ARCHIVIST'S NOTES #4:

LUNAR SAMPLES CURRENTLY STORED IN THE FREEZER

March 24, 1994
J. H. Allton

Additional Keywords: cold storage, thermoluminescence, volatiles, permanently shadowed samples

ARCHIVIST'S NOTES #4: LUNAR SAMPLES CURRENTLY STORED IN THE FREEZER

Judy Allton
April 28, 1994

LSAPT correspondence indicates that collecting and storing permanently shadowed samples at low temperature was first implemented in preparation for Apollo 17. Seventeen samples from Apollo 17 mission are currently stored in the commercial freezer in room 1109 of B. 31N. These samples consist of 6 samples from the Apollo 17 deep drill (one sample from each tube section, 70001 thru 70006), 9 samples of permanently shadowed soils (72320 and 76240), soil 70180 (a surface reference soil for the drill core), and rock 71036 (from boulder at station 1A). [List attached]

The Apollo 17 mission occurred Dec 7-19, 1972. C.O.s, core procedures and LSAPT memos direct the taking of samples from the drill core and the permanently shadowed soils for the freezer in late December 1972 and January of 1973. Actual date of transfer to freezer is undetermined. Sample processing in B. 37 closed down in 1973 after Apollo 17 PET was complete. Samples were moved to various parts of B. 31 during 1972-1973. [The freezer was located in Returned Sample Processing Lab (RSPL), (in B. 31?)]

Two samples of permanently shadowed soils (76240,22 and 72320,4) were removed from the freezer and sent to Durrani for thermoluminescence studies in early 1974. Except for rock 72375, 0, which was put into the freezer 1/30/73 and permanently removed from the freezer 4/25/73 for consortium processing, and the samples for Durrani, no other samples have been allocated from the freezer.

RATIONALE FOR COLLECTING SAMPLES WITH A NATURAL EXPOSURE TO LOWER MAXIMUM TEMPERATURES (BELOW SURFACE OR SHADOWED SAMPLES): The Geochemistry Group Report of the 1965 NASA Summer Conference on Lunar Exploration and Science (NASA SP-88, p. 260-262) deemed returning samples with lunar volatiles as essential. The report also lists thermoluminescence among the "desirable but not essential" measurements. LSAPT correspondence during the missions document the idea that subsurface and permanently shadowed samples were thought to be good places for preservation of volatiles and good samples to retain characteristics measured by thermoluminescence. LSAPT wrote to mission managers, just prior to Apollo 17, to request that the drill and shadowed samples to be collected not be left lying in the sun during subsequent lunar surface activities and be protected from heat sources during the return voyage.

RATIONALE FOR LABORATORY STORAGE OF LUNAR SAMPLES AT COLD TEMPERATURES: In the November 10, 1972, issue of *Nature*, Durrani presented evidence that low temperature storage better preserved TL glow curve peaks. LSAPT memo of November 13, 1972 states "Even protracted storage at room temperature may alter the properties of lunar materials. For the benefit of future investigations of temperature-sensitive properties [thermoluminescence, volatile trace elements], we consider it important that aliquots of selected lunar samples be stored at low temperatures."

There were concerns about placing samples in cold storage as noted in a letter to Durrani from Mike Duke October 11, 1972, "It is not obvious how the cold storage can be reconciled with contamination protocols." Specific contamination concerns were not documented in the letter or LSAPT minutes, but may have been sample container sealing during sample storage in air instead of nitrogen and the condensation of moisture onto cold samples. The decision to place samples in cold storage resulted in procurement of a freezer and development of sample handling procedures. Procedures called for transferring samples to a small nitrogen cabinet and for highly efficient processing to minimize the time the samples remained in the room temperature environment.

In recent years discussions of the need for freezer storage of samples has taken place in the meteorite community and focused on thermoluminescence (it's use as a survey technique vs in-depth science value and the sample requirements for effective TL analysis) and is not directly applicable to lunar samples.

PRESENT FREEZER STATUS: According to the freezer logbook, the last time samples were removed for processing was 8/17/77 (possibly just repackaging). Thus, freezer samples are presently static.

LISTING FOR SAMPLE TRANSFER

CO NUMBER:
DATE: 16-Mar-1994
LIST GENERATED BY:

NOTEPAD codes: NS = notes about specific; NG = notes about generic

GENERIC	SPECIFIC	PARENT	LOCATION	GROUP CONTAINER	CONTAINER	WEIGHT G	DESCRIPTION	NOTEPAD	FLAG
70001	5	1	RPL-FZ		8 2573	3.431	047-40 BULK	NG	
70002	5	1	RPL-FZ		8 2208	3.005	028-23 BULK	NG	
70003	5	1	RPL-FZ		8 2290	3.004	018-12 BULK	NG	
70004	5	1	RPL-FZ		8 2325	2.970	020-15 BULK	NG	
70005	5	1	RPL-FZ		8 2339	3.026	020-14 BULK	NG	
70006	5	1	RPL-FZ		8 2490	2.998	028-23 BULK	NG	
70180	2	0	RPL-FZ		3B 80	20.020			
71038	0	0	RPL-FZ		3B 54	118.400	REFRIG		
72320	1	0	RPL-FZ		3B 83	18.910			
72320	2	0	RPL-FZ		3B 83	8.622			
72320	4	2	RPL-FZ	1B 156	10 9780	0.131	FREEZER FI		
72320	5	4	RPL-FZ	1B 156	10 9730	0.035	FREEZER FI		
76240	5	1	RPL-FZ		3B 83	19.870			
76240	6	1	RPL-FZ		3B 83	4.523			
76240	22	6	RPL-FZ	1B 156	10 9760	0.099	FREEZER FI		
76240	33	22	RPL-FZ	1B 156	FV	0.025	FREEZER FI		WEIGHT ESTIMATED
76240	34	22	RPL-FZ	1B 156	10 9763	0.046	FREEZER FI		

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DEPARTMENT OF PHYSICS
The University of Birmingham, P.O. Box ...
Telephone 021-472 1301

Poynting Professor: P B Moon FRS (Dean of the Faculty of Science and Engineering). Oliver Lodge Professo... Head of Department: W E Burcham FRS. Professor W F V... Professor of Applied Nuclear Science: J Walker. Professor of Crystallography: A J C Wilson FRS. Professor of Applied Radioactivity: J H Fremlin

113/SAD/DMP

2nd May, 1972.

Dr. Michael B. Duke,
Lunar Sample Curator (Code TL4),
Manned Spacecraft Centre,
Houston,
Texas 77058,
U.S.A.

Dear Dr. Duke,

Refrigeration of Apollo-16 material

Thank you very much for the useful literature you recently sent me as a prospective Principal Investigator of Apollo 15 to 17 samples. I hope soon to receive further particulars from you regarding the actual sample allocations to me for our charged particle track work.

The present letter is, however, concerned primarily with a different but rather urgent matter. I have hesitated before writing to you since Dr. J.A. Edgington is no longer a PI (nor I a Co-Investigator) for work on thermoluminescence of future lunar samples beyond Apollo-15. The proposal should, nevertheless, be of great importance, I believe, for other workers on thermoluminescence (TL), such as Professor R.M. Walker of Washington University, St. Louis, and it is out of consideration for their interests and for the benefit of the total lunar programme that I venture to make it.

I have previously mentioned to Professor Paul Gast as well as to yourself the desirability of deep freezing the samples meant for TL analysis. At Houston in January you were kind enough to say that you will endeavour to do so for future samples. In the case of Apollo 16 mission, it appeared from the TV coverage of the sample collection excursions, that some samples were collected from the shaded parts of craters/boulder formations, etc. These samples therefore may have remained at quite low maximum lunar temperatures (around 240°K?), thus retaining their radiation dose much more effectively. It is of great important (especially for these samples, but generally for all) that any portions of these which are meant for TL work should be kept refrigerated until their release to the investigators. In our paper for the Proceedings of the Third Lunar Science Conference we have stated that "..... This underlines the importance of placing lunar samples, destined for TL study, in deep freeze (say at liquid nitrogen temperatures - though even

TL 4/72 - 522

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(258)

storage would help), as well as of their prompt distribution for ork". I hope that you will be able to implement these suggestions. ight drainage of TL at ambient temperature during the return y of the astronauts (and any subsequent delays in the LRL) can, ve, be allowed for - but the earlier they are placed under ration, and distributed, the better.

Incidentally, Dr. Edgington tells me that despite several ters, he has, to date, not received any core samples of Apollo 14 collections. We need these urgently for our current programme investigation of material from these missions. We should be rateful if you would personally look into this and send us these amples.

Finally, I hope that by now the Surveyor III components have been ly housed and catalogued by you, and that you will be kind enough d me urgently a piece of Surveyor glass, for our track registration n it, as promised by you in February.

With kind regards.

Yours sincerely,

S.A. Durrani

S. A. Durrani

Professor R. M. Walker,
Cal. Tech. Division of Geological Sciences,
Pasadena, California 91109, U.S.A.

Dr. B.G. Pressey, S R.C. London.

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958) LDMU U.S. Gov

TL4 May 24, 1972

Dr. S. A. Durrani
University of Birmingham
Department of Physics
Birmingham B15, 2TT
England

Dear Dr. Durrani:

Thank you for your letter of May 2. I have again forwarded your comments to the Lunar Sample Analysis Planning Team (LSAPT) for their comments. However, before we can consider the possible refrigeration of lunar samples, we will need to have some more definitive data. The shadowed samples remained about three weeks at room temperature before they were found (it was not clear which sample bag they were returned in). We hope to repeat the experiment on Apollo 17 and need to have some hard data to establish the validity of a refrigeration requirement, which would involve other problems of sample contamination control.

We have the Surveyor III parts here at MSC, with the exception of the glass filters, which we expect here soon. The LSAPT, however, which has the responsibility for allocations of that material, has not yet reached a decision on your request. I will inform you when they have acted.

Sincerely yours,

Michael B. Duke
Lunar Sample Curator

TL4/MBDuke:cmg:5-24:72:3274

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L SAPT file

NATIONAL AERONA[illegible] [illegible]MINISTRATION
MANS[illegible]

5 October 1972

TL4

MEMORANDUM

TO: TL/LRL Supervisor

FROM: Vice Chairman, LSAPT

SUBJECT: Low temperature storage of selected lunar samples

The attached letter raises a question that we must consider seriously. Approximately one cubic foot of storage is at issue. The combined requirements for cold and security could make this difficult. LSAPT would appreciate it if you can advise us on feasibility at our next meeting (Nov. 1-3).

John A. Wood

cc: TA/Mr. A. J. Calio
TL4/Dr. M. B. Duke
TN/Dr. P. W. Gast
LSAPT members

JAW/skl

6

TL4

October 11, 1972

Dr. S. A. Durrani
University of Birmingham
Department of Physics
Birmingham B15, 2TT, England

Dear Dr. Durrani:

The LSAPT discussed your proposal to refrigerate samples at their September meeting. They feel that it is generally a good idea and are preparing suggestions for its implementation; however, it is not obvious how the cold storage can be reconciled with sample contamination protocols. I will let you know how the situation develops.

The LSAPT has not allocated you core material from Apollo 14 or 15. We are now in the process of allocating Apollo 16 core samples and it is difficult to go back to previous missions. I suggest that you resubmit a request for Apollo 16 core samples.

Apollo 15 soil samples were sieved and numbered according to a standard plan. Sample numbers ending in 1 (i.e. 61281) passed through a one millimeter sieve. Numbers ending in 2 passed through a 2 millimeter sieve and were retained on one millimeter. I caution you that the sieving is not particularly efficient, as it is all done in dry nitrogen and static effects are great. These procedures are defined in the Apollo 15 sample catalog.

Sincerely yours,

M. B. Duke
Lunar Sample Curator

TL4/MBDuke:gs:10-11-72:3274

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

7 November 1972

TL4

MEMORANDUM

TO: TA/Chairman, LSAPT

FROM: Vice Chairman, LSAPT

SUBJECT: Temperature-sensitive samples to be collected by Apollo 17

Much of the interest in collecting a deep drill sample and a permanently shadowed sample stems from their presumed content of volatile elements and compounds. From discussions with SWP members it appears that these samples, once collected, may be left for substantial periods of time in direct sunlight on the lunar surface. If so, they will become hot and their content of volatiles will be lost or redistributed.

We urge that every possibility be explored of protecting the deep drill cores and the permanentl shadowed (and reference soil) samples from high temperatures, either by stowing them immediately in the LM, or storing them on the lunar surface in a shaded position or under an insulating blanket.

John Wood

John A. Wood

cc: Prof. R. O. Pepin
TL4/Dr. Michael B. Duke
TN/Dr. Paul W. Gast
LSAPT members

jaw/skl

OCT. 1972

NATIC ND SPACE ADMINISTRATION
ECRAFT CENTER
TEXAS 77058

TL4

13 November 1972

MEMORANDUM

TO: TA/Chairman, LSAPT

FROM: Vice Chairman, LSAPT

SUBJECT: Cold Storage of Selected Lunar Samples

Certain scientific investigations (thermoluminescence, volatile trace elements) are compromised if the lunar samples they are applied to have experienced high temperatures since they were collected. Even protracted storage at room temperature may alter the properties of lunar materials. For the benefit of future investigations of temperature-sensitive properties, we consider it important that aliquots of selected lunar samples be stored at low temperatures.

Accordingly we recommend that the Curator obtain a commercial deep freeze unit, capable of sustained operation at -25°C. This should be capacious enough to hold 10 1-liter bolt-top cans in Styrofoam insulating cases (the latter to maintain low temperatures in the bolt-top cans during defrost cycles of the unit, or power failures). Storage of anything other than lunar samples in the unit should be prohibited. The lid should be fitted with an appropriately secure hasp and lock. We request that this system be obtained and installed by the time the Apollo 17 samples are returned.

John A. Wood

cc: TL/Mr. W. B. McCown
TL4/Dr. Michael B. Duke
TN/Dr. Paul W. Gast
LSAPT members

JAW/skl

Table 1 Comparison of Compositions of Basalt Cinders and Lunar Sample 14310

	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O+
A	47.9	0.83	19.3	n.d.	4.59	4.74	0.17	6.59	12.43	2.31	0.34	0.08	0.49
B	46.4	1.22	19.8	0.18	4.37	4.31	0.11	7.75	12.10	2.39	0.48	0.33	0.49

A is basalt cinders 14802 from Mansion pyroclastics, St Kitts (15); B is 14310 (16) recalculated after addition of 0.44% O_2, 0.50% H_2O and 1.80% Na_2O.

Both magmas are suspected to have precipitated An_{90-93} at moderate water vapour pressure, An_{70} on eruption after dehydration. B then lost alkalis as well, and precipitated groundmass An_{93}.

Terrestrial basic magmas of the calc-alkaline type, having "normal" Na/Ca ratios much higher than those of 14310, precipitate very calcic feldspars (anorthite) in enclosed magma chambers at elevated water vapour pressures, yet after eruption and water loss by volatilization these magmas precipitate much more sodic feldspars (labradorite/bytownite)[14,15]. A specific example is provided by the basalt cinders from the Mansion pyroclastics of St Kitts[15] which crystallized early plagioclase An_{70} with olivine of Fo_{77} after eruption, but are associated with plutonic accumulate blocks containing feldspar An_{90-93} and olivine Fo_{77}. The compositions of these basalt cinders, and of 14310 after addition of appropriate alkalis, oxygen and some water, are compared in Table 1.

14310 was derived from a calc-alkaline basaltic magma similar in major element chemistry to a common terrestrial type (the minor element chemistry precludes any closer analogy). That magma had "normal alkali contents and was crystallizing at about 1,150° C, and 250 bars pressure in a magma chamber buried approximately 5 km below the lunar surface[7]. This wet magma, containing 1–2% H_2O, was precipitating spinel-troctolite. Some of the magma was erupted, carrying with it a few of the low density equilibrium plagioclase phenocrysts (An_{93}) from the magma chamber. At the surface the water was lost by volatilization; in the absence of dissolved water the liquidus and solidus temperatures increased rapidly, and the remaining silicate liquid found itself markedly supercooled under the new conditions. Plagioclase crystallized rapidly on the existing nuclei at first and feldspar had a sodic composition, An_{71}, reflecting the still high alkali contents of the silicate magma on eruption. Following and accompanying the water loss, however, selective volatilization of alkalis took place, again contributing towards higher liquidus and solidus temperatures. By the time general nucleation of groundmass plagioclase had occurred, the stable composition formed from the alkali depleted silicate liquid was An_{93}[1] (perhaps not significantly different from the experimentally observed An_{92}[2]).

The temperature of the magma, 1,150° C, was below that at which olivine or aluminous spinel are present in the dry low pressure equilibrium crystallization histories[7]; consequently neither formed during the groundmass crystallization of 14310, but relatively iron-oxide rich calcium-poor pyroxene precipitated. Oxygen loss, however, continued beyond this stage so that the final composition of 14310 was too depleted in oxygen to yield such iron-oxide ric[illegible] pyroxenes in e[illegible]periments, a more magnesian pyroxene and [illegible]ic iron be[illegible]served instead.

The [illegible]ltimate s[illegible]ce of the [illegible]10 magm[illegible] massive partial meltir[illegible] of a w[illegible]-rich lu[illegible] interior, [illegible]ng a liquid of gabbroic-anorthosite type which fraction[illegible] extensively by plagioclase crystallization close to the lunar surface. The pre-eruption 14310 magma was a residual liquid from that fractionation process[7].

Summarizing, the petrography of sample 14310 provides the strongest evidence yet for the real operation of a process which was always a common sense probability, namely the significant alteration of magma compositions by the selective volatilization of water, alkalis and oxygen from silicate liquids erupted at 1,100–1,300° C into a vacuum of harder than 10^{-10} torr on the lunar surface. In the light of this there is no need to appeal to a special and separate accretion of the lunar crust with its present composition, and no case for ascribing the dry, reduced and alkali-poor of lunar surface samples to the Moon as a whole.

M. J. O'Hara

University of Edinburgh, Grant Institute of Geology, Edinburgh EH9 3JW

Received September 5, 1972.

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Refrigeration of Lunar Samples destined for Thermoluminescence Studies

I wish to provide quantitative data supporting the need for refrigeration of lunar samples, retrieved by both manned and unmanned missions, which are meant for thermoluminescence (TL) investigations. The same arguments apply to freshly fallen meteorites. This need for low-temperature storage does not seem to be generally appreciated, with the result that a good deal of useful information is irretrievably lost.

The main purposes of TL investigations of lunar (or meteoritic) material are, first, to derive the radiation and temperature histories of the samples and, second, to estimate the (cosmic-ray exposure) age of the samples or their parent bodies. In essence,

Table 1 Half-lives of First Peaks in Typical Lunar Samples held at Different Storage Temperatures

Sample (and peak temperature)	Trap parameters Depth E(eV)	Freq. factor s(s^{-1})	Half-life $\tau_{\frac{1}{2}}$ at $+20°$ C	$-20°$ C	$-80°$ C*	$-196°$ C†
12070,112 (fines) (160° C)	1.15	$\sim 7\times10^{12}$	64 days	200 yr	3×10^{9} yr	3×10^{54} yr
12051,15 (rock chip) (175° C)	1.05	$\sim 2\times10^{11}$	40 days	90 yr	3×10^{8} yr	4×10^{49} yr
15261,70 (fines) ‡ (140° C)	1.00	$\sim 5\times10^{11}$	2 days	4 yr	4×10^{6} yr	1×10^{46} yr

* CO_2 snow ("dry ice") temperature.
† Liquid nitrogen temperature.
‡ This sample, which comes from the bottom of a trench ~20 cm deep on Hadley Delta, is estimated by us[3] to have remained at ~250 K for the last 15,000 yr.

the amount of "natural" TL observed in a body is the result of two competing processes: the radiative filling of "electron traps", and the thermal drainage of these traps in the natural environment of the body. The mean life $\tau(T)$ of electrons in traps of "depth" E and "frequency factor" s in a body held at an absolute temperature T is given[1] by

$$\tau(T)=s^{-1}.\ e^{E/kT} \quad (1)$$

where k is Boltzmann's constant.

Parameters E and s for each "glow peak" in a TL readout can be determined experimentally[2], and the values of τ at various storage temperatures calculated from equation (1). For peaks which are observed at relatively low readout temperatures (say ~150° C), half-lives $\tau_{\frac{1}{2}}$ ($=\tau\times\ln 2$) at room temperature are often quite short (a few days or weeks). Low-temperature storage as well as prompt distribution of lunar (and meteoritic) samples destined for TL studies is thus called for. The loss of low-temperature peaks is particularly unfortunate in the case of lunar core tube samples which, having remained at low ambient temperatures (~240 K) on the Moon, should have displayed substantial TL in the first natural peaks, had fading been arrested by placing them in deep freeze in the laboratory. (Ideally, refrigeration should start during the return journey of the spacecraft; but allowance can be made for a few days of fading.) The same is true of samples from manned or unmanned Moon missions collected from depths as little as ~20 cm (where effective storage temperatures are ~250 K, ref. 3) or from locations which are shaded by projecting crater walls and boulders, and also of samples from any future lunar polar missions. Similarly meteorite cores (that is, regions away from "fusion crusts") may still be at or near their outer-space temperatures[4] (~200 K) if recovered soon after an observed fall. The advantages of refrigeration were demonstrated[5] in the case of the Allende meteorite, which fell on February 8, 1969.

Fig. 1 shows the situation in the case of a fines sample[2] from Apollo 12. The first peak (see natural TL curve A) had obviously been totally drained during the pre-readout storage of the sample in the laboratory (at 20° C for ~18 month)s. Table 1 records the half-lives of the first peak in some typical Apollo 12 and 15 samples at a number of storage temperatures of interest, as calculated from the values of E and s measured in this laboratory.

The need for refrigerating at least a small fraction of the lunar samples (preferably at liquid nitrogen temperature), immediately upon receipt in the Lunar Receiving Laboratory, is obvious from Table 1. Depositing parts of freshly fallen meteorites in the freezing compartments (~ −10° C) of even ordinary refrigerators—and preferably in "deep freeze" units (~ −20° C)—in museums and laboratories is strongly recommended. Prompt distribution of samples destined for TL studies is urged in all cases.

S. A. DURRANI

Department of Physics,
University of Birmingham, Birmingham B15 2TT

Received September 3; revised September 20, 1972.

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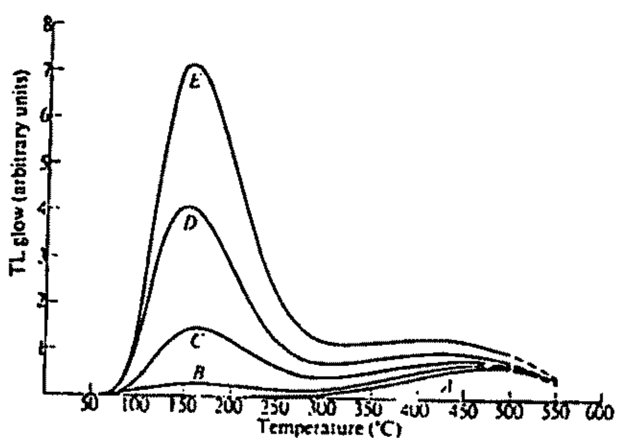

Fig. 1 Typical TL glow curves from a lunar fines sample (rate of heating, 5° C s^{-1}; black body contribution subtracted). The first peak had become drained in the natural sample (curve A) during its laboratory storage (for ~18 months; $\tau_{\frac{1}{2}}$ ~64 days), but is reinstated upon irradiating the sample with ^{60}Co γ-rays. The high-temperature peak was found to have $\tau_{\frac{1}{2}}$ ~7×10^{9} yr at 20° C. A, Natural sample; B, natural sample +35 krad;

Influence of Continental Positions on Early Tertiary Climates

CONTINENTS can be positioned in their earlier places on the Cainozoic globe by means of their rock magnetism; continents for which such data are lacking can be placed in their relative positions by removing the subsequently generated seafloor. On such a reconstructed globe for a particular time in the Cainozoic the distribution of palaeoclimates, as deduced from significant rock-types and fossil plants and animals, can be plotted in their true geographical relationships. Locations of the continents and subcontinents with respect to the rotational coordinate system, as well as to each other, will largely determine the prevailing climatic trends by affecting the circulation patterns in oceans and atmosphere. Here we attempt to model, in a semi-quantitative way, the climates of the Earth in the later half of the Eocene (40–48 m.y. ago) and in the early half of the Oligocene (30–37 m.y. ago), an interval of marked climatic change.

For deciphering global palaeoclimates a reconstruction must

TL4

December 14, 1972

MEMORANDUM

TO: Vice Chairman, LSAPT

FROM: Sample Container Subcommittee (SCS)

SUBJECT: Storage of Refrigerated Samples

Reference is made to memo dated February 3, 1971. In addition to meeting all specifications for category I containers as set forth in the reference, containers for storage of Apollo 17 samples for extended periods of time at -20^{o}C should meet the following additional requirements:

1. "O" rings must be made from 300 series stainless steel (that is nonmagnetic) "V" type seals. Conventional type "O" rings will cold flow and lose their seal after extended periods of time. The "V" type seal must be confined within the rings and are thus not adaptable to existing containers. Until new containers can be designed and fabricated for the "V" type seal teflon "O" ring in existing containers will be acceptable for storage for a period of time not to exceed three months.

2. The category I containers are to be enclosed in three heat sealed teflon bags which will serve as moisture and frost barriers while under refrigeration and during transfer out of storage and returning to room temperature.

3. Triple bagged category I container must be packed and stored inside a protective outer stainless steel or aluminum container which has no vacuum requirements.

D. Gault

A. Burlingame

OFFICIAL FILE COPY

CONCURRENCES

cc:
TL4/W. B. McCown
TL4/M. B. Duke
D. Gault

PREVIOUS EDITIONS MAY BE USED.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

C. O. No. 810

REPLY TO ATTN OF: TL4

December 20, 1972

MEMORANDUM

TO: TL/Mission Manager

FROM: TL4/Curator's Office

SUBJECT: Sampling Apollo 17 Bit and Cores 70001 - 70009

A. Open the Apollo 17 eight-section drill string according to SP-12. The NSI core specialist should monitor all portions of this C.O.

B. The following allocations are to be made from the bit 70001 and drill stem sections 70002 - 70009, subsequent to x-ray analysis of the cores. G. Heiken will be S.C.

1. 70001

If the bit contains material; it should be excavated and allocated as follows:

Excavate the material in half centimeter intervals. Each half centimeter should contain approximately 2 gm of material.

a. From the deepest half centimeter sample, pick out, describe and group package all grains larger than 1 mm in diameter. Package aliquots of the fraction finer than 1 mm as follows:

2 each	200 mg
1 each	150 mg
1 each	75 mg
2 each	50 mg
1 each	25 mg

Transfer all samples to SCC. The remainder should be packaged for storage. If there is not enough material in the first interval to make the samples above, continue with the second interval until they have been completed.

b. Package 3 g of unsieved bit material for cold storage. Sample is to be sealed in acid washed FTH container or can. Additional packaging and transfer of material to cold storage will be described in a subsequent C.O.

c. From succeeding half centimeter intervals, pass the material through a 125 μm acid cleaned sieve. Describe the larger fragments, package and store. From the finer than 125 μm sample, remove 100 mg, package and store. Add the remaining < 125 μm material to the biomedical testing sample. This sample is to consist of < 125 μm material from the bit and material should be added until the total weight of the biomedical testing sample is 12.0 gm. This will result from the excavation of from 6 to 12 or more half centimeter units, depending on the coarseness of the sample.

d. Repeat b for succeeding half centimeter intervals until the biomedical sample is completed. The same 125 sieve can be used for all sections sampled in b and c. Transfer the biomedical sample to SCL.

e. Following completion of the biomedical sample, remove and package separately material in half centimeter intervals until the bit is emptied. Individual large fragments may be separately documented and packaged.

2. <u>70002</u>

If the biomedical sample has not been completed, notify Curator. On Curator's approval, repeat 1 c and 1 d above at the bottom of 70002 until it is complete. Deliver the completed biomedical sample to SCL.

3. <u>70002 - 70006</u>

Excavate material in half-centimeter intervals from the top of each of these stems and prepare an allocation identical to 1 a and 1 b above. In addition, prepare allocations from each core as follows:

70006	1.5 gm	DAVIS
70005	2 gm	DAVIS
70004	2 gm	DAVIS
70003	2 gm	DAVIS
70002	2 gm	DAVIS

Transfer samples, excluding remainder, to SCC.

4. An allocation list authorizing samples to be transferred from SCL to Principal Investigators will follow on a separate C.O.

5. Please insure that all identified aliquots are properly transferred to SCC.

6. 70003 will be dissected, as described on a subsequent C.O.

Michael B. Duke

TL4/MBDuke:cmg:12-20-72:3274

-SAPT

NATIONAL AERONAUTICS AND SPACE
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

U.S. Gov't

TL4 27 December 1972

MEMORANDUM

TO: TA/Chairman, LSAPT

FROM: Vice Chairman, LSAPT

SUBJECT: Cold Storage of Apollo 17 Samples

LSAPT recommends that the following Apollo 17 samples be placed in cold storage as soon as feasible:

3g soil from each junction of the deep drill string (but not from the surface layer)

10g or 10% (whichever is larger) of reference surface soil collected near the deep drill site

The core sample vacuum container

The top half of the double drive tube from which the bottom half was placed in the CSVC

50% each of one trench soil and its reference surface soil

One or two of the lunar rocks that were set aside from thin-section chipping (see memorandum, "Thin sectioning of rocks during Apollo 17 PET"), to be chosen by an early LSAPT representative

(Probably) samples of the orange soil and its reference soil.

A memorandum specifying containers to be used for cold storage of lunar samples is appended.

John A. Wood

John A. Wood

encl.

cc: TL4/Dr. Michael B. Duke
TN/Dr. Paul W. Gast
LSAPT members

240

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SSPL

MEMO 872
RECVD 1-5-73
1-10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO ATTN OF: TL4

January 4, 1973

C.C.#975

MEMORANDUM

TO: TL/Mission Manager

FROM: TL4/Curator's Office

SUBJECT: Refrigeration of Apollo 17 Samples

The following samples are to be refrigerated and packaged according to the attached procedure.

70001,5
70002,5
70003,5
70004,5
70005,5
70006,5

Please complete this work ASAP. The S.O. for the operation is Dr. M. A. Reynolds.

John O. Annexstad

Enclosure

TL4/JOAnnexstad:cmg:1-4-73:3274

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO ATTN OF: TL4

January 4, 1973

MEMORANDUM

TO: TL/Mission Manager

FROM: TL4/M. A. Reynolds

SUBJECT: Refrigerated Samples

The following is the procedure that should be used for packaging of the refrigerated samples.

1. All lunar samples should be put into an FTH or bolt-top can as a primary container. These should be then triple-bagged in heat sealed teflon bags cleaned to CP-7 of MSC-02343.

2. These containers should be then placed into an approved refrigerated sample container. These containers should be also triple-bagged with teflon cleaned to CP-7 of MSC-02343.

3. These containers should be then placed into a protective outer stainless steel, aluminum or polystryene container.

In addition, each sample should also have as part of its data pack a form indicating the original time of refrigeration, and a record of any time outside the deep freeze. An example of a form is attached.

M. A. Reynolds

CONCURRENCE:

M. B. Duke, Lunar Sample Curator

cc:
TL/W.B. McCown
TL3/K. Suit
D. White
T. McPherson
TL4/R. Butler

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005571

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

C.O. 105

REPLY TO ATTN OF: TL4

January 19, 1973

MEMORANDUM

TO: TL/Mission Manager

FROM: TL4/Curator's Office

SUBJECT: Refrigeration of Apollo 17 Samples

The following samples are to be refrigerated according to the approved procedure.

1. 25 grams or 10% of total, whichever is less of Bag 500 - Station 2

2. 25 grams or 10% of total, whichever is less of 76240 Bag 312.

These samples should be taken prior to any process of the sample. Please complete this work ASAP. The S.O. for the operation is Dr. M.A. Reynolds.

Michael B. Duke

TL4/MBDuke:cmg:1-19-73:3274

NN

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION 005570
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO
ATTN OF: TL4

C.O. #1099

January 24, 1973

MEMORANDUM

TO: TL/Mission Manager

FROM: TL4/Curator's Office

SUBJECT: REFRIGERATION OF APOLLO 17 SAMPLES. MODIFICATION TO C.O. #1050

1. From sample 76240 (Bag 321), obtain a 25 gram sample from sample 76240,1 (Reserve). Refrigerate according to approved procedures.

2. Process DB 500 (temporarily in the computer, unsorted, as sample 72320). S.O. and alternate for this operation are McKay/Clanton.

Sort the material according to Sample Processing Procedure SP-3 with the following special instructions:

a. Take a reserve of 25 grams of the unsorted material. This sample is to be transferred for refrigeration according to approved procedures.

b. If the above reserve is less than a normal reserve would be, take an additional reserve to take up the difference. Package per procedures.

R. B. Laughon
Associate Curator

UNITED STATES GOVERNMENT

KSOL
NNPL

Co # 1425

2-Way Memo

Subject: Transfer 72375

DATE OF MESSAGE 4/19/73

DATE OF REPLY

INSTRUCTIONS
Use routing symbols whenever possible.
SENDER:
Forward original and one copy.
Conserve space.
RECEIVER:
Reply below the message, keep one copy, return one copy.

To: → TL/Mission Manager

—FOLD—

USE BRIEF, INFORMAL LANGUAGE

Please transfer sample 72375 from freezer storage to NNPL for ~~[illegible]~~ in preparation for boulder excavation work. Priority immediate. Reference the attached procedure for this work. Sample is not to be returned to the freezer.
MBRD

Completed
4/26/73
0900

OK
J. Townsend

TL4/J. Arnoldstad

5027 – 102

1. TO BE RETAINED BY ADDRESSEE

OPTIONAL FORM 27
OCTOBER 1962
GSA FPMR (41 CFR) 101 – 11.6

Procedure for Removing Samples
From Freezer and Transfer to Nitrogen Cabinet

1. Samples in the freezer are packaged in bolt top cans protected by three layers of heat-sealed teflon bags. Within the bolt top can, samples are sealed with three layers of protection, generally, a hard container and two teflon bags.

2. To guard against potential contamination of the laboratory and the container, the following steps are to be taken to transfer the sample back to a working cabinet:

   a. Remove the container from the freezer and immediately place it in a zip top poly bag.

      Note: Handle the sample container with disposable nylon or poly gloves. Discard the gloves after use.

   b. On an adjacent work bench, slit the outermost teflon bag while retaining the first poly bag as a cover. With a clean pair of gloves, extract the container and unopened teflon bags, and place it in a second clean poly bag as a dust cover. Seal the original outer teflon bag in the first poly bag and dispose of the bags, transferring them outside of the laboratory immediately.

   c. Transfer the sample to the laboratory in which it will be processed and enter it according to standard transfer procedures.

      Note: For handling of cold storage samples, it is important that the samples be allowed to remain outside the freezer

60#1425

for the shortest possible time. Transfer should be arranged for a time when all systems are prepared to function for sample preparation. If samples are to be returned to the freezer, all operations should be scheduled for completion within one working day, including return to cold storage.

LOG? RSP?

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

CO# 1637

REPLY TO ATTN OF: TL

October 11, 1973

MEMORANDUM

MEMO #	
RECVD	10-12-73
TPS #	
COMP	7-25-74

TO: TL/W. A. Parkan

FROM: TL/Lunar Sample Curator

SUBJECT: Freezer Samples for Durrani

Please have two freezer samples prepared for Durrani:

72320,2	.25 g
76240,6	.5 g

These samples are contained in a bolt top can with other samples and it is important to return the samples to the freezer as rapidly as possible. Refer to C. O. # for procedure for repackaging parent sample and documentation of the temperature history.

Each split should be packaged in an FTH container. The container should be immobilized in an aluminum can and doubly sealed in teflon bags. The split should then be transferred back to the freezer for storage until transport to the PI is available.

It is important to keep small the time that the samples are above 0°C. I recommend that the parent sample be transferred to a nitrogen cabinet airlock as soon as visible frost on the outside bag has disappeared. The readiness of the cabinet to do the preparation should be double checked before removing samples from the freezer. Work should proceed continuously, once it has started.

The samples will be transferred cold using dry ice in an insulated container. We should acquire a suitable container (small dewar?) and test its ability to hold dry ice for a period of 24 hours, which is the maximum transit time we will allow. When we have a satisfactory container and have made appropriate travel arrangements, we will transfer the samples to Durrani.

Michael B. Duke

- - U.S.-6

The University of Birmingham

DEPARTMENT OF PHYSICS
Chancellor's Court, The University of Birmingham, P.O. Box 363, Birmingham B15 2TT
Telephone 021-472 1301

SAD/EAS

11th January 1979

Dr. John O. Annexstad
Secretary - Meteorite Working Group
Johnson Space Center
Houston, Texas 77058
U.S.A.

Dear Dr. Annexstad,

The Antaractic Meteorites

Thank you very much for your letter of 11th October 1978, and the accompanying list of samples. Since then, these samples have been received by Drs. Sears and Bull of my group. Actually, it might have been administratively more convenient if you had, in the first instance, allocated all the Antarctic Meteorite samples in my name as Group Leader. I would, then, have allocated the necessary portions to Drs. Sears and Bull (both of whom are working as Research Fellows under my general direction). Your present procedure of formal internal transfer is somewhat unnecessarily complicated! If you send us any further samples, please allocate them to me as the Principal Investigator.

In addition, I also wonder what action your Meteorite Working Group is proposing to take on my original request (04) dated 31st August 1977 (and repeated in my letter to you dated 19th July 1978) for some samples which have been kept specially deep-forzen for TL studies. These would be particularly interesting to us in order to compare their low-temperature thermoluminescence (TL) glow with TL from other portions of the same meteorites kept by you at room temperature. In the case of both Apollo shaded samples and Luna-24 drill core samples, we observed marked differences between the deep-frozen and room-temperature counterparts. One way to send these deep-frozen samples to England would be for one of the British Lunar PI's attending the Lunar Science Conference at JSC, Houston in March, to bring back these samples in a CO_2 - snow package (as I did in 1974 for the Apollo deep-frozen material). Please let me know how you feel about this question.

With best wishes for the New Year.

Yours sincerely,

S.A. Durrani

.25

84-095

DEPARTMENT OF CHEMISTRY
Chemistry Building
Fayetteville, Arkansas 72701
(501) 575-4601

UNIVERSITY OF ARKANSAS · College of Arts and Sciences

U.S. Gov't

February 29, 1984

370

Sears

Dr. John O. Annexstad
Secretary, Meteorite Working Group
Lyndon B. Johnson Space Center
Houston, TX 77058

Dear John:

Further to Mike Lipschutz's letter to you concerning RKPA80213 I would like to request samples of this meteorite for thermoluminescence measurements, taken adjacent to those you send Mike. We have found that the dark matrix of regolith breccias has a TL sensitivity a factor of 2-3 lower than the light clasts, but are unclear as yet whether this is because the matrix contains 50 - 70% unequilibrated material or 50-70% shocked material. A collorative study on this and other regolith breccias might shed some light on the problem (pun intended!). To avoid a possible complication due to albedo differences, we propose to use a relatively sophisticated sample preparation procedure (acid-washing and fine-grained, $\lesssim$ 10 μm, desk preparation) and will require 100-200 mg samples. They should be relatively unweathered, crust-free material. There is no need for any other special handling precautions (working in darkened rooms at sub-zero temperatures etc.).

Best wishes.

Sincerely,

Derek Sears

DS/jc
cc: Professor M.E. Lipschutz

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