LUNAR *NEWS*

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Deadline for LAPST Requests:

Feb. 12, 1992

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Editor's Notes

"Lunar News" is published by the Solar System Exploration Division, Johnson Space Center of the National Aeronautics and Space Administration. "Lunar News" is intended to be a forum of facts and opinions regarding lunar sample study. It is sent free to all interested individuals. To be included on the mailing list, write to the address below. Your contributions to "Lunar News" on topics relating to the study of the Moon and comments about "Lunar News" and materials appearing here should be sent to:

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New Assignments

1990-1991 was a time of change for the JSC Solar System Exploration Division. In February 1991, Mike Duke announced he was leaving the division to take on the job of Science Manager in the Lunar and Mars Exploration Program Office which is located at JSC. Mike has long been a leading voice in the quest to return to the Moon and to explore Mars. His new position engages that task head-on and is responsible for maintaining a high science content in the program.

Doug Blanchard is now the Division Chief. Doug was the Lunar Sample Curator from 1981 to 1988 and the Chief of the Planetary Science Branch from 1988 to 1990. The division is in excellent condition and Doug expects no change in the intense level of curation and planetary and space science research.

Gordon McKay has taken over the reins of the Planetary Science Branch. Gordon brings a very strong background of research in planetary geochemistry and experience as the manager of the electron microprobe lab and as the technical manager of the Lockheed support contract.

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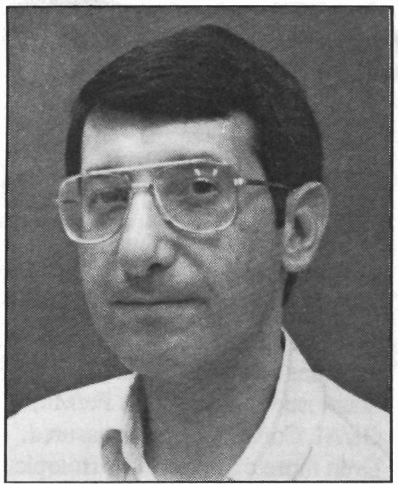


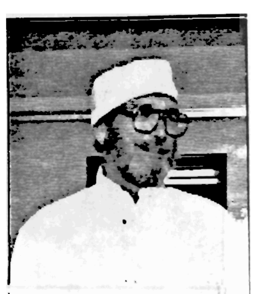
Curator's Comments

By Jim Gooding
NASA/JSC

One Curator Retires While Another Aspires

Dr. John W. Dietrich retired from NASA service on December 31, 1991 after a successful career in lunar and planetary science. John's 25-year career at Johnson Space Center began in 1966 with support for the Apollo program, first as a photogeologist mapping the Moon with Lunar Orbiter data and then as an instructor in the geological training program for astronauts who were to explore the lunar surface. After helping guide the Apollo missions to the Moon, John worked in the Earth Observations Division using data from a variety of space-based sensors, including LANDSAT. In 1981, he moved to the Solar System Exploration Division and joined the lunar sample curation effort. After accepting increasingly substantial responsibilities for lunar sample curation, John was appointed Lunar Sample Curator, and Deputy Chief of the Planetary Science Branch, in 1988. Thus, John's NASA career achieved poetic completion as he supervised distribution of samples from the same rocks that his mapping and coaching had helped to collect. We bid John a fond farewell and confess to being envious of his new freedom to return to the geology and scenery of Texas which he knows and loves so well.

I am honored by my appointment to succeed John Dietrich and I am committed to sustaining the planetary materials curation efforts for which our organization is well known. In my ten years at JSC, I have served separately as Associate Curator of Cosmic Dust and as Associate Curator of Meteorites, while remaining actively involved in planetary materials research. More recently, I have acted as Contamination Control Officer for the Cosmic Dust Laboratory although much of my time has been spent helping NASA plan possible future Mars exploration projects, including Mars sample return. Therefore, I understand and endorse the importance of high-quality curation of planetary samples while also enjoying a forward-looking perspective on new opportunities. Our lunar curatorial team would be delighted to someday receive and curate new samples from the Moon. Until then, we remain devoted to the Apollo lunar samples and to providing the best possible support for the scientists who study them. The Curator may be new, but our quest for excellence has not changed.



Dr. John Dietrich

New Assignments
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John Dietrich, who replaced Doug as Lunar Sample Curator in 1988, served through 1991 then passed the baton to Jim Gooding (see "Curator's Comments, this page). The curatorial team has moved Chuck Meyer to lab manager for the Lunar Processing Labs. David Lindstrom has taken on the duties of the Contamination Control Officer. Marilyn Lindstrom and Mike Zolensky continue to curate the Antarctic Meteorite and Cosmic Dust collections, respectively.

Magma Ocean Workshop

By John Longhi
Lamont-Doherty Geological Observatory

Some 58 planetary scientists from Japan, Canada, Russia, Czechoslovakia, and the U.S. participated in the LPI-LPSAT sponsored workshop on The Physics and Chemistry of Magma Oceans held in Burlingame, CA from December 6 through 8. Keynote speakers began each of the formal sessions and were followed by several contributed talks. Keynote addresses included: Evidence For and Against Magma Oceans (G.J. Taylor), Phase Equilibria (C. Agee), Dynamics and Evolution (D.J. Stevenson), Mechanisms of Formation (W. Kaula), and Geophysical Consequences (G. Shubert).

There were lively discussions in all of the sessions with most of the emphasis on the characteristics of a terrestrial magma ocean, although lunar, martian, and asteroidal magma oceans were not

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Magma Ocean Workshop
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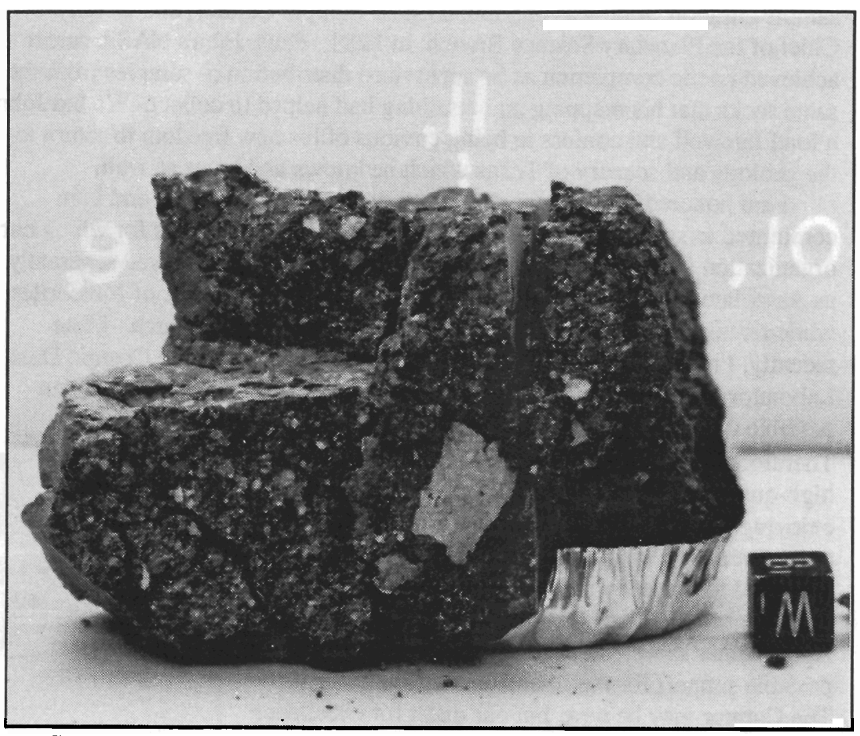
neglected; and the possible lack of a primordial magma ocean on Venus (no giant impact?) was invoked to explain the observation that its volatile content is apparently higher than the Earth's. The possibility of collisions of planet-sized bodies producing extensive melting and vaporization no longer seems controversial, although satisfactory explanations of apparent concentrations of many elements in the Earth-Moon system, in terms of such a model, remains elusive. Extensive melting of asteroidal-sized objects as inferred from iron meteorites implies that other mechanisms of formation of magma oceans were operative too. There was considerable debate over the most appropriate partition coefficients to employ in geochemical calculations stemming from the fact that different values for key elements have been obtained from experiments in different laboratories and from uncertainties derived from extrapolating partition coefficients obtained at moderate temperatures to very high temperatures. The ability of a large magma ocean to produce a lasting geochemical signature was also questioned, first in the context of solidification (vigorous turbulence might impede any significant fractionation among silicate and oxide phases until the late stages of solidification) and then, in the context of billions of years of solid state convection possibly removing any traces of layering. The only truly lasting signature of a magma ocean, or lack thereof, is the temperature profile that it imparts to the planet as reflected in subsequent contraction or expansion of the planet (initially cold planets expand as they heat up from radioactive decay, whereas totally molten planets contract). See page 14 for further details.

Lunar Meteorites

By Paul Warren
University of California, Los Angeles

Direct sampling of the Moon was accomplished at six Apollo plus three Luna sites. Unfortunately, these nine sites are clustered within a small region of the central nearside. The degree of clustering can be appreciated by noting that if a polyhedron is drawn so as to barely encompass all nine sites, its area is just 4.4% of the total lunar surface. A major development since the 1970s has been the discovery, starting in 1982, of numerous lunar meteorites in Antarctica (Table 1). Lunar meteorites are rocks blasted to Earth by kinetic energy from collisions between the Moon and asteroids or comets. Evidence for lunar provenance is typically discernible simply on the basis of overall petrographic similarity to lunar highlands-anorthositic materials. Low-Ti mare basalts are less obviously distinct from eucrites, but the distinction becomes clear enough once diagnostic ratios such as Fe/Mn, Ga/Al, Co/Cr, etc., are measured. Even more diagnostic are isotopic ratios; e.g., O-isotopic ratios for lunar samples (determined by R. N. Clayton and coworkers at Chicago) fall along the terrestrial fractionation line. Lunar meteorites also differ in texture from superficially similar meteorites, and lunar meteorites that are regolith breccias are distinctively enriched in solar-wind-derived noble gases.

Many recent studies of lunar meteorites can be found in a special issue on the MAC88104/5 meteorite which appeared November 1991



MAC 88105, NASA Photo # S89-47064

in *Geochimica*, and in the *Proceedings of the Symposium on Antarctic Meteorites*, No. 4 (1991). The first non-Antarctic lunar meteorite was discovered in southwestern Australia, apparently sometime in the 1960's.

The great value of the lunar meteorites stems from the possibility that they represent otherwise unsampled regions of the Moon, but the number of such regions depends on whether each meteorite represents a separate source crater. Some of the highlands meteorites are obviously paired with one another, in the traditional sense of having struck the Earth as part of a single shower (Table 1). Thus, the number of distinct lunar meteorites is not twelve but nine or less. To check for less obvious source-crater pairing, isotopic clocks sensitive to cosmic-ray exposure can be used to constrain the ages of the cratering events responsible for blasting the samples to the Earth. Exposure ages have thus far been obtained for five lunar meteorites: all four of the distinct highlands meteorites plus EET87521 (these data are gathered by O. Eugster at Bern and K. Nishiizumi at San Diego, among others). The results reveal that at least two separate source craters, and more likely 3-5, are represented by this group.

Most (arguably all) of the four highlands meteorites are regolith breccias, which is fortunate in the sense that it implies they formed by thorough mixing of the crust surrounding their locations of origin. In terms of mineralogy, petrography, and major-element geochemistry, the highlands meteorites have basically confirmed the 1970s assumption that the anorthositic Apollo 16 site is representative of the highlands surface crust. Volatile and labile trace metal concentrations are also generally similar. For other trace elements, however, the meteorites indicate that the Apollo 16 site is highly unrepresentative. The highlands meteorites tend to have far lower contents of REE and other incompatible elements. The highlands meteorites also tend to have far lower siderophile-element contents, and less fractionated (relatively low, more nearly chondritic) Ni/Ir and Au/Ir ratios. Also, among the many clasts found in these breccias are a few that appear "pristine" (i.e., they retain bulk compositions, although not necessarily textures, unaffected by impact-mixing). Several of these pristine clasts are geochemically unique, and thus add important new constraints for models of lunar crustal evolution.

Lunar meteorites composed dominantly of mare material have suddenly become relatively common. In late 1989, data for Fe/Mn, Ga/Al, Co/Cr, etc., revealed the lunar affinity of EET87521, which had been classified as a eucrite. Two other mare meteorites were found by K. Yanai and H. Kojima at Tokyo, and the Y-793274 meteorite once classified as highlands was shown from numerous detailed studies to consist of a mixture of highlands and mare materials, mainly the latter. Compared to mare samples from the nine Apollo/Luna sites, the mare meteorites all have uncommonly low Ti contents. At least two, and arguably all four, are dominantly composed of hitherto-

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Table 1. Summary of Known Lunar Meteorites, as of End of 1991

Meteorite	Mass, grams	Rock Type	Season Collected	Year Shown to be Lunar
MAC88104	723.7	Highlands	88-89	89
MAC88105	(paired)	Highlands	88-89	89
Yamato-82192	total	Highlands	82-83	84
Yamato-82193	712.1	Highlands	82-83	85
Yamato-86032	(paired)	Highlands	86-87	87
Asuka-31	442.1	Mare gabbro	88-89	90
Yamato-791197	52.4	Highlands	79-80	83
ALHA81005	31.4	Highlands	81-82	82
EET87521	30.7	Mare breccia	87-88	89
Calcalong Creek, Australia	19	KREEP breccia	?	91
Yamato-793274	8.7	Mare-highlands breccia	79-80	87
Yamato-793169	6.1	Mare basalt	79-80	90

Lunar Meteorites
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rare "very-low-Ti" (VLT) mare basalt. Also, mare-type clasts found within several highlands meteorites typically have pyroxene compositions that imply VLT affinity. These trends suggest that the global average Ti content for mare basalts is considerably lower than previously supposed. Also, VLT-mare materials are relatively close in composition to some types of nonmare Mg-gabbronorites. Thus, the abundance of VLT meteorites suggests that the dichotomy of lunar magmatic events into mare and nonmare types was less abrupt than previously envisaged.

These are just a few of the important lunar-science implications of these meteorites. As the total number of collected meteorites continues to grow, we can be sure that additional lunar rocks will be among them, at a rate of roughly one per thousand. Although the exact locale of origin of any individual lunar meteorite cannot be determined, collectively these samples afford a vastly improved coverage of the compositional-petrologic characteristics of the total lunar surface. Improved coverage is necessary because, as the lunar meteorites have underscored, the Moon's upper crust is in some respects remarkably heterogeneous. Many key models relatable to the Moon's crust (e.g., origin of the Earth-Moon system, the magmasphere hypothesis) are to a high degree testable through further investigations of lunar meteorites.

Samples of Lunar Core 60014/60013 Are Available

By Carol Schwarz
Lockheed Engineering & Sciences Company

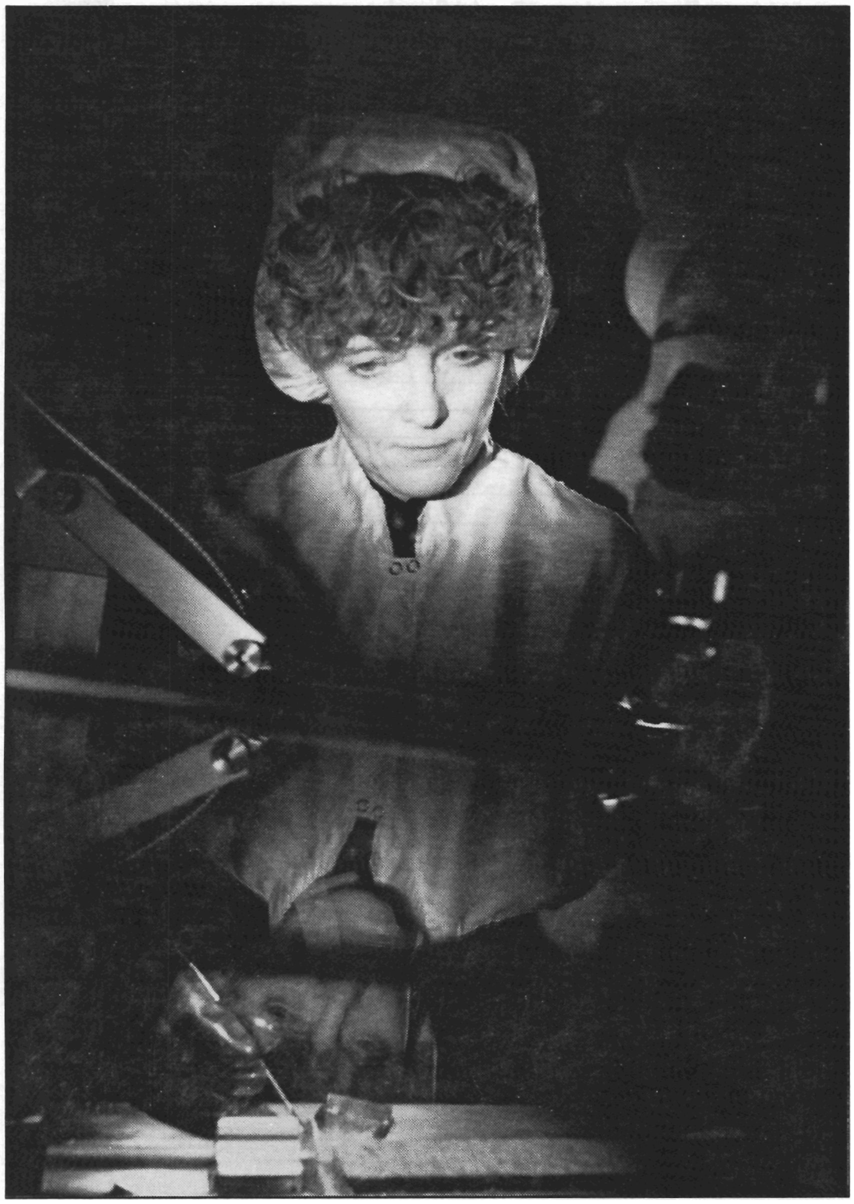
Dissection of both segments of the Apollo 16 double drive tube 60014/60013 has been completed. The core was dissected in 0.5 cm depth increments along three 1 cm thick longitudinal layers (passes), starting at the lunar surface and continuing through the length, 61.9 cm, of the core. (The length of 60014 is 28.2 cm and 60013 is 33.7 cm.) Soil from each increment of the first and third passes was separated into coarse and fine fractions using a 1 cm sieve. The coarse particles were examined under a binocular microscope, classified (as much as possible), and photo-documented. All samples are now available for study. Thin sections of 60014 are available now and those of 60013 are being prepared and will be available soon.

This core sample was taken in April 1972 at Station 10', about 75 m west-southwest of the LM (Lunar Module) at the Descartes landing site in the Central Highlands. Three cores were taken near the LM in a triangular pattern; 60010/60009 and 60014/60013, both double drive tubes; and 60007-60001, a deep drill string. The material sampled by the 60014/60013 core is believed to be South Ray Crater Ejecta.

Core 60014 was extruded from the drive tube on October 26, 1990. The color was determined to be approximately 10YR 5/1 on the Munsell color scale and no distinct color boundaries were observed during dissection. After the dissections and peel were completed, no boundaries were evident except for a very subtle darkening in a wedge-shaped area extending across the width of the core approximately 3 to 7 cm from the top. Noticeable textural variations were observed while dissecting. The upper 5 cm was loose and followed by a more coherent zone from 6 to 13 cm. From 13 to 19 cm the core became loose once again, grading into a coarse-grained layer at 21 cm and continuing to about 22.5 cm. In this interval were a large number of 4-10 mm particles, mostly soil breccias. The remainder of the core— from 23 cm on— was similar to the coherent 6 to 13 cm zone.

A close examination of the >1 mm fraction showed that about 80% (by number) of the particles were in the 1-2 mm size range, 19% were 2-4 mm, 1% were 4-10 mm, and less than 1% were >10 mm.

The lithology of the >1 mm fraction was determined by binocular examination of the particles and is summarized as follows: 17% of the particles were white or light gray, 15% were dark and coherent, 13% were glasses, and 55% were breccias. The white or light gray particles included plagioclase, anorthositic breccias, crystalling anorthosite, and light gray basalts, and were distributed evenly throughout the core. The dark particles were fine-grained,



Carol Schwarz, scraping a layer off of the lunar core sample 60014. NASA Photo # S91-26935

coherent, and often dusty. The glasses consisted of 68% agglutinates, 3% shards, 2% spheres (usually not much larger than 1 mm), and 27% miscellaneous glass fragments. Finally, the breccias included soil breccias, soil breccias with glass, dark matrix breccias, light matrix breccias, and those breccias too dusty to identify. The eleven particles at least 1 cm in diameter which were given individual split numbers included 5 breccias, 2 anorthosites, 2 basalts, 1 agglutinate and 1 of unknown classification.

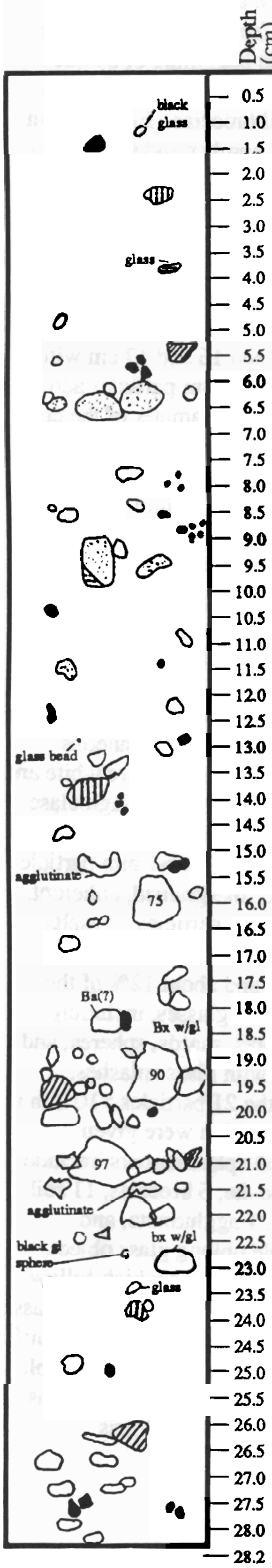
Core 60013 was extruded on June 19, 1991. A distinct color boundary was observed in the core approximately 18 cm from the top. The upper 18 cm was dark, 10YR 5/1 on the Munsell color scale. Below about 18 cm the color was lighter, 10YR 6/1. Approximately 3 cm above the 18 cm boundary (at 15 cm from the top of 60013) marked the beginning of a zone characterized by numerous large friable soil breccias. Below about 18 cm the number and size of soil breccias decreased abruptly. Near the bottom, at a depth of about 31.5 cm, a less obvious darkening was observed. It was irregular and varied with each successive pass. The peel exposed a light-colored zone between 16 and 17 cm with numerous 1-2 mm particles across about half the diameter of the core.

A close examination of the >1 mm particles showed that about 75% are in the 1-2 mm size range, 23% are 2-4 mm, 1% are 4-10 mm, and <1% are >10 mm.

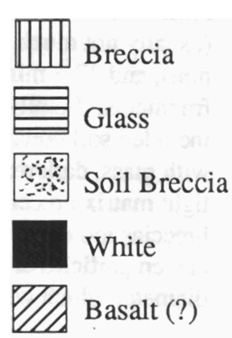
The lithology of the >1 mm fraction was determined by binocular examination of the particles and is summarized as follows: 55% were breccias, either soil breccias or miscellaneous breccias. About 13% are white and light gray fragments (plagioclase crystals or anorthositic breccias). About 18% of the >1 mm particles are black, fine-grained, coherent, dust-covered particles. Basalts comprise 2% of the >1 mm particles, and about 12% of the particles are glasses, including agglutinates, shards, spheres, and breccias with glass splashes. Among the 21 particles >10 mm in diameter which were given individual split numbers, include 1 anorthosite, 6 breccias, 11 soil breccias, 1 agglutinate, and 1 possible oblong glass object.

The diagrams which follow illustrate the three dissection passes for each core segment and identify sample splits which are available for allocation. Is/FeO data was provided by Dick Morris.

DRIVE TUBE 60014 (First Dissection)

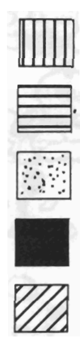


<1 mm Fraction Sample		>1 mm Fraction Sample		Special Samples		
No.	Wt.	No.	Wt.	No.	Wt.	Type
11	.951	12	.131			
13	.763	14	.054			
15	.832	16	.061			
17	1.014	18	.102			
19	1.384	20	.154			
21	1.243	22	.066			
23	1.424	24	.026			
25	1.601	26	.061			
27	1.283	28	.009			
29	1.774	30	.044			
	1.936	32	.123			
33	1.840	34	.137			
35	1.676	36	.355			
37	1.664	38	.089			
39	1.642	40	.089			
41	1.726	42	.061			
43	1.962	44	.163			
45	1.935	46	.127			
47	1.714	48	.266			
49	2.008	50	.152			
51	1.667	52	.071			
53	2.144	54	.053			
55	1.928	56	.164			
57	1.797	58	.085			
59	1.69	60	.067			
61	1.714	62	.125			
63	1.716	64	.127			
65	2.181	66	.152			
67	1.761	68	.081			
69	1.888	70	.112			
71	1.984	72	.141			
73	1.842	74	.122	75	.373	dust covered
76	1.771	77	.144			
78	1.879	79	.092			
80	2.115	81	.167			
82	2.137	83	.200			
84	1.822	85	.193			
86	1.747	87	.168	90	.487	soil bx/glass
88	1.576	89	.364			
91	1.986	92	.254			
93	1.635	94	.137			
95	1.89	96	.286	97	.456	basalt
98	1.945	99	.150			
100	1.631	101	.262			
102	2.028	103	.099			
104	1.927	105	.177			
106	2.075	107	.166			
108	1.988	109	.151			
110	2.094	111	.188			
112	2.323	113	.159			
114	2.207	115	.180			
116	1.929	117	.109			
118	1.891	119	.326			
120	1.858	121	.086			
122	1.675	123	.162			
124	1.907	125	.153			
126	1.077	127	.070			

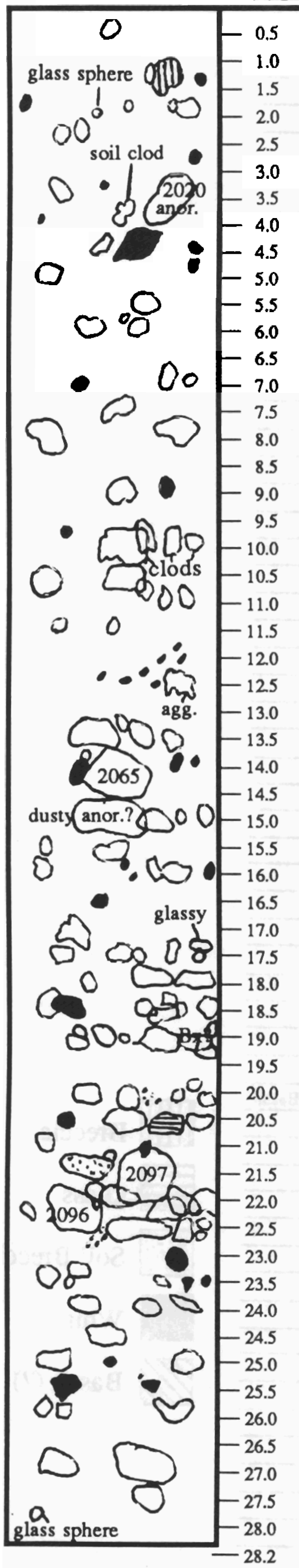


DRIVE TUBE 60014 (Second Dissection)

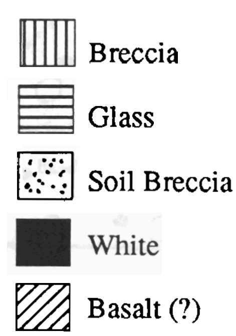
Depth (cm)	Unsieved Sample No.	Unsieved Sample Wt.	No.	Wt.	Special Samples No.	Special Samples Wt.	Special Samples Type
0.5	1014	2.106					
1.0	1015	1.660					
1.5	1016	1.848					
2.0	1017	1.901			1018	.162	- Soil Breccia
2.5	1019	1.920					
3.0	1020	1.946					
3.5	1021	2.025					
4.0	1022	2.179			1024	.726	Glassy Bx?
4.5	1023	1.957					
5.0	1025	2.485					
5.5	1026	2.678					
6.0	1027	2.527					
6.5	1028	2.531					
7.0	1029	2.696			1030	.194	Anorthosite
7.5	1031	2.560					
8.0	1032	3.121					
8.5	1033	2.476					
9.0	1034	2.921					
9.5	1035	2.907					
10.0	1036	2.692					
10.5	1037	2.291					
11.0	1038	2.860					
11.5	1039	2.752					
12.0	1040	2.656					
12.5	1041	2.581					
13.0	1042	2.979					
13.5	1043	2.951					
14.0	1044	2.455					
14.5	1045	3.280					
15.0	1046	2.822					
15.5	1047	2.804					
16.0	1048	2.922					
16.5	1049	2.876					
17.0	1050	2.730					
17.5	1051	2.661					
18.0	1052	2.370					
18.5	1053	3.105					
19.0	1054	2.838					
19.5	1055	2.747					
20.0	1056	3.245					
20.5	1057	2.634			1058	.822	Med-gray Basalt
21.0	1059	2.607					
21.5	1060	2.921					
22.0	1061	2.556					
22.5	1062	2.884					
23.0	1063	2.574					
23.5	1064	2.881					
24.0	1065	2.942					
24.5	1066	2.685					
25.0	1067	2.896					
25.5	1068	2.791					
26.0	1069	2.882					
26.5	1070	2.913					
27.0	1071	2.477					
27.5	1072	2.386					
28.0	1073	2.284					
28.2	1074	1.401					



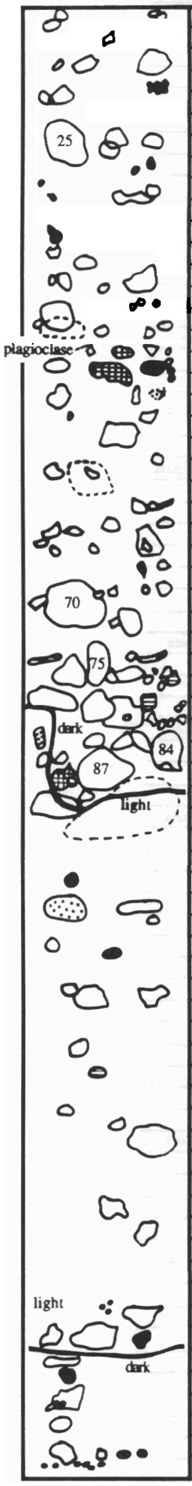
DRIVE TUBE 60014 (Third Dissection)



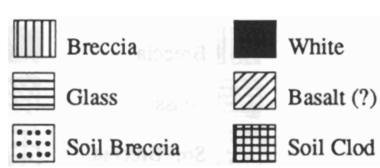
<1 mm Fraction Sample		>1 mm Fraction Sample		Special Samples		
No.	Wt.	No.	Wt.	No.	Wt.	Type
2006	2.365	2007	.190			
2008	2.033	2009	.100			
2010	2.713	2011	.233			
2012	2.771	2013	.183			
2014	2.457	2015	.174			
2016	2.449	2017	.228			
2018	2.295	2019	.212	2020	.266	Anorthosite
2021	2.343	2022	.088			
2023	2.508	2024	.330			
2025	2.189	2026	.133			
2027	2.573	2028	.122			
2029	2.507	2030	.084			
2031	2.784	2032	.137			
2033	2.948	2034	.147			
2035	2.717	2036	.126			
2037	2.505	2038	.152			
2039	2.688	2040	.111			
2041	2.638	2042	.121			
2043	2.818	2044	.139			
2045	2.914	2046	.276			
2047	2.426	2048	.193			
2049	2.972	2050	.140			
2051	2.402	2052	.143			
2053	2.244	2054	.094			
2055	2.731	2056	.181			
2057	2.560	2058	.241			
2059	2.293	2060	.298			
2061	2.329	2062	.191	2065	.627	Breccia w/glass
2063	2.138	2064	.122			
2066	2.231	2067	.900			
2068	2.335	2069	.168			
2070	2.796	2071	.320			
2072	2.203	2073	.138			
2074	2.752	2075	.315			
2076	2.503	2077	.312			
2078	2.858	2079	.358			
2080	2.490	2081	.351			
2082	2.822	2083	.303			
2084	2.518	2085	.103			
2086	3.218	2087	.264			
2088	2.622	2089	.385			
2090	2.698	2091	.174			
2092	2.112	2093	.261	2096	.682	Soil Breccia
2094	2.293	2095	.967	2097	.458	Agglutinate
2098	2.429	2099	.390			
2100	2.784	2101	.138			
2102	2.892	2103	.159			
2104	2.972	2105	.244			
2106	2.934	2107	.197			
2108	3.057	2109	.205			
2110	2.723	2111	.167			
2112	2.749	2113	.231			
2114	2.817	2115	.205			
2116	2.235	2117	.518			
2118	2.790	2119	.121			
2120	1.935	2121	.136			
2122	1.438	2123	.072			



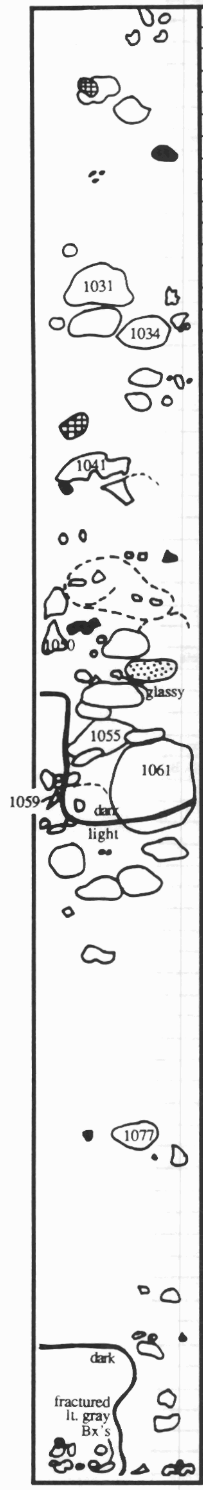
DRIVE TUBE 60013 (First Dissection)



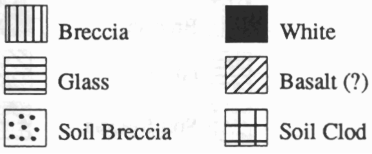
Depth (cm)	Depth from surface	<1 mm Fraction Sample No.	<1 mm Fraction Sample Wt.	>1 mm Fraction Sample No.	>1 mm Fraction Sample Wt.	Special Samples No.	Special Samples Wt.	Special Samples Type
0.5	28.2-28.7	11	1.952	12	.183			
1.0	28.7-29.2	13	1.736	14	.084			
1.5	29.2-29.7	15	1.296	16	.205			
2.0	29.7-30.2	17	1.91	18	.186			
2.5	30.2-30.7	19	2.092	20	.189			
3.0	30.7-31.2	21	1.666	22	.169			
3.5	31.2-31.7	23	1.87	24	.238	25	.574	Dusty anor.
4.0	31.7-32.2	26	1.746	27	.111			
4.5	32.2-32.7	28	1.547	29	.202			
5.0	32.7-33.2	30	1.812	31	.132			
5.5	33.2-33.7	32	1.821	33	.142			
6.0	33.7-34.2	34	1.871	35	.178			
6.5	34.2-34.7	36	1.922	37	.303			
7.0	34.7-35.2	38	1.878	39	.423			
7.5	35.2-35.7	40	1.551	41	.143			
8.0	35.7-36.2	42	1.852	43	.228			
8.5	36.2-36.7	44	1.903	45	.348			
9.0	36.7-37.2	46	1.299	47	.132			
9.5	37.2-37.7	48	2.129	49	.223			
10.0	37.7-38.2	50	1.794	51	.302			
10.5	38.2-38.7	52	1.778	53	.176			
11.0	38.7-39.2	54	2.247	55	.194			
11.5	39.2-39.7	56	2.001	57	.209			
12.0	39.7-40.2	58	1.642	59	.207			
12.5	40.2-40.7	60	2.099	61	.262			
13.0	40.7-41.2	62	1.612	63	.138			
13.5	41.2-41.7	64	1.554	65	.280			
14.0	41.7-42.2	66	1.046	67	.191			
14.5	42.2-42.7	68	1.947	69	.431	70	1.331	Anor Bx?
15.0	42.7-43.2	71	1.636	72	.168			
15.5	43.2-43.7	73	1.35	74	.554	75	.404	Soil breccia
16.0	43.7-44.2	76	1.165	77	.741			
16.5	44.2-44.7	78	.889	79	.312			
17.0	44.7-45.2	80	1.634	81	.563			
17.5	45.2-45.7	82	1.008	83	.160	84	.829	Soil breccia
18.0	45.7-46.2	85	1.079	86	.549	87	.715	Fragmented S. Bx
18.5	46.2-46.7	88	.768	89	.402			
19.0	46.7-47.2	90	1.086	91	.193			
19.5	47.2-47.7	92	2.821	93	.131			
20.0	47.7-48.2	94	1.68	95	.067			
20.5	48.2-48.7	96	2.011	97	.074			
21.0	48.7-49.2	98	1.927	99	.244			
21.5	49.2-49.7	100	2.17	101	.146			
22.0	49.7-50.2	102	1.98	103	.07			
22.5	50.2-50.7	104	2.53	105	.136			
23.0	50.7-51.2	106	2.283	107	.266			
23.5	51.2-51.7	108	1.984	109	.084			
24.0	51.7-52.2	110	2.121	111	.075			
24.5	52.2-52.7	112	2.238	113	.144			
25.0	52.7-53.2	114	2.341	115	.140			
25.5	53.2-53.7	116	2.485	117	.083			
26.0	53.7-54.2	118	1.800	119	.122			
26.5	54.2-54.7	120	2.134	121	.369			
27.0	54.7-55.2	122	2.433	123	.260			
27.5	55.2-55.7	124	2.098	125	.154			
28.0	55.7-56.2	126	2.094	127	.102			
28.5	56.2-56.7	128	2.069	129	.172			
29.0	56.7-57.2	130	2.305	131	.078			
29.5	57.2-57.7	132	2.161	133	.301			
30.0	57.7-58.2	134	2.23	135	.143			
30.5	58.2-58.7	136	2.442	137	.187			
31.0	58.7-59.2	138	2.067	139	.375			
31.5	59.2-59.7	140	2.266	141	.183			
32.0	59.7-60.2	142	2.021	143	.111			
32.5	60.2-60.7	144	2.322	145	.306			
33.0	60.7-61.2	146	2.428	147	.239			
33.5	61.2-61.7	148	1.982	149	.253			
33.7	61.7-61.9	150	1.30	151	.083			



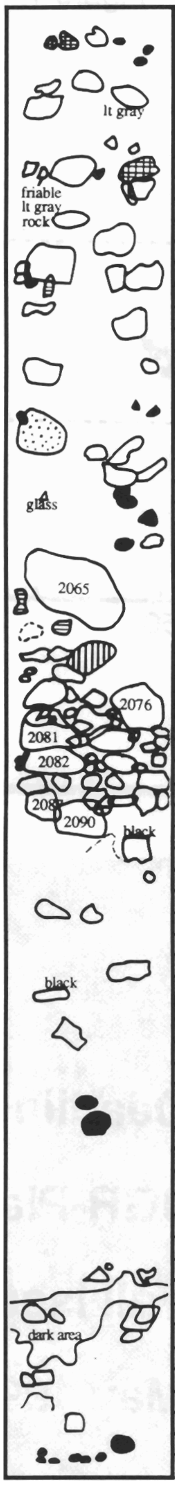
DRIVE TUBE 60013 (Second Dissection)



Depth (cm)	Depth from surface	Unsieved Sample No.	Unsieved Sample Wt.	No.	Wt.	Special Samples No.	Special Samples Wt.	Special Samples Type
0.5	28.2-28.7	1017	3.017					
1.0	28.7-29.2	1018	3.205					
1.5	29.2-29.7	1019	2.217					
2.0	29.7-30.2	1020	3.447					
2.5	30.2-30.7	1021	2.785					
3.0	30.7-31.2	1022	2.712					
3.5	31.2-31.7	1023	3.319					
4.0	31.7-32.2	1024	2.823					
4.5	32.2-32.7	1025	3.258					
5.0	32.7-33.2	1026	3.067					
5.5	33.2-33.7	1027	2.72					
6.0	33.7-34.2	1028	2.906					
6.5	34.2-34.7	1029	2.196					
7.0	34.7-35.2	1030	2.592			1031	1.159	Bx w/glass
7.5	35.2-35.7	1032	3.465					
8.0	35.7-36.2	1033	2.22			1034	.981	Bx w/glass?
8.5	36.2-36.7	1035	3.25					
9.0	36.7-37.2	1036	3.264					
9.5	37.2-37.7	1037	2.978					
10.0	37.7-38.2	1038	3.041					
10.5	38.2-38.7	1039	3.401					
11.0	38.7-39.2	1040	3.207			1041	.211	S. Bx. w/glass
11.5	39.2-39.7	1042	2.65					
12.0	39.7-40.2	1043	2.912					
12.5	40.2-40.7	1044	3.234					
13.0	40.7-41.2	1045	2.201					
13.5	41.2-41.7	1046	2.242					
14.0	41.7-42.2	1047	2.028					
14.5	42.2-42.7	1048	2.552					
15.0	42.7-43.2	1049	3.920			1050	.38	Agglutinate
15.5	43.2-43.7	1051	4.025					
16.0	43.7-44.2	1052	2.327					
16.5	44.2-44.7	1053	2.614					
17.0	44.7-45.2	1054	2.67			1055	.756	Soil breccia
17.5	45.2-45.7	1056	2.644					
18.0	45.7-46.2	1057	1.053					
18.5	46.2-46.7	1058	1.486			1059	.437	Breccia
19.0	46.7-47.2	1060	2.144			1061	7.629	Soil breccia
19.5	47.2-47.7	1062	2.884					
20.0	47.7-48.2	1063	3.427					
20.5	48.2-48.7	1064	3.001					
21.0	48.7-49.2	1065	3.56					
21.5	49.2-49.7	1066	2.133					
22.0	49.7-50.2	1067	3.089					
22.5	50.2-50.7	1068	2.959					
23.0	50.7-51.2	1069	3.11					
23.5	51.2-51.7	1070	3.444					
24.0	51.7-52.2	1071	3.542					
24.5	52.2-52.7	1072	2.723					
25.0	52.7-53.2	1073	2.925					
25.5	53.2-53.7	1074	4.011					
26.0	53.7-54.2	1075	3.289					
26.5	54.2-54.7	1076	2.84			1077	.386	Glass ball?
27.0	54.7-55.2	1078	3.478					
27.5	55.2-55.7	1079	2.853					
28.0	55.7-56.2	1080	3.259					
28.5	56.2-56.7	1081	2.758					
29.0	56.7-57.2	1082	3.575					
29.5	57.2-57.7	1083	3.164					
30.0	57.7-58.2	1084	2.938					
30.5	58.2-58.7	1085	3.693					
31.0	58.7-59.2	1086	3.366					
31.5	59.2-59.7	1087	3.222					
32.0	59.7-60.2	1088	3.184					
32.5	60.2-60.7	1089	3.038					
33.0	60.7-61.2	1090	3.345					
33.5	61.2-61.7	1091	2.449					
33.7	61.7-61.9	1092	2.313					

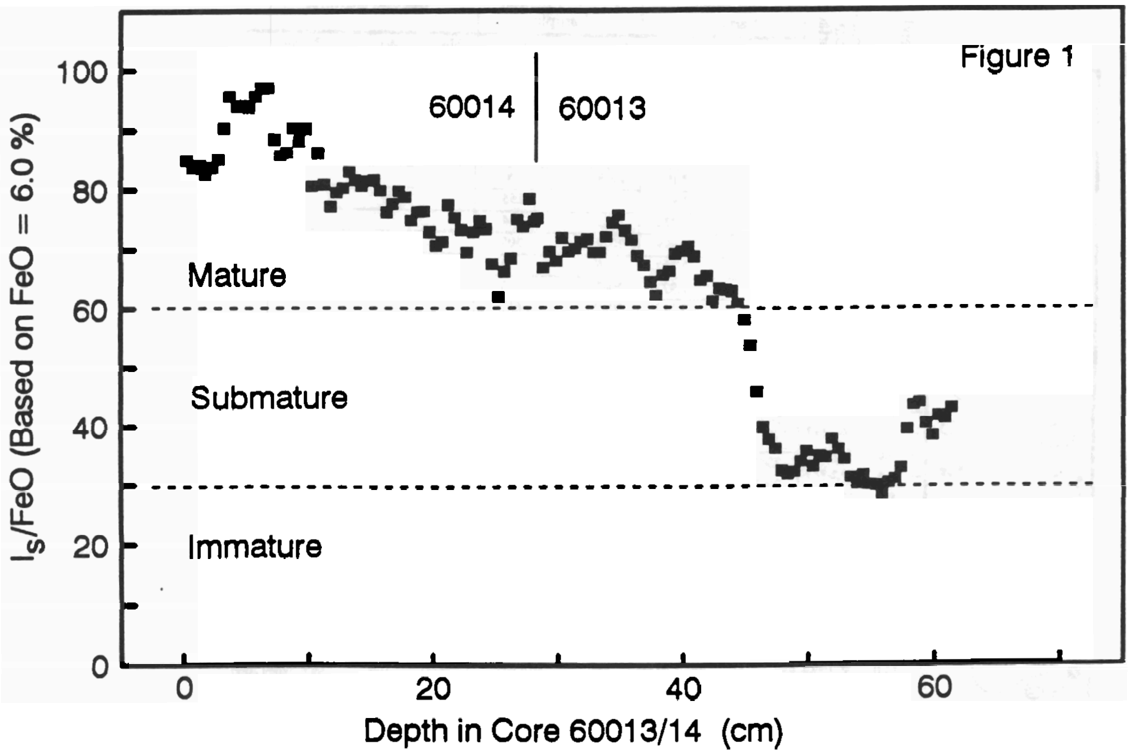


DRIVE TUBE 60013 (Third Dissection)



Depth (cm)	Depth from surface	<1 mm Fraction Sample		>1 mm Fraction Sample		Special Samples		
		No.	Wt.	No.	Wt.	No.	Wt.	Type
0.5	28.2-28.7	2007	3.026	2008	.213			
1.0	28.7-29.2	2009	2.965	2010	.356			
1.5	29.2-29.7	2011	2.348	2012	.215			
2.0	29.7-30.2	2013	2.595	2014	.291			
2.5	30.2-30.7	2015	2.13	2016	.551			
3.0	30.7-31.2	2017	2.198	2018	.200			
3.5	31.2-31.7	2019	3.478	2020	.155			
4.0	31.7-32.2	2021	2.723	2022	.634			
4.5	32.2-32.7	2023	1.999	2024	.305			
5.0	32.7-33.2	2025	2.292	2026	.207			
5.5	33.2-33.7	2027	1.922	2028	.453			
6.0	33.7-34.2	2029	2.113	2030	.612			
6.5	34.2-34.7	2031	2.647	2032	.977			
7.0	34.7-35.2	2033	2.181	2034	.187			
7.5	35.2-35.7	2035	2.724	2036	.283			
8.0	35.7-36.2	2037	2.669	2038	.170			
8.5	36.2-36.7	2039	2.348	2040	.324			
9.0	36.7-37.2	2041	2.326	2042	.204	2151	.079	Breccia?
9.5	37.2-37.7	2043	2.686	2044	.289			
10.0	37.7-38.2	2045	2.333	2046	.533			
10.5	38.2-38.7	2047	2.65	2048	.877			
11.0	38.7-39.2	2049	2.503	2050	.424			
11.5	39.2-39.7	2051	2.755	2052	.332			
12.0	39.7-40.2	2053	2.319	2054	.137			
12.5	40.2-40.7	2055	2.458	2056	.228			
13.0	40.7-41.2	2057	2.618	2058	.172			
13.5	41.2-41.7	2059	1.276	2060	.169	2065	7.685	Breccia
14.0	41.7-42.2	2061	1.143	2062	.06	2066	.607	Swp. from 2065
14.5	42.2-42.7	2063	2.326	2064	.261	2067	.084	Swp. from 2065
15.0	42.7-43.2	2068	2.381	2069	.304	2154	.653	Friable S.Bx.
15.5	43.2-43.7	2070	2.107	2071	.554			
16.0	43.7-44.2	2072	2.328	2073	1.047			
16.5	44.2-44.7	2074	1.605	2075	.98	2076	.775	Soil breccia
17.0	44.7-45.2	2077	1.294	2078	.882	2081	.601	Soil breccia
17.5	45.2-45.7	2079	1.522	2080	1.009	2082	.400	Soil breccia
18.0	45.7-46.2	2083	1.321	2084	.703			
18.5	46.2-46.7	2085	.909	2086	.926	2087	.935	Soil breccia
19.0	46.7-47.2	2088	1.627	2089	.356	2090	1.352	Fr. S. Bx.
19.5	47.2-47.7	2091	2.297	2092	.511			
20.0	47.7-48.2	2093	2.801	2094	.177			
20.5	48.2-48.7	2095	2.683	2096	.161			
21.0	48.7-49.2	2097	2.699	2098	.294			
21.5	49.2-49.7	2099	2.82	2100	.236			
22.0	49.7-50.2	2101	2.915	2102	.348			
22.5	50.2-50.7	2103	2.495	2104	.43			
23.0	50.7-51.2	2105	2.01	2106	.165			
23.5	51.2-51.7	2107	2.822	2108	.21			
24.0	51.7-52.2	2109	2.578	2110	.191			
24.5	52.2-52.7	2111	3.092	2112	.099			
25.0	52.7-53.2	2113	2.521	2114	.062			
25.5	53.2-53.7	2115	2.846	2116	.081			
26.0	53.7-54.2	2117	3.31	2118	.310			
26.5	54.2-54.7	2119	2.663	2120	.272			
27.0	54.7-55.2	2121	2.408	2122	.236			
27.5	55.2-55.7	2123	2.926	2124	.205			
28.0	55.7-56.2	2125	2.746	2126	.245			
28.5	56.2-56.7	2127	2.565	2128	.35			
29.0	56.7-57.2	2129	2.888	2130	.049			
29.5	57.2-57.7	2131	2.605	3132	.272			
30.0	57.7-58.2	2133	2.55	2134	.177			
30.5	58.2-58.7	2135	2.606	2136	.579	2157	.397	Dusty fragment
31.0	58.7-59.2	2137	1.97	2138	.14			
31.5	59.2-59.7	2139	2.715	2140	.437			
32.0	59.7-60.2	2141	3.069	2142	.267			
32.5	60.2-60.7	2143	2.667	2144	.21			
33.0	60.7-61.2	2145	2.606	2146	.209			
33.5	61.2-61.7	2147	2.251	2148	.289			
33.7	61.7-61.9	2149	1.335	2150	.176			

Breccia — White
Glass — Basalt (?)
Soil Breccia — Soil Clod



Special Section of JGR-Planets: Magma Oceans

Many participants at the recent, highly successful LPI-LAPST sponsored workshop on The Physics and Chemistry of Magma Oceans (see page 3 of this newsletter) expressed interest in contributing to a special issue of a journal. JGR-Planets editor Clark Chapman is enthusiastic about devoting a portion of a Fall issue of JGR-Planets to this interesting topic. Papers need to be submitted to him by mid-May, 1992. Jeff Taylor, Associate Editor, will coordinate the review process. Address questions to Jeff: (808) 956-3899; gjtaylor@esther.pgd.hawaii.edu; NASAmail: jefftaylor.

Deadline for JGR-Planets Fall Issue is May 1992