15565 REGOLITH BRECCIA FRAGMENTS ST. 9A-LM 822.6 g

INTRODUCTION: 15565 is a collection of regolith breccia fragments which are the residue from Sample Collection Bag 2, which also contained three other loose rocks (15556-15558). Some of the fragments could have been part of 15558, which is also a regolith breccia. The Lunar Sample Information Catalog Apollo 15 (1972) states that there are 38 pieces. The pieces range from friable to coherent. Those studied contain mare basalt, non-mare (KREEP) basalt, breccia, and mineral fragments, and glasses, all in a glassy matrix. Only one piece has a surface glass.

The sampling location of 15565 has not been identified but appears to have been somewhere between 9 and LM inclusive, collected on EVA 3 (Sutton et al., 1972). The reason for this uncertainty is that at the end of EVA 3 grab samples were placed into the bag, including samples from under the seat of the rover.

PETROLOGY: No comprehensive description has been made, and individual pieces may not be closely related. However, all seem to be regolith breccias ranging from friable to coherent, with brown glassy matrices and containing mare basalt, KREEP basalt and other types of clastic materials (Fig. 1).

Piece ,1 was studied by Michel-Levy and Johann (1973) who found that it contained basaltic, vitrophyric, noritic, and glassy clasts (including green glass). They also found that it had a striated glassy coating in which the results of several events are superimposed, from original splashing to zap pits. Sewell et al. (1974) and Gleadow et al. (1974) also studied ,1, with the former reporting defocussed beam (energy dispersive) microprobe analyses of a feldspathic basalt clast, feldspathic recrystallized breccia, and several types of glasses, as well as analyses of mineral fragments and minerals in lithic clasts. These analyses demonstrate the diversity of materials in ,1 but emphasize the dominance of mare and KREEP materials.

Juan et al. (1972) found that piece ,7 was a welded breccia with 50% glassy matrix enclosing 20% lithic clasts (mare, non-mare, and older breccias), 19% mineral clasts (bytownite, pigeonite, olivine, ilmenite, and ulvospinel), 10% glass fragments, and 10% glass spherules. Engelhardt et al. (1972, 1973) found that piece ,8, consisted of soil components in a fragmental, perhaps partly glassy matrix. It contains both mare basalt and material described as "Apennine Front material." The dominant crystalline materials are, in order of abundance, intersertal noritic basalts (presumably KREEP basalts), ophitic basalts, noritic cumulates, and fragmental rocks. Glass and mineral fragments and glass spheres are present. McKay and Wentworth (1983) and McKay et al. (1984) found that piece ,11 was subporous with a low fracture porosity, had common agglutinates, common glass spheres, minor shock features, and an immature FMR index (I_s/FeO = 14; reported as 19 in Korotev, 1984 unpublished). Warren et al. (1981)

analyzed minerals in the matrix of ,11; An_{78-92}, $Ol_{61.5-64.5}$, and disperse pyroxenes. They also studied an 8 x 7 mm anorthositic norite clast which is a pristine highlands lithology (see CHEMISTRY). It has grain sizes (cataclasized zones) up to 2 mm, with a uniform and uncomplicated mineralogy: An_{93-95}, $En_{78}Wo_3$, with about 25% pyroxene. Fe-metal grains contain 2.8 to 3.0% Co and less than 1% Ni. Housley et al. (1976) show an absorption spectrum for ,21 which strongly resembles lunar fines.

CHEMISTRY: Analyses of breccia samples were made by Blanchard (1973 unpublished) and Korotev (1984 unpublished) (Table 1). The analyses indicate that the two fragments (,3 and ,11) are similar to each other. However, their high incompatible element levels and low iron make them more similar to a few high-KREEP breccias scattered around the site than to either 15558 (from the same bag) or LM-ALSEP area regoliths. They are certainly not like Station 9 or 9A regoliths.

Cadenhead and Buergel (1973), Cadenhead et al. (1973), and Cadenhead and Stetter (1974) studied the outgassing properties of the piece ,3 (which they refer to as a "typical complex breccia"), with emphasis on the production of water vapor and planetary atmospheres. They concluded that water vapor could be produced by the interaction of solar wind hydrogen and sample oxygen.

Warren et al. (1981) analyzed a small anorthositic norite clast for major and trace elements (Table 2, Fig. 2). The low abundances of siderophile elements, as well as the metal composition (above) indicate that this is a pristine fragment, derived from a lunar highlands igneous cumulate.

PROCESSING AND SUBDIVISIONS: Sample processing documentation is complicated by some sample number changes from a collection of separate numbers to the unified group 15565, and by erroneous numbering on the documentation of sample splitting diagrams. The individual pieces appear to be ,1 to ,15 and ,19 to ,43, i.e., 40 pieces. More than half of the sample mass is taken up with ,1 (80.6 g); ,2 (121.3 g); ,3 (126.8 g); ,4 (137.7 g); and ,5 (23.1 g). A list of thin section derivations is given in Table 3.

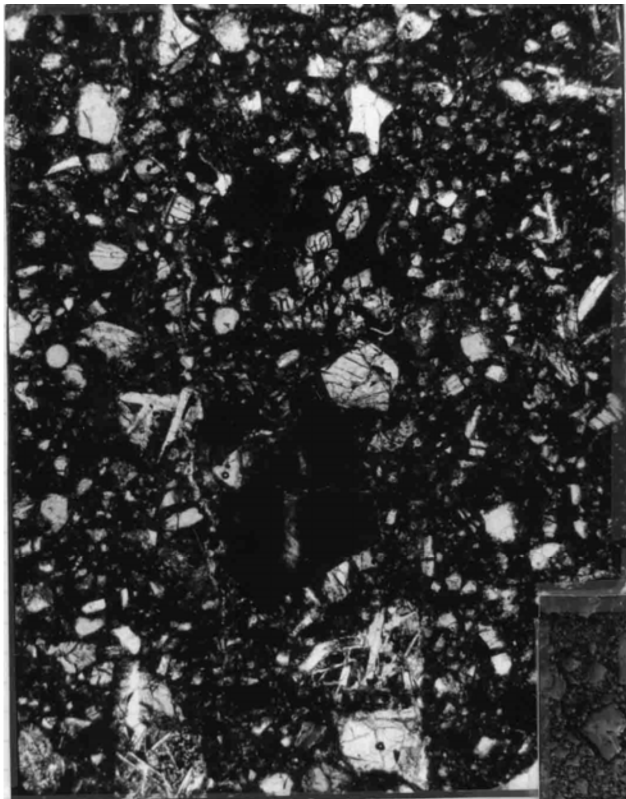

Fig. 1a

Fig. 1b

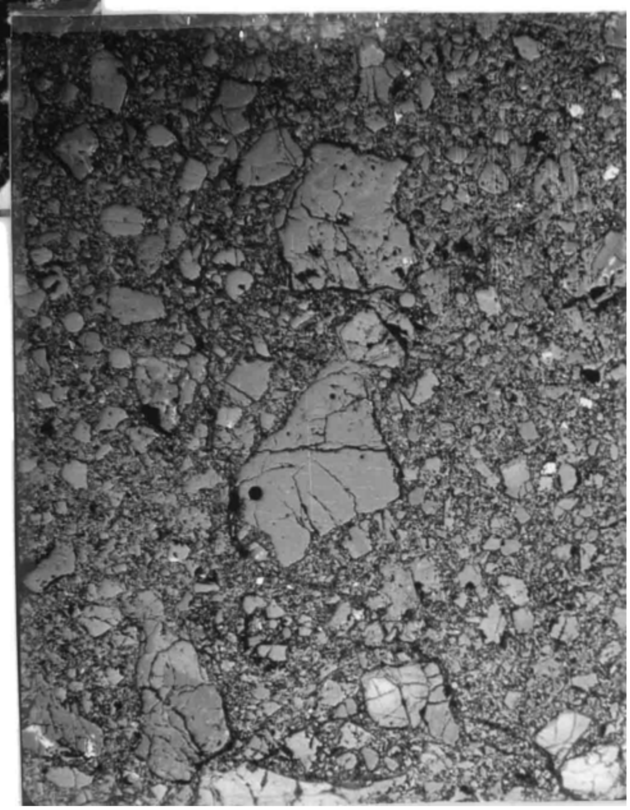

Figure 1. A,B, General matrix of 15565,87, a piece of ,1. a) plane light;
b) same view, reflected light, showing porosity. Clasts include KREEP basalts (bottom),
pyroxene vitrophyre (top center), and glass (center). Width 2 mm.
c)d) clasts in 15565,86, pieces of ,10.
c) pyroxene porphyritic mare basalt, plane light.
d) KREEP basalt, plane light. Widths 2 mm.

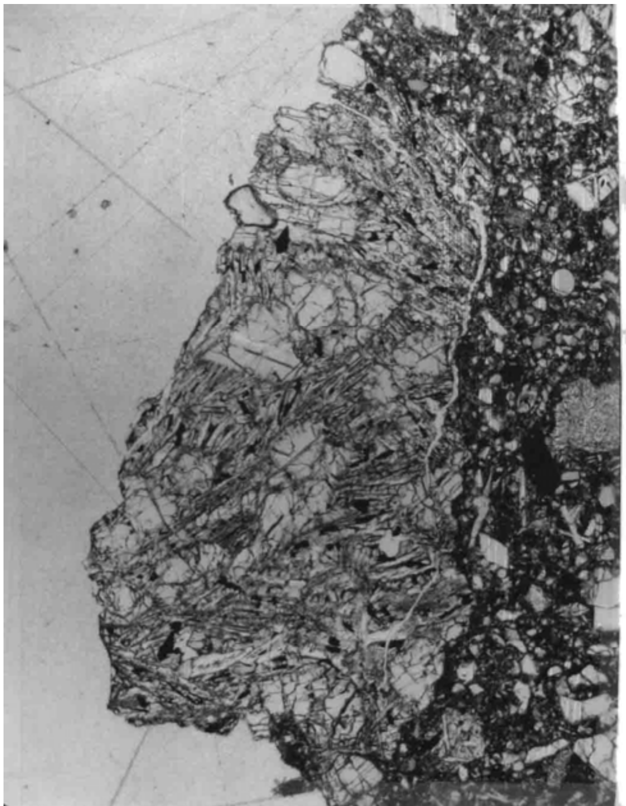
Fig. 1c

Fig. 1d


TABLE 15565-1. Chemical analyses of breccia fragments

		,3	,117
Wt %	SiO2		
	TiO2	1.91	
	Al2O3	13.3	14.1
	FeO	13.5	
	MgO	9.2	
	CaO	10.5	9.6
	Na2O	0.58	0.58
	K2O		
	P2O5		
(ppm)	Sc	28.1	29.0
	V		
	Cr	2890	2600
	Mn	1400	
	Co	32.7	33.2
	Ni	95	111
	Rb		
	Sr	100	150
	Y		
	Zr		620
	Nb		
	Hf	17.8	14.6
	Ba	760	385
	Th		6.6
	U		1.72
	Pb		
	La	42.9	40.6
	Ce	103	105
	Pr		
	Nd	68	61
	Sm	20.1	18.4
	Eu	1.85	1.74
	Gd		
	Tb	4.08	3.63
	Dy		
	Ho		
	Er		
	Tm		
	Yb	14.4	13.5
	Lu	1.99	1.72
	Li		
	Be		
	B		
	C		
	N		
	S		
	F		
	Cl		
	Br		
	Cu		
	Zn		
(ppb)	I		
	At		
	Ga		
	Ge		
	As		
	Se		
	Mo		
	Tc		
	Ru		
	Rh		
	Pd		
	Ag		
	Cd		
	In		
	Sn		
	Sb		
	Te		
	Cs	430	360
	Ta		1790
	W		
	Re		
	Os		
	Ir		<3
	Pt		
	Au		<4
	Hg		
	Tl		
	Bi		
		(1)	(2)

References and methods:

(1) Blanchard (1973 unpublished); INAA

(2) Korotev (1984 unpublished); INAA

TABLE 15565-2. Chemical analysis of a pristine highlands clast

		,113
Wt %	SiO2	48.15
	TiO2	0.10
	Al2O3	24.9
	FeO	4.1
	MgO	8.8
	CaO	13.3
	Na2O	0.425
	K2O	0.060
	P2O5	
(ppm)	Sc	6.7
	V	
	Cr	1510
	Mn	573
	Co	20
	Ni	8.8
	Rb	
	Sr	
	Y	
	Zr	<260
	Nb	
	Hf	0.69
	Ba	68
	Th	0.43
	U	0.31
	Pb	
	La	4.25
	Ce	9.5
	Pr	
	Nd	5.4
	Sm	1.38
	Eu	1.36
	Gd	
	Tb	0.24
	Dy	1.9
	Ho	
	Er	
	Tm	
	Yb	1.35
	Lu	0.19
	Li	
	Be	
	B	
	C	
	N	
	S	
	F	
	Cl	
	Br	
	Cu	
	Zn	1.68
(ppb)	I	
	At	
	Ga	
	Ge	18.1
	As	
	Se	
	Mo	
	Tc	
	Ru	
	Rh	
	Pd	
	Ag	
	Cd	
	In	
	Sn	
	Sb	
	Te	
	Cs	
	Ta	
	W	
	Re	0.0071
	Os	
	Ir	<0.03
	Pt	
	Au	0.069
	Hg	
	Tl	
	Bi	
		(1)

Reference and method:

(1) Warren et al. (1981); RNAA, fused bead.

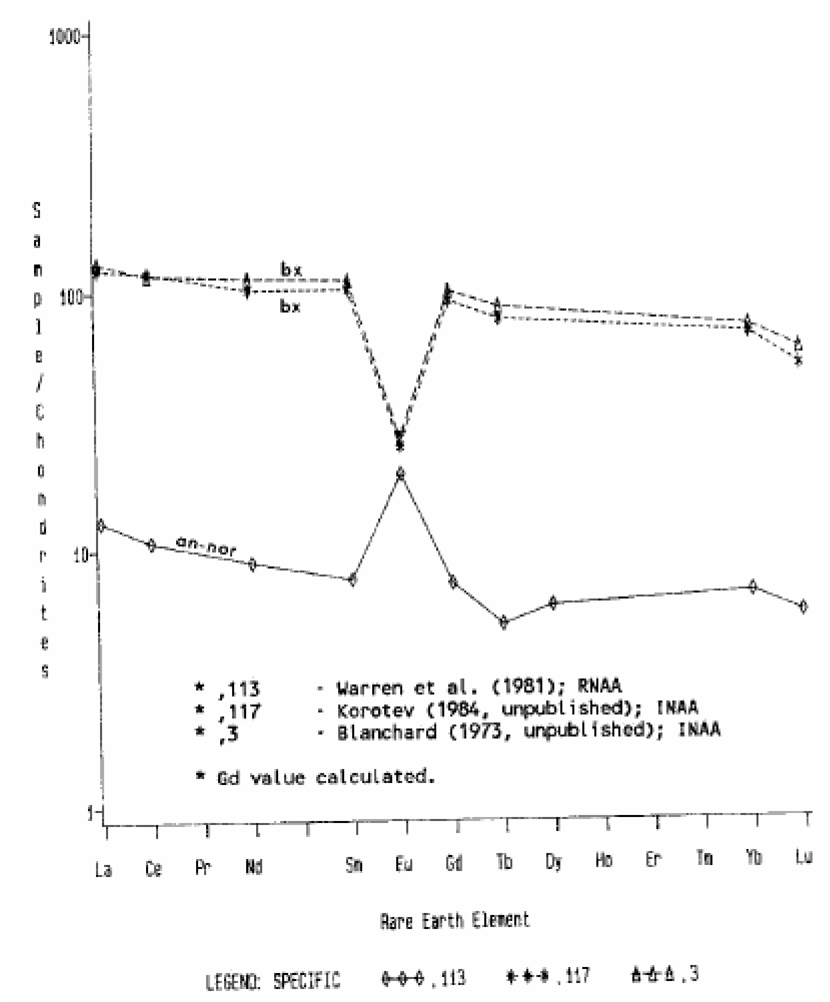

Figure 2. Rare earths.

TABLE 15565-3. Thin section derivations

Ultimate Parent Piece	Potted Butt	Thin Sections or Probe Mount
,1	,52	,83; ,87; ,92; ,95; ,96; ,98
,7	,59	,84; ,93
,8	,65	,85; ,94
,10	,75	,82; ,86
,11	,56	,57
,15	(,15)	,16; ,17; ,18; ,44; ,45; ,46; ,47; ,48; ,80; ,81