Comprehensive Sample (14169-14188, 14250-14299)

The comprehensive sample from Apollo 14 has been described, classified and discussed by Phinney et al. (1975). The information collected and discussed by them is included herein for purposes of completeness only, and little attempt has been made to describe these samples again except that new thin section descriptions are included whenever possible.

The purpose of the comprehensive sample was to acquire a statistically significant set of small rock samples to petrographically characterize the distribution of rock types in the lunar regolith. The sample location was selected 100 to 125 m west of the LM. A two to three meter diameter circle was marked and all of the walnut sized rocks on the surface within the circle were collected with tongs. Then, a soil sample was collected from within the circle. Two weigh bags were to be used to contain the samples: weigh bag 1039 was to contain rock fragments and weigh bag 1007 was to contain the soil sample. Unfortunately, as discussed in the Apollo 14 Preliminary Science Report (1971), there was some confusion about the origin of the contents of weigh bag 1027. It contained 20 small rock fragments (14169-14188) and a large undocumented rock, 14303. On the basis of their association with two documented rocks (14304 and 14305) returned in the same weigh bag and collected near the comprehensive sample site, the 20 fragments and 14303 were tentatively considered to be parts of the comprehensive sample. Later, 14303 was found to have been part of 14304, collected at the end of the first EVA. The astronauts were unable to get all of the weigh bags containing the comprehensive sample in the SRC so they put the “small samples of small rocks" from the comprehensive sample in the weigh bag (1027) with the football-size rocks collected later (14303/14304 and 14305). It seems probable, therefore, that some portion of the samples 14169-14188 could be parts of the larger samples 14303/14304 and 14305 that were in the same bag but not part of the contingency sample. It was believed by Phinney et al. (1975) that all of the small samples 14169-14188 were fragments of 14303 because they are all identical in their lithologies and are lithologically identical to 14303 and because they show freshly fractured surfaces with no patination or zap pits and one end of 14303 is a fracture surface (later shown to fit 14304).

The following table summarizes the contents of the three weigh bags:

Weigh Bag Number	Rock Samples	Soil Samples
1007	14250-14255 (Rocks separated from soil)	14256-14259 14298-14299
1039	14264-14288	14260-14263 (Soil collected with rocks)
1027	14169-14188 14303/14304 and 14305	14165-14168 (Residue)

This entire set of samples was returned in weigh bag 1027, along with 14303/ 14304 and 14305. They were determined to be fragments of 14303 by Phinney et al. (1975) and described as such in their booklet on the comprehensive sample (see especially samples 14250-14288).

PHYSICAL CHARACTERISTICS

	Mass	Dimensions
14169	78.66 g	7.1 x 3.2 x 2.7 cm
14170	26.34 g	4.2 x 3.3 x 1.3 cm
14171	37.79 g	3.9 x 4.3 x 1.5 cm
14172	32.10 g	4.0 x 1.8 x 2.3 cm
14173	19.59 g	3.7 x 2.2 x 1.8 cm
14174	11.62 g	3.5 x 2.3 x 1.8 cm
14175	7.48 g	2.8 x 2.0 x 1.6 cm
14176	4.12 g	2.3 x 1.8 x 1.0 cm
14177	2.32 g	0.5 x 1.0 x 1.8 cm
14178	2.88 g	1.8 x 1.4 x 1.1 cm
14179	3.03 g	0.7 x 2.0 x 2.0 cm
14180	4.75 g	0.6 x 1.2 x 1.6 cm
14181	2.48 g	0.6 x 1.1 x 1.4 cm
14182	2.29 g	0.6 x 1.7 x 1.9 cm
14183	1.40 g	1.2 x 1.0 x 1.0 cm
14184	1.48 g	1.6 x 1.1 x 0.6 cm
14185	1.52 g	2.0 x 1.2 x 1.0 cm
14186	1.26 g	1.0 x 0.8 x 0.5 cm
14187	1.90 g	1.2 x 1.2 x 0.4 cm
14188	1.60 g	1.5 x 1.0 x 1.0 cm

These samples contain a seriate distribution of clasts as large as two centimeters across. The samples are all polymict breccias with fragmental matrices.

SURFACE FEATURES

Glass lined zap pits are present on samples 14169, 14171, 14172, 14173, 14176, 14182, 14185, and samples 14170 and 14187 contain only unlined pits. Sample 14169 has pits ranging from 0.1 to 2.0 mm in size with a density of 10 to 12 pits per square centimeter. One hackly surface is sparsely pitted, perhaps indicative of the sample's bottom. The rest are less densely pitted. None of the samples contains surface glass.

The only cavities present are clast molds on all samples except for 14181 and 14186. Sample 14181 contains irregularly shaped vugs 0.5 to 1.5 mm in size with a homogeneous distribution in the matrix only. These are 10 mm apart and account for less than 1% of the sample's volume. Sample 14186 also contains irregularly shaped vugs with an average size of 0.8 mm. These occur in clusters on one side of the rock. A few others are widely spaced. Several are lenticular. No projecting minerals have been observed.

Fractures are present in all samples except 14175 and 14188. The only shock features noted occur on sample 14172. The substrate below the zap pits has milky feldspar characteristic of surface shock material.

PETROGRAPHIC DESCRIPTION

Samples range in coherence from tough (14180, 14186) to friable (14171, 14185, 14187). All samples appear to be fragmental polymict rocks in hand specimen. Most clasts are medium gray, aphanitic fragments which contain some white spots and may be partially devitrified. The bulk

of the other clasts are white to light gray lithic fragments which are composed mostly of plagioclase grains with 10-20% mafic minerals, and 1% opaques. In order to better characterize the clast population, all of the clasts larger than 5 mm across were described by Phinney et al. (1975) and are included in Table 7.

TABLE 7

Clast Descriptions (Phinney et al., 1975)

	Color	Shape	Size (mm)	Comments
14169	Medium Gray	Subrounded	20.	Similar to main matrix of 14303 but somewhat darker and more annealed, Sharp contact with matrix, Contains many white clasts and a large olivine clast.
14169	Medium Gray	Subrounded	20.	Identical to previous clast.
14169	Light Gray	Round	6.0	Dark gray rind around 1.0 mm size mixture of white plagioclase, resinous brown material and gray vitreous patches.
14169	Dark Gray		10.	Aphanitic, crystalline with white feldspar specks.
14170	Dark Gray	Angular	5.0	Aphanitic, crystalline, contains 10%white feldspar clasts.
14170	Med. Dark Gray	Angular	5.0	Aphanitic, crystalline with a few white specks <0.1 mm.
14171	Pinkish brown	Round	10.	Band of pinkish brown, to Dk. Gray fine-grained material across center. On one side is black, aphanitic, crystalline material with a few white feldspar clasts. On other side is a mixture of medium gray and white material.
14171	Dark Gray	Subrounded	10.	Aphanitic, crystalline with a few white feldspar clasts.
14171	Lt. Med. Gray	Round	5.0	Mare basalt? 5-10% opaques as stringers 2-3 mm long and 0.1 mm wide through a mixture of plagioclase and pinkish brown mafic minerals.
14172	Gray & White	Subrounded	15 x 7	Core of white plagioclase as 0.5 mm grains mantled by dark gray aphanitic material.

(Clast Description Table cont'd)

	Color	Shape	Size (mm)	Comments
14172	Medium Gray	Angular	5.0	Very similar to main matrix of 14303 but sharp contacts definitely indicate a clast.
14173	Greenish Gray	Diffuse	7.0	Primarily vitreous gray Boundaries plagioclase with 30% green mafic silicate as 1.0 mm crystals and <1% black opaques.
14173	Med.Dk. Gray	? Makes up	20.	Aphanitic, crystalline with end of rock many white specks.
14174	Medium Gray	Angular	10.	Aphanitic, crystalline with many white specks of feldspar.
14179	Gray & Lt. Green	Angular	5.0	3.0 mm patch of fractured green mafic silicate and 5.0 mm patch of gray, vitreous feldspar probably from a coarse-grained gabbroic rock.
14180	Med.Dk. Gray	Angular	15.	Clastic to somewhat annealed breccia with many subrounded white feldspar clasts and one subrounded crystalline clast with mottled appearance of poikilitic melt rocks.
14181	Entire Sample is 2 Clasts		7.0	1) Medium gray aphanitic crystalline rock with many white feldspar specks. 10. 2) Troctolitic anorthosite with 0.5-1.0 mm plagioclase as crushed white or vitreous gray material, 10% 0.5-1.0 mm green mafic silicate (olivine) and a few <0.5 mm dark red grains (spinel).
14182	Medium Gray			Subrounded 5.0 Very similar to main matrix of 14303 but somewhat darker and a bit more annealed.
14186	Medium Gray		10 x 6	Very similar to main matrix of 14303 but somewhat darker and a bit more annealed.

Several thin sections from generics in this group are available and were examined for this booklet. The following descriptions are included for purposes of completeness:

14169,8

There is a small amount of dark brown "glass" (5-10%) present in the matrix of sample 14169,8. Only one clast larger than 1 mm is present in the section. It is a fine-grained breccia with crystallites scattered throughout. Many of these crystallites appear to be pyroxene. The clast has fractured and the matrix has been injected between the two pieces. A seriate mixture of shocked mineral fragments (including reddish spinel) and three dark clast-like areas are present in the matrix. These "ghost clasts" are areas of fine-grained, turbid material with abundant small crystallites present. These areas merge into the matrix.

14170,4 & 14170,5

Some "glass" is present in the matrix of breccia 14170. The samples consist of a partly crystalline-partly "glassy" matrix with abundant mineral and lithic clasts. Several large clasts of pyroxene and basaltic igneous rock fragments are scattered throughout the sections. There are fewer clasts in 14170,4 than there are in 14170,5. Sample 14170,4 contains several devitrified clasts and larger "glassy" breccia clasts. Few, widely scattered, pyroxene/basaltic clasts are present in section 14170,4 but are common in 14170,5. Pyroxene crystals are nearly free of inclusions. Basaltic lithic clasts have a subophitic texture with anhedral masses of brownish pyroxene and acicular plagioclase. 0nly small, scattered clasts of plagioclase are present in either section.

14171,11

Section 14171,11 is nearly holocrystalline and contains numerous lithic clasts. Lithic clasts include a variety of dark matrix microbreccias, a clast of devitrified glass containing abundant dendritic crystals, and a small, crystalline rock fragment. Opaque minerals are scattered throughout the section. The matrix is a seriate mixture of mineral fragments and small lithic fragments. Mineral fragments are pyroxene and plagioclase in approximately equal proportions.

14172,7

Section 14172,7 is a breccia with a "glassy" matrix (30%) in one area, which grades into a much more crystalline area in other areas (5-10% "glass"). Very few lithic fragments are present, and only one clast is larger than 1 mm. This clast consists of a shocked plagioclase crystal with minor pyroxene adhering to one edge. The crystal is highly fractured and shows poorly defined twin planes. Of the identifiable mineral fragments in the matrix, 80% are pyroxene and 20% are plagioclase. Lithic fragments are a fine-grained breccia with corroded pyroxene crystals. These crystals contain some inclusions.

14173,6 & 14173,7

Section 14173,6 grades from vitric to more crystalline as does 14172,7. Sample 14173,7, cut from the same rock chip is almost entirely crystalline with a few small masses of a more "glassy" breccia. Most clasts consist of pyroxene and plagioclase grains and almost all grains are fractured. Twinning is present in some of the pyroxene. A crystalline cumulate is present near the edge of the section. A few small, glassy breccia clasts are present in 14173,7. Crystals in 14173,7 appear fresher with less evidence of shock and fewer inclusions than those in 14173,6.

14174,5

A very minor amount of "glassy" material is present in the matrix. Several large lithic clasts are present and consist of fine-grained microbreccias with remnant pyroxene shards, small igneous fragments, and several masses of devitrified glass. One microbreccia fragment has a small mass of olivine cumulate present.

14175,3

Section 14175,3 resembles section 14174,5 but contains more plagioclase and more "glassy" material. One edge has what appears to be a totally devitrified glass coating which has bent and radiating crystals. Some areas have larger crystal grains than others and may be "ghost" clasts, however the contact is gradational. Lithic microclasts are scarce and most are small clusters of plagioclase and pyroxene surrounded by a mass of crystallites. Pyroxene (80%) and plagioclase (20%) make up the mineral grains, and all are shocked. Chondrule-like bodies occur as remnant features, and patches of opaque minerals are also present.

14179,4

Sample 14179,4 is an olivine-rich granulitic rock with 2-3% pyroxene cemented together by anhedral plagioclase. The olivine crystals are highly rounded and somewhat elongate. Pyroxene crystals are more equant and square in outline. Only a trace of brownish "glassy" material is scattered throughout the section.

14180,3

Sample 14180,3 contains a fine-grained, nearly holocrystalline microbreccia clast surrounded by a small border of a dark opaque-rich breccia. In this clast, smaller fragments of darker, fine-grained, opaque-rich breccias are present. Opaques form subhedral to anhedral crystals, and are widely dispersed throughout the section. Euhedral crystals occur in the matrix surrounding the clast.

14181,5

This sample is a section of a troctolitic anorthosite with large, anhedral olivine grains and long, bladed plagioclase crystals. A second generation of anhedral crystals of plagioclase has filled the interstices between other phases. Large crystals of iron metal and other opaques are also present. One, well rounded, reddish spinel is enclosed in an olivine crystal.

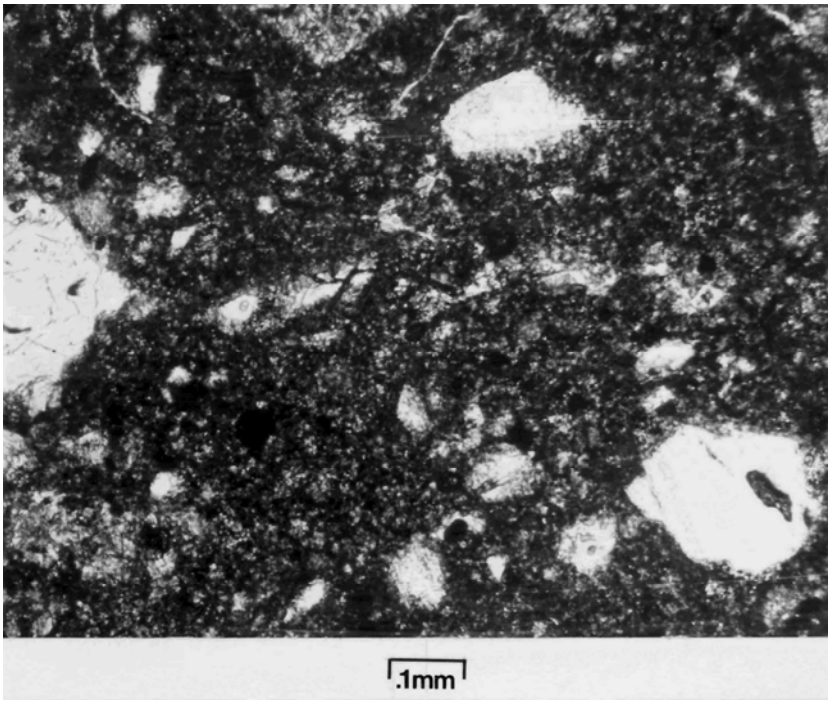
14187,3

This section is essentially a holocrystalline breccia with abundant, dark gray matrix material which is unresolvable. Abundant, small, opaque crystals are present in the matrix. The section area is small, so an accurate evaluation of the clast population is not possible. Large fragments present include a few shards of pyroxene, plagioclase, and partly devitrified glass. The thin section has a very turbid appearance.

DISCUSSION

The only samples that have received detailed study in this group are 14169 and 14180. Eldridge et al. (1972) determined potassium, thorium, uranium, ^{26}Al, and ^{22}Na concentration in these samples using gamma-ray spectrometry. They found a remarkable uniformity in the primordial radio element content in all samples. They estimate a KREEP content of 60-85% in Apollo 14 soils and breccias on the basis of a two-component mixing model.

S-75-24302



14169,8

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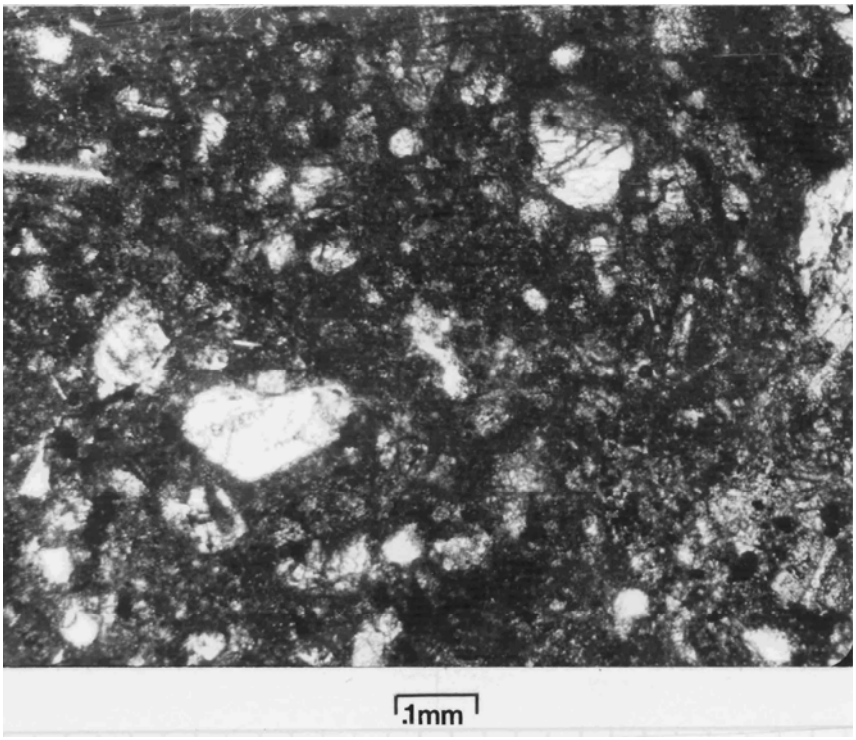

14170,4

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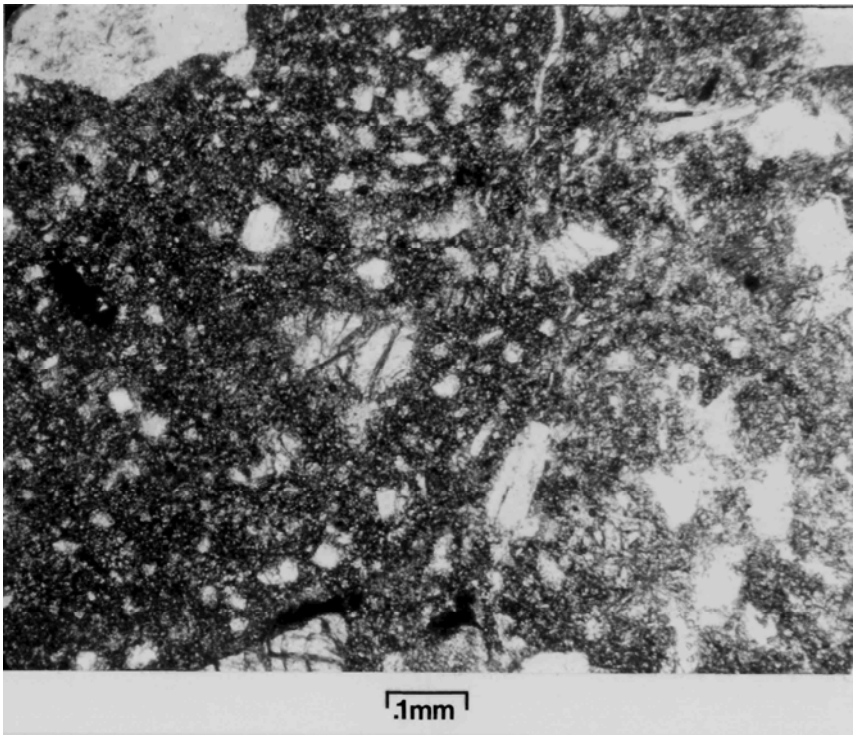

14171,11

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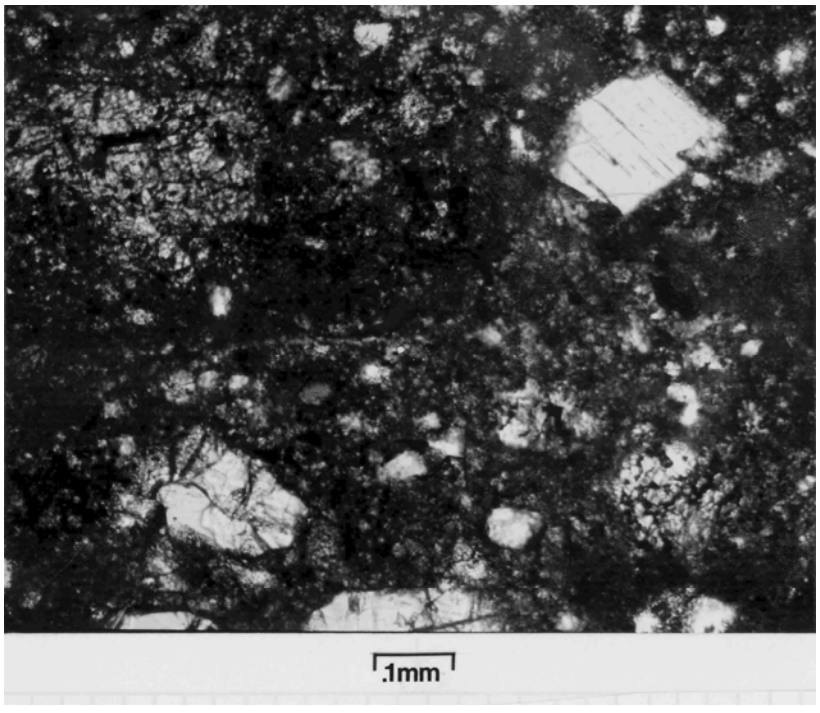
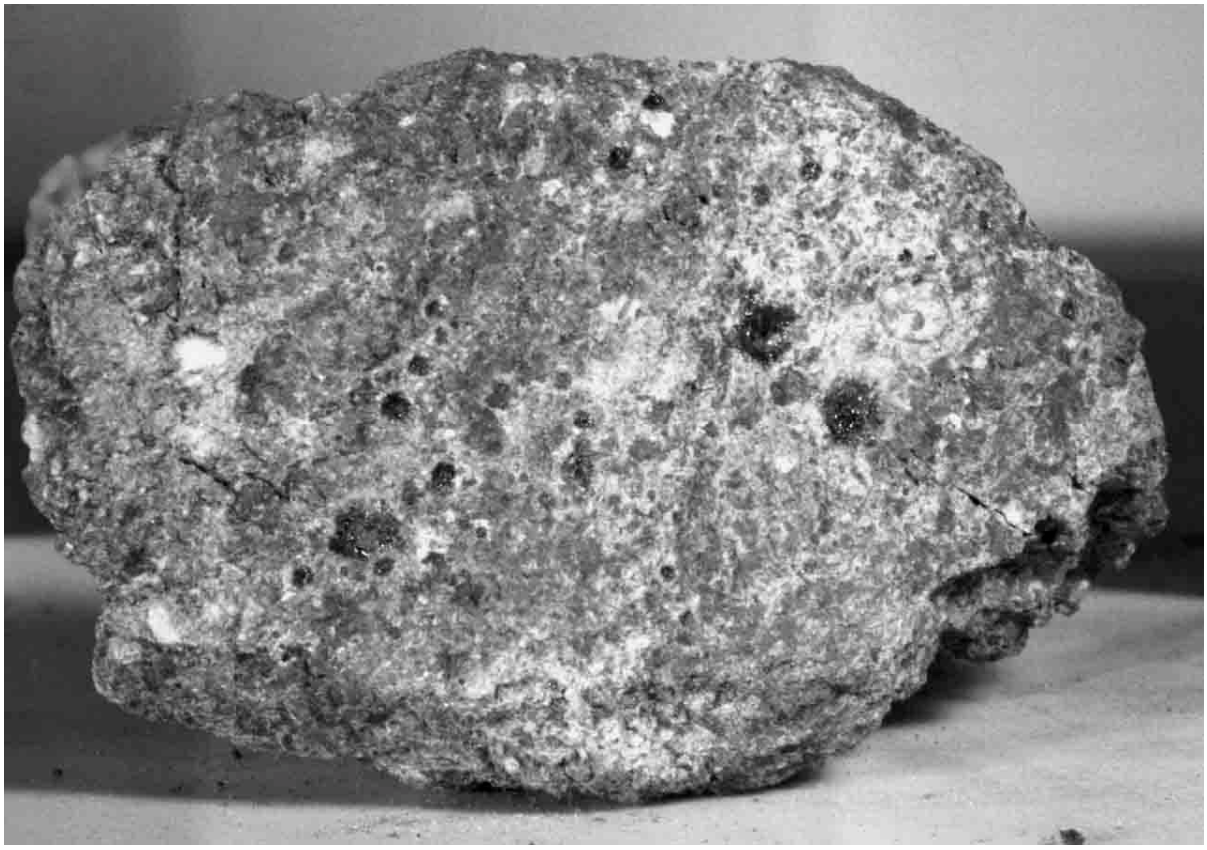


14172,17



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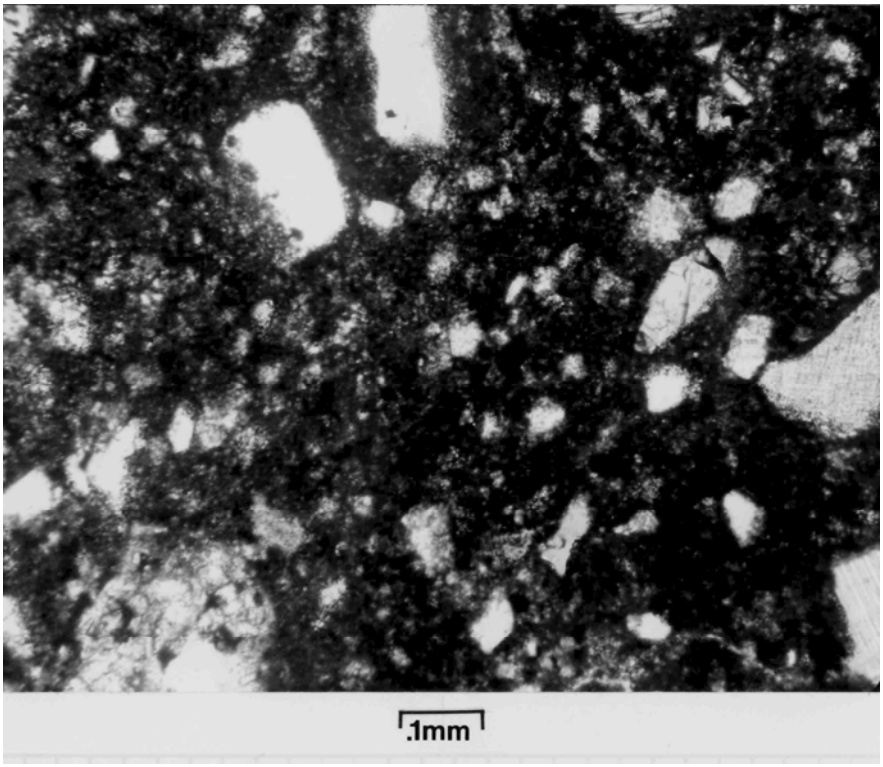

14173,17

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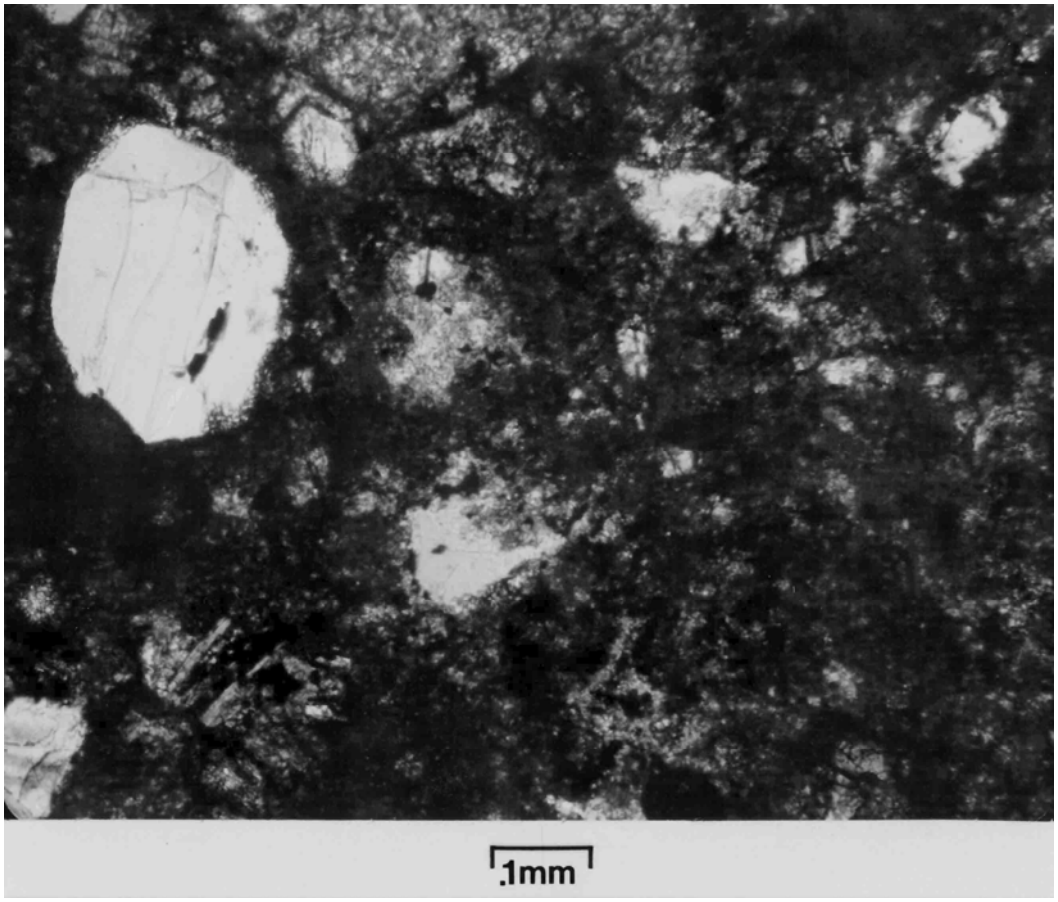

14174,5

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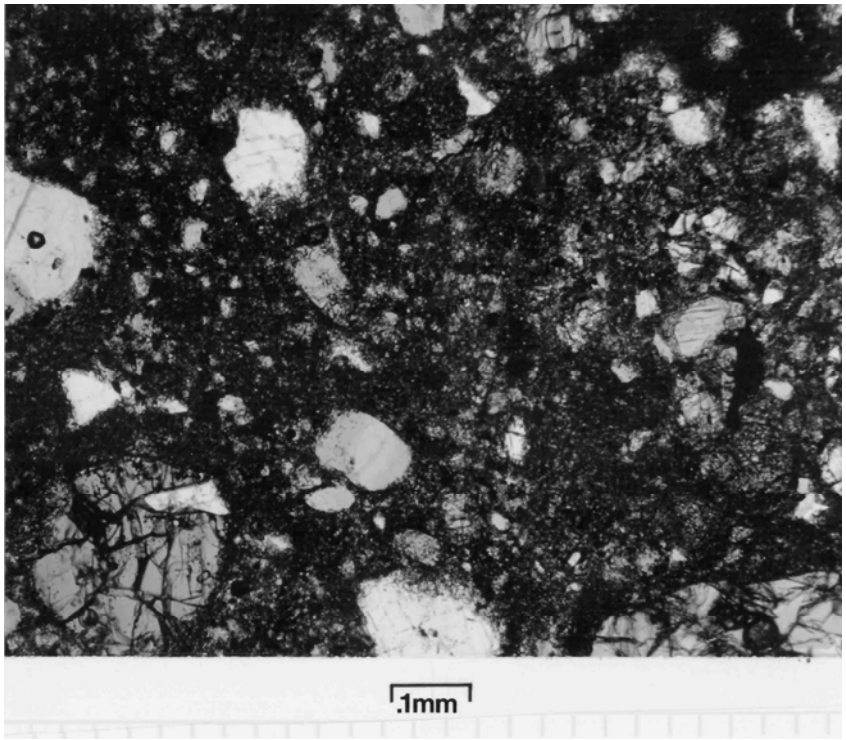

14175,3

14176: width of image is approximately 2.5 cm, S-71-26858

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14179,0

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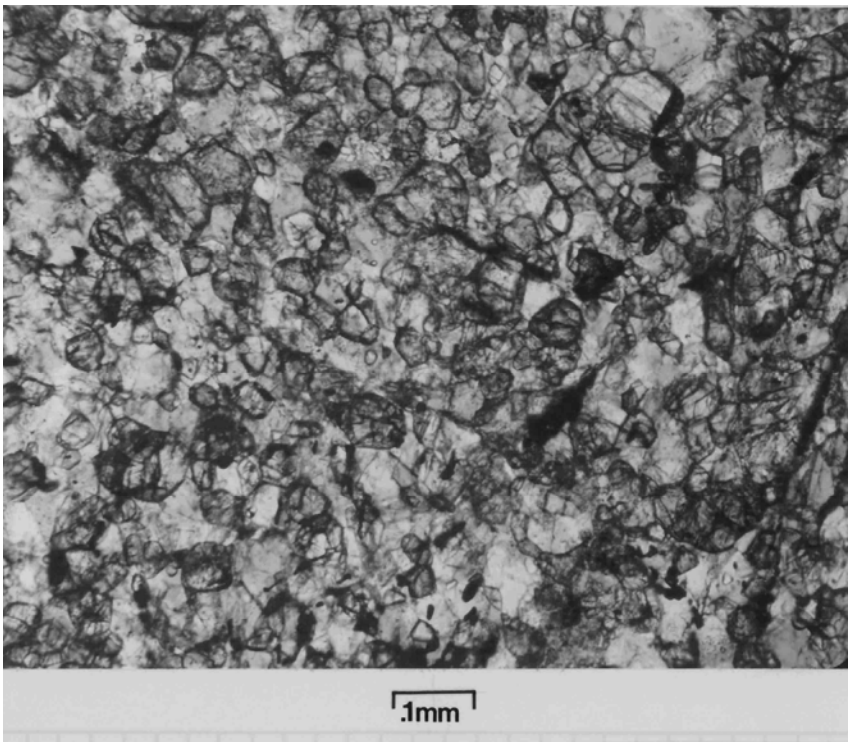

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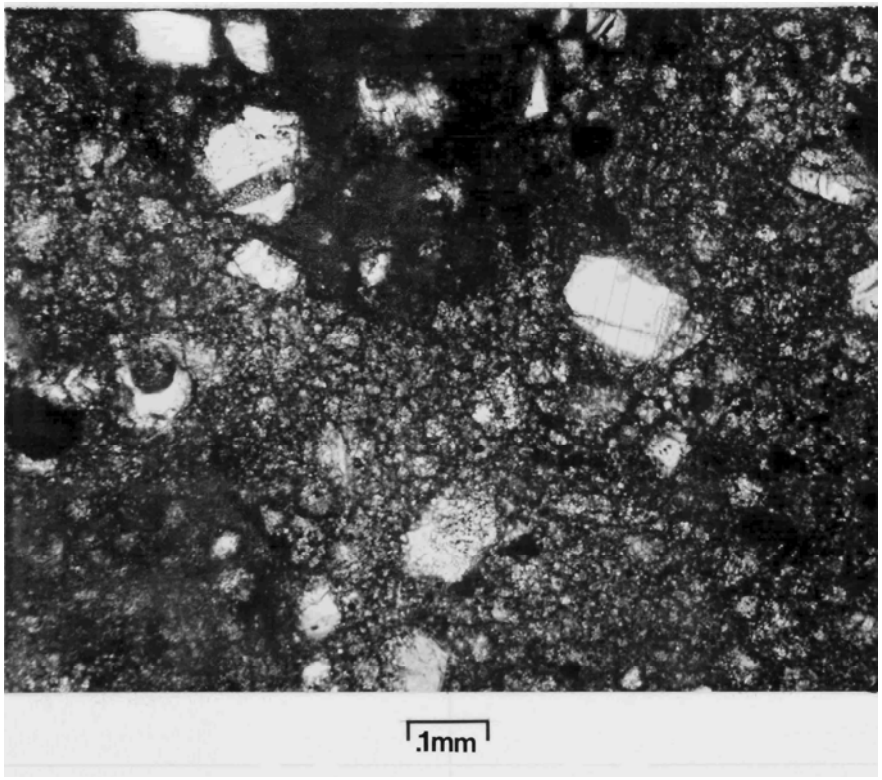

14180,3

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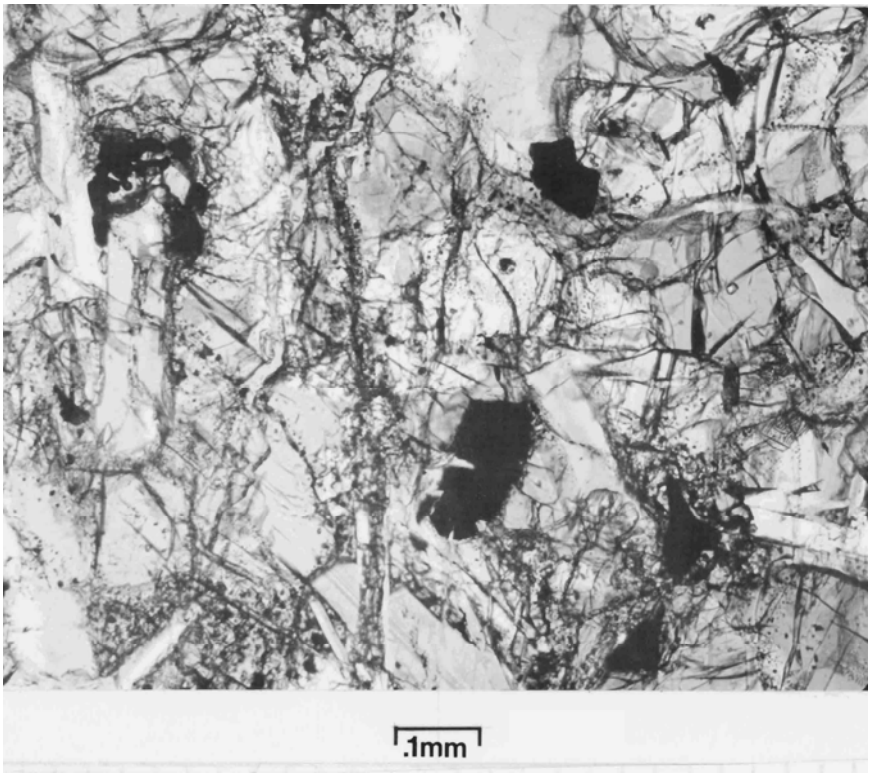

14181,5

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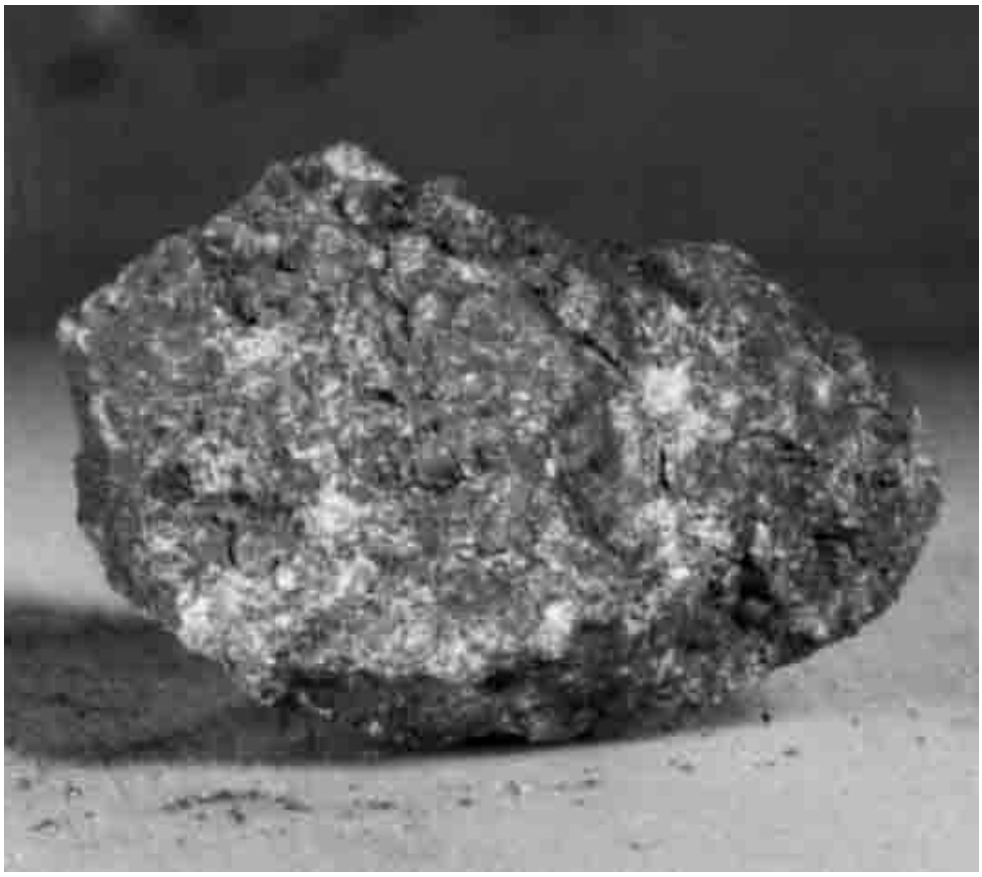

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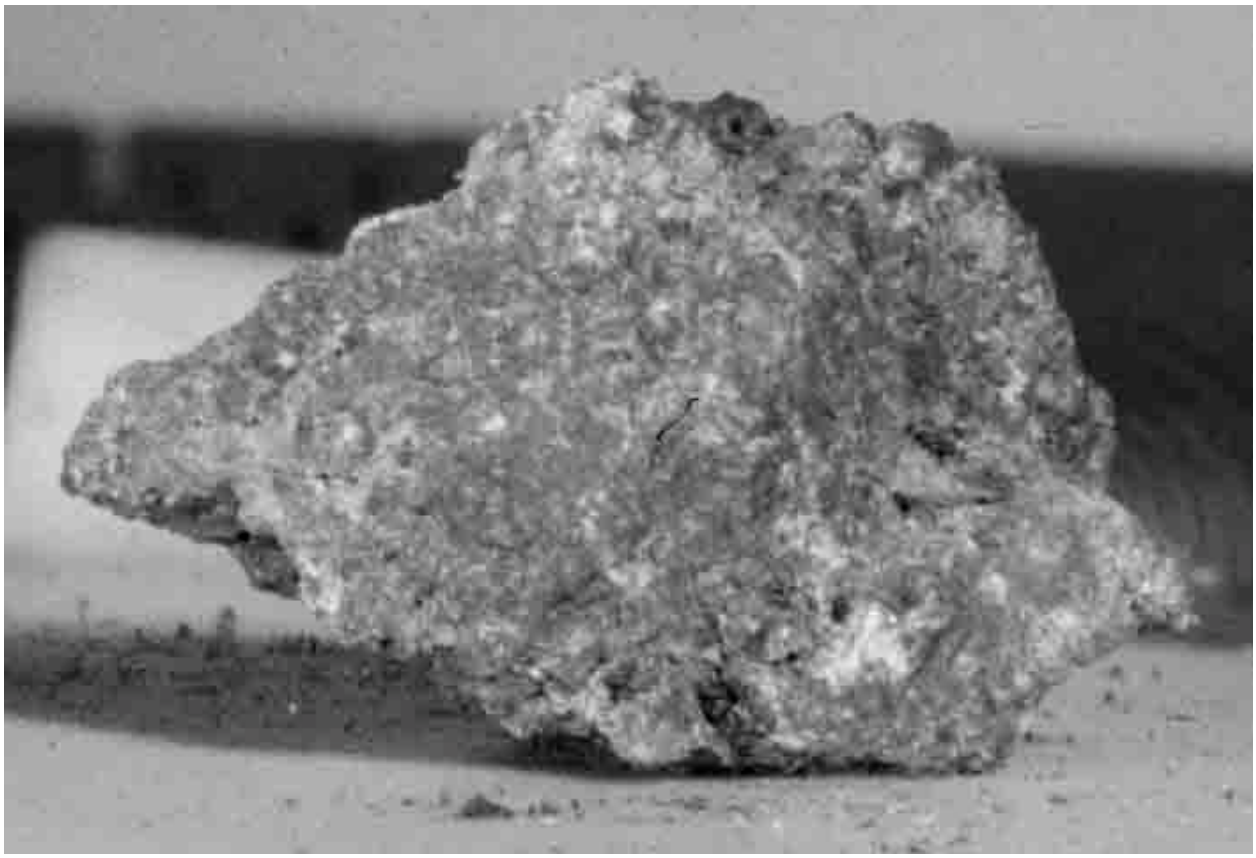

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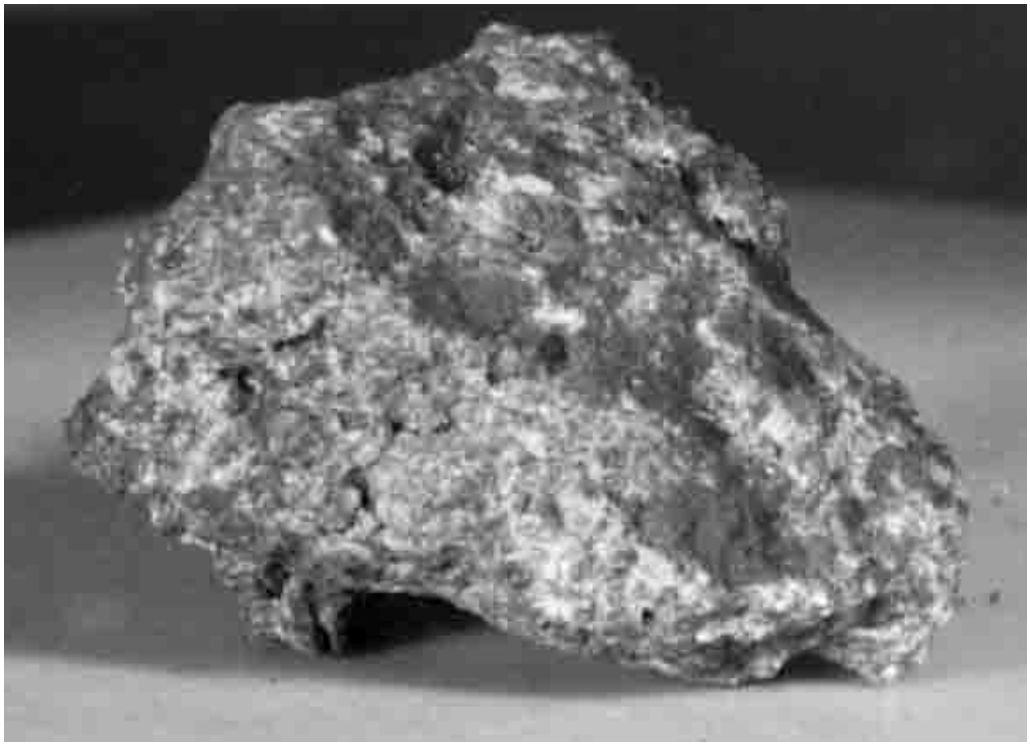

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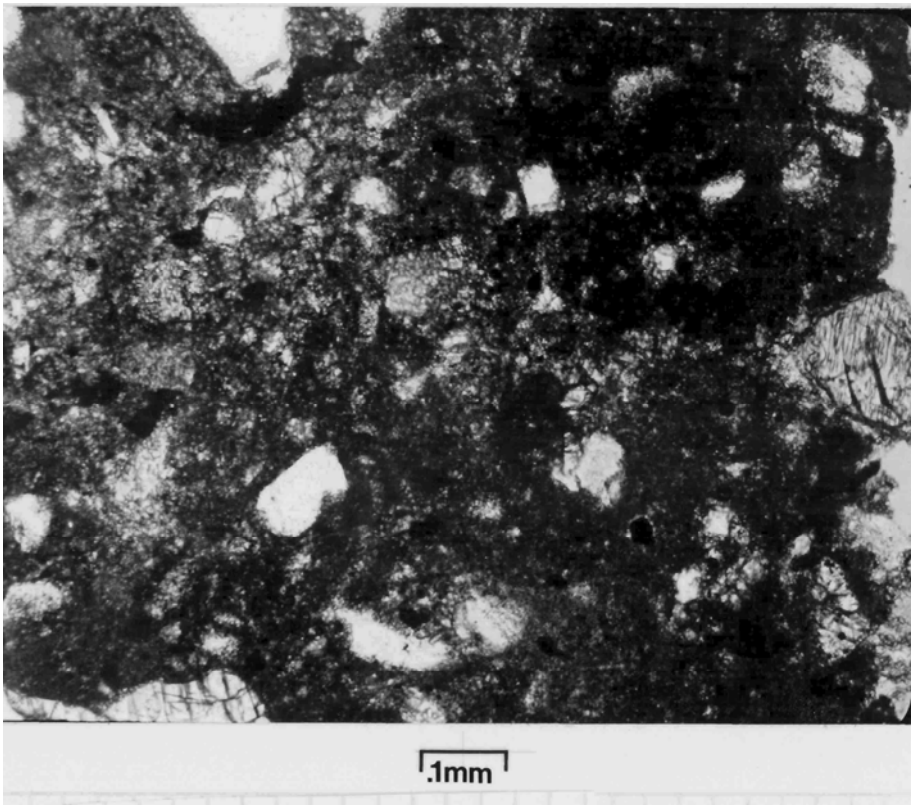
14187: width of image is approximately 1.5 cm, S-71-26957



14187,3