12005
Ilmenite Basalt
482 grams

Figure 1: Photo of top surface of 12005. Note the zap pits on rounded top surface. The bottom surface was flat. Cube is 1 cm. NASA# S76-23966

Introduction
12005 is one of the most Mg rich (and has the highest Mg/Fe ratio) of the lunar basalts. It contains a high percentage of olivine and is said to have a “cumulate texture” (Rhodes et al. 1977). It might be considered a “picritic” basalt. Although it is grouped with “ilmenite basalts” (Rhodes et al. 1977, Neal et al. 1994), it has relatively low TiO$_2$ (2.8 wt %) and, perhaps, belongs in a group by itself!

The top surface of 12005 was covered with micrometeorite craters and apparently rounded by the process (figure 1). The bottom surface was flat.

Petrography
According to Dungan and Brown (1977), 12005 has apparent “distinct textural regions”. This is apparently caused by large pyroxene oikocrysts (2-6 mm) that enclose an early crystallizing assemblage of rounded and embayed olivine and glomerophyric aggregates of chrome spinel (figures 2a,b). The pyroxene oikocrysts have augite cores and distinct rims dominated by low-Ca pyroxene (figure 2). A mineral orientation fabric is imparted to 12005 by the alignment of elongate pyroxene oikocrysts.

Interstitial to the large pyroxene oikocrysts are bands of plagioclase poikilitically enclosing olivine and ilmenite. Ilmenite, in turn, poikilithically encloses olivine and pyroxene. Mesostasis is holocrystalline consisting of plagioclase, K-feldspar, phosphate, ilmenite, troilite and metal.

Subsolidus reduction of ilmenite and or ulvöspinel is common in 12005.
Mineralogy

Olivine: The cores of large olivine in 12005 are more magnesian than the rims of the same grains. The trace element content of the olivine is less than for that of other Apollo 12 rocks (when compared with equivalent Fo content, figure 4).

Spinel: Dungan and Brown (1977) have carefully studied the spinel in 12005. Chromite is common as inclusions in olivine and augite cores of pyroxene. Ulvöspinel is common in the interstitial areas and often has ilmenite exsolution (figure 5). One grain of Ti-poor Cr pleonaste was reported.

Pyroxene: Pyroxene compositions are given in figure 4 and are more restricted than for other mare basalts, apparently due to slow cooling. Augite cores are overgrown by low-Ca pyroxene with distinct boundaries. It is fair to say that the pyroxenes in 12005 deserve more study.

Metal grains: The Ni content of metal grains in 12005 is high (up to 18 wt. %, Dungan and Brown 1977, figure 6).

Ilmenite: Ilmenite analyses by Dungan and Brown have high Mg content (4.5 wt. %) compared with other Apollo 12 basalts.

Chemistry

Rhodes et al. (1977) and Nyquist et al. (1977) give the composition (table 1, figure 8). 12005 has the highest

<table>
<thead>
<tr>
<th>Mineralogical Mode</th>
<th>Dungan and Brown 1977</th>
<th>Neal et al. 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olivine</td>
<td>30 vol. %</td>
<td>30</td>
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<tr>
<td>Pyroxene</td>
<td>56.5</td>
<td>56.5</td>
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<tr>
<td>Plagioclase</td>
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<td>11</td>
</tr>
<tr>
<td>Opaques</td>
<td>2.4</td>
<td></td>
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<tr>
<td>Ilmenite</td>
<td></td>
<td>1.9</td>
</tr>
<tr>
<td>Chromite + usp.</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Mesostasis</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Lunar Sample Compendium
C Meyer 2010
Mg content and is thus likely to be a cumulate (figure 7). Neal et al. (1994) group 12005 with ilmenite basalts, even though the TiO₂ content (2.76 wt. %) is low (there is also the possibility that the analysis by Rhodes et al. may not be representative).

**Radiogenic age dating**

12005 has not been dated, but Nyquist et al. (1977) have determined the isotopic composition of Sr and Unruh et al. (1984) determined the isotopic composition Nd and Hf.

**Cosmogenic isotopes and exposure ages**

Rancitelli et al. (1971) determined $^{22}$Na (72 ± 2 dpm/kg), $^{26}$Al (81 ± 2 dpm/kg), $^{46}$Sc (5.5 ± 0.8 dpm/kg), $^{54}$Mn (37 ± 4 dpm/kg), $^{56}$Co (46 ± 6 dpm/kg) and $^{60}$Co (0.5 ± 0.29 dpm/kg).

**Processing**

This sample is featured in the Lunar Petrographic Educational Thin Section Package (Meyer 2003). The largest remaining piece of 12005 is ~400 grams.
Figure 7: Composition of lunar basalts showing relative position of 12005.

Figure 8: Normalized rare-earth-element composition diagram (data from Rhodes et al. 1977 and Nyquist et al. 1977).

List of Photo #s for 12005
S69-62294-298 B&W
S69-64089
S69-64114
S76-23960-968 color
Table 1. Chemical composition of 12005.

| reference | weight | SiO2 % | TiO2 | Al2O3 | FeO | MnO | MgO | CaO | Na2O | K2O | P2O5 | S % | Sc ppm | V | Cr | Co | Ni | Cu | Zn | Ga | Ge ppb | As | Se | Rb | Sr | Y | Zr | Nb | Mo | Ru | Rh | Pd ppb | Ag ppb | Cd ppb | In ppb | Sn ppb | Sb ppb | Te ppb | Cs ppm | La | Ce | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Er | Ho | Tm | Yb | Lu | Hf | W ppb | Re ppb | Os ppb | Ir ppb | Pt ppb | Au ppb | Th ppm | U ppm |
| Rh 77     | 41.56  | (a)    |      |       |     |     |     |     |      | 0.04| 0.04 | 0.04| 0.041     |   | 37.1  | 5200| 71| 90|    |     |     |    |     | 38.5|     | 83 | 28 | 66 | 4.3|     |     |    |     |     |     |     |     |    | 35| 10.2|     |     | 2.99| 0.62| 0.77| 0.41| 2.4 |     | 0.403|    | 0.403| 0.106|    |
| Nyquist 77| 41.56  | (a)    |      |       |     |     |     |     |      | 0.04| 0.033| 0.032| 0.042     |   | 37.1  | 5200| 71| 90|    |     |     |    |     | 38.5|     | 83 | 28 | 66 | 4.3|     |     |    |     |     |     |     |     |    | 35| 10.2|     |     | 2.99| 0.62| 0.77| 0.41| 2.4 |     | 0.403|    | 0.403| 0.106|    |
| Rancitelli 71| 41.56 | (a)    |      |       |     |     |     |     |      | 0.04| 0.033| 0.032| 0.042     |   | 37.1  | 5200| 71| 90|    |     |     |    |     | 38.5|     | 83 | 28 | 66 | 4.3|     |     |    |     |     |     |     |     |    | 35| 10.2|     |     | 2.99| 0.62| 0.77| 0.41| 2.4 |     | 0.403|    | 0.403| 0.106|    |
| Unruh 84  | 41.56  | (a)    |      |       |     |     |     |     |      | 0.04| 0.033| 0.032| 0.042     |   | 37.1  | 5200| 71| 90|    |     |     |    |     | 38.5|     | 83 | 28 | 66 | 4.3|     |     |    |     |     |     |     |     |    | 35| 10.2|     |     | 2.99| 0.62| 0.77| 0.41| 2.4 |     | 0.403|    | 0.403| 0.106|    |

References for 12005


