CHARACTERIZATION OF MARTIAN SOIL FINES FRACTION IN SNC METEORITES. M. N. Rao[1] and D. S. McKay[2], [1]Lockheed Martin, 2400 NASA Road One, Houston. TX. 77058, [2]NASA, Johnson Space Center, Houston. TX. 77058. (e-mail : david.s.mckay@jsc.nasa.gov).

Introduction: Some impact-melt glasses in shergottite meteorites contain large abundances of martian atmospheric noble gases with high ^{129}Xe / ^{132}Xe ratios, accompanied by varying ^{87}Sr / ^{86}Sr (initial) ratios [1,2]. These glasses contain Martian Soil Fines (MSF) probably from young volcanic terrains such as Tharsis or Elysium Mons. The compostion of the MSF bearing samples is different from the average bulk composition of the host rock. These samples show the following charecteristics: a) simultaeneous enrichment of the felsic component and depletion of the mafic component relative to the host phase and b) significant secondary sulfur/sulfate excesses over the host material [3,4]. The degree of enrichment and associated depletion varies from one sample to another. Earlier, we found large enrichments of felsic (Al, Ca, Na and K) component and depletion of mafic (Fe, Mg, Mn and Ti) component in several impact melt glass veins and pods of samples ,77 ,78 , 18, and ,20A in EET79001 accompanied by large sulfur/ sulfate excesses [3,4]. Based on these results, we proposed a model where the comminution of basaltic rocks takes place by meteoroid bombardment on the martian surface, leading to the generation of fine-grained soil near the impact sites. This fine-grained soil material is subsequently mobilized by saltation and deflation processes on Mars surface due to pervasive aeolian activity. This movement results in mechanical fractionation leading to the felsic enrichment and mafic depletion in the martian dust.

We report, here, new data on an impact-melt inclusion ,507 (PAPA) from EET79001, Lith B and ,506 (ALPHA) from EET79001, Lith A and compare the results with those obtained on Shergotty impact melt glass (DBS).

Experimental: These samples were studied using a Cameca SX100 microbeam automated electron microprobe at JSC using standard analytical and calibration procedures described earlier [3,4].

Results and Discusion: We discuss below the elemental enrichment and depletion factors for samples ,506 and ,507 relative to the host Lith A and Lith B respectively. For purposes of discussion, we consider Al_2O_3 as proxy for felsic component and FeO as proxy for mafic component. In the case of ,507 sample (Lith B), Al_2O_3 is enriched (average) by ~80%. Al_2O_3 is similarly enriched by ~74% in the case of DBS glass belonging to Shergotty. Here, the composition of the starting materials that undergo bombardment is considered to be similar to the bulk composition of the host rock. Moreover, for ,507 sample, the average FeO depletion is ~10%, whereas FeO in the case of DBS Shergotty sample is depleted by ~33%. Considering that Shergotty and EET79001, Lith B are texturally similar [5], the mafic depletion is less in Lith B compared to Shergotty, though the felsic enrichment is similar between the glasses of the two meteorites. During the laboratory simulation experiments regarding comminution of basaltic rocks by meteoroid bombardment of planetary regoliths, Hoerz and Cintala [6] found that the Al_2O_3 is enriched by ~25% wheras FeO is depleted by ~65% relative to the host in the fine (<20 um) fraction. This indicates that the percentage of mafic depletion is more than the felsic enrichment in the fine-grained fraction. This is opposite to what is observed in the case of Martian soil fines. The reason for the differences in the degree of enrichment and associated depletion may be related to the effects of saltation and deflation processes operating on Mars surface, which are absebnt in the case of [6] lab simulation experiments.

Further, in the case of ,506 sample the average Al_2O_3 enrichment is similarly ~19% while the FeO depletion is ~4%. Note that both the enrichment and depletion factors in the case of ,506 are much less compared to those in ,507 and DBS samples. These results suggest the degree of enrichment and depletion of these components differs from one sample to another on Mars regolith.

We discuss below the sulfur/sulfate excesses found in the impact melt glasses and their implications. We plot SO_3 vs FeO and SO_3 vs Al_2O_3 for glass samples ,506 (Lith A) ,507 (Lith B) and DBS (Shergotty) in Figs.1-3. In the case of ,507 sample, the SO_3 content varied from ~1% to ~7% while the FeO abundance varied from ~10 to 21%, showing positive correlation between SO_3 and FeO (note that the SO_3 content of bulk Lith B is only ~0.6%). These results suggest a significant amount of a secondary sulfate component seems to have been added to the soil precursors of the glasses in Lith B. However, in the case of ,506 sample, the SO_3 content varied only from ~0.5% to ~1% while the FeO content varied from 15 to 19% showing a negative correlation between FeO and SO_3 (note that the SO_3 cotent of bulk Lith A is ~0.4%). It appears that only modest amount of sulfate component is added in the case of ,506 sample. Further, in the case of DBS Shergotty glass sample, the SO_3 content varies from 0.4% to ~3.5% while the FeO content varied from 9 to 17%. The data points show poor correlation between FeO and SO_3 (the SO_3 content of bulk Shergotty is 0.3%). The poor correlation of the DBS data points in the SO_3 vs FeO plot may be due to the fact that our sample had only glass pods (no veins) and also limted sampling statistics because of the availability of very small sample. Further, we find that, in the case of ,507 glass , as the SiO_2 content was increasing from 43 to 51%, the SO_3 content decreased from 6 to 0.5% showing good correlation. This suggests that sulfate bearing material is well mixed with silicates in the glass melt.

Now, we discuss the correlations between Al_2O_3 and SO_3 in these samples (some figures only shown). In the case of ,506 sample (Fig.2) the SO_3 content varies from 0.4 to 1% whereas the Al_2O_3 conent varies from 4 to 8%, showing positive correlation between Al_2O_3 and SO_3. This result is consistent with the findings of S-rich aluminosilicates in EET79001, Lith C sample by [8]. Extending this analogy to ,507 glass, the SO_3-FeO positive correlation suggests the occurrence of S-rich iron-silicates in the precursor materials of the glasses in Lith B. In this context, we like to add that we have extensively searched for pyrrhotite in these glasses by point-counting mode and failed to find any individual FeS grains. Moreover, in the case of ,507 sample , the SO_3 conent is found to vary from 1 to 6.5% whereas Al_2O_3 varied from 16 to 19%, showing negative correlation between between SO_3 and Al_2O_3. Also, in the case of SO_3 vs Al_2O_3 plot for DBS sample (Fig.3), the data points show no correlation. The FeO—SO_3 correlation in Lith B glasses and the Al_2O_3—SO_3 correlation in Lith A glasses observed in this study may throw light on the conditions of acid-sulfate weathering of comminuted young volcanic rock material [9,10] presumably from the Tharisis or Elysium regions on Mars.

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Figure 1: SO3 vs FeO plot for EET79001, 507 (Lith B). Note the positive correlation between the two. In the SO3 vs Al2O3 diagram (not shown here) for this sample, there is a negative correlation between the two.

Figure 2: SO3 vs Al2O3 diagram for EET79001, 506 (Lith A). There is a positive correlation between the two. In the SO3 vs FeO plot for this sample (not shown), there is negative correlation.

Figure 3: SO3 vs Al2O3 plot for DBS Shergotty sample. The data points are randomly distributed showing poor correlation. (the reasons discussed in the text).