SEARCH FOR MARTIAN REGOLITH COMPONENTS IN SHOCK MELTED SHERGOTTITES QUEEN ALEXANDRA RANGE 94201 AND DHOFAR 378. T. Mikouchi[1], A. Takenouchi[2], N. Shirai[3] and A. Yamaguchi[2],
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Introduction: Martian regolith (soil) records important information about the surface environmental evolution of the red planet. Martian rovers are analyzing such regolith/soils and found that sulfates are one of the major constituent phases [e.g., 1]. It is reported that such Martian regolith component is also trapped in some shergottites (e.g., EET 79001) within shock melt pockets because of high abundances of S, possibly from sulfates [2]. Since there are other shergottites that are considered to have been formed near the Martian surface as lava flow or shallow intrusion and contain abundant shock melt [e.g., 3], these samples may have a good chance to contain Martian regolith components. Queen Alexandra Range 94201 (QUE 94201) and Dhofar 378 are such samples with abundant shock melt pockets [3-5]. In this study we analyzed shock melts of these two basaltic shergottites to search for Martian regolith components and compare the results with other shergottites by [2].

Samples and Methods: We studied polished thin sections of QUE 94201 and Dhofar 378. We selected a thin section of QUE 94201 (QUE 94201,34) with abundant shock melt for this study [3]. The thin sections were first observed by optical microscope and then by back-scattered electron imaging by FE-EPMA (JEOL JXA 8530F at Univ. of Tokyo). The elemental X-ray maps were obtained and the shock melt composition was analyzed with broad electron beam (beam diameter: 5 micrometers) by FE-EPMA.

Result and Discussion: Both QUE 94201 and Dhofar 378 have abundant shock melt pockets, reaching ~10-15 % of the thin sections studied (Fig. 1). The melt pockets show flowing textures and some relict minerals are entrained in the pockets. The X-ray mapping of these shock melt pockets shows heterogeneous compositions. In QUE 94201, droplets of Fe sulfide with spherical shapes are abundant that are likely to be formed by recrystallization from shock melt, while such Fe sulfide is absent in Dhofar 378 (Fig. 1). Such a difference is related to the S abundance of shock melts in these two shergottites. The shock melt in QUE 94201 has 0.5-1.0 wt% SO_3 in general (up to 2.9 wt% SO_3), but shock melt is depleted in S (mostly <0.1 wt% SO_3) in Dhofar 378 (Fig. 2). The S compositional variation of shock melts in QUE 94201 (SO_3: 0.1→2.9 wt%) is weakly correlated to other elements such as Fe (FeO: 17→34 wt%), Mg (MgO: 8→1 wt%), Si (SiO_2: 48→35 wt%), Al (Al_2O_3: 1→9 wt%), P (P_2O_5: 0→8 wt%) and Cl (Cl: 0→0.09 wt%), but the correlation to Ca (CaO: 6~14 wt%) is unclear (Fig. 2).

The correlation of S abundance with some elements can be interpreted by incorporation of certain mineral phases. For example, increasing P suggests more incorporation of Ca phosphates. Cl increase may be related to the incorporation of chlorides as they are found on the Martian surface [6], but we cannot rule out that Cl is from Ca phosphates. The reason of the correlation of S to Mg, Fe, Si and Al is not straightforward because these elements are major components of potentially melted phases including primary igneous minerals (pyroxene, plagioclase and pyrrhotite) as well as regolith minerals (sulfates and aluminosilicates), and the melted abundances of each phase control the melt compositions.

Nevertheless, the amount of SO_3 in QUE 94201 shock melt (and a few spots of Dhofar 378 shock melt) is equivalent to those in Shergotty, Zagami, EET 79001 and Tissint (Fig. 2) [2]. Especially, they are similar to one of shock melt pockets in Shergotty ("DBS #1") [2]. This is consistent with the similar ejection age of QUE 94201 to those of Shergotty and Zagami [7], suggesting sampling of the same region on Mars (although their source reservoirs were different [e.g., 8]) and incorporation of similar local regolith materials. It is thus indicated that some sulfate and/or S-bearing aluminosilicate phase(s) may be entrained in shock melts of these two shergottites, especially QUE 94201. Because the incorporation of Martian soil components (assuming a Gusev and Meridiani composition [6]) is estimated to be 5-50% by the mass balance calculation for other shergottites, shock melt pockets of QUE 94201 may contain similar abundance of Martian regolith, perhaps 10-20% [2]. However, these estimates are highly model-dependent and require more careful modelling.

Conclusion: Shock melt pockets of QUE 94201 (and small parts of Dhofar 378) shergottite contain ~0.5-1.0 wt% SO_3, which may be attributed to melting of some sulfate and/or S-bearing aluminosilicate phase(s) in the Martian regolith, since the elemental abundances of these melt pockets are equivalent to the reported values in other shergottites [2]. We plan to analyze minor and trace element contents in shock melt pockets of these two shergottites and other shock-melt-bearing shergottites (e.g., Y-793605) by LA-ICP-MS to get better insights into their mixing components.

References: [1] McAdam C. et al. (2014) *JGR Planets*, *119*, 373-393. [2] Rao M. N. et al. (2018) *Meteoritics & Planet. Sci.*, *53*, 2558-2582. [3] Mikouchi T. et al. (1998) *Meteoritics & Planet. Sci.*, *33*, 181-189. [4] Mikouchi T. and McKay G. (2003) *LPS XXXIV*, Abstract #1920. [5] Park J. et al. (2008) *JGR*, *113*, E08007, doi:10.1029/2007JE003035. [6] McSween H. Y. Jr. et al. (2010) *JGR*, *115*, E00F12. doi:10.1029/2010je003582. [7] Nyquist L. E. et al. (2001) *Space Sci. Rev.*, *96*, 105-164. [8] Symes S. J. et al. (2008) *GCA*, *72*, 1696-1710.

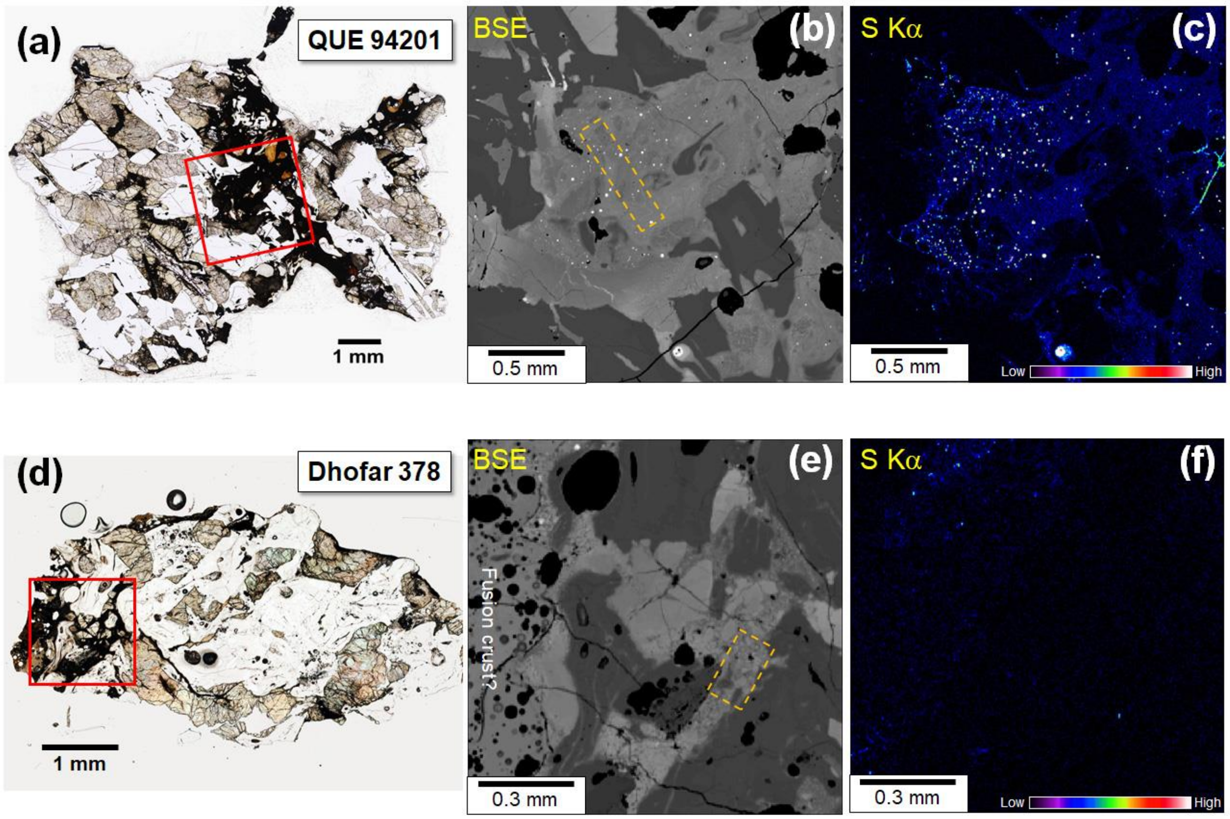

Fig. 1. Optical, back-scattered electron (BSE) and X-ray S Kα images of QUE 94201 and Dhofar 378. (a)-(c) are QUE 94201 and (d)-(f) are Dhofar 378, respectively. In (a) and (d), the areas of BSE and sulfur images are shown as red rectangles. Chemical compositions of shock melts in Fig. 2 are from dashed orange rectangles in (b) and (e).

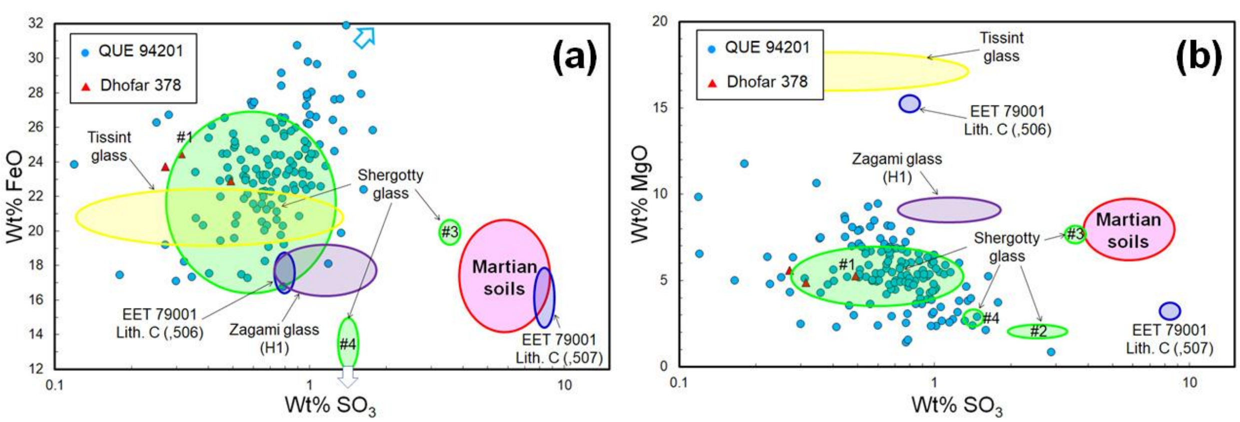

Fig. 2. Chemical compositions of shock melts in QUE 94201 and Dhofar 378. (a) FeO vs. SO_3. (b) MgO vs. SO_3. Compositions of Martian soils and shock melts of other shergottites are from [2]. Note that most of the shock melt compositions of Dhofar 378 are <0.1 wt% SO_3 and so plotted outside of these graphs.