

1/11/06

CURATORIAL BRANCH
SAMPLE PROCESSING PROCEDURE

DATE: October 2, 1980

SPP 79

X-RADIOGRAPHING LARGE DIAMETER
DRIVE TUBE CORES

1 INTRODUCTION

X-radiographs provide primary scientific data on lunar core composition and structure which cannot be preserved any other way. In addition, the x-radiograph provides information on the condition of the core, such as evidence of slumping or settling, which is required in planning the extrusion and the dissection. The compositional and structural data is also used in making the dissection plan. This procedure details the steps required to produce a stereoc pair of x-radiographs for each of 2 orthogonal views for large diameter drive tubes. An earlier series of x-rays were taken of the cores using medical x-ray equipment. If these x-rays are not of good quality, new ones should be taken following this procedure. This procedure, which uses industrial x-ray equipment, finer grain film, and custom plate to compensate for differences in x-ray density due to curvature of the tube, has improved resolution. In taking x-rays the core is subjected to the movement of being bagged, transferred to and from the x-ray site, and rotated 90°. It is also subjected to possible contamination resulting from being taken out of nitrogen or clean room conditions into areas where some lead is present.

These steps covered in this procedure include:

- 1.1 Cleaning of room and equipment to be used.
- 1.2 Set-up of x-ray equipment. JSC Radiological Health Unit will survey and cordon off hazardous areas.
- 1.3 Preparation of core for transfer to x-ray site.
- 1.4 Placement of core in x-ray fixture and transfer.
- 1.5 Details of exposure time and film processing are given in a procedure written by and for the x-ray technicians of the Materials Technology Branch who do the actual exposures.

- 1.6 Transfer of core back into Pristine Laboratory or Vault.

2 RESPONSIBILITY

- 2.1 The Area Technical Monitor is responsible for scheduling use of work area and the services of the Materials Technology Branch x-ray technicians and the Radiological Health Unit.
- 2.2 Radiological Health Unit is responsible for seeing that the performance of this procedure poses no health hazards.
- 2.3 Materials Technology Branch is responsible for setting up their equipment, making the x-ray exposures, and processing the film.
- 2.4 Curatorial Operations is responsible for installing the cooling water line, cleaning the work area, and wiping down the x-ray equipment.
- 2.5 The Curator must be present and give approval each time the core is picked up and moved when outside of a processing cabinet.
- 2.6 All handling of the core is to be done by a core processor. When the core is outside of a secure area (the Pristine Lab), the core person will watch the core at all times except during actual x-ray exposure when he will monitor the access to the core from the hall.

3 SAFETY

JSC Radiological Health Unit must approve the set-up and cordon off the hazardous areas each time this procedure is undertaken. A CAUTION note precedes step 6.3.2.

4 DEFINITIONS - NOT APPLICABLE

5 EQUIPMENT AND SUPPLIES

X-ray fixture	1	SEZ 36115197-301
X-ray density compensation plate	1	SEZ 36115196-001 through -006
Holding rack	1	
Film holder	1	
Table, stable, approximately 37" high	1	

Following equipment to be provided by the Materials Technology Branch:

Industrial x-ray source
X-ray film 13"x7"

6 PROCEDURE

6.1 Preparations

- 6.1.1 Clean the work area by removing clutter. Dry mop the floor. Install cooling water supply and drain line by running 1/2" Tygon tubing from Room 1104 (Normal Mechanical Room) water faucet through pass-through pipe in wall to Room 1107A. Return drain line by same route to drain grate on floor of 1104.
- 6.1.2 Locate the tools listed in step 5.1 and make sure they are in working order. Select the proper x-ray density compensation plate based on core density. Table 1 shows the table of core sample numbers and the proper compensation plate for each as determined by Dr. Jim Keith. Install the compensator plate into the fixture.
- 6.1.3 Vacuum and freon wipe this equipment. Have Materials Technology Branch off load their x-ray equipment into the high bay area before it is brought into Building 31A. Furnish a clean cart to transport the equipment into the building. These instruments are used and stored around large quantities of lead; therefore, it is critical to remove as many particles as possible before bringing the equipment into

31A. Check to see that no sheets of lead or a lead lettering set is brought into the building.

- 6.1.4 Set up the x-ray equipment and core fixture in holding rack as shown in Fig. 1. Note proper orientation of compensator plate that corresponds to configuration of x-ray equipment. This is shown in Fig. 2.
 - 6.1.5 Radiological Health Unit must check out set-up, cordon off hazardous areas, and give approval to continue.
 - 6.1.6 The core should be enclosed in 2 close-fitting 2 mil teflon bags and 1 outer, close-fitting nylon bag. If the core is not so bagged, transfer the core to a processing cabinet and rebag properly. Save any loose soil in the old bag and place in FTH. Clearly note the serial number of the container and the estimated sample weight on the F-4.
 - 6.1.7 Set up a clean, polyethylene covered table in Room 2102S near the door to Room 2103 (Transfer Room). Move the core fixture to this table. Clamps on fixture should be open and ready to receive core. Right-hand clamp should be rotated out of position. Entire fixture should be elevated at both ends by the amount of 1 inch in order to facilitate installation of compensator plate. Blocks will be placed under the fixture to raise the fixture to provide the required 1 inch clearance.
- 6.2 Transfer of core to x-ray work area
- 6.2.1 Transfer core to table in Room 2102S via Room 2103. Place drive tube in fixture with the bottom or cap end in the left clamp. Swing the right clamp over the top or flight adapter end. Drive tube should be oriented so that tube number is upward.

- 6.2.2 Secure clamps on both ends of fixture with knurled thumb screws.
 - 6.2.3 Install compensator plate in the correct orientation (see section 6.1.4 and Fig. 2) and fasten securely.
 - 6.2.4 Core in fixture is to be hand carried to Room 1107A. Core handler is to be escorted by 2 persons, one leading and one following, who will assure that personnel and objects are kept free of the transfer route. Document transfer on F-4.
 - 6.2.5 Place fixture in holding rack oriented so that compensator plate is toward x-ray source. Secure in place with thumb screw at both ends.
- 6.3 X-ray exposure and film development
- 6.3.1 Label x-ray film according to Fig. 1. Label the first stereo pair taken, in which the tube number faces upward, as ST1.
 - 6.3.2 X-ray technician will install the 2 films in the film holder and core member will install holder onto the fixture. Two copies of x-radiograph will be obtained by using 2 films.
- CAUTION
- Before any x-rays are emitted, the area must be inspected by the Radiological Health personnel and their recommended precautions must be taken.
- 6.3.3 Take x-radiograph. The flux and exposure time are prescribed in the Materials Technology Branch procedure.
 - 6.3.4 Core member will remove film holder from core. X-ray technicians will take film to Building 13 and develop it. Take additional

exposures if necessary to obtain satisfactory quality.

- 6.3.5 After a satisfactory x-radiograph has been made, reset the x-ray source to take the other half of the stereo pair. Remove the compensator plate, invert orientation to meet requirements for stereo view. (See Fig. 2) and reinstall plate.
- 6.3.6 Produce another x-radiograph according to steps 6.1.1 to 6.3.4.
- 6.3.7 After both views of the ST1 stereo pair have been taken, the Curator will review the x-rays to determine if disturbance to soil from rotating the tube would be significant enough to avoid taking the second pair of x-radiographs. If approval to continue is given, remove the compensator plate and rotate the core 90° so that tube number is toward x-ray source. Re-install compensator plate in same orientation as when removed (then x-ray source will not have to be moved). The stereo pair taken with the tube in this position will be labeled ST2.
- 6.3.8 Label the film according to Fig. 1.
- 6.3.9 Perform steps 6.3.2 through 6.3.6 to obtain both views of the ST2 stereo pair.
- 6.4 Return of the core to Pristine Laboratory
 - 6.4.1 Do not return core to Pristine Laboratory until all x-radiographs have been ascertained as being of good quality.
 - 6.4.2 Remove fixture from holding rack and hand carry the core in the fixture back to the table in Room 2102S. Two escorts, one leading and one following, shall clear the path.
 - 6.4.3 Since the fixture and outer bag on the core have been in a dirty environment and may have been exposed to lead, be sure the table

is covered with plastic before placing the fixture on the table away from the transfer door.

- 6.4.4 Remove the core from the fixture and place on the table.
- 6.4.5 Keeping in mind the potential contamination of the outer bag, carefully cut off bag. A second person with clean gloves should remove the core from the bag and transfer it to the storage or processing cabinet where another bag will be cut off prior to placement in airlock.
- 6.4.6 If the soil from the original bag has been placed in a separate container, seal this soil in bag with core before returning to storage.

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Ch. Shi 10/c/80

NSI Laboratory Manager

Patrick Butler Jr 10/7/80

Lunar Sample Curator

3/12/80 Version Signed by D.P. Blanchard
Contamination Control Officer

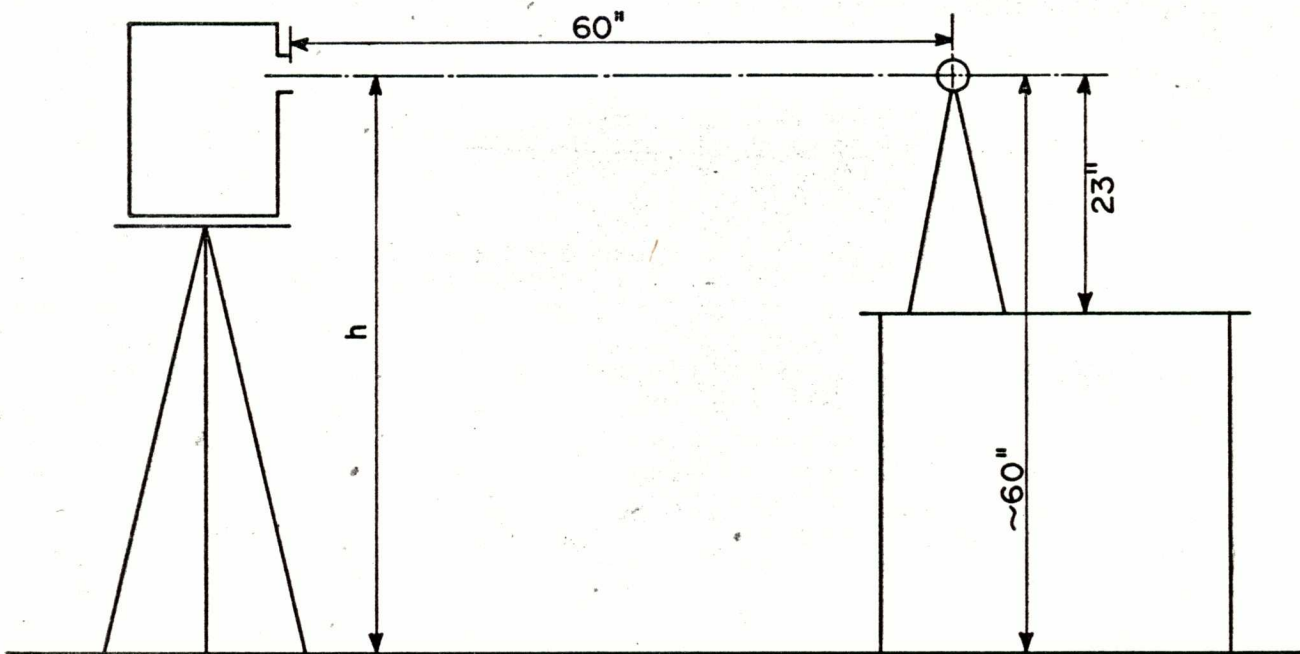
3/12/80 Version Signed by A.W. Orsak, Radiological Safety Officer
NASA Safety

This procedure replaces the 3/12/80 version of SPP 79. The revisions made do not affect SAFETY or CONTAMINATION CONTROL; therefore, their signatures are not required for approval of this version per MP 90, Step 6.7.

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

The term of the procedure is indefinite.

Figure 1
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$h = 66\frac{1}{2}$ " STIL or ST2L

$h = 53\frac{1}{2}$ " STIR or ST2R

ST1 when numerals on core tube face upward
ST2 when numerals on core tube face x-ray source

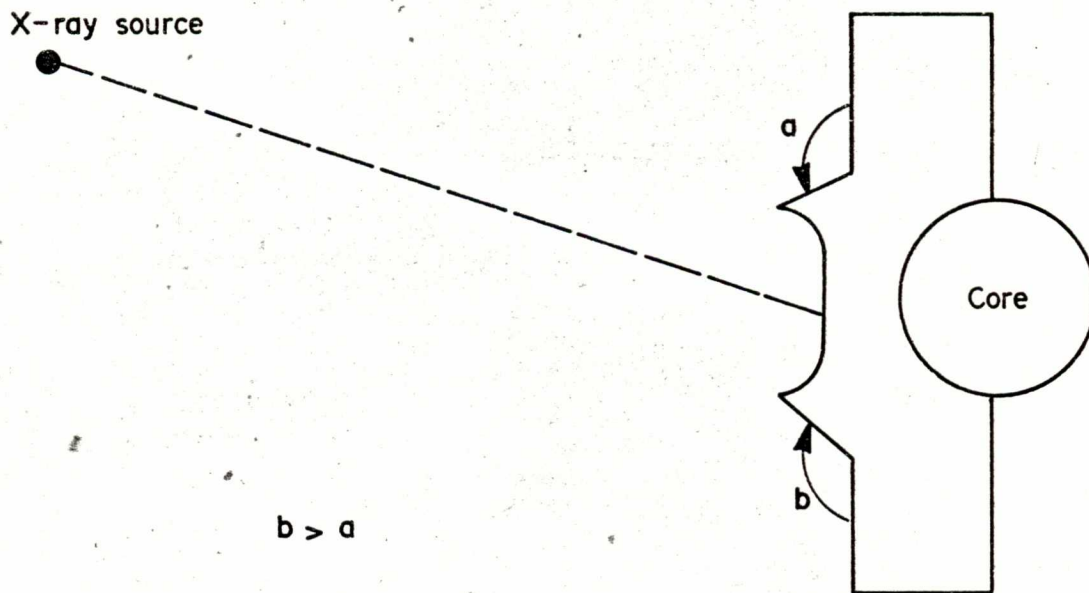


Fig. 2
Orientation of compensator plate with respect to x-ray source.

LUNAR CORE X-RAY PROCEDURE
(NASA X-radiography Lab Machine Operation Procedure)

NOTE

Do not bring unnecessary lead into Building 31A. Unload equipment in Building 31 Hi-Bay for cleaning before entry into Building 31A.

- 1 Regulate film processing water temperature 68° before leaving Building 13.
- 2 Close off Visitors Room on 1st floor.
- 3 Insure proper alignment of x-ray tube and empty core tube holder.
 - a. Height as measured from floor to x-ray beam center and empty core tube holder center are to be equal.
 - b. Distance from x-ray source to parting line of empty core tube holder equal to 60 inches.
 - c. Visually align x-ray tube so that central x-ray beam is perpendicular to front of empty tube holder.
 - d. Raise x-ray tube 6 1/2" above center position.
 - e. Grease-pencil mark table legs, empty core tube holder base, and x-ray tripod legs.
- 4 Turn water on and check for leaks.
- 5 Insert 2 films (ready pack unleaded Kodak type M) in film holder and give to curator core member for placement in holder. Identify film by using tungsten letters. Do not bring lead letters into Building 31A. Use 13" x 7" film.
- 6 Check core tube holder for proper identification and film holder placement.
- 7 Clear area of personnel.
- 8 Station monitor to roped off area.

- 9 Insert control panel interlock and turn on control panel. Begin x-ray exposure and adjust to 130 Kilovolt and 4 milliamperes.
- 10 Time of exposure.
 - a. Core tube 74001 and 74002 - 35 minutes.
 - b. All others - about 13 minutes (a 13 minute exposure for 64001/2 was too dark).
- 11 Turn off machine, remove interlock.
- 12 Have curator core member retrieve film.
- 13 Turn off water to tube head.
- 14 Return to Building 13 and process film to insure proper film density.
 - a. Developer - 5 minutes
 - b. Short stop - 30 seconds
 - c. Water rinse - 5 seconds
 - d. Fixer - 20 minutes
 - e. Visual check film density
 - f. Water rinse - 60 minutes
 - g. Dry in forced air over - approximately 30 minutes
 - h. Trim corners
 - i. Package individually in film envelopes
 - j. Deliver to J. Townsend, Building 31
- 15 If film is not proper density return to Building 13 and repeat steps 3 through 13. Adjust time of exposure to get proper film density.
- 16 If film proper density, return to Building 31.

- 17 Check that x-ray tube and core tube holder align, by checking the grease-pencil mark.
- 18 Lower x-ray tube to 6 1/2 inches below center or 13 inches below upper position.
- 19 Repeat steps 4 through 11.
- 20 Repeat steps 5 through 11.
- 21 Raise x-ray tube to 6 1/2 inches above center or 13 inches above lower position.
- 22 Repeat steps 5 through 13.
- 23 Return equipment to Building 13.

COMPENSATOR PLATE SELECTION CHART

CORE	μ	PLATE P/N 36115196	f(o) thickness at midpoint (cm)
64002	.235		
15009	.239	not fabricated	.917
15008	.240		
76001	.263	-005	.624
68002	.269	-005	
79002	.281	-004	.468
64001	.281	-004	
15011	.312	-003	.113
15010	.342 (?)	-003	
15007		-001	
79001	-	-001	
All 16		-001	
74001	.397	-002	
74002	.397	-002	
Use not apparent		-006	1.25