

PLANETARY MATERIALS BRANCH
SAMPLE PROCESSING PROCEDURE

Date: May 4, 1987

SPP 70

DRIVE TUBE EXTRUSION AND CROSS DISSECTION OF UPPER 5 MM

1 INTRODUCTION

This procedure outlines the steps needed to extrude lunar soil from a large diameter drive tube into a receptacle in which the core can be dissected (as described in SPP 71).

Much of this procedure concerns assembly and manipulation of the large number of specially constructed tools and devices needed for extrusion. Another portion covers preparation and handling of the core tube.

If the core contains undisturbed material from the lunar surface it may be desirable to dissect the top-most 1/2 to 1 cm millimeter by millimeter by slicing across the whole diameter of the core. This sub-procedure may be specified only by Curatorial Order and is done by extruding 1/2 to 1 cm into a special cross-dissection receptacle. When the cross dissection has been completed, the rest of the core is extruded into the horizontal receptacle for the normal dissection.

The extrusion device is shown in Appendix A. While the core is clamped in a holder, a ram head is attached to the bottom end of the core after uncapping it and other restraining fixtures are added. Then by turning a capstan that advances the ram, the core is extruded out of the top of the core tube, which is a continuation of the direction of movement by which the core material entered the tube when collected. The mechanical advantage of the capstan-driven screw combination is 117 to 1; one full turn of the capstan advances the ram 5 mm (0.20 inches).

Once started the core extrusion is done slowly with the lightest touch possible to keep the advance rate somewhat below 1 mm/second. Because starting friction is probably significantly greater than sliding friction, movement is kept continuous though slow unless an abrupt change in resistance is felt (though the change may be slight). When such a change is felt, the advance is halted for investigation, and not restarted until everyone present agrees that the extrusion should be continued.

Throughout this procedure the processor records the condition and description of the lunar soil and measures the core length before and after extrusion.

2 RESPONSIBILITY

2.1 The Lunar Sample Curator must be present for all steps that involve moving core material, either in bulk, the core tube receptacle, or in extruding or cross-dissecting core materials. These operations are covered in Sections 6.4, 6.5, and 6.6.

2.2 The extrusion and dissection of a specific core, is the responsibility of a single core team member, whose designation will be approved on the Curatorial Order that authorizes the extrusion. No one else should enter the processing cabinet without the specific consent of that core team member except in emergencies with the

supervisors consent. Except as explicitly stated, a single core processor is responsible for all steps of this procedure. (As in the case of all sample operations, however, anyone perceiving a problem can order the operation to halt.)

2.3 A second core processor shall assist in placing the core in the extruder, installing clamps, and as directed by the core team member in charge of the extrusion. A third person shall read the procedure and annotate the procedure to reflect actual circumstances (the Lunar Sample Curator may serve in this capacity).

2.4 It is the responsibility of the core processor to propose modifications to this procedure for incorporation into a Curatorial Order when the condition of the core requires it. For example, cores with large void spaces should not be turned up on end until slumping can be minimized.

3 SAFETY

No specific CAUTIONS are incorporated; however, take common sense care in all actions.

4 DEFINITIONS

Flight hardware - all parts of the core tube that have been to the moon.

5 EQUIPMENT AND SUPPLIES

Fit checking of assembled tools is especially important since the fit tolerance on the hardware is close, and after extrusion begins no alteration or changing of equipment is possible. Where possible under procedural constraints, assembly and fit checking should be done and documented before items are cleaned.

Hardware required for processing one core is listed below. All equipment which can withstand acid washing should be so cleaned. Items marked by an asterisk are required only when optional cross dissection operation is done.

<u>Description</u>	<u>Quantity</u>	<u>P/N</u>
Attachment Assy., 5 mm (W/Ring Layer) (set of Screws)	1	SEZ 36112704-301
Bags, Teflon 5 Mil	Asst.	N/A
Balance, Mettler 200	1	N/A
Balance, Mettler 8000	1	N/A-Used outside of cabinet
Base Plate Assy. (W/3 screws)	1	SDZ 36112003-301
Brush, Teflon, 3/8" x 7"	1	SC-034
Brush, Teflon, Artist	1	PC-075
Brush, Teflon, Floor	1	PC-049
Cap Remover, Drive Tube	1	SDZ 36112664-001
Cart for Receptacle	1	SDZ 36111357-301 (Tray)

*Collector Assy. (W/Cont. Holder)	1	SDZ 36112700-301
Color Chart (bagged in nylon)	1	N/A
Containers (FTH #9, salve can, #251 Sliptop-2)	Asst.	N/A
*Cover, Sample	1	SDZ 36112715-001
Dust Pan	1	N/A
Extensions, Ram	5-6	SDZ 36112663-001 (Shortest)
Extruder (clamp teeth for upper & lower drive tubes are different)	1	SDZ 36105790-302 (Liner Extractor Assy)
Foil, Aluminum, 4 Mil	Var.	N/A
Follower Assy.	1	SDZ 36111354-301
Follower Receptacle Clamp (slotted, w/2 screws)	1	SDZ 36111356-301 (Clamp Assy.)
Follower Split Clamp (with 2 screws)	1	SDZ 36112710-301 (Split End Assy)
Forceps, Brookstone 10	3	SC-001 or equal
*Funnel Assy. (offset)	5	SDZ 36113173-301
Guard Assy. (w/1 screw)	2	SDZ 36111352-301
Heat Sealer	1	N/A
Keeper Remover Assy.1 (long or short)	1	SDZ 36111358-301 or 302
Lead Screw Ram	1	SDZ 36105381-302 (Ram Assy., Core Tube)
Monopole Camera & Stand	1	N/A
Photo Scales	2	SDZ 36114127
Quartz Top (must match receptacle)	1	SDZ 36112000-001
Ram Receptacle Clamp (w/pins, 2 screws are required, extra 6-32 .312 inch screws are recommended)	1	SDZ 36111356-301 (Clamp Assy.)
Ram Collar Clamp (w/Ferule and ring)	1	SDZ 36111984-301
Ram Head (long or short)	1	SDZ 36111350-001 or 002
Receptacle Assy. (w/screws, pins, and washers)	1	SEZ 36111999-301
`Rocket Launcher' Core Holder and Base (w/4 bolts)	1	SEZ 36111985-301 (Stand Assy, Drive Tube)
	1	SEZ 36112880-301 (Platform Assy)
`Rocket Launcher' Tool Tray	1	SDZ 36113324-301 (Tray Assy Tool)
Rod, Locking	1	SDZ 36112493--002
Scissors	1	
*Scoop, Core (small)	1	SDZ 36112706-003
*Scoop, Core (medium)	1	SDZ 36112706-002
*Scoop, Core (large)	1	SDZ 36112706-001
*Scoop, Long-Handle (small)	1	SDZ 36112707-003

*Scoop, Long-Handle (medium)	1	SDZ 36112707-002
*Scoop, Long-Handle (large)	1	SDZ 36112707-001
Scale, Metric	1	SL-063 or equal
*Scraper, (notched)	1	SDZ 36112708-001
Screwdriver Kit Assy.	1	SDZ 36113529-301
Support block for lead screw	1	N/A
Table for Receptacle (w/pins)	1	SEZ 36112879-301 (Stand Assy.Fixed Core)
Teflon blocks for simulated core		
Tension Fixture Assy. (w/2 bolts, 3 rods, 14 nuts)	1	SDZ 36113523-301
Tool Tray	3	PC-072 or equal
Turnbuckle (one of each of of 3 sizes)	3	SDZ 36111355-001 to 003
Wrench, Open End 3/8	1	SDZ 36113284-001
Wrench, Open End 7/16	2	SDZ 36113284-002
Wrench, Open End 1/2	1	SDZ 36113284-003
Wrench, Open End 3/4	1	SDZ 36113284-007
Wrench, Allen L-shaped 7/64	1	SDZ 36108813-001

6 PROCEDURE

6.1 PREPARATIONS

Verify that the cabinet is clean to CP-1 and insert verification document in F-4 section of data pack.

6.2 LOADING OF EQUIPMENT IN CABINET

6.2.1 Load the Baseplate, the Lead Screw Ram, and the Extruder prior to loading any other equipment following the steps below.

6.2.2 Assure that the correct equipment is properly positioned for loading. The baseplate should be inserted track end first or so that the clamps on the extruder will face the operator.

6.2.3 Load baseplate according to the LOP 38 provision for items too long for the air lock chamber which includes removing the cabinet from the monitor.

6.2.4 Load remaining equipment and position in cabinet as shown in Figure 1.

6.3 ASSEMBLY AND FIT CHECK

6.3.1 Unbag all equipment.

6.3.2 Assure that the Receptacle is properly assembled and that the counterbore ends are mated and that the Quartz Top fits. Also fit check Follower and Ram in bore hole. The Cart for Receptacle is correctly

assembled when the two teflon washers are on the wheels toward the operator.

- 6.3.3 Place the receptacle in the cart. (The counterbore end of the receptacle should be at the end of the cart which connects to the tension fixture end plate.) On the end of the cart away from the extruder install the bottom half of the slotted Follower Receptacle Clamp, and lower it to lock the receptacle in the cart. Set this unit aside in the corner most distant from the airlock door which should provide a safe area to protect the quartz top.
- 6.3.4 Place the extruder over the three screw holes in the baseplate and install screws.
- 6.3.5 Practice the installation of the Ram Receptacle Clamp on the counterbore end of the receptacle per steps 6.6.11. Good coordination of the two persons involved should be achieved. To accomplish this step, it will be necessary to temporarily install the tension fixture plates and attach the cart by the two bolts. Remove tension fixture and the two bolts when this step is completed.
- 6.3.6 Install the lead screw ram into the extruder.
- 6.3.7 Install 'Rocket Launcher' Core Holder to its base using four bolts. If the cross-dissection is to be done, install the 'Rocket Launcher' Tool Tray on the base as shown in Figure 2 and cover with Al foil.
- 6.3.8 Adjust the 'rocket launcher' to a 45° position and install the locking rod. Test configuration for strength.
- 6.3.9 Rehearse extrusion using teflon bars of appropriate length to simulate core soil. This practice should verify that all processors work together and that correct lengths for follower turnbuckles are used.

6.4 PREPARATION OF CORE TUBE AND PLACEMENT IN EXTRUDER

- 6.4.1 Weigh core in bags on Mettler 8000.
- 6.4.2 Transfer core into cabinet, remove bags, and transfer bag out to weigh on Mettler 8000. Record weight on F-6. Approval is needed on the F-6 to continue with procedure whether or not the weight is in balance.
- 6.4.3 Remove the pull ring from the drive tube, (if installed). Place in flight hardware tray or bag. (Flight hardware should be kept together, since by the time the procedure is completed, serial numbers and weights must be recorded.)

- 6.4.4 Place the drive tube with the bottom up on the 'rocket launcher'. Clamp the drive tube in the stand. Rotate rocket launcher so that cap faces operator. Adjust feet to level.
- 6.4.5 Place foil under cap. Remove the drive tube cap, using the cap remover. Place the cap on foil.
- 6.4.6 Sketch or photograph and describe appearance of soil with regard to void space, fractures, etc.

- 6.4.7 Remove any lunar material which remains in the cap or that protrudes above the flush opening of the drive tube. Use core tube cap as catch pan. Place this material in a pre-weighed and serialized CP-4 clean #9 FTH container.

Record depth of soil from end of tube: _____

- 6.4.8 Install ferule and ring portions of the Ram Collar Clamp.
- 6.4.9 Install a ram head of appropriate length with bottom half of clamp (so load screw can be engaged). Add extensions if necessary as described in Section 6.5.5. Threaded portion of the ram head or extension should protrude above the ferule by a minimum of 2.1 cm. When using the medium or long ram head, the maximum should be 6.5 cm.
- 6.4.10 Install the remaining portion of the collar and tighten the two screws so that the halves are equally spaced and the number on the drive tube is facing the same direction as the screws. Move foil out of way.

Record:

threaded portion above ferule _____ cm

threaded portion outside clamp _____ cm

Rotate rocket launcher parallel to cabinet length. Adjust feet to level.

- 6.4.11 Following the five steps below, carefully invert the drive tube.
- a) Remove the retaining clamps.
 - b) Invert the drive tube.
 - c) Re-install the retaining clamps.
 - d) Rotate rocket launcher so top end may be observed. Adjust feet to level.
 - e) Install foil beneath top end.
- 6.4.12 Unscrew the core adapter and place in the 251 container. (The keeper may be inside the core adapter. If so, place the keeper in the 251 slip top container which is located in the flight hardware tray and continue with step 6.4.14). Describe configuration observed:

- 6.4.13 Visually inspect the keeper for any damage which may hamper its removal from the drive tube.
- 6.4.14 Remove any lunar material that could impede operations from the drive tube threads and shoulder and the top of the keeper.
- 6.4.15 Remove the keeper using the keeper removal tool of appropriate length. Follow the steps below.
- a) Loosen and remove the knurled nut and loosen the set screw, and remove the center housing.
 - b) Screw the adapting collar into the drive tube.
 - c) Insert the center housing through the adapting collar and into the drive tube.
 - d) Hook the remover to the keeper by rotating the center housing clockwise until resistance is felt.
 - e) Tighten the housing set screw.
 - f) Install and tighten the knurled nut.
 - g) Release the housing set screw.
 - h) Retract the housing and keeper away from the soil surface and hold in place.
 - i) Tighten the housing set screw.
 - j) Have the 251 slip-top container close to the drive tube in order to place the keeper into it without spilling soil. Unscrew the entire keeper remover from the drive tube being very careful not to cause soil or the keeper to fall back upon soil surface.
 - k) Separate the keeper from the remover by loosening the knurled nut. Place the keeper in the 251 slip-top container in the flight hardware tray or bag.
 - l) Put the keeper remover in the used hardware bag and store in a convenient place away from the operations.

6.4.16 Visually inspect the soil surface for irregularities and record observations:

6.4.17 Remove any lunar material from the drive tube threads and shoulder.

NOTE: If the cross dissection sub-procedure (5 mm dissection) is not specified by CO, remove the ring layers from the 5 mm extension before continuing with the next step.

6.4.18 Install the 5 mm attachment without the Follower Split Clamp.

6.4.19 Attach a turnbuckle to the follower. Make sure plate of follower is firmly screwed to teflon blades.

6.4.20 Insert the follower into the drive tube. Follower should protrude above 5 mm attachment no less than 1.0 cm and no more than 5.3 cm. these dimensions apply when the ram-soil interface is flush with the bottom of the tube, and the core is to be extruded so that the ram-soil interface is at the 0.0 cm mark in the receptacle.

Record the length of turnbuckle protruding above the 5 mm attachment
_____cm

NOTE: For conditions where ram-soil interface is not at the bottom of the tube, the soil will have to be extruded far enough into the receptacle to allow the turnbuckle to be clamped. The maximum length the turnbuckle can extend outside the receptacle after extrusion is 8.5 cm.

6.4.21 Sketch below is for reference only.

- 6.4.22 Attach the Follower Split Clamp, assuring that the screws are in the same orientation as those on the collar. Remove the foil catcher. Rotate rocket launcher parallel to cabinet length.
- 6.4.23 Use insert sketch for core length calculations. Record length of turnbuckle protruding from clamp: _____ cm
- 6.4.24 Move core receptacle off end of track as far as possible to give maximum clearance. Remove retaining clamps. The third person will move rocket launcher out of way as the core is removed from the rocket launcher and transferred to extruder..
- 6.4.25 Carefully install the drive tube in the extruder with assistance from second person to steady core and open clamps.
- 6.4.26 Clamp the drive tube in the extruder so that the collar butts up against the clamp fixture (but not so tightly that the collar cannot be removed and reinstalled), and the screws in the split end and collar are oriented upward.

6.5 OPTIONAL CROSS DISSECTION

NOTE: If the cross dissection procedure is not specified by CO, continue with step 6.6.

- 6.5.1 Engage the ram head into the lead screw. Set the brake.
- 6.5.2 Install the tension fixture end plate and rods over the 5 mm attachment. Place cap remover under tension fixture for height adjustment.
- 6.5.3 Release the clamps and remove the split clamp, then the collar. Release the brake.
- 6.5.4 Advance the ram until the turnbuckle/follower interface is flush with the opening of the 5 mm attachment barrel. (Take note if extensions to the ram head must be added before extruding too far or the collar cannot be replaced.) Set the brake.

Recalculate core length to determine amount of compression/compaction.

6.5.5 Ram Head Extension Sub-Procedure

NOTE: If extensions must be added to the ram head in order to achieve the desired extrusion of the 5 mm section, the following steps should be followed; if none are necessary continue with step 6.5.6.

- a) Clamp the drive tube in the extruder using the "upper" clamp only.

- b) Set the brake.
 - c) Attach the collar.
 - d) Release the brake.
 - e) Retract the lead screw.
 - f) Add an extension.
 - g) Engage the lead screw.
 - h) Set the brake.
 - i) Remove the collar.
 - j) Release the clamp.
 - k) Release the brake.
 - l) Repeat as often as necessary to achieve the desired extrusion.
- 6.5.6 Replace the follower split clamp and the ram collar. Retighten the clamps on the extruder. Release the brake.
- 6.5.7 Disengage the lead screw from the ram head.
- 6.5.8 Remove the tension fixture end plate from the 5 mm attachment.
- 6.5.9 Release the extruder clamps and remove the drive tube from the extruder.
- 6.5.10 Place the drive tube with the 5 mm attachment upward in the 'rocket launcher' (assure the stand is at 60°).
- 6.5.11 Install and secure the retainer clamps and adjust the stand to the vertical position. Rearrange the 'rocket launcher' and extruder so as to bring the 'rocket launcher' close to the operator. (It may be necessary to remove lead screw ram.)
- 6.5.12 Install the collector below the flange and facing 180° from the screw orientation of the 5 mm attachment flange. The screws on the collector should be on the opposite side from the number on the core tube.
- 6.5.13 Loosen and remove the three screws retaining the upper barrel portion of the 5 mm attachment.

- 6.5.14 Remove as a unit, the split clamp and barrel with follower and turnbuckle and place in a clean teflon bag, temporarily. Remove the foil covering on the tool tray, then put the dissection tools on the tool tray.
- 6.5.15 Remove the top 1 mm layer plate using the scraper and tweezers. Carefully dust the plate and place it in the teflon bag reserved for 5 mm dissection attachment parts.
- 6.5.16 Install the sample cover in the same orientation as the collector, so that the tapped holes are exposed.
- 6.5.17 Install the longest screws. Install a preweighed, numerically identified FTH container and the offset funnel into the collector.
- 6.5.18 Remove the sample cover and store with the open side upward in the hardware tray until needed again.
- 6.5.19 Describe and photograph soil surface.
- 6.5.20 Holding an appropriate tool flat against the 5 mm attachment ring and working from the perimeter inward, remove the soil protruding above the tube opening and sieve the soil through the funnel into the FTH container. Record observations pertaining to the soil removed. As it becomes necessary to clear the funnel sieve, place the coarse particles collected in a separate pre-weighed container. Place the >1 mm fragments in a separate, preweighed numerically identified FTH container. Set aside soil containers for later weighing.
- 6.5.21 Distinctive objects that merit special attention, such as large rock fragments that span several dissection intervals, unusual soil formations, etc., should be dissected around, cleaned off as much as possible without disturbance, stereophotographed in polaroid and cut film, and special sample numbers assigned before the objects are removed for packaging in individual, pre-weighed FTH containers. Set aside sample containers for later weighing. When removing or installing screws, first install the sample cover. Screws for each layer ring have a specific length and should be handled using the screw holder.
- 6.5.22 Repeat steps 6.5.15 to 6.5.21 being sure to dedust the sample cover each time. Place all used funnels in the bag containing the removed 5 mm dissection layer plates.
- 6.5.23 The descriptions of the soil and the fragments as well as sample weight, container identification and weight should be recorded in the manner described for samples created in the standard dissection (SPP 71). This includes classifying and weighing individual fragments as described in SPP 71. The samples created during this cross dissection will be included on the F-6 form generated for the first dissection.

- 6.5.24 Reinstall, after complete dusting, the unit removed in step 6.5.14 using the second shortest screws. Any material removed should be put with the cabinet sweepings. Put the dissection tools back in their tray.
- 6.5.25 Remove the collector. Rearrange the position of the 'rocket launcher' and extruder. (Reinstall lead screw ram, if removed previously.)
- 6.5.26 Adjust the stand to the 60° position and release the clamps.
- 6.5.27 Remove the drive tube from the stand and place in the extruder so that the collar butts up against the clamp fixture and the screws in the split clamp are oriented. Secure the drive tube with the clamps.

6.6 COMPLETION OF EXTRUDING OF SOIL INTO DISSECTION RECEPTACLE

- 6.6.1 Engage the ram head into the lead screw. Set the brake.
- 6.6.2 Install the tension fixture end plate over the 5 mm attachment. Make sure the tension fixture plates are parallel and nuts on rod are tight.
- 6.6.3 Release the holding clamps.
- 6.6.4 Remove the split clamp and position the cart. The bolts for connecting the cart to the tension fixture should not yet be installed.
- 6.6.5 Advance the cart toward the extruder. (Line up the drive tube with the receptacle counterbore.) Lift tension rod to ease 5 mm attachment into bore fixture. Connect the cart to the tension fixture end plate using the two bolts. Secure and check for proper fit. Finger tighten nuts and watch so that core is not backed away from plate.
- 6.6.6 Remove the collar and store in the used hardware bag. Release the brake. Extensions must be added if core is to be extruded past the 0.00 cm mark. If extensions are to be added, don't remove the collar at this time. See step 6.5.5.
- 6.6.7 Read entire step 6.6.6 before performing any part. Using only finger tips, turn the capstan (less than a quarter turn per second) in order to keep the rate of advance of the core below 1 mm/sec. (NOTE: One complete turn advances the core 5 mm; therefore, 1/4 turn will advance it 1-1/4 mm.) Stop if any change is detected. Restart the advance only after everyone present concurs.

NOTE: While extruding be watchful that the extruder end of the ram always protrudes at least 2 cm out of the counterbore of the receptacle. If it is less than 2 cm, the Ram Receptacle Clamp cannot be engaged or the extruder safely disengaged.

At the same time keep in mind that when the core has been extruded, the follower turnbuckle should protrude out of the receptacle at least 1 cm but not more than 8.5 cm (so that the clamp and guard can be installed later).

Continue until the core is completely extruded and the interface of the core and the ram head are at the "0" (zero) mark on the dimensioned receptacle.

- 6.6.8 Set the brake.
- 6.6.9 Raise the bottom half of the Follower Receptacle Clamp into holding position and tighten screws.
- 6.6.10 Install the top half of the clamp.
- 6.6.11 Install the guard. Retract the empty drive tube to the maximum extent allowable. Support the tension fixture before pulling 5 mm attachment out of counterbore.
- 6.6.12 Install the bottom half of the Ram Receptacle Clamp to the lower end of the receptacle. A second person, in the gloves opposite the principal operator, will hold the clamp and screw in place with long tweezers while the screws are being tightened. Insert the screws through the holes in the tension fixture end plate.
- 6.6.13 Install the upper half of the clamp. Release the brake.
- 6.6.14 Retract the extruder, and slide tube away from capstan. The extruder lead screw can then be brushed off to remove any lunar dust which might come into contact with and foul the extruder bearings.
- 6.6.15 Remove the two bolts attaching the cart to the extruder and back the cart to the end of the track.
- 6.6.16 Remove the tension fixture rods and front tension plate.
- 6.6.17 Remove the 5 mm attachment from the extruder and catch any dirt with foil.
- 6.6.18 Install the guard.
- 6.6.19 Carefully transfer the receptacle from the cart onto the Table for Receptacle. Place table away from disassembly activities to protect core and quartz top.
- 6.6.20 Remove the drive tube and disassemble the extruder and transfer along with the cart and all unnecessary tools to the airlock to be removed. Record the weight and serial number of all pieces of flight hardware

after removing as much lunar materials as possible. FLIGHT
HARDWARE SHOULD BE GIVEN TO THE PERSON WHO IS THE
CUSTODIAN OF FLIGHT HARDWARE.

- 6.6.21 Transfer out all hardware which is not necessary for the dissection procedure. Only the base plate should remain in the cabinet. Assemblies should be reassembled.
- 6.6.22 Clean the cabinet by sweeping to recover any spilled sample. Place sweepings in an identified, pre-weighed container to be weighed at a later time when all dissections are completed.

NSI Laboratory Manager

Chief, Planetary Materials Branch

Contamination Control Officer

This procedure replaces the 1/10/80 version.

This procedure takes effect on the date of the last signature.

The term of the procedure is indefinite.