EXPERIMENTAL REPRODUCTION OF SHOCK MELTS IN SHERGOTTITES USING HAWAIIAN PICRITIC BASALT AND JSC MARS-1 MARTIAN SOIL SIMULANT. T. Sato[1,2] and T. Mikouchi[2,1], [1]Dept. of Earth and Planet. Sci., University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, [2]University Museum, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, E-mail: sato-takeru0121@g.ecc.u-tokyo.ac.jp.

Introduction: Shergottite Martian meteorites often contain melts formed by impact on Mars which we call "impact melt" or "shock melt". Such shock melts are sometimes associated with "vugs" that contain trapped gas matching with Martian atmospheric composition [e.g., 1], which is concrete evidence for the Martian origins of these mafic igneous rocks. Recently, there have been discussion about/against the possible incorporation of Martian soil components in these shock melts [e.g., 2,3] and shock experiments have been carried out [4]. However, the condition of melting is not well constrained because of disequilibrium condition of shock melting. Therefore, we tried to first understand specific melting temperature to produce a shock melt texturally and compositionally similar to that found in shergottites. Also, we employed a JSC Mars-1 Martian soil simulant to mix with a basaltic rock for melting in order to test its validity as an example of mixed component in shock melts in shergottites. Therefore, the ultimate purpose of this study is to reveal melt precursors (if present) and to determine if Martian soils are really incorporated into shergottite Martian meteorites.

Samples: For the *in-situ* heating experiments, we used a picritic basalt sample (olivine phenocrysts with chemical zoning: Fo#=85.5-54.7 (analysis in this study)) from Hawaii island as an analogue of shergottites, especially olivine-phyric shergottites such as EETA 79001. The powder of JSC Mars-1 Martian soil simulant was employed as a mixing agent for the melting experiment. The compositional details of Mars-1 are described in [5,6].

Experiments and Analytical Methods: First, the Hawaii basalt was sliced into *ca.* 10 x 10 x 2 mm pieces. The Mars-1 powder was placed between the two slices and wrapped in a Pt foil (Fig. 1). The samples were then placed in a Pt crucible and heated for 1 hour at 1100, 1150, 1200, and 1300 ℃ using a 1-atm vertical electric furnace (Siliconit Co.). During the experiment, the oxygen fugacity (fO$_2$) was set at QFM-1, which is close to the Martian condition, using influx of H$_2$ and CO$_2$ gases.

After quenching, run products were cut and polished. The texture of polished sections was observed by a reflection optical microscopy. Analyses of mineral and glass compositions were done by a JEOL JXA-8900L and JEOL JXA-8530F electron probe microanalyzers (EPMA), both at the University of Tokyo. Fe XANES

(X-ray absorption near edge structure) analysis was performed to determine the Fe^{3+}/ΣFe ratios of the glasses in the samples before and after the experiments at beam line BL-4A, Photon Factory, High Energy Accelerator Research Organization (KEK), Tsukuba, Japan. We used kaerstutite amphiboles as standards. The details of the XANES experiment are same as described in [7].

Results: At 1100 ℃, we found only small degrees of melting produced. In contrast, at 1200 and 1300 ℃, the two sandwiched slices were almost completely melted together except for the relict olivine phenocrysts and some opaque minerals (chromite), producing melts with similar compositions at two runs.

At 1150 ℃, the melting degree was moderate (~5-10 % of the whole sample) and broadly similar melting textures to shock melts in shergottites were produced (Fig. 2). The texture of the run product at 1150 ℃ shows a decrease in the amount of plagioclase compared to the original igneous mineralogy and the rims of the plagioclase grains are clearly melted. Also, the JSC-1 powder was completely melted and only small melt portions remained at the sandwiched areas (Fig. 2). The compositional analysis of glasses at different locations shows that there is not much difference in major elements of the glass compositions (Fig. 3), suggesting that the melt was widely transported into the sample interior during heating. Minor elements such as K and Ti were present in the melt at higher abundance perhaps due to preferential melting of plagioclase and Ti-bearing minerals such as ilmenite.

Fe XANES analysis of the experimental glasses showed that the 1100 ℃ glass had a higher Fe^{3+}/ΣFe ratio compared to that of the 1300 ℃ glass (Fig. 4). The reason for this result is probably due to the dissolution of Fe^{2+} in olivine and pyroxene into the melt in the 1300 ℃ glass.

Discussion and Conclusions: Although this experimental study cannot confirm the evidence that Martian soil is being incorporated into Martian meteorites, it can provide an important constraint on the melting conditions to incorporate Martian soil during shock melting. From this study, it was found that the appropriate melting temperature conditions for mixing of the Martian simulated soil with some minerals in picritic basalt was ~1150 ℃ as is found in shergottite Martian meteorites, especially olivine-phyric

shergottites. The JSC-1 Martian soil simulant does not contain sulfate components [5,6] that are different from sulfate-bearing soils abundantly found on the Martian surface [e.g., 8-11]. From this point of view, JSC-1 is not an appropriate soil analog for this kind of experiment as performed in this study. Therefore, we plan to directly employ an appropriate sulfate mineral instead of JSC-1 in the future experiment. The candidate sulfate minerals are jarosite, kieserite, and gypsum, all of which are found on the Martian surface [e.g., 8-11]. Also, in the future experiment, it is needed to have a much shorter heating time to mimic disequilibrium shock melting.

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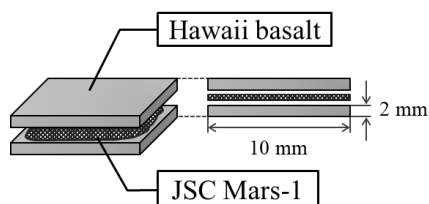

Fig. 1. Schematic representation of the experimental sample. Two square slices are Hawaiian basalt and in between represents JSC Mars-1 powder.
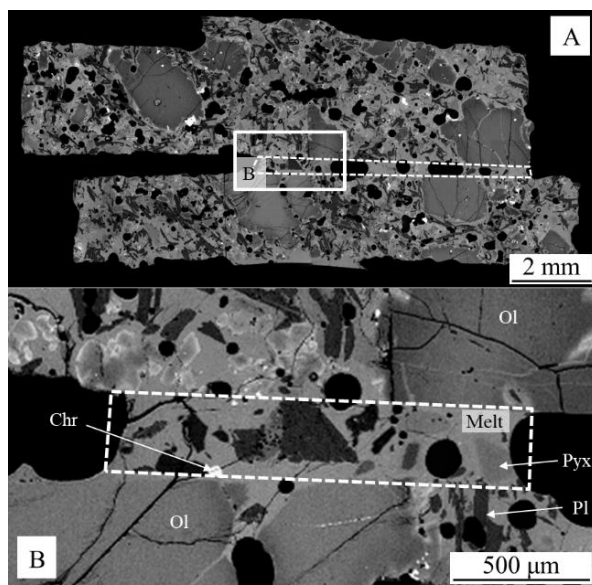

Fig. 2. Back-scattered electron (BSE) images of the run product at 1150 °C. Melts are enclosed by white dashed lines, where JSC-1 powder was originally located. Large phenocrysts with chemical zoning (size is about 2 mm) in the image are olivine (Ol). Dark gray phases are plagioclase (Pl). Whitish phases are chromite (Chr). (A) the run product at 1150 °C. (B) the area indicated by a white square in (A).
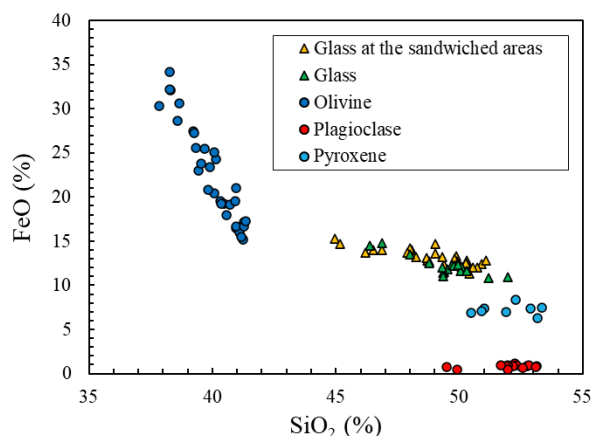

Fig. 3. FeO abundance plotted against SiO_2 in the run product heated at 1150 °C (Fig. 2) as determined by EPMA.
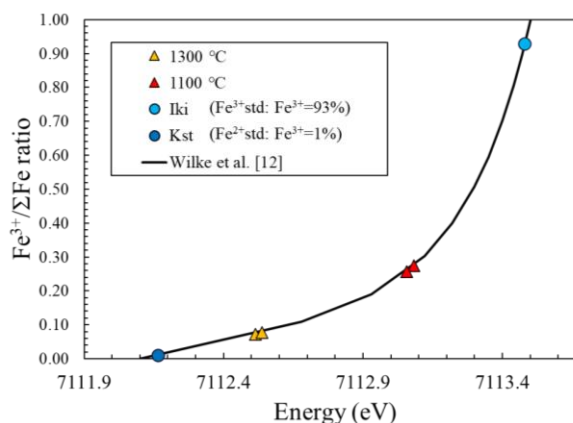

Fig. 4. Fe XANES analysis of the glasses in the run products heated at 1100 and 1300 °C. The horizontal axis is the detected centroid peak position of analyzed samples while the vertical axis is a corresponding $Fe^{3+}/\Sigma Fe$ ratio determined by [12].