VAPOR DEPOSITION AND SOLAR WIND IMPLANTATION ON LUNAR SOIL-GRAIN SURFACES AS COMPARABLE PROCESSES. A. Basu[1], S. J. Wentworth[2] and. D. S. McKay[3]. [1]Department of Geological Sciences, Indiana University, Bloomington, IN 47405 (basu@indiana.edu); [2]Lockheed-Martin, Houston; [3]NASA-JSC, Houston

Introduction. Vapor deposited patinas (VDP) on lunar soil grains consist of a thin (<1µm) layer of amorphous silicate (glass) embedded with nanoscale Fe^0 globules as seen in many TEM images [1, 2]. VDPs are also present on larger space-weathered lunar rocks [3]; these larger samples will not be discussed here although the process of vapor deposition is common to exposed 'grains' of all sizes. Whether or not the majority of the Fe^0 globules present in lunar soils reside in vapor deposited patina is a matter of some concern [4]. Some Fe^0 globules are clearly seen to reside within the glass of agglutinates and might represent remobilized Fe^0 in agglutinitic melts.

Arguments. We argue that because VDP coatings are present only on the surfaces of lunar soil grains, their distribution as a surface correlated component (SCC) of lunar soils should parallel those of Solar Wind Elements (SWE) implanted in the outermost rinds of lunar soil grains [5]. SWE residing in the interior of soils grains make up the volume correlated component (VCC). Relative to Fe^0 in VDP, the distribution of various SWE have been studied well. The reason is understandable because instrumentation for nanoscale imaging is not ubiquitous. In this study we use the distribution of SWE in lunar soils as a guide to understanding the fate of Fe^0 in VDP. To keep our comparisons reasonable we use ferromagnetic resonance (FMR), specifically I_S/FeO measurements by Morris [6], as a proxy for Fe^0 in VDP. We use the plots of SWE concentration and I_S/FeO values in grain size fractions of lunar soils against $1/r$ where r is the nominal radius of each size fraction [7] for comparison. Such plots quantitatively bring out the distribution of SCC and VCC of any 'element' of interest, for example H, He, C, N, S, Ne, etc., as well as VDP.

Analysis and Comparison. The total abundance of any such 'element', say X, in each size fraction r is given by

$[X]_r = [X]_V + kS_X$ where $[X]_V$, the volume-correlated component and $[X]_r$ are expressed in "µg X/g sample", S_X is the surface-concentration is expressed in "µg X/cm^2 of grain surface", and k is a constant for the grain shape and grain density [7,8]. Experimental results show that for most SWE, especially carbon, a linear relationship between $[X]_r$ and $1/r$ is maintained and that the slope is constant for different soils with different maturities. This indicates that the S_C, or surface concentration, of any SWE is constant. Under such circumstances, DesMarais et al. [8] argue that any deviation from the slope for any soil or any size fraction of a soil is due to perturbations by VCC; i.e., addition or depletion of agglutinates. We expect similar behavior for Fe^0 in VDP.

We find only one study in which I_S/FeO was measured in five size fractions of two soils [9]. In both, there is a strong correlation between I_S/FeO and $1/r$ (Fig. 1). This correlation indicates that I_S/FeO and, by proxy, nanoscale Fe^0, has a significant SCC, conforming to the Fe^0 in VDP model. Note, however, that the slopes of the lines are different. This implies that either the surface concentration of Fe^0 in VDP in the two soils is not constant or that VCC, i.e. Fe^0 in agglutinate interiors, affects the regression. There is no reason to suspect that two soils 79002 and 79001, differing principally in maturity, would retain Fe^0 in VDP differentially. Rather, it stands to

reason to argue that the higher slope of soil 79002 is because Fe^0 in agglutinitic glass contributes more to I_S/FeO signals in finer fractions due to comminution and recycling of agglutinates [10, 11, 12, 13]. Our interim interpretation of the higher slope of soil 79002 is shown in Fig. 2.

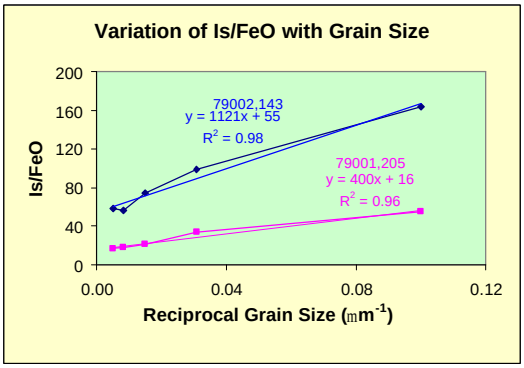

Figure 1. Excellent correlation of I_S/FeO and 1/*r* (data from Morris et al. [9])

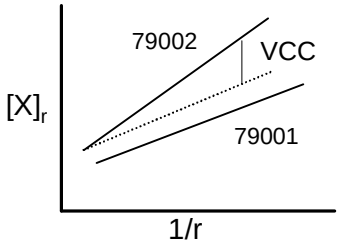

Figure 2. Increase in slope of 79002 is due to VCC contribution (arguments after DesMarais et al. [7, 8])

Additionally, it is important to remember that not all grain coatings on lunar soils are VDP. Many are inherited grain coatings, i.e., remnants of broken agglutinates and soil breccias. A good example is shown in Fig. 3, in which a clastic grain is completely encased in agglutinitic glass, thereby making the agglutinitic glass resemble SCC.

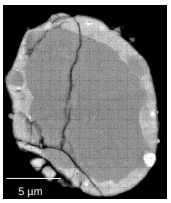

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Figure 3. Plagioclase encased in agglutinitic glass, i.e. grain coating at present, which contributes to SCC but is not VDP.

Conclusion. We have a long way to go before we understand the origin, behavior and the distribution of nanoscale Fe^0 in lunar soils, especially on and in soil-grains.

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