

65315

Cataclastic Anorthositic with glass coat

300 grams



Figure 1: Photo of 65315. Sample is about 8 cm across. This side was glass coated. NASA S72-42565.

Introduction

65315 is a chemically pristine lunar anorthosite that has been crushed, but not highly shocked. It had a black glass coating on one side (possibly all sides) that has broken off during meteorite bombardment and during the trip to earth and processing in laboratory (figure 1 and 2). The other side is covered with micrometeorite pits and the sample is generally rounded (figure 3). 65315 was placed in the bag with the rake samples from that location (lower slope of Stone Mountain).

65325 and 65327 (from the same sample bag) both have textures and mineralogy similar to 65315. 65366

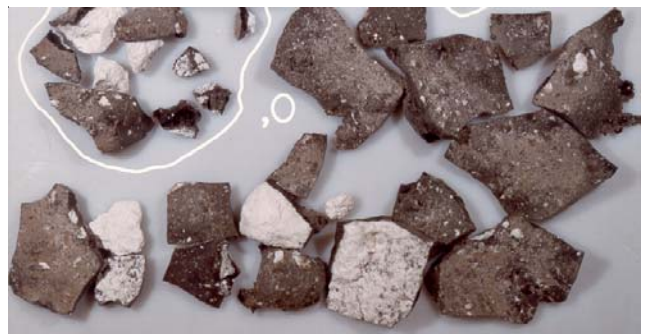


Figure 2: Sample 65366. Additional glass chips found in same bag and probably from 65315. NASA S82-29748. Each about 1 cm.



Figure 3: Photo of 65315. NASA S72-39419. Sample is about 8 cm across. Note abundant micrometeorite pits and patina on this surface. Location of saw cut is indicated.

(figure 2) is probably the glass coating that was originally attached to 65315.

65315 has not been successfully dated, but it has a relatively young cosmic-ray exposure age of 1.3 – 1.8 m.y.

Petrography

65315 is a badly crushed, ferroan anorthosite with relic plagioclase grains up to 4 mm long (figure 4). The only mafic mineral reported is pyroxene which is found at grain boundaries. All grains exhibit undulose extinction (due to shock) but shock melting and/or recrystallization was not observed (Ryder and Norman 1980).

McGee (1993) describe 65315 as: “*Cataclastic anorthosite 65315 has plagioclase fragments with seriate grain size, as much as 3 mm across. Rare equant pyroxene fragments are generally less than 0.1 mm across and have no visible (i.e. greater than ~ 0.1 micron) exsolution lamellae. Some equant pyroxenes are included in plagioclase. Rare relict intergranular texture is preserved. Low-Ca pyroxene compositions are somewhat variable. Plagioclase and pyroxene compositions are similar to those reported by Dixon*

Mineralogical Mode for 65315

| | Dixon and Papike 1975 |
|---------------|----------------------------------|
| Plagioclase | 98.5 % |
| Orthopyroxene | 1.2 |
| Clinopyroxene | 0.2 |
| Opaque | 0.3 |

and Papike (1975). Rare chromite, ilmenite, and (Zn,Fe)S occur adjacent to or included in, pyroxene.”

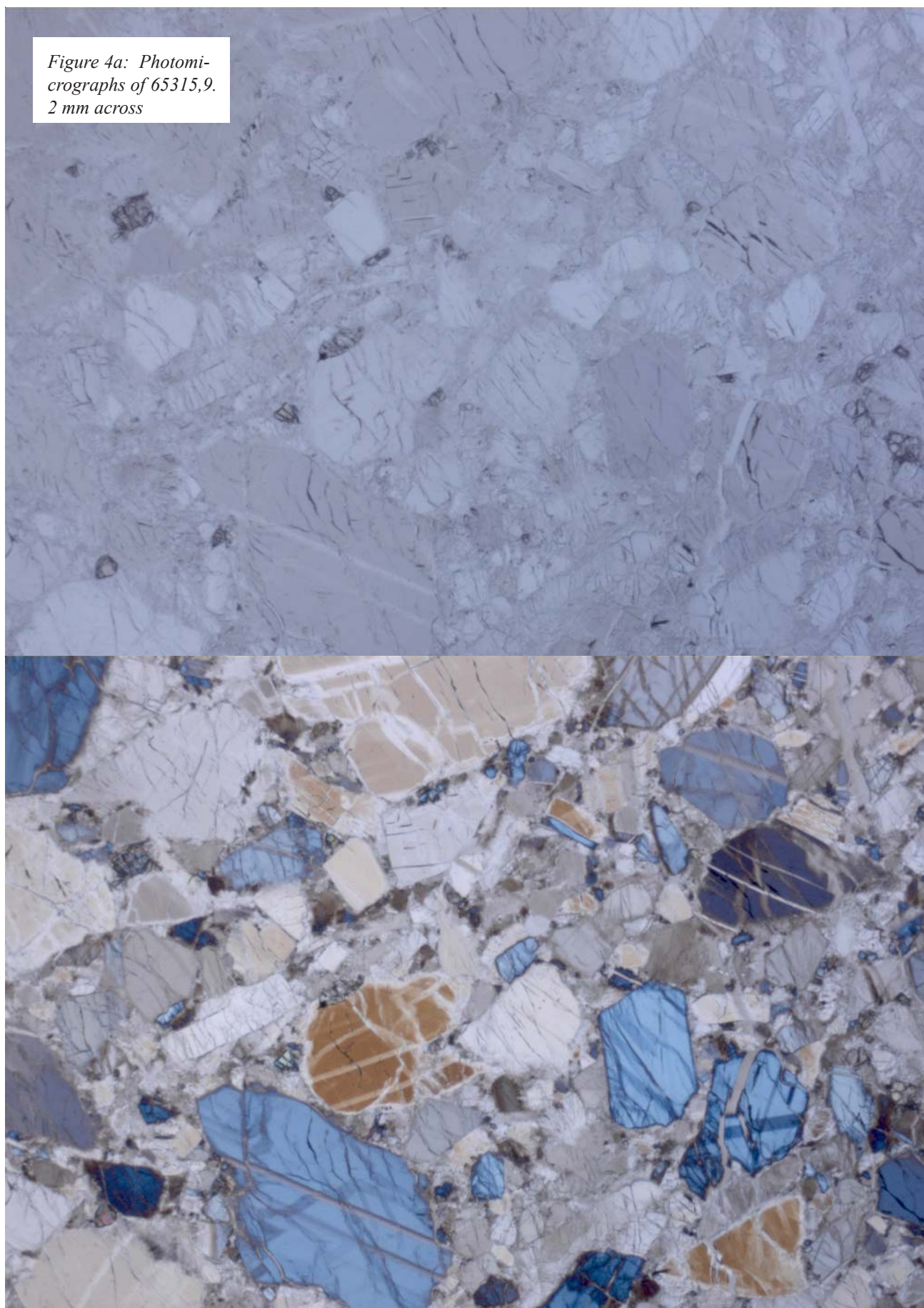
Mineralogy

Olivine: none

Pyroxene: Dixon and Papike (1975) found the pyroxene was $Wo_{43}En_{41}$ and Wo_2En_{65} (figure 5). McGee (1993) found pyroxenes were slightly more Fe rich.

Plagioclase: Dixon and Papike (1975) determined plagioclase to be homogeneous at $An_{97.5}$. Meyer (1979) and McGee (1993) determined the trace element content of plagioclase (figure 6).

*Figure 4a: Photomicrographs of 65315,9.
2 mm across*



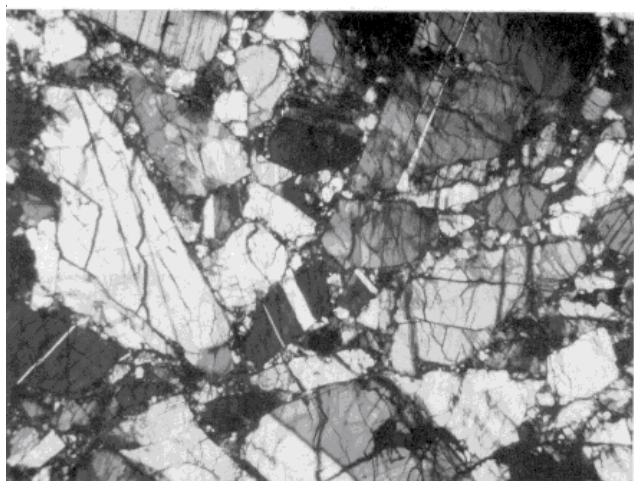


Figure 4b: Thin section photomicrograph of 65315,4 with crossed polarized light. Field of view is 2 mm. (from Ryder and Norman 1980)

Glass: See et al. (1986) and Morris et al. (1986) studied the glass coating.

Metal: Mehta and Goldstein (1980) studied the metal particles from the glass (figure 7).

Chemistry

Wanke et al. (1974) and Ebihara et al. (1992) determined the chemical composition of this anorthosite, while Morris et al. (1986) and See et al. (1986) analyzed the glass coating (figure 9).

Warren and Wasson (1983) used 65315 to define what it means for a lunar sample to be “pristine”.

Radiogenic age dating

Stettler et al. (1974) were not able to get a plateau in the Ar release (figure 10).

Cosmogenic isotopes and exposure ages

Stettler et al. (1974) and Eberhardt et al. (1975) determined exposure ages of 1.8 m.y. and 1.6 m.y. respectively, by ^{38}Ar . Eberhardt et al. (1975) found 1.5 ± 0.7 m.y. by ^{81}Kr and Gopalan and Rao (1976) reported 1.5 m.y. by ^{21}Ne . Finally, Eugster et al. (1984) determined the age by ^{81}Kr was 1.3 ± 0.7 b.y. – linking it to the ejecta from South Ray Crater.

Other Studies

Leich et al. (1974) found significant amounts of F on the surface of 65315 (probably contamination). Filleux

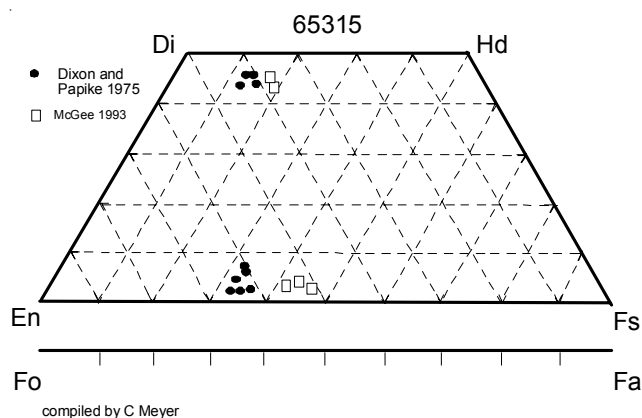


Figure 5: Pyroxene composition of 65315 (from Dixon and Papike 1975; McGee 1993).

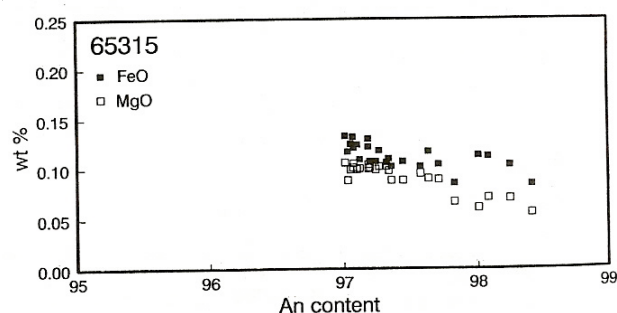


Figure 6: Composition of plagioclase in 65315 (McGee 1993).

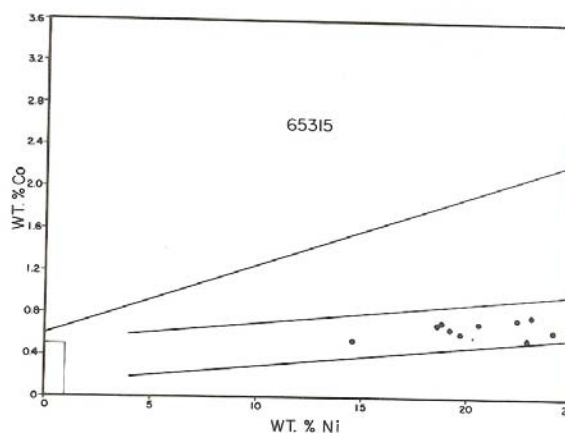


Figure 7: Composition of metallic particles in glass from 65315 (Mehta and Goldstein 1980).

et al. (1977) looked for solar wind-implanted carbon (without success). Nagel et al. (1976) and Hartung et al. (1978) studied the glass linings of micrometeorite pits. Gopalan and Rao (1976) studied the solar cosmic ray interaction with this friable sample.

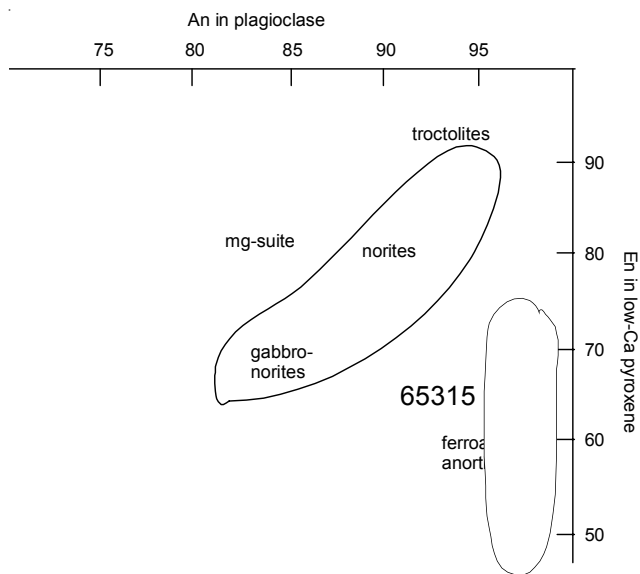


Figure 8: Composition of plagioclase and orthopyroxene in 65315 (from Dixon and Papike 1975) compared with rock types found in lunar highlands.

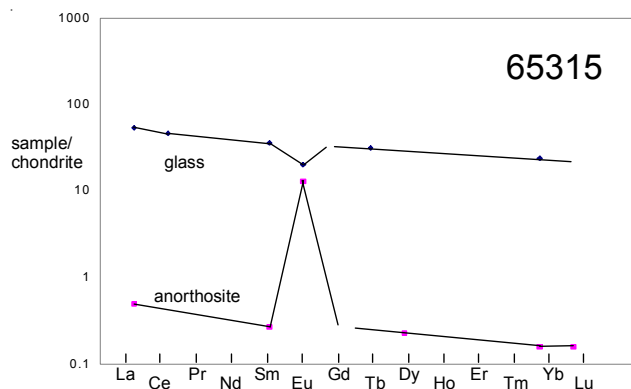


Figure 9: Normalized rare-earth-element diagram for 65315 (data from Wanke et al. 1974 and Morris et al. 1986).

Processing

65315 was sawn (figure 11) and the end piece was broken for distribution (figure 12). There are 19 thin sections of 65315.

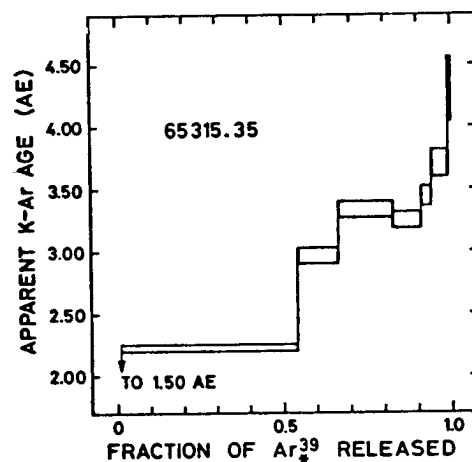


Figure 10: Ar⁴⁰/Ar³⁹ diagram for 65315 (Stettler et al. 1974).

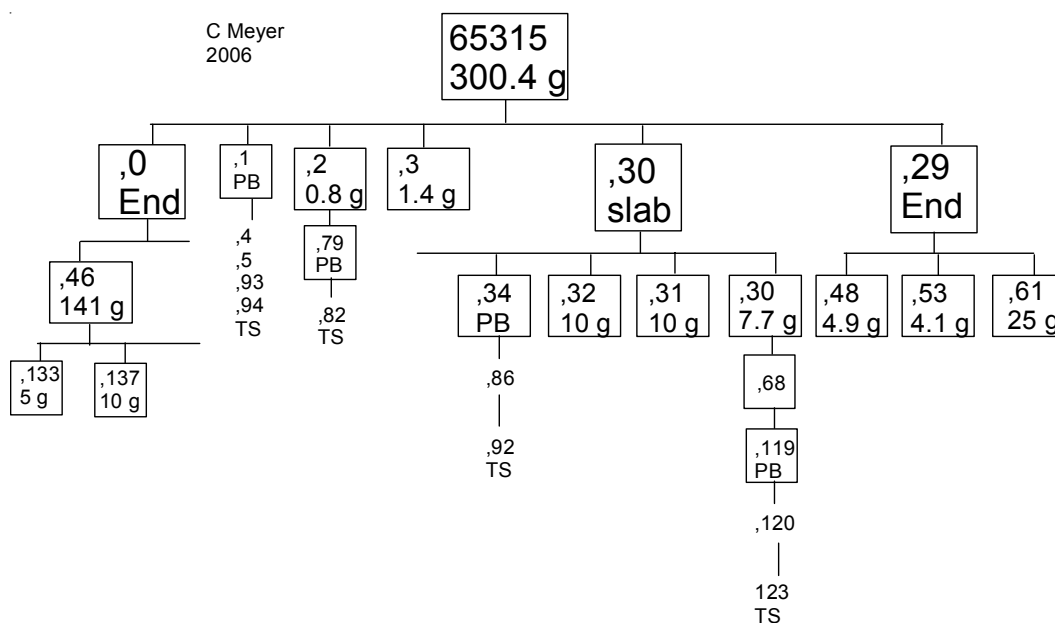


Table 1. Chemical composition of 65315 (and 65366).

| | glass | | | | | | |
|--------------------------------|------------|-------|-----|--------|------------|------------|-------------|
| reference | Morris 86 | glass | | See 86 | Wanke 74 | Ebihara 92 | |
| weight | 65315 | 65366 | | anor | | | |
| SiO ₂ % | 44.59 | 44.54 | (a) | 44.3 | (c) 44.3 | (b) | |
| TiO ₂ | 0.4 | 0.38 | (a) | 0.01 | (c) 0.01 | (b) | |
| Al ₂ O ₃ | 25.7 | 25.56 | (a) | 34.87 | (c) 34.86 | (b) | |
| FeO | 6.34 | 6.48 | (a) | 0.31 | (c) 0.31 | (b) | |
| MnO | 0.07 | 0.08 | (a) | 0.01 | (c) 0.008 | (b) | |
| MgO | 7.8 | 7.9 | (a) | 0.25 | (c) 0.25 | (b) | |
| CaO | 14.42 | 14.39 | (a) | 19.07 | (c) 19.1 | (b) | |
| Na ₂ O | 0.42 | 0.4 | (a) | 0.3 | (c) 0.3 | (b) | |
| K ₂ O | 0.11 | 0.07 | (a) | 0.01 | (c) 0.007 | (b) | |
| P ₂ O ₅ | | | | | 0.01 | (b) | |
| S % | | | | | | | |
| sum | | | | | | | |
| Sc ppm | 6.46 | 6.9 | (b) | | 0.39 | (b) | |
| V | | | | | | | |
| Cr | 923 | 1013 | (b) | | | | |
| Co | 67 | 73 | (b) | | 0.58 | (b) | |
| Ni | 1103 | 1416 | (b) | | 1.4 | (b) | <1.22 (d) |
| Cu | | | | | 2.1 | (b) | |
| Zn | | | | | 93 | (b) | 53 (d) |
| Ga | | | | | 3.25 | (b) | |
| Ge ppb | | | | | | | 4.59 (d) |
| As | | | | | 2 | (b) | |
| Se | | | | | | | 6.78 (d) |
| Rb | | | | | 0.17 | (b) | 0.087 (d) |
| Sr | | | | | 167 | (b) | |
| Y | | | | | 0.3 | (b) | |
| Zr | | | | | 15 | (b) | |
| Nb | | | | | 0.2 | (b) | |
| Mo | | | | | | | |
| Ru | | | | | | | |
| Rh | | | | | | | |
| Pd ppb | | | | | | | <0.49 (d) |
| Ag ppb | | | | | | | 0.89 (d) |
| Cd ppb | | | | | | | 279 (d) |
| In ppb | | | | | | | 21.6 (d) |
| Sn ppb | | | | | | | |
| Sb ppb | | | | | | | 0.3 (d) |
| Te ppb | | | | | | | 0.93 (d) |
| Cs ppm | | | | | 0.015 | (b) | 0.0089 (d) |
| Ba | 441 | 151 | (b) | | 4.8 | (b) | |
| La | 12.6 | 11.8 | (b) | | 0.12 | (b) | |
| Ce | 28.5 | 33.6 | (b) | | | | 0.251 (d) |
| Pr | | | | | | | |
| Nd | | | | | | | 0.22 (d) |
| Sm | 5.32 | 5.6 | (b) | | 0.04 | (b) | |
| Eu | 1.14 | 1.05 | (b) | | 0.74 | (b) | 0.748 (d) |
| Gd | | | | | | | |
| Tb | 1.15 | 1.21 | (b) | | | | 0.0057 (d) |
| Dy | | | | | 0.056 | (b) | |
| Ho | | | | | | | |
| Er | | | | | | | |
| Tm | | | | | | | |
| Yb | 3.85 | 3.65 | (b) | | 0.026 | (b) | 0.0137 (d) |
| Lu | 0.53 | 0.52 | (b) | | 0.004 | (b) | 0.0019 (d) |
| Hf | 3.74 | 3.82 | (b) | | 0.49 | (b) | |
| Ta | | 0.51 | (b) | | | | |
| W ppb | | | | | 0.019 | (b) | |
| Re ppb | | | | | | | 0.0019 (d) |
| Os ppb | | | | | | | <0.07 (d) |
| Ir ppb | | | | | | | 0.011 (d) |
| Pt ppb | | | | | | | |
| Au ppb | | | | | 1 | (b) | <0.0025 (d) |
| Th ppm | 2.54 | 2.85 | (b) | | | | |
| U ppm | 0.81 | 0.5 | (b) | | <0.0006 | (b) | 0.00094 (d) |

technique: (a) emp, (b) INAA, (c) tabulation, (d) RNAA

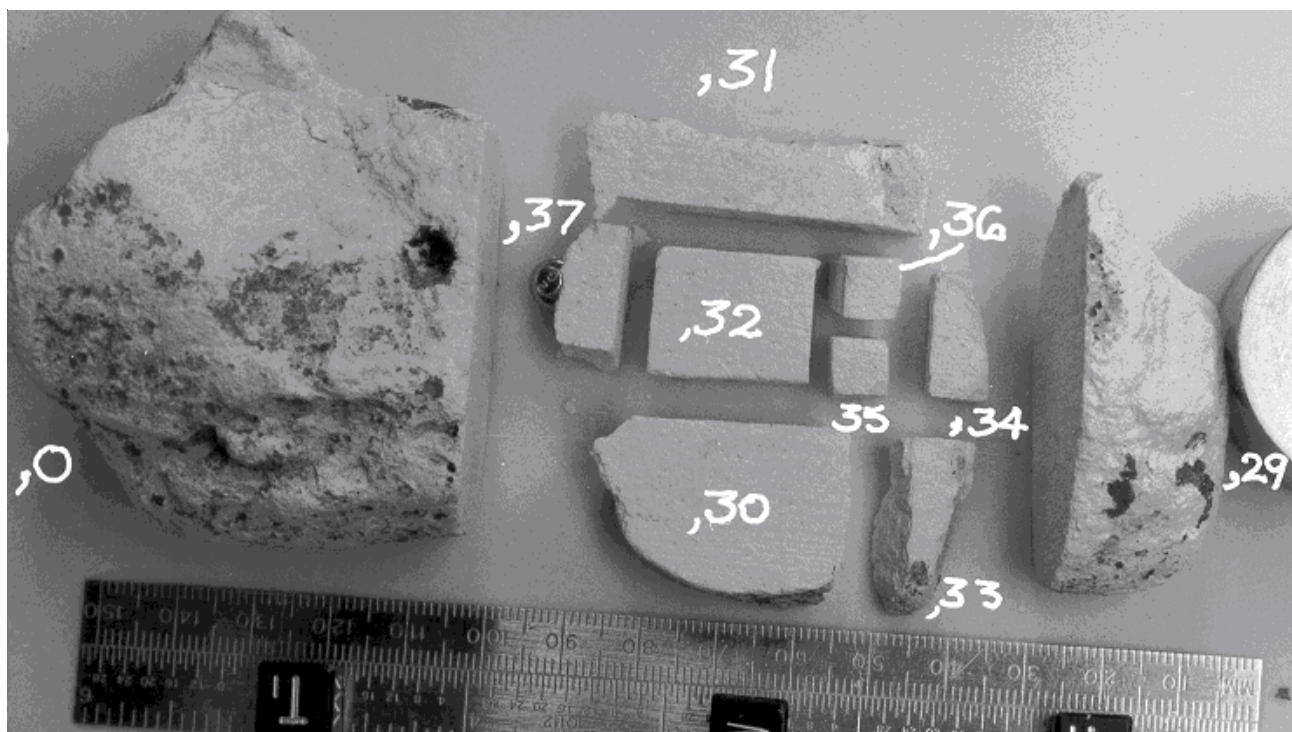


Figure 11: Group photo of 65315 after saw cut. Cube is 1 cm. NASA S73-28310.

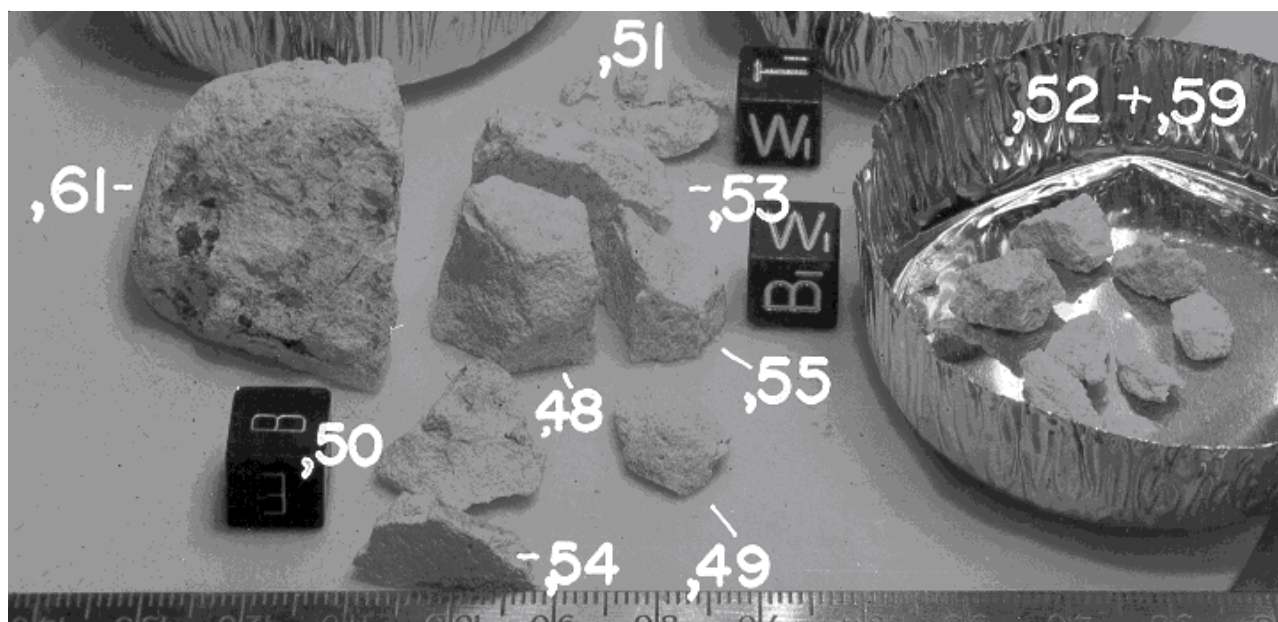


Figure 12: Splitting of 65315,29. Cubes are 1 cm. NASA S73-28409.



Figure 13: Sawn surface of 65315,46. Scale 3 cm across. NASA S73-28409.

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