Table 7. Modal composition of grain size fractions of Apollo 12 soils (12070 and 12001).

	20–63 μm			63–125 μm			125–250 μm			250–500 μm	500–1000 μm
	70	1	Av.	70	1	Av.	70	1	Av.	Av.	Av.
Basalt	—	—	—	4.6	4.6	4.6	8.0	11	9.5	32	28
Anorthosite	—	—	—	1.2	2.2	1.6	3.1	3.8	3.9	—	6
Breccia	—	—	—	} 50	} 46	} 48	} 59	} 56	} 58[1]	} 27	34
Agglomerates	—	—	—							} 29	31
Glass fragments, dark	41	38	39	7.1	3.6	5.3	3.1	7.2	5.1		—
Glass fragments, light	7.7	8.3	8.0	3.8	4.5	4.2	2.2	1.2	1.7	3	1
Regular glass bodies	0.7	1.7	1.2	0.3	1.5	0.9	0.7	0.5	0.6	—	—
Pyroxene + olivine	37	36.	37	24	28	26	22	17	19	8	—
Plagioclase	11	12	11	4.7	7.9	6.3	1.5	2.4	1.9	—	—
Opaques	2.7	4.7	3.7	4.2	1.1	2.6	0.9	1.4	1.2	—	—
Pyroxene/plagioclase	3.4	3.0	3.4	5.1	3.6	4.1	15	7.1	10.0	—	—

[1] Breccia ≈ 10%. Agglomerates ≈ 48%.

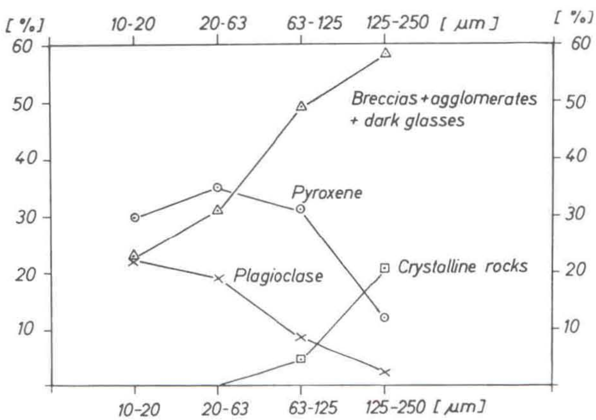

Fig. 10. Modal composition of grain size fractions of Apollo 11 soil (10084,106).

The modal compositions of the two Apollo 12 soils are nearly identical and very similar to that of the Apollo 11 soil. Differences are the higher (pyroxene + olivine)/plagioclase ratio, the higher amount of glass fragments, the slightly higher ratio of dark glasses to light glasses, and the lower content of regular glass bodies in the Apollo 12 soils. The higher content of crystalline rocks in Apollo 12 soils (Table 8) is mainly due to the fact that the modal composition of the rock rich fractions > 250 μm of Apollo 11 soil has not been determined.

Lunar soils consist of three groups of constituents: (1) fragments of minerals and rocks, produced by mechanical disintegration; (2) glasses produced by shock melting, mixed with fragmental material and in part mechanically disintegrated; (3) meteoritic material. Of group (1), rock fragments (basalts, breccias, anorthositic rocks) prevail in size fractions > 100 μm. Below 100 μm, rock fragments are replaced by single

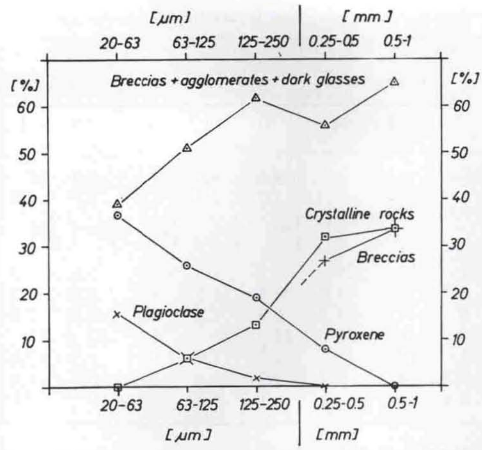

Fig. 11. Modal composition of grain size fractions of Apollo 12 soil (average of 12001,84 and 12070,139).

mineral grains. The ratio (pyroxene + olivine)/plagioclase diminishes with decreasing size, probably due to the larger size of pyroxene in the average source rocks. Olivine is a minor constituent. Taking into account the increase of plagioclase in the finest fractions the ratio (pyroxene + olivine)/plagioclase may be a little less than 2.0 for the Apollo 11 soil and a little less than 3.6 for Apollo 12 soils 12001 and 12070.

The average of 14 basaltic rocks from Apollo 11 (COMPSTON *et al.*, 1970) gives a normative ratio of pyroxene/plagioclase of 1.63, in fairly good agreement with the modal ratio of Apollo 11 soil. We conclude, therefore, that the clastic components of this soil were essentially produced by disintegration of local basaltic rocks forming the basement of the regolith. Nine analyses of Apollo 12 basalts published by LSPET (1970) give an average (pyroxene + olivine)/plagioclase ratio of 1.96. Twenty-eight analyses of basaltic fragments from Apollo 12 made by KEIL *et al.* (1971) result in an average ratio of 1.23. Both ratios are appreciably lower than the modal ratio found in Apollo 12 soil. We conclude that the clastic components of the soil at the Apollo 12 site were produced from rocks richer in pyroxene than those which occur as larger fragments at the surface.

Most of the glasses forming the second group of soil constituents are glassy agglomerates. We assume that they were formed by splashes of a low viscosity melt which met the soil surface at low velocities, incorporating and agglutinating solid soil particles. The melt was ejected from young primary or secondary impact craters, not far from both landing sites, because shape and fragility of the agglomerates exclude any reworking and transportation over long distances. Some agglomerates may have a different origin, as discussed in the next section.

Splashes of shock-produced melt formed glass coatings on larger rocks and on small rock and mineral fragments. Glass-coated breccia fragments are much more frequent than coated fragments of crystalline rocks. This fact possibly reflects the composition of the uppermost layer of the regolith when it was hit by melt splashes.