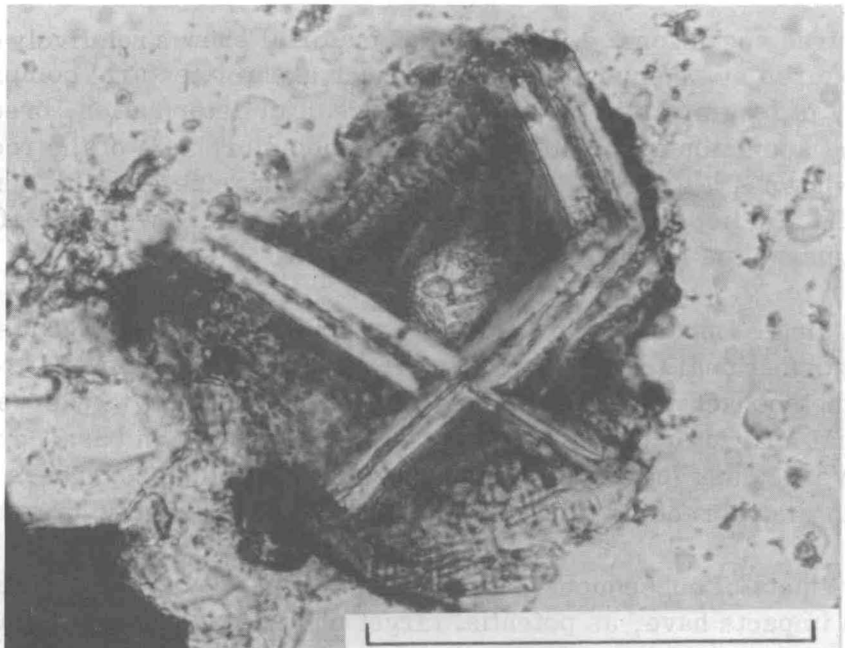

Figure 41. Glassy inclusion containing large clear skeletal plagioclase laths in a matrix of brownish glass that is partly devitrified to quench microlites (pyroxene?). The texture in the fragment suggests rapid cooling and quenching of a melt. It is not clear whether the fragment represents rapidly cooled magmatic rock (a flow margin) (plagioclase microporphyry) or whether the fragment represents quenching of an impact melt formed by fusion of feldspathic source rocks. Fragment 318,377; plane polarized light; scale bar 0.1 mm.

basaltic material and the common occurrence of unshocked basalt fragments indicates that the basaltic rocks are the local bedrock and that Mare Fecunditatis is underlain by basaltic flows which are chemically similar to Apollo 12 material.

The feldspathic rocks (gabbros to anorthosites) are less common, although their abundance is comparable to that observed in Apollo 11 and 12 samples (20, 21). They occur as rare, apparently shocked, rocks and as more common diverse microbreccias. The apparently higher level of shock in the feldspathic rocks is consistent with transport by meteorite impact from source regions outside the Luna-16 landing site. These feldspathic rocks may be highland material (e.g., 6, 20, 21, 24), because the Luna-16 landing site, located near the eastern margin of Mare Fecunditatis (13) might be expected to receive significant amounts of material transported from the nearby highlands. Another possible source of non-mare material would be produced by deeply excavated ejecta from the postmare crater Langrenus about 300 km SE of the landing site.

The source rocks for the Luna-16 soil material show a relatively restricted range of textures and compositions. The much greater textural complexity of the majority of fragments in the soil is the result of deformation, brecciation, melting, and accretion associated with shock metamorphism of the rocks. The flow chart shown in Figure 42 is an attempt to summarize, for the Luna-16 material (and, by implication, for the other lunar soils as well) the effects of shock metamorphism on the presumed source rocks.

Even a single impact event on a uniform source rock will produce a wide range of deformational textures, ranging from simple fracturing to complete fusion, in the shocked material. Single impacts also tend to preserve the original chemical character of the target rock, i.e., impacts on basaltic rocks produce the diverse dark (basaltic) microbreccias, while the occurrence of light (feldspathic) microbreccias implies the existence of feldspathic target rocks.

The products of subsequent or multiple impacts, however, are more complex. Such impacts have, as potential target materials, not only the unaltered source rocks, but also the entire range of shocked rocks and microbreccias produced by earlier impacts. As a result, multiple impacts tend to increase the observed shock level of the soil (6). Multiple impacts also tend to homogenize the regolith by mixing together discrete fragments of originally different chemistry and texture, thus forming composite fragments containing clasts of light microbreccia in dark microbreccia (Figures 9, 12) or cores of light microbreccia surrounded by dark (basaltic?) glass (Figure 13).

In certain cases, as discussed above, the impact-produced melts cannot be distinguished from rapidly quenched magma. In the Luna-16 soil, two types of fragments which reflect quenching of melt produced by either impact or volcanism are the quenched/intersertal basalts (Figures 5, 39) and the plagioclase microporphyry (Figure 41). These relations are indicated by the dashed lines in Figure 42.

The strong evidence for the formation of a fragmental layer at the Luna-16 site by repetitive meteorite impact strengthens the view that this process operates generally over the whole moon. The regolith at the Luna-16 site has apparently been formed by the fragmentation and shock metamorphism of diverse basaltic rocks present on the mare. Additional feldspathic material, apparently more highly shocked, has been introduced into the fragmental layer from an outside source, possibly (though not definitely) from the adjacent highlands or from large craters excavating highland materials. The establishment of such general conclusions about lunar processes by examination of such a small amount of material emphasizes both the usefulness of petrographic methods and the unique character of the shock-metamorphic effects themselves.