

CHEMICAL AND OPTICAL PROPERTIES OF APOLLO 15 AND 16 DEEP DRILL CORE SAMPLES AS COMPARED TO THOSE OF APOLLO 15 AND 16 SURFACE SOILS FROM THE SAME SITES. M.Z. Ali and W. D. Ehmann, Dept. of Chemistry, Univ. of Kentucky Lexington, Kentucky, 40506, and T. Gold, E. Bilson and R. L. Baron, Center for Radiophysics & Space Res., Cornell Univ., Ithaca, N.Y., 14853.

The bulk chemical composition, the surface concentration of several major elements and the optical reflectivity were determined for four core samples, from different depths below the lunar surface: 15003,645 (from 139 cm depth), 15001,338 (from 229 cm depth), 60002,319 (from 185 cm depth) and 60005,97 (from 55-73 cm depth); and also for a surface soil sample: 60501,81 from the site of the Apollo 16 deep drill core.

The bulk chemical composition of 28 major, minor and trace elements in the samples was determined by instrumental neutron activation analysis. The data are presented in Tables 1 and 2. Details of the experimental procedure and precision are described by Ali & Ehmann (1). The elemental concentrations in the core samples are within the range of the concentrations in the surface soils at each site. Thus the chemistry of the core samples seems to be related in each case to the chemistry of the surface soil samples found in the same location.

Surface chemical concentration of Si, Ca, Ti and Fe was determined by Auger electron spectroscopy (described in (2)). In Table 3 we show a comparison between the bulk and surface elemental concentrations of these elements.

A small increase in the surface Si concentration is observed for all the samples. Ti was present in a very small concentration in all cases and the increases shown by the Auger determinations are barely significant. The results for Fe and Ca are however of definite interest: three of the core samples and the Apollo 16 surface sample are markedly depleted in Ca on their surfaces and enriched in iron, in (at least semi-quantitative) accord with earlier observations (3). 15001 seems to be different from all the surface samples examined by us so far (from all the Apollo missions): there is only a slight (less than 1.2 fold) enrichment in iron on the surface of this sample and the calcium is unchanged (within the  $\pm 15\%$  error limits of the Ca Auger determinations). The surface exposure time of this sample is possibly much shorter than the exposure time of the other samples examined so far. The cosmic ray track density data (which are to be determined in the near future) could be helpful along with other maturity indices, when available, to explain the surface chemical data.

In Figure 1 the albedos of the core samples are plotted vs the surface iron and titanium concentration along with the data points for the soil samples previously measured. Our previously determined data points were least square fitted to a curve also shown in Figure 1. The albedo of the core sample 15001,338 is much higher than expected on the basis of this curve, which is again a possible indication of a relatively short surface exposure time. In general all the core samples have somewhat higher albedos than would be predicted from the surface iron + titanium concentration-albedo curve, based on the surface soil data, but due to the semiquantitative nature of the Auger determinations only the deviation of 15001,338 can be firmly considered as significant.

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References

- (1) Ali, M.Z. and Ehmann, W.D. (1976) Proc. Lunar Sci. Conf. 7th, p. 241-258.
- (2) Gold, T., Bilson, E. and Baron, R.L. (1975), Proc. Lunar Sci. Conf. 6th, p. 3285-3303.
- (3) Gold, T., Bilson, E. and Baron, R.L. (1976) Proc. Lunar Sci. Conf. 7th, p. 901-911.

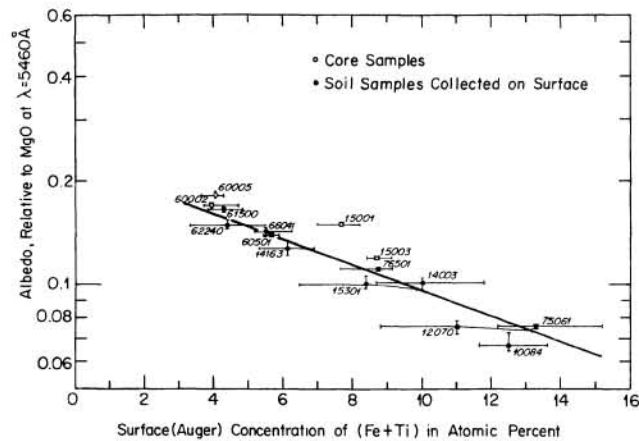


Fig. 1

Table 1.

| Sample # | O%wt. | Si%wt. | Al%wt. | Ca%wt. | Mg%wt. | Fe%wt. | Ti%wt. | Na%wt. | K%wt. |
|----------|-------|--------|--------|--------|--------|--------|--------|--------|-------|
| 60002    | 43.2* | 20.7*  | 13.9   | 11.0   | 4.13   | 5.12   | 0.43   | 0.347  | 0.14  |
| 60005    | 43.1* | 20.4*  | 14.3   | 11.6   | 4.55   | 5.14   | 0.62   | 0.332  | 0.14  |
| 60501    | 44.1  | 20.3   | 15.0   | 11.5   | 4.10   | 4.20   | 0.42   | 0.349  | 0.12  |
| 15003    | 43.0  | 22.1   | 7.67   | 7.52   | 5.89   | 11.57  | 1.12   | 0.332  | 0.21  |
| 15001    | 42.9  | 21.7   | 5.72   | 6.10   | 6.96   | 14.53  | 1.10   | 0.294  | 0.25  |

\* These data for O and Si were adjusted 2-5% relative, based on estimations of sample positioning variations due to fine powder creeping around sample positioning plug during the 14 MeV activation procedure. The remainder of O and Si values are assigned error limits of 2-3% relative.

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Table 2.

| Sample # | Mn<br>ppm | Cr<br>ppm | Sc<br>ppm | Co<br>ppm | Ba<br>ppm | La<br>ppm | Ce<br>ppm | Nd<br>ppm | Sm<br>ppm | Eu<br>ppm | Tb<br>ppm |
|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 60002    | 650       | 864       | 10.8      | 49.7      | 169       | 14.3      | 35.6      | 20.       | 6.62      | 1.14      | 1.04      |
| 60005    | 750       | 913       | 12.4      | 30.4      | 139       | 12.5      | 33.7      | 16.       | 6.00      | 1.25      | 0.89      |
| 60501    | 650       | 760       | 9.8       | 26.8      | 147       | 11.9      | 31.4      | 29.       | 6.23      | 1.13      | 0.88      |
| 15003    | 1660      | 2670      | 28.9      | 41.2      | 285       | 24.4      | 71.7      | 48.       | 13.2      | 1.45      | 1.80      |
| 15001    | 1820      | 3750      | 31.5      | 54.8      | 252       | 21.6      | 64.5      | 35.       | 11.2      | 1.13      | 1.38      |
|          | Dy<br>ppm | Yb<br>ppm | Lu<br>ppm | Hf<br>ppm | Th<br>ppm | V<br>ppm  | Ta<br>ppm | Ni<br>ppm |           |           |           |
| 60002    | 5.4       | 4.7       | 0.76      | 5.17      | 1.66      | 28.4      | 0.67      | 773       |           |           |           |
| 60005    | 3.9       | 4.2       | 0.67      | 4.62      | 1.70      | 27.9      | 0.65      | 397       |           |           |           |
| 60501    | 6.4       | 4.3       | 0.70      | 4.60      | 2.03      | 20.4      | 0.75      | 562       |           |           |           |
| 15003    | 16.       | 8.4       | 1.36      | 9.81      | 3.40      | 129.      | 1.26      | 383       |           |           |           |
| 15001    | 12.       | 7.2       | 1.13      | 8.20      | 1.72      | 151.      | 0.97      | 124       |           |           |           |

Estimated accuracy for most trace element determinations is  $\pm$  5-10%, relative.

Table 3

## Concentrations in Atomic Percent

|    | 60002 |       | 60005 |       | 60501 |       | 15003 |       | 15001 |       |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|    | Bulk  | Auger | Bulk  | Auger | Bulk  | Auger | Bulk  | Auger | Bulk  | Auger |
| Si | 16.4  | 18.9  | 16.1  | 21.5  | 15.9  | 20.0  | 17.9  | 22.2  | 17.8  | 20.2  |
| Ca | 6.2   | 2.6   | 6.4   | 3.8   | 6.3   | 3.6   | 4.3   | 1.8   | 3.4   | 3.1   |
| Ti | 0.2   | --    | 0.2   | 0.5   | 0.2   | 0.6   | 0.5   | 0.8   | 0.5   | 0.85  |
| Fe | 2.0   | 4.0   | 2.0   | 3.5   | 1.75  | 5.0   | 4.7   | 7.9   | 5.9   | 6.8   |