

10049
Ilmenite Basalt (high K)
193 grams



Figure 1: Photo of 10049. Sample is 6 cm long. NASA S76-25449.

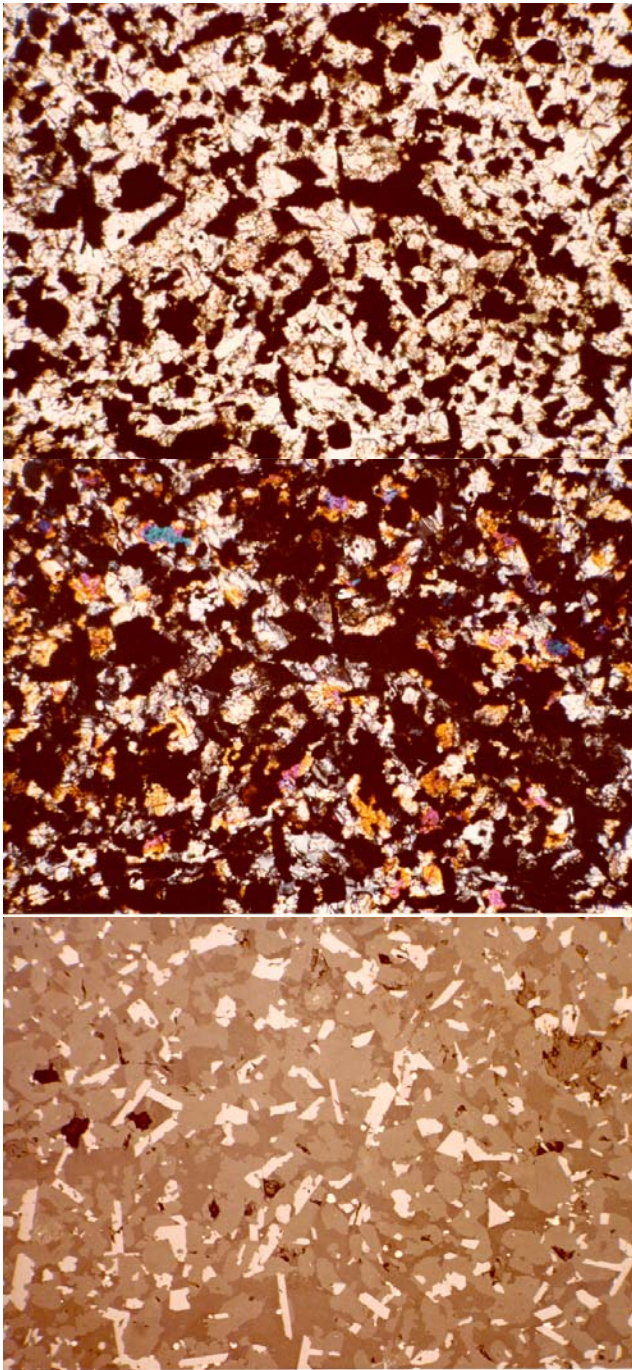


Figure 2: Photomicrographs of thin section 10049,32 (top: plane-polarized, middle: crossed Nicols, bottom: reflected light). Scale is 0.68 mm. NASA S79-270887, 88 and 89.

Introduction

Lunar sample 10049 is a high-K ilmenite basalt with a fine-grained intersertal texture (figure 1). It has an age of about 3.5 b.y. with exposure to cosmic rays for ~20 m.y.

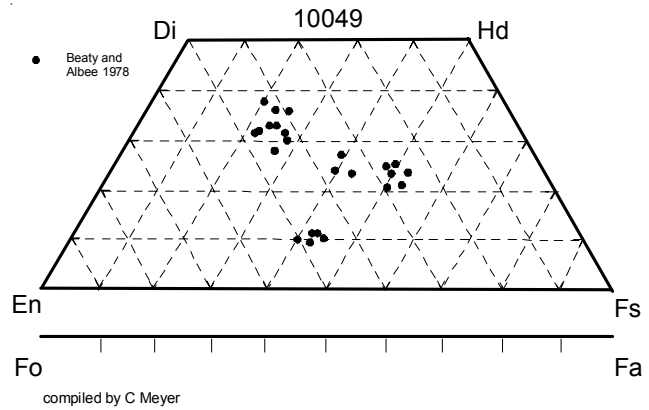


Figure 3: Pyroxene composition of 10049.

Petrography

Schmitt et al. (1970) termed 10049 as a “very-fine-grained, vesicular to vuggy, granular basalt.” McGee et al. (1977) describe 10049 as a fine-grained intersertal basalt which consists of a network of intergrown crystals of anhedral pyroxene (0.02-0.08 mm), plagioclase (0.03-1.1 mm), ilmenite (0.01-0.1 mm) and rare olivine (0.04 mm). A few small round vesicles (0.1-0.3 mm) are seen in thin sections. Mesostasis includes glass, troilite with metallic iron blebs and other minerals.

Mineralogy

Pyroxene: Beatty and Albee (1978) determined the composition of pyroxene (figure 3).

Plagioclase: Stewart et al. (1970) determined the crystallographic data for plagioclase (An73) in 10049.

Ilmenite: Beatty and Albee (1978) and Cameron (1970) gives the composition of ilmenite, while Stewart et al. (1970) reported the cell dimensions.

Chemistry

The chemical composition of 10049 is typical of the high K, Apollo 11 basalts (figures 4 and 5). Kaplan et

Mineralogical Mode for 10049

| | Beatty and Albee 1978 | McGee et al. 1977 |
|-------------|-----------------------|-------------------|
| Olivine | | |
| Pyroxene | 51.03 | 47 |
| Plagioclase | 24.47 | 18 |
| Ilmenite | 14.12 | 16 - 17 |
| mesostasis | 8 | 18 |
| silica | 1.38 | |
| troilite | 0.72 | 1 |
| phosphate | 0.27 | |

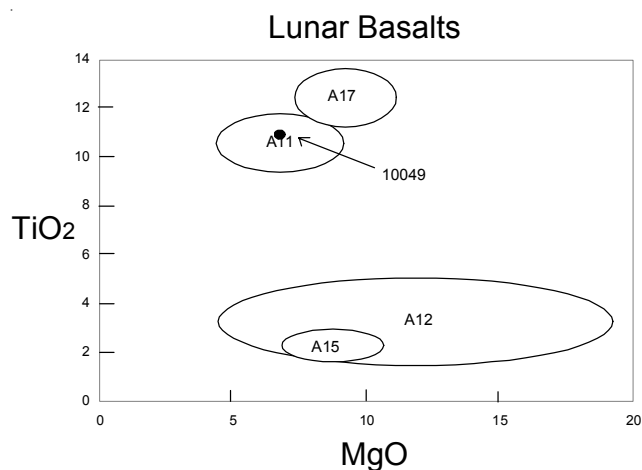


Figure 4: Composition of 10049 compared with that of other Apollo lunar samples.

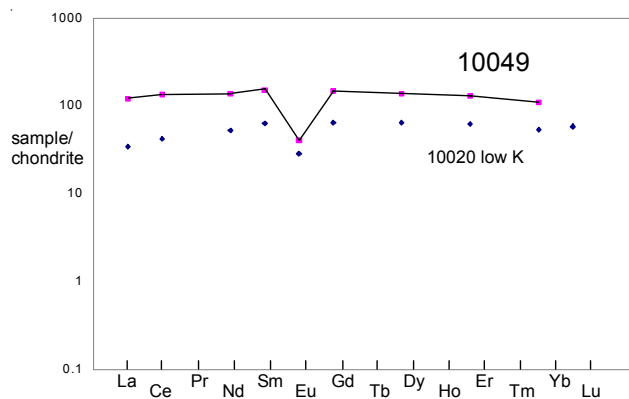


Figure 5: Normalized rare-earth-element composition for high-K basalt 10049 (the line) compared with that of low-K basalt 10020 (the dots) (data from Wiesmann et al. 1975).

al. (1970) reported 63 and 77 ppm carbon and 2200 ppm sulfur in 10049. Moore et al. (1970) reported 70 ± 8 ppm carbon and 166 ± 4 ppm nitrogen in 10049.

Radiogenic age dating

Geiss et al. (1977) reported an age of $\sim 3.45 \pm 0.04$ b.y. from an intermediate plateau for Ar release (figure 6).

Cosmogenic isotopes and exposure ages

Hintenberger et al. (1971) and Guggisberg et al. (1979) determined $^{37}\text{Ar}/^{38}\text{Ar}$ exposure ages of 36 m.y. and 21 m.y., respectively.

Other Studies

The total organic carbon content of 10049 was determined by hydrogen flame ionization pyrolysis (Ponnamperuma et al. 1970). Kaplan et al. (1970) determined the isotopic composition of carbon and sulfur in 10049.

Hintenberger et al. (1971), Funkhouser et al. (1970) and Bogard et al. (1971) reported the abundance and isotopic composition of rare gasses from 10044.

Fuller (1979) studied the magnetism.

Processing

Apollo 11 samples were originally described and cataloged in 1969 and “re-cataloged” by Kramer et al. (1977). There are 10 thin sections.

List of Photo #s for 10049

- | | |
|------------------|----------|
| S69-45684 – 717 | B&W mug |
| S69-47337 – 9 | |
| S69-57241 | |
| S69-59273 | TS B&W |
| S69-59283 | |
| S69-59347 | |
| S69-59352 | |
| S69-59413 | |
| S69-59854 | |
| S70-17980 – 1 | TS color |
| S70-48995 – 9000 | |
| S70-49447 – 8 | |
| S70-49475 – 6 | |
| S72-41428 – 9 | display |
| S72-41336 – 9 | |
| S76-25446 – 56 | |
| S76-26330 – 1 | |
| S79-27087 – 9 | |

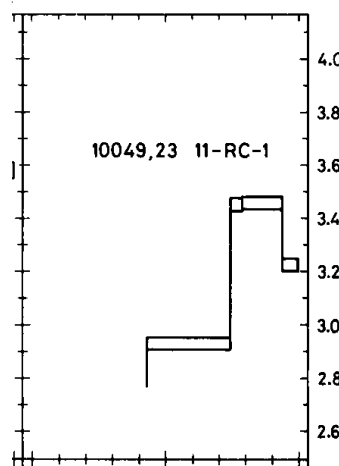


Figure 6: Ar release pattern for 10049 from Guggisberg et al. (1979).

Summary of Age Data for 10049

| | |
|-------------------|--------------------------------|
| | Ar/Ar |
| Geiss et al. 1977 | $(3.45 \pm 0.04 \text{ b.y.})$ |

Table 1. Chemical composition of 10049.

| reference weight | Gast70 | | Wiesmann75 | | Rose70 | Wanke71 | Kharkar71 | Beaty78 | Neal2001 | |
|--------------------------------|--------|------|------------|-------|----------|----------|-----------|-----------|----------|----------|
| SiO ₂ % | | | | | 41 | (c) 42.8 | (d) | 41.56 | (e) | |
| TiO ₂ | | | | | 11.3 | (c) 8 | (d) 11.2 | (d) 11.51 | (e) | |
| Al ₂ O ₃ | | | | | 9.5 | (c) 8.5 | (d) | 7.95 | (e) | |
| FeO | | | | | 18.7 | (c) 18.1 | (d) 17.6 | (d) 19.21 | (e) | |
| MnO | | | | | 0.25 | (c) 0.21 | (d) 0.22 | (d) 0.24 | (e) | |
| MgO | | | | | 7.03 | (c) 7.3 | (d) | 7.54 | (e) | |
| CaO | | | | | 11 | (c) 8.81 | (d) 10.8 | (d) 10.93 | (e) | |
| Na ₂ O | 0.54 | | (a) 0.54 | | (a) 0.71 | (c) 0.48 | (d) 0.51 | (d) 0.47 | (e) | |
| K ₂ O | 0.33 | 0.35 | (b) 0.33 | 0.35 | (b) 0.36 | (c) 0.27 | (d) | 0.31 | (e) | |
| P ₂ O ₅ | | | | | | | | 0.15 | (e) | |
| S % | | | | | | | | 0.38 | (e) | |
| sum | | | | | | | | | | |
| Sc ppm | | | | | | | 80.9 | (d) 86 | (d) | 75.4 (f) |
| V | | | | | | | | | | 40.5 (f) |
| Cr | | | | | 2190 | (c) 1960 | (d) 2100 | (d) 2330 | (e) | 1692 (f) |
| Co | | | | | | 24 | (d) 23 | (d) | | 25.2 (f) |
| Ni | | | | | | | | | | 6.34 (f) |
| Cu | | | | | | | | | | 49.9 (f) |
| Zn | | | | | | | | | | 77.4 (f) |
| Ga | | | | | | 4.3 | (d) | | | 4.9 (f) |
| Ge ppb | | | | | | | | | | |
| As | | | | | | | | | | |
| Se | | | | | | | | | | |
| Rb | 6.24 | 6.2 | (b) 6.24 | 6.2 | (b) | | | | | 7.27 (f) |
| Sr | 161 | | (b) 161 | | (b) | 180 | (d) | | | 177 (f) |
| Y | | | | | | | | | | 197 (f) |
| Zr | | | | | 300 | (c) | | | | 472 (f) |
| Nb | | | | | | | | | | 30.3 (f) |
| Mo | | | | | | | | | | |
| Ru | | | | | | | | | | 0.12 (f) |
| Rh | | | | | | | | | | |
| Pd ppb | | | | | | | | | | |
| Ag ppb | | | | | | | | | | |
| Cd ppb | | | | | | | | | | |
| In ppb | | | | | | 16 | (d) | | | |
| Sn ppb | | | | | | | | | | |
| Sb ppb | | | | | | | | | | 230 |
| Te ppb | | | | | | | | | | |
| Cs ppm | 0.166 | 0.18 | (b) 0.166 | 0.177 | (b) | | | | | 0.16 (f) |
| Ba | 338 | 330 | (b) 338 | 330 | (b) | 202 | (d) | | | 310 (f) |
| La | 29.2 | 28.8 | (b) 29.2 | 28.8 | (b) | 27.4 | (d) 24.6 | (d) | | 28 (f) |
| Ce | 84.2 | 82.8 | (b) 84.2 | 82.8 | (b) | 118 | (d) 71.1 | (d) | | 82.1 (f) |
| Pr | | | | | | | | | | 12.9 (f) |
| Nd | 64.3 | 62.8 | (b) 64.3 | 62.8 | (b) | 59.1 | (d) | | | 63.8 (f) |
| Sm | 22.5 | 22.3 | (b) 22.5 | 22.3 | (b) | 12.8 | (d) 15.7 | (d) | | 21.9 (f) |
| Eu | 2.31 | 2.29 | (b) 2.31 | 2.29 | (b) | 2.11 | (d) 2.1 | (d) | | 2.27 (f) |
| Gd | 29.6 | 29.3 | (b) 29.6 | 29.3 | (b) | | | | | 29.8 (f) |
| Tb | | | | | | 5.46 | (d) | | | 5.22 (f) |
| Dy | 34 | 33.4 | (b) 34 | 33.4 | (b) | | | 30.6 | (d) | 35.1 (f) |
| Ho | | | | | | | | | | 7.23 (f) |
| Er | 21.2 | 20.9 | (b) 21.2 | 20.9 | (b) | | | | | 21.3 (f) |
| Tm | | | | | | | | | | 2.93 (f) |
| Yb | 20.2 | 20.2 | (b) 18 | 18 | (b) | 16.4 | (d) 14.2 | (d) | | 19 (f) |
| Lu | | | | | | 2.45 | (d) 2.58 | (d) | | 2.57 (f) |
| Hf | | | | | | | | 17.3 | (d) | 16.9 (f) |
| Ta | | | | | | 2 | (d) 1.9 | (d) | | 1.86 (f) |
| W ppb | | | | | | | | | | 320 (f) |
| Re ppb | | | | | | | | | | |
| Os ppb | | | | | | | | | | |
| Ir ppb | | | | | | | | | | |
| Pt ppb | | | | | | | | | | |
| Au ppb | | | | | | 1.1 | (d) | | | |
| Th ppm | | | | | | 4.03 | (d) | | | 3.78 (f) |
| U ppm | | | | | | 0.814 | (d) | | | 0.91 (f) |

technique: (a) AA, (b) IDMS, (c) semimicro XRF, (d) INAA, RNAA, (e) elec. Probe, (f) ICP-MS

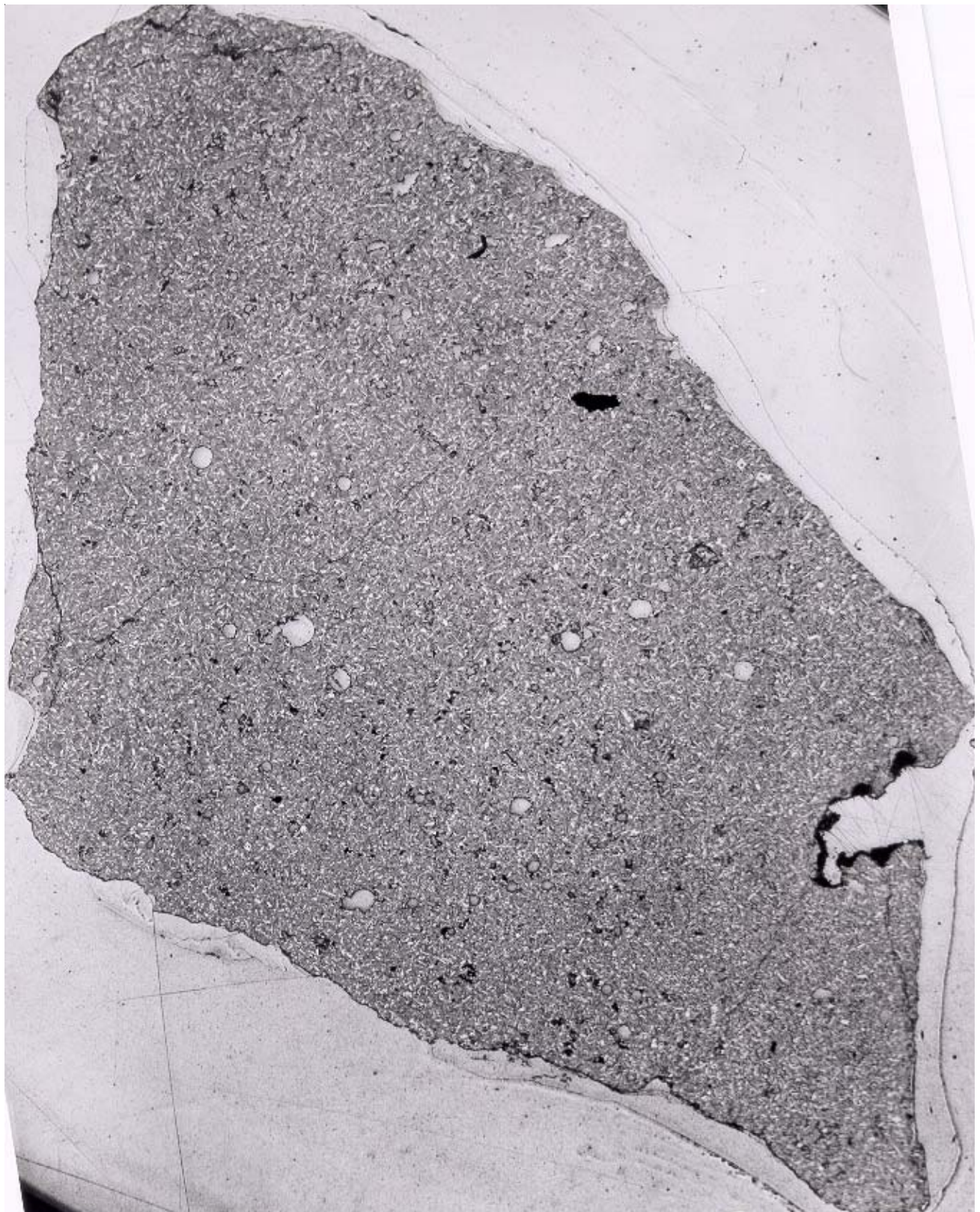
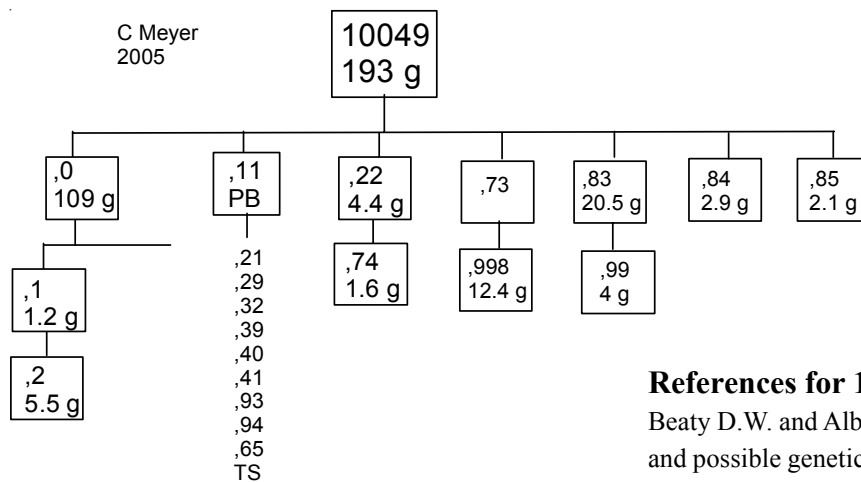


Figure 7: Reflected light photo of whole thin section of 10049 showing ilmenite distribution. Length about 2 cm. NASA S69-59273.



Figure 8: Display sample 10049. NASA S72-41336.



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