PETROGRAPHIC SURVEY OF LUNAR REGOLITH BRECCIAS

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Regolith breccias from the moon and from parent bodies of some meteorites may provide us with samples of ancient regoliths which have been frozen in time. If these rocks were essentially closed at some earlier time and we can determine that time, then these rocks provide a record of conditions in the solar system at that point in time. The breccias may record the composition and relative abundance of solar wind species. They may record the flux and composition of the meteoroid complex. They may record outgassing conditions and volcanic activity of their parent body. For the moon, the record of lunar surface interactions frozen in regolith breccias may extend backward in time far beyond the oldest core sample and may fill in the large time gap extending from the time at which the material in the lunar cores was buried to the time of the last volcanic activity as recorded in the basalts. Even if the closure time of regolith breccias cannot be determined with certainty, the probability that these regolith breccias contain samples of regoliths closed off at some time other than the present is reason enough to investigate them and to determine if a record of a solar system environment different than the present-day one can be deciphered.

Lunar regolith breccias are probably better understood than meteorite regolith breccias mainly because the geologic setting is relatively well known. However, among the lunar samples, regolith breccias have been the least studied sample type and the data on them are sparse compared to other rock types and particularly to the lunar soils and cores. We have therefore started a survey of regolith breccias in the Apollo collection concentrating initially on Apollo 15 and 16. We have surveyed all available thin sections for 32 regolith breccias from Apollo 15 and 19 breccias from Apollo 16. These are most of the returned regolith breccias larger than 1 cm from these two missions. For comparison we have also investigated several fragmental matrix breccias which do not strictly qualify as regolith breccias. We are using the definition of Stoffler et al (1979). The criteria for classification as a regolith breccia is the presence of identifiable soil components such as glass spheres or agglutinates.

Following our usage in Mckay and Wentworth (1983) we are classifying the breccias according to their intergranular porosity. In addition we note the fracture porosity and the relative abundance of agglutinates and spheres. Of the 32 examined Apollo 15 breccias, 16 are porous to subporous and 16 are compact to subcompact. Where available, we have analyzed more than 1 section of each breccia; for some as many as 4 sections have been studied. The porosity characteristics of the breccia is similar from section to section of the same rock although some slight variation exists; the porosity variations among breccias is clearly not an artifact of thin section preparation. Examples of porous regolith breccias include 15086, 15265, 61175, and 63507. Examples of compact regolith breccias include 15205, 15295, and 60019.

We have noted several petrographic trends. Identifiable regolith material decreases with decreasing intergranular porosity while fracture porosity increases. For the most compact breccias, regolith components are normally rare and consist mostly of small glass spheres. This correlation between porosity and indentifiable soil components may reflect the maturity of the soil from which the breccia was made or it may result from some aspect of the breccia making process which destroys regolith components or makes them difficult to identify. Even the most mature of the porous regolith breccias do not appear to have as many identifiable soil components (agglutinates, glass spheres) as typical soil samples.

This relative lack of maturity of regolith breccias may reflect their generally earlier formation age and the maturity of the regolith at that earlier time. Alternatively, it may reflect the relative immaturity of that part of the regolith from which the breccias were made, deeper zones for example. Other mechanisms which may influence the maturity of regolith breccias include mixing of regolith and comminuted bedrock and a change in the meteorite flux distribution over geologic time. Additional data may help to choose among these possible explanations. One implication of these observations is that meteorite regolith material of greater maturity than that observed in collected meteorites may exist but may not be preserved in meteorite regolith breccias. Clearly, an understanding of the petrology of lunar regolith breccias will contribute to our understanding of meteorite regolith breccias and may lead to a more complete record of solar system history.

References Mckay D. and Wentworth S. (1983) Lunar and Planet. Sci. 14, LPI, P. 481-482; Stoffler D., Knoll D. and Maerz U.(1979) Proc. Lunar Planet. Sci. Conf. 10th, P. 639-675.