[JJ] Evening Poster | M (Multidisciplinary and Interdisciplinary) | M-IS Intersection

[M-IS18]Aqua planetology

convener:Yasuhito Sekine(Department of Earth and Planetary Science, University of Tokyo), Tomohiro Usui(Earth-Life Science Institute, Tokyo Institute of Technology), Hidenori Genda(東京工業大学 地球生命研究所, 共同), Takazo Shibuya(Japan Agency for Marine-Earth Science and Technology)

Tue. May 22, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

This proposed session covers a wide range of topics related to aqua planetology, including chemical reactions involving water on planetary bodies, water-rock reactions within planetesimals, distribution of water in the early Solar system and the origin of water on terrestrial planets, hydrological and biogeochemical processes on Earth, geochemical cycles and habitability on Mars and icy moons, exploration of water in the solar system, and theory to understand how to build a habitable aqua planet.

[MIS18-P08]An experimental and field study toward evaluation of chemical weathering on early Mars

*Maya Nakamura[1], Yasuhito Sekine[1], Keisuke Fukushi[2], Takazo Shibuya[3], Noriko Hasebe[2], Jaahanaa Davaadorj[4], Yoshio Takahashi[1] (1.Department of Earth and Planetary Science, The University of Tokyo, 2.Institute of Nature &Environmental Technology, Kanazawa University, 3.Japan Agency for Marine-Earth Science and Technology, 4.Department of Geography, National University of Mongolia)

Keywords:Mars, Gale crater, lacustrine sediments, chemical weathering

Abstract

NASA’s Curiosity rover has performed in-situ chemical analyses for the 3.5-Gyr-old lacustrine mudstones deposited within the Gale crater, Mars (e.g., Hurowitz et al., 2017). The results show that a paleoclimate proxy of Chemical Index of Alteration or CIA increases by up to 20% in the lacustrine mudstones (Hurowitz et al., 2017), implying occurrence of chemical weathering on early Mars. However, the CIA assumes feldspar-dominant, felsic parent rocks and no addition of salts and evaporates into sediments, which are invalid for Gale’s lacustrine sediments. In addition, the CIA has been developed based on knowledge of chemical weathering with abundant water on Earth. In contrast, chemical weathering on early Mars might have proceeded in a closed system with limited availability of water (Ehlmann et al., 2011).

The present study aims to evaluate the degree of chemical weathering on early Mars, especially for the lacustrine sediments within the Gale crater, through a combination of a multivariate analysis, laboratory experiments of chemical weathering in a closed reaction system, and a field research for lake sediments in semi-arid desert area on Earth. We performed the Principle Component Analysis or PCA for the chemical compositions of the following samples; the lacustrine mudstones within the Gale crater (Hurowitz et al., 2017), conglomerates within the Gale crater (as a proposed parent rock of Gale’s lacustrine mudstones)(Mangold et al., 2016), and weathering profiles of Earth’s basalts (Price et al., 1991, Soubrand-Colin et al., 2005). In order to interpret the results of PCA, the present study conducts aqueous batch experiments to investigate changes in the chemical composition of synthesized Martian rock analogs upon chemical weathering in a closed reaction system. In addition, the present study analyzes the chemical compositions of sediments deposited in closed saline lakes in Altai-Gobi desert, Mongolia (the Olgoy lake, the Böön Tsagaan lake, and the Tsagaan lake).

Figure 1 shows the results of a PCA biplot for Gale’s lacustrine mudstones and conglomerates, and weathering profiles of Earth’s basalts. This figure shows that the data points of Gale’s lacustrine sediments distribute along with a line from the second quadrant to the forth

one; whereas, those of the conglomerates are mainly located in the first quadrant. These results indicate that the chemical composition of Gale’s lacustrine mudstones would have been significantly changed from that of the proposed parent rock. In addition, our results show that Gale’s lacustrine sediments cannot be simply explained by weathering profiles of Earth’s basalts.

The results of our batch experiments are superposed on the PCA biplot in Fig. 2. This figure shows that the rock compositions in the batch experiments evolve upon chemical weathering along with the line of Gale’s lacustrine sediments on the PCA biplot. This happens because dissolution of Na and K reaches equilibrium in a short time, meanwhile dissolution of Mg and Ca proceeds slowly over time. Our results of the chemical analyses for Mongolian lake sediments show that the data from Mongolian sediments also distribute along with the line of Gale’s lacustrine sediments (Fig. 3), supporting that the above-mentioned chemical weathering could occur in a basin-scale geological field. These results suggest that chemical weathering in a water-limited, closed reaction system could explain the obtained data trend of Gale’s lacustrine sediments. Such a climate condition would be consistent with recent climate modeling that can explain the spatial distribution of valley networks (Wordsworth, 2016).