IMPACT GLASSES IN APOLLO 14 REGOLITH BRECCIAS AND THE ORIGIN OF SOILS.

D. S. McKay[1] and S. J. Wentworth[2]; [1]SN 14, NASA JSC, Houston, TX 77058; [2]Lockheed, 2400 NASA Rd. 1, Houston TX, 77058.

Apollo 14 soils and regolith breccias contain a variety of impact and volcanic glasses. Previous studies of glasses from Apollo 14 regolith breccias [1-3] have shown that, except for breccia 14315, glass types and bulk compositions are very similar for the regolith breccias and soils. Individual regolith breccias contain different populations of mare glass types, however, and these populations may be correlated with relative closure times of the breccias [1]. Relative proportions of impact glass types also differ and may also reflect earlier closure times of the breccias compared to the continued exposure for the soils [3].

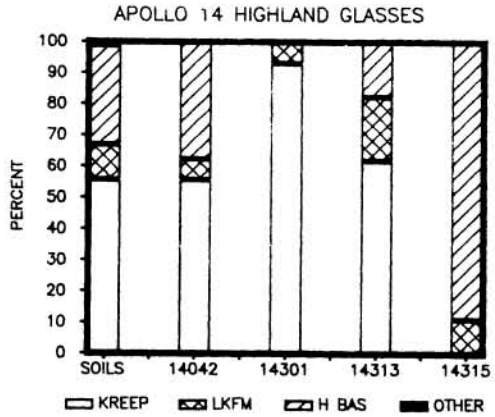
We have investigated glasses in four regolith breccias from Apollo 14 (14042, 14301, 14313, and 14315), with emphasis on glasses of highland composition. Soil glass compositions used for comparison are from [4,5]. The glasses were classified on the basis of composition according to the criteria given in [6]. We made 520 electron microprobe analyses of 150 glasses, being careful to acquire representative analyses of inhomogeneous glasses by analyzing multiple points per grain.

The highland glass population in breccia 14042 is much like that of the soils (Fig. 1), but glass populations in the other regolith breccias differ considerably from each other and from the soils. Although this difference may be due partly to sampling sizes, there is clearly a real difference which is reflected in the bulk compositions of the regolith breccias. As noted by previous workers [2,3], 14315 is very low in KREEP glasses and high in highland basalt glasses, and the bulk sample contains relatively low K_2O and high Al_2O_3 compared to soils or other Apollo 14 regolith breccias. We also find that for 14301, which is high in KREEP glasses and low in highland basalt glasses, the bulk chemistry is slightly higher in K_2O and lower in Al_2O_3 [3] than the other breccias. The combined glass populations from our breccias are very close to the soil population (Fig. 1, 3). It has been suggested by [3] that Fra Mauro composition glasses (KREEP and LKFM) are still being added to the soil from local impacts because these glasses have compositions similar to those of local bulk soils. Our data, however, do not show that soils are appreciably enriched in these glasses compared to our average breccia glass populations.

Figure 2 demonstrates differences between glass compositions in the breccias and soils. Glasses in aluminous breccia 14315 tend to have higher Mg' values (atomic Mg/Mg+Fe) than glasses in the other breccias or soils. In addition, if the breccias are considered as a group, they contain a higher proportion of glasses with high Mg' values (> 0.80) and a lower proportion of glasses with low Mg' values (< 0.50) than do the soils. Mg' values are bimodal for both the breccias and the soils, but the mode of the lower Mg' peak for the breccias is somewhat lower than that for the soils; this last difference is due, in part, to the presence of a large number of glasses with Mg' in the range 0.55-.60 in 14301. These glasses, most of which are ropy KREEP glasses, seem to be characteristic of 14301 (Fig. 3). They tend to be enriched in K_2O and SiO_2 relative to KREEP glasses in the other Apollo 14 breccias and soils; their compositions are similar to those of yellow and brown ropy glasses from Apollo 12 [7] (Mg'= 0.57 and 0.56 respectively), but are less similar to ropy glasses from other Apollo sites, e.g., high Zr ropy glasses from Apollo 15 (Mg'=0.39). If the 14301 glasses are related to Apollo 12 ropy glasses, the history of 14301 is puzzling: based on mare glass populations, [1] suggested that 14301 became closed to regolith processing during the time of mare basalt volcanism; the Apollo 12 ropy KREEP glasses, however, are known to be much younger (dated at 0.8-1.2 Gy [9]). It therefore seems unlikely that both sets of ropy glasses come from the same event, but the same or related source areas may be involved.

The soils at Apollo 14 are generally intermediate in composition within a larger variation represented by the regolith breccia population. The soils may be an average of all the regolith breccias. This relationship can be explained in two ways. The conventional explanation is that the regolith breccias become closed systems at earlier times but the soil keeps evolving as additional material is added over time. Hence, the soils should have a more complete suite of glass types compared to most of the regolith breccias, particularly the oldest ones. This is indeed what is observed. However, an alternate explanation also fits this observation. In this explanation, the soil is made mostly from comminuted and degraded regolith breccias of various compositions [10]. The soil would then tend to be a weighted average of the contributing regolith breccias. At this time, it is not possible to firmly discriminate between these two alternative soil/regolith breccia evolution concepts. Age dates on individual impact glass beads along with regolith breccia closure ages might resolve this problem.

FIGURE 1



REFERENCES: [1] Delano (1988) *Proc. LPSC 18th*, pp. 59-65.; [2] Jerde et al. (1987) *Proc. LPSC 17th*, pp. E526-E536; [3] Simon et al. (1989) *Proc. LPSC 19th*, in press; [4] Brown et al. (1971) *NASA TM X-58080*, 89 pp.; [5] Reid et al. (1971) *NASA TM X58081*, 28 pp.; [6] Wentworth and McKay (1988) *Proc. LPSC 18th*, pp. 67-77; [7] Taylor et al. (1972) *Proc. LPSC 3rd*, pp. 995-1014; [8] McKay et al. (1989) *Proc. LPSC 19th*, in press; [9] Alexander et al. (1976) *Proc. LPSC 7th*, pp. 625-648; [10] Basu et al. (1989) This volume.

FIGURE 2

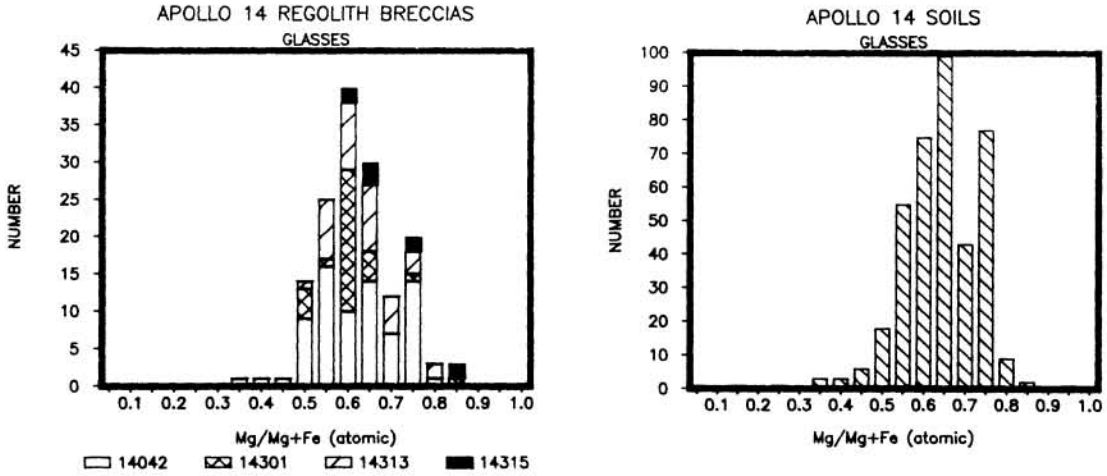


FIGURE 3