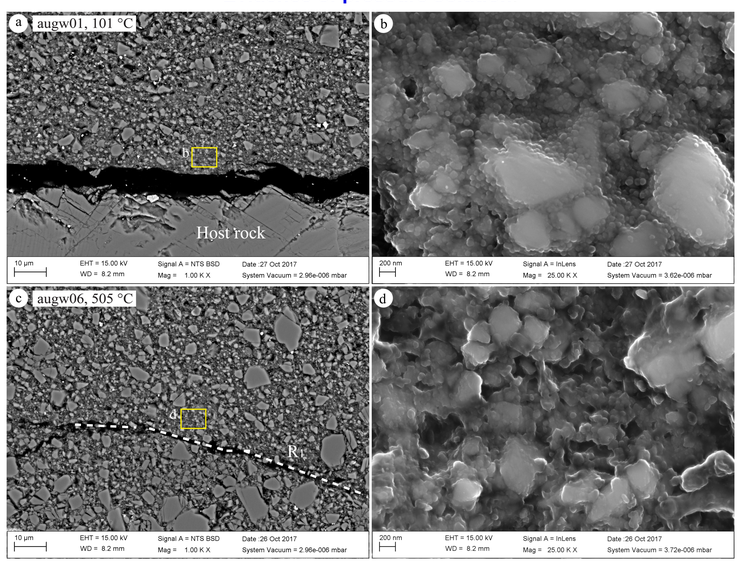




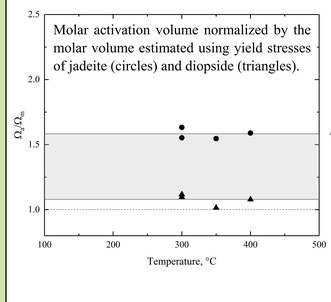


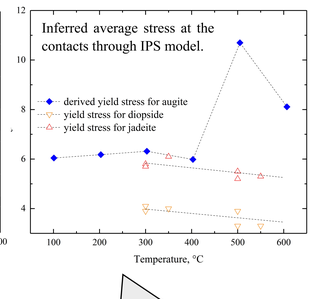


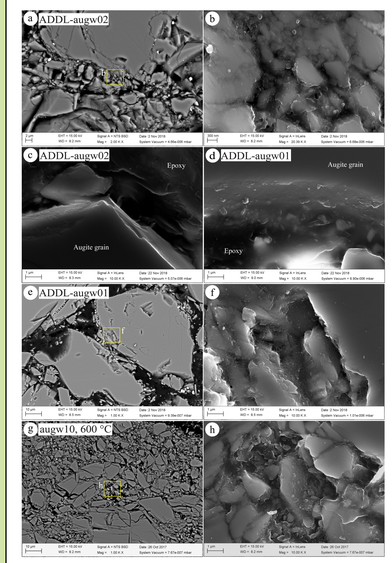
Evidence of pressure solution.



3. Analysis







BE model[1]:

denoting the evolution effect by crystalline plasticity

$$b_{BE} = \frac{d\mu_s}{d(\ln t)} = \frac{\tau_{tr}}{\sigma_{tr0}} \frac{RT}{\Omega_a \sigma_{tr0}}$$

Ω_a is activation volume

IPS model[2]:

denoting the evolution effect by intergranular pressure solution

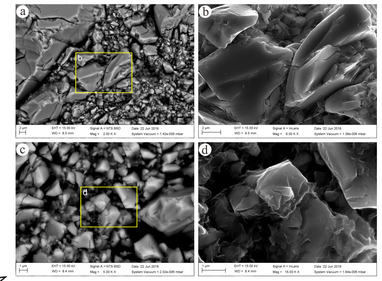
$$b_{IPS} = \frac{d\mu_s}{d(\ln t)} = \frac{\tau_{tr}}{\sigma_{tr0}} \frac{RT}{\Omega_m \sigma_{tr0}}$$

Ω_m is molar volume

◄ microstructural features of two supplementary tests.

The rate of pure dissolution is negligibly low .

Supplementary tests
ADDL-augw01:
effective Cp 2 MPa at 300 °C
ADDL-augw02:
effective Cp 97 MPa at 300 °C



▲ Microstructural feature of chemical etched deformed sample.

No crystalline plasticity observed.

Conclusion

1. Minor velocity weakening behavior was observed between 303 °C to 607°C. The absolute (*b*-*a*) values range from 0.0009 to 0.0014 with average *b*/*a* values between 1.15-1.18.
2. Inferred constitutive parameters show that the evolution effect has an increasing trend with temperature up to 403 °C.
3. For all deformed samples, ubiquitous precipitated particles (50-100 nm) with platy morphologies were observed to attach to the surfaces of crushed grains, which is a typical signature of intergranular pressure solution process .
4. The comparison between inferred activation volume in the creep equation and the molar volume, together with the observed signatures of the intergranular pressure solution and the absence in evidence of recognizable crystalline plasticity, implies that intergranular pressure solution may be the most likely mechanism governing the evolution effect for augite.

Acknowledgments and Reference

This work was funded by Natural Science Foundation of China (Grant No. 41774103). We thank Xi Ma for his technical support in SEM, and Yongsheng Zhou and Wenming Yao for their assistance.

[1] Bréchet, Y., & Estrin, Y. (1994). The effect of strain rate sensitivity on dynamic friction of metals. *Scripta Metallurgica et Materialia*, 30(11), 1449-1454.

[2] He, C., Luo, L., Hao, Q., & Zhou, Y. (2013). Velocity-weakening behavior of plagioclase and pyroxene gouges and stabilizing effect of small amounts of quartz under hydrothermal conditions. *Journal of Geophysical Research: Solid Earth*, 118(7), 3408–3430.