THE APOLLO 16 DRILL CORE: PETROLOGY OF LITHIC AND MONOMINERALIC FRAGMENTS. D. T. Vaniman, Board of Earth Sciences, University of Calif., Santa Cruz, Calif. 95064; K. L. Cameron, Board of Earth Sciences, University of Calif., Santa Cruz, Calif. 95064; and J. J. Papke, Dept. of Earth and Space Sciences, State University of New York, Stony Brook, N. Y. 11794.

This report characterizes the mineral chemistry of lithic and monomineralic fragments from samples 60001, 60002, 60003, 60004, 60006 and 60007 of the Apollo 16 deep drill core. In accompanying abstracts, Lellis et al. (1) discuss a core stratigraphy based on modal analyses, and Naney et al. (2) discuss the chemistry of glasses from the core. The core has a total length of about 225 cm.; however, a 45 cm. section (60005) near the middle of the core was not available for study. Fifteen thin sections* were selected for analysis at intervals of -13 cm. along the remaining length of the core. Lellis et al. distinguished four stratigraphic units, A to D, and this stratigraphy forms the basis for the discussion below of the lithic and particularly of the monomineralic fragments.

Lellis et al. describe the following groups of crystalline lithic fragments from the Apollo 16 core: 1) recrystallized/remelted noritic breccia (RNB) and pyroxene poikilitic rock (Poik); 2) norite and troctolite; 3) anorthosite; 4) recrystallized anorthosite; 5) light matrix breccia (LMB); and 6) feldspathic basalt. These categories generally correspond to those recognized by Delano et al. (3) in their study of the 2-4 mm. soil fragments from the Apollo 16 site. Lellis et al. also distinguished dark matrix breccias (DMB); these represent reworked soil of the regolith and were not analyzed in our study.

In order to obtain an unbiased sample of mafic mineral compositions, all ferromagnesian monomineralic fragments larger than 30 microns were analyzed in arbitrarily selected areas of -10 mm.² in each section. Randomly selected monomineralic plagioclase fragments were analyzed in 6 thin sections. In all, chemical analyses were collected for 202 pyroxene, 118 olivine, and 84 plagioclase monomineralic fragments, as well as 170 mineral analyses from 78 lithic fragments.

Lithic Fragments. Pyroxene, olivine and feldspar analyses from the lithic fragments are plotted in Figs. 1b, 2b and 3b respectively. The compositions of the ferromagnesian phases coincide closely with those reported by Delano et al. (3) for the same lithic types from the 2-4 mm. soil fragments. The plagioclase feldspars from the RNB, Poik and feldspathic basalt fragments are noticeably enriched in KAlSi₃O₈ (0.3-1.6 mol. %) relative to the other lithic types (0.3±0.1 mol. %).

Monomineralic Pyroxene Fragments. Compositions of monomineralic pyroxene fragments and pyroxenes from lithic fragments are shown in Figure 1a for each stratigraphic unit. Units A, C and D show no particular concentration of monomineralic pyroxene compositions, but Unit B has noticeable maxima at Wo₄₅ En₇₀.₅Fs₂₅ (32 analyses) and Wo₄₂En₇Fs₁₃ (8 analyses). Apparently Unit B is enriched in a component representing some rock type(s) with exceptionally

* 60007,333; 60007,334; 60007,337; 60006,249; 60006,253; 60004,473; 60004,474; 60004,479; 60004,483; 60003,230; 60003,234; 60002,244; 60002,380; 60002,383; 60002,387.
homogeneous pyroxenes. The pyroxene clusters lie in the general compositional range for the Poik and ANT (anorthosite, norite, troctolite) groups. The monomineralic pyroxene fragments commonly are larger (-0.25 mm.) than the pyroxene crystals in Poik fragments from the core; thus a cumulate ANT source may be more likely.

Monomineralic Olivine Fragments. The range of olivine compositions is broader in monomineralic than in lithic fragments (Fig. 2). This is likely a result of the small size of the lithic population studied, and the limits of the monomineralic olivine compositional range lie within the range of compositions reported by Delano et al. (3) from the 2-4 mm. soil fragments. Possible lithic sources of the more magnesium- and iron-rich olivine fragments are evident in the large population of ANT and LMB soil fragments they analyzed.

The compositional range of olivine from lithic fragments is broader in the lower units, A and B, than in the upper units of the drill core (Fig. 2a). In Unit A this reflects the greater abundance of ANT, LMB and Recrystallized Anorthosite fragments at depth in the core ("others;" Table 1). All but six of the 171 olivines analyzed have CaO contents closely clustered within the 0.15-0.3% CaO range defined for ANT rocks (4). The six divergent olivines, with CaO contents of 0.33 to 0.43%, may represent fragments from mare basalts. The pyroxene/(pyroxene + olivine) ratio is fairly constant at 0.59±0.20 throughout Units A, C, and D and in the lower part (60003) of Unit B. However, the upper part of Unit B (60004) is considerably richer in pyroxene, with ratios of 0.80±0.10.

An exotic fragment of olivine quench rock, one of the most mafic lunar specimens yet reported, occurs in thin section 60004,474. This fragment has zoned olivine crystals (Fog7 cores to Fog3 rims) in a glass matrix of 48.9% SiO2, 30.8% Al2O3, 14.5% CaO, 0.1% TiO2, 2% FeO and 6% MgO by weight.

Monomineralic Feldspar Fragments. Plagioclase compositions throughout the core range from An63 to An48, but the majority (91%) fall between An49 and An98 (Fig. 3). There is little stratigraphic variation in the limits of feldspar composition between the four recognized units. However, there is a noticeable concentration of monomineralic plagioclase fragments of composition An96.3Ab3.4Or0.3 in Units C and D, as well as the upper portion (60004) of Unit B. This cluster is not found in Unit A. The greatest concentration of grains with this composition is within Unit C, which has been distinguished (1) as a unit of abundant (7.1%) large plagioclase fragments. This cluster indicates a coarse-grained (>0.5 mm.) ANT source distinct from the hypothetical ANT source of closely clustered abundant pyroxene fragments in the lower part of Unit B.

REFERENCES
(2) Naney, M.T., Lellis, S.F., Papke, J.J., & Cameron, K.L., in "Lunar Science VII."
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Table 1. Summary Modal Compositions (After Lellis, et al. 1976)

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Lithics</th>
<th>Nonmineralogic Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feldspar, Basalt, POIK, NRB</td>
<td>Others, Feldspar, Olivine, Pyroxene</td>
</tr>
<tr>
<td>Lunar Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>RL, (1.5%)</td>
<td>Lo, (4.5%)</td>
</tr>
<tr>
<td>C</td>
<td>RL, (1.7%)</td>
<td>MOD, (7.0%)</td>
</tr>
<tr>
<td>(60000 gap)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Lo, (2.8%)</td>
<td>Lo, (4.3%)</td>
</tr>
<tr>
<td>A</td>
<td>RL, (4.5%)</td>
<td>RL, (15.6%)</td>
</tr>
</tbody>
</table>

FIG. 1: Pyroxene Compositions; stratigraphic (A) and lithic (B) distributions.

FIG. 2: Olivine Compositions; stratigraphic (A) and lithic (B) distributions. Each unit is one analysis; solid boxes are lithic analyses.

FIG. 3: Plagioclase Compositions; stratigraphic (A) and lithic (B) distributions.