COMPOSITIONAL VARIATIONS IN THE HADLEY APENNINE REGION, P.E. Clark, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91109, and B.R. Hawke, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii 96882.

INTRODUCTION. The orbital geochemistry data present a complex picture of the Hadley Apennine region. This complexity is not obvious on the basis of available geological information alone. Specifically, this area has been considered a geochemical anomaly (1,2,3) due to variations in Al/Si and Mg/Si ratios (4), Fe (5), and Th (6). This study presents a synthesis and analysis of local variation in the best available orbital geochemical data, including the data sets already mentioned as well as Ti (5). Variations in improved orbital XRF Al/Si and Mg/Si values, which have the highest spatial resolution of all of these data, form the basis for this study. The results of this study have provided more insight into the distribution and origin of the rock types found in the Apollo 15 sample collection (7).

TREATMENT OF ORBITAL XRF DATA. A method had been developed to correct the Apollo 15 and 16 orbital XRF data for spurious inter-orbit variations, by the use of direct solar flux measurements made contemporaneously by a terrestrial satellite (8). Variations in the solar flux, which is the source for lunar fluorescent X-rays, are the principal cause of spurious inter-orbit variation in the orbital XRF data. Unfortunately, solar flux measurements were available for a limited number of the XRF data in the Hadley Apennine region. Therefore, this method was modified to correct all XRF data in the region by the use of an internal parameter which was correlated to solar flux variation. As previously described (8), emission measure ratios (EMR's), which are good indicators of relative variation in the solar flux, were derived from the solar flux data. In the original method (8), the EMR's were compared directly to Al/Si and Mg/Si ratios derived theoretically at particular EMR's. The new modified method involved comparing the fairly constant Silicon intensities, normalized to an incident solar flux of 30° (the median value for the XRF data), to the EMR's, wherever both kinds of information were available. This relationship is best described by the following equation:

$$EMR = .900 \ (I^{-.680})$$

where I is the silicon intensity. From these calculated EMR's, a correction factor for each Al/Si or Mg/Si intensity ratio was derived, as in the previous method (8).

GEOCHEMICALLY DEFINED UNITS. On the basis of variations in the Al/Si and Mg/Si intensity ratios, several distinctive units in the Hadley Apennine region became apparent. (See Figure 1.) These units will be described from west to east below. (Al/Si and Mg/Si intensity ratios were converted to Al and Mg concentrations, respectively (9), and will be referred to as such.)

Archimedes-Apennine Bench Area. This area borders southeastern Imbrium, and is bounded by Archimedes on the north, Mons Huygens on the south, and the Apennines on the east. Splotches of low Al, low Mg material appear in this area, particularly adjacent to basaltic basin material. Generally, the area is low to moderate in Al, and moderate in Mg. Fe is quite high, Ti moderate to low, and Th high. This could indicate the presence of KREEP-rich

Hadley Apennine Compositional Variations

Clark P.E., and Hawke, B. R.

material, medium K Fra Mauro basalt perhaps, with isolated patches of high K Fra Mauro basalt (10). Due to its distribution, this KREEPy material is probably of endogenic origin; there is no regular trend in Al or Mg variation as a function of distance from Archimedes or the Imbrium basin. A few outcrops of high Mg, low Al material occur here as they do throughout the other units. These may be related to pockets of pyroclastic activity (11).

Palus Putredinis. Mg is moderate to high, Al low in this area. The Al increase which is correlated with Mg decrease in a few places may be due to the presence of Autolycus and/or Aristillus ray material. A center of pyroclastic activity may be seen in the area of an embayment just west of Mons Hadley in eastern Putredinis. Here Mg rises dramatically. Fe, Ti, and Th values are similar to those in the Archimedes-Apennine Bench area.

Apennine Mountains and Imbrium Backslope. A sudden increase in Al and decrease in Mg can be seen in the vicinity of the Apennine Mountains. Here Al is moderate to high, and Mg moderate to low. There is a decrease in Fe, Ti, and Th values. All of these data indicate the presence of somewhat contaminated anorthositic material. There is an obvious low Al, high Mg spot near Mons Hadley delta, probably the result of a pyroclastics deposit, which has also been observed both in the visual and radar data (12). East of the Apennines, the high Al values drop slightly. Al values continue to fall, Mg values to rise , from west to east in the Imbrium Backslope area. This trend may be related to the increasing abundance of mafic pyroclastic material associated with Serenitatis.

Sulpicius Gallus and Vicinity. This area includes portions of the Haemus Mountains, and the southwestern rim area of Mare Serenitatis. High Mg and low Al values are prevalent, the trend continuing from the Imbrium Backslope. Fe and Ti values rise in this area. These data lend support to the idea that this area contains centers of pyroclastic activity, and is covered by variable thicknesses of dark mantling material (13).

The orbital geochemistry data for this entire region are consistent with the presence of a mixture of mafic pyrocliastic material with a highland component, frequently dominated by a KREEP basalt component.

This work was partially supported under NASA contract NAS 7-1000 at JPL.

REFERENCES

(1) Clark P.E. et al (1978) Proc Lun Plan Sci Conf 9th, 3029.
(2) Hawke B.R. and J. Head (1978) Proc Lun Plan Sci Conf 9th, 3285.
(3) Spudis P. (1978) Proc Lun Plan Sci Conf 9th, 3379.
(4) Adler I. et al (1973) Proc Lun Sci Conf 4th, 2783.
(5) Davis P.A. (1980) JGR 85, 3209.
(6) Metzger A. (1979) Proc Lun Plan Sci Conf 10th, 1701.
(7) Taylor S.R. (1975) Lunar Science: A Post-Apollo View, Pergamon Press, NY
(8) Clark P.E. and I. Adler (1978) Proc Lun Plan Sci Conf 9th, 3015.
(9) Clark P. (1980) Lun Plan Sci Abstracts XI, 155.
(10) Irving A. (1977) Proc Lun Plan Sci Conf 8th, 2433.
(11) Hawke B.R. et al (1979) Proc Lun Plan Sci Conf 10th, 2995.
(12) Zisk S. et al (1971) Science 173, 808.
(13) Head J. et al (1980) Proc Lun Plan Sci Conf 11th, 418.

Hadley Apennine Compositional Variations

Clark, P.E., and Hawke, B. R.

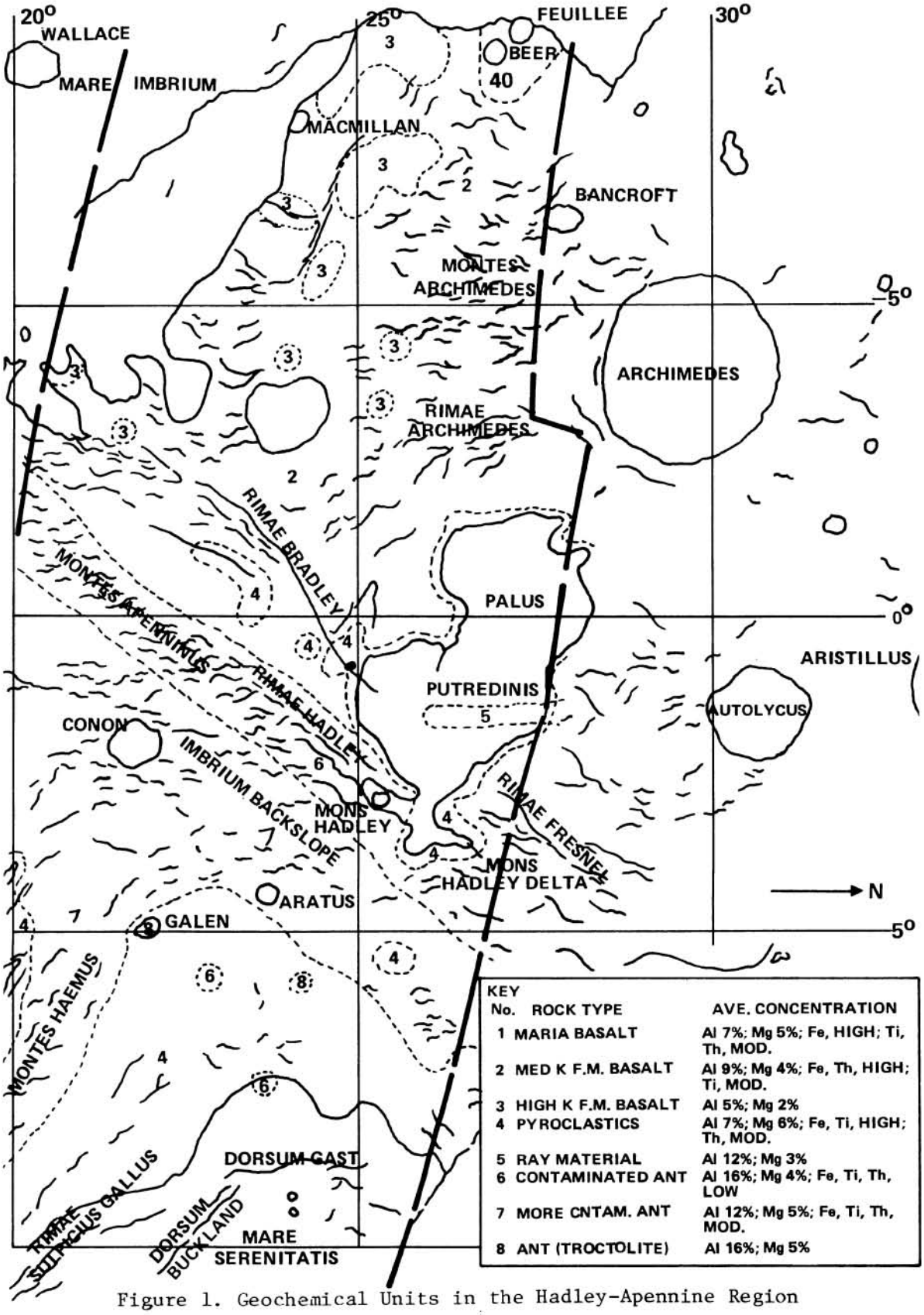

Figure 1. Geochemical Units in the Hadley-Apennine Region