15017 GLASS SHELL ST. LM 9.8 g

INTRODUCTION: 15017 is a hollow glass sphere which was 3 to 4 cm in diameter (Fig. 1). It had broken by the time of receipt at LRL. Its composition is very similar to local regolith, except perhaps very slightly more felsic. The glass sphere is dark gray, and its walls vary from 1 to 3 mm thick. The inside surface is vesicular (Fig. 1); the outside surface is smooth where glassy but hackly to irregular where breccia fragments are embedded or vesicles are open. There are very few zap pits, indicating a very young age.

15017 was noticed from the LM window, and is atypical. It was collected and bagged with 15018, 15019, 15027, and 15028; all were lying in a subdued l-m crater 4 m south of the LM + Z footpad. It had no fillet; sampling was documented but its orientation was not decipherable because of its spherical shape.

Figure 1. Six chips of 15017, as received. S-71-43662

PETROLOGY: 15017 is a vesicular, thin glass with a smooth surface on both the interior and exterior sides (Fig. 2). Larger vesicles open to the interior. The glass is pale green, banded, with some portions slightly devitrified. Some portions contain or grade into a glassy breccia or clast-rich glass, which contains mineral and glass fragments. Fabel et al. (1972) made electron probe analyses and found the sample to be inhomogeneous; however, they probably analyzed inclusions which gave the ranges. Their analyses are suspect because the silica ranges as low as 25%, and their highest alumina content is not as high as the bulk chemical analysis. Fabel et al. (1972) also reported X-ray emission shift data for SiK_{β}, AlK_{β}, and OK_{α}, as well as Raman spectra which showed pyroxene bands. Morrison et al. (1973), in a detailed examination of the glass surface, found it to be smooth, full of vesicles, and to have a few superposed glass splashes. Most of the accretionary objects are less than 10 microns across, very thin, and mainly elliptical.

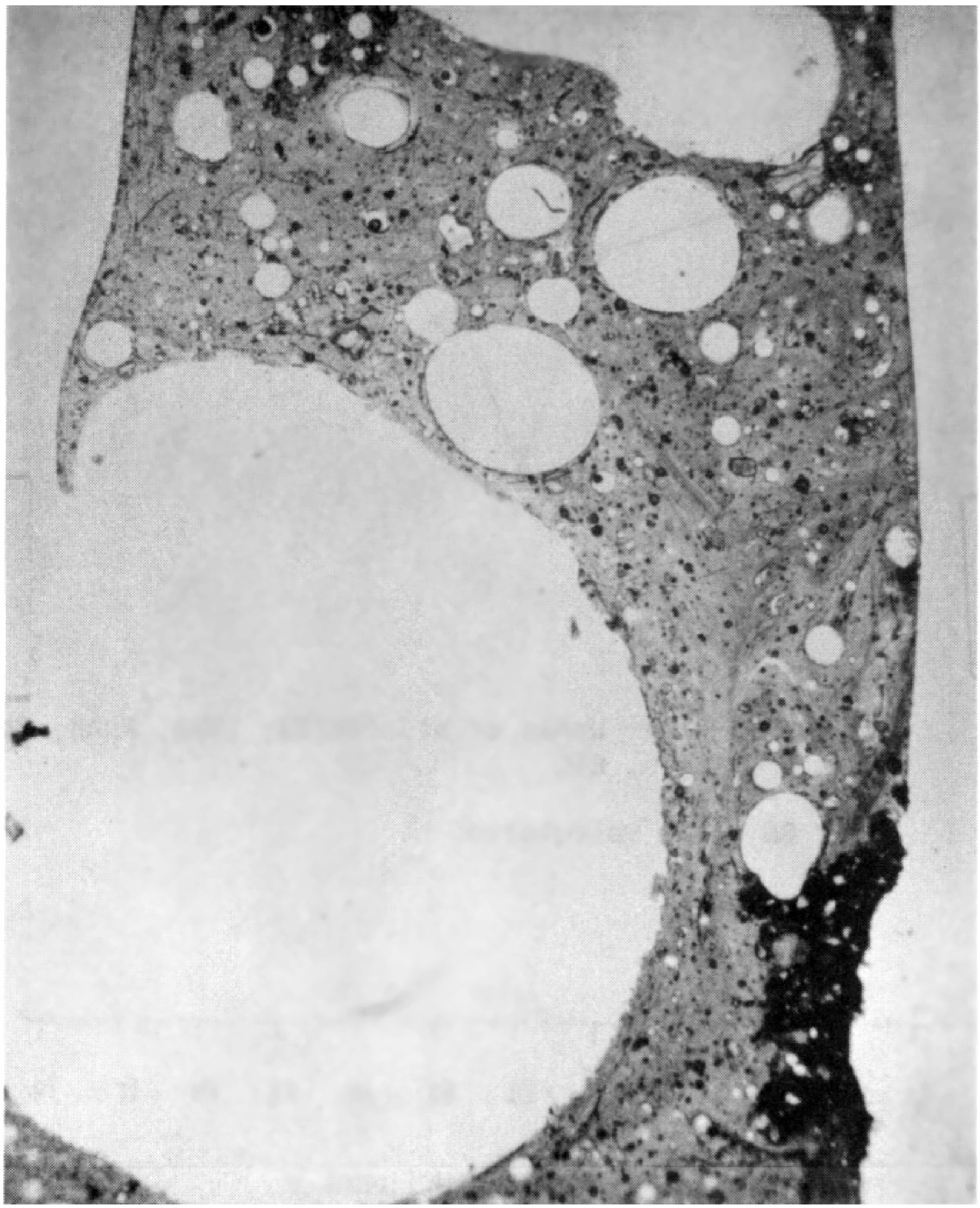

Figure 2. Photomicrograph of 15017,22. Width about 2 mm.
Transmitted light. Section cut across shell; interior is to left.

CHEMISTRY: Chemical analyses are listed in Table 1 and rare earths are shown in Figure 3. The composition is very similar to local regolith compositions except slightly richer in $A1_2O_3$ and poorer in FeO. The SiO_2 content (Wanke et al., 1977) appears to be too high; the major elements listed, even without TiO_2 or P_2O_5 (which can be expected to sum to nearly 2%) is 100.2%, suggesting some analytical error.

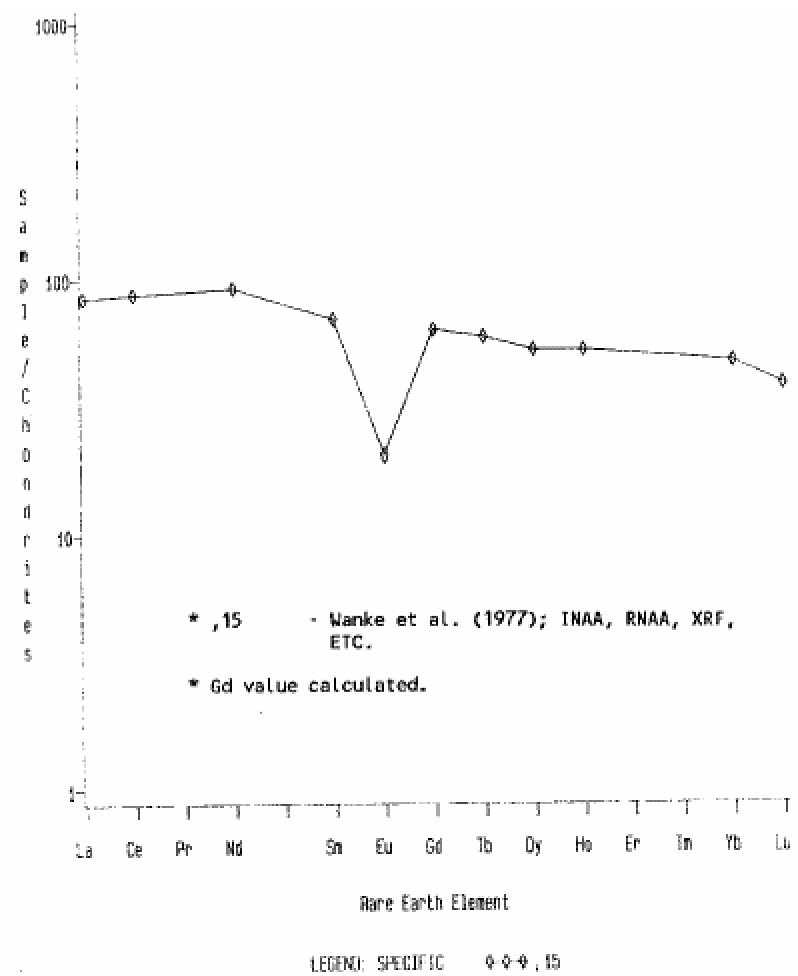

Figure 3. Rare earths in 15017.

TRACKS, MICROCRATERS, AND EXPOSURE: Fleischer et al. (1973) found that the exterior of ,6 had a low density of impact pits; one area of about 1 cm^2 has one pit larger than 200 microns, three larger than 100 microns, and six larger than 50 microns. From the flux of Hartung et al. (1973), such a density would suggest 14,000 years exposure. Tracks (Fig. 4) suggest an age of 2½ months, a discrepancy of a factor of 10^5, and suggests thermal fading of tracks. Experiments showed that 50 minutes at 230°C removed nearly all tracks. Fleischer et al. (1973) suggested that the flux in the 2½ months prior to the Apollo15 mission was too low to produce the tracks, and that the glass retained tracks for about one year (using the Surveyor 3 solar flare energy spectrum determination).

TABLE 15017-1. Chemical analyses

		,15	,16
Wt %	SiO2	49.88	
	TiO2		
	Al2O3	14.91	
	FeO	14.34	
	MgO	10.72	
	CaO	9.74	
	Na2O	0.442	
	K2O	0.211	
	P2O5		
(ppm)	Sc	29.9	
	V		
	Cr	3000	
	Mn	1530	
	Co	40.6	49
	Ni	260	
	Rb		2.2
	Sr	135	
	Y		
	Zr	437	
	Nb		
	Hf	10.3	
	Ba	300	
	Th	3.93	
	U		1.410
	Pb		
	La	28.2	
	Ce	77.7	
	Pr		
	Nd	56	
	Sm	12.7	
	Eu	1.42	
	Gd		
	Tb	2.79	
	Dy	16.8	
	Ho	3.7	
	Er		
	Tm		
	Yb	9.49	
	Lu	1.32	
	Li		
	Be		
	B		
	C		
	N		
	S		
	F		
	Cl		
	Br		0.076
	Cu		
	Zn		5.8
(ppb)	I		
	At		
	Ga		
	Ge		241
	As		
	Se		363
	Mo		
	Tc		
	Ru		
	Rh		
	Pd		
	Ag		2.3
	Cd		4.2
	In		1.95
	Sn		
	Sb		47
	Te		20
	Cs		273
	Ta	1260	
	W		
	Re		0.87
	Os		
	Ir	8	9.1
	Pt		
	Au		2.9
	Hg		
	Tl		1.55
	Bi		0.59
		(1)	(2)

References and methods:

(1) Wanke et al. (1977); INAA, RNAA, XRF, etc.
(2) Ganapathy et al. (1973); RNAA

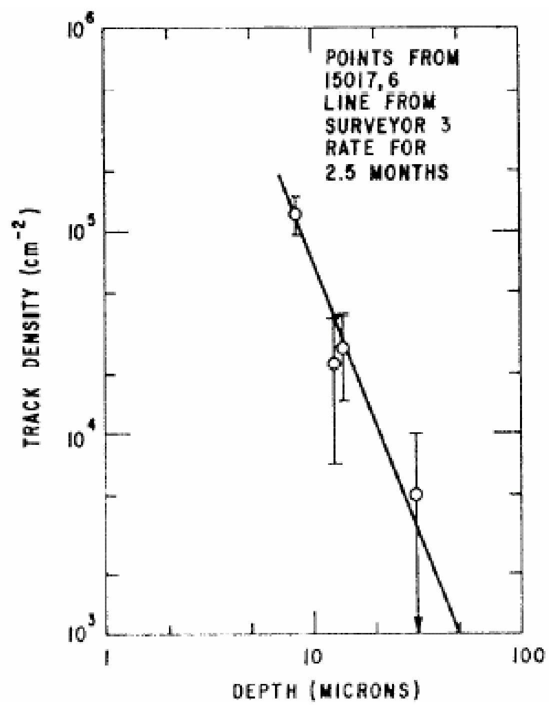

Figure 4. Track density gradient in 15017,6 (Fleischer et al.,1973).

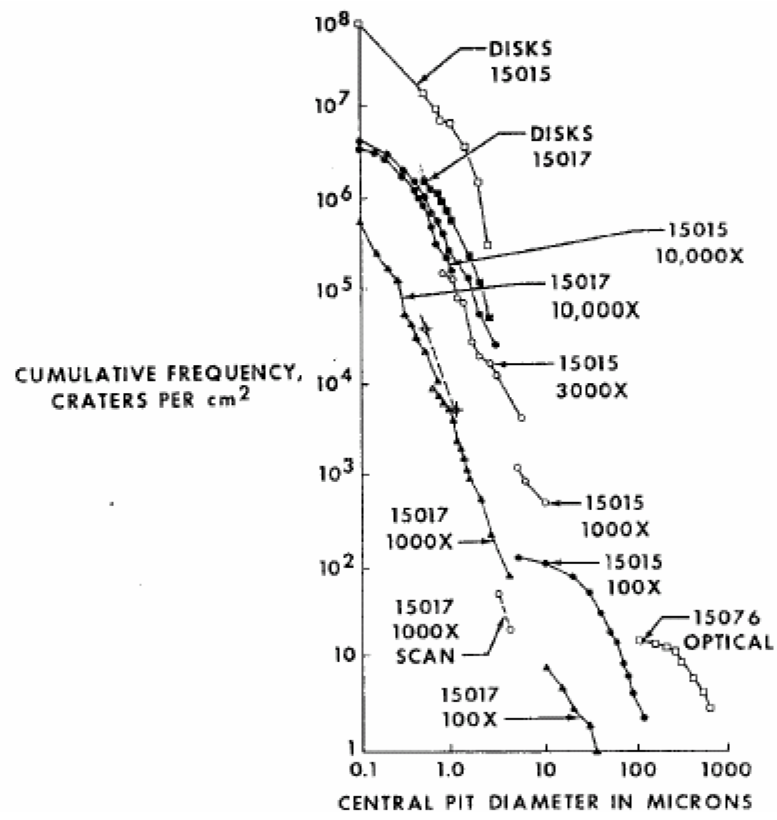

Figure 5. Cumulative microcrater and accretioning object frequency distributions for 15017 exterior, and for 15015 (Morrison et al., 1973).

Morrison et al. (1973) studied microcraters, and placed 15017 in their Category 4 (exceptionally low frequency of microcraters), suggesting it is very young. Cumulative frequencies were obtained from photomosaics, visual scanning at greater magnification, and SEM. The cumulative frequency distribution (Fig.5) has a flat slope in the 10 to 30 micron region. The frequencies are more than three orders of magnitude below a steady state. The bimodal distribution is typical, like 15205 and 15076 (Horz et al., 1975). Morrison et al. (1973) noted that the exposure age was difficult to determine because of the few craters larger than 100 microns, and the probable flexure on the frequency distribution below but near that size. They suggested that 15017 was probably about 1/30 the age of 15015, i.e., 300 to 700 years old. They interpreted the distribution in terms of a mass-flux distribution (Fig. 6). Accretionary objects (glass splashes) have a distribution similar to the craters.

PROCESSING AND SUBDIVISIONS: The sphere was received as 6 separate pieces (Fig. 1), and numbered ,1 to ,6. ,2 was chipped to produce ,7, from which thin sections ,22 to ,25 were made, and other allocations were also made from ,2; ,5; and ,6. The other three chips remain untouched.

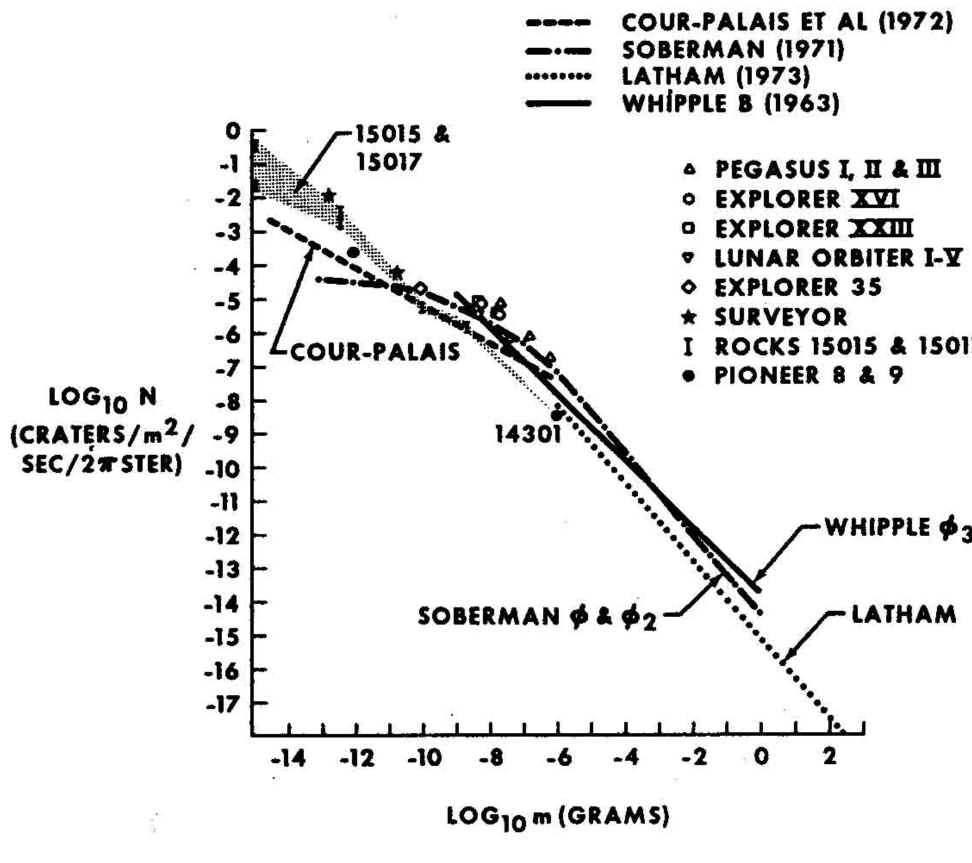

Figure 6. Mass-flux distribution estimates based on 15017 and other samples (Morrison et al., 1973).