The glass fragments were formed by later fracturing of larger bodies or flows of glass. Formation and transport mechanisms were different for the regular glass bodies and the fragments. However, both types of glass apparently originated from the fusion of the same source material.

Results of microprobe analyses of 17 regular bodies and fragments of light colored glasses and of 17 regular bodies and fragments of dark glasses are presented in Tables 3 and 4 and Figs. 9–11. The individual pieces have been either separated from

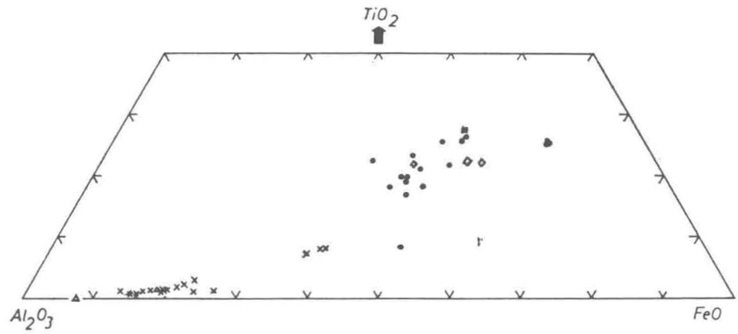

Fig. 10. Fused glasses: Al_2O_3. FeO and TiO_2 content (wt. %).
● Yellow-brown, red-brown and violet-brown glasses; × Colorless and green glasses; ◊ Vesicular glass coatings; ■ Lunar basalt, average; △ Lunar anorthositic rocks.

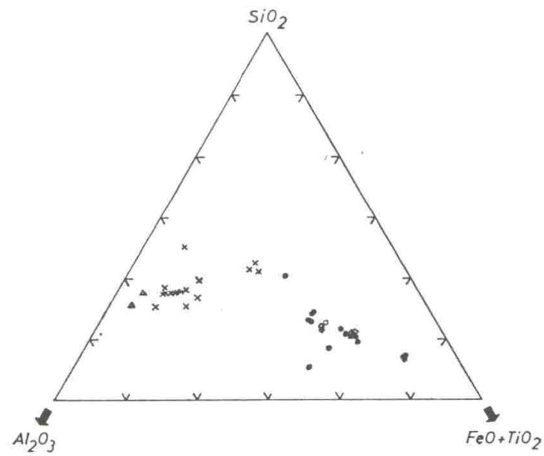

Fig. 11. Fused glasses: Al_2O_3, FeO + TiO_2 and SiO_2 content (wt. %).
● Yellow-brown, red-brown and violet-brown glasses; × Colorless and green glasses; ◊ Vesicular glass coatings; ■ Lunar basalt, average; △ Lunar anorthositic rocks.

the soil or analyzed in polished sections of breccias and grain mounts of the soil. Within each group there is a broad variability of chemical composition. Calculation of norms showed that each individual glass can be interpreted as a fusion product of a particular mixture of the lunar rock forming minerals: plagioclase, pyroxene and ilmenite, in some cases with admixtures of free silica or olivine.

The chemical dissimilarity of the individual glass pieces distinguishes lunar soil and breccias from terrestrial pyroclastic rocks. Individual glass particles of pyroclastics are of essentially the same chemical composition because they are products of the dispersion of the same uniform magma.

It must therefore be concluded that the lunar glass bodies and fragments, constituting an essential part of the soil and breccia, are not of volcanic origin. They did not originate in large and homogeneous lava pools. Instead, they must have been formed individually, by fusion of relatively small rock volumes. We assume that all fused glasses in soil and breccias have been formed from melts produced by meteoritic impacts. Such impacts can provide sufficient energy for instant and local fusion and for a dispersion of these fusion products over large areas.

Notwithstanding the differences between the individual glasses, the light colored and dark glasses form two groups which are distinctively different in chemical composition. Major differences exist in the contents of SiO_2, TiO_2, Al_2O_3, FeO and MnO (see Tables 3 and 4 and Figs. 9–11). The colorless and green glasses contain more SiO_2 (average 45%), less TiO_2 (average 0·7%), more Al_2O_3 (average 24%), less FeO (average 7%) and less MnO (average 0·1%). The yellow-brown, red-brown and violet-brown glasses have less SiO_2 (average 39%), more TiO_2 (average 8%), less Al_2O_3 (average 11%), more FeO (average 18%) and more MnO (average 0·2%).

As can be seen in the linear plots of Al_2O_3, TiO_2, FeO and MnO vs. SiO_2 and in the triangular representations of $Al_2O_3 - FeO + TiO_2 - SiO_2$ and $Al_2O_3 - TiO_2 - FeO$, resp., the two groups are fairly distinct from one another.

The average composition of the yellow-brown, red-brown and violet-brown glasses is very similar to the average composition of the Apollo 11 basaltic rocks (see Table 4 and Figs. 9–11).

We conclude that these glasses were formed from melts produced by meteoritic impacts on basaltic rocks or on breccias and soils of basaltic composition. Sources of the dark colored glasses may be craters in the vicinity of the Apollo 11 landing site. The colorless and green glasses, on the other hand, have a composition similar to that of the anorthositic rocks occurring in small pieces in Apollo 11 soil and breccias (see Table 3 and Figs. 9–11). We assume that the light colored glasses are products of meteoritic impacts on rocks of anorthositic composition. In the Apollo 11 soil and breccias such rocks occur only as minor constituents. The impact sites, sources of anorthositic rock framents and light colored glasses, may perhaps be located somewhere on the highlands.

This hypothesis—also expressed for the anorthosites by KING *et al.* (1970) and WOOD *et al.* (1970)—is supported by the fact that the chemical composition of the surface north of Tycho, determined by the α-scattering experiment of Surveyor 7, comes close to that of the light colored glasses and anorthositic rocks. It shows higher SiO_2- and Al_2O_3- and lower TiO_2- contents than the mare materials analyzed by Surveyor 5 (Sinus Medii) and Surveyor 6 (Mare Tranquillitatis) (Table 5).

The two types of impact-induced fused glasses deposited in the soil and breccias of Mare Tranquillitatis may be connected with the two ray-systems in the vicinity of the Apollo 11 landing site. The north–northwest trending ray which is perhaps related to Tycho or to another crater on the highlands may have delivered unshocked