Standard petrographic and electron microprobe techniques have been used in a detailed examination of the mineralogy, petrology and major element chemistry of a portion of the Luna 20 soil. Approximately 0.002 gms of soil less than 125um in grain size was studied. In summary the results obtained indicate that:-

1) The soil at the Luna 20 landing site is predominantly feldspathic and is in marked contrast to the soils of the mare regions.
2) The high feldspar content of the Luna 20 site is due to the abundance of anorthosite type rocks.
3) In comparison to mare basalts, FeO and TiO₂ are low; whereas, Al₂O₃ and CaO are high.
4) Glasses appear to be much less common at the Luna 20 site than at previous sites for Apollo and Luna 16 missions.
5) There are no examples of mare basalt fragments in the Luna 20 sample examined.

Generally, the largest mineral clasts are plagioclase feldspar which consist of 91 to 98 percent of the anorthite molecule (Table 1). Minor element variations (Fe, Mg, Ti, Cr) are all within ranges normally found for lunar calcic-rich plagioclases. These feldspars are comparable with feldspars from Apollo 16 rocks, and to feldspars previously considered to be from Highland sources. The high anorthite content of the Luna 20 feldspars exceeds that of most feldspars from mare basalts (1,2,3). Examples of re-crystallized diaplectic glass are common.

Pyroxenes, although subordinate in number to feldspars, appear to be the next most abundant minerals in the sample examined. Calcic clinopyroxene is the most common, whereas pigeonite is less plentiful than orthopyroxene. As with most lunar samples, large compositional variations between and within clinopyroxene grains was noted. Compositions observed include diopside, augite, sub-calcic augite, hedenbergite and ferro-augite (Table 1). Diopsidic pyroxene is not generally observed in mare basalts and seems to be confined to the anorthositic type rocks of the Highlands (4). The general clinopyroxene trend to iron enrichment (5,6) is partly duplicated by the Luna 20 clinopyroxenes as a group. Furthermore, compositions regarded as pigeonitic also lie within this overall trend.

Orthopyroxenes (Table 1) range between En₈₈ and En₆₈. They contain appreciable amounts of calcium (1.5 to 3.0 wt%) and are low in alumina and titania. These orthopyroxenes are comparable with the most magnesian-rich reported in lunar samples (7). In comparison, some pyroxenes in Apollo 16 rocks contain no calcium and are richer in ferrosilite.

The olivines as a group display a range in composition between Fo₈₈ and Fo₂₀, with the majority lying between Fo₈₈ and Fo₆₈ (Table 1). Some minor variations in composition within single grains was observed but for the most part the fragments examined were homogenous. Titania is low, whereas calcium...
LUNA 20: MIN./PET. OF SOIL (125um)

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and manganese increase in amount toward the more iron-rich olivines. In general these olivines are richer in forsterite than most olivines from mare basalts, and appear to be counterparts of the magnesium-rich pyroxenes mentioned above.

Dark pink spinels are present and are predominantly MgAl$_2$O$_4$ with minor amounts of chromium (Table 1). Spinels of similar composition have been recognised in material from several previous Apollo sites (8). However, they are extremely rare at these other sites and appear to be present only in association with alumina-rich rocks.

In the Luna 20 sample examined lithic clasts amounted to approximately 20% of the total fragment population; glass and agglutinates - 25% and mineral clasts - 55%. The majority of lithic fragments resembled anorthositic type rocks, including anorthositic breccias and gabbric (troctolitic and noritic) anorthosites. The remaining rock clasts contain more than 20% of mafic minerals as well as feldspar. Some of these latter rocks are probably products of recrystallization and thermal metamorphism and are equivalent to some of the Apollo 16 Type II1 igneous and high grade metamorphic rocks (9). No rocks were found in the sample studied that could be unequivocally designated as mare basalt.

REFERENCES

(9) LSPET (1972)
LUNA 20: MIN. / PET. OF SOIL (125μm)

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TABLE 1: Representative analyses of minerals in Luna 20 sample 22001,17 (<125μm).

<table>
<thead>
<tr>
<th>Oxides</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>44.7</td>
<td>49.5</td>
<td>48.1</td>
<td>49.5</td>
<td>54.7</td>
<td>41.3</td>
<td></td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.03</td>
<td>0.03</td>
<td>0.37</td>
<td>0.56</td>
<td>0.43</td>
<td>0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>34.6</td>
<td>34.4</td>
<td>0.74</td>
<td>1.63</td>
<td>0.93</td>
<td>0.09</td>
<td>59.9</td>
</tr>
<tr>
<td>Cr₂O₃</td>
<td>0.00</td>
<td>0.02</td>
<td>0.30</td>
<td>0.61</td>
<td>0.66</td>
<td>0.17</td>
<td>9.79</td>
</tr>
<tr>
<td>FeO</td>
<td>0.15</td>
<td>0.08</td>
<td>34.8</td>
<td>24.3</td>
<td>13.1</td>
<td>11.6</td>
<td>9.55</td>
</tr>
<tr>
<td>MgO</td>
<td>0.13</td>
<td>0.14</td>
<td>6.65</td>
<td>11.6</td>
<td>29.0</td>
<td>47.5</td>
<td>21.5</td>
</tr>
<tr>
<td>CaO</td>
<td>19.8</td>
<td>19.0</td>
<td>8.02</td>
<td>11.8</td>
<td>1.54</td>
<td>0.29</td>
<td>0.01</td>
</tr>
<tr>
<td>MnO</td>
<td>-</td>
<td>-</td>
<td>0.50</td>
<td>0.36</td>
<td>0.20</td>
<td>0.12</td>
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<tr>
<td>Na₂O</td>
<td>0.28</td>
<td>0.71</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K₂O</td>
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<td>0.08</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>99.7</td>
<td>100.0</td>
<td>99.5</td>
<td>100.4</td>
<td>100.6</td>
<td>101.1</td>
<td>100.8</td>
</tr>
</tbody>
</table>

An 97.2 92.9 Wo 18 25 En 69 0 Fo 80
Ab 2.7 6.6 En 21 34
Or 0.1 0.5 Fs 61 40

1,2 Feldspars
3,4 Clinopyroxenes
5 Orthopyroxene
6 Olivine
7 Spinel

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