MICROPROBE ANALYSES OF A SINGLE AGGLUTINATE. R.V. Gibbons, F. Hörz, NASA Johnson Space Center, Houston, TX 77058; R.B. Schaal, UCLA, Los Angeles, CA 90024.

An agglutinate consists of mineral and rock detritus bonded and engulfed by vesicular, schlieren-rich glass (e.g.,1,2,3,4). It has generally been considered to be a mixture of "whole soil" impact melt and less extremely shocked or essentially unshocked detrital material, the typical impactite of (e.g.,5). Recently, systematic differences have been noted between magnetic agglutinates (i.e., the magnetic fraction of a bulk soil) and the bulk soils (e.g.,1,4); the results indicate that magnetic agglutinates are not bulk soil melts but, instead, are relatively enriched in Fe, Ti, and other elements and, conversely, depleted in plagioclase components. Since these studies have been made on bulk soil fractions (XRF,4), such analyses are averages of the impact glasses, all incorporated detritus, and any other component that may reside in the magnetic fraction. The analysis of individual 1 - 2 mm agglutinates by (2,8, INAA) has shown similar trends, but generally of lesser magnitude. In order to determine whether those trends are truly properties of the impact glass, we chose a single 1 - 2 mm agglutinate (78222,23,2) for detailed microprobe analysis of all its components.

78222 is the 1 - 2 mm sieved fraction of 78220, a soil collected at the base of the Sculptured Hills (6). Modal analyses of 78222 give agglutinate contents ranging from 30 to 50% (3,6,7). 78222,23,2 is one of these agglutinates. It consists of vesicular, schlieren-rich glass engulfing crystals of ilmenite, plagioclase, pyroxenes, olivine, and metal spherules as well as bonding larger rock, mineral, and glass fragments. The vesicles range from microns to mm in size; they occur in a distinctly bimodal distribution. The mineral grains vary from rounded to quite angular in shape; they are generally more rounded if completely engulfed in the glass. Shock evidence in minerals is rare, but a few grains do show crushing and fracturing and a number of plagioclase crystals exhibit very low birefringence, approaching isotropism and maskelynite grade shock (≤300 kb). This is consistent with formation by a "whole soil" melt mixing with lithic and crystal debris which is relatively unshocked, rather than by partial shock melting, with the debris as remnant crystals (9). Rounding of the engulfed clasts is consistent with partial digestion of clasts while the glass was being quenched; however, some of the rounding was probably due to abrasion during mixing and ejection and some of the clasts were probably fairly round to begin with. In addition, there is no indication of significant reaction rims on the clasts and the glass has well-preserved schlieren. Both these observations suggest that the clasts behaved much like ice cubes in jello and helped quench the melt very rapidly (e.g.,9,10). Very little digestion could have occurred.

We have analysed a number of the mineral fragments and many areas of the glassy matrix. Our results are presented in Table 1 and Figs. 1 and 2. The CaO FeO plot in Fig. 1 shows that the glass varies from 8 to 15% FeO and 10 to 14% CaO; the averages are 12.8% FeO and 11.8% CaO. Compared to analyses of included plagioclase, olivine, pyroxenes, and ilmenite, the glass is heterogeneous but forms a pseudo-homogeneous cluster near the composition of the bulk soil. INAA analysis of bulk soil 78222,2 (2,8) shows 12.0% FeO. The average of 22 INAA analyses of 78222 glassy breccias (including 11 identified as agglutinates) is

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12.7% FeO. This average agrees with ours and may indicate a real enrichment in Fe of 0.7% in the impact glass relative to the bulk soil, or it may just reflect differences in the FeO contents of source regions of different agglutinates. Our CaO average equals the CaO content of 78221,4 bulk soil (11), indicating no change in Ca, provided the 2-4 mm fines can be considered representative of the 1-2 mm fines.

The Fig. 2 variation diagrams show even more dramatically the clustering and relations of the glass to the component minerals than the CaO-FeO plot. The major minerals are plagioclase and pyroxene with smaller contributions from ilmenite and olivine. The glass forms fairly close clusters near the bulk soil analysis. Comparing with Table 1, we note slight enrichments in Ti, Mn, and Mg and similar depletions in Si, Al, and Na. However, we have not included in our averages several analyses of plagioclase-rich glass which would decrease the trends substantially. The latter are not "whole soil" melts but selective shock melts (e.g.,9,12,13).

The chemical variations that we have observed, including the systematic differences of the glasses from bulk soil compositions, are readily explained by shock melting. The detailed mechanism is essentially that described by (1), though we would de-emphasize their calling it a "multistage partial melting" (1) or "multistage fluxing" (4) process. Briefly, shock melting generally produces a whole rock (soil) melt, as has been characterized for both terrestrial and lunar basalts (15,16). However, when superheated whole rock melt engulfs detritus with very different melting points, lower melting point phases are preferentially digested before the melt is quenched, as has been noted in both lunar and terrestrial rocks (e.g.,14,17). Thus, the chemical trends observed by (1,2,4) are consistent with a single event shock origin in regolithic target materials. They are also consistent with our observations on a single impactite. The sole discrepancy appears to be in the magnitude of the variations. We suggest that, although the trends represent modest pyroxene and ilmenite enrichments in some impact glasses, the magnitude of the Fe, Ti, and Mg variations in the XRF data (4) may, in part, also be due to the technique of magnetic separation used to isolate "agglutinates" from other soil constituents.
Such a separation technique may enrich the magnetic fraction in other components (e.g., 18). We suggest that the only technique that has sufficient control to give an accurate measurement of the chemical variations of the shock melt is microprobe analysis of the glassy matrix plus the mineral detritus compared with bulk XRF analysis of soil fractions.

REFERENCES:
(18) Morris, R.V., 1976, This Volume.