# 15076

Pigeonite Basalt

400.5 grams

*Figure 1: Photo of 15076 showing large micrometeorite crater on S1 surface. Sample is 7 cm across. NASA S71-47679.*

## Introduction

15076 is a coarse-grained, porphyritic pigeonite basalt with subophitic matrix. It has been dated at 3.35 b.y. and has been exposed on the lunar surface for ~300 m.y. (Elbow Crater ?). The top surface is rounded with numerous micrometeorite craters.

## Petrography

McGee et al. (1977) and Ryder (1985) provide detailed petrographic descriptions. 15076 and 15075 and have similar texture and pyroxene zoning (figures 3 and 4). Pyroxene is dominant, occurring both as large phenocrysts and subophitically intergrown with plagioclase laths in between. It zones outward to pyroxferroite. Plagioclase occurs as hollow straws. Other minerals are ilmenite, ulvospinel, tridymite, cristobalite, troilite and metallic iron. There is residual glass in the interstices (Brown et al. 1972).

Brett (1975), Lofgren et al. (1975), Onorato et al. (1979) and Walker and Grove (1977) studied the cooling rate of the basalt sequence 15065 – 15076 – 15085 to determine the thickness of the basalt flow sampled by Elbow Crater (~1 m?).

**Mineralogical Mode for 15076**

| | Rhodes and Hubbard 1973 | McGee et al. 1977 | Brown et al. 1972 | Sample catalog Butler 1971 |
|---|---|---|---|---|
| Olivine | | | - - | |
| Pyroxene | 66.3 | 53 – 66 | 53.3 | 55 |
| Plagioclase | 28.5 | 28 – 36 | 35.7 | 45 |
| Opaques | 2.4 | | 3.9 | 3.2 |
| Ilmenite | | 0.5 | | |
| Ti Spinel | | 1.4 | | |
| Troilite | | 0.5 | | |
| Christobalite | 2.1 | 2 – 6 | 6.4 | |
| Mesostasis | 0.6 | 0.6 | 0.7 | |

*Figure 2: Photomicrograph of thin section of 15076. NASA S71-52193. Section # and scale unknown.*

## Mineralogy

***Olivine:*** none

***Pyroxene:*** Brown et al. (1972) studied pyroxene zoning (figure 4).

***Plagioclase:*** Plagioclase laths have hollow cores.

***Metal:*** Taylor and Misra (1975) and Taylor et al. (1975) reported Ni, Co in metal grains (figure 5).

## Chemistry

LSPET (1972), Rhodes and Hubbard (1973), Fruchter et al. (1973) and Cuttitta et al. (1973) determined the chemical composition of 15076 (table 1, figures 6 and 7). Gibson et al. (1975) determined the sulfur content (970 ppm).

## Radiogenic age dating

Stettler et al. (1973) and Kirsten et al. (1973d) determined the age of 15076 as 3.35 ± 0.04 b.y. by Ar/Ar plateau technique (figures 9). Papanastassiou and Wasserburg (1973) determined 3.33 ± 0.08 b.y. by Rb/Sr internal isochron (figure 8). Note that Shaeffer and Schaeffer (1977) reported an older age for 15075 by Ar/Ar.

## Cosmogenic isotopes and exposure ages

Eldridge et al. (1972) reported the cosmic ray exposure of $^{22}$Na = 43 dpm/kg, $^{26}$Al = 62 dpm/kg, $^{46}$Sc = 6 dpm/kg, $^{54}$Mn = 27 dpm/kg and $^{56}$Co = 20 dpm/kg.

Stettler et al. (1973) and Kirsten et al. (1973d) determined the exposure age of 15076 by $^{38}$Ar as 330 m.y. and 280 m.y. respectively (age of Elbow Crater?).

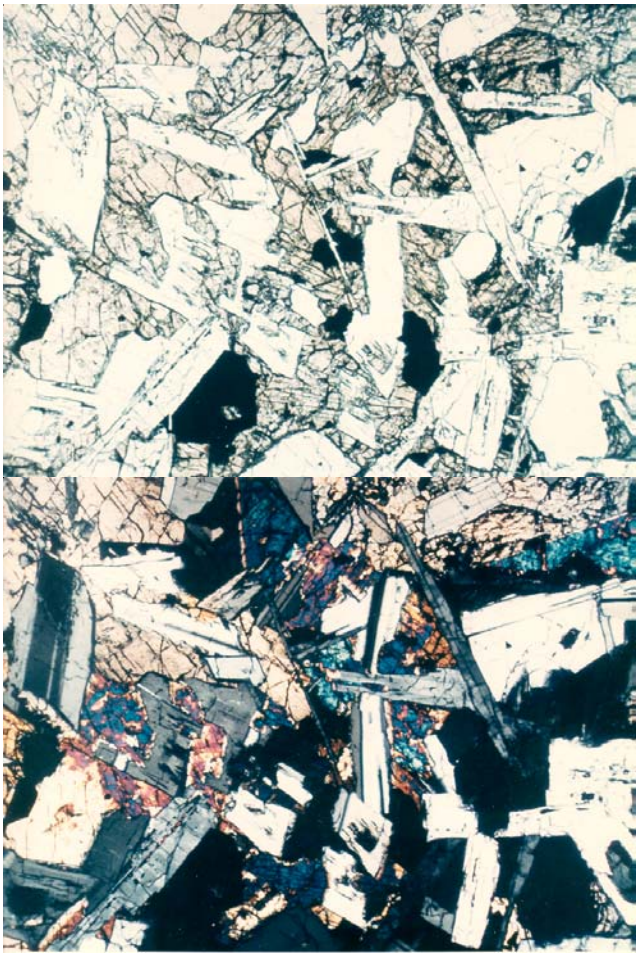


*Figure 3: Photomicrographs of thin section of 15076. Top is plane polarized light; bottom is with crossed polarizers. NASA S71-51760 and 51783.*

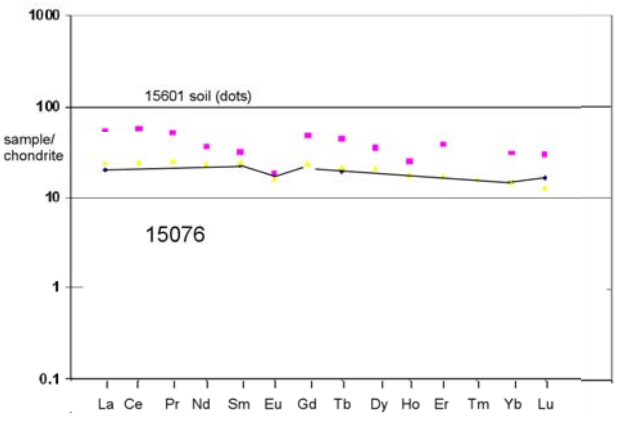



*Figure 6: Normalized rare-earth-element pattern for 15076 compared with 15601 soil.*

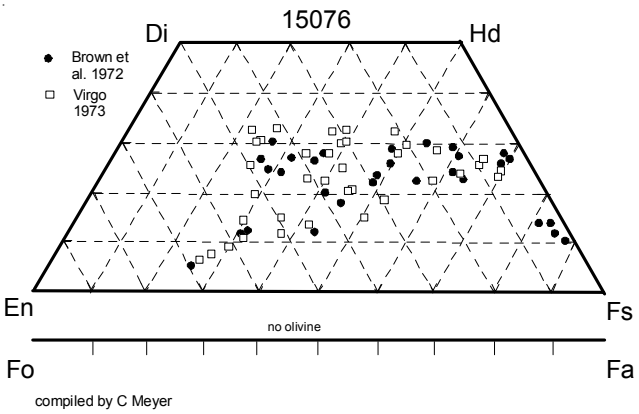



*Figure 4 : Pyroxene composition of 15076.*

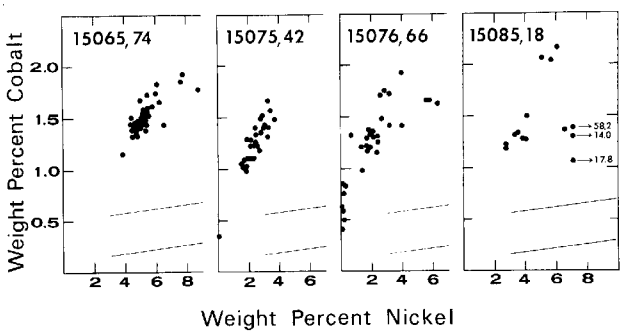



*Figure 5: Composition of metal grains in basalt samples from Elbow Crater (from Taylor et al. 1975).*

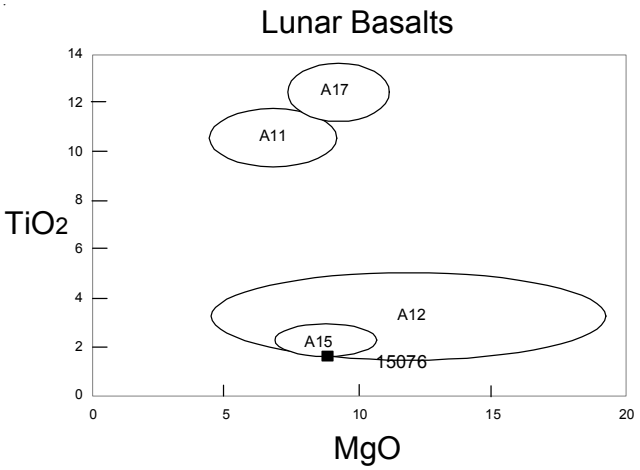



*Figure 7: Chemical composition of 15076 compared with that of other lunar basalts.*

## Other Studies

The concentrations of Sm, Nd, Lu and Hf and the isotopic ratios of $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ were determined by Unruh et al. (1984). U, Th and Pb isotopes were found to be similar to those of 15065 and 15085 by Tatsumoto et al. (1972) with an intercept at ~3.5 b.y.

Solar flare and cosmic ray tracks were studied by Storzer et al. (1973) and Kratschmer and Gentner (1975).

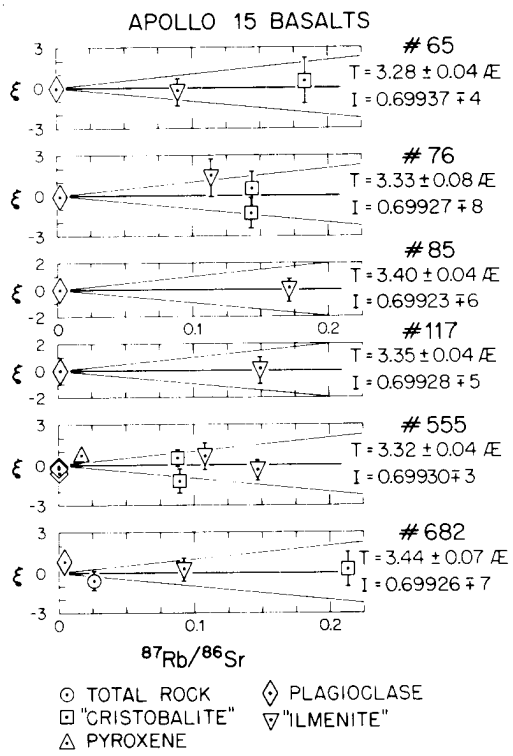



*Figure 8: Rb/Sr isochron diagrams of various Apollo 15 basalts (from Papanastassiou and Wasserburg 1973).*

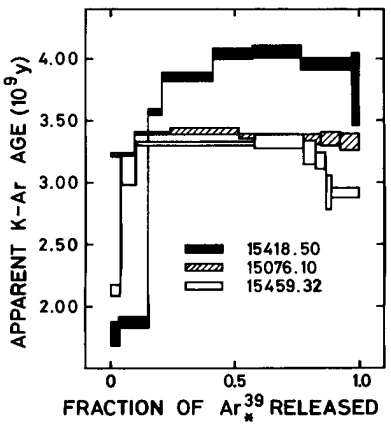


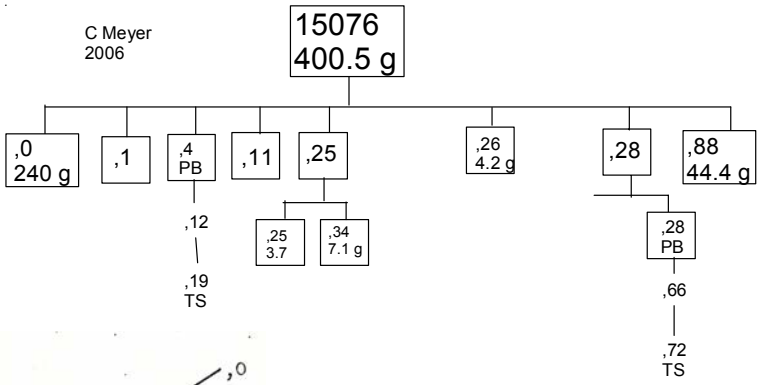

*Figure 9: Ar/Ar plateau diagram for 15076 and other rocks (from Stettler et al. 1973).*

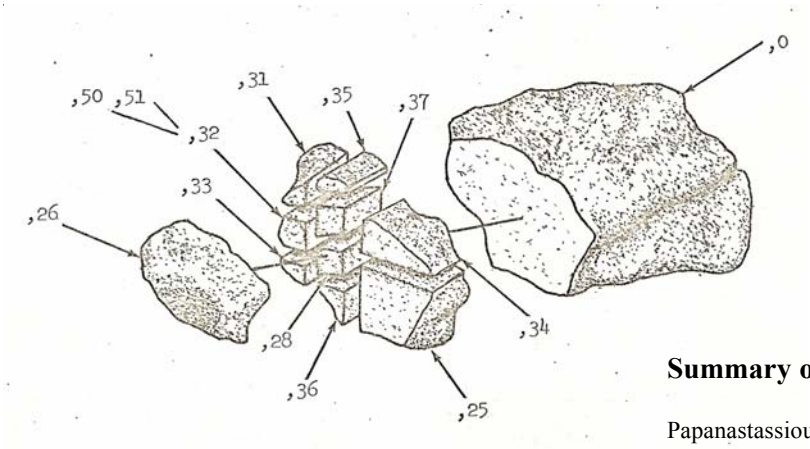
Morrison et al. (1973) and Schneider et al. (1973) reported the micrometeorite crater density.

Gose et al. (1972) and Pearce et al. (1973) reported magnetic data.

## Processing

A small slab was cut from one end of 15076. There are 14 thin sections.




### Summary of Age Data for 15076

| | Ar/Ar | Rb/Sr |
|---|---|---|
| Papanastassiou and Wasserburg 1972 | | 3.33 ± 0.08 b.y. |
| Stettler et al. 1973 | 3.35 ± 0.04 | |
| Kirsten et al. 1973 | 3.35 ± 0.15 | |

**Caution: Ages reported with original decay constants.**

## Table 1. Chemical composition of 15076.

| *reference* | Wiesmann75 | | Rhodes 73 | | | Cuttitta73 | | Fruchter73 | | O'Kelley72 | | Unruh 84 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *weight* | Hubbard 73 | | | | | Christian72 | | | | | | | |
| SiO2 % | | | 48.8 | 48.06 | (b) | 48.82 | (c ) | | | | | | |
| TiO2 | 1.9 | (a) | 1.46 | 2.01 | (b) | 1.83 | (c ) | 1.47 | (d) | | | | |
| Al2O3 | | | 9.3 | 9.63 | (b) | 8.31 | (c ) | 9.26 | (d) | | | | |
| FeO | 18.5 | | 18.62 | 20.22 | (b) | 20.45 | (c ) | 19.35 | (d) | | | | |
| MnO | | | 0.27 | 0.29 | (b) | 0.29 | (c ) | | | | | | |
| MgO | 7.75 | | 9.46 | 7.8 | (b) | 9.43 | (c ) | | | | | | |
| CaO | | | 10.82 | 10.74 | (b) | 10.3 | (c ) | | | | | | |
| Na2O | 0.3 | | 0.26 | 0.29 | (b) | 0.4 | (c ) | 0.3 | (d) | | | | |
| K2O | 0.05 | (a) | 0.03 | 0.05 | (b) | 0.08 | (c ) | | | 0.049 | (e) | | |
| P2O5 | | | 0.03 | 0.08 | (b) | 0.05 | (c ) | | | | | | |
| S % | | | 0.03 | 0.08 | (b) | | | | | | | | |
| *sum* | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Sc ppm | | | | | | 40 | (c ) | 47 | (d) | | | | |
| V | | | | | | 135 | (c ) | | | | | | |
| Cr | | | | | | 2121 | (c ) | 3380 | (d) | | | | |
| Co | | | | | | 42 | (c ) | 41 | (d) | | | | |
| Ni | | | 11 | | (b) | 32 | (c ) | | | | | | |
| Cu | | | | | | 9.1 | (c ) | | | | | | |
| Zn | | | | | | | | | | | | | |
| Ga | | | | | | 4.1 | (c ) | | | | | | |
| Ge ppb | | | | | | | | | | | | | |
| As | | | | | | | | | | | | | |
| Se | | | | | | | | | | | | | |
| Rb | 0.917 | (a) | 1.1 | | (b) | 1.2 | (c ) | | | | | | |
| Sr | 112 | (a) | 120 | | (b) | 98 | (c ) | | | | | | |
| Y | | | 29 | | (b) | 26 | (c ) | | | | | | |
| Zr | | | 97 | | (b) | 64 | (c ) | | | | | | |
| Nb | | | 6.2 | | (b) | <10 | | | | | | | |
| Mo | | | | | | | | | | | | | |
| Ru | | | | | | | | | | | | | |
| Rh | | | | | | | | | | | | | |
| Pd ppb | | | | | | | | | | | | | |
| Ag ppb | | | | | | | | | | | | | |
| Cd ppb | | | | | | | | | | | | | |
| In ppb | | | | | | | | | | | | | |
| Sn ppb | | | | | | | | | | | | | |
| Sb ppb | | | | | | | | | | | | | |
| Te ppb | | | | | | | | | | | | | |
| Cs ppm | | | | | | | | | | | | | |
| Ba | 62.7 | (a) | | | | 58 | (c ) | | | | | | |
| La | 7.38 | (a) | | | | 10 | (c ) | 4.7 | (d) | | | | |
| Ce | 15.1 | (a) | | | | | | | | | | | |
| Pr | | | | | | | | | | | | | |
| Nd | 10.6 | (a) | | | | | | | | | | 11.85 | (a) |
| Sm | 3.52 | (a) | | | | | | 3.4 | (d) | | | 3.796 | (a) |
| Eu | 0.978 | (a) | | | | | | 0.98 | (d) | | | | |
| Gd | 4.95 | (a) | | | | | | | | | | | |
| Tb | | | | | | | | 0.7 | (d) | | | | |
| Dy | 5.6 | (a) | | | | | | | | | | | |
| Ho | | | | | | | | | | | | | |
| Er | 3.4 | (a) | | | | | | | | | | | |
| Tm | | | | | | | | | | | | | |
| Yb | 2.77 | (a) | | | | 3.7 | (c ) | 2.4 | (d) | | | | |
| Lu | 0.326 | (a) | | | | | | 0.4 | (d) | | | 0.394 | (a) |
| Hf | | | | | | | | 2.1 | (d) | | | 2.866 | (a) |
| Ta | | | | | | | | 0.44 | (d) | | | | |
| W ppb | | | | | | | | | | | | | |
| Re ppb | | | | | | | | | | | | | |
| Os ppb | | | | | | | | | | | | | |
| Ir ppb | | | | | | | | | | | | | |
| Pt ppb | | | | | | | | | | | | | |
| Au ppb | | | | | | | | | | | | | |
| Th ppm | | | | | | | | | | 0.45 | (e) | | |
| U ppm | 0.15 | (a) | | | | | | | | 0.12 | (e) | | |

*technique: (a) IDMS, (b) XRF, (c ) "microchemical", (d) INAA, (e) radiation counting*

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