MAJOR ELEMENT CHEMISTRY OF APOLLO 14 MARE BASALT CLASTS AND HIGHLAND PLUTONIC CLASTS FROM LUNAR BRECCIA 14321: COMPARISON WITH NEUTRON ACTIVATION RESULTS. **SHERVAIS, John W.**, Department of Geological Sciences, University of South Carolina, Columbia SC 29208 and **VETTER, Scott K.**, Department of Geology and Geography, Centenary College, Shreveport, LA 71104.

Studies of lithic components in lunar breccias have documented a wide variety of rock types and magma suites which are not found among large, discrete lunar samples. Rock types found exclusively or dominantly as clasts in breccias include KREEP basalts [1,2], VHK mare basalts [3,4], high-alumina mare basalts [5,6], olivine vitrophyres [7], alkali anorthosites [8-10], and magnesian anorthosites and troctolites [8-12]. These miniature samples are crucial in petrogenetic studies of ancient mare basalts and the highlands crust of the western nearside, both of which have been battered by basin-forming impacts and no longer exist as distinct rock units [13].

Despite the importance of these clasts for petrogenetic models of mare basalt and highland evolution, many have not been analyzed for major element chemistry because of their small size. As a result, systematic chemical data are not available for most samples, which have only been studied by instrumental neutron activation analysis (INAA). Activation analysis has the advantage of producing excellent data for a large number of trace elements (including REE) and a few major elements (FeO, Al_2O_3, Na_2O) from small analytical samples. The primary disadvantage of INAA is that several important major elements cannot be analyzed accurately (MgO, TiO_2, K_2O), and SiO_2 cannot be determined at all. Several of these major elements produce short-lived isotopes which require special irradiation and counting techniques (Al_2O_3, MgO, TiO_2); as a result, these are not determined routinely. When these elements are determined, it is customary to calculate "SiO_2" by difference, assuming the major elements sum to 100 percent by weight. As a result, dunites and troctolites may have calculated SiO_2 as low as 34-36 wt%, despite the fact that they consist of Fo88 olivine and An94 plagioclase [12]. These problems may be overcome by using fused bead electron microprobe analysis for major elements in conjunction with INAA for trace elements and selected major elements [e.g., 8-11]. Fused bead EMP analysis produces results comparable in quality to X-ray fluorescence analysis when basaltic samples are analyzed [B. Schuraytz, pers. comm., 1990], and can be applied to samples as small a 10 milligrams. Since INAA samples generally range from 10 to 100 mg in mass, both techniques can be applied to the same sample, either by splitting a homogenized powder, or by serial analysis (INAA followed by fused bead EMPA).

We present here fused bead EMPA major element data for mare and highland clasts found in lunar breccia 14321. These clasts have already been analyzed for trace elements and selected major elements by INAA [5,7,12]. This data set represents the first complete major element for these samples, which we compare to the INAA major element results.

ANALYTICAL TECHNIQUES: A total of 20 clasts from breccia 14321 were studied here by fused bead EMPA. These clasts include 11 mare basalts [5], 3 olivine vitrophyres [7], 3 Mg-troctolites [12], 2 Mg-anorthosites [12], and one dunite [12]. All samples were powdered by hand in an agate mortar prior to fusion in a dry nitrogen atmosphere [14]. The powders were fused in molybdenum foil boats, and the fused samples analyzed for 12 elements on a Cameca SX-50 EMP at the University of South Carolina. Standards included a natural basaltic glass similar in composition to lunar low-Ti mare basalts (VG2; SiO_2, Na_2O, CaO, TiO_2, FeO), plagioclase (Al_2O_3), microcline (K_2O), ilmenite (MnO), fused MgO, chromite, apatite (P_2O_5), and molybdenum metal (to monitor dissolution of Mo into the fused glass). The basaltic glass standard VG2 was analyzed periodically to monitor analytical drift; results for all elements were generally within 1% of the accepted values.

RESULTS: Our fused bead EMPA results are shown in figure 1 compared to the published INAA results. All of the INAA data were produced in one lab by the same analyst (Dr. M.M. Lindstrom at Washington University), so there is no interlaboratory bias in either data set. Silica in the INAA data set was calculated by difference for "complete" analyses.

Differences between the two data sets are generally smallest for those elements which can be measured accurately by INAA: Al_2O_3, FeO, MnO, Na_2O, and CaO (figure 1). Fused bead EMPA for Na_2O are systematically 5-10% lower than the INAA results, suggesting that Na was mobilized under the electron beam. INAA results for TiO_2 and MgO are systematically too high by 15% to 20% on average, while K_2O and SiO_2 show significant scatter to both high and low values. Cr_2O_3 values correspond well for the mare basalts, but show significant differences in the highland samples.

CONCLUSIONS: Fused bead EMPA provides superior analytical results for the major elements SiO_2, TiO_2, MgO, and K_2O on small samples extracted from lunar breccias. This method can be applied to samples which have been irradiated for INAA and compliments the data obtained by INAA. Fused bead EMPA eliminates the need for "rabbit runs", which are used primarily to obtain data for the major elements Al, Mg, and Ti. These data will allow us to refine petrogenetic models for 14321 mare basalts and highland rocks, and expand the range of clast sizes from which complete geochemical data may be obtained.

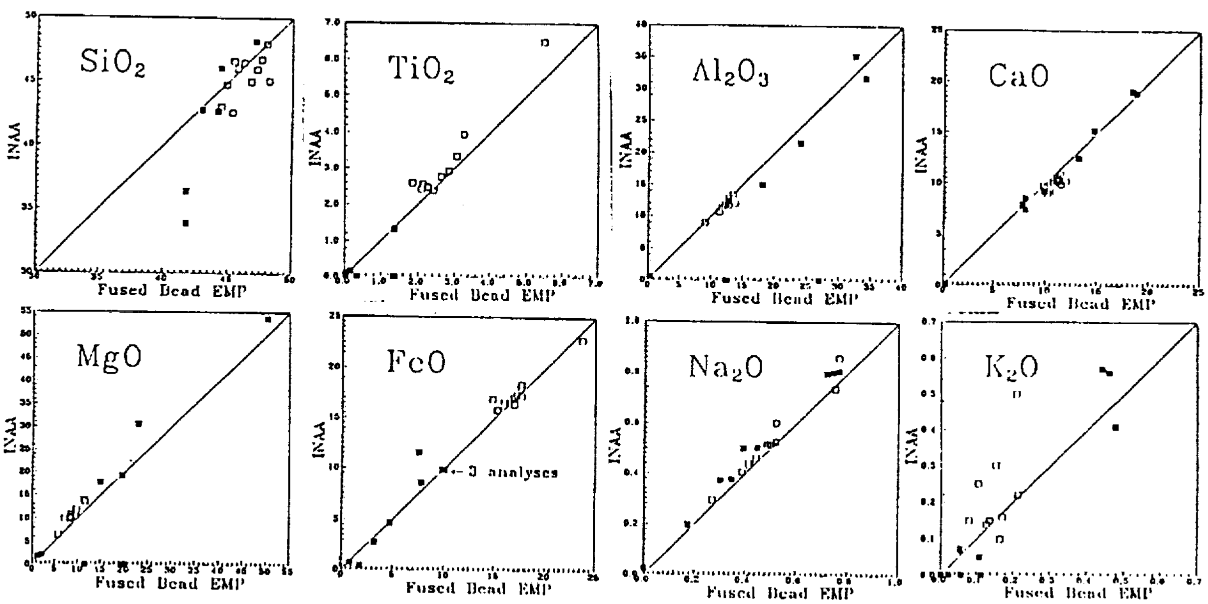

Figure 1. Fused bead EMPA of lithic clasts from lunar breccia 14321, compared to INAA results on the same samples [5,7,12]. Solid symbols = highland plutonics and melt rocks; open symbols = high-Al mare basalts. Correlations are good for Al, Ca, Fe, and Na, but poor for other elements.

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