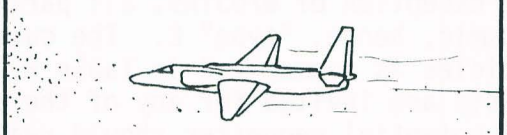
Cosmic Dust Courier



Compiled and issued by:

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Code SN2

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Number 2 **June 1982**

Reconnaissance for Large "Cosmic" Particles

Extraterrestrial particles on our collection flags commonly occur within the size range of ∿ 5-20 μm. Extraterrestrial particles of larger size are needed in order to facilitate scientifically important analyses by techniques which, in their current states of refinement, cannot meaningfully treat smaller particles. Consequently, the whole-flag optical microscopic survey, which is routinely performed after each flag has completed its sampling mission, includes the search for unusually large (≥ 20 μm) particles.

In early 1982, reconnaissance picking was performed on several such particles on a total of 5 different flags (W7026, W7028, W7029, W7031, W7032). In each case, a clean glass-needle micromanipulator was used to gently probe the particle of interest. If fragments could be found or generated during the process, one or more were removed for examination. The remainder of the large parent particle was retained on the flag in essentially pristine condition. Large particles which did not shed suitable fragments upon mechanical probing were likewise retained on the flags. Thus, maintenance of large-particle pristinity was favored over identification during the reconnaissance.

Five relatively large particles suspected to be "cosmic" did not yield fragments for examination and remain on their respective flags in pristine condition but unidentified (two on W7026; two on W7028; one on W7031). Among the other large particles for which suitable small fragments could be found or generated, 8 were tentatively identified as "cosmic". Preliminary examination data for samples from the two most impressive large-particle occurrences (W7029*A and W7029*B) were published in Cosmic Dust Courier No. 1 as Figures 1 and 2, respectively, and the accompanying descriptions. Similar data for 6 other particles are presented in this issue as Figures 1 through 6. The data in Figures 1 through 6 are presented in the same format used in the Cosmic Dust Catalog. Thus, the equivalent of one catalog page is devoted to each preliminary examination sample. "Size" is quoted in μm, particle "shape" is irregular (I), "transparency" ("Trans.") is translucent (TL) to

opaque (O), and "luster" is dull (D), subvitreous (SV), or submetallic (SM). With the possible exception of W7031A9, all particles are judged to be extraterrestrial or cosmic, hence, "type" C. The current status of each of the 8 large parent particles is summarized in Table 2.

Sample requests are invited for any of the particles described in Table 2. However, each potential requester should realize that the sizes quoted for the large parent particles are only approximate and that no meaningful predictions about the fragmentation behavior of any particle can be made, except possibly for W7029*A and W7029*B. W7029*A is a unique cluster of discrete fragments of various size (see Fig. 1, Cosmic Dust Courier No. 1) whereas W7029*B is a loose conglomeration of numerous small ($\leq$ 5 μm) fragments. Thus, experience to date suggests that the W7029*A cluster is the only large particle which can be split in a systematic manner.

Status of Cosmic Dust Collection Activities

Since May 1981, cosmic dust collection flags have been flown on NASA WB-57F and U-2 aircraft. The particular WB-57F which was used to fly the first three sets of collectors (yielding a total of 24 flags for sample inventory) was grounded by budget cuts. Our WB-57F collection activity has now been transferred to a second WB-57F which is operated jointly by NASA and DOE in support of the DOE Airstream project. Unfortunately, the recently intensified Airstream sampling schedule will soon require that the time-shared pylon positions revert to Airstream experiments, thereby curtailing cosmic dust collection with the NASA-DOE WB-57F for approximately one year. Thus, continued time-sharing of collector space on NASA U-2 aircraft (which has already yielded 4 flags) appears to be the best near-term opportunity for continuing stratospheric sampling.

We are slowly moving forward with plans to build and fly large-area stratospheric dust collectors. As currently designed, each large-area collector will have a surface area 15 times greater than that of a standard collection flag. The deployment of 4 large-area collectors on a U-2 aircraft, for example, would increase the dust collection rate per unit time by a factor of 30 relative to the current collection rate which is limited by the deployment of only 2 flags per U-2 collection mission. The principal justification for the large-area collectors is the anticipated yield of large ($\geq$ 50 μm) particles. Such particles are currently very rare in the sample inventory but are required for several types of important analyses (e.g., neutron activation analysis, isotopic analysis, noble gas analysis). Unfortunately, the funds required to construct the large-area collectors and install them on appropriate aircraft are not yet available. Nevertheless, design and planning for the collectors are continuing.

Status of Cosmic Dust Sample Inventory

As of June 1982, a total of 4 whole collection flags, 7 complete SEM particle mounts, and 19 individual particles have been (or are scheduled to be) allocated to a total of 6 different scientific research groups. Many of these allocations have involved samples described in Volumes 1 and 2 of the Cosmic Dust Catalog such that some are no longer available from the advertised sample inventory. As an aid to investigators who wish to submit new sample

requests, we have compiled Table 1 as a summary of the current availability of samples from our inventory. In addition, the availability of relatively large ($\geq$ 20 μm), documented particles is summarized in Table 2 and discussed below.

Sample Requests

All sample requests should be made in writing to "Curator/Cosmic Dust" at the address given in the Courier letterhead. Each request should contain enough information to permit evaluation of the proposed study and the adequacy of the requester's facilities. All necessary information should probably be condensable into a one- or two-page letter, although informative attachments (e.g., copies of pages from related proposals, reprints of publications, flow diagrams for analyses) are welcome. Prospective sample requesters may contact us for further information.

Sample requests will be reviewed by the Lunar and Planetary Sample Team (LAPST), a committee of scientists which advises NASA on matters related to lunar sample and cosmic dust sample curation and distribution. The NASA/JSC Curator will arrange for all required LAPST reviews and will inform sample requesters of results as rapidly as possible.

Table 1

NASA/JSC COSMIC DUST PROGRAM: SAMPLE AVAILABILITY SUMMARY

Sample Generic	Whole Flag	Mount	Particles From Mount 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Comments
W7009																			
W7010	p	A: I1																	Also 17-32
		B: I1																	Also 17-39
W7011	r																		
W7012	I2																		
W7013																			
W7014																			
W7015																			
W7016	r																		
W7017	p	A: I1	n									n					n		Also 18
		B: I1															n		Also 3A
		C:		I1*			I1*			n			n		n	n	n		
		D:	n		I6*	n					n	n				I6*	n	n	
		E: I1																	Also 17-18
		F:						I5*				n	I6*						
		G:	I1*		I1*	I5*		I1*		I1*		I1*	I5*	I5*	I1*	I1*	I3*		
W7018	I3																		
W7019																			
W7020	r																		
W7021	I3																		
W7022																			
W7023	r																		
W7024																			
W7025	r																		
W7026	p	A:		u	u	u	u	u	u	u	u	u	u	u	u	u	u	u	LPRS
W7027	(I2)																		
W7028	p	A:			u						u	u	u	u	u	u	u	u	LPRS
		B: I4x																	Also 17
W7029	p	A:						I6*											Also 17-19
		B:														I6*			Also 17-18;I6*/17
		C: I1		n		n	n	n				n	n						
		D:																	
		E:																	
		F:											n	n		n	n		Also 17
		G:																	
		H:																n	
		I:													n				Also 17-20
		J:		n				n	n										Also 18-20
W7030	r																		
W7031	p	A:			u	u		u	u	u		u	u	u	u	u	u	u	LPRS
W7032	p	A:				u	u	u	u	u	u	u	u	u	u	u	u	u	LPRS
U2001	p*	A:																	
		B:																	Preliminary Examination In Progress
		C:																	
		D:																	
		E:																	
U2002	r																		
U2003																			Heavy Contamination (Volcanic Ash?)
U2004																			

NOTE: KEY TO TABLE IS ON OPPOSITE SIDE.

KEY TO TABLE:

A, B, C, ... etc.	=	particle mount designation
I...	=	allocated to investigator "I..." (see separate listing)
I...x	=	allocated to investigator "I..." but without preliminary examination by scanning electron microscopy (i.e., no catalog-type data were published).
I...*	=	allocation to investigator "I..." now being prepared
(I...)	=	now at JSC but previously allocated to investigator "I..."
LPRS	=	large-particle reconnaissance sample
n	=	not available (i.e., lost during sample handling or preliminary examination)
p	=	particles picked to yield samples as listed
p*	=	particles now being picked
r	=	reserved for posterity
u	=	unassigned (no sample yet assigned this number)

Investigators:

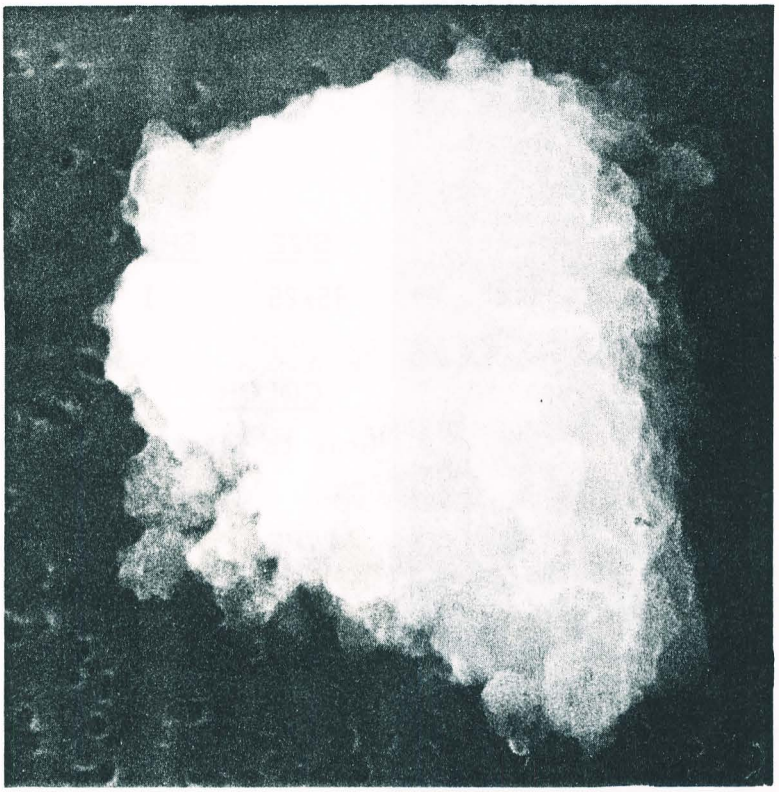
I1	=	D.S. McKay (NASA Johnson Space Center, Houston, Texas)
I2	=	D.E. Brownlee (University of Washington, Seattle, Washington)
I3	=	R.M. Walker (Washington University, St. Louis, Missouri)
I4	=	P.R. Buseck (Arizona State University, Tempe, Arizona)
I5	=	M. Maurette (Laboratoire Rene Bernas, Orsay, France)
I6	=	G.L. Nord, Jr. (U.S. Geological Survey, Reston, Virginia)

NASA/JSC COSMIC DUST PROGRAM:
LARGE (≥20 μm) PRISTINE "COSMIC" PARTICLE INVENTORY
June 1982

Parent Particle	Pristine Material Remaining on Flag	Preliminary Examination Sample and Description
W7026*A	One ≈20-μm, mostly opaque, moderately transparent/ porous particle of irregular shape.	W7026A1, a small companion adjacent to the ≈20-μm particle; see Fig. 1 in CD Courier #2.
W7028*C	One ≈30-μm, opaque, mostly dense (very slightly transparent/porous) particle of irregular but moderately angular and blocky shape; numerous small (≤5-μm) fragments crumbled from large particle.	W7028A4, a few small fragments obtained by mechanical (glass needle) probing of large particle; see Fig. 2 in CD Courier #2.
W7029*A	Approximately 21 fragments (≈5-35-μm size range) of slightly transparent/porous material in an open cluster [Note: Approximately 7 of the fragments are now in the process of being allocated].	W7029C1, a single small fragment; see Fig. 1 in CD Courier #1.
W7029*B	One ≈30-40-μm open cluster of numerous small, mostly opaque fragments [Note: a "grab sample" of fragments is now in the process of being allocated].	W7029B13, a few small fragments obtained by mechanical (glass needle) probing of original, friable but compact cluster; see Fig. 2 in CD Courier #1.
W7031*A	One ≈25-μm, mostly opaque, moderately transparent/ porous particle of irregular shape; a few small (≤ 5-μm) fragments crumbled from large particle.	W7031A1, a few small fragments obtained by mechanical (glass needle) probing of original large particle; see Fig. 3 in CD Courier #2.
W7031*B	One ≈30-μm, mostly opaque, slightly transparent/ porous particle of irregular shape.	W7031A2, a small companion adjacent to the ≈30-μm particle; see Fig. 4 in CD Courier #2.
W7031*C	One ≈30-40-μm, mostly dense and opaque particle of irregular but moderately blocky and angular shape; one ≈10-μm companion adjacent to the large particle.	W7031A5, a small companion adjacent to the ≈30-40-μm particle (and its other small companion); see Fig. 5 in CD Courier #2.
W7031*D	One ≈30-35-μm, mostly dense and opaque particle of irregular but moderately blocky and angular shape; numerous small (<5-μm) fragments surrounding large particle.	W7031A9, several small fragments taken from fragment population surrounding large particle; see Fig. 6 in CD Courier #2; identification as "cosmic" is very tentative.

Figure 1

W7026A1



SIZE	SHAPE	TRANS.
10x11	I	O/TL

COLOR	LUSTER
Pale Gray to Black	SV/SM

TYPE	COMMENTS
C	Sample of W7026*A

S-82-31335

Note: Stray electrons induce copper x-radiation from some SEM internal parts. Thus, the peak labelled "CU" may include contributions from both sample and instrument.

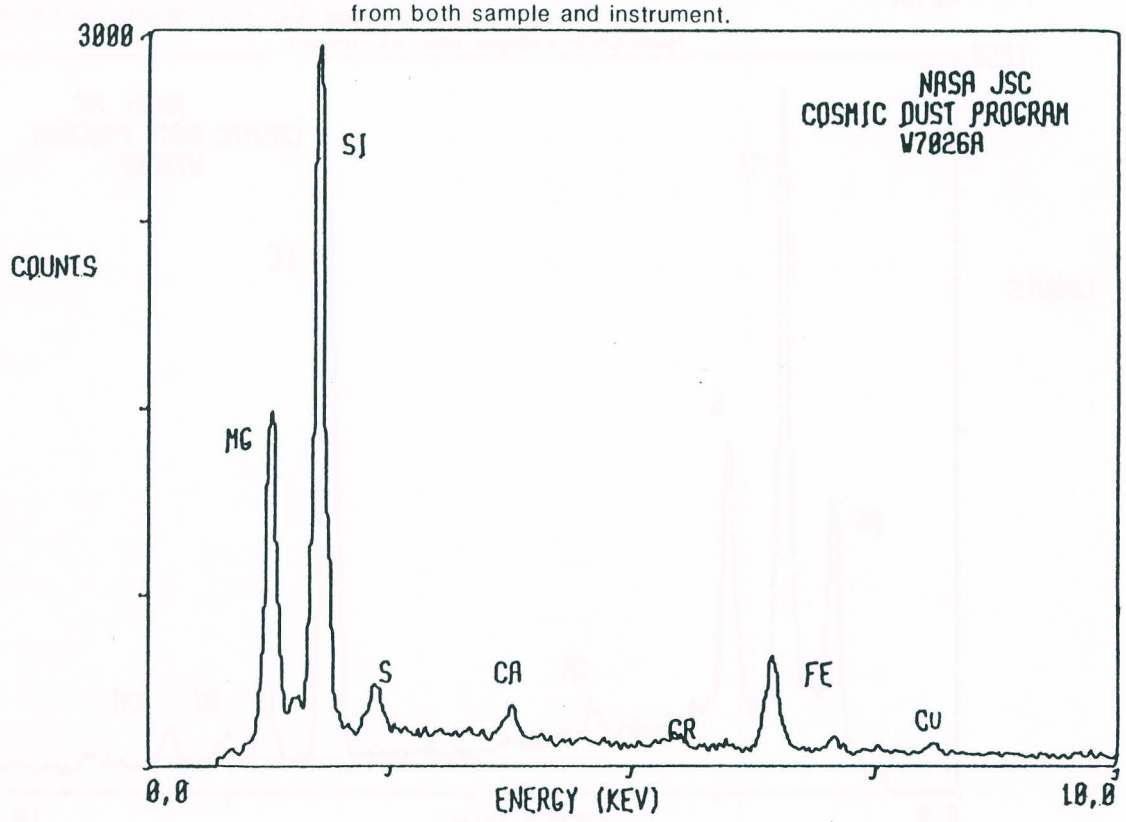
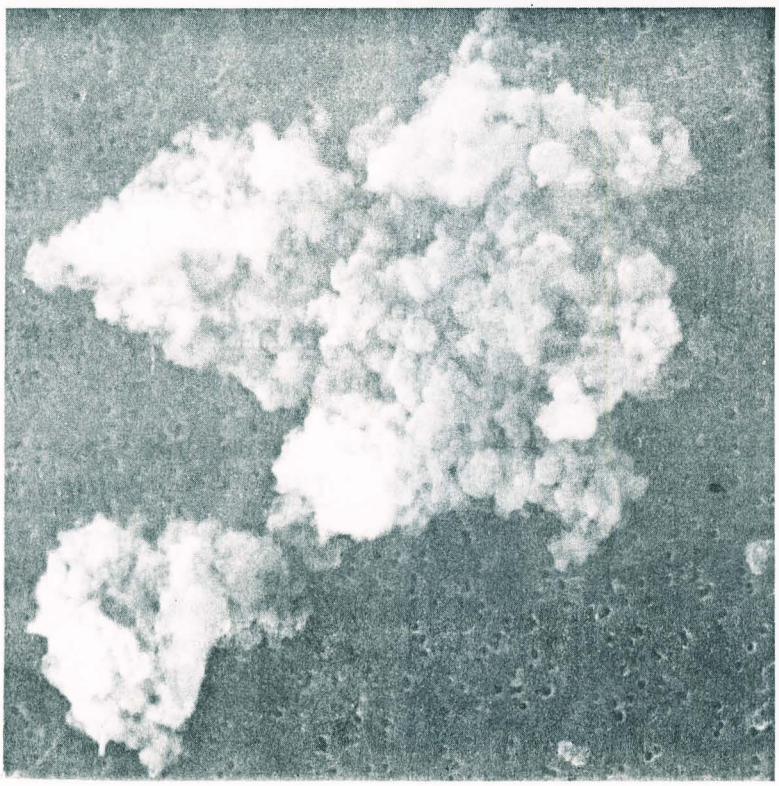


Figure 2

W7028A4



SIZE	SHAPE	TRANS.
15x25	I	0

COLOR	LUSTER
Gray to Black	D/SM

TYPE	COMMENTS
C	Sample of W7028*C

S-82-31347

Note: Stray electrons induce copper x-radiation from some SEM internal parts. Thus, the peak labelled "CU" may include contributions from both sample and instrument.

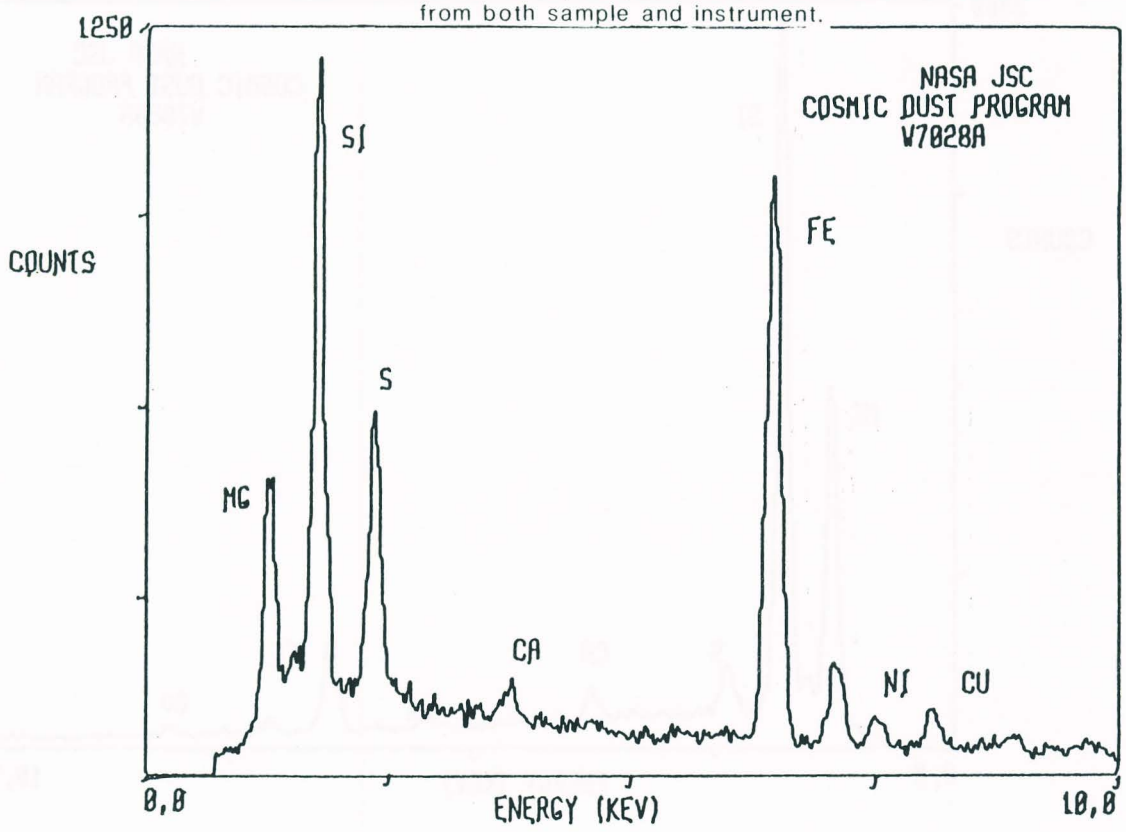
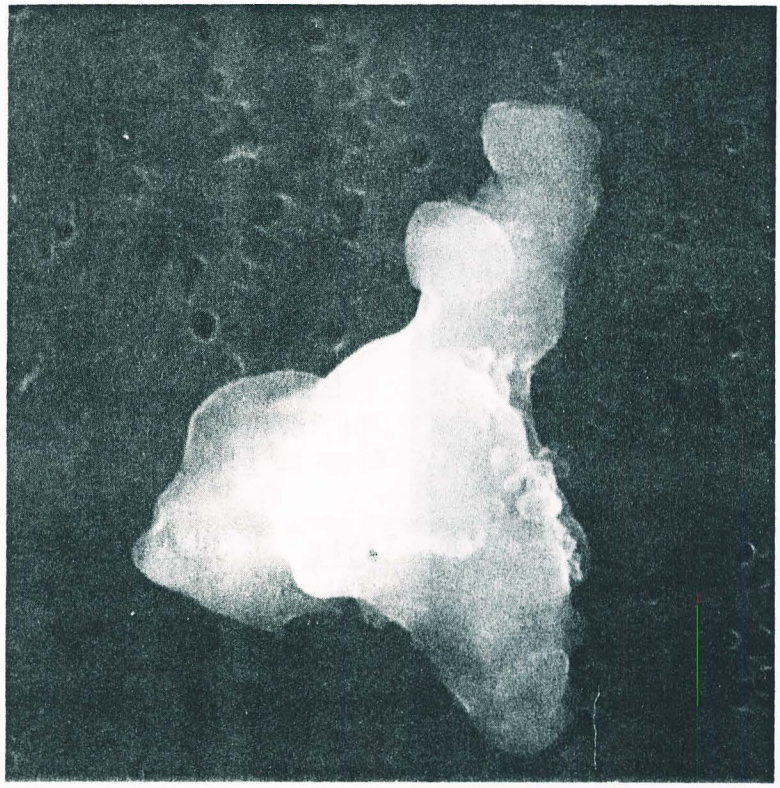


Figure 3

W7031A1



S-82-31621

SIZE	SHAPE	TRANS.
6x8	I	TL/O

COLOR	LUSTER
Lt. Yellow-Gray to Brown	D/SV

TYPE	COMMENTS
C?	Sample of W7031*A

Note: Stray electrons induce copper x-radiation from some SEM internal parts. Thus, the peak labelled "CU" may include contributions from both sample and instrument.

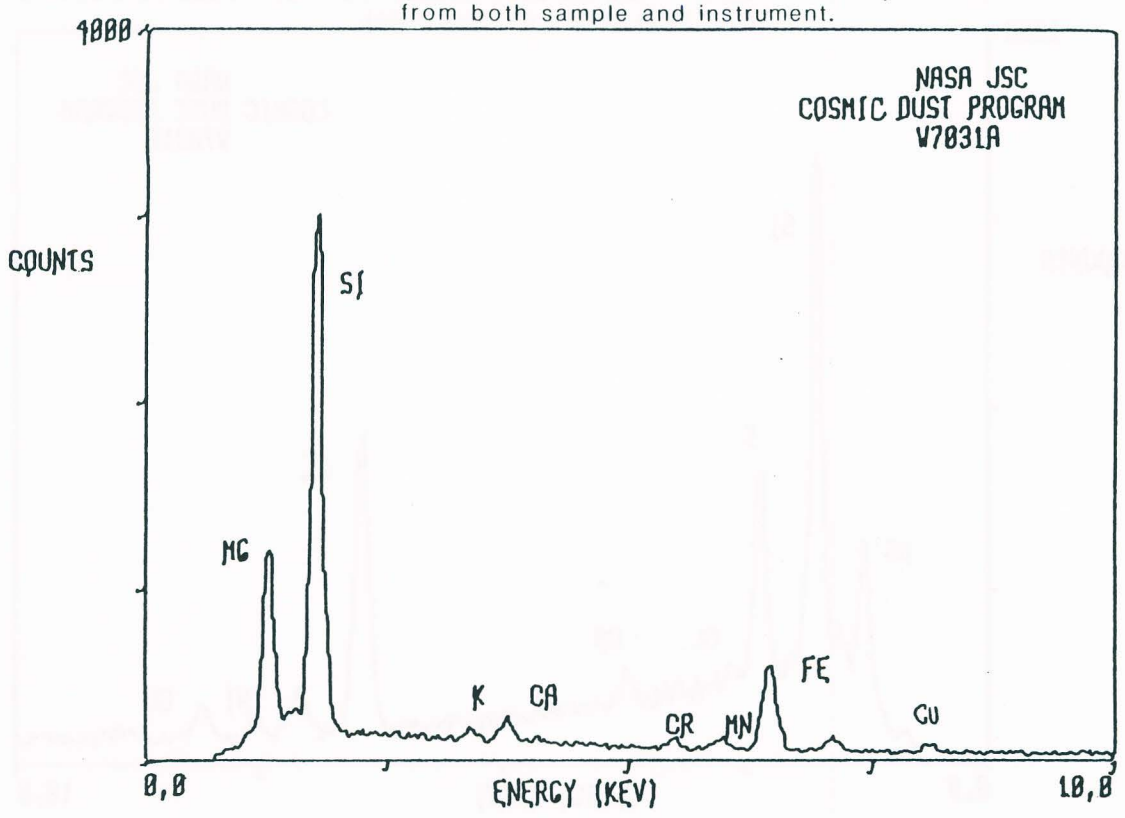
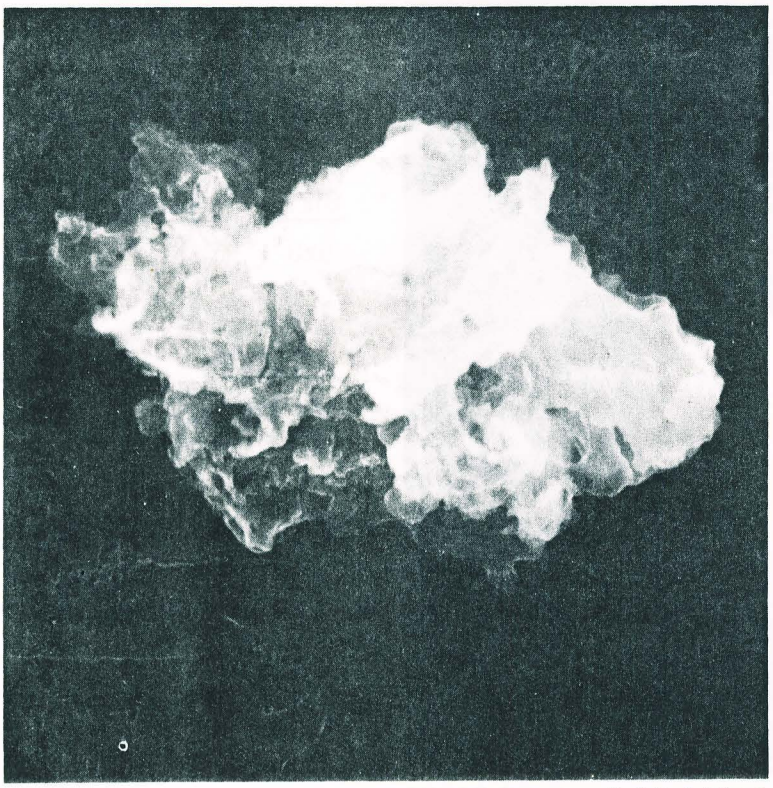


Figure 4

W7031A2



SIZE	SHAPE	TRANS.
14x21	I	0

COLOR	LUSTER
Dk. Brown-Gray to Black	D/SM

TYPE	COMMENTS
C	Sample of W7031*B

S-82-31619

Note: Stray electrons induce copper x-radiation from some SEM internal parts. Thus, the peak labelled "CU" may include contributions from both sample and instrument.

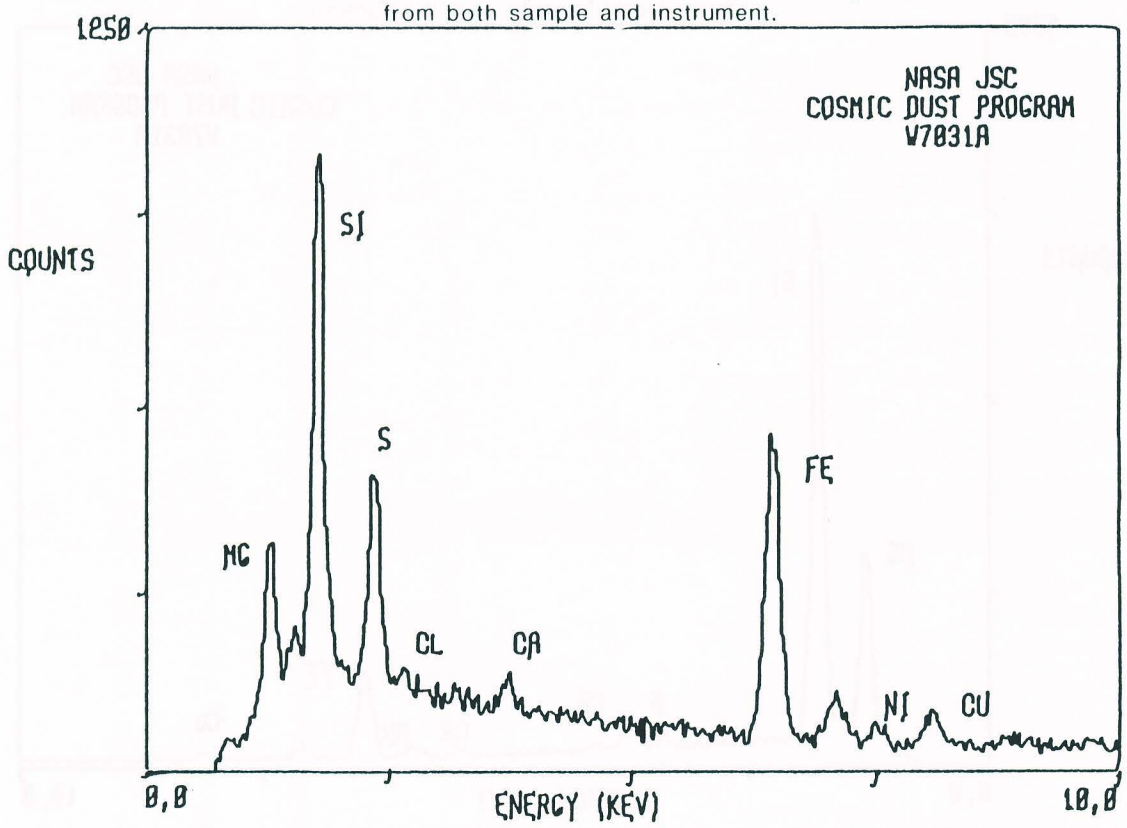
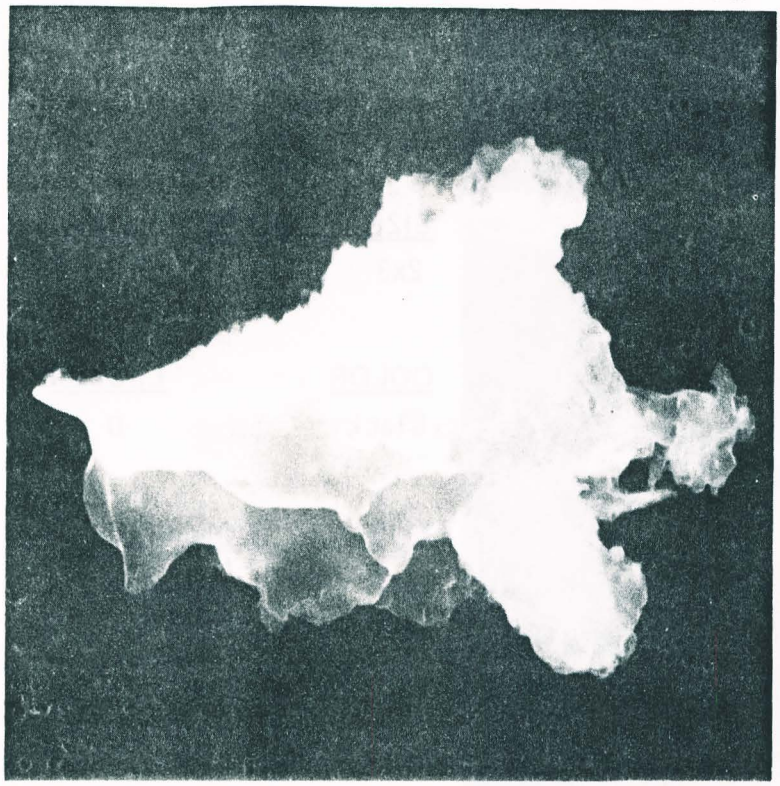


Figure 5

W7031A5



SIZE	SHAPE	TRANS.
16x22	I	0

COLOR	LUSTER
Black	D/SM

TYPE	COMMENTS
C	Sample of W7031*C

S-82-31615

V0501

Note: Stray electrons induce copper x-radiation from some SEM internal parts. Thus, the peak labelled "CU" may include contributions from both sample and instrument.

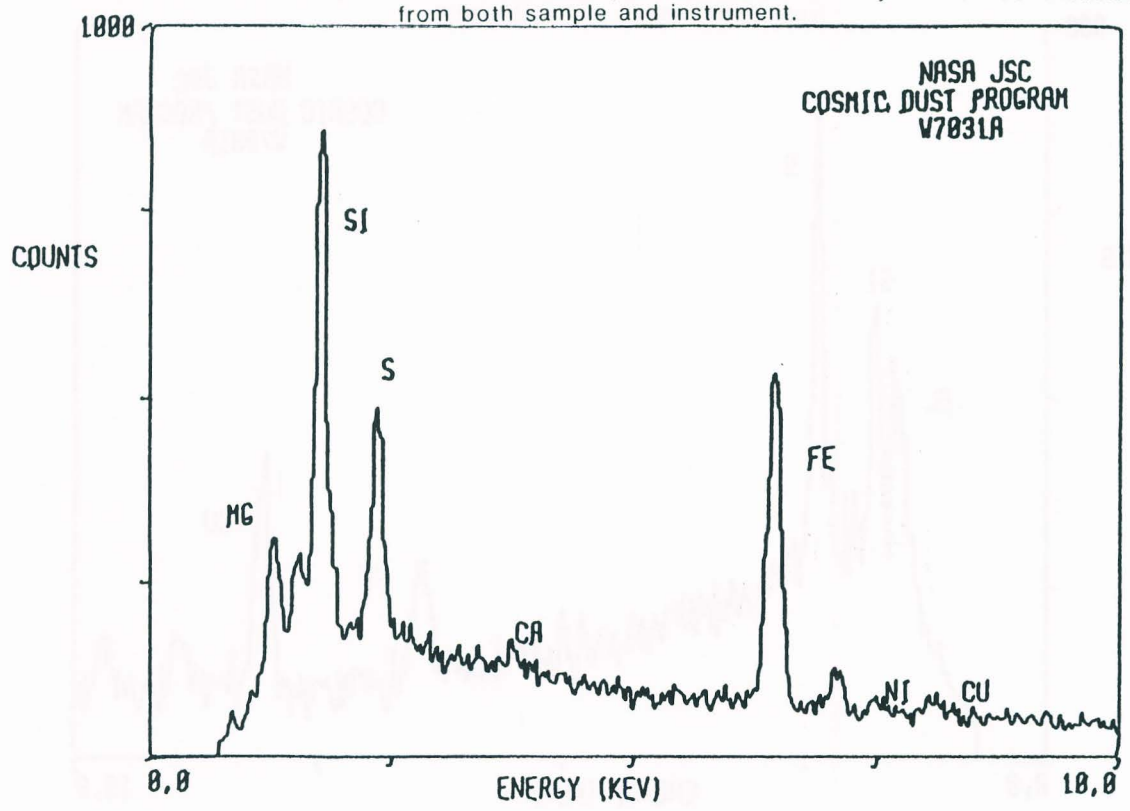
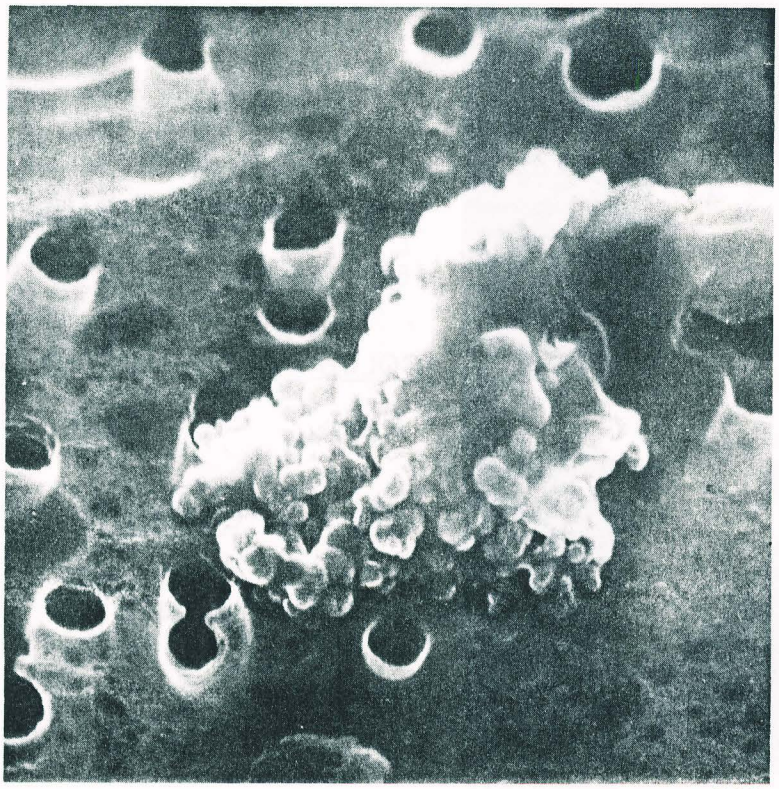


Figure 6

W7031A9



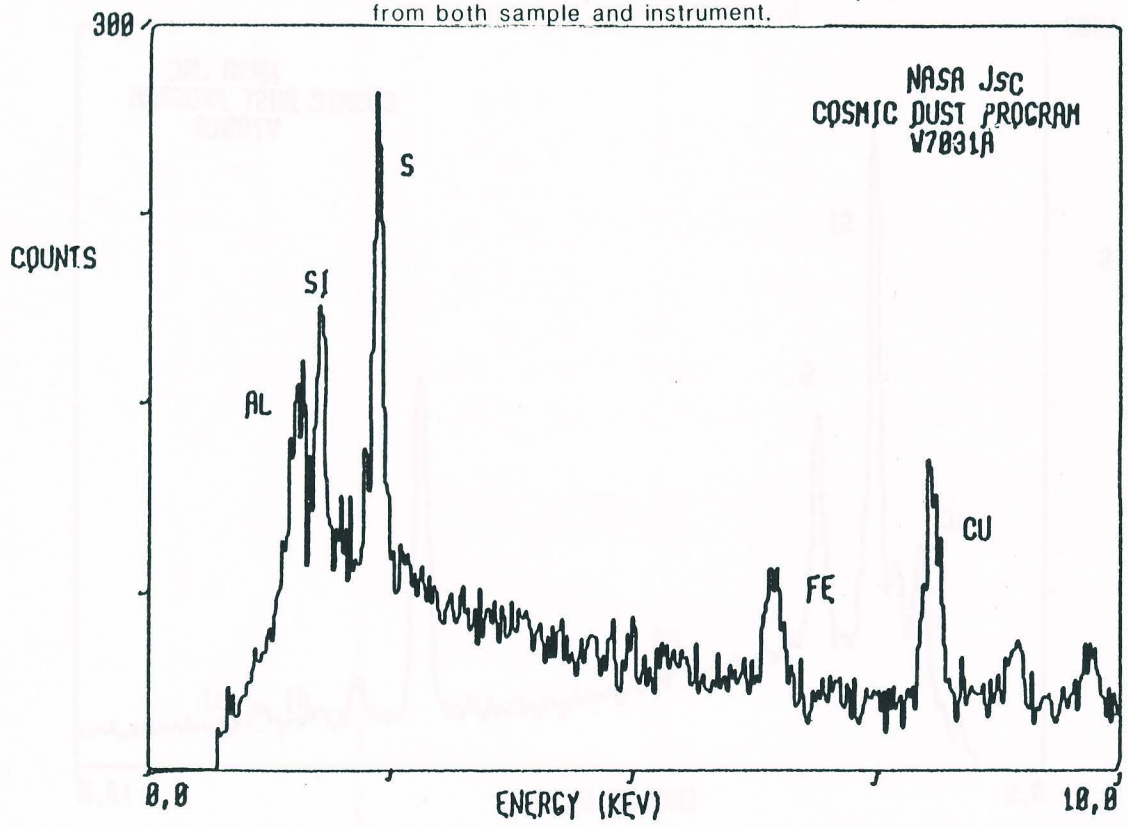
SIZE	SHAPE	TRANS.
2x3	I	0

COLOR	LUSTER
Black	D

TYPE	COMMENTS
C??	Sample of W7031*D

S-82-31623

Note: Stray electrons induce copper x-radiation from some SEM internal parts. Thus, the peak labelled "CU" may include contributions from both sample and instrument.



El Chichón Volcanic Ash Captured for Study

Recent collection activities using the NASA-DOE WB-57F yielded 8 collection flags (W7033 through W7040) heavily contaminated with ash from the March and April eruptions of the volcano El Chichón in Mexico. Collection flights made by a U-2 at about the same time yielded two other flags (U2003, U2004) which were also contaminated by ash but which, in contrast with the WB-57F flags, may still yield cosmic dust particles upon careful search. Consequently, the material on the WB-57F flags is being offered to investigators who wish to study the stratospheric components of the El Chichón particulate ejecta. The ash was injected into the stratosphere by a relatively unknown volcano but by a type of eruption which has potentially serious environmental and climatic ramifications. Scientists interested in geological or environmental problems related to volcanic ash clouds are invited to request samples from flags W7033 through W7040.

The ash samples were collected during late April and early May of 1982 as part of a series of NASA-DOE Project Airstream flights over the western United States (including Alaska). Throughout the flights, the cosmic dust collectors were opened only above 60,000 ft. (18 km.) altitude and each collector accumulated ∿ 13-1/2 hours of exposure.

The aircraft departed Ellington AFB (Houston, Texas) on April 27 and flew to McCord AFB (Tacoma, Washington). Mechanical problems forced a two-day delay in Tacoma before the aircraft proceeded to Elmendorf AFB (Anchorage, Alaska) on April 30. Flights on May 1 and 2 involved traverses to latitude 75°N but with subsequent return to Anchorage whereas the flight on May 3 was confined to the general vicinity of Anchorage. The plane flew from Anchorage to Tacoma on May 4 and on to Houston on May 5. On May 7, the plane flew from Houston to central Colorado then north to the U.S.-Canadian border before turning south to land at Kirtland AFB (Albuquerque, New Mexico). At the conclusion of the mission, the flight crew reported unambiguous visual evidence of the ash cloud as far north as the U.S.-Canadian border and estimated that the ash cloud extended vertically to an altitude in excess of 70,000 ft. (21 km.).

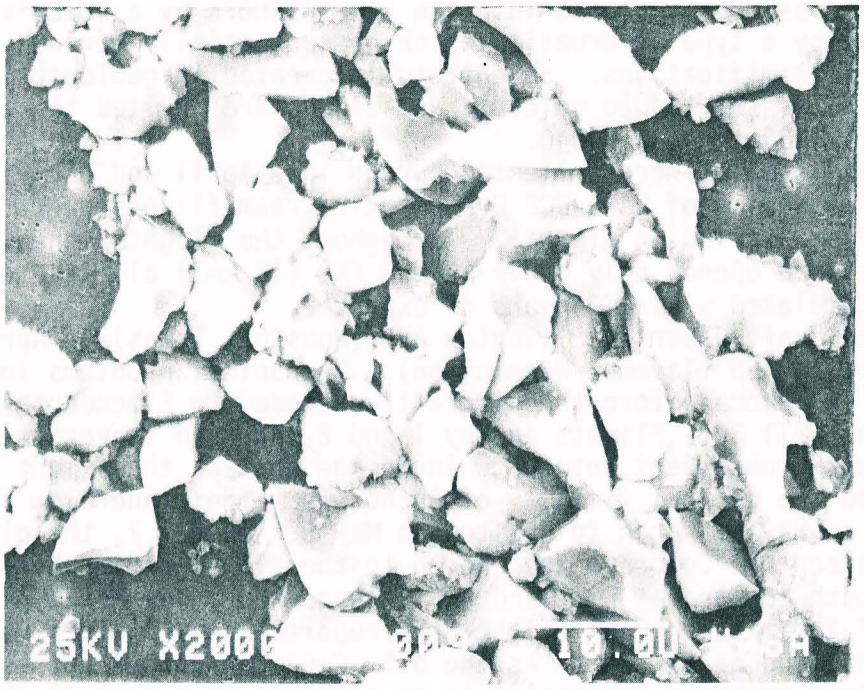
Preliminary examination of the ash-laden flags revealed that the ash is a well-sorted (∿ 5-10-μm-sized particles) assemblage of angular fragments of plagioclase crystals and silicic glass (Fig. 7). Other phases include minor amounts of a mafic mineral (probably an amphibole) and traces of a Ca, S-rich mineral (probably a Ca-sulfate). The ash occurs on the flags as irregular patches of particles arranged in open, reticular arrays. When immersed in the silicone oil, particles are predominantly translucent to transparent and colorless to light gray. Once washed free of oil, the same particles appear white to light gray under oblique fiber-optic illumination.

We estimate that each flag contains ∿ 0.2-2 mg of ash such that the entire inventory from all 8 flags is probably on the order of several mg. Thus, a relatively large amount of ash is available for studies which require mg or sub-mg quantities of sample.

Scientists interested in obtaining ash samples from flags W7033 through W7040 should contact Curator, Code SN2, NASA Johnson Space Center, Houston, Texas 77058 (telephone (713) 483-3274). All sample requests should be made in writing and contain enough information to permit evaluation of the proposed study and the adequacy of the requester's facilities. All necessary information should probably be condensable into a one- or two-page letter, although

informative attachments (e.g., copies of pages from related proposals, reprints of publications, flow diagrams for analyses) are welcome. We anticipate that requests for ash samples can be reviewed and approved rapidly in most cases.

Figure 7



Scanning electron photomicrograph (secondary electron image) of El Chichón volcanic ash from cosmic dust collection flag W7036. The ash is composed mostly of fragments of silicic glass and plagioclase crystals. Some of the small crystals which reside on the surfaces of the larger particles are probably a variety of Ca-sulfate. The scale bar is 10 μm. See text for additional description of sample history.