GEOCHEMISTRY OF APOLLO 11 IMPACT GLASSES: REGOLITH COMPOSITIONS.

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Impact glasses are an abundant component in mature lunar regoliths and have been a frequent target for electron microprobe analysis [e.g. 1-3]. Interpretation of those compositional data have often relied on statistical methods, such as cluster analysis, to define specific groups. Although valid conclusions have been drawn from those past studies, we believe that lunar impact glasses may have greater scientific potential for exploring the compositional range of mare and highlands provinces exposed on the Moon. To assess this view, we have handpicked spherules of impact glass from Apollo 11 regolith 10084. These samples have been analyzed individually for major elements by electron microprobe and for trace elements by instrumental neutron activation (INAA).

An implicit assumption was frequently made in past studies of lunar impact glasses that the average composition of a perceived cluster of glasses is equal to that of the fused target. While there are probably rare instances where this might be true for most lithophile elements of geochemical interest, it is not likely to be generally applicable. For example, during impact fusion on the Moon, accumulated data show that, among the major elements, K, Na, and Si can be fractionally lost [e.g. 3-6]. This open-system behavior for the moderately volatile elements can complicate efforts at interpreting a data set. For example, fractional vaporization during a single impact event that generates a large number of impact glass spherules from fusion of the target could produce a wide compositional range among those glasses, even if the target were chemically homogeneous. In order to avoid these complications and still permit the use of impact glass compositions to yield chemical/petrological information about the target-materials, it is necessary to rely on ratios among refractory elements. Although loss of volatile elements will, of course, increase the absolute abundances of refractory components, the <u>ratios</u> of those refractory elements will not be affected [e.g. 4,5]. This simple concept leads to the following hypothesis:

RATIOS AMONG REFRACTORY LITHOPHILE ELEMENTS IN IMPACT GLASSES ARE EQUAL TO THOSE IN THE TARGET.

If correct, a suite of impact glasses from a single site can be used to define the compositional range of regoliths exposed in the region. The Apollo 11 site is a good place to establish 'ground truth' for this notion since it is located on a mare that is not far from a mare/highlands boundary. This setting is ideal for producing a compositional gradient of regoliths in the region due to the mixing of different proportions of mare/highlands components.

Major-element analyses of Apollo 11 impact glasses [5] have been plotted on a ternary diagram involving three refractory lithophile elements (i.e. Ti, Al, Ca). The compositional range among these impact glasses not only overlaps that of the local regolith and the mare basalts, but also displays a systematically larger range of compositions. We interpret this latter characteristic as resulting from a regionally varied collection of

impacted regoliths having different mare/highland proportions. This method of plotting combinations of three elements on a ternary diagram is an improvement over the two-dimensional diagrams originally used by Delano [5].

Apollo 11 impact glasses have also been analyzed for trace elements by INAA. As shown in the figure below, the glasses possess ratios among refractory lithophile elements that overlap those of the local regolith and mare basalts.

These relationships indicate that, from a chemical perspective, a single impact glass contains as much information as the bulk composition of a regolith, at least for the refractory lithophile elements. As such, an observed compositional range among refractory elements in a suite of impact glasses is representative of ranges in regolith composition that actually exist in a particular region of the Moon. This view is being applied to a suite of impact glasses in a lunar meteorite (ALHA 81005) in order to understand the compositional range of regoliths that exist in the region of the lunar highlands from which this meteorite was launched to Earth [7].

These results are in agreement with earlier pioneering work [8] showing that impact glasses on the Moon have dominantly regolith, rather than rock, compositions.

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