APOLLO 15: ORIGIN OF GLASSES AND EVOLUTION OF THE REGOLITH, W.v.Engelhardt, J.Arndt and H.Schneider, Mineralogical Institute, University of Tübingen, Germany (BRD).

89 glasses (size range 1-0.1 mm) have been analyzed from soil samples 15031,68; 15041,78; 15601,99; 15602,77; 15471,48; 15221,58; 15291,54 and from breccia samples 15565,94; 15505,54; 15086,42; 15285,10. Of these analyses 75 form six well defined chemical groups (Reference No.6), similar to those already described by several authors (1, 2, 3 and others). None of these groups corresponds to the average composition of Apollo 15 soils and breccias (4). Group VI includes plagioclase glasses produced by shock in the solid state. All other groups can be related to types of magmatic rocks: Group III corresponds closely to the composition of Apollo 15 mare basalts (4), group I (green glasses) to pyroxene- and olivine-rich rocks of possibly deep origin, group IV to a Ti-rich basalt of mare type, group V to high-K Fra Mauro basalts, group II to high-Al highland basalts with a distinct trend to anorthositic composition. The differences in FeO/MgO-ratios make it difficult to derive these rock types from one differentiation process. The 14 analyses which do not fit into these groups may represent rarer rock types or melted soil. The correspondence of glass compositions to distinct rock types indicates that glass particles larger than about 0.1 mm predominantly represent products of larger impacts which penetrated the regolith and shock melted underlying bedrock. Shock melting of the regolith by small impacts resulted mainly in glassy agglomerates.

Estimations of cooling rates of two glass particles from Apollo 11 (10085,26; 1.78 mm) and Apollo 15 (15032,9; 1.0 mm) by measuring softening and transformation temperatures at constant heating rates (5) resulted in about 40°C/sec at 567°C and about 100°C/sec at 685°C, respectively.

The main components of the Apollo 15 soils are derived from local mare basalts and Apennine front material. Characteristic constituents of the latter are: green glasses, feldspar-rich rocks ("anorthosites") and fragmental rocks (feldspar and pyroxene clasts in a fine-grained crystalline matrix) which probably represent pre-Imbrian impact melt rocks. Fig. 1 shows abundances of mare- and Apennine-derived components in the 125-500µm fraction of some soils. The soil at station 6 (15291), close to the Apennine front, is richest in Apennine material and the thin soil at station 9A (15601), close to the edge of Hadley Rille, is most enriched in mare basalts. Due to the excavation of basaltic bedrock by the post-mare Dune, Elbow and St. George Craters, soils at stations 4(15471) and 2 (15221)
are richer in mare derived fragments than the soils from station 8 (15041, 15031).

Grain size distribution and modal composition of Apollo 15 soils reveal the evolution of the regolith. Soil 15041 from the surface at station 8 (Fig. 2) represents a mature regolith developed by multiple small impacts which reworked the uppermost soil layer. The content of glassy agglomerates and breccias produced by impacts into the regolith is high. The abundance of glass particles increases with decreasing grain size due to the disruption of agglomerates and larger glass particles. The median diameter is relatively low (56\mu m). The coarser (median diameter 77\mu m) soil from the edge of Hadley Rille (15601, station 9A, Fig. 3) represents a regolith of lower maturity due to the effects of impacts penetrating into the basaltic bedrock: Glassy agglomerates, breccias and small glass particles are less abundant, and the content in basalt fragments and large glass particles is higher. Soils from stations 4 (15471), 2 (15221), and 6 (15291) show intermediate stages of evolution.

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References
(4) LUNAR SCIENCE PRELIMINARY EXAMINATION TEAM (1972) in Apollo 15 Preliminary Science Report NASA SP-289, page 6-1 - 6-25.
Fig. 1:
Apollo 15 soils, 125-500μm, from stations 2 (15221), 4 (15471), 6 (15291), 8 (81: 15041; 82: 15031), 9A (15601). Abundance of green glasses and rock fragments.

Fig. 2:
Modal composition of soil 15041.

Fig. 3:
Modal composition of soil 15601.

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