U-PB AGES AND COMPOSITIONS OF APOLLO 14 REGOLITH GLASSES.

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Introduction: Glass beads and fragments found in the lunar regolith were formed by both volcanic and impact processes. The chemical compositions and ages of lunar regolith glasses potentially provide information about the nature of their source regions in the lunar crust and mantle, the timing of fire-fountain eruptions, and the flux of impactors to the lunar surface, but obtaining geochemical and geochronological data for individual particles is challenging due to their relatively small size (typically 0.01-0.5 mm) and the lack of mineral phases suitable for dating.

Here we present a study of 145 glass beads separated from Apollo 14 regolith 14163 that have been characterized for major element, trace element, and U-Pb isotopic compositions by a variety of microbeam techniques including electron microscopy, SIMS, and laser ablation ICPMS. Most of these glasses appear to be impact-produced, with major and trace element element compositions that are similar to the bulk Apollo 14 regolith, but offset to lower SiO_2 and higher incompatible element abundances. Trends to lower concentrations of SiO_2 and alkali elements are likely due to volatile depletion. An interesting feature of the volatile-depleted glasses is their systematically higher Th/U (ranging between 6 and 13), which correlates with low concentrations of volatile lithophile elements such as Na. Our preliminary interpretation is that this reflects volatile loss of U during impact melting, although the nature of the volatile species (oxide? fluoride?) and conditions under which this occurred are not well understood.

U-Pb isotopic compositions and concentrations of individual particles may provide meaningful ages if Pb was also lost as a volatile element during impact melting. U-Pb compositions of the Apollo 14 impact glasses suggests multiple impact events with two prominent age groups around 3.6-3.8 G and less than 1.0 Ga, with smaller clusters occurring at ~2.5-2.6 Ga and 1.4-1.2 Ga. The range of chemical compositions within the age groups suggests multiple impact events contributed to these groups. The bimodal distribution of ages in these glasses is generally similar to that obtained from argon dating of individual beads from this same soil by Culler et al. [1] and from regolith glasses at other Apollo landing sites [2, 3, 4, 5]. This may reflect the actual flux of bead-producing impacts to the lunar surface, or a systematic process of gardening and preservation that is characteristic of the lunar regolith.

References: [1] Culler T. S., Becker T. A., Muller R. A. and Renne P. R. 2000. *Science* 287: 1785–1788. [2] Levine J., Becker T. A., Muller R. A. and Renne P. R. 2005. *Geophys. Res. Lett.* 32, L15201, doi:10.1029/2005GL022874. [3] Zellner N. E. B., Delano J. W., Swindle T. D., Barra F., Olsen E. and Whittet D. C. B. 2009. Geochim. Cosmochim. Acta 73: 4590–4597. [4] Hui S., Norman M. and Jourdan F. 2010. Proc. 9th Aus. Space Sci. Conf.: 43–54. [5] Norman M. D, Adena K. J. D. , and Christy A. G. 2012. Aus. J. Earth Sci. 59: 291-306.