GLOBAL PETROLOGIC VARIATIONS ON THE MOON: A TERNARY-DIAGRAM APPROACH. Philip A. Davis and Paul D. Spudis, U.S. Geological Survey, Flagstaff, Arizona 86001

Introduction. Last year we presented a new method for using both orbital and sample geochemical data simultaneously to show the distribution of petrologic provinces within the lunar highlands [1]. The provinces were defined on the basis of the orbital data's clustering or coincidence with sample compositions or both, using biaxial plots of elemental concentrations (Fe, Al) versus concentration ratios (Mg^*, Th/Ti_c). The Mg^* ratio is equal to 100 (Mg/Mg+Fe); the Th/Ti_c ratio is the Th/Ti ratio normalized to chondrite values. The petrologic units were assigned different colors to show their spatial distributions on classification maps. In order to provide maximum distinction between units on the maps, especially the units represented by relatively few picture elements (pixels), it was necessary to use color codes in which gradations between units were lost. To overcome this earlier limitation, we have since designed a more refined method of analysis and display that uses a ternary-diagram concept. In this paper we present this ternary method and discuss some of the general results of our preliminary analyses of the entire Apollo 15 and 16 groundtracks, which cover both maria and highlands.

Method. The ternary approach is quite simple in theory. It is designed to show subtle compositional differences between adjacent areas, areas with pristine rock compositions, and the areal transitions from one pristine rock composition to another. In this analysis, we used the gamma-ray Fe (wt%) and Th/Ti_c data to establish end-member compositions for the ternary apexes because of the circumequatorial coverage of these data. Two of the apexes were always assigned the average composition of FAN (ferroan anorthosite) and mare basalt. The third apex was tentatively assigned the average composition of KREEP for this preliminary analysis; it is also geologically reasonable to replace the KREEP composition with that of norite or troctolite. Error databases were produced for each of the orbital geochemical databases, in order to exclude from the ternary analysis pixels that have errors above a user-defined limit. The three apexes of the ternary diagram were also assigned the distinct colors red, green, and blue, so that compositional transitions from one apex to another within the diagram are represented by subtle color changes involving the entire color spectrum.

Each orbital pixel that fell within the predefined ternary compositional boundaries was assigned three values, representing the relative contribution of each apex composition to the observed composition of the pixel. These values were multiplied by 100 and placed in red, green, and blue image files, representative of each apex, at the pixel's location within the original chemical databases. For each pixel, the three values resulting from this analysis were also used as indices of a ternary scattergram plot, in order to show pixel frequency distribution within the defined ternary system. After all pixels were labeled with their respective ternary indices, a composition map of the lunar surface was prepared by color coding and compositing the three resultant global-image files. A color-reference scheme was also prepared by similarly color coding and compositing the ternary scattergram. The scattergram was then used with the

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global color-composition image to display the relative contributions of each of the three end-member compositions by matching pixel color with ternary color. (Alternatively, the exact relative compositional character of each pixel in the global composition image could be extracted directly from the three separate color image files, either by printout or by interactive display.)

Our preliminary analysis of the technique shows that a certain amount of color binning is necessary because color differences near the middle of the ternary diagram are too subtle to be discerned. Thus, a binning approach was used for color coding that results in 25-30 colors within the ternary diagram.

Results. The composition map (not shown) produced from this ternary analysis substantiates an interpretation made in our previous analysis [1], i.e., areas within the eastern limb and farside highlands require the presence of approximately 30% mare-basalt component in order to produce their higher-than-average highland Fe values and near-chondritic Th/Ti_c values. Of course, by this interpretation we assume that there is no need to invoke large quantities of highland gabbro [1] or some proposed but as yet unsampled lunar composition such as "HON" [2]. The Apennine Bench region is shown to be composed of a mixture of KREEP and mare basalt, consistent with previous studies [1,3]. The intermare highlands on the lunar eastern limb are shown to be composed of an admixture of ferroan anorthosite and mare basalt, as expected from their proximity to the maria. Mare Tranquillitatis differs from most other maria in that its lower-than-average Fe values give it a closer similarity to the surrounding intermare highlands. This same intermare compositional affinity is also observed for the region just east of Aristarchus in Oceanus Procellarum. These observations suggest that mare basalts are very thin in these areas and that vertical mixing has added substantial amounts of underlying highland debris to the mare regolith [4]. The Van de Graaff region appears to have a KREEPy composition, in accord with previous observations [5].

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