DETERMINING LUNAR TITANIUM ABUNDANCE ON THE BASIS OF COMBINED REMOTE SENSING TECHNIQUES. P. E. Clark, L. Evans, NASA Goddard Space Flight Center, Greenbelt MD 20771.

Global lunar compositional maps, generated from orbital instruments, have already played key roles in providing constraints on the origin of major terranes and the nature of crustal formation and mare basalt petrogenesis on the Moon (1,2). Useful parameters derived from orbital measurements include Fe and Ti abundances (3). Although good estimates of individual elemental abundances have not yet been made from the Lunar Prospector data (4,5), such composition maps, limited in coverage, were derived from orbital Gamma-ray measurements made by the Apollo mission in the 1970’s (3,6,7). We have already successfully combined Apollo Gamma-ray (AGR) and Clementine spectral reflectance (CSR) derived measurements of iron, explained the nature and origin of differences in iron maps derived from the two techniques, and as a result mapped the distribution of iron in the major iron-bearing minerals pyroxene and olivine (8,9).

Here, we compare titanium abundance as mapped by AGR and CSR techniques (3,10). The presence of titanium should reflect the presence of ilmenite primarily associated with mafic materials. Both techniques show a primarily unimodal distribution with a shoulder in the high titanium direction and a primary mode at approximately .25% Ti, but the AGR Ti data have more structure in the shoulder, including an apparent minor mode at 1.2% Ti, representing non-highland areas. In both datasets, Ti is highest on the nearside and in the maria, particularly in southern Serenitatis/northern Tranquillitatis and northwestern Procellarum, where values above 5% are frequently found. Unlike CSR derived values, AGR Ti values show modest increase (up to .7%) on the northern farside. Table 1 shows the relationship between average Ti values for typical regions. Errorbars on AGR Ti values are on the order of 0.5%.

<table>
<thead>
<tr>
<th>Region</th>
<th>AGR Ti</th>
<th>CSR Ti</th>
<th>Bulk Fe (AGR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procellarum North</td>
<td>2.9</td>
<td>3.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Procellarum South</td>
<td>2.4</td>
<td>2.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Mare Imbrium East</td>
<td>1.3</td>
<td>1.8</td>
<td>13.2</td>
</tr>
<tr>
<td>Mare Imbrium West</td>
<td>2.4</td>
<td>2.6</td>
<td>14.0</td>
</tr>
<tr>
<td>Mare Tranquillitatis</td>
<td>3.0</td>
<td>3.5</td>
<td>10.6</td>
</tr>
<tr>
<td>Mare Serenitatis</td>
<td>2.5</td>
<td>3.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Mare Fecunditatis</td>
<td>1.8</td>
<td>2.4</td>
<td>13.7</td>
</tr>
<tr>
<td>Mare Crisium</td>
<td>1.3</td>
<td>2.4</td>
<td>14.4</td>
</tr>
<tr>
<td>Mare Smythii</td>
<td>2.6</td>
<td>1.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Farside Northwest</td>
<td>0.9</td>
<td>0.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Farside Northeast</td>
<td>1.3</td>
<td>0.4</td>
<td>4.9</td>
</tr>
<tr>
<td>Farside Southwest</td>
<td>0.4</td>
<td>0.6</td>
<td>5.5</td>
</tr>
<tr>
<td>Farside Southeast</td>
<td>0.7</td>
<td>0.6</td>
<td>5.9</td>
</tr>
</tbody>
</table>
The CSR Ti values tend to be relatively higher in the maria and lower for highlands terrane than AGR Ti values. CSR Fe values were related to AGR Fe values in a similar manner. Where bulk iron (derived from AGR Fe map) is relatively low, as in Mare Smythii, CSR derived Ti values are substantially lower. In most mare, where Fe values are relatively high, CSR derived Ti values are also relatively high. This relationship has been observed previously by Metzger and coworkers (11) between AGR Ti and ground-based spectral reflectance derived Ti estimates. Apparently, the methodology used to derive Ti from Clementine spectra, particularly where highland soils are present, does not effectively remove the influence of iron either. The ilmenite component may be estimated from CSR derived Ti data by calibrating maria and highland areas separately (12), as has been done in the past.