

**EVOLUTION OF SHOCK MELT COMPOSITIONS IN LUNAR AGGLUTINATES.** A.M. Vance<sup>1</sup>, R. Christoffersen<sup>2</sup>, L.P. Keller<sup>3</sup>, <sup>1</sup>Department of Geology, Beloit College, 700 College St, Beloit, WI 53511 (vancea@beloit.edu), <sup>2</sup>Jacobs, NASA Johnson Space Center, Mail Code XI, Houston, TX 77058, USA, (roy.christoffersen-1@nasa.gov), <sup>3</sup>Code XI, NASA Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058.

**Introduction:** Lunar *agglutinates* are aggregates of regolith grains fused together in a glassy matrix of shock melt produced during smaller-scale (mostly micrometeorite) impacts [1]. Agglutinate formation is a key space weathering process under which the optically-active component of nanophase metallic Fe (npFe<sup>0</sup>) is added to the lunar regolith [1,2,3,4]. Here we have used energy-dispersive X-ray (EDX) compositional spectrum imaging in the SEM to quantify the chemical homogeneity of agglutinitic glass, correlate its homogeneity to its parent soil maturity, and identify the principle chemical components contributing to the shock melt compositional variations.

**Samples and Method:** A JEOL JSM-7600F field-emission SEM (FE-SEM) was used to collect quantitative EDX element maps on agglutinates in lunar soils 10084, 73241, 78501, 76281, and 78421, with approximately 16-21% Al<sub>2</sub>O<sub>3</sub> and varying maturity (respective I<sub>s</sub>/FeO ratios: 78, 18, 36, 45, 92) [4]. Numerical methods were devised to plot ternary oxide compositions of only the glassy matrix, minimizing contributions from entrained grains, to create large, highly spatially resolved datasets showing mixing trends and relationships. Soil samples 73241 and 78501 were also characterized using the JSA-8530 field-emission electron probe microanalyzer in order to test the accuracy of the SEM spectrum imaging approach.

**Results:** Our FE-SEM spectrum image-based compositional analysis technique yielded ternary variation diagrams only slightly less precise than those obtained by microprobe, but with a factor of 10 to 100 higher number of spatially-resolved individual analyses. For the various 3-component permutations among the major element ternary variation diagrams, the following relations are observed for all samples: 1) The degree of scatter among the various permutations of 3-oxide variations diagrams, as a measure of glass homogeneity, shows no clear correlation with maturity (I<sub>s</sub>/FeO) of the parent soil, 2) the mixing relations for all 3-oxide combinations, except those including Fe as FeO, are easily modeled based on varying relative contributions from model regolith plagioclase, pyroxene/olivine and ilmenite compositions, 3) the mixing trends involving FeO, such as those in MgO-FeO-TiO<sub>2</sub> plots (Fig. 1), require a fourth mixing component with an Fe/Mg ratio much higher than normal mare regolith pyroxene and olivine.

**Discussion:** The nature of the apparent “fourth” mixing component was investigated by sub-

tracting normative plagioclase and ilmenite oxide proportions from all analyses to obtain a “residual” MgO-FeO-SiO<sub>2</sub> variation diagrams (Fig. 2). The diagram confirms the inability of the FeO/MgO ratio of normal lunar pyroxene and olivine compositions to explain the high FeO/MgO ratio of the fourth component. It also reveals excess SiO<sub>2</sub> in some of the fourth component compositions as well. Source materials in the regolith target assemblage that might account for the Fe-rich fourth component include Fe-metal from meteoroid impactors (although proportional additional Ni does not occur), and admixtures of Fe-rich pyroxene/olivine compositions from a highland source. A third contribution from vapor-deposits on the outer margins of regolith grains, that characteristically have the needed higher FeO/MgO values, is also an intriguing possibility. Although volumetrically small, such deposits may gradually contribute to adding local glass regions with high FeO/MgO over multiple cycles of regolith impact gardening.

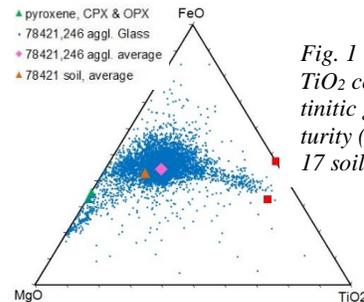


Fig. 1 (left). MgO-FeO-TiO<sub>2</sub> compositions of agglutinitic glass in high-maturity (I<sub>s</sub>/FeO=92) Apollo 17 soil 78421.

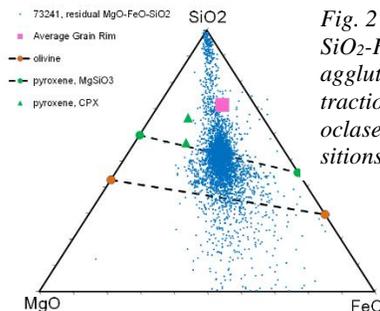


Fig. 2 (left). Residual MgO-SiO<sub>2</sub>-FeO compositions of agglutinitic glass after subtraction of normative plagioclase and ilmenite compositions.

**References:** [1] Basu A. and McKay, D. S. (1985) Proc. 16<sup>th</sup> Lunar Sci. Conf, JGR, 90, D87. [2] Pieters, C. M. et al. (2000) *Meteoritics & Planet Sci.*, 35, 1101-1107. [3] Taylor, L. A. et al. (2001) *JGR*, 106, 27985-27999. [4] Taylor, L. A. et al. (2000) *Meteoritics & Planet Sci.*, 36.