A RE-EXAMINATION OF THE ORBITAL X-RAY DATA FROM APOLLO 15 AND 16.
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The orbital X-ray data from Apollo 15 and 16 are being re-examined in order to learn what improvements can be made in the data reduction and to what extent these data can be used to study geochemical and geological problems on the Moon. A simple and much superior method of reducing the data has been found. This method provides a superior ability to follow chemical changes across the lunar surface and provides a stable starting point for further improvements in data reduction. This abstract concerns only the initial re-examination of the data reduction: a companion abstract applies the results of this re-examination to the use of some Apollo 16 data.

Past usage of the orbital X-ray data have been limited to the use of Al/Si and Mg/Si ratios in very broad surveys (2) or to the use of only Al/Si ratios in studies of very limited areas (3,4). The Mg/Si data are of marginal quality (5). The major steps of this re-examination will be illustrated by using the last six orbits of data from Apollo 16 to show that the inherent quality of the Mg data is much greater than previously thought. Figure 1 shows how the fluorescence X-ray flux from the lunar surface, recorded by #1 spectrometer, increases as the spacecraft approaches and passes the subsolar point. The ideal case is shown by the graph of a simple empirical photometric function: deviations are due primarily to changes in the solar X-ray emission. Figure 2 shows the result of dividing the observed values by the ideal values for #1 spectrometer. This spectrometer carried no filter: the X-radiation recorded by this spectrometer is largely SiKα, with much lesser amounts of AlKα. Si abundances and the SiKα mass absorption coefficients for common lunar chemical compositions are rather invariant (<10%). The result is that this spectrometer can be used to follow and correct for changes in the exciting X-ray flux from the Sun. This detector is not a perfect solar monitor: Figure 2 shows that gross changes in chemical composition (e.g., mare-highland differences) are visible when the solar X-ray emission is rather stable, as it is for these orbits. It also shows that on repeated passes over an area differences in the total solar X-ray emission are easily measured. Figure 3 shows the results when #2 spectrometer (Mg filter) data are treated the same way. This spectrometer is responsive almost entirely to MgKα and SiKα radiation: due to the relative constancy of Si the variations in signal are due to Mg and solar variations. Due to the quiet solar conditions during these Apollo 16 orbits, the major variations shown in Figure 3 are due to Mg. The solar component can be greatly reduced by dividing #2 by #1 (Figure 4). The variations seen correlate well with the surface geology of the Moon. Preliminary study indicates that these data are relatively free of solar induced changes in ratios, which is a major problem with the Mg/Si data used by Adler et al. (2). Figure 5 shows these same data only reduced via the matrix inversion procedure used by Adler et al. (2): the data are now worse than the raw data before solar corrections.

The Al/Si ratio used by Adler et al. (2) and others is currently the best way to use the data from the #3 spectrometer (Al filter). The total signal in this spectrometer consists of such a large percent of MgKα radiation, in addition to AlKα, that the variations in Al are masked to a serious degree because Mg and Al are commonly inversely correlated. The use of Al/Mg ratios from matrix inversion or, better yet, #3/#2 spectrometer ratios is the superior
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Mg VARIATIONS CORRECTED FOR SOLAR VARIATIONS

FIGURE 4.

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Technique for tracing chemical changes across the lunar surface and for recognizing contiguous areas of similar chemical composition.

References: