THE HISTORY OF LUNAR BRECCIA 14267, The European Consortium*.
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Rock 14267 was a 55g polymict breccia from the ALSEP area of the Apollo 14 site. It is partially glass coated and a few zap pits occur on the glass and rock surfaces. Dust coated regions exhibit complex structures built up by adhesion and most grains are rough on the micron scale. The optical properties of this type of surface resemble that of the lunar fines and the large scale lunar surface. The optical behaviour of the glass and freshly chipped interior surfaces do not reproduce the lunar polarisation characteristics.

The bulk composition of the rock determined from saw cuttings (SiO_2 48.35 TiO_2 2.11, Al_2O_3 16.87, Cr_2O_3 0.19, Fe_2O_3 0.28, FeO 10.10, MnO 0.13, MgO 9.72, CaO 10.29, Na_2O 0.90, K_2O 0.78, P_2O_5 0.57, S 0.08) is similar to type C Fra Mauro basalt glass (1) and to average dark metaclastic fragments from < 1mm Apollo 14 fines (2). The matrix of the breccia is dark vitreous or just annealed, corresponding to Grade 2 of Warner (3). The 0.02-1mm clast population is as follows: (%) glass ropey fragments 34.5, fine-grained metaclastics 44, basaltic 4.5, minerals 14, ultramafic 1.5, miscellaneous 1.5. Occasional cored lapillae occur. Glasses are dominantly quartz-normative Fra Mauro types with subordinate basaltic glasses.

Lithic clasts are pale and dark metaclastics with non-equilibrated porphyroclasts of olivine, orthopyroxene, clinopyroxene, plagioclase, ilmenite and spinel. Both mineral and lithic clasts show evidence of shock deformation.

Unique to this rock are a few microharzburgite fragments in which enstatite has undergone shock deformation to a fine-grained aggregate of clinoenstatite (En 90) associated with mosaicised olivine (Fo 89). Kinkbanding in hypersthene clasts does not show development of clinoenstatite (c.f. Tromsdorf and Wenk (4)). It is possible that this deformation antedates the ejection of 14267 to the collection site. One small granitic clast of the pale metaclastics showed evidence of partial melting and the possible development of quench crystallites of clinohypersthene from protohypersthene.

The exposure history of 14267 has been studied using carbon chemistry, noble gas and track data. DCl dissolution of two interior chips released no CH_4 and only trace amounts of CD_4 (0.1 µg/g) in accordance with either a low initial carbon content or a metamorphic history of Warner group 2 or greater. The concentration and isotopic composition of the light noble gases suggest that the trapped component of the gases is severely altered (e.g. $^{20}Ne/^{36}Ar$ 0.8). Considerable loss of radiogenic ^4He and partial loss of ^{40}Ar have occurred; the U, Th/He age is 0.7 by whereas the approximate K/Ar age is calculated as 3.9 by. Exposure ages deduced from the spallogenic components are: ^3He 30my, ^{21}Ne 60my and ^{38}Ar 100my. A preirradiation of at least some of the constituent grains prior to compaction is indicated.

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No radiation damage features, such as amorphous coatings or high density of latent tracks, characteristic of highly irradiated soil particles, have been observed. Moreover, no tiny micro-crystallites which would suggest the presence of partially-faded solar flare tracks (no longer observable directly as latent tracks), appeared in grains of 14267 until a fragment had been heated for 2 hours at 800°C under vacuum. Similar microcrystallites may be usually induced by heating lunar fines and are found in mildly metamorphosed Apollo 11 breccias. Therefore, it is suggested that shock metamorphism, without a strong thermal effect, erazed the latent tracks of 14267 without converting them to microcrystallites. The relatively narrow density distribution of etched tracks suggests a post brecciation galactic ray contribution and a VII exposure age of ca. 30my is deduced.

The above consortium investigations allow a tentative history for 14267 to be drawn:-

Formation of this Warner metamorphic grade 2 rock from soil took place around 3.9by ago. The event could have been the result of a shock process in which the induced temperature did not exceed 800°C. A proportion of the constituent grains had experienced a prior irradiation by the solar wind; however, this must have been small, assuming that the temperature of compaction was as low as 700-800°C. After consolidation 14267 was buried at a depth greater than 2 metres until ejection, presumably by the Cone Crater event, to the near surface of the Apollo 14 site about 30my ago. The temperature accompanying this event is unlikely to have been >500°C.

References:

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