15085
Pigeonite Basalt
471.3 grams

Introduction
15085 was found on the surface about 60 meters east of the rim of Elbow Crater and probably came from the ejecta blanket of Elbow Crater (Swann et al. 1971). It is one of the samples collected as a suite, from different distances from a small crater (15065 to 15085). It is a coarse grained mare basalt that is about 3.4 b.y. old.

Petrography
15085 is a coarse-grained, quartz-normative mare basalt (catalog reports 5 mm) dominated by pigeonite. Brown et al. (1972) found extreme Fe-enrichment during pyroxene growth. The rounded surface of 15085 was probably caused by micrometeorite bombardment, but there were no zap pits.

The cooling rate of this suite of mare basalts has been determined by several techniques (Onorato et al. 1979). Lofgren et al. (1975) performed controlled cooling rate experiments to obtain similar textures from melts. Takeda et al. (1975) studied the order of cations in pyroxene crystals, while Taylor et al. (1975) used the Zr content of ilmenite. Grove and Walker (1977) determined the cooling rate from plagioclase dimensions.

Mineralogical Mode for 15085

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<td>Olivine</td>
<td>1.3</td>
<td>56</td>
<td>46.2</td>
<td>62.3</td>
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<tr>
<td>Pyroxene</td>
<td>40-45</td>
<td>66</td>
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<td>Plagioclase</td>
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<td>22</td>
<td>47.9</td>
<td>31.3</td>
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<td>Opaque</td>
<td>3</td>
<td>3+</td>
<td>3.5</td>
<td>3.5</td>
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<tr>
<td>Silica</td>
<td>0.7</td>
<td>3+</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Other</td>
<td>1.7</td>
<td>3+</td>
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Mineralogy
Olivine: none

Pyroxene: Large pyroxene grains in 15085 are beautifully zoned and twinned (figures 2, 3 and video). Brown et al. (1972) and Papike et al. (1976) reported compositions of pyroxene (figure 4). Takeda et al. (1975) determined cell dimensions of both pigeonite and augite.

Spinel: Taylor et al. (1975) studied the solid solution of chromite – ulvospinel.

Metallic iron: Taylor et al. (1975) found high contents of Ni in iron grains in 15085 (figure 5).

Silica: Mason et al. (1972) described and analyzed tridymite and cristobalite in 15085.

Chemistry
Mason et al. (1972), Duncan et al. (1975) and Fruchter et al. (1973) found that 15085 was similar to other Apollo 15 basalts (especially the 15065-15076 suite). Wanke et al. (1976), Helmke et al. (1973) and others determined the trace elements (figure 6).

Rhodes and Blanchard (1983) reported that they had analyzed 15085, but gave no data. Gibson et al. (1975) determined the sulfur content (855 ppm). Helmke et al. (1972) also provided trace element analyses of mineral separates (showing that plagioclase has high Eu).

Radiogenic age dating
Papanastassiou and Wasserburg (1973) determined an age of 3.40 ± 0.04 b.y. by Rb/Sr isochron (figure 8). Unruh and Tatsumoto (1977) determined the U, Th and
Figure 3: Photomicrographs of 15085,19 by C Meyer with video.

Figure 4: Pyroxene composition of 15085.

Figure 5: Composition of metal grains in basalt samples from Elbow Crater (from Taylor et al. 1975).

Figure 6: Normalized rare-earth-element pattern for 15085 compared with 15601 soil.

Pb isotopes of mineral separates, but the age obtained (~3.5 b.y) was not precise.

**Cosmogenic isotopes and exposure ages**

Keith et al. (1972) determined the cosmic ray induced activity of $^{22}$Na = 37 dpm/kg, $^{26}$Al = 84 dpm/kg, $^{46}$Sc = 3.9 dpm/kg, $^{54}$Mn = 23 dpm/kg and $^{56}$Co = 12 dpm/kg.

**Other Studies**

Collinson et al. (1973) determined the magnetic properties, Bhnadari et al. (1973) studied the distribution of solar flare tracks and Greenman and Gross (1972) reported luminescence due to radiation damage under soft X-ray bombardment.

**Processing**

15085 was chipped, not sawn. There are 17 thin sections.
Lunar Basalts

Figure 7: Composition of 15085 compared with that of other Apollo samples.

Figure 8: Rb/Sr isochrons for various Apollo 15 basalts including 15085 (two point isochron!). From Papanastassiou and Wasserburg (1973).

Summary of Age Data for 15085

\[
\text{Rb/Sr} \\
Papanastassiou and Wasserburg 1973 \quad 3.40 \pm 0.04 \text{ b.y.} \\
\text{Caution: old decay constant for Rb used.}
\]
Table 1. Chemical composition of 15085.

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<tr>
<th>reference</th>
<th>Fruchter73</th>
<th>Wolf79</th>
<th>Mason 72</th>
<th>Helmke72</th>
<th>Keith 72</th>
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<td>SiO₂ %</td>
<td>46.39 (a)</td>
<td>46.61</td>
<td>47.73 (e)</td>
<td>48.06 (a)</td>
<td>46.61</td>
<td>47.33</td>
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<td>TiO₂</td>
<td>1.67 (c)</td>
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<td>3.07 (a)</td>
<td>2.63</td>
<td>1.96</td>
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<td>5.79 (a)</td>
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<td>CaO</td>
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<td>Na₂O</td>
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<td>P₂O₅</td>
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<td>0.107</td>
<td>0.064</td>
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<td>S %</td>
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<td>0.137</td>
<td>0.068</td>
<td>0.138</td>
<td>0.138</td>
<td>0.13 (a)</td>
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Sc ppm 41 51 (c) 110 (b) 172 165 (e) 44 (a)
V 3350 3980 (c) 4600 (b) 4200 3565 (e) 2940 (a)
Cr 42 48 (c) 43 41 (e) 36 (a)
Ni 45 (b) 37 20 23 (e) 31 (a)
Cu 18 (b) 9 <1.5 17 (e)
Zn 1.05 (a) 1.8 <1.5 0.73 (a)
Ga 2.8 (a)
Ge ppb 123 (a)
As Rb 0.86 (a) <5 (b) 1.8 1.5 (e) 0.73 (a)
Sr 92 (b) 120 112 (e) 107 (a)
Y 54 (b) 44 28.6 (e) 21 (a)
Zr 150 (b) 156 92 (e) 99 (a)
Nb 8.2 (b) 120 112 (e) 107 (a)
Mo 10 6.6 (e)
Ru Rh
Pd ppb 1 (a)
Ag ppb 0.68 (a)
Cd ppb 0.6 (a)
In ppb 0.035 (a)
Te ppb 6.2 (a)
Cs ppm 0.04 (a)
Ba 4.5 6.5 (c) 87 (b) 68 110 60 (e) 62 (a)
La 4.92 (c) 4.92 (c) 5.88 (a)
Ce 4.92 (c) 4.92 (c) 4.92 (c) 5.88 (a)
Pr 1.07 (a)
Nd 13.1 (a)
Sm 3.96 (c) 3.86 (c) 3.79 (a)
Eu 0.84 (c) 0.84 (c) 1.07 (a)
Gd 4.9 (c) 4.9 (c) 5.4 (a)
 Tb 0.9 (c) 0.9 (c) 0.92 (a)
Dy 5.65 (a)
Ho 1.2 (a)
Er 3.5 (a)
Tm
Yb 2.63 (c) 2.63 (c) 2.72 (a)
Lu 0.36 0.53 (c) 0.393 (c) 0.43 (a)
Hf 0.393 (c) 0.393 (c) 0.43 (a)
Ta 0.41 (a)
W ppb 59 (a)
Re ppb 0.0015 (a)
Os ppb 0.0069 (a)
Ir ppb 0.012 (a)
Pt ppb 0.135 (a)
Au ppb 0.135 (a)
Th ppm 0.57 (d) 0.44 (a)
U ppm 0.138 (d) 0.13 (a)

technique: (a) RNAA, (b) SSMS, (c) INAA, (d) radiation counting, (e) XRF

Lunar Sample Compendium
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References for 15085


Butler P. (1971) Lunar Sample Catalog, Apollo 15. Curators’ Office, MSC 03209


Mason B., Jarosewich E., Melson W.G. and Thompson G. (1972) Mineralogy, petrology, and chemical composition of lunar samples 15085, 15256, 15271, 15471, 15475,


Ryder G. (1985) Catalog of Apollo 15 Rocks (three volumes). Curatoial Branch Pub. # 72, JSC#20787


