INAA OF ROPY GLASSES FROM THE APOLLO 12 AND 14 SITES: PRELIMINARY RESULTS.
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Introduction. Ropy lunar glasses are impact glasses characterized by their sorted and welded debris coatings and by their dynamic shapes. Most previous studies, *e.g.*, [1-3], concluded that ropy glasses formed during major impacts, so the glasses may have originated very far from the soils in which they were found. Recent geochemical studies by [4] indicated that the ropy glasses from Apollo 17 Station 4 (Shorty Crater) may have formed from local soils, but it is clear that some ropy lunar glasses cannot be derived from the regoliths in which they were found. High Zr ropy glasses in Apollo 15 regolith breccia 15025, for example, are definitely exotic; their compositions and relict mineral inclusions (which include zircon, fayalitic olivine, and SiO_2) are very different from the compositions and components of known local soils and rock types at the Apollo 15 site [5]. Exotic ropy glasses may contain clues to the character of parts of the lunar crust that have not been directly sampled. An understanding of the nature and origins of the ropy glasses will also help us more fully define the processes which formed the lunar regolith and its components.

We have begun a multidisciplinary study of ropy glasses from various Apollo sites. Planned procedures include SEM petrography, electron microprobe analysis, INAA, and (possibly) age dating of individual glasses. Our objectives are to determine whether the ropy glasses are locally derived, to more fully define their nature, and to understand their mode(s) of origin. The data reported here are preliminary results of INAA (final counts not included) for 12 ropy glasses, including six from Apollo 12 soil 12032,40 and six from Apollo 14 (three each from 14163,76 and 14259,52).

Techniques and Results. The ropy glasses, ranging from ~150 micrometers to 1 mm in size, were selected on the basis of their characteristic morphologies and surface coatings. We broke most of the glasses into several pieces, and sent one small chip (~1.5-20 ug) of each glass for irradiation, with the exception that six fragments of one ropy glass (12032,40-R1) were treated as separate samples. Therefore, 17 individual glass fragments (12 ropy glasses in all) were analyzed by INAA for 29 elements. The techniques used for sample preparation and INAA were similar to those described by [6].

Because of the extremely small sizes of the irradiated samples, the largest sources of possible error and uncertainty in the data are possible errors in measured sample weights. If the samples are homogeneous, accurate weights are not needed because the data can be scaled to some element, such as Fe, determined by an independent analytical technique (*e.g.*, microprobe analysis). This scaling method may not possible for very heterogeneous samples, however. Because many ropy glasses are heterogeneous, one of the important objectives of our initial studies of these samples is to determine the feasibility of the techniques we are using.

One of our purposes in analyzing six chips of ropy glass 12032,40-R1 separately was to help determine sample heterogeneity. Initial analytical results indicated that the six chips of R1 have very similar compositions, and that differences between the analyses were caused by weight uncertainties. Therefore, the data for each R1 chip were normalized to the mean composition for the six chips. Figure 1 shows selected elements plotted against FeO for all the samples, including R1, the other Apollo 12 glasses, and the Apollo 14 glasses. In all cases, the R1 chips show very good agreement, demonstrating that R1 is homogeneous and that the data are consistent. Some of the other Apollo 12 glasses have compositions similar to R1 but the Apollo 14 glasses seem to be quite different. Some of the variations shown in Fig. 1 are probably due to weighing errors, but if all the variations were due to weighing errors, the two-element variations would be proportional and would form straight lines in Fig. 1, so some of the differences must be real. The Apollo 12 ropy glasses seem to be distinct from the Apollo 14 ropy glasses in that they are richer in alkalis (Fig. 1B) and excluded elements (Fig. 1C, D). The preliminary results given in Fig. 1 suggest that the Apollo 12 and 14 ropy glasses analyzed for this study have compositions unlike those of bulk Apollo 12 and 14 soils, also plotted in Fig. 1 (soil data from [7]), and suggests that Apollo 12 ropy glasses are enriched in trace elements (KREEP component) relative to Apollo 12 soils, while Apollo 14 ropy glasses are depleted in trace elements relative to Apollo 14 soils. Further work (petrography, SEM, and electron microprobe analysis) is needed to constrain the INAA data.

References: [1] McKay D. S. et al. (1971) Proc. Lunar Sci. Conf. 2nd, pp. 755-773. [2] Cavarretta et al. (1972) Proc. Lunar Sci. Conf. 3rd, pp. 1084-1094. [3] Fruland R. M. et al. (1977) *Proc. Lunar Sci. Conf. 7th*, pp. 3095-3111. [4] Korotev R. L. (1990) *Lunar Planet. Sci. XXI*, pp. 660-661. [5] McKay D. S. et al. (1989) *Proc. Lunar Planet. Sci. Conf. 19th*, pp. 19-41. [6] Lindstrom D. J. et al. (1989) *Lunar Planet. Sci. XX*, pp. 574-575. [7] Laul J. C. and Papike J. J. (1980) *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1307-1340.

Figure 1: INAA results for Apollo 12 and 14 ropy glasses. Bulk soil compositions from [7] are shown for comparison.