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Apollo 15 regolith breccia provides first natural evidence for olivine incongruent melting

Niccolò Satta[1,2,*], Masaaki Miyahara[3], Shin Ozawa[4], Hauke Marquardt[2], Masahiko Nishijima[5], Tomoko Arai[6], and Eiji Ohtani[4]

[1]Bayerisches Geoinstitut, Universität Bayreuth, Bayreuth 95440, Germany
[2]Department of Earth Sciences, University of Oxford, Oxford OX1 3AN, U.K.
[3]Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University, Higashi-Hiroshima 739-8526, Japan
[4]Department of Earth Science, Graduate School of Science, Tohoku University, Sendai 980-8578, Japan
[5]Laboratory for Protein Crystallography and Laboratory for Electron Structural Biology Institute for Protein Research, Osaka University, Suita-shi Osaka 565-0871, Japan
[6]Planetary Exploration Research Center, Chiba Institute of Technology, Chiba 275-0016, Japan

Abstract

The Apollo 15 mission returned various samples of regolith breccias, typical lunar rocks lithified by impact events on the Moon's surface. Here we report our observations on shock features recorded in a section of the Apollo Sample 15299. We observe the presence of ferropericlase crystals confined in a shock-melt pocket and conclude that their formation is related to a shock-induced incongruent melting of olivine. While predicted by experiments, this phenomenon has never been observed in a natural sample. The incongruent melting of olivine provides an important signature of melting under high-pressure conditions and allows for estimating the pressure-temperature (*P*-*T*) experienced by the studied sample during the impact event. We infer that the fracture porosity that likely characterized the studied sample prior to the shock event critically affected the *P*-*T* path during the shock compression and allowed the studied sample to be subjected to elevated temperature during relatively low shock pressures.

Keywords: Ferropericlase, olivine incongruent melting, Apollo 15