THE GEODYNAMICS SEMINAR № 609

Dr. Jiejun Jing

JSPS Postdoctoral Research Fellow
Geodynamics Research Center

2024.05.17 (Fri.) 16:30 ~

Venue: Meeting Room #486

Science Research Bldg. 1, 4th floor.
Ehime Univ.

Keywords:

1. Lunar magma ocean
2. Halogen
3. Plagioclase

Halogen (F and Cl) abundances of the lunar magma ocean

A giant impact between the proto-Earth and a Mercury-to-Earth sized object (Theia) has been the favored formation mechanism of Earth's Moon for the past five decades. The large amount of heat liberated by a giant impact must have led to the Moon being covered by a global magma ocean, referred to as the lunar magma ocean. Degassing of volatiles from the Moon-forming material and from this initial high-temperature magma ocean are expected to cause extensive losses of volatile elements and compounds. Substantial depletions of a wide range of volatiles in lunar rock samples compared to terrestrial samples have been observed. For example, chlorine isotopes of the lunar samples are extremely heavier relative to the bulk silicate Earth (BSE), which is generally attributed to isotopic fractionation during a whole-scale evaporation event in the early Moon.

To constrain details of the Moon's early volatile loss history, the volatile abundances in the Moon during the different stages of LMO crystallization need to be quantified. The abundances of the volatile elements H, Cl and F have been studied extensively in a wide range of lunar samples including apatite, glass, olivine-hosted melt inclusions, and nominally anhydrous minerals (NAMs). Some of these studies provide constraints on the halogen abundances of two end members in the LMO crystallization history, the bulk silicate Moon (BSM, i.e., the initial LMO) and the urKREEP reservoir, representing the last dreg of residual LMO melt with trace element-enriched features. However, volatile abundances in the lunar crust, which is primarily composed of plagioclase and is an early product in the LMO crystallization history, are not well understood. Few recent studies analyzed the hydrogen abundance in the NAM plagioclase in Apollo samples to constrain the hydrogen abundance in lunar crust and tried to link them to the hydrogen evolution in the LMO. The incorporation of the halogens in this key lunar mineral remains poorly known.

In this seminar, a brief introduction to the evolution history of the lunar magma ocean will be given at the beginning, followed by a presentation of my recent experimental investigations (using a piston cylinder press) on the halogen (F and Cl) partition coefficients (Ds) between silicate mineral and melt. Using these newly obtained Ds and literature Apollo data, the halogen abundances in the lunar magma ocean at the start of crust formation have been constrained. Based on these abundances, the halogen contents of the BSM, urKREEP and the halogen degassing history will be further discussed.

Contact: Steeve Gréaux, PhD. (e-mail: greaux.steeve_georgi.me@ehime-u.ac.jp)