15499

Vuggy Vitrophyric Pigeonite Basalt

2024 grams

Figure 1: Photo of 15499. NASA S71-44158. Edge of cube is 1 inch.

Introduction

Sample 15499 (figure 1) was collected from the top of a meter-sized boulder at station 4 on the rim of Dune Crater (figures 2 and 3). Samples 15485 and 15486 were collected from the side of this boulder (Sutton et al. 1972, Swann et al. 1971).

The top surface of 15499 is rounded with micrometeorite craters, whille the bottom suface is freshly broken. The radiometeric age of this boulder is ~3.4 b.y., with an exposure age of 114 m.y.

Petrography

15499 is a very vesicular and/or vuggy basalt with a porphyritic (sometimes diktytaxitic) texture (figures 1 and 9). It is composed of long needles of euhedral clinopyroxene (42%), set in a dark brownish grey microcrystalline groundmass (57%). The pyroxene needles are up to 1 cm long, a few mm wide, and were orginally hollow. In some areas the pyroxene crystalls penetrated large vugs. The groundmass has fine lamallae of pyroxene, ilmenite, etc. Euhderal chromite,

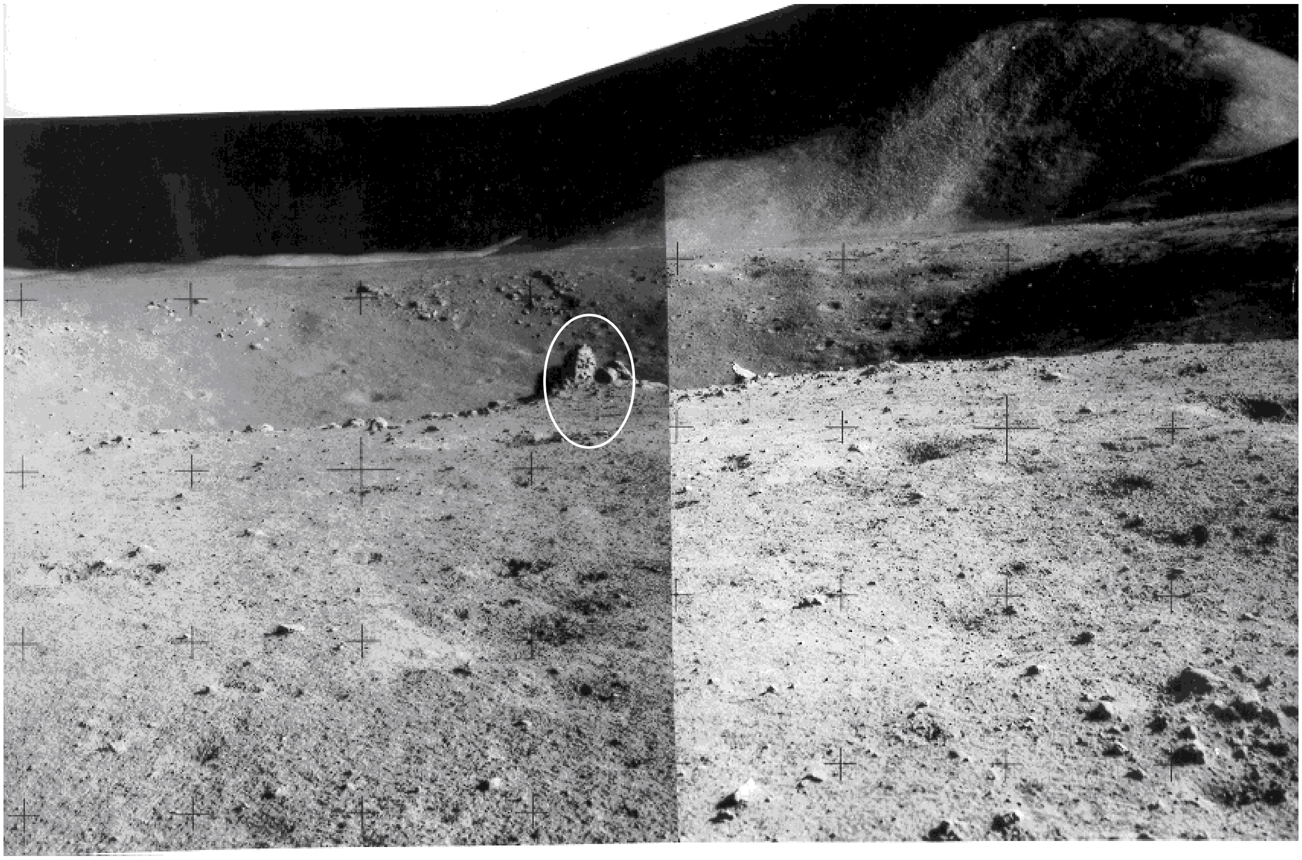

Figure 2: Dune crater Apollo 15. NASA S71-51736. Samples 15485, 15486 and 15499 were collected from the boulder in center of photo (on south rim). Hadley-Delta in the distance.

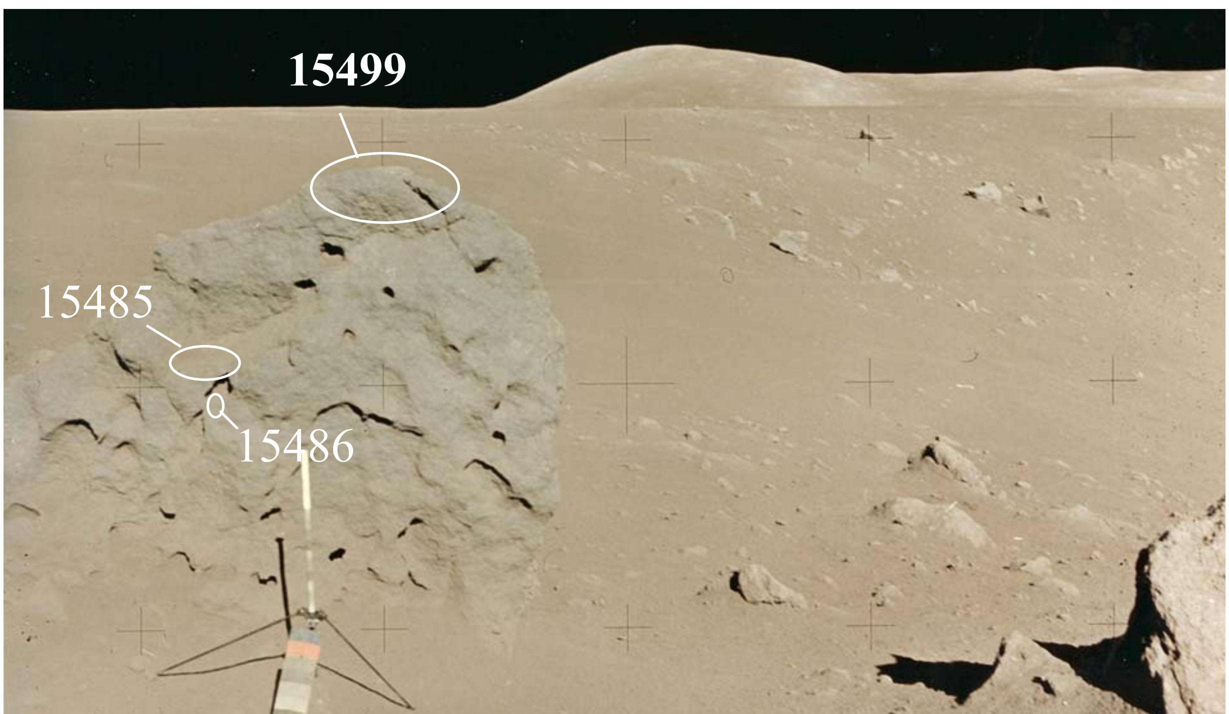

Figure 3: Boulder at Dune crater with location of samples. The feet on the gnonen are 50 cm apart. AS15-87-11768.

Figure 4: Thin section of 15499,4 showing pyroxene phenocrysts in cross section and lengthwise. Scale 5 mm. NASA S71-52198.

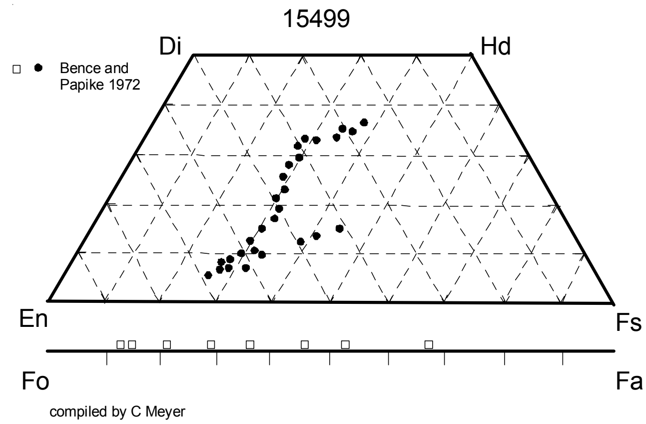

Figure 5: Composition of pyroxene in 15499 showing two Ca trends, dependent upon crystallographic direction (from Bence and Papike 1972). Also showing wide variation in composition of large, zoned, olivine grain.

zoned to ulvospinel, crystalls are found in the outer zones of the pyroxene. Olivine pheneocrysts are rare.

Phenocrysts in 15499 are easy to study because they have regular and distinct forms with all their faces clearly recognizable (Bence and Papike 1972).

Humphries et al. (1972) determined the phase diagram and crystallization sequence for Apollo 15 magma of this composition. The cooling rate of Apollo 15 basalts has been studied experimentally by Lofgren et al. (1974), Grove and Walker (1977), Grove (1982) and others. The chromite, pyroxene and olivine crystalls are highly zoned.

Mineralogy

Olivine: Bence and Papike (1972) noted a single skeletal olivine phenocryst zoned from Fo_{88} to Fo_{33}, core to rim.

Pyroxene: Bence and Papike (1972) found individual skeletal pyroxene phenocrysts from 15499 have two crystallization trends due to different Ca and trace element partioning along different crystallographic directions (sector zoning) (figure 5). Bence and Autier (1972) and Dowty et al. (1974) also studied the chemical zoning in pyroxene.

Opaques: 15499 also has ilmenite, Cr-spinel, ulvospinel, troilite and Fe-Ni metal.

Chemistry

Several labs determined the chemical composition of 15499 (table 1). The composition is the same as for 15485 and 15486 from the same boulder. REE analyses are available for 15486.

15499 has only 12 ppm C (Moore et al. 1973, Kaplan et al. 1976) and 640-830 ppm S (Kaplan et al. 1976, Gibson et al. 1975).

Mineralogical Mode of 15499

	Sample Catalog Butler 1973	McGee et al. 1977	Rhodes and Hubbard 1973
Olivine	1 grain	1	0.8
Pyroxene	42	42	41.8
Mesostasis	57	57	57.3

Radiogenic age dating

Papanastassiou and Wasserburg (1973) and Compston et al. (1972) determined the isotopic composition of Sr for the bulk sample, but did not report an age. Hussain (1974) obtained an age of 3.34 b.y. by Ar/Ar plateau technique (figure 8).

Cosmogenic isotopes and exposure ages

Husain (1974) determined a cosmic ray exposure age of 114 ± 8 m.y by Ar.

Other Studies

Collinson et al. (1973) and Fuller (1979) studied the magnetism in 15499. Abu-Eid et al. (1973) obtained Mossbauer spectra.

Adams and McCord (1972) and Charette and Adams (1975) obtained reflectance spectra with an absorbtion band for Ca-rich pyroxene.

Processing

15499 broke into three main pieces, which have been subdivided further. One piece of 15499 is used for a public display at the Cite de L'Espace in Toulouse, France. There are 18 thin sections.

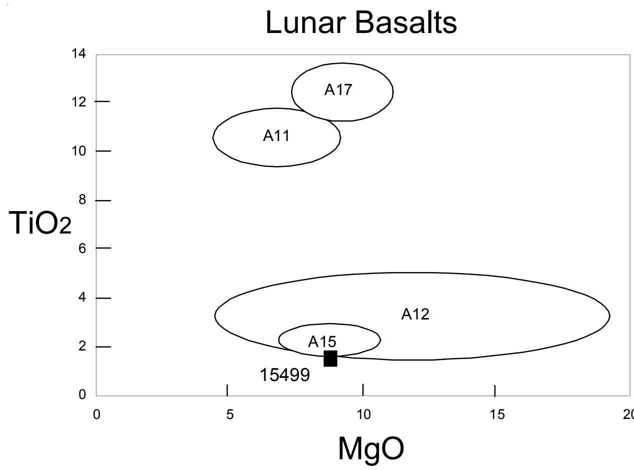

Figure 6: Chemical composition of 15499 compared with that of other lunar basalts.

Summary of Age Data for 15499

	Ar/Ar	Rb/Sr
Husain 1974	3.34 ± 0.08 b.y.	
Papanastassiou and Wasserburg 1973		?
Compston et al. 1972		?

Caution: Old decay constant.

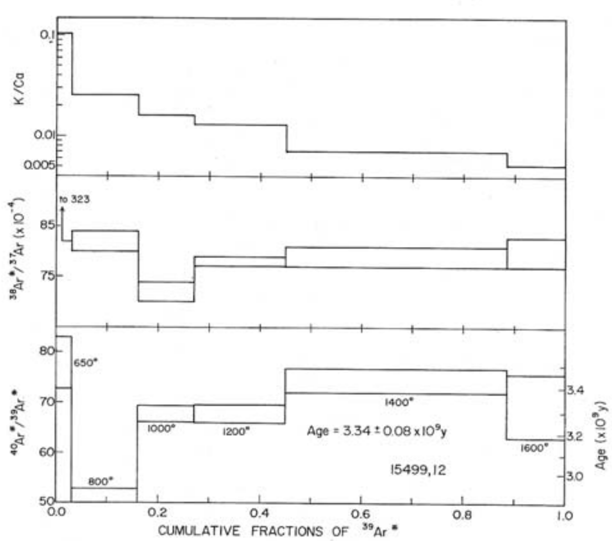

Figure 8: Ar/Ar plateau diagram for 15499 (Husain 1974).

Table 1. Chemical composition of 15499.

reference	A15PET 72		O'Kelley72		Rhodes73	Chappell73	Duncan76		Wolf 79	
weight										
SiO2 %	47.62	(a)			47.62	47.89	47.93	(a)		
TiO2	1.81	(a)			1.81	1.81	1.73	(a)		
Al2O3	9.27	(a)			9.27	9.19	8.88	(a)		
FeO	20.26	(a)			20.26	20.47	19.84	(a)		
MnO	0.28	(a)			0.28	0.3	0.27	(a)		
MgO	8.94	(a)			8.94	9.11	9.93	(a)		
CaO	10.4	(a)			10.4	10.41	10.23	(a)		
Na2O	0.29	(a)			0.29	0.38	0.29	(a)		
K2O	0.06	(a)	0.058	(b)	0.06	0.06	0.028	(a)		
P2O5	0.08	(a)			0.08	0.08	0.083	(a)		
S %	0.07	(a)			0.07	0.06	0.066	(a)		
sum										
Sc ppm										
V							189	(a)		
Cr						3558	4221	(a)		
Co							44	(a)		
Ni							19	(a)	51	(c)
Cu							3	(a)		
Zn									1.07	(c)
Ga						3		(a)		
Ge ppb									4.28	(c)
As										
Se									115	(c)
Rb						0.9	1.4	(a)	1.2	(c)
Sr	105	(a)				109.4	100	(a)		
Y						28	31.1	(a)		
Zr	112	(a)				111	109	(a)		
Nb						8	5.4	(a)		
Mo										
Ru										
Rh										
Pd ppb									<0.61	(c)
Ag ppb									0.99	(c)
Cd ppb									3.37	(c)
In ppb									0.9	(c)
Sn ppb									23	(c)
Sb ppb									1.42	(c)
Te ppb									3.2	(c)
Cs ppm									0.049	(c)
Ba							69	(a)		
La										
Ce										
Pr										
Nd										
Sm										
Eu										
Gd										
Tb										
Dy										
Ho										
Er										
Tm										
Yb										
Lu										
Hf										
Ta										
W ppb										
Re ppb									7E-04	(c)
Os ppb									<0.06	(c)
Ir ppb									0.004	(c)
Pt ppb										
Au ppb									0.013	(c)
Th ppm			0.59	(b)						
U ppm			0.16	(b)					0.089	(c)

technique: (a) XRF, (b) radiation counting (c) RNAA

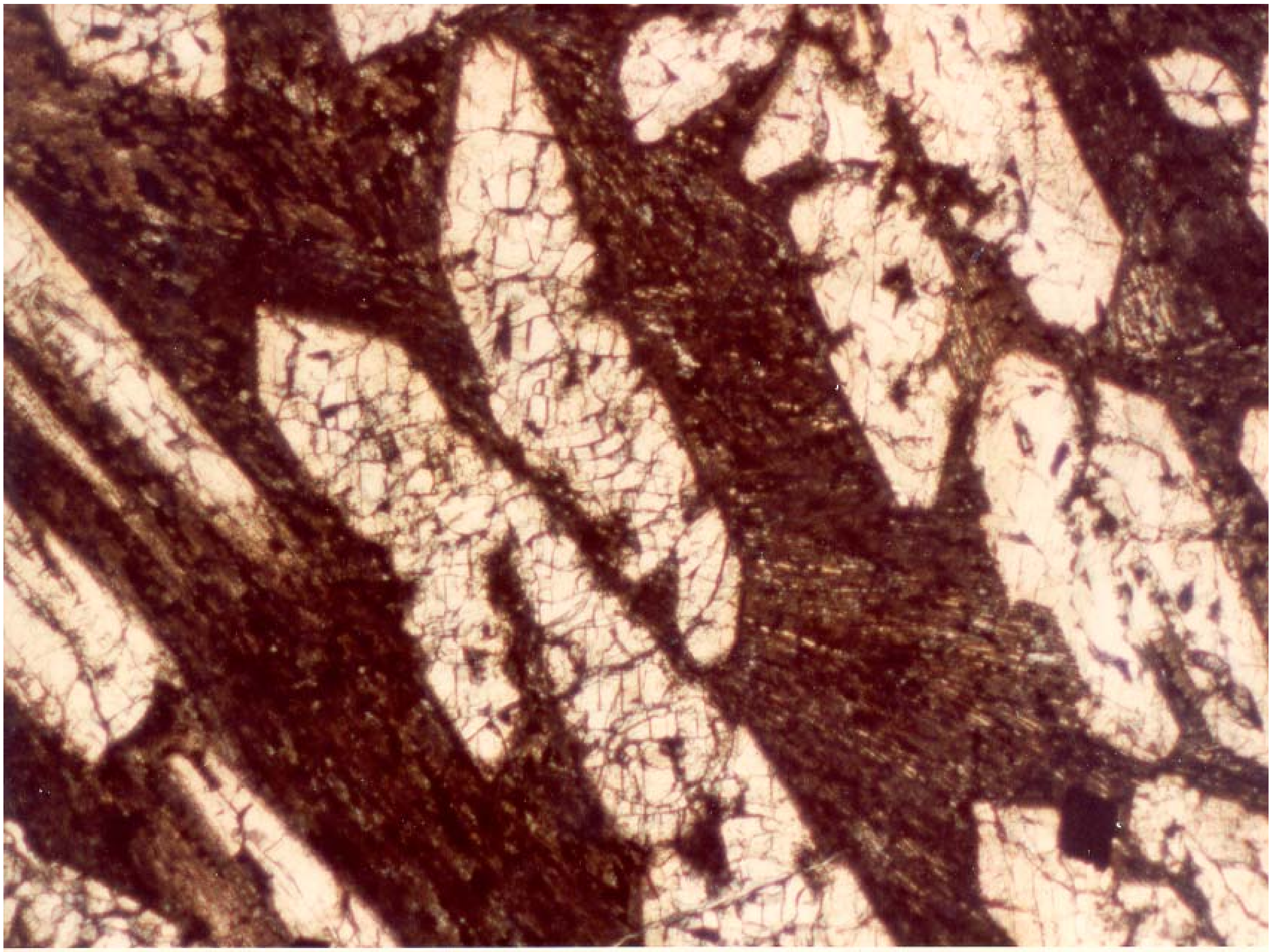

Figure 7: Photomicrograph of thin section of 15499 showing euhedral pyroxene phenocrysts in fine-grained groundmass. NASA S75-34080. Field of view is 3 mm.

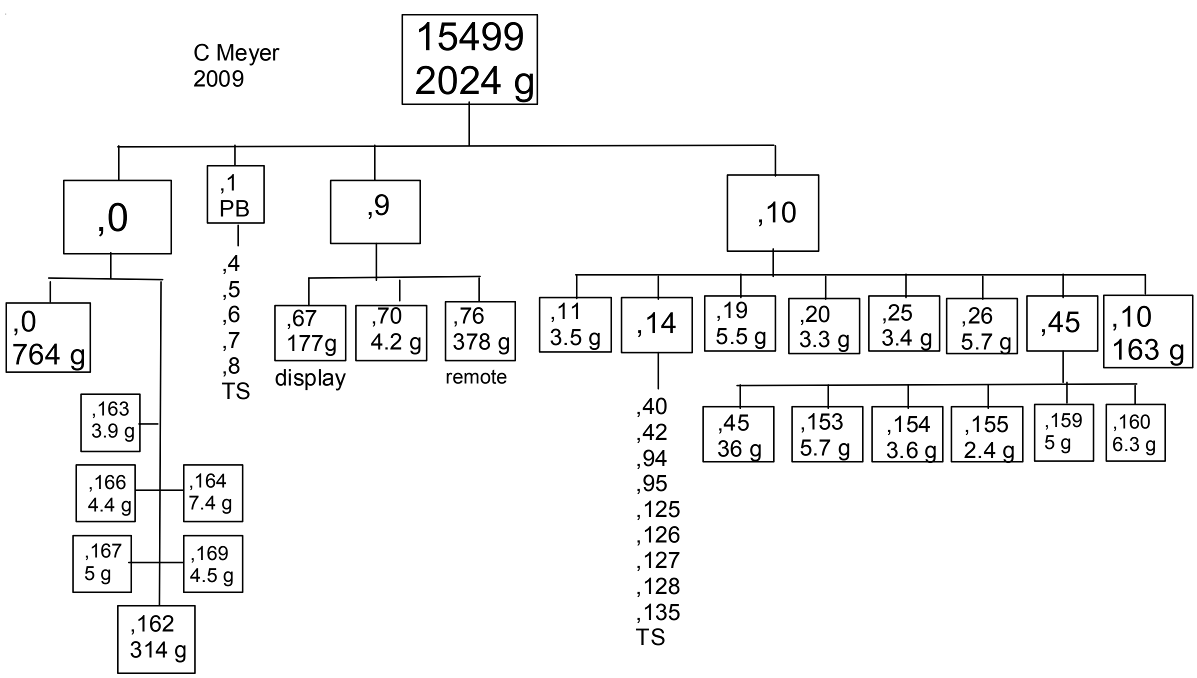

Figure 9: Closeup photo of freshly broken surface of 15499,67 - about 2 inches worth. NASA S86-39024. This complex interwoven texture is termed “diktytaxitic”.

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