15595 and 15596

Vuggy Vitrophyric Pigeonite Basalt

237.6 and 224.8 grams

Figure 1: Photo of 15595. Sample is about 9 cm across. NASA S71-44491.

Figure 2: Photo of 15596 showing surface that was exposed to micrometeorites. NASA S71-47070. Sample is 7 cm across.

Introduction

Lunar samples 15595 and 15596 were chipped from a small boulder near the edge of Hadley Rille in an area called The Terrace (see transcript in 15597). The boulder is thought to be "bedrock" in this region (equivalent to the outcrops seen in telephoto of the other side of the Rille (figure 2). The lunar regolith was thin in this area, with abundant rock samples (basalts) exposed (Swann et al. 1971). However, both pigeonite basalt and olivine-normative basalts were found in this location.

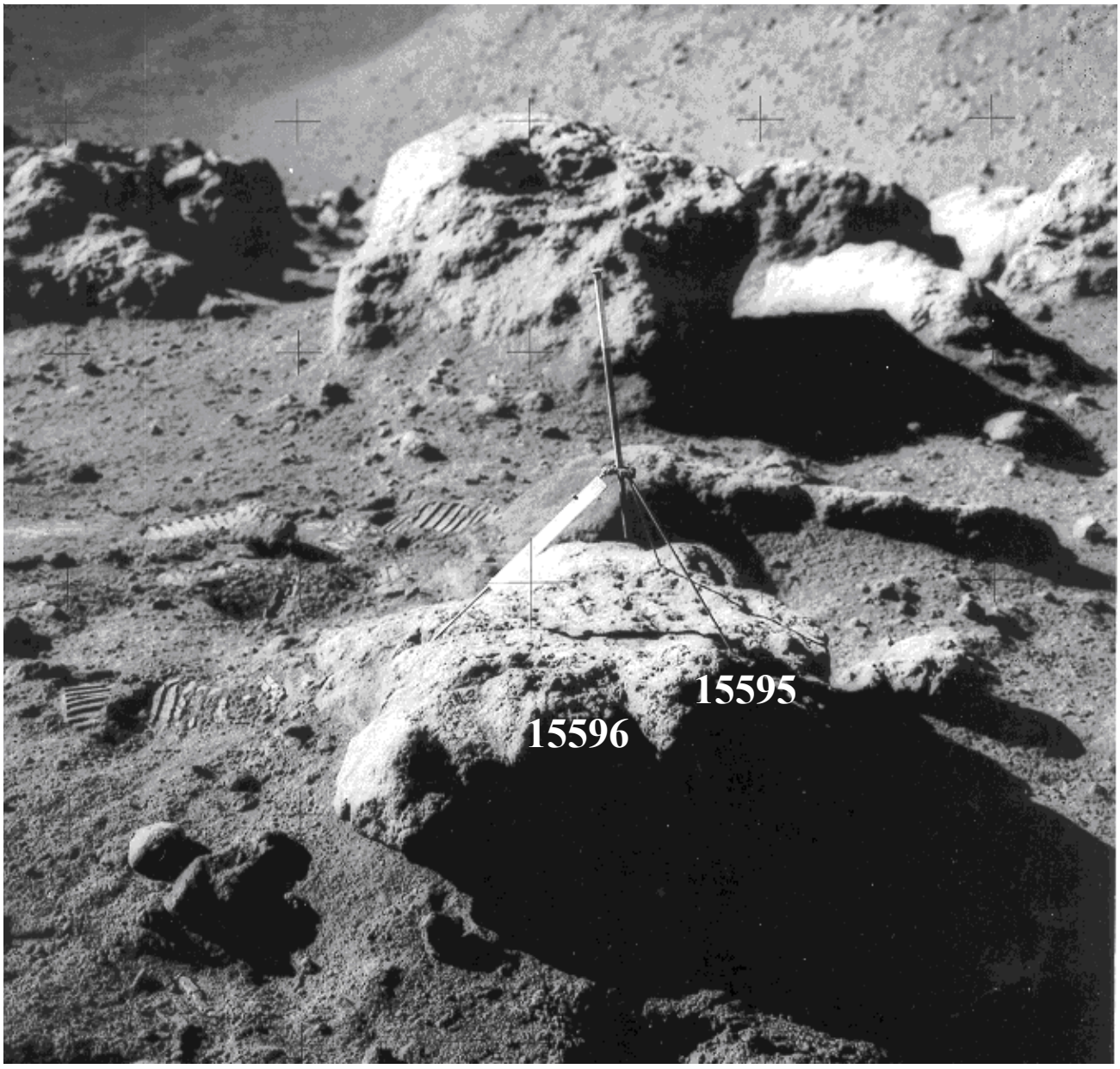


Figure 3: Boulder sampled with 15595 and 15596 (location indicated). AS15-82-11143.

Petrography

Ryder (1985) describe both 15595 and 15596 as a "fine-grained, porphyritic mare basalt with conspicuously irregularly distributed vugs (figures 1 and 2). Pigeonite phenocrysts are set in as spherulitic, almost vitrophyric groundmass. - - - The sample is olive gray to olive black, angular, and tough. The broken surface is hackly, the other are smoothed to irregular and have zap pits (micrometeorite craters)". Vugs make up 15 to 30 % of volume.

15596 has the same texture but with somewhat larger pyroxenes, and a groundmass that is more crystalline.

Brown et al. (1972) described the groundmass as made up of "clinopyroxene, plagioclase and opaques, with occasional rare zoned olivine and Cr-spinel microphenocrysts."

The larger pyroxene phenocrysts have homogeneous pigeonite cores, with a sharp transition to sub-calcic augite rims. The fine groundmass pyroxene are zoned to Fe-rich pyroxferroite (Brown et al. 1973).

Lofgren et al. (1975, 1976) and Grove and Walker (1977) have studied the cooling history of vitrophyric pigeonite basalts.

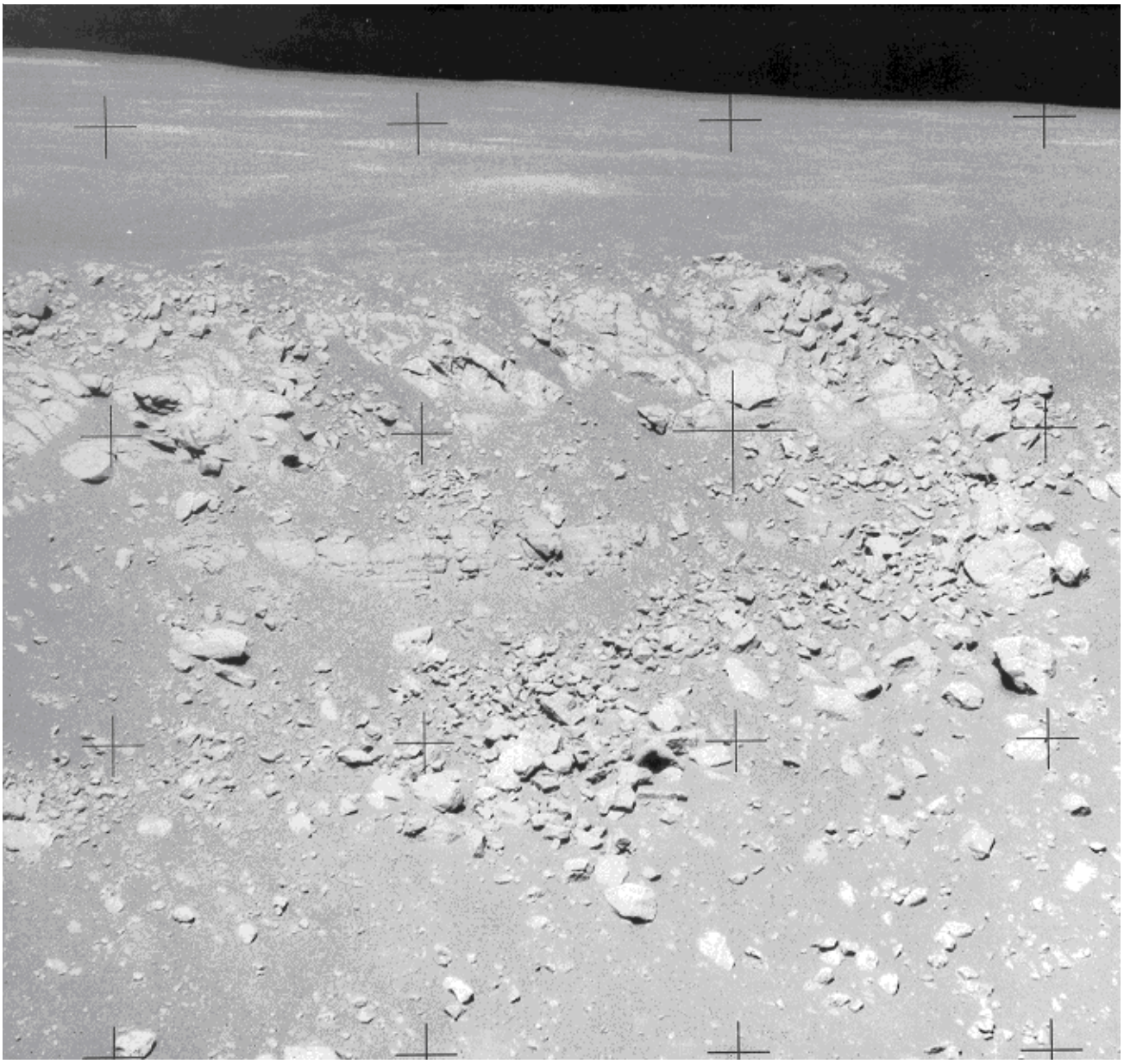


Figure 4: Telephoto of opposite side of Hadley Rille showing thining of regolith and layered outcrop of basalt, possibly similar to sample collection side of 15595. NASA AS15-89-12045

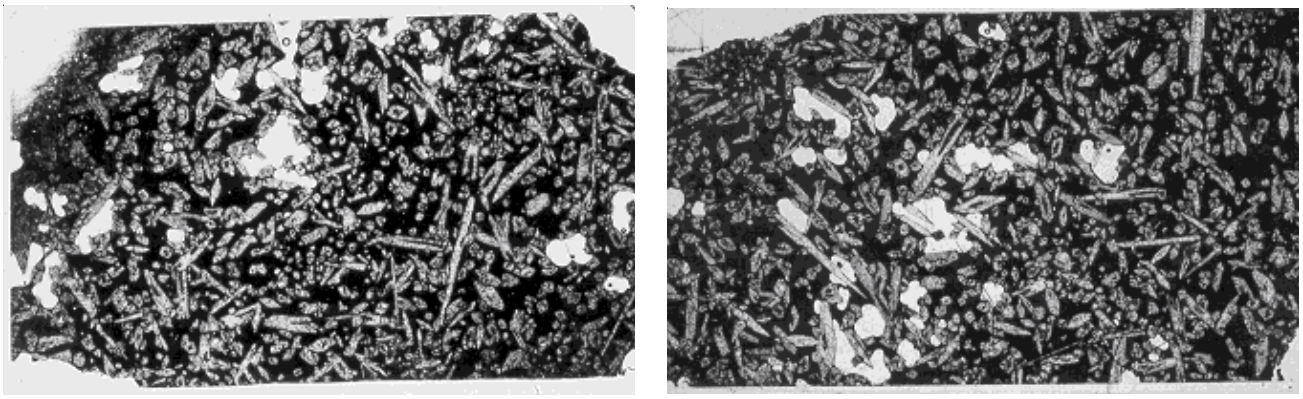


Figure 5: Thin section photos of 15595,39 and 15595,37. Scale is about 1 cm.

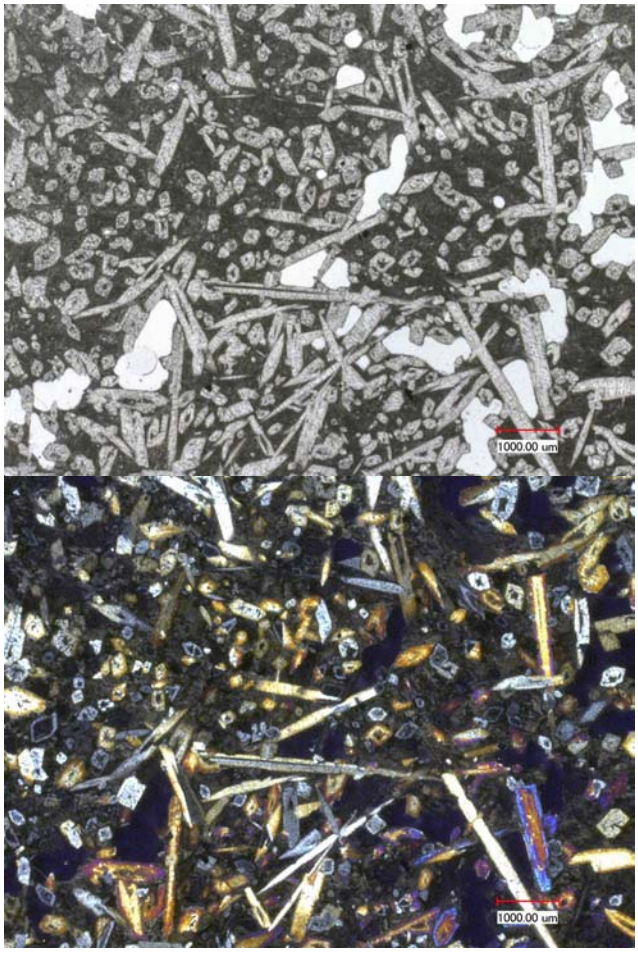


Figure 6: Photomicrographs of 15595,33 by C Meyer @30x (bottom is with crossed polarizers).

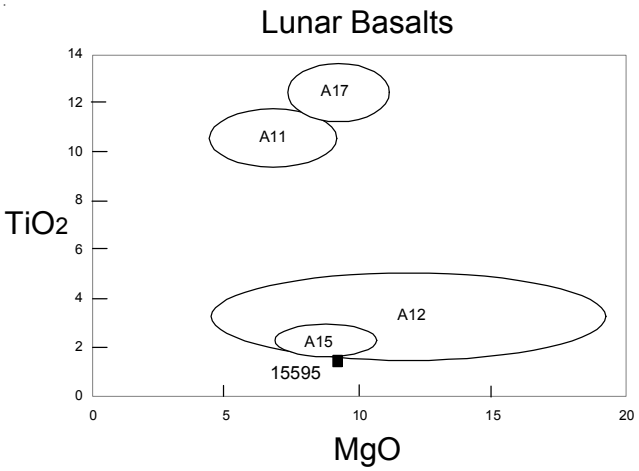


Figure 7: Chemical composition of 15595 compared with that of other lunar basalts.

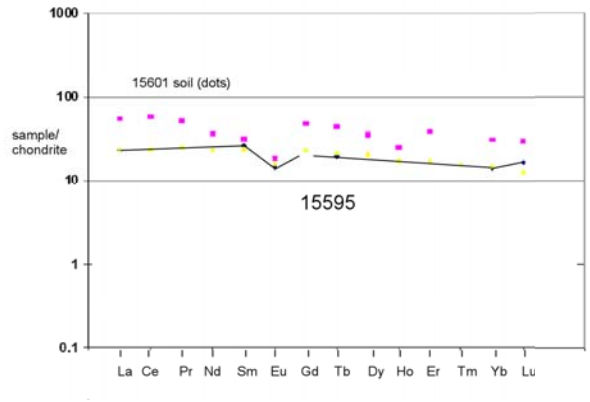


Figure 8: Normalized rare-earth-element digram for 15595 (data by Fruchter et al. 1973) compared with 15601 soil.

Chemistry

Fruchter et al. (1973) and Chappell and Green (1973) analyzed 15595 (figures 7 and 8). Rhodes and Blanchard (1983) reported that they had analyzed 15596, but gave no data.

Cosmogenic isotopes and exposure ages

Behrmann et al. (1972) and Pepin et al. (1974) determined a cosmic ray exposure age of 110 m.y. by ^{81}Kr method.

Other Studies

Behrmann et al. (1972), Pepin et al. (1974) and Drozd et al. (1974) measured the isotopic ratios of all of the rare gas elements and studied the spallation reactions of the rock with solar and galactic cosmic rays.

Gose et al. (1972) and Pearce et al. (1973) measured the magnetic properties of 15595 and 15596, finding that the direction of remanent magnetizations was different for the two sample (of the same boulder?).

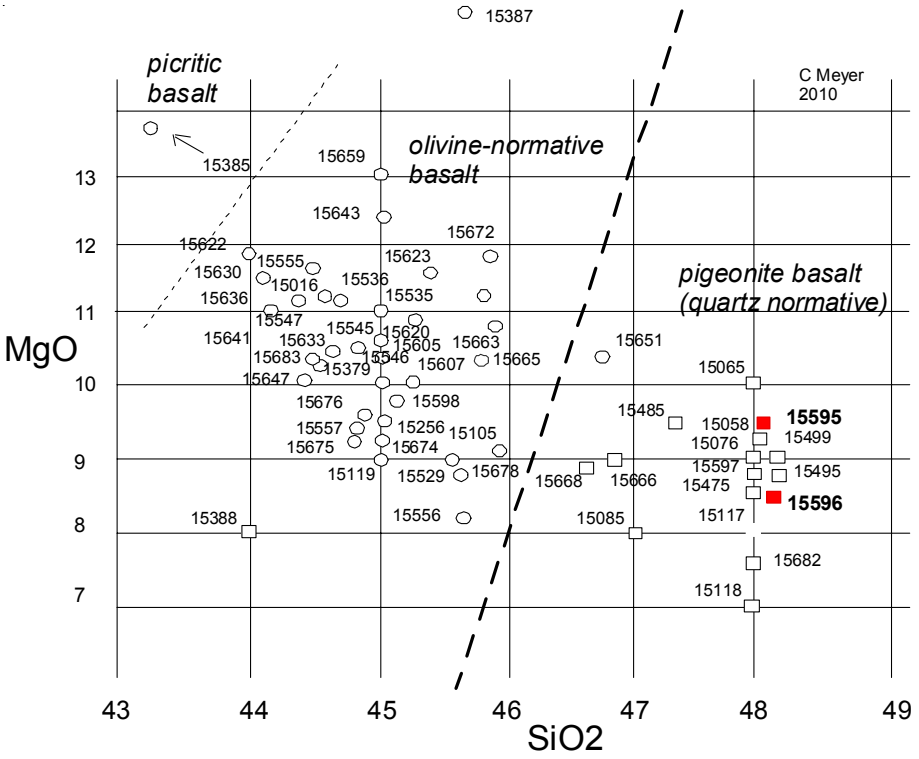
Mineralogical Mode of 15595

	Sample Catalog Butler 1971	Papike et al. 1976	Grove and Walker 1977	15596
Olivine	3-5 %			
Pyroxene	60-65	48.1	52	41
Plagioclase	35			
Opaque	1	0.3		0.2
Silica				
Groundmass		51.6	48	59

Table 1. Chemical composition of 15595.

reference	Chappell73		Fruchter73	
weight				
SiO2 %	48.07	(a)		
TiO2	1.77	(a)	1.68	(b)
Al2O3	9.06	(a)	9.07	(b)
FeO	20.23	(a)	18.91	(b)
MnO	0.3	(a)		
MgO	9.21	(a)		
CaO	10.52	(a)		
Na2O	0.35	(a)	0.286	(b)
K2O	0.05	(a)		
P2O5	0.07	(a)		
S %	0.05	(a)		
sum				
Sc ppm			45	(b)
V				
Cr	3558	(a)	3450	(b)
Co			42	(b)
Ni				
Cu				
Zn				
Ga	2.8	(a)		
Ge ppb				
As				
Se				
Rb	0.72	(a)		
Sr	103.8	(a)		
Y	26	(a)		
Zr	94	(a)		
Nb	8	(a)		
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm				
Ba				
La			5.4	(b)
Ce				
Pr				
Nd				
Sm			3.9	(b)
Eu			0.81	(b)
Gd				
Tb			0.7	(b)
Dy				
Ho				
Er				
Tm				
Yb			2.3	(b)
Lu			0.4	(b)
Hf			2	(b)
Ta			0.35	(b)
W ppb				
Re ppb				
Os ppb				
Ir ppb				
Pt ppb				
Au ppb				
Th ppm				
U ppm				

technique: (a) XRF, (b) INAA



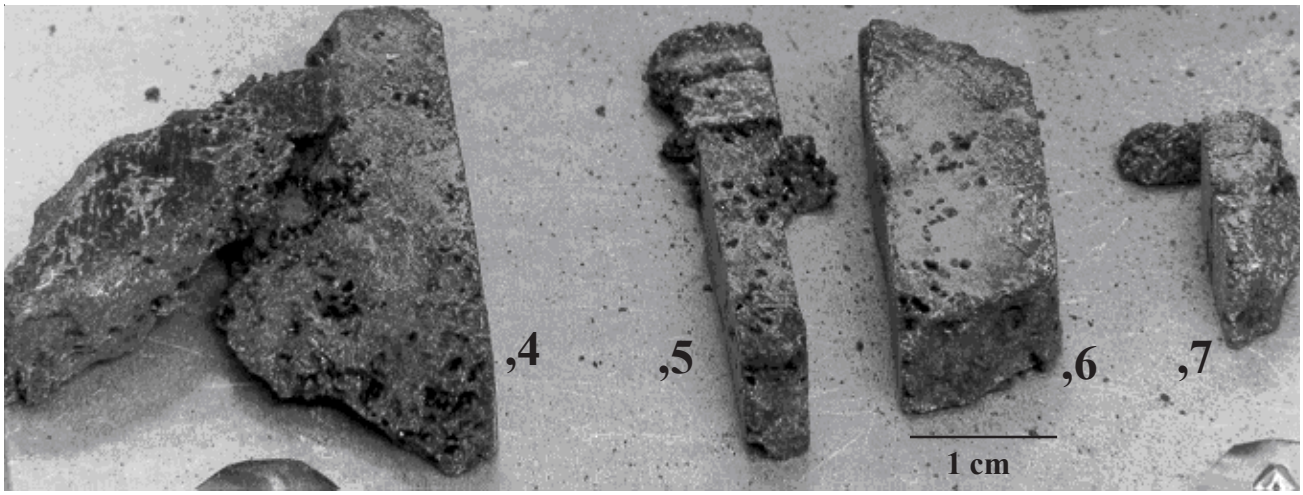
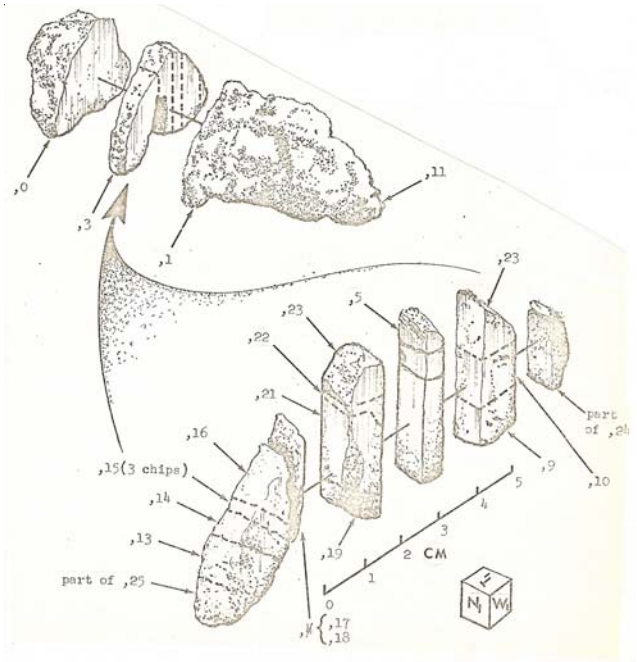


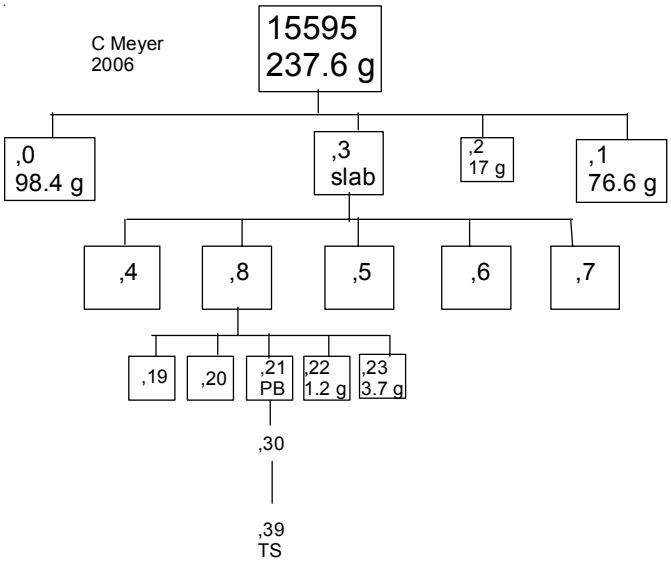
Figure 9: Group photo of pieces cut from slab cut from 15595. NASA S71-60629.

Sato et al. (1973) measured the oxygen fugacity as a function of temperature by an *insitu* technique.

Processing

A slab was cut through the middle of 15595 (figure 9) and cut into columns. 15596 remains essentially intact. There are 10 thin sections for 15595 and 5 for 15596.





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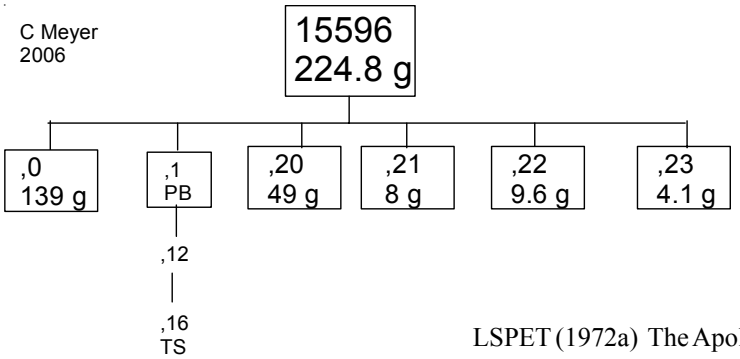

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