**76315**
Impact Melt Breccia
671 grams

*Figure 1: Location of 76315 on station 6 boulder (block 2). AS17-140-21436.*

*Figure 2: Photo of front, exposed, surface of 76315. The lack of zap pits on the upper left corner, indicate that this corner was facing down on the boulder. Cube is 1 cm. S73-17108.*
Figure 3: Fresh broken side of 76315, showing thin remnants of large white clast. About 10 cm across. S73-17109.

Figure 3: Photo of top of 76315, showing portion of thin white clast. Cube is 1 cm. S73-17104.

CDR: This is the easiest part of the rock in the world to work. Here’s a big white clast. There’s one on top about a foot and a half across, and here’s one – must be 2 feet across – 3 feet, and that’s in the blue-grey.

LMP: Well, Bob, I think I’ve done the best I can. I would – I’d say that there’re pretty clearly inclusions of the blue-grey in the anorthositic gabbro near the contact.

CC: OK. And Gene, your bag is hanging by one hook there. Be careful, if you can – or LMP...

LMP: OK, Bob, by accident – I didn’t think I could do it but I got a sample of the inclusion. And it’s in bag 539 (76315).

CDR: Hey, Jack, that’s your bag that’s hanging by one hook. Let me get it.

LMP: Oh, they’re talking to me, huh? I didn’t think they could see me. I’m way up on top. And it’s blue-grey with light colored inclusions in it. But the whole thing seems to be pretty well altered, or metamorphosed – compared to the major rock we sampled – to the other grey rock.

LMP: OK, Bob, I think that inclusion will give you an example of what this thing – what the anorthositic gabbro did to the blue-grey breccia.
Introduction
Sample 76315 was chipped from the side of the big boulder at Station 6, Apollo 17 (figure 1 and transcript). It is a micropoikilitic impact melt breccia that has been studied by many investigators, and is typical of other samples of this big boulder, which is generally thought to have been produced by the Serenitatis impact.

The crystallization age of 76315 is 3.9 b.y. with an exposure age of 22 m.y.

Petrography
Heiken et al. (1973) mapped the visible features of the Station 6 boulder and identified this blue-gray breccia sample to be from the “transitional zone” (lithology AB). The surface of 76315 was covered with patina (figure 2) such that the underlying lithology could not be discerned except on the freshly broken B1 face (figure 3). The broken surface was composed of dark grey breccia with a large irregular patch of “pink grey” material (clast 1) and a 1 x 2 cm light grey clast (2).

McGee et al. (1977), Phinney (1981) and Meyer (1994) previously made summaries of the studies conducted on 76315. The breccia matrix has finely-divided flow banding which can be seen best in the sawn surface (figure 12a). The distinct foliation is due to variations in matrix color and trains of minute vesicles. The large clasts seen in figures 3 and 4 were found to be very thin and disappointingly small in volume.

The modal mineralogy of the matrix of 76315 is about 50% plagioclase and 40% low-Ca pyroxene with minor amounts of augite, olivine, ilmenite, armalcolite and metallic iron. The grain size of the matrix feldspar is ~10 microns while pyroxene is 25-35 microns (figure 4).

Simonds et al. (1974) studied numerous small lithic class in 20 thin sections of 76315, including two poikilitic 70-80% plagioclase fragments, three granulitic 70-80% plagioclase fragments, one crushed feldspar or anorthositic fragment, three intersertal plagioclase-pyroxene-olivine fragments, one crushed olivine or dunite, one poikilitic 50-60% plagioclase, two crushed spinel-olivine fragments, one crushed troctolite fragment and three aphanitic feldspathic fragments. McGee et al. (1979) one basalt clast (1 mm) with acicular plagioclase and subhedral olivine in section 76315,95 and one dunite clast (2 mm) with polygonal olivine and symplectite in 76315,97.

Norman et al. (1993) reported on the chemical composition of mineral clasts in the matrix of 76315, with the hope that they could determine the precursor rock type(s), concluding that “troctolites” were the source of the mineral fragments. However, this doesn’t explain the relatively high trace element content (figure 9). No mineralogical evidence for “low-K Fra Mauro basalt” could be found.
**Figure 6**: Pyroxene and olivine composition of matrix and clast in 76315 (from Simonds 1975).

**Figure 7**: Ni and Co content of metal grains in 76315 (Misra et al. 1976).

**Figure 8**: Composition of plagioclase and low-Ca pyroxene in 76315.

**Significant Clasts**

**Clast 1: Feldspathic Granulite (1,3,22,52)**
Figure 3 shows a large patch of crumbly “pink-grey” material. This thin brecciated clast is aligned with the direction of foliation in the matrix forming a zone of weakness along which the rock was broken during sampling from the boulder. According to Simonds (1975) this clast is granulitic in texture with ~70% plagioclase (An,95), ~15% low-Ca pyroxene (WoEnFs) and ~15% olivine (Fo). Table 1 and figure 8 include an analysis (52). However, there may be more than one rock type present in this patch.

**Clast 2: Anorthositic breccia (46,61,62,95)**
Figure 3 shows a cm-sized light-grey clast, which also turned out to be thin (figure 12a). It has a poikilitic texture with ~70% plagioclase (An,96), ~17% low-Ca pyroxene (WoEnFs) and ~13% olivine (Fo). The minerals in this clast were found to be homogeneous in composition. An analysis (62) showed it to be Al-rich and the Ar plateau (61) showed that it may be significantly older than the matrix (figure 10). McGee et al. (1979) reported that thin section 76315,95 has a seriate size distribution of subangular plagioclase with less abundant pyroxene and olivine. The largest plagioclase grains have olivine necklaces with 50 micron overgrowths (figure 13).

**Clast xyz:**
Internal clast exposed by slab cut (see figure 12b).

**Mineralogy**

**Olivine:** Olivine in 76315 has a narrow range of composition Fo70-76.

**Pyroxene:** Simonds (1975) determined the composition of pyroxene in matrix and clasts (figure 6). The low-Ca pyroxene is WoEnFs while the high-Ca pyroxene is WoEnFs.

**Feldspar:** Plagioclase in 76315 is variable (An).

**Pink Spinel:** Simonds (1975) reports the occurrence of minor amounts of pink spinel in some areas.

**Metallic Iron:** Misra et al. (1976) determined Ni and Co in iron grains (figure 7).

**Chemistry**

Hubbard et al. (1974), Rhodes et al. (1974) and Wiesmann and Hubbard (1976) reported numerous analyses of matrix and clasts in 76315 (Table 1 and figure 9). Morgan et al. (1974), Gros et al. (1976) and Norman et al. (2002) have determined the siderophile and trace element content of the matrix of 76315. Jovanovic and Reed (1975) and Allen et al. (1975) determined F, Cl, I, Li, U, Ru, Os and Pb.
**Radiogenic age dating**

Turner and Cadogen (1975) determined the age of the station 6 boulder (figure 10). This has been confirmed by Dalrymple and Ryder (1996) who obtained an age of 3.9 b.y. (figure 11). That’s the age of Serenitatis!

Nyquist et al. (1974) found the Rb/Sr systematics of the granulite clast were aligned with other Apollo 17 granulites and gave old model ages. Silver (1974) studied U, Th and Pb isotopes in 76315.

**Cosmogenic isotopes and exposure ages**

Turner and Cadogen (1975) determined the cosmic ray exposure age of 20, 19 and 17 m.y. by the $^{38}$Ar method while Crozaz et al. (1975) determined $^{81}$Kr = 22 m.y. (see discussion in Arvidson et al. 1975). Crozaz et al. (1975) also studied cosmic ray tracks in 76315.

**Other Studies**

Crozaz et al. (1975) and Hohenburg et al. (1980) reported Xe analyses of 76315. Bogard (1974) also analysed rare gas content.

Mayeda et al. (1975) determined the isotopic composition of oxygen in plagioclase and olivine in 76315.

Nagata et al. (1975) reported magnetic data and discussed Ni/Fe phases and Brecher (1976) studied the alignment of magnetization with foliation. Magnetization of this rock was also studied by Stephenson et al. (1974), Pearce et al. (1974) and Gose et al. (1976). Housley et al. (1975) determined the ferromagnetic resonance and Huffman et al. (1975) determined the iron distribution by Mossbauer.

Adams and Charette (1975) compared the reflectance spectra with other samples (but didn’t discuss the effect of patina).

**Processing**

76315 was studied as part of the Station 6 boulder consortium (Phinney 1981).

A slab was cut through the middle of 76315 (figure 12). There are 22 thin sections.

There were about 22 grams of dirt and chips in the bag with 76315 - which might include additional chips of the white clast (someone needs to look). In addition, chips of the white clast may have fallen off during sawing of the slab (sawing is a rough operation).
### Table 1. Chemical composition of 76315.

| Reference Weight | SI02 % | TiO2 | Al2O3 | FeO | MnO | MgO | CaO | Na2O | K2O | P2O5 | SiO2 % | TiO2 | Al2O3 | FeO | MnO | MgO | CaO | Na2O | K2O | P2O5 | Sc ppm | V | Cr | Co | Ni | Cu | Zn | Ga | Ge ppb | As | Se | Rb | Sr | Y | Zr | Nb | Mo | Ru | Rh | Pd ppb | Ag ppb | Cd ppb | In ppb | Sn ppb | Sb ppb | Te ppb | Cs ppm | Ba | La | Ce | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | Hf | Ta | W ppb | Re ppb | Os ppb | Ir ppb | Pt ppb | Au ppb | Th ppm | U ppm |
|-----------------|--------|------|-------|-----|-----|-----|-----|------|-----|-----|--------|------|------|------|-----|-----|-----|-----|------|-----|-----|------|---|---|---|---|---|---|---|------|---|---|---|---|---|---|---|------|---|---|---|---|---|---|---|
| Norman2002      | 46.6   | 1.4  | 18.3  | 8.02| 0.1 | 12  | 11   | 0.65 | 0.21| 0.21 | 18.2 | 31.2 | 46.3 | 283 | 12.1 | 13.8 | 5.1 | 58   | 71  | 182 | 113 | 493 | 35.1 | 6.77 | 7.87 | 0.12 | 23  | 355 | 28.6 | 72.5 | 9.99 | 45.8 | 13.1 | 1.83 | 14.6 | 2.59 | 16.5 | 3.61 | 10.3 | 3.81 | 9.43 | 1.37 | 10.1 | 1.5 | 0.86 | 0.36 | 1.5  | 1.22 | 1.22 | 0.82 | 1.67 | 373 | 34 | 88.3 | 99.9 |
| Dalrymple96 melt| 45.6   | 1.5  | 18.8  | 9.53| 0.13| 12.5 | 15.12| 0.47 | 0.097| 0.06 | 16.3 | 31.5 | 26.3 | 83  | 0.07 | 1.4  | 95  | 330  | 95  | 179  | 135 | 301  | 137 | 3.3  | 3.3  | 0.22 | 0.22 | 373 | 34 | 88.3 | 99.9 |
| Hubbard74       | 46.45  | 1.5  | 18.8  | 8.83 | 0.13 | 12.5 | 15.12| 0.47 | 0.097| 0.06 | 16.3 | 31.5 | 26.3 | 83  | 0.07 | 1.4  | 95  | 330  | 95  | 179  | 135 | 301  | 137 | 3.3  | 3.3  | 0.22 | 0.22 | 373 | 34 | 88.3 | 99.9 |
| Wiesmann76       | 46.21  | 1.5  | 18.8  | 8.95 | 0.12 | 13.5 | 15.12| 0.47 | 0.097| 0.06 | 16.3 | 31.5 | 26.3 | 83  | 0.07 | 1.4  | 95  | 330  | 95  | 179  | 135 | 301  | 137 | 3.3  | 3.3  | 0.22 | 0.22 | 373 | 34 | 88.3 | 99.9 |
| Rhodes 74        | 48.57  | 1.5  | 18.8  | 7.66 | 0.13 | 13.5 | 15.12| 0.47 | 0.097| 0.06 | 16.3 | 31.5 | 26.3 | 83  | 0.07 | 1.4  | 95  | 330  | 95  | 179  | 135 | 301  | 137 | 3.3  | 3.3  | 0.22 | 0.22 | 373 | 34 | 88.3 | 99.9 |

| Technique: (a) ICP-MS, (b) fused-bead, e-probe, (c) INAA, (d) IDMS, (e) XRF, (f) RNAA

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Lunar Sample Compendium
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Figure 12a, b: Front and back sides of slab cut through the middle of 76315. Cube is 1 cm. Top is S73-35833; bottom is 34145. Note how thin the “white clast” is.
References for 76315


Simonds C.H., Phinney W.C., Warner J.L. and Heiken G.H. (1975) Thermal regimes in crater debris as deduced from


Figure 13: Plagioclase-rich clast with olivine necklace in large plagioclase grain (0.7 mm). 76315,95 (clast 2?). From McGee et al. (1979).