ANALYSIS OF LOW ALTITUDE X-RAY FLUORESCENCE DATA FROM MARE CRISIUM
AND MARE SMYTHII. T. A. Maxwell, P. L. Strain and F. El-Baz, National Air
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Low altitude (15-20 km) Apollo 15 and 16 X-ray fluorescence (XRF) data
provide increased spatial resolution (about 30 km for the 8 second data: see
(1) for details) that is necessary for photogeologic interpretation of lunar
features. Although Mg/Si intensity ratios show an overall inverse trend to
the Al/Si ratios, the present investigation deals primarily with the Al/Si
data. Low altitude data from Apollo 15 revs. 4 through 9 (Figs. 1 and 2) are
consistent with those of higher altitude orbits (2,3), although rapid fluctu-
ations in Al/Si intensity can be related to smaller surface features. In
addition, close spacing of these orbits permits increased statistical reli-
ability.

Mare Crisium

Mare material in the Crisium basin has been mapped as a relatively
homogeneous deposit of Imbrian-age basalt, although the eastern portion of
the basin contains a few scattered cones and surrounding dark mare (4).
Multispectral imagery suggests several different color units within the basin
that may be related to basalts with varying TiO₂ content (5). Although some
local deviations are seen in the low altitude XRF data, average Al/Si inten-
sity ratios are relatively constant both in longitude and from orbit to orbit
(Fig. 3). Average intensity values of Crisium mare material are consistently
higher than those of Mare Serenitatis, which may be the result of a slightly
different basalt type, or the admixture of a small amount of highland
material (rays) in Crisium.

Over the small (about 4 km) cones and surrounding dark halos in
eastern Crisium, the Al/Si intensity ratios are lower than elsewhere on the
same mare. Adjacent to the dark mare patches, intensity values are higher
than the average; most likely a result of north-trending rays (Figs. 4 and 5).
Intensity ratios over the dark units are similar to those of southern Mare
Serenitatis, where mare material of the dark annulus has a slightly lower Al/
Si ratio than the central mare. Consequently, the gross relationship of low
albedo with low Al/Si ratios is matched on a more local scale by the low
altitude data. Assuming that: 1) there is a linear relationship between
measured intensity and Al/Si concentration ratios, and 2) a relatively con-
stant SiO₂ in the dark and light mare, it is possible that the darker mare
regions have approximately 3.5% less Al₂O₃ than the lighter mare units.
Although this value does not represent a great difference in basalt composi-
tion, it is nonetheless consistent with the observations of low topographic
slopes on lunar volcanic cones (6).

Mare Smythii

Apollo 16 low altitude data over southern Mare Smythii distinguish
between two major units. Imbrian to Nectarian age furrowed and pitted
material is similar to hilly and furrowed material on the lunar near side,
and an impact origin for the unit is preferred (7). Al/Si intensity ratios,
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although not as high as those over the Descartes region, are greater than Mg/Si ratios, which suggests a highland-type material. Over the crater Warner, a 30 km dark-floored crater (with a brighter central peak) the Mg/Si ratio is greater than that of Al/Si; probably the result of the mare material in the crater floor.

Although the Al/Si data are affected by bright highland craters, the Al/Si to Mg/Si ratio is greater over the eastern part of the basin than in the west. This is consistent with the observation that furrowed and pitted terra materials in the eastern part of Smythii are morphologically distinct from those in the west. In the eastern part of the basin, the terra blocks are several kilometers in size and they are surrounded by light-colored plains that fill craters and inter-crater areas (hilly and pitted material). In the western part, the blocks are usually smaller and appear more mantled (hilly and furrowed material).

The result of this study indicates that low altitude XRF data may contribute to a more detailed description of small lunar surface features, and contains resolution necessary to extrapolate groundtruth data from Apollo and Luna sampling sites. Published bulk chemical analyses of regolith samples indicate that despite impact mixing, the Al/Si ratio is a sensitive indicator of rock types.

FIG. 1. Apollo 15 (Serenitatis-Crisium) and 16 (Smythii) low altitude XRF coverage (ASB-6665).

FIG. 2. Apollo 15 intensity ratios for Crisium-Serenitatis pass shown above. Top: rev. 5; Bottom: rev. 6.
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FIG. 3. Average intensity ratios for Crisium mare; Al/Si values show less deviation than do Mg/Si ratios; and may be related to the relative homogeneity of Crisium mare materials.

FIG. 4
Apollo 15 data in eastern Crisium. Note high Al/Si ratios over lighter mare and rays, and lower values over darker unit. (Apollo 17 metric Fr. 282).

FIG. 5

REFERENCES