61175 FRAGMENTAL POLYMICT BRECCIA 543 g

INTRODUCTION: 61175 is a friable, gray matrix breccia (Fig. 1) with a wide variety of clast types. It is subrounded in shape, and homogeneous in color and texture.

61175 was collected near the northeast rim of Plum Crater, and its orientation is known. Zap pits are abundant on the "lunar up" surface and rare to absent on other surfaces.

FIGURE 1. S-78-31342.

PETROLOGY: Winzer et al. (1977) provide detailed petrographic information. A variety of mineral and lithic clasts rest in a friable, clastic matrix sintered by a small amount of alkali-rich glass (Fig. 2). Modal data are presented by Winzer et al. (1977) and reproduced here as Table 1. Grain size of the matrix is seriate from several millimeters down to a few microns. A significant regolith component is suggested by the several types of glass beads and fragments present in the matrix. Glass compositions are plotted in Figure 3. A mare component is present in the glasses and as a glassy breccia clast (Winzer et al. 1977; Delano, 1975). Coarse spinel fragments (up to several mm) are scattered through the matrix but are not present in any of the lithic clasts, suggesting that at least one rock type not present as clasts has contributed to the matrix (Winzer et al., 1977).

Lithic clasts include, in approximately decreasing order of abundance, basaltic melt rocks (clast-free and clast-bearing), coarse-grained annealed rock (granulite), fine-grained annealed rocks (hornfelses), and cataclastic anorthosites.

Basaltic melt rock clasts (Fig. 2) have textures ranging from vitrophyric to diabasic. Most are holocrystalline with plagioclase, clinopyroxene, orthopyroxene, olivine, ilmenite and a complex mesostasis as the principal constituents. Minerals are zoned and compositions from all textural varieties overlap. Olivine and pyroxene compositions are shown in Figures 4 and 5. Plagioclase is An_{95-83}. Some of the basaltic clasts carry xenocrysts of olivine and plagioclase and rare lithic fragments. Accessory minerals, normally associated with the mesostasis but also occurring as xenocrysts, include Mg-spinel, chromite, troilite: metal (up to 9% Ni), schreibersite, ilmenite, armalcolite, rutile and a Zr-mineral.

Coarse-drained granoblastic clasts (granulites of Winzer et al., 1977) include anorthositic, noritic and troctolitic lithologies with the anhedral minerals, smooth grain boundaries and triple junctions indicative of extensive subsolidus annealing (Fig. 2). Mafic minerals are unzoned and largely equilibrated within any single clast (Fig. 6). Some large plagioclase grains have calcic cores (An_{95-97}) and narrow, more sodic rims. Some of the noritic clasts have anhedral orthopyroxene poikiloblasts (up to ~1 mm) which enclose anhedral plagioclase and rare ilmenite. Several of the poikiloblasts show exsolution lamellae (up to 0.1 mm) of high-Ca pyroxene. Anhedral, magnesian ilmenites are found in some granoblastic clasts.

Fine-drained granoblastic clasts (hornfelses of Winzer et al., 1977) are characterized by an interlocking mass of anhedral plagioclase plus olivine and/or pyroxene with smooth grain boundaries and triple junctions. Grain size is typically ~50 µm or less. Many of these clasts are rich in xenocrysts. Minerals are unzoned and largely equilibrated (Fig. 5); glass is absent. Xenocrysts of plagioclase often have calcic cores (An_{95}) and thin rims of the same composition as the groundmass plagioclase (down to An_{88}). Metal (4.5-9% Ni), troilite, ilmenite, apatite and schreibersite occur as accessory minerals. Several of the fine-grained annealed clasts have a poikiloblastic texture that ranges from poorly to well developed (Fig. 2). These poikiloblastic clasts are texturally distinct from the typical Apollo 16 poikilitic rocks (such as 60315) which usually show a melt texture characterized by euhedral crystallites of plagioclase enclosed by anhedral pyroxene oikocrysts.

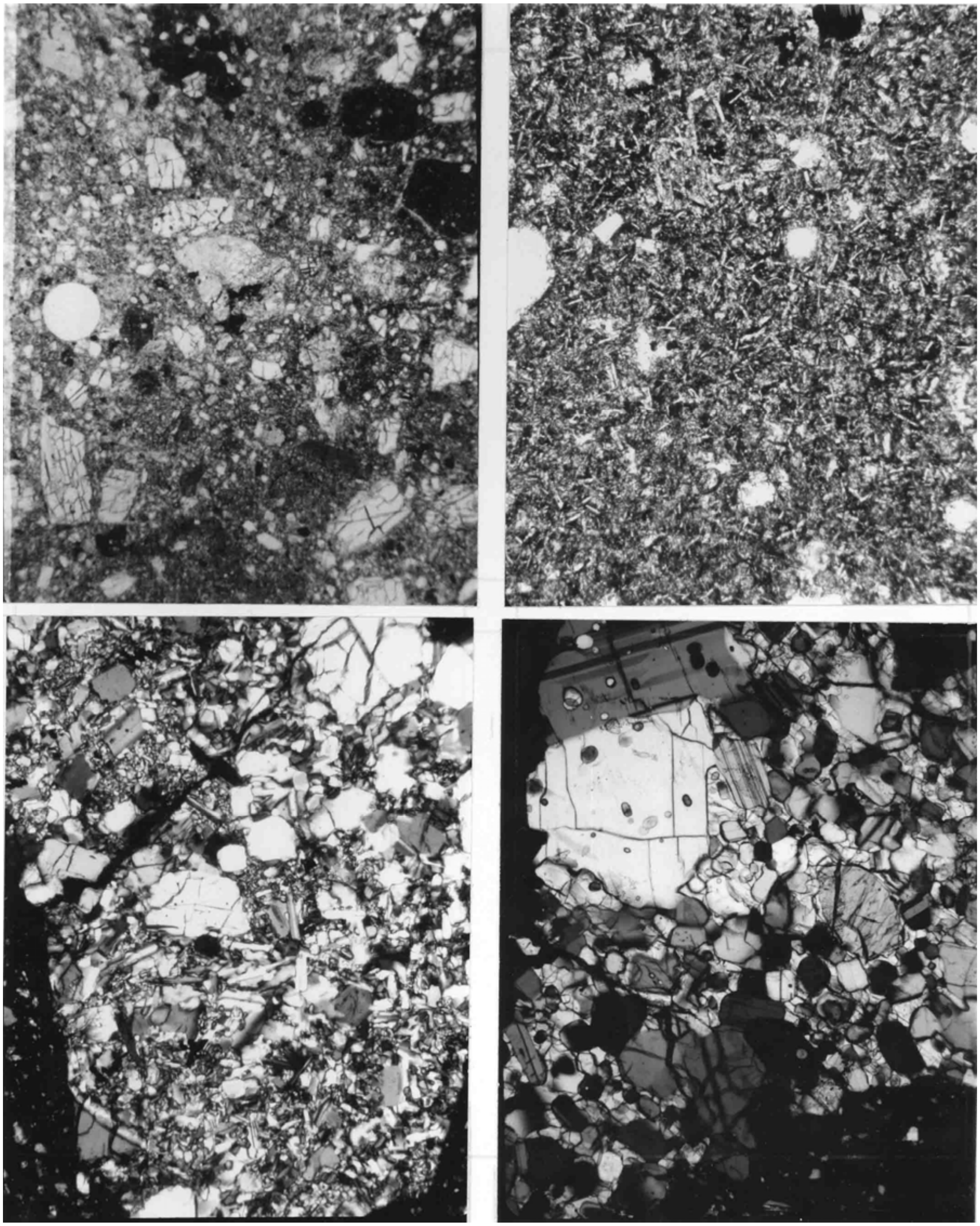


FIGURE 2.
a) 61175,108, general view, ppl. Width 2 mm.
b) 61175,97, basaltic clast, ppl. Width 1 mm.
c) 61175,108, fine-grained granoblastic clast, xpl. Width 2 mm.
d) 61175,97, coarse-grained granoblastic clast, xpl. Width 2 mm.

Cataclastic anorthosites occur as larger clasts (up to 2 cm) which have been moderately to severely shocked and brecciated. Maskelynite is abundant and melting has occurred in some clasts. Original grain size of the plagioclase (An_{95-100}) was several millimeters. Minor phases include olivine, orthopyroxene, and rare ilmenite and spinel.

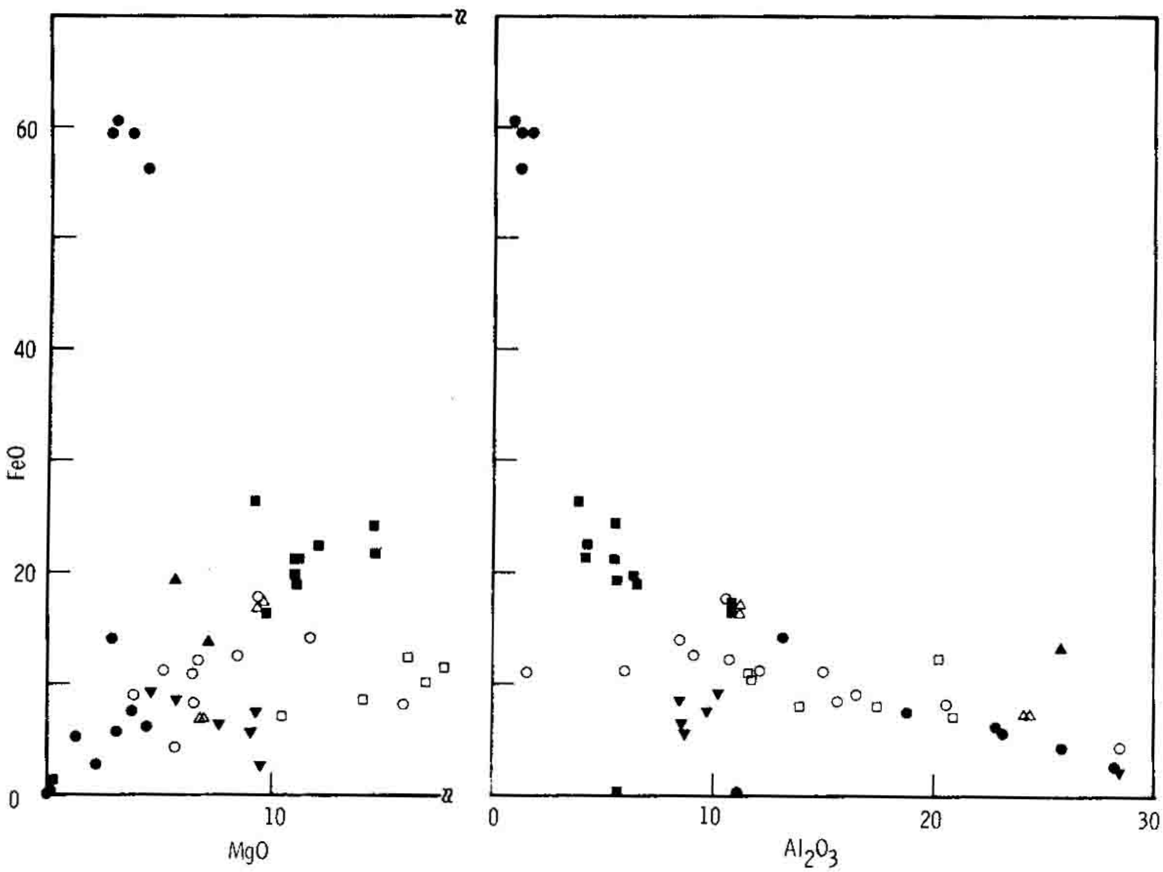


FIGURE 3. Glass compositions, from Winzer et al. (1977).

CHEMISTRY: Winzer et al. (1977) provide major and trace element data for matrix and various clast samples. S.R. Taylor et al. (1974) report major and trace element analyses on a plagioclase-rich separate of a whole rock sample. Cripe and Moore (1974) report bulk sulfur and Moore and Lewis (1976) give bulk carbon and nitrogen data. Eldridge et al. (1973) determined K, U, and Th by gamma-ray spectroscopy.

Analyses by Winzer et al. (1977) show the matrix of 61175 to be somewhat more mafic than its clasts (Table 2). Compared to the local soils, the 61175 matrix has the same Fe/Mg but is depleted in absolute abundances of ferromagnesian elements and REEs.

None of the rock types classified on the basis of texture can be singled out as chemically distinct. Figure 7 shows that the major element chemistry of all of the clast types overlap although some clustering is apparent. Coarse-grained clasts tend to plot near the anorthite apex while the fine-grained annealed rocks have compositions similar to other Apollo 16 poikilitic melt rocks and plot near the olivine-plagioclase-spinel peritectic. Basaltic textured clasts cluster between these two groups.

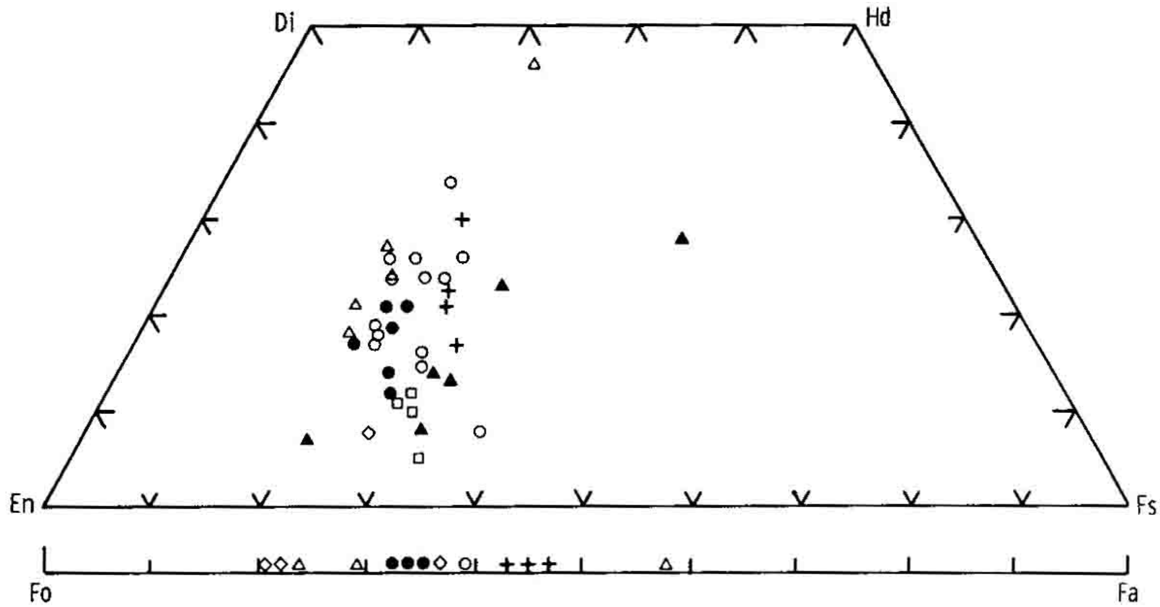


FIGURE 4. Pyroxene, olivine compositions in clast-free basaltic clasts, from Winzer et al. (1977).

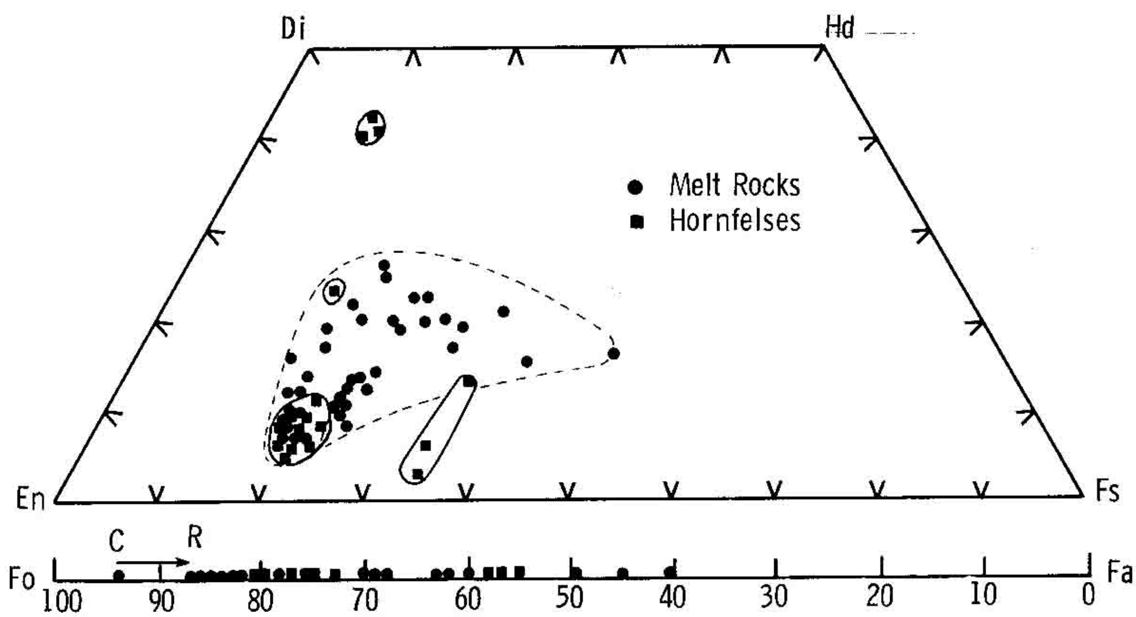


FIGURE 5. Pyroxene, olivine compositions in bearing melt clasts and fine-grained granoblastic clasts, from Winzer et al. 1977).

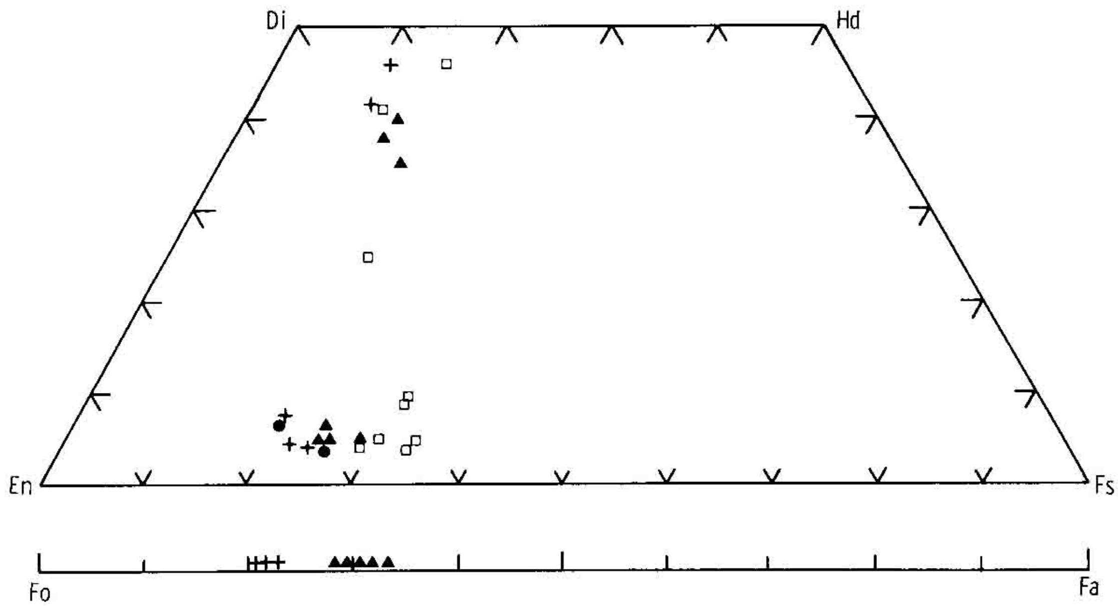


FIGURE 6. Pyroxene, olivine compositions in coarse-grained granoblastic clasts, from Winzer et al. (1977).

Rare earth elements (Fig. 8) also show the diversity of clast compositions although too few clasts have been analyzed to show definite trends. Apparently the clasts have a range of REE abundances which bracket that of the matrix. Of particular interest is split 61175, 170 which sampled a small anorthosite clast. This clast has very low REE abundances and may represent a pristine lithology although no siderophile data are available. Other anorthositic clasts from this rock have significantly higher REEs (,131 on Fig. 8) and have probably been contaminated with KREEP. Basaltic clasts may be either poor or rich in a KREEP component (e.g. ,126 and ,133 respectively, Fig. 8).

STABLE ISOTOPES: Clayton et al. (1973) determined a whole rock $\delta\,O^{18}$ value of 5.78°/oo, typical of Apollo l6 breccias.

EXPOSURE AGE: A maximum track exposure age of 10 m.y. is reported by Crozaz et al. (1974, reference to Fleisher and Hart, 1974, unpublished). Crozaz et al. (1974) also calculate a surface exposure age of > 1.5 m.y. from the cosmogenic radionuclide data of Eldridge et al. (1973).

MICROCRATERS: Morrison et al. (1973) and Neukum et al. (1973) report size-frequency data for microcraters 61175 (Fig. 9). From the subrounded shape of the rock and its crater distribution, both authors conclude that 61175 is probably in equilibrium.

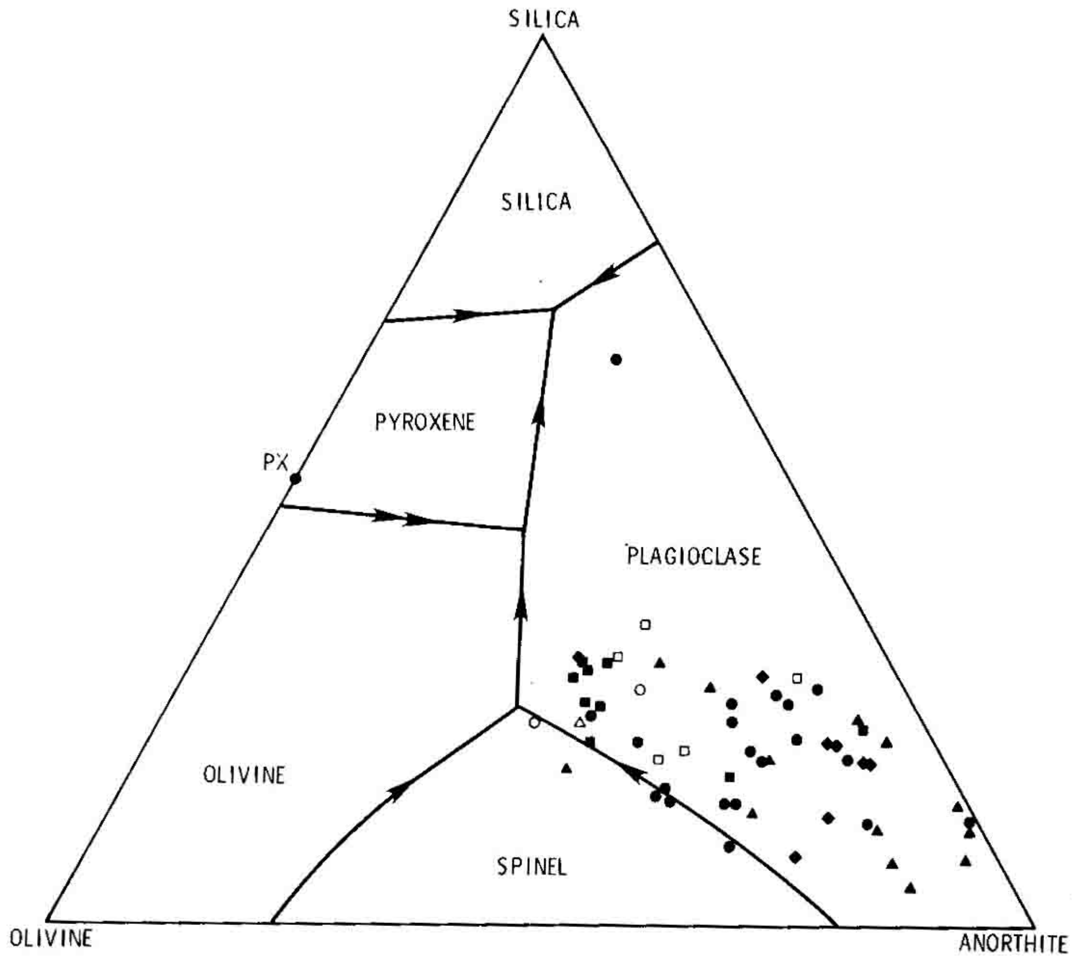
Schaal et al. (1976) provide detailed petrography and microprobe analyses of a thin section cut through a 3.6 mm, glass-lined microcrater as an example of an impact into a complex, polymict host. Preferential assimilation of plagioclase over pyroxene and small scale flow and mixing was observed. The glass lining is inhomogeneous (30-37% Al_2O_3)and significantly enriched in a plagioclase component relative to the host matrix. Shock effects in the host progressively diminish away from the crater through a zone ~1.5 mm into the rock.

PHYSICAL PROPERTIES: Compressional and shear wave velocities at pressures up to 10 kb were measured by Mizutani and Osako (1974) (Fig. 10). The porous nature of 61175 results in velocities significantly less than those determined for the lunar crust.

TABLE 1. Summary chemistry of 61175.

SiO_2	45.5
TiO_2	0.53
Al_2O_3	27.8
Cr_2O_3	0.06
FeO	4.3
MnO	0.06
CaO	16.2
Na_2O	0.51
K_2O	0.10
P_2O_5	
Sr	201
La	
Lu	0.5
Rb	2.3
Sc	
Ni	
Co	
Ir ppb	
Au ppb	
C	69
N	91
S	570
Zn	
Cu	

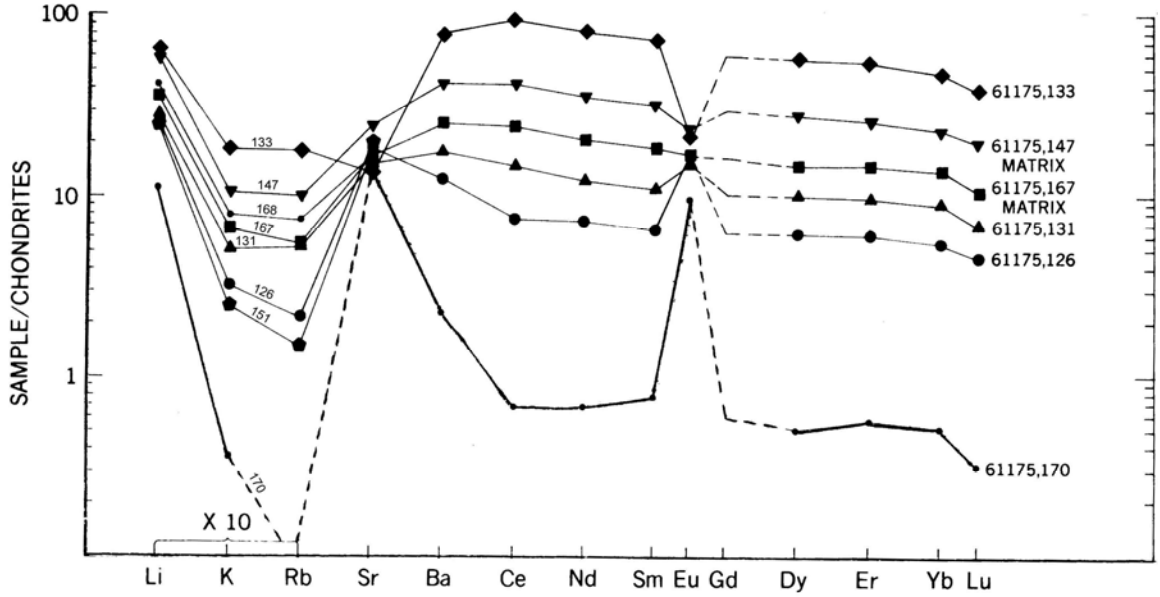
Oxides in wt%; others in ppm except as noted.



▲—ANT, ■—hornfels, ●—impact melts, and ◆—basalts. Unfilled symbols mark clasts whose classification is uncertain.

FIGURE 7. From Winzer et al. (1977).

PROCESSING AND SUBDIVISIONS: In 1972, 61175 was chipped into six main pieces (,0 - ,5). In 1973 the largest of these (,0) was cut into three pieces (,16 ,19 and ,20) one of which was a slab (,19). The slab was subsequently divided for allocations (Fig. 11). All of the Winzer et al. (1977) allocations came from the slab with most of them being taken from ,21 and ,30. The large white clast shown in ,30 is a moderately shocked anorthosite and was analyzed as ,151 (see CHEMISTRY). The anorthosite clast with very low REEs (,170) was a small clast from ,21. It was not the large white clast seen in ,21 in Figure 14. S.R. Taylor et al. (1974) received several whole rock chips from butt end ,16 but the analysis (,80) is unlike any of the other matrix analyses and looks more like a plagioclase-rich separate.



Lithophile trace element abundances from clasts and matrix of 61175. 61175,133 and ,126 are dark clasts and are probably melt rocks. 61175,131 and ,170 are white clasts, and are moderately shocked anorthosites.

FIGURE 8. From Winzer et al. (1977).

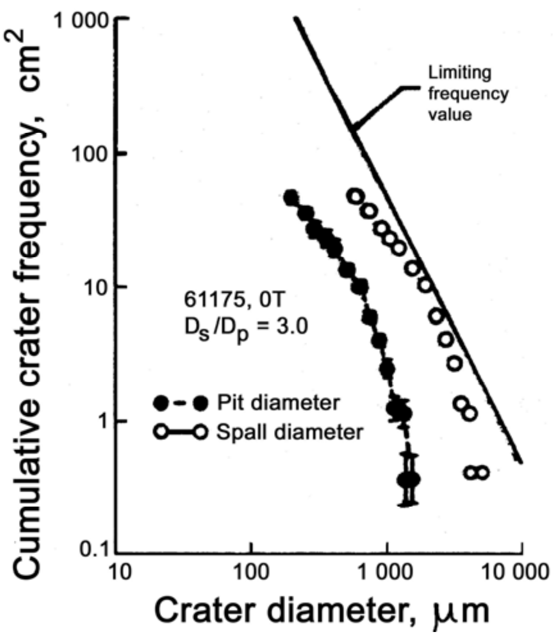


FIGURE 9. Microcraters, from Morrison et al. (1973).

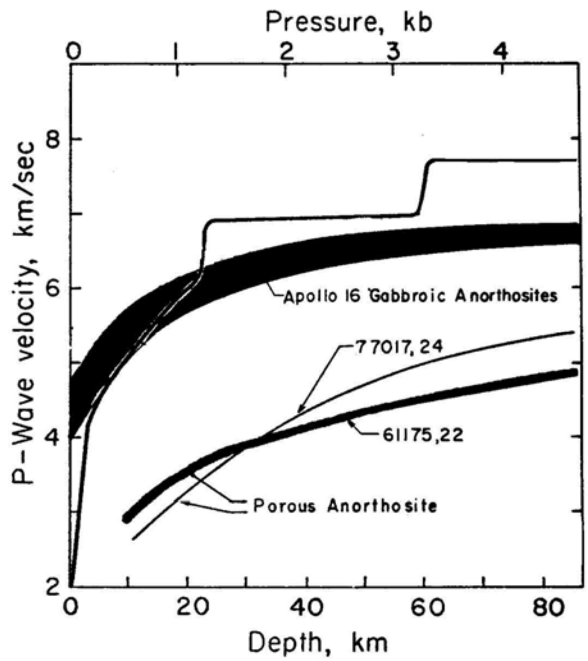


FIGURE 10. Wave velocity profile, from Mizutani and Osako (1974).

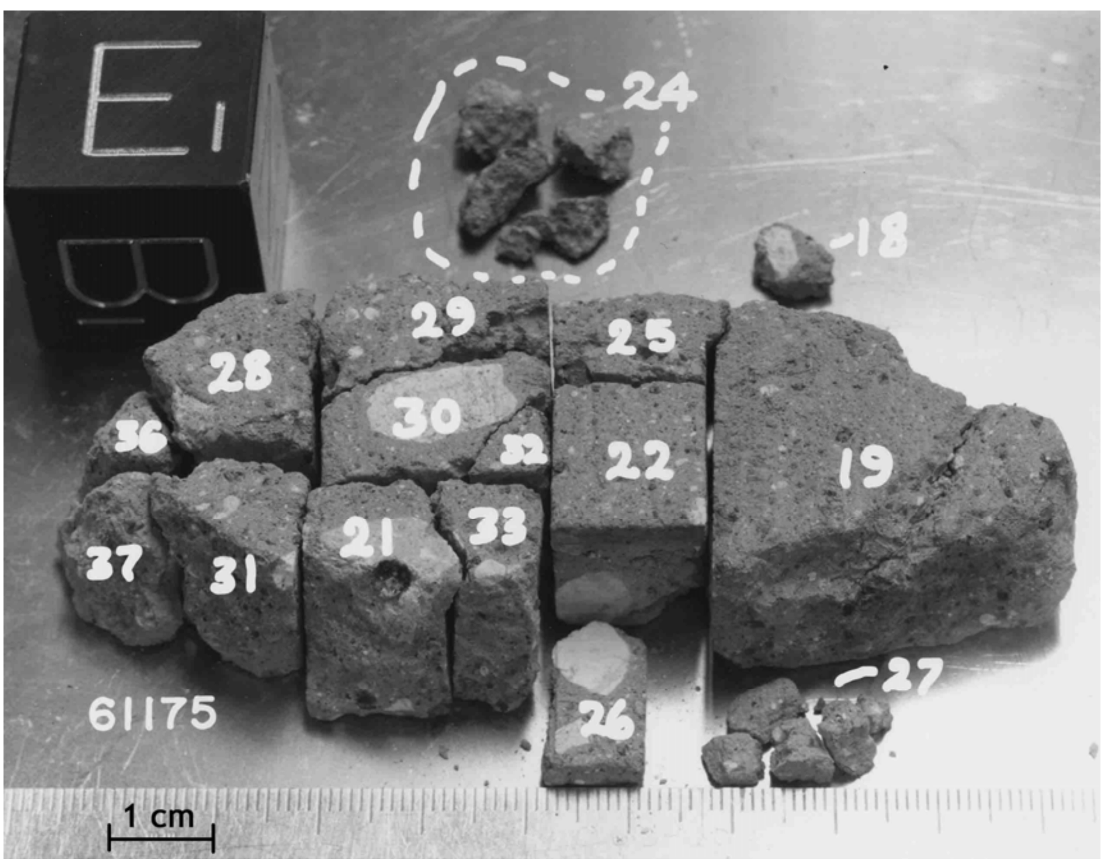


FIGURE 11. Slab subdivisions. S-73-25605.