AVERAGE CHEMICAL COMPOSITION OF THE LUNAR SURFACE,
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The available analytical data for the principal chemical
elements at eleven sites on the moon (eight mare and three
terra) have been combined to estimate the average chemical com-
position of the lunar surface. The principal chemical elements
are those present in amounts greater than a few tenths of a
percent by atom. The analyses used are those for the powdered
material, on the assumption that this approximates the average
surface composition at a given site. The results of this
exercise are presented in Table I.

The small number of locations on the moon that have been
examined, particularly of terrae, with no detailed data avail-
able for the back side of the moon, make this a tentative
estimate of the average chemical composition of the lunar
surface. However, the general similarity in chemical compo-
sition of different maria, the agreement in composition of three
terra sites thousands of kilometers apart, and the indication
from orbital X-ray measurements (Adler et al., 1972) that the
Al/Si ratio in many terra regions (including the backside) is
enhanced over that in the maria by amounts similar to that
indicated in Table I, suggest that these estimates will not be
changed significantly--as, in fact, they have not since the
original estimates by Turkevich (1971).

The estimated average density of the parent rocks in the
case of the maria material is 3.19 g cm\(^{-3}\); for terrae material,
it is 2.97 g cm\(^{-3}\) (Turkevich, 1973). The differences in chemi-
cal composition between terrae and maria provide reasonable
explanations for the major albedo and gross elevation differ-
ences on the moon (Turkevich, et al., 1968a, b).

If solar system elemental abundances (Cameron, 1968) are
taken as a reference, the enrichment, relative to silicon, of
the lunar surface for the elements Al, Ca and Ti is by a factor
of 6.5\(\pm\)1.5; the depletion of the elements Na, Mg and Fe is by
a factor of 4\(\pm\)2.
Average Chemical Composition of the Lunar Surface

<table>
<thead>
<tr>
<th>Element</th>
<th>Maria Average (a)</th>
<th>Surveyor 7 (b)</th>
<th>Luna 20 (c)</th>
<th>Apollo 16 (d)</th>
<th>Terra Ave.</th>
<th>Average Lunar Surface Percent of Atoms (e)</th>
<th>Weight % of Oxides (f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>60.6±1.2</td>
<td>61.8±1.0</td>
<td>(60.3)</td>
<td>(61.1)</td>
<td>61.1</td>
<td>61.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Na</td>
<td>0.4±0.1</td>
<td>0.5±0.2</td>
<td>0.4</td>
<td>0.29±0.02</td>
<td>0.4</td>
<td>0.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Mg</td>
<td>5.3±1.2</td>
<td>3.6±1.6</td>
<td>5.2</td>
<td>3.0±0.4</td>
<td>4.0</td>
<td>4.3</td>
<td>22.3</td>
</tr>
<tr>
<td>Al</td>
<td>6.6±0.6</td>
<td>9.2±0.4</td>
<td>9.7</td>
<td>11.6±0.4</td>
<td>10.2</td>
<td>9.5</td>
<td>45.0</td>
</tr>
<tr>
<td>Si</td>
<td>16.8±1.0</td>
<td>16.3±1.2</td>
<td>16.0</td>
<td>16.26±0.06</td>
<td>16.2</td>
<td>16.3</td>
<td>79.0</td>
</tr>
<tr>
<td>Ca+K</td>
<td>4.7±0.5</td>
<td>6.9±0.6</td>
<td>5.9</td>
<td>6.1±0.2</td>
<td>6.3</td>
<td>6.0</td>
<td>15.5</td>
</tr>
<tr>
<td>Ti</td>
<td>1.0±0.6</td>
<td>0 ±0.4</td>
<td>0.15</td>
<td>0.15±0.02</td>
<td>0.1</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Fe</td>
<td>4.5±0.8</td>
<td>1.6±0.4</td>
<td>2.1</td>
<td>1.6±0.2</td>
<td>1.8</td>
<td>2.3</td>
<td>7.6</td>
</tr>
</tbody>
</table>

(a) The average mare chemical composition is calculated from the results of the Surveyor 5 and 7, Apollo 11, 12, 14 and 15 and Luna 16 and 17 missions, using an average value from Surveyor 5 and Apollo 11 for Mare Tranquilitatis. (Turkevich, 1973). The ± represent the variability in mare composition calculated as the root-mean-square deviations from the average of the different mare results.

(b) Turkevich et al., 1968a; Patterson et al., 1970. The data are the averages of results on two soil samples at a location outside the crater Tycho. The ± represent estimated error limits at the 90% confidence level.

(c) Vinogradov (1972). The oxygen value is from stoichiometry.

(d) Average of eleven soil samples from Apollo 16. The ± are the root-mean-square deviations of the results of the different samples from the average. Apollo 16 Preliminary Examination Team (1973). The oxygen values are from stoichiometry.
(e) Calculated on the basis that 80% of the lunar surface is terra-type material.
(f) The oxide composition is calculated on the basis that all the iron is present as FeO.

REFERENCES


APOLLO 16 PRELIMINARY EXAMINATION TEAM (1973) Science 179, 23-34.


