



# LUNAR SAMPLE NEWSLETTER

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## Table of Contents

	<u>Page</u>
Workshop on the Geology and Petrology of the Apollo 15 Landing Site	2
Proposed Plans for Renewed Lunar Core Processing	3
LAPST Recommends Two Workshops for 1986	5
Next LAPST Meeting Will be February 21-23, 1986	6
LAPST Has Two New Members	7
Apollo 15 Rock Catalog is Available	7
Horizons and Opportunities in Lunar Sample Science	8
New Breccia Surface Available for Study	8
Coarse Fines Pilot Program	9
Come See Our New Display	10
Upcoming Dates of Interest	11
Appendix 1: Unmapped Surfaces of 15459,0 and the New Slab	12
Appendix 2: Unmapped Surfaces of 15498,0 and the New Slab	14

Workshop on the Geology and Petrology of the Apollo 15 Landing Site  
November 13-15, 1985  
(Conveners P. Spudis, USGS, and G. Ryder, LPI)

A workshop to review the geology and petrology of the Apollo 15 landing site and to formulate and discuss potential relevant research was held at the Lunar and Planetary Institute. It benefitted in having both Dave Scott and Jim Irwin, the astronauts who explored the site, participating. It differed from most recent planetary workshops in that it was site-specific rather than thematic, and covered a panoply of scientific problems. The Hadley landing site, considered the most beautiful of the Apollo sites, with its cratered mare plain, unequalled Hadley Rille, and majestic smooth Apennine Mountains, harbors information pertaining to most known aspects of lunar evolution, both endogenic and exogenic. The workshop therefore attracted a diverse set of more than 60 sample- and geology-oriented scientists, including several who had been active in the planning, preparation, and execution of the mission. As a review, synthesis, and debate about our current understanding of the landing site, the workshop was an immense success. Discussion was more often vigorous than not. As a basis for future research, several avenues were shown to be open, and perhaps subliminal ones exist too. Fruition is likely, but an estimation of success must necessarily be, for the moment, suspended.

Following a morning of background presentations on the geologic setting and samples from the site, the workshop was organized around six geologic/petrologic topics, each with keynote talks, contributed talks, and much discussion. These topics were: The Apennine Front Rocks and Their Sources; Apollo 15 KREEP Basalts; Apollo 15 Perspective on Lunar Basins; Mare Volcanism at the Apollo 15 Landing Site; Mare Rocks and Their Implications for the Mantle Beneath the Apollo 15 Site; and Post-mare Cratering and Regolith Evolution. The final morning included an update on and discussion of a lunar base, with some emphasis on the Apollo 15 landing site, and was completed with an open forum on major problems for future Apollo 15 research. In addition, on the first evening a keg session was held for participants to view two hours of video tape highlights of the Apollo 15 EVAs, with Jim Irwin in attendance.

An LPI Technical Report of the workshop will be published early in 1986. This report will include the abstracts of papers presented at the workshop, summaries of the discussion which took place under each topic, the rationale for the workshop, and an assessment of potential research avenues. This document should stimulate and direct future research on the Apollo 15 landing site. The workshop was recorded (temporarily) on video tape; anyone desiring access to these tapes should contact G. Ryder (LPI). Prior to the workshop, the conveners published a background paper in the Transactions of the American Geophysical Union (EOS). Reprints of this paper are available from P. Spudis (USGS).

## Proposed Plans for Renewed Lunar Core Processing

The Lunar and Planetary Sample Team and the Curator have discussed the possibility of resuming core dissection on a limited basis. LAPST has asked the Curator to suggest alternate procedures for opening the remaining cores. (A list of all the cores and their status is included in this newsletter.) The staff of the Planetary Materials Branch and of Northrop Services, Inc. have investigated some abbreviated procedures that may allow opening more cores with less impact to the curation effort than past core dissection has made.

The essential elements of information that were identified included:

1. Discrete intervals of samples for grain petrography, chemistry, exposure studies, etc.
2. Continuous thin section coverage over the entire length of the core.
3. Detailed textural information for the interior of the core.
4. Recovery of >1 mm particles from the core soils.
5. Good photography of the core, especially photography of the "post-peel" surface.

Given these objectives, a tentative plan is proposed that will meet some of these objectives and will preserve the option to complete others at a later time.

Briefly, the proposal is to extrude the cores from the lunar surface hardware into the core dissection apparatus as has been done in the past. Only the topmost one or two layers will be carefully removed in 0.5 cm intervals. The core will then be secured in its dissection hardware and stored in its partially dissected condition.

The advantages of this proposal are that the entire length of the core can be sampled for grain petrography, chemistry, exposure studies, etc. (objective 1 above). Some textural clues will be evident from the partially dissected core (objective 3). The >1 mm particles uncovered in the dissection passes can be recovered (objective 4). Some photography of the core interior can be done, however, there is no plan to take a peel of the core (objective 5).

The major disadvantage of this procedure is that there is no means of taking a continuous thin section of the length of the core. There is also a potentially significant hardware cost to fabricate the dissection hardware that will be used to process and store the partially dissected cores. Additionally there will be some development work to assure that the cores are stored in a configuration that will preserve their information.

We anticipate a rate of two cores per year. This rate is based on our estimate of the capacity of the investigators' laboratories for analyzing the next core samples. At this rate the impact to other curatorial functions

will not be severe. Presently we have requests for 79001-2 and 15009; unless other arguments are forthcoming, they will be the first cores to be worked.

LAPST and the Curator want your advice about this plan. The proposal will be refined and discussed again at the next LAPST meeting in February. Please call or (better) write the Curator or any member of LAPST with your suggestions or concerns. If the plan is approved the first core could be in work by the summer months.

#### STATUS OF CORE PROCESSING

DRIVE TUBE	LUNAR SITE	LOCATION	X-RAY LENGTH CM.	DISSECT. LENGTH CM.	NEW X-RAY	DISSECT.	SPECTRAL REFLECT.	PEEL	EPOXY IMPG	THIN SECTION
10004	LM		-	14.0	-	Y				
10005	LM		-	10.5	-	Y				
12025(U)	HALO		?	9.5	-	Y				
12028(L)	HALO		?	31.6	-	Y				
12026	LM		?	19.3	-	Y, SPILLED				
12027	SHARP		17.4	17.0	-	Y	Y	Y	Y	
14210(L)	WEIRD			30.0	-	Y	Y	Y	Y	Y
14211(U)	WEIRD			7.7	-	Y	Y	Y	Y	Y
14220	TRIPLET			16.0	-	Y	Y	Y	Y	Y
14230	TRIPLET			14.2	-	Y		Y	1/2	
15007(L)	ELBOW		33.9	34.1	Y	Y		Y	Y	Y
15008(U)	ELBOW		28	23.1	Y	Y	Y	Y	Y	Y
15009	FRONT		33.9		Y	UNOPENED				
15010(L)	H.RILLE		32.9	29.9	Y	Y		Y	Y	Y
15011(U)	H.RILLE		29	26.4	Y	Y		Y	Y	Y
60009(L)	LM		33.1	31.5	Y	Y		Y	Y	Y
60010(U)	LM		32.3	27.3	Y	Y		Y	Y	Y
60013(L)	LM	BROOKS	34.7			UNOPENED				
60014(U)	LM	BROOKS	28.6			UNOPENED				
64001(L)	STONE MT		33.9		Y	Y		Y	Y	Y
64002(U)	STONE MT		31.7	26.4	Y	Y		Y	Y	Y
68001(L)			34.9			UNOPENED				
68002(U)			27.4			UNOPENED				
69001		SEALED				UNOPENED				
70012	LM		18.4			UNOPENED				
73001(L)	LARA	SEALED	34.9			UNOPENED				
73002(U)	LARA	BROOKS	21.8			UNOPENED				
74001(L)	SHORTY		34.9	34.3	Y	Y		Y	Y	Y
74002(U)	SHORTY		33.3	32.0	Y	Y	Y	Y	Y	Y
76001	N.MASSIF		34.5	31.4	Y	Y	Y	Y	Y	Y
79001(L)	VAN SERG		31.9			UNOPENED				
79002(U)	VAN SERG		19.4			UNOPENED				

## LAPST RECOMMENDS TWO WORKSHOPS FOR 1986

The highly successful Apollo 15 workshop demonstrated the effectiveness of a well-planned meeting in focusing lunar sample studies and the stimulation provided by interactions between different disciplines. At its November meeting, the Lunar and Planetary Sample Team reviewed several study areas that could benefit from additional emphasis and recommended organizing two workshops to be convened in 1986. One should focus on lunar sample science, the other on lunar materials applications.

Basalts as Planetary Probes is proposed as a focus on a lunar sample science topic that is overdue for review. Much has happened, in both planetary science and igneous petrology, since the 1975 conference on mare basalts and the resulting publication of "Basaltic Volcanism." Remote sensing has shown that basalts in unsampled regions of the moon are distinct from returned samples in both age and composition. New types of mare basalts and glasses have been identified in the lunar samples. Some of these suggest that assimilation was important in their petrogenesis. Studies of meteoritic basalt have attempted to place constraints on the parent bodies. Meanwhile, petrologists working with terrestrial basalts have called on assimilation, mixing, or mantle metasomatism to account for variations in composition. Tectonic environments have been related to petrologic characteristics. Experimental petrology has placed new constraints on basalt petrogenesis. The recommended workshop would bring together scientists from these disciplines in order to use basalts as probes that reveal the nature of planetary interiors. The workshop should be convened in Fall 1986.

LAPST endorses and will participate in the development of a workshop on the applications of lunar materials. Workshop site and details of workshop topics will be decided by the end of 1985, depending upon the possible integration of this workshop with another meeting on lunar utilization. Major goals for the workshop are: 1) to encourage experimenters to work together; 2) to introduce experimenters in the applied sciences to the extensive scientific data base on lunar samples; and 3) to introduce the present lunar sample research community to data needs of workers in the applied sciences. Meeting these goals could stimulate research on innovative products and materials for the space environment and encourage carefully planned experiments that will not perturb the important work of lunar sample curation. The workshop on applications of lunar materials should be convened during Summer or Fall 1986.

The Lunar Sample Newsletter will carry additional information about these two workshops as the plans develop.

NEXT LAPST MEETING WILL BE FEBRUARY 21-23, 1986

The Lunar and Planetary Sample Team (LAPST) met at the Lunar and Planetary Institute November 16-18, 1985. LAPST reviewed 16 requests for lunar samples and recommended allocation of 96 samples weighing 99.9 grams and 84 thin sections to 13 investigators. LAPST endorsed the curator's recommendation for allocation of 16 samples weighing 6.6 grams and 66 thin sections to six investigators in response to lunar sample requests received between the June and November meetings.

The number of requests for Apollo 15 samples (seven) clearly illustrated the influence of the Apollo 15 Workshop. Several investigators requested thin sections of Apollo 15 rocks in the months preceeding the workshop. Others worked with small particles sieved from soil samples or incorporated in breccias. Three investigators requested samples from the Apollo 15 collection of 4-10 mm particles. Another will map new surfaces of a slab cut from an Apollo 15 breccia and select clasts for petrographic and chemical studies.

Studies of clasts in breccias collected at the Apollo 14 site generated three requests. One investigator requested the cutting of new slabs from two Apollo 14 breccias; two groups requested samples of clasts extracted from previously mapped surfaces.

Another investigator will measure the Be10, Mn53, and Al26 in a suite of samples from different depths within an oriented lunar basalt to determine the cosmic ray production of radionuclides and the corresponding neutron flux. Two investigators requested samples to support studies of nitrogen and rare gas isotopes in soil and soil breccias.

Successful occupation of the lunar surface for extended periods will require the use of lunar materials for construction. One investigator will test the feasibility of melting lunar soil using microwave energy. The test is to confirm the results of research on microwave heating of simulants.

Other requests supported:

- o photoconductivity of lunar samples
- o abundance and spatial distribution of boron
- o spectral reflectance of lunar materials
- o a soil exhibit for EPCOT center

Three requests for lunar samples were denied.

LAPST scheduled the next two meetings for February 21-23 and June 6-8, 1986. Your requests are welcome at any time; some allocations can be recommended by the Curator between LAPST meetings. We encourage you to submit requests that require LAPST review well ahead of the meeting date so that adequate background materials can be assembled.

## LAPST Has Two New Members

Two new members joined the Lunar and Planetary Sample Team at the November meeting. LAPST welcomes Dr. Michael J. Drake, Professor of Planetary Sciences and on the staff of the Lunar and Planetary Laboratory of the University of Arizona, and Dr. Marilyn M. Lindstrom, Senior Research Scientist in the Department of Earth and Planetary Sciences of Washington University at St. Louis. They replace Dr. Paul H. Warren of the Institute of Geophysics and Planetary Physics, University of California at Los Angeles and Dr. Randy L. Korotev of the Department of Earth and Planetary Sciences of Washington University, St. Louis. The sage advice of these retiring members will be missed. LAPST, and the lunar sample community, thanks them for their faithful service.

Dr. Drake's current research includes experimental studies of partitioning, solubility, and diffusivity of the noble gases in mantle minerals and melts, with application to the origin and evolution of the atmospheres of Venus, Earth, and Mars. He also brings to LAPST recent experience in the planning and advocacy of unmanned missions that support sample science.

Dr. Lindstrom is a member of one of the more active groups studying lunar samples. Her research includes several tasks in the program of analytical, experimental, and modeling studies of lunar and terrestrial igneous rocks that is currently active at Washington University. She substituted for R. Korotev at the June 1986 meeting.

## APOLLO 15 ROCK CATALOG IS AVAILABLE

The "Catalog of Apollo 15 Rocks" by Graham Ryder characterizes each of the 267 individually numbered rock samples in the Apollo 15 collection. Information on sample collection, petrography, chemistry, stable and radiogenic isotopes, surface characteristics, physical properties, and curatorial processing is summarized and referenced. The intention has been to include all published studies of any kind which provide information on a sample. Previously unpublished information is reported for some samples.

This catalog does not totally replace the original Apollo 15 Sample Information Catalog (1971). That volume, published only three months after the mission, was compiled from descriptions based mostly on macroscopic observations. For most samples, it contains more information on macroscopic observations than the new catalog. The original catalog remains the basic source of information about the unconsolidated regolith (soil) samples from the Apollo 15 site.

Some of you received the Catalog of Apollo 15 Rocks during its initial distribution prior to the Apollo 15 Workshop. Others who need this comprehensive review of scientific results from the study of Apollo 15 rocks should address a request to:

Lunar Sample Curator  
Code SN2  
NASA/Johnson Space Center  
Houston, TX 77058

## HORIZONS AND OPPORTUNITIES IN LUNAR SAMPLE SCIENCE

Lunar sample studies have been fundamental in developing our understanding of the early evolution and continued development of planetary bodies. They have increased our understanding of fundamental processes and led to major revisions in our understanding of the process of planetesimal accumulation and planet formation. Although the lunar sample research program has been highly productive, many important questions remain unanswered. Continued study of lunar samples will further illuminate the shadows of our knowledge about the solar system and provide information that will be needed for a successful lunar base.

The Lunar and Planetary Sample Team has reviewed its role, the role of the sample research community, and the perceived role of future researchers over the next decade in ensuring the effective use of lunar sample studies in space exploration and exploitation. The review encompasses: (1) lunar sample science; (2) lunar materials applications; (3) lunar sample studies and their relation to future space missions; and (4) lunar sample curation. Plans in all four areas are summarized in Horizons and Opportunities in Lunar Sample Science which is available from the Lunar and Planetary Institute as LPI Technical Report 85-04.

## NEW BRECCIA SURFACES AVAILABLE FOR STUDY

New slabs have been sawed from four breccia samples: 14305,29; 14321,46; 15459,0; and 15498,0. The two Apollo 14 slabs were sawed in response to requests from the leader of existing consortium studies. LAPST recommended sawing slabs from the two Apollo 15 samples because the team expected the study focus provided by the Apollo 15 Workshop would generate requests to study clasts exposed on slab surfaces. One request was received; at its November meeting, LAPST recommended Dr. John Shervais of the University of South Carolina as leader of a consortium for studying the 15498 surfaces.

Cut surfaces from 15459 and 15498 are now available for study. The distribution of clasts has not been mapped on surfaces of either rock. Photographs of the surfaces are reproduced in black and white as Appendixes 1 and 2 to this newsletter. Slabs of other breccias are also available for adoption and study in the consortium mode. Lunar sample processors have mapped the distribution of different types of clasts on the cut surfaces. The maps and clast descriptions are published in recent issues of the Lunar Sample Newsletter. A list of the recently slabbed breccias follows:

<u>Sample</u>	<u>Surfaces</u>	<u>Mapped?</u>	<u>Newsletter Reference</u>
14303	3 faces	yes	#44 July 19, 1985
15459	3 faces	no	#45 December 30, 1985
15498	3 faces	no	#45 December 30, 1985
60016	5 faces	yes	#43 March 8, 1985
60019	5 faces	yes	#43 March 8, 1985
72255	3 faces	yes	#43 March 8, 1985
72275	5 faces	yes	#42 January 3, 1985

## NEW BRECCIA SURFACES AVAILABLE FOR STUDY Continued:

Would you like to adopt a rock? Send in your request today! If you do not want to lead a consortium, but need one or more clasts of a mapped rock for your research, please submit a request for specific clasts. It will be forwarded to the consortium leader; or, if no consortium has been formed, it will be reviewed separately.

### COARSE FINES PILOT PROGRAM

The Lunar and Planetary Sample Team believes that the coarse-fine particles sieved from lunar regolith samples are an underutilized resource in the Apollo collection. Many 4-10 mm particles have been studied; but the collections of 1-2 mm and 2-4 mm particles have received little attention. These collections may contain many rare and possibly important rock types that are not represented in the collection of larger rocks.

To help promote a search for these new rock types, the Curator has initiated a pilot program to describe, process, and make available selected samples of coarse fines from the Apollo 15 site.

Several particles listed in Apollo 15 Coarse Fines (4-10 mm) [MSC 03228] have been studied since the catalog was prepared in 1972. Published petrographic and chemical data for the 4-10 mm particles will be reviewed and correlated with Powell's groupings reported in the catalog. The Curator will publish a summary of the data, updated descriptions, and photomicrographs of selected thin sections to supplement descriptions in the 1972 catalog.

Few investigators have studied particles in the 1-2 or 2-4 mm collections. The Curator has included preliminary examination of 2-4 mm particles in the pilot program to illustrate the value of samples in this size fraction in the search for new types of rock. The sample will be selected from a station along the Apennine front. About 1,000 freon-rinsed particles will be sorted into groups of similar lithology using a binocular microscope. A few representative samples will be selected from each lithologic group for further study. A thin section made from half of each selected particle will be described in order to characterize the group and its lithologic variability.

Descriptions of the samples studied in the pilot program will be published. Aliquants from the lithologic groups will be available for allocation to interested investigators.

## COME SEE OUR NEW DISPLAY

The Curator invites you to visit the new exhibits in the public display areas of the Lunar Sample Building -- Building 31-A at the Johnson Space Center. The new display was opened in early September 1985.

The Lunar Sample Building is a popular stop on the JSC walking tour. From hundreds to a few thousand JSC Open House visitors pass through the display area each week. Most climb the stairs to the second floor viewing room where they can look into the Lunar Sample Processing Laboratory and can examine large lunar rocks displayed in a nitrogen cabinet next to the window.

This presents a rare opportunity to tell the general public about extraterrestrial materials. The old exhibits described the collection and care of lunar samples and told how the samples had improved our knowledge of the history of the earth-moon system. It was a pretty good display; but, after five years, it was somewhat faded and tattered. Also, the curation of Antarctic meteorites and Cosmic Dust have become important activities since the original display was designed.

The Planetary Materials Branch and the Public Affairs Office cooperated to design and build the new display which presents a better balanced story of the collection, curation, and study of all three types of extraterrestrial material.

## Upcoming Dates of Interest

1986

Jan. 5-9 American Astronomical Society, 167th Meeting, Houston, TX

Jan. 10 Deadline for LPSC XVII Abstracts

Jan. 24 Voyager 2 flies by Uranus

Feb. 21-23 LAPST Meeting, Lunar and Planetary Institute

Mar. 2-6 TMS-AIME Annual Meeting "Experimental Methods for Micro-gravity Materials Science Research" New Orleans, LA

Mar. 17-21 Lunar and Planetary Science Conference XVII, Houston, TX

May 1 Deadline for submission of papers to LPSC XVII Proceedings

May 19-23 American Geophysical Union, Spring Meeting, Baltimore, MD

June 6-8 LAPST Meeting, Lunar and Planetary Institute

June 22-26 American Astronomical Society, 168th Meeting, Ames, IA

June 30-July 4 Sixth International Conference on Geochronology, Cosmochronology, and Iostope Geology, Cambridge, England

July 12-17 Astronomical Society of the Pacific, 98th Annual Meeting, Boulder, CO

Sept. 22-25 Meteoritical Society, 49th Annual Meeting, New York, NY

Oct. 14-18 International Symposium: Origin and Evolution of Planetary and Satellite Systems, Potsdam, DDR

Dec. 8-12 American Geophysical Union, Fall Meeting, San Francisco, CA

Dec. 15-19 Space Exploitation and Utilization, Honolulu, HI

## APPENDIX 1

### UNMAPPED SURFACES OF 15459,0 AND THE NEW SLAB

Sample 15459 is a tough glassy matrix regolith breccia with mostly small, light-colored clasts. A few clasts range up to several centimeters across. Clast types include mare basalt, plutonic norites, impact melts, and numerous types of glass as balls, shards, and schlieren.

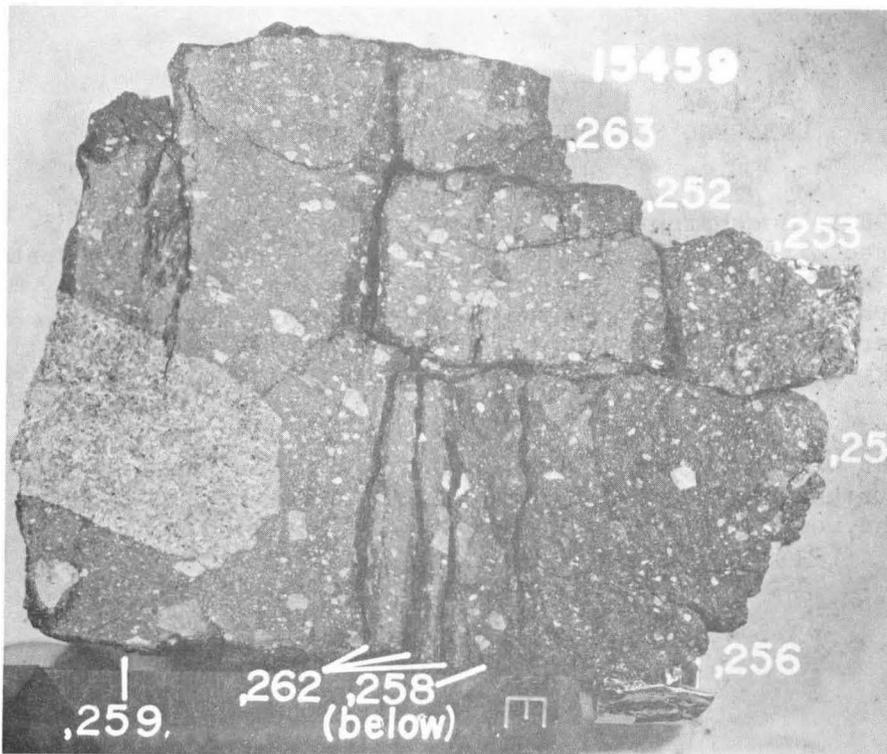
The sample was collected on the northeast inner wall of Spur crater. It is the center part of a 30 x 30 x 15 cm rock that was one-third to one-half buried about six meters from the rim crest.

S-85-42239

15459,0 WEST FACE



APPENDIX 1

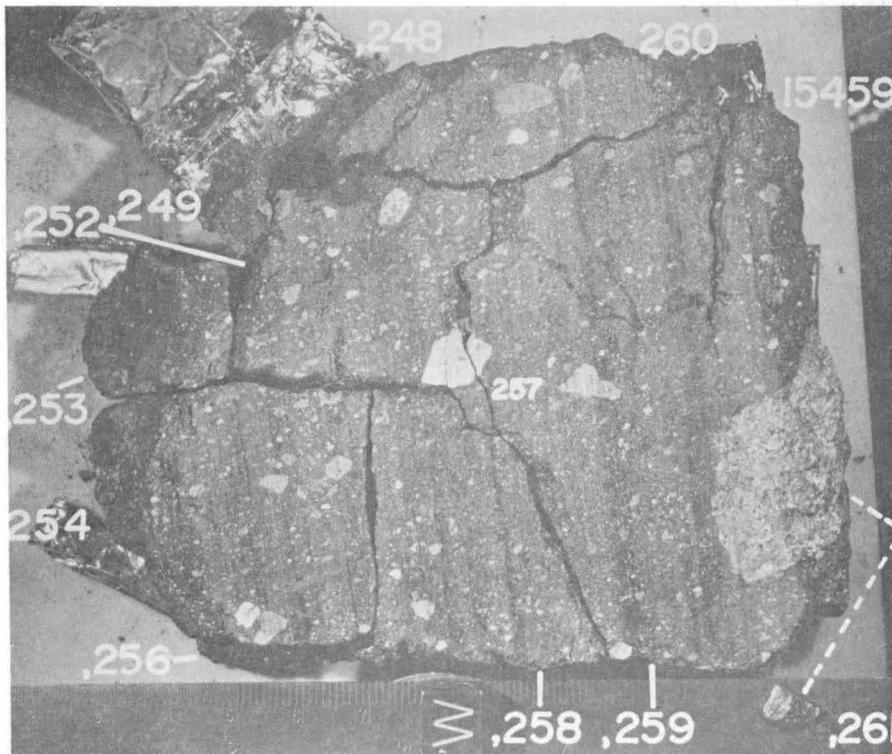


S-85-42244

15459 EAST FACE

S-85-42241

15459 WEST FACE



## APPENDIX 2

### UNMAPPED SURFACES OF 15498,0 AND THE NEW SLAB

Sample 15498 is a coherent, glassy matrix breccia with numerous light-colored, irregularly shaped clasts up to 1 cm across. Most of the components are of mare origin: rock fragments that are commonly mare basalt, pyroxene fragments, opaque fragments and mare glasses. A thin coat of vesicular black glass covers part of the rock; glass also fills fissures in the rock. Clasts larger than 0.2 mm compose about 85 percent of the rock.

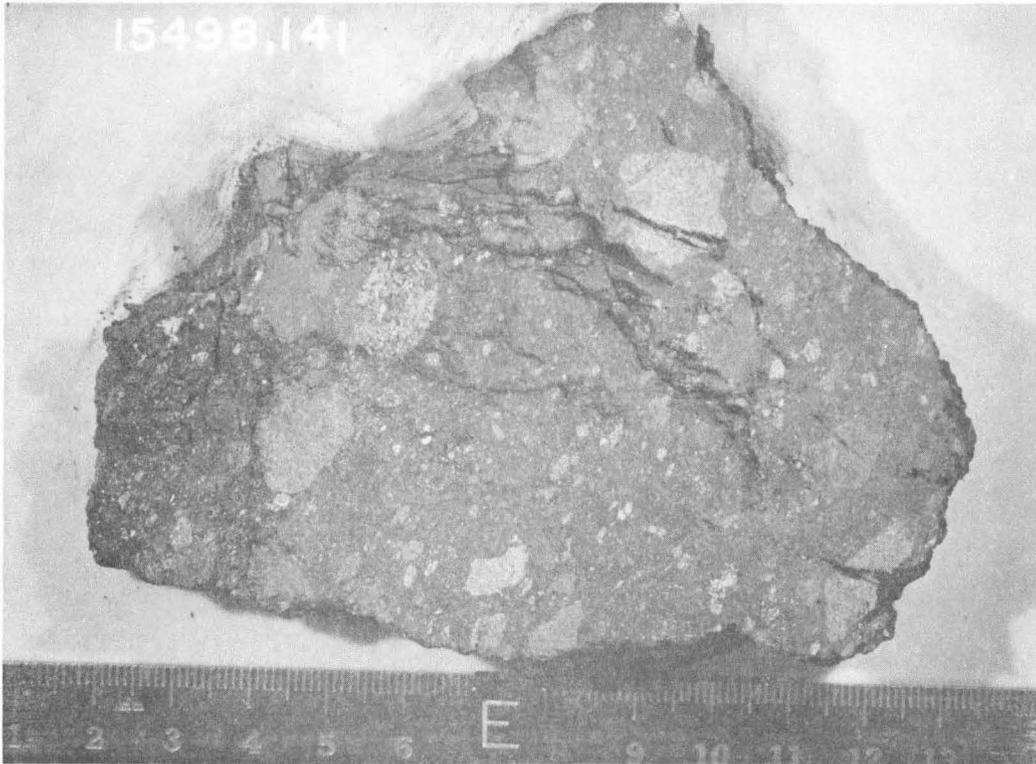
Sample 15498 was collected at the south rim of Dune Crater. It was one-third to one-half buried in the fillet at the base of the boulder that was the source of samples 15485, 15486, and 15499.

S-85-43130

15498,0 WEST FACE



APPENDIX 2



S-85-43129

15498,141 EAST FACE

S-85-43128

15498,141 WEST FACE

