Mineralogical and Chemical Studies of Lunar Fines (No. 12070-98 and No. 10084-148)

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Abstract

A portion of the lunar fines of Apollo 11(No. 10084-148) and 12(No. 12070-98) provided from NASA was analized for determination of the consituent elements.

For chemical analysis, the consituent elements were qualitative and quantitatively determined by Emission Spectroscopy, X-Ray Fluorescence Spectrometry, Atomic Absorption Spectroscopy and Radioactivation Analysis. The results were in relatively good agreement with those reported on "Science", volume 165, September 1969, and 167, March 1970 with a relative error of less than 10% except some elements such as Ni, Al, P.

The Apollo 12 fines were examined for mineralogical and petrological studies that comprise grain size and mode analyses, and characteristics of individual mineral constituents: with an emphasis on genesis of spherule. The obtained results are compared with the previous works of Apollo 11.

Mineral constituents of the fines studies are similar to that of the Apollo 11. However, the size distribution as well as the mode of the fines are different between them. Median grain size of the fines received lies at 18 microns whereas that of the Apollo 11 is at 43 and 62 microns, reported by Fredriksson et al. and Finkelaman, respectively. The Apollo 11 fines of Fredriksson et al. contain a larger amount of rock-fragments as compared with that of the fines analysed.

However, a larger amount of glasses is contained in the Apollo 12. This fact may indicate that mechanical disintegration of the regolith at the site of the fines received were advanced than that of the Apollo 11, considering the fines of the lunar surface are derivatives of the bedrock by mechanical disaggregation is situ.

In comparison of mineral composition of the fines studied with that of the Apollo 11, pyroxene shows wide variety in the latter, ranging from titaniferous augite, ferroaugite, subcalcic augite, to pigeonite reported from coarse particuate minerals by King et al., whereas the augite from the Apollo 12 fines received indicates a short range of the composition. On the other hand, plagioclase of the fines studied is somewhat less calcic than that of the Apollo 11. The composition of the former ranges from An_{73} to An_{88} in comparison with that of An_{85} to An_{90} in the latter. However, olivine in the fines received, contains somewhat more magnesia content than that of the Apollo 11.(King et al.) Composition of the olivine determined by x-ray diffraction and optical methods indicates chrysotile, a composition of Fo_{82}. The composition of glass as spherule contained in the fines, indicated by their refractive indices, are quite similar in both.

Various features of mineral fusion in the fines are described. The complete mineral fusion may leads to irregular glasses and homogeneous spherule. The partial fusions are seen in the mineral fragments along the margins or cleavages and part of a grain. The gradual ones are observed in "the concentric spherule", in which the core pyroxene relics are surrounded by brown colored admixed glass, in turn surrounded by the homogeneous clean yellow glass. The complete and partial fusion may be produced from impact metamorphism by meteorites or meteoroids or the secondary ejects, and some of it is derived from melted ejecta near by the impacts. However, the gradual fusion seen in "the concentric spherule" can not be explained by impaction of meteorites.

The reasons are discussed. They were probably formed by mechanical heating, perhaps due to the past strong solar radiation in the early solar phase or some other solar effects.