

14321

Lunar sample 14321 (also known as Big Bertha) is the largest sample returned during the Apollo 14 mission. This sample is the third largest sample returned by any Apollo mission. This breccia was collected during the second EVA at station C1, near the rim of Cone Crater. A voice transcript made during the collection, as well as a more detailed discussion of the lunar environment can be found in Geological Survey Professional Paper 880 (Swann et al., 1977). The sample was returned in bag 1038.

This large sample is typical of the apparently dominant rock type in the Cone Crater ejecta blanket. It is a moderately well-indurated breccia, in which predominately dark clasts are set in a lighter matrix. The relative abundance of this rock type suggests that it is probably representative of the Fra Mauro Formation.

PHYSICAL CHARACTERISTICS

Mass

8998 g

Dimensions

23 x 23 x 17 cm

This rock, 14321, is a partly annealed, moderately coherent polymict breccia. The blocky surface is gray with patches of black and white.

SURFACE FEATURES

Pit diameters vary from 0.1 to 5 mm with an average size of 1 mm. Glass lining of the pits consists of dark brown to black vesicular glass. Pits cover approximately 5% of the entire rock surface.

Cube shaped to rounded clast molds which range from 0.5 to 20 mm in length occur on 5% of the surface and occur in clusters along broken surfaces.

There are two sets of fractures present, one of which parallels the rock surface. The second set has a random orientation, including fracturing around clasts which are ready to break out of the matrix.

PETROGRAPHIC DESCRIPTION

Before the rock was cut and distributed, a map was made of its surface by Warner and Heiken (1972).

Warner and Heiken (1972) were able to map four lithologic types:

- I. Dark gray breccia with an olive hue. The microbreccia matrix is fine grained and contains feldspathic lithic clasts and powdery, white feldspar fragments up to 2 cm long with an average length of 1-2 mm.
- II. Medium gray breccia - very fine grained, friable, fractured.
- III. White, feldspar-rich somewhat friable breccia - matrix.
- IV. Feldspar-rich basalts.

Petrographic descriptions and an excellent discussion of the lithification processes and genesis of sample 14321 can be found in articles by Duncan et al. (1975) and Grieve et al. (1975).

DISCUSSION

The polymict character of this and many other breccias makes it especially interesting to study, because it is possible to place the various clasts into a relative time sequence. A series of brecciation and lithification events are preserved in the three or four generations of microbreccia contained in this rock.

Duncan et al. (1975) have unraveled the events leading to the lithification of rock 14321. They observe two distinct episodes of thermal metamorphism. The first affected their 1A components producing well developed recrystallization textures lacked by their 1B lithic components, mineral clasts and dark matrix. The latter contain evidence of a less severe thermal event. One or more impact events can also be shown to have occurred leading to the following partial schematic history:

1. Serinitatis impact produces ejecta blanket over Imbrium area.
2. KREEP basalts are extruded, followed by lesser amounts of Apollo 14 type mare basalts.
3. Impacts on south Imbrium region form early (group 1) breccia stages.
4. Imbrium impact forms Fra Mauro ejecta - creates microbreccias 2 and 3.
5. Extrusion of 14321 - type basalt and additional Apollo 14 type mare basalt on the Fra Mauro Formation and adjacent areas.
6. Impact events - final assembly of 14321.
7. Cone Crater impact excavates 14321.

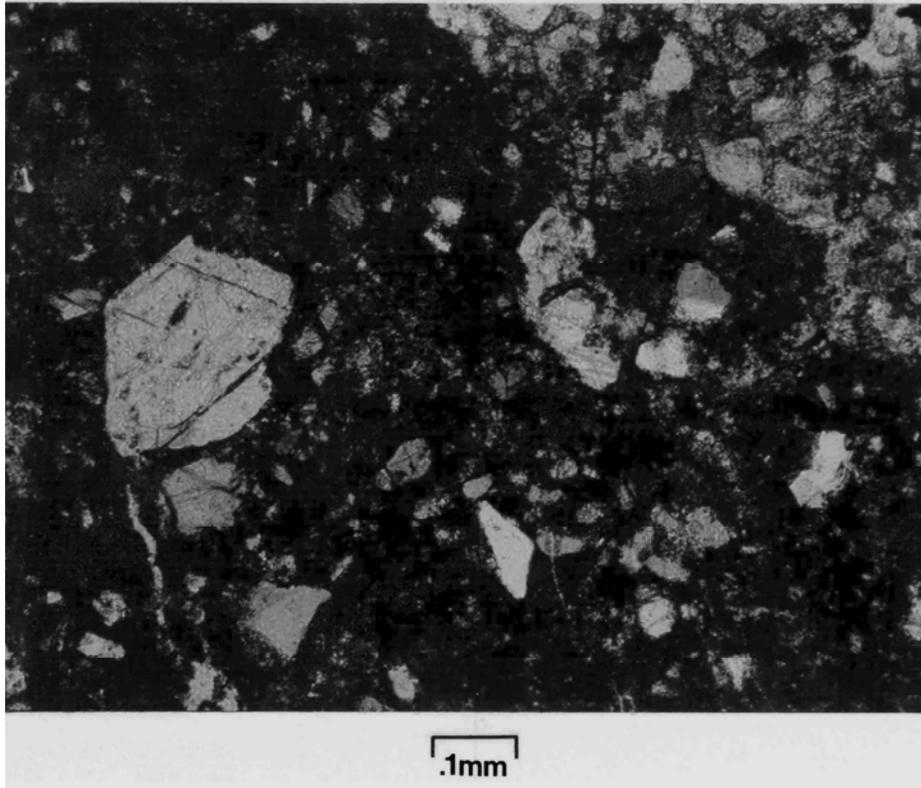
In their petrographic study of 14321, Grieve et al. (1975) found it to be composed of basaltic clasts, a set of fragmental clasts which they designated as microbreccia 3, and a light matrix cementing these two groups. Their microbreccia 3, itself polymict, corresponds to lithology I of Warner and Heiken (1972). Lithology II was not present on the samples sent to Grieve and his co-workers and was, therefore, not described by them.

Other authors have also discussed the clastic nature of 14321. Swann et al. (1972) delineated a big clast within Big Bertha. Mark et al. (1975) found that while the basalt clasts had equilibrated at 4.0 b.y. ago, two microbreccia clasts indicate lack of complete equilibration at that time. This heterogeneity is used to demonstrate an inconsistency with thermal metamorphism of the sample.

Chao et al. (1972) describe 14321 as having a moderately coherent, white, feldspathic matrix that contains two main fragment types: ophitic mare basalt (like 14053), and fragment-laden extremely fine grained, annealed black glass. The latter probably corresponds to Grieve's microbreccia 3. The complex nature of this breccia is a result of mixing several generations of breccia precursors to form this rock.



S-71-28416



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SAMPLE MODELS AND GENELOGIES

In order to facilitate the job of determining specific sample orientation and orientation within the parent, as well as for historical interest, models of the larger lunar samples have been constructed by the curatorial staff. Photographs of the models made of Apollo 14 samples are included in this section to acquaint the scientific community with their availability and to help lunar scientists identify the original location of their sample within the parent rock.

Genealogies of several Apollo 14 samples have been made and are also included. These genealogies do not reflect any processing which has taken place since the first thin section was made of each sample. It is hoped that these methods of illustrating samples will prove useful, and will become a routine part of sample documentation procedure.



Model of 14321, S-78-26758