UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Core Handling Procedures Used for the Cajon Pass, California, Deep Drilling Experiment

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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INTRODUCTION

In June 1986, the U.S. Geological Survey Core Research Center, located in Denver, Colorado, was contracted to provide an on-site core processing facility for the Deep Observation and Sampling of the Earth's Continental Crust (DOSECC) drilling experiment at Cajon Pass, California, as part of a cooperative agreement between the U.S. Geological Survey (USGS) and DOSECC. The Core Research Center also agreed to curate samples during and after completion of the experiment.

The Cajon Pass Project involved drilling a well approximately 2-1/2 miles northeast of the San Andreas fault in southern California. The purpose of the well was to study the magnitude and orientation of stresses adjacent to the fault zone. Samples recovered during the coring phases of drilling were to be subjected to isotope, paleomagnetic, thermal conductivity, and fluid analysis testing. The sensitivity of many of these tests to contamination required more sophisticated sample handling techniques than those normally used on conventional drilling projects. Input on proceedures and techniques for sample handling was received from scientists in industry, academia, the Department of Energy (DOE), and the USGS. From this input, a document entitled "DOSECC Sample Handling and Curation Protocol" (see Appendix II) was generated and used as a guideline for the services provided to DOSECC by the USGS. Specific proceedures for processing the core samples were developed, tested, and refined during drilling at Cajon Pass.

This report describes core handling and testing proceedures used on the Cajon Pass core samples and is intended as a reference guide for scientists studying this core. It may also serve as a procedural model for similar drilling projects in the future.

SUMMARY OF
CORE HANDLING PROCEDURES
AT CAJON PASS

I) **Core Recovery**:
   A) Core barrel placed on catwalk.
   B) Core removed from core barrel.
   C) Recovered core "caught" in numbered plastic trays as it exits the core barrel.
   D) Core washed with local well water.
   E) Trays covered, secured, and transported to USGS lab trailers.
   F) Unusual situations relative to core recovery photographed and noted.
   G) "Catwalk Operations" form completed.

II) **Initial Preparation**:
   A) Tray covers removed.
   B) Exposed core washed with local well water.
   C) Measurement taken of total core recovered.
   D) Entire core washed carefully and thoroughly with local water, using sponges and paper towels (as core condition permits).
   E) Core segments adjusted to approximate 3 foot lengths using the appropriate number of trays to accomodate the segments.
   F) Fractured pieces aligned and fitted together where possible.
   G) Fracture match points marked with symbols (□, O, V, etc.) for visual assistance in unique fitting of pieces.
   H) Segment numbers assigned. (Segment #1 = bottom segment with increasing numbers upward.)
   I) Archive lines added--looking downhole black line on right, red on left.
   J) Depth marked on core at one-foot intervals.
   K) On-site geologist specifies sample to be wax-dipped for physical properties and fluid analysis.
   L) Photographs for sample location indentification taken.
   M) Sample for physical properties and fluid analysis prepared.
      1) Sample separated from core. Where necessary, sample separated using conventional rock saw.
      2) Orientation maintained by noting it on remaining core and sample.
      3) Sample dipped in bee's wax, wrapped with cellophane, and covered with another layer of bee's wax.
      4) Sample's orientation and depth marked on the bee's wax.
      5) Waxed sample replaced into its original

5) Waxed sample replaced into its original position in the core until photographic documentation completed.

N) Pieces >2" numbered using the following numbering system:
   1) Each piece numbered with depth number in tenths of feet (eg. 3445.9).
   2) When more than 1 piece located at the same depth can be fit accurately into the core, assigned depth number is supplemented with "-A, -B, -C, etc." (eg. 4221.6-A, 4221.6-B, 4221.6-C).
   3) Unfitted pieces >2" assigned depth numbers supplemented with "-1, -2, -3, etc." (eg. 2431.8-1, 2431.8-2, 2431.8-3).
   4) Unfitted pieces <=2" placed into appropriately sized plastic bags according to their respective core depth intervals. Bag is labelled. (eg. CORE #XX - RUBBLE FROM INTERVAL 2231.5 - 2234.3).

O) Thin-section specimens identified, documented, and removed. (Note: this step does not necessarily take place in this particular sequence of "Initial Preparation" procedures.)

P) "Initial Core Examination" form completed.

Q) Transfer core to filming room.

III) **Video Recording and 35mm Photogrpahy Procedures**:

A) Core is aligned end to end in segment order with Archive Lines up. (Facing perpendicular to layed out core, top is on the left.)

B) Labels added for filming (eg. CORE #, SEG. #, DATE, FOOTAGES).

C) Core is dampened using a spray bottle of local water.

D) Core is filmed from top to bottom with overhead fluorescent lights turned off.

E) Core is rotated and filmed at each rotation. (Core rotated either 90 degree turns or 180 degree turns in a counterclockwize direction looking down the axis of the core depending upon the condition of the core.)

F) Specially requested photography, if any, performed.

G) "Core Documentation" form completed.

IV) **Core-Gamma Procedures**:

A) Four-inch "Core Standard" run in static position for a representation of 2" on the recording paper (approx. 8 minutes).

B) Core run:
   1) Each core run independently.
   2) Core must be solid, full diameter or pieced together to form a solid cylinder.
   3) Core run in static position at intervals of 1 foot, for a 2" representation on the recording paper.

C) To end Core-gamma run, the "Core Standard" is run in the same fashion as above.

D) Procedure duplicated for subsequent cores.

V) **Inventory of Core**:

A) Each core is inventoried and reinventoried in detail every step of handling.

B) "Core Inventory Forms" completed.

VI) **Boxing of Cores**:

A) Transfer each segment of core to core storage boxes.
   1) At discretion of handler, fragile or potentially disrupted core wrapped in plastic and/or placed in pvc pipe tube trays with covers and secured with tape, prior to box storage.
   2) Containers labeled with core #, segment #, core interval, box number, and box number of boxes per core.

VII) **Cutting and Slabbing Procedures**:

A) Less than 4-1/2" diameter core:
   1) cut one slab 1-1/4" thick, the full length of the core.
   2) position the core with the archive slab continuous across breaks, fractures, etc.
   3) place original black and red lines on sample material side of the core.
      after cutting, add "up" arrows and depth marks to archive face.
   4) photograph core in each archive box after the box has been filled and "up" arrows and depth marks have been placed on the core.

B) Greater than or equal to 4-1/2" diameter core:
   1) cut 2 slabs, 1-1/4" thick, the full length of the core; a) archive slab, b) working slab.
   2) position core as with the >4-1/2" diameter core to produce a continuous slab.
   3) align segments so cut/break joints are matched. Include part of the break joints on both slabs.
   4) make 2nd cut at 90 degree angle to the first cut to produce 90 degree angle on the cut faces of sample material.
   5) photograph core in each archive box using same procedure as smaller diameter core.

C) Oriented Core:
   1) for core diameter <= 4-1/2", proceed the same as for reqular core except cut core with reference scribe on the archive slab.
   2) for core diameter >= 4-1/2", position core with a reference scribe line on the archive slab and another scribe line located 120 degrees counter clockwise from reference (looking downhole) on the working slab.

D) Core #, segment #, which slabs taken, date, and handler(s) recorded on the "Slabbing Record" form.

VIII) **Core Allocation Procedures**:

A) Allocations approved by the allocations committee or, in rare circumstances, by the acting chief scientist.

B) "Allocation" forms completed, including signatures.

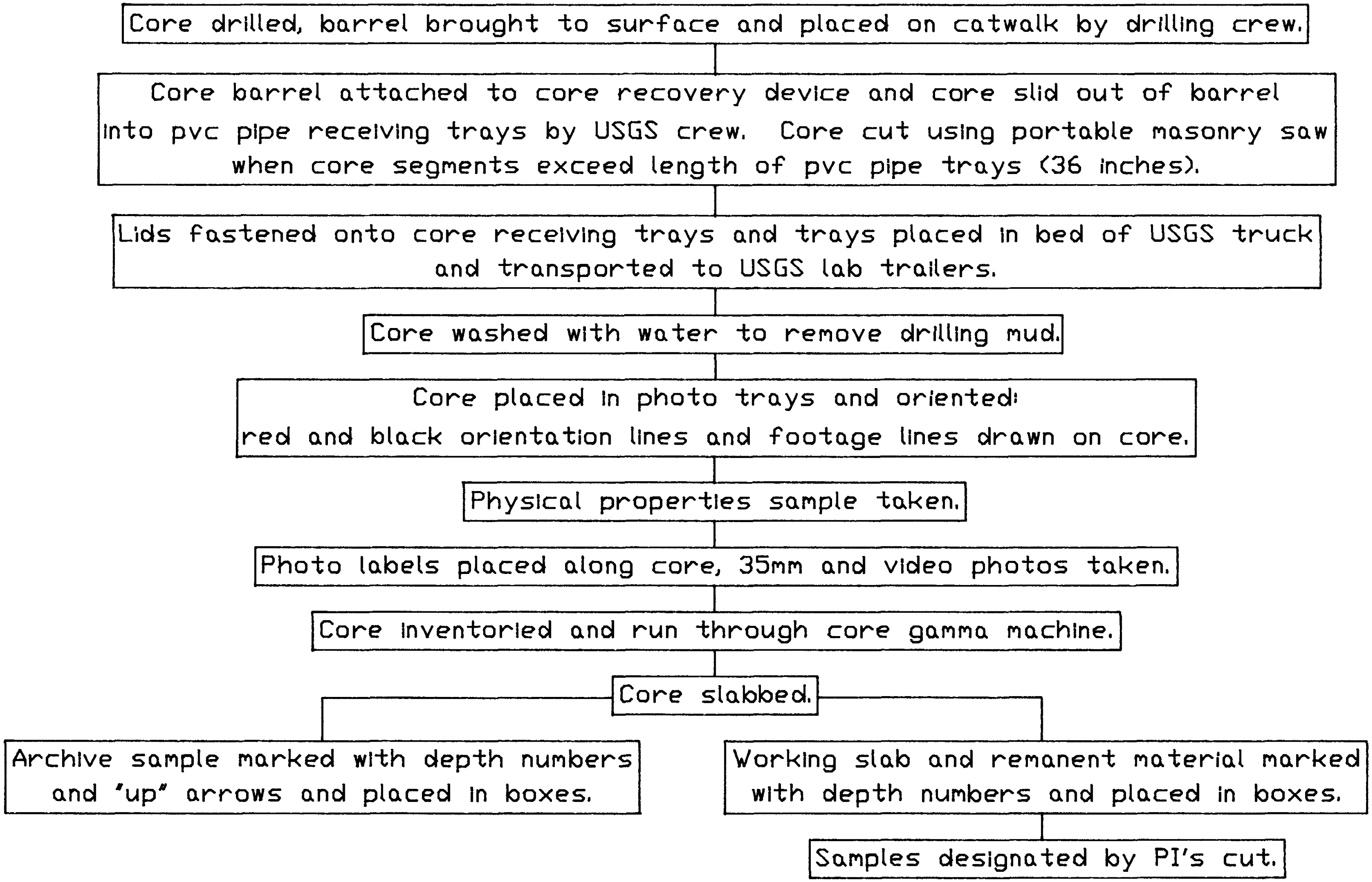
C) Samples packaged with regard to each investigator's request.

D) Samples released either:
   1) personally to investigator.
   2) to be shipped to investigator.

FIGURE 1

CORE RECOVERY OPERATIONS FLOW CHART

Cajon Pass Drilling Experiment



CORE RECOVERY

The decision to take a core was made by the chief scientist at the drill site (or his representative) and the drilling engineer. Generally, the drilling engineer informed the USGS core recovery team of all pertinent information about the coring run (core diameter, intended length, estimated time when the core would reach the surface, etc.). When USGS personnel were not on-site, the drilling engineer notified USGS crew by phone approximately 1-2 hours before the core barrel was expected to be in position for core extraction.

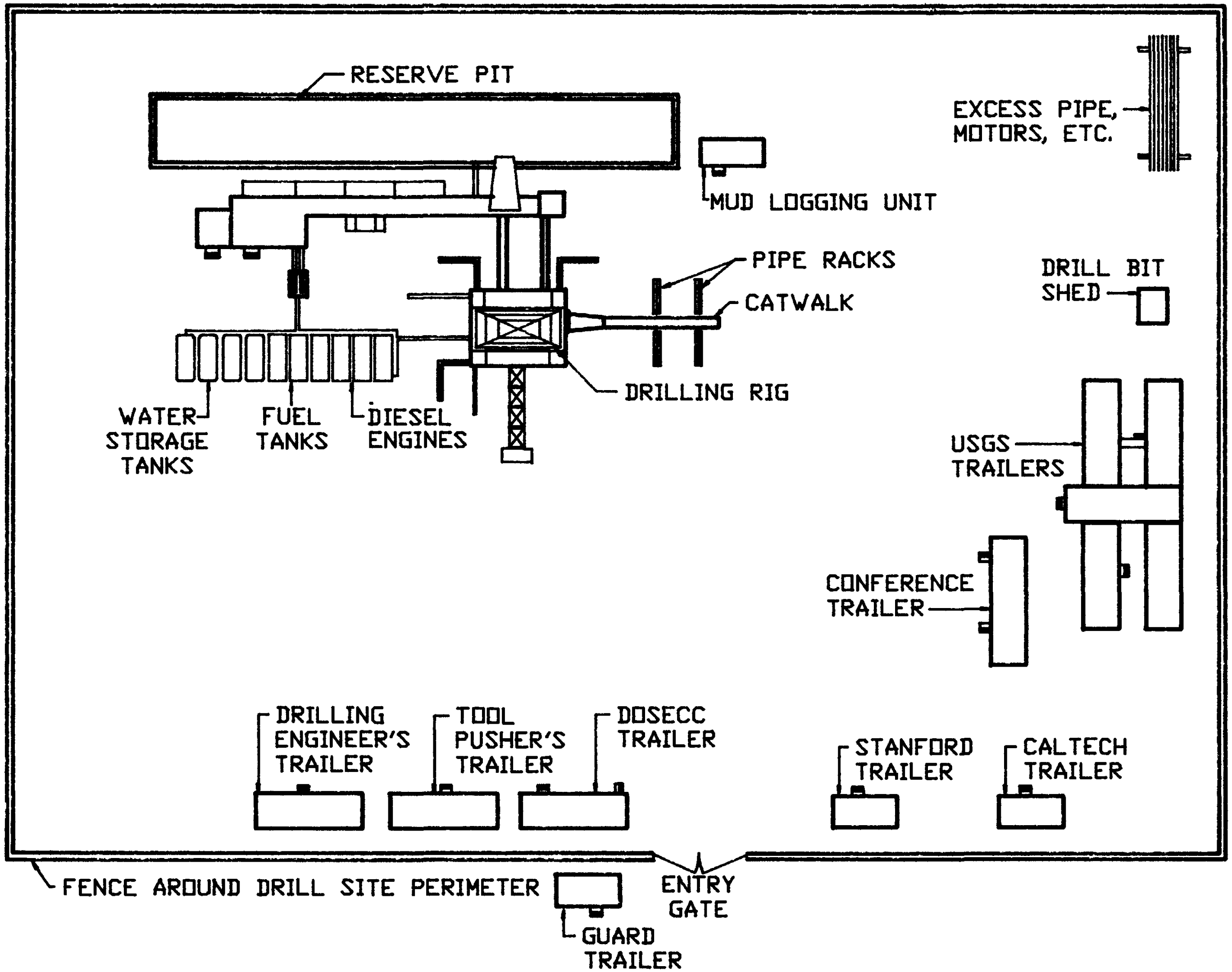
Before the core arrived at the surface, the equipment used in core recovery was prepared (see equipment list). The equipment varied slightly depending on how much core was anticipated, the type of rock drilled, and whether recovery took place during daylight hours or during the night. The necessary equipment was gathered and placed in the bed of the survey truck for transport to the catwalk (see Figure 2 for a map view of the drill site). When core recovery took place at night, a floodlight was placed at the catwalk. The U.S. Geological Survey trailer was generally used as the source of electricity for the electrical equipment used at the catwalk.

The number of crew members required for a core recovery was dependent on diameter and quantity of core expected. Two individuals were sufficient for a small quantity (3 feet or less in length and less than 4-1/2" in diameter) of core. At least three individuals were required for larger quantities (longer than 3 feet in length and greater than or equal to 4-1/2" in diameter) of core.

The location of core recovery was determined by the drilling engineer. Generally, the core was recovered on the piperacks located along side the catwalk.

During a standard recovery operation, members of the drilling crew transported the core barrel from the rig floor to the catwalk using a cable. The barrel was laid on the catwalk while the core catcher was removed. On occasion, as the core catcher was being removed for core extraction, a significant amount (up to 0.5 ft.) of rock debris would fall from the bottom of the barrel. Because project scientists were concerned about having sufficient quantities of core, the rock debris was collected and recorded. The procedure for preparing the core barrel for core recovery consisted of rolling it onto the forks of a lift-truck and moving it to the piperacks beside the catwalk. The bottom end of the core barrel was fastened into the USGS core recovery device, which was attached to the piperack. The forks of the lift-truck were raised to elevate the upper end of the core

FIGURE 2:
MAP VIEW OF THE CAJON PASS DRILL SITE



barrel (see Figure 3). A core receiving tray was placed in the USGS core recovery device and wooden blocks were placed between the back stop on the core recovery device and the bottom of the receiving tray. This secured the top of the tray against the bottom of the core barrel, preventing gaps that pieces of rock could fall through. Drilling crew members tapped the elevated core barrel with hammers to loosen the core. One or two USGS crew members positioned themselves on either side of the core recovery device to help feed the rock into the trays. As the trays were filled they were covered with their complementary lids, sealed with fiber tape, and placed in the bed of the USGS truck.

When the core came out of the core barrel in segments longer than the receiving tray, the core was sawed into lengths that would fit into the trays. A masonry saw and stand were set up beside the USGS core recovery device for this purpose. Before sawing, the core barrel was lowered to a horizontal position. The wooden blocks were removed, and the receiving tray was slid against the stop at the base of the core recovery device, allowing a gap for the saw blade. The core was sawed by slowly lowering the revolving blade until approximately 1" of solid rock was left; then the unsawed core was broken to allow proper orientation of the sawed segment. When the recovery process was completed, the core was transported to the USGS trailers for cleaning and processing.

Safety Considerations

As in any project using heavy machinery, safety considerations were important near the drilling rig. Standard safety equipment, such as steel-toed boots and a hard hat, was required at all times on the drill-site. During core recovery, it was important that personnel not stand directly in front of the core barrel to avoid injury from a heavy fragment of core that might unexpectedly break loose and slide out the end of the core barrel. It was recommended that personnel not look directly up into the core barrel during core extraction to avoid the possibility of being hit in the face by a fragment of core. Two people were required to move core segments weighing more than 50 pounds (1.5 feet of 6 inch core or 3.5 feet of 4 inch core). This policy was initiated to reduce the potential for injury, especially back injury. Generally, wearing rubber or plastic gloves during the core recovery process is advisable to protect against hazardous chemicals in the drilling fluid.

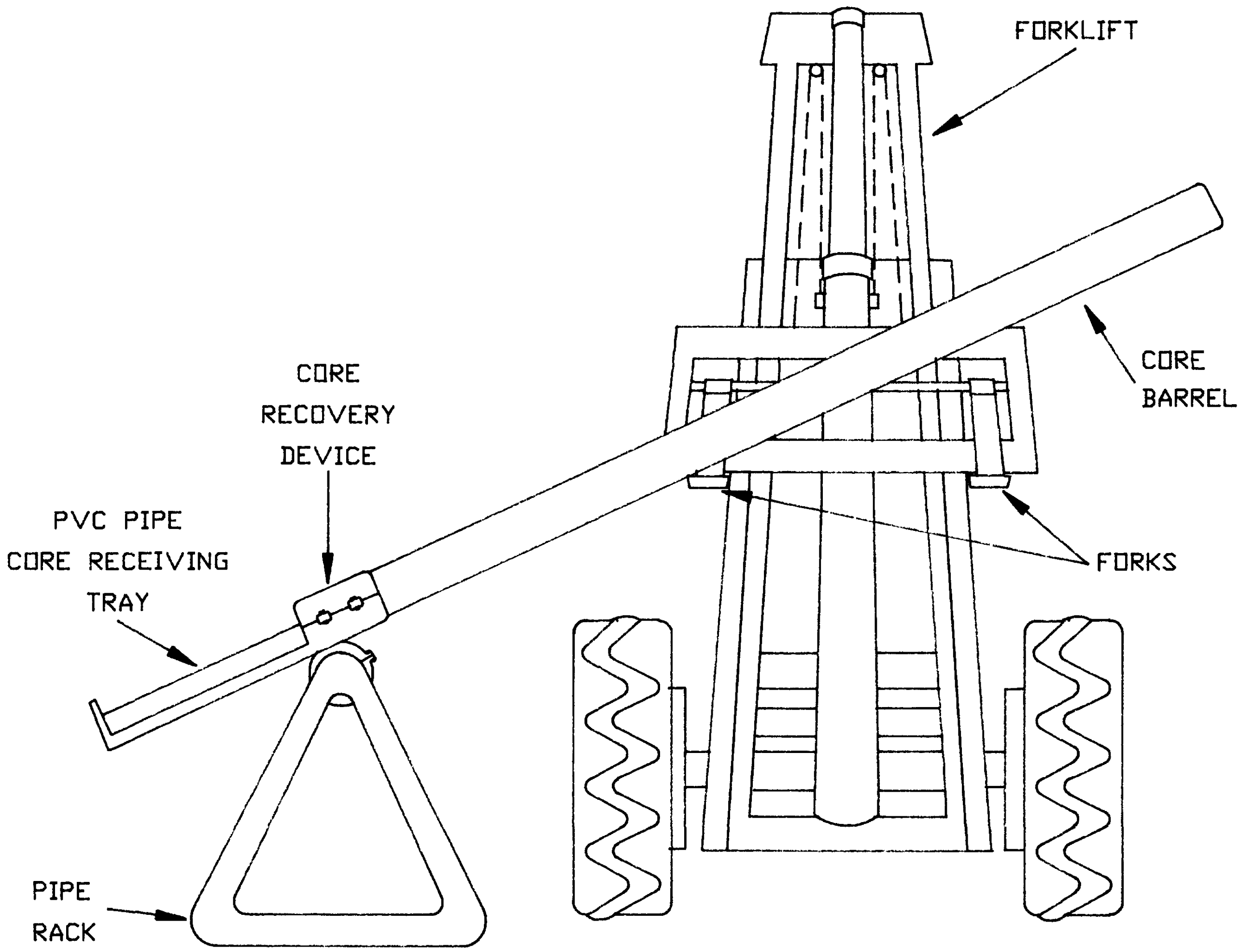


FIGURE 3: Core barrel clamped into the core catching device and elevated into position for core extraction.

Standard Equipment for Core Recovery:

Bucket containing water	--For washing the core
Sponge	--For washing the core
Rubber gloves	--used when handing core
"Core Recovery Forms"	--See attached sample
Clipboard	--To hold "Core Recovery Forms"
Writing implement	--Important that it works in wet conditions
Zip-lock plastic bags	--For collecting debris that falls from the barrel.
Plastic receiving trays	--Size & quantity dependant upon expected core recovery
Fiber tape	--To secure covered trays
Knife	--For cutting tape
Plastic tarp	--To lay on the ground beneath the area of core collection.

Other Equipment:

Portable masonry saw	--For cutting core when necessary
USGS Core Recovery Device	--To aid core handlers with long, heavy sections of core
Floodlight	--For nighttime recovery

INITIAL CORE EXAMINATION

Initial Preperation

From the catwalk, the core was transported to the examination trailer where segments were laid out in proper depth sequence for cleaning and viewing. The core was washed with tap water and sponged clean of all drilling mud. The on-site geologist made a preliminary examination of the washed core and determined if there was a suitable section of core to be sealed in beeswax for later physical properties and fluid analysis.

Archive Lines and Core Orientation

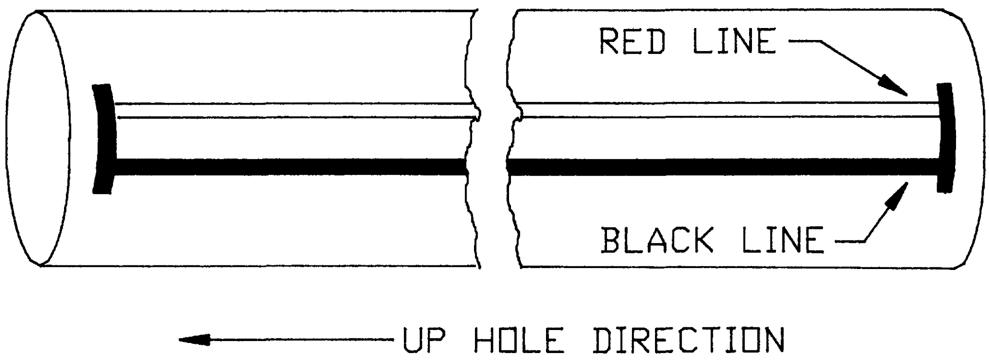
Once the physical properties sample was chosen, all core segments were laid out in the photo trays and fitted together so that their fracture surfaces matched and the same side of each core segment faced up. If the opposing fracture surfaces did not match, an attempt was made to determine the core orientation across the fracture by use of through-going veins, rock fabrics (eg. foliation, lineation, etc.), or any other available structures. When core segments could not be oriented by these techniques, an arbitrary orientation was used. After the core was fitted together, the number of feet of core recovered was measured for the on-site geologist and drilling engineers.

Parallel black and red archive lines were drawn along the length of the core using water proof markers. <u>The black archive line was drawn on the right and red on the left when looking in the downhole direction along the core's axis.</u> When core segments matched across breaks in the core, the archive lines were drawn continuously across the breaks so that when the core segments were fitted together the archive lines also fitted. When segments did not match across breaks and the orientation was ambiguous or unknown, the archive lines were not drawn continuously across the breaks and a short black line was drawn perpendicular to the archive lines on both sides of the fractures (see Figure 4). If the core was oriented with scribe lines, the archive lines were placed so that the main scribe line would be on the archive slab when the core was cut.

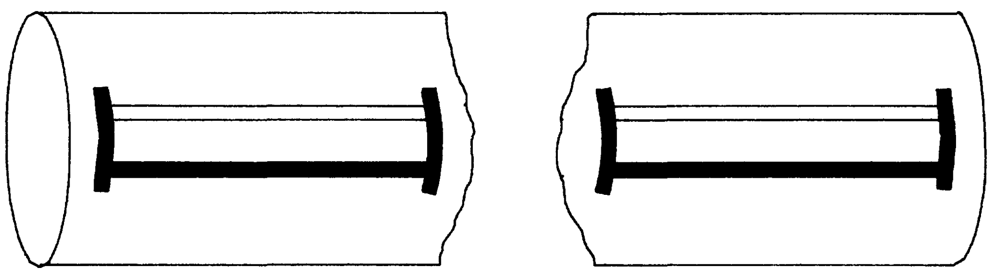
Physical Properties and Fluid Analysis Sample

Once the core was oriented and the archive lines drawn, a 3-inch long section of full diameter core designated as the physical properties sample was removed for processing. Four 35mm photos were taken of the Physical Properties Sample (one each of the 0, 90, 180, and 270 degree rotation

FIGURE 4



Example of application of archive lines when core can be fit together across break.



Example of application of archive lines when core cannot be fit together across break.

faces). When the photography was completed, the sample was dipped in beeswax. The optimum temperature for the beeswax was between 150 and 170 degrees C; at higher temperatures, the beeswax began to breakdown and became useless for sealing the physical properties samples. Six to eight hours were needed for a full pot of solidified wax to melt completely. The physical properties sample was thoroughly dried at room temperature before sealing with beeswax to prevent any possible alteration of the original rock fluids in the sample.

Sealing of the physical properties sample was done in four steps. 1) The trim saw was used to cut a small grove (about 1/8 inch deep) along the black archive line and a small notch (1/8 inch deep and 1/4 to 1/2 inch long) at the top of the physical properties sample along the red archive line. This provided a permanent marking of orientation since the red and black ink markings tend to fade through time. 2) Several wax coatings were applied to the sample's surface by tying a cord around the sample and dipping it into the melted wax. 3) The wax-dipped sample and cord were completely covered with plastic wrap. 4) Another cord was tied around the sample, and several more coats of wax were applied until the plastic wrap was completely sealed. After the final coat of wax cooled, an identification tag was taped onto the sample. The tag included the core number, segment number, interval cored, assigned sample depth, and date and time that the sample was sealed. The sample was then placed in a plastic bag for protection and returned to its original position in the core until documentation procedures were completed and the core was boxed for storage.

Depth Designations

Once the preparation of the physical properties sample was completed, the core was labeled for photographic documentation. When the core was broken or fractured, the broken pieces were fitted (if possible) and properly oriented to the rest of the core. Matched points along fractures were marked with various symbols (ie. squares, circles, triangles, etc.) to facilitate any later reassembly (see Figure 5).

Depth marks, circumscribing the core at every foot along its entire length, were applied with a red waterproof pen and the corresponding depth number was written to the left of the archive lines using a black waterproof pen. **For cores 35-55, depths were measured from the top of the core downward. Depths for cores above core 35 (0' to 6938') were sometimes marked from the bottom up.** For a list of the cores marked from bottom to top see Appendix III.

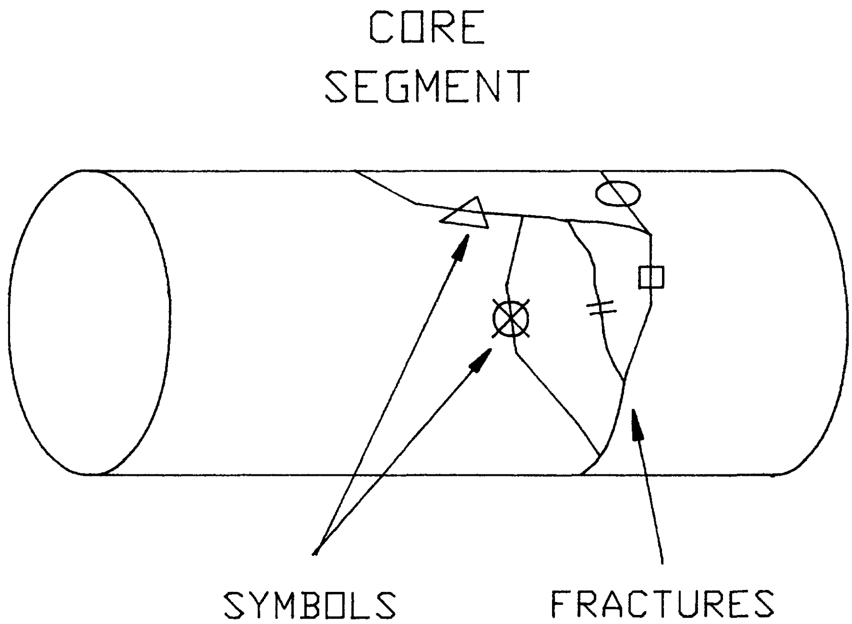


FIGURE 5: Example of symbols used to show fit of pieces in fractured core.

After the depth marks were placed on the core, the core was divided into segments utilizing existing breaks or cutting with the masonry saw. The segments were limited to a maximum length of **35 inches** so they could ultimately be stored in 36-inch core boxes.

CORE DOCUMENTATION

Core Photo Labels

After dividing the core into segments and while it was still laid out in the photo trays, the core was labeled for video tape and 35mm photo documentation. All labels were made in 36 pt. Helvetica characters with a KROY lettering machine, so that labels could easily be read in the photo prints. The labels were affixed to yellow cardstock to reduce background contrast.

A label designating the number of each segment was placed at the top of the corresponding core segment. **Core segments were numbered from the bottom up**, starting with segment one. Each depth mark on the core had the appropriate depth label (in feet) placed along the side of the core. Reference scales were also placed alongside the entire length of the core. The top and bottom of the core were labeled and a header put at the top of the core (see Figure 6). The header used the format:

DOSECC/USGS
CAJON PASS PROJECT
FEDERAL # 2-26
[core no.]
[interval cored]
[amount recovered]
[core orientation - 0,90,180,or 270 deg.s rot.]

Note: prior to core 35, the core photo header was sometimes labeled with the depth interval recovered instead of the interval cored (ie., depth interval actually drilled). In cores 35-55, all headers used the footages representing the interval cored as well as the amount recovered.

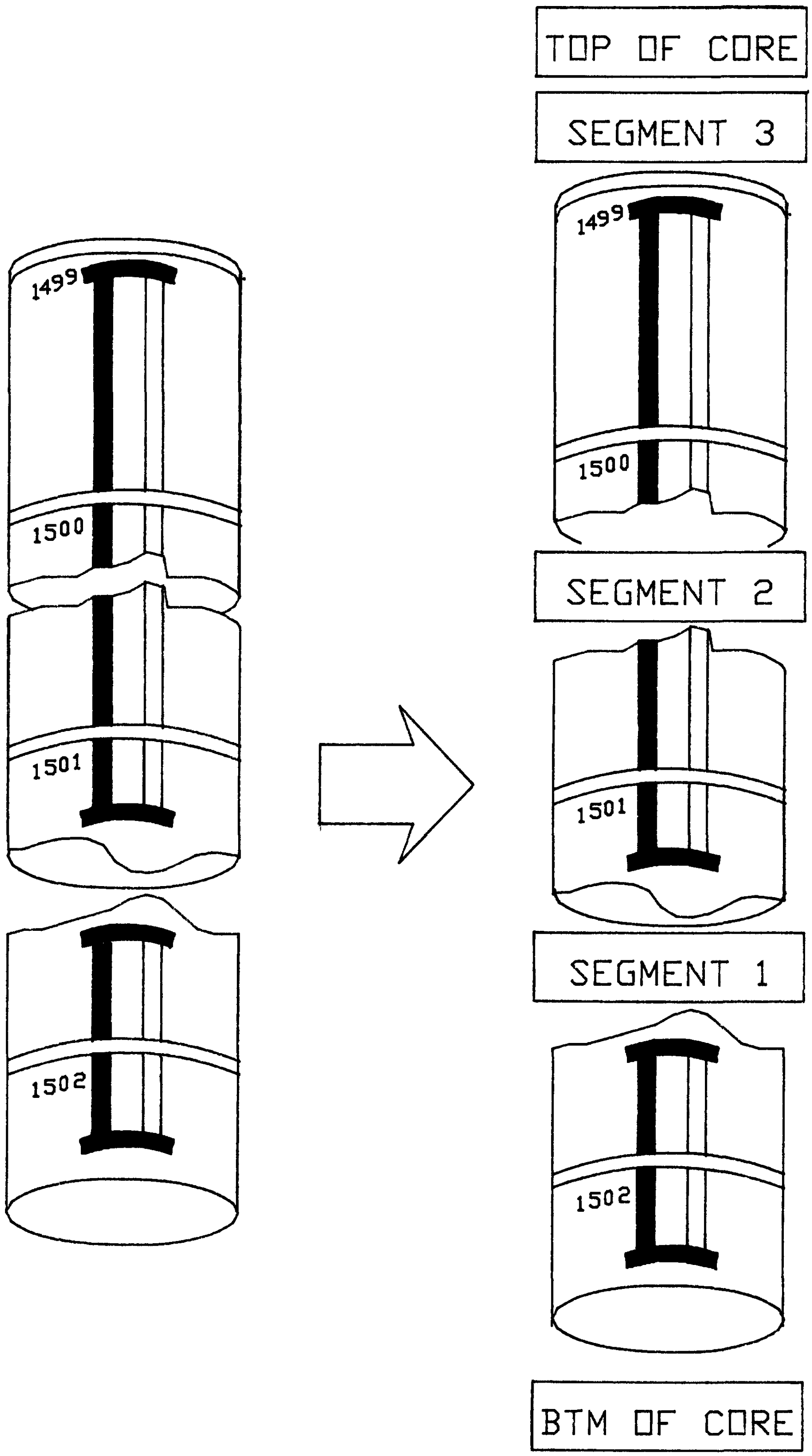


FIGURE 6: Example of core with foot markers and segment labels.

Filming of the Core

Once the core was labeled, it was documented photographically. Each core was videotaped and photographed in color along its entire length. This was done for each of four rotations - 0, 90, 180, and 270 degrees - so that the entire surface of each core was documented. If the core was fragile and might be broken during rotation, only the 0 and 180 degree rotations were filmed. The rotation direction was determined using the Right-Hand-Rule with the thumb pointed up the core and 0 degrees being when the archive lines were facing up (ie., clockwise while looking up the core's axis). Rubble zones were generally not rotated. When rubble zones consisted of more than a few pieces, a label was placed at the bottom of the header for the 90, 180, and 270 degree rotations, stating that the rubble was not rotated. **All** photography or videotaping was done with the overhead fluorescent lights turned off to prevent streaks of reflected light from appearing on the core. A blue filter (30A) was used on the 35mm camera.

The 35mm and video cameras had their own fixed stands mounted over the photo tray assembly. The cameras were positioned directly over each of the three photo trays for individual filming of each length of core. The core's surface was sprayed with water and the photo tray assembly was slowly moved under the cameras by a variable speed drive mechanism.

When video taping the core, the tray assembly was moved continuously (from the top to bottom of each core segment) below the video camera at a rate of five to seven feet per minute. At the start of video taping, the tray assembly was left stationary so that the core header was recorded for **at least 20 seconds.** This was also done at the bottom of the core for **a minimum of 20 seconds** before the video tape machine was turned off. Between each core run, **30 seconds** of blank tape allowed enough space for later editing and for prevention of overlaps in filming.

When taking 35mm photographs, the core was positioned for each shot so that there was at least a **two-inch overlap** between photos. This resulted in photographing about **one foot of core per shot**. In each photograph, a rotation label showing which core face was being viewed was placed beside the core for more efficient identification of prints after the photos were developed. Usually each rotation was both photographed and videotaped before going on to the next rotation. This helped reduce unnecessary handling.

Every photograph was logged noting the core number, date, F-stop setting, exposure, core rotation, and any special conditions. The video tape was also logged noting the core number, date, cassette tape number, and tape footage interval within which the core was recorded (see Appendix III).

Under normal conditions, the core was run through the core gamma unit immediately after filming. However, if necessary, the core gamma run was done after the core had been inventoried and boxed for storage but before the core was slabbed and sampled.

CORE-GAMMA PROCEDURES

Introduction

This section documents the operation of the core-gamma unit used to measure gamma-ray emissions from recovered core samples. Under normal operating conditions, core is placed on the conveyer belt that carries the core over the analyzing crystal at a constant rate for measurement of its gamma-ray emission level. The rate at which the core is passed over the analyzing crystal usually matches the rate at which the drill hole gamma log was run for comparison of results. Unfortunately, the weight of the nearly six-inch diameter core kept the conveyer belt from turning. Additionally, the variation of the measured values from a constant emission source was as high as 60 API gamma-ray units. Therefore, the operational procedures for the core-gamma unit at Cajon Pass were altered from the operating procedures recommended by the manufacturer to allow measurement of static core samples and improve the counting statistics of each measurement.

Calibration Procedures for the Core-gamma Unit

Each time the core-gamma unit is set up for use, it must be calibrated relative to known standards both to optimize operating conditions and to determine appropriate correction factors. Although the unit is relatively stable while it is set up for operation, it should be calibrated every few months or when measurements of the standards show a significant drift in values between periods of use. All gamma-ray emission measurements are relative to background.

Instrument Settings

Five instrument settings affect the output of the core-gamma unit: 1) Integrating Time, 2) High Voltage Adjustment, 3) Counts per Minute Sensitivity Selector, 4) Recorder Range, and 5) Level Discriminator. Standard values, listed in the "Equipment Operations Manual", were used for the first three settings. These values are appropriate for most measurements but can be varied by trial-and-error to suit the situation.

The Recorder Range is used to set the zero point position for the pen on the chart recorder and is adjusted as needed to keep the lower gamma readings on the chart paper.

The Level Discriminator is used to eliminate as much of the background noise as possible without losing gamma emissions from the core sample. To optimize this setting, a core-gamma standard is placed in the unit for static measurement as outlined in the "General Operational Procedures" section. Gamma readings are then taken for progressively higher settings of the Level Discriminator. The gamma readings are plotted against the level settings as shown in Figure 7.

The relative gamma readings in Figure 7 remain near zero for low settings of the discriminator (only a few gamma-emissions are counted). As the level setting is increased the gamma readings rapidly increase until they reach a plateau where higher level settings no longer affect them (all gamma emissions are counted including background). The object is to set the Level Discriminator low enough to detect the gamma emissions from the sample while filtering out background emissions.

This optimal setting for the Level Discriminator is determined from Figure 7 by the gamma reading midway between where the curve begins to increase rapidly (Background) and the point at which all gamma emissions are detected (Energy Plateau). The optimal level setting is found from where the mid-point gamma reading lies on the curve.

Calibration for Core Diameter Variations

The gamma emission level from a sample is dependent on the amount of rock being measured by the core-gamma unit. Because core samples vary in length (discussed below) and diameter, the unit's response with respect to both must be calibrated before the measured gamma readings become meaningful. The core-gamma unit comes with three core standards, which are used for this purpose. These standards, encased in plastic tubing, are composed of a uniform material but vary in diameter: 2.5", 3.5", and 4.0".

To calibrate the core-gamma unit's response to variations in core diameter, each core standard must be measured in a static position as described in the "General Operational Procedures" section. A minimum of four different gamma readings for each standard should be made. These gamma readings are then plotted against their corresponding diameters and a regression line drawn through the data set. This regression line is used to calculate what the gamma reading would be for the same rock at any given core diameter. This allows gamma readings from various diameter core samples to be directly compared.

OPTIMIZATION OF THE LEVEL SETTING

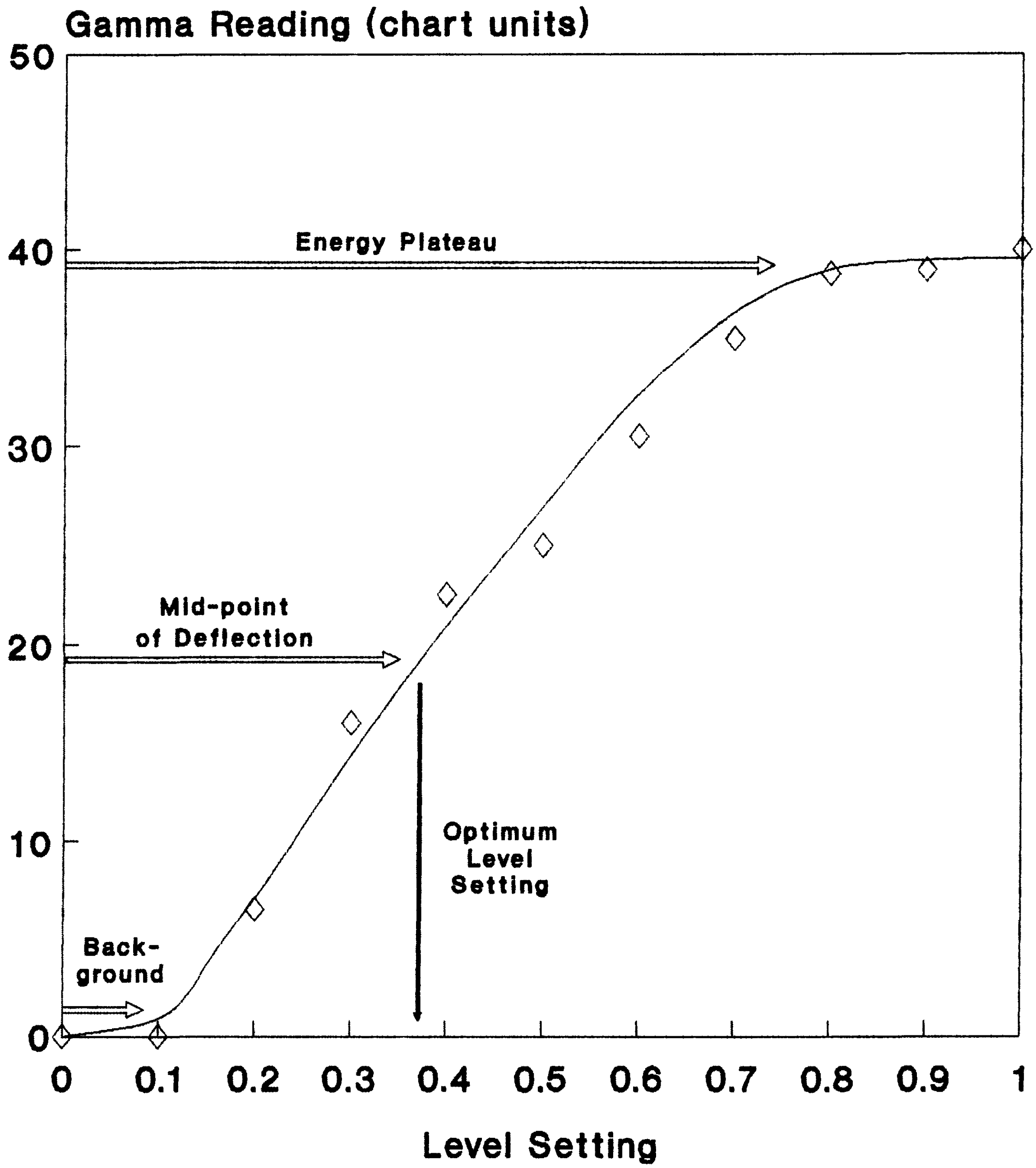


FIGURE 7

Figure 8 is a gamma reading plot for calibration runs carried out at the beginning of Cajon Pass drilling phases I and II. The two sets of data depicted in Figure 8 demonstrate the need for periodic calibration runs as the unit's electronic characteristics shift with time.

Calibration for Core Length Deficiency

This calibration is determined by placing the 4.0" core standard to the right of the core-gamma unit's lead shield. Gamma readings begin with the left edge of the core standard at least +0.15 feet from the right edge of the lead shield (see Figure 12). The core standard is measured as it is incrementally fed from right to left beneath the lead shield. The distance from the lead shield's right edge to the left edge of the core standard, designated "i", must also be noted with each measurement. To the right of the lead shield's edge "i" is positive and to the left it is negative.

As the core standard is fed from left to right, the gamma readings will start at zero relative to background because no gamma-emitting material is within detection distance. However, the readings progressively increase as the core standard's edge passes over the core-gamma unit's analyzing crystal. The readings eventually level out as the analyzing crystal receives gamma emissions from a full length of the core standard. This sequence is reversed when the right edge of the core standard passes beneath the lead shield and over the analyzing crystal.

Because core standards of variable length are not available with this unit, the one long 4.0" diameter core standard was utilized to determine the length-deficiency correction. This is justified because insertion of the standard's leading edge and then subsequent withdrawal of the trailing edge are equivalent (provided that both ends give symmetrical gamma readings) to the effect that would be observed if the end of two cores were inserted below the lead shield simultaneously from the right and left. To the core-gamma detector, this is the same as core standards composed of the same material and diameter, which increase in length from zero to full-length but are centered below the lead shield.

Figure 9 depicts the data collected from length deficiency calibration runs performed for drilling phases I and II at the Cajon Pass, California, drill site. As can be seen, both sets of data are symmetrical with respect to the core standard's ends approaching and leaving the analyzing crystal; this is required for proper operation and calibration of the core-gamma unit. These standard length-deficiency curves allow gamma readings from core samples of

CORE DIAMETER CORRECTION CURVES FOR CAJON PASS DRILLING PHASES I&II

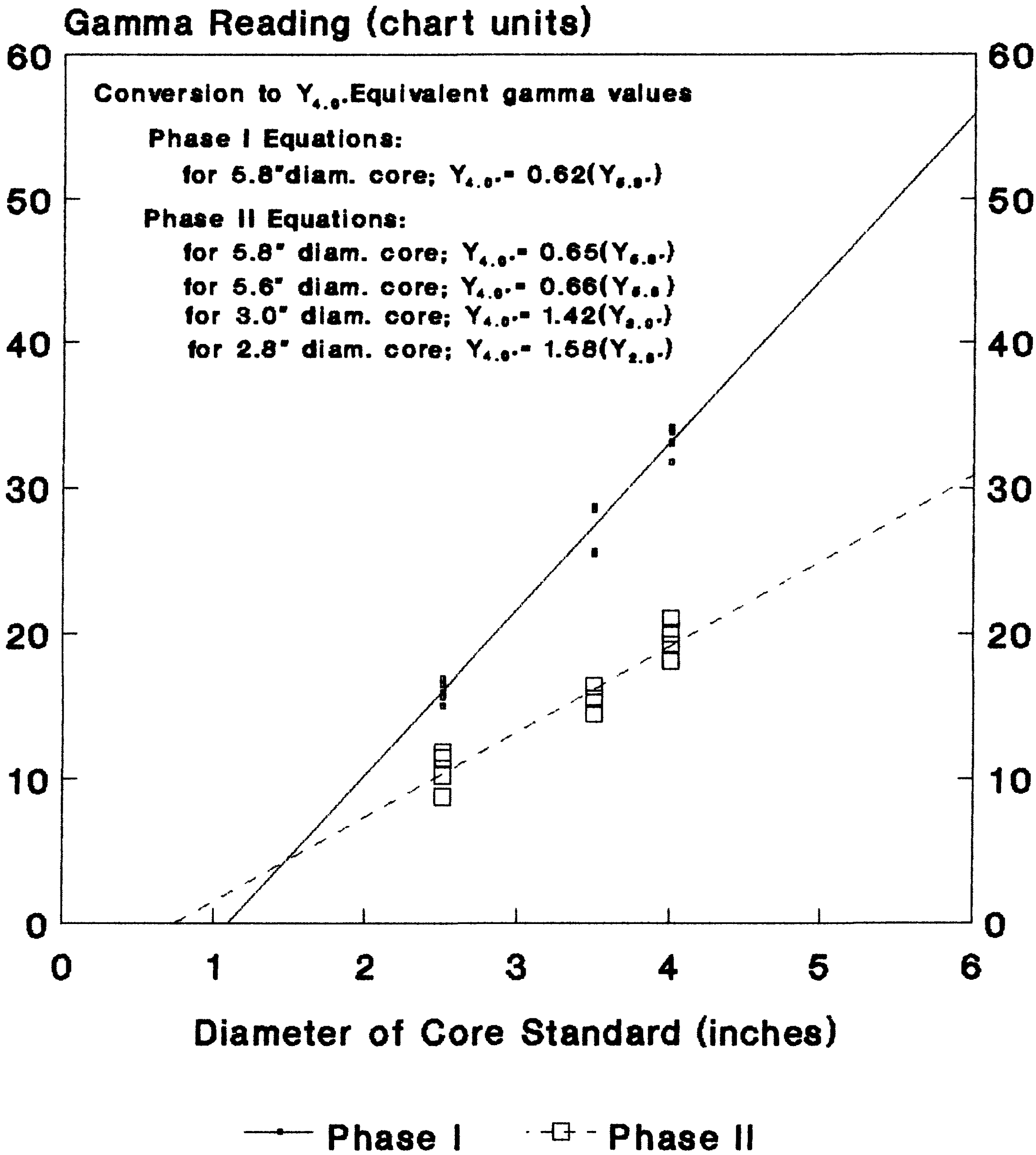


FIGURE 8

LENGTH DEFICIENCY CALIBRATION
FOR CAJON PASS DRILLING PHASES I&II

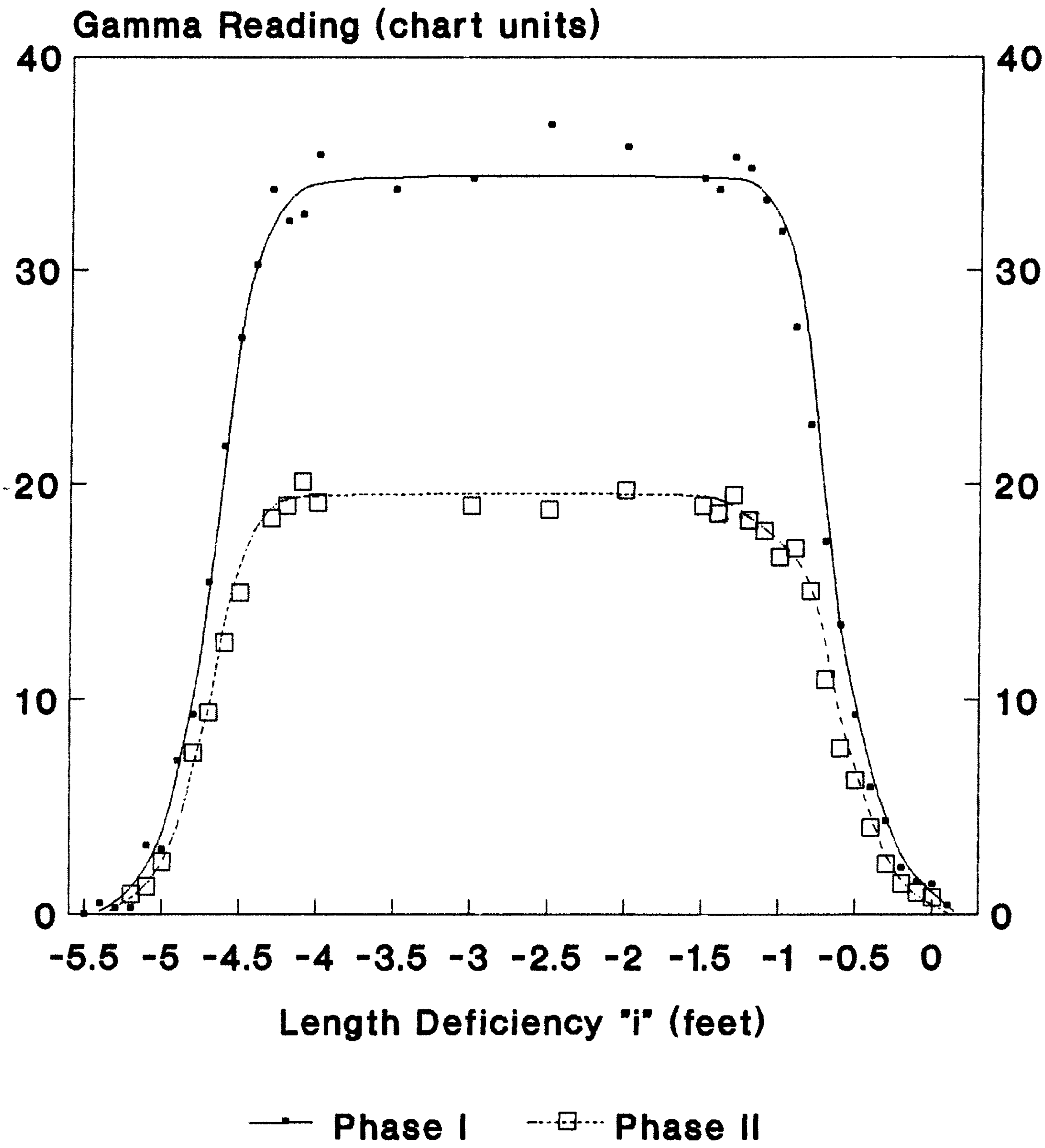


FIGURE 9

various lengths to be corrected to a common datum (i.e., full-length core equivalents) for direct comparison of results.

General Operational Procedures

Standard instrument settings for the core gamma analyzer are:

RCDR RANGE	=	0.54
INTEGRATING TIME-SEC	=	11
HIGH VOLTAGE ADJUST	=	900
COUNTS PER MINUTE	=	5K
LEVEL	=	0.71

Once the Count-Rate-Meter and Recorder have warmed up, the counts per minute switch should be temporarily set to 10K. At this setting, allow one half inch of background to be recorded on the chart, then hold the 60 CPS test switch up until the reading stabilizes. The test should give a full scale deflection on the chart recording. When the 60 CPS test switch is released, allow another one half inch of background to be recorded before turning the counts per minute switch back to the standard 5K setting.

At least two inches of 5K background must be recorded at the beginning and end of each recording session. Once the 5K background has been recorded, the largest (4.0" inside diameter) core standard is placed into the core gamma analyzer. The standard and all samples are to be measured in a static position allowing no less than two inches of readings to accumulate on the recorder. The top of the core standard is marked and should always be to the left of the analyzing crystal. The core standard is to be inserted until the 3.0 foot mark is lined up with the edge of the lead shield (see Figure 10). The large core standard must also be run at the beginning and end of each recording session. Once the standard has been measured, another two inches of 5K background should be recorded before samples are run.

Since gamma readings are dependent on mass and shape, only core with complete cross-sections are run. This means that unless they can be entirely pieced together, the broken and rubble intervals are not run. For continuous core, measurements should be taken on approximately one-foot spacings (always with the archive lines up). If the core is less than full length (1.65 feet, see length correction section) measurements can still be taken if the short core is centered under the lead shield. When approaching the end

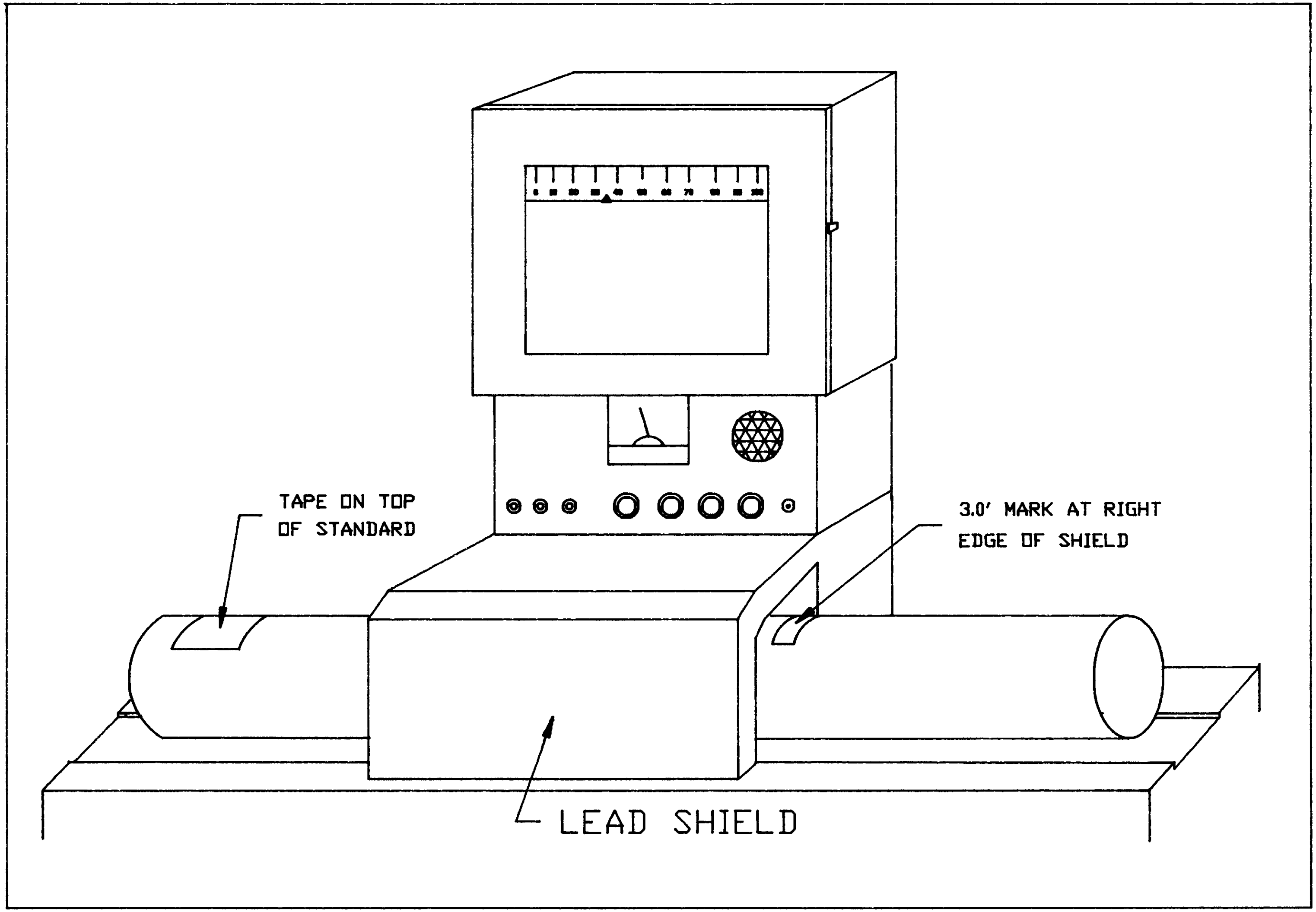


FIGURE 10: Allignment of 4.0″ diameter standard in Core-Gamma detector.

of a continuous core segment, the end must not be placed less than 0.15 feet from the edge of the lead shield to prevent the analyzing crystal from measuring an asymmetrical sample.

Correction for Variable Core Diameters

Correction of gamma measurements from Cajon Pass core samples with different diameters to a standard diameter (i.e., 4.0" dia.) and subsequent conversion to API gamma-ray units is necessary to compare results between cores. This is accomplished by using the Core-Diameter-Correction curves for Cajon Pass drilling phases I and II depicted in Figure 8.

These curves show that for phase I drilling core-gamma measurements, a 5.8" diameter core composed of the same material as the 4.0" core standard will have a gamma deflection that is 62% greater than the deflection caused by the 4.0" core standard. Therefore, the equation to convert the gamma measurement for a 5.8" diameter core ($Y_{5.8''}$) to an equivalent 4.0" core gamma reading ($Y_{4.0''}$) is:

$$Y_{4.0''}=0.62(Y_{5.8''}). \qquad \text{eq. 1}$$

Thus, a core sample with a diameter of 5.8" having a gamma measurement of 53.6 is equal to a gamma reading of 33.1 for a 4.0" diameter core composed of the same material. No core diameter correction is needed if the core being measured has a diameter of 4.0". Similar equivalencies to the 4.0" standard diameter may be derived for other core diameters. The equations used during both phases at Cajon Pass, California, are shown on Figure 8.

Length Deficiency Correction

The core-gamma detector utilizes a crystal to detect gamma rays. This crystal will only detect gamma rays that originate within a certain distance (the crystal's aperture) from the crystal. If a length of core is shorter than the aperture of the crystal, then the amount of gamma rays measured is less than that measured for core longer than the crystal's aperture (i.e., full-length core). Therefore, a correction for core shortness must be made.

For this core-gamma machine, the crystal aperture extends symmetrically +0.15 feet out from each edge of the lead shield (see Figure 11). Therefore, any core that does not extend more than +0.15 feet beyond the edge of the lead shield will have to be corrected for the length deficiency.

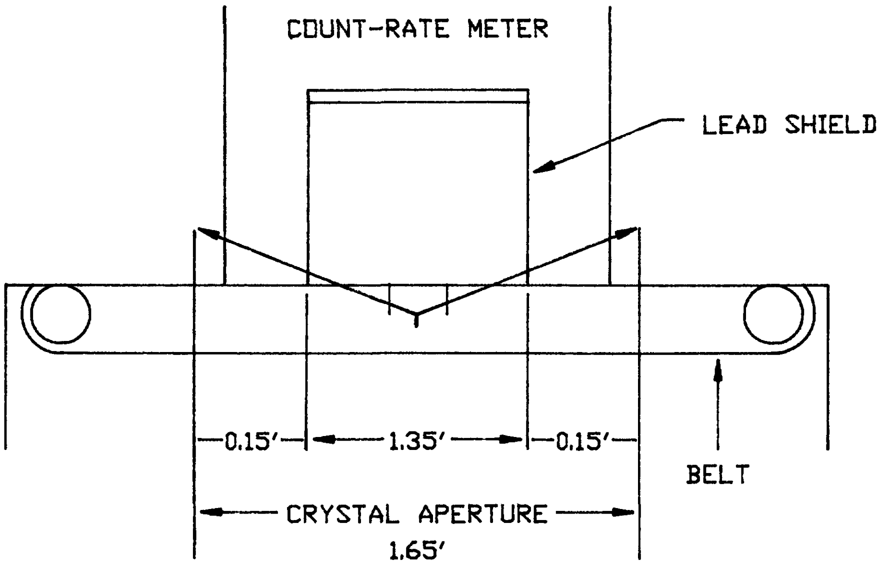


FIGURE 11: Core gamma crystal aperature.

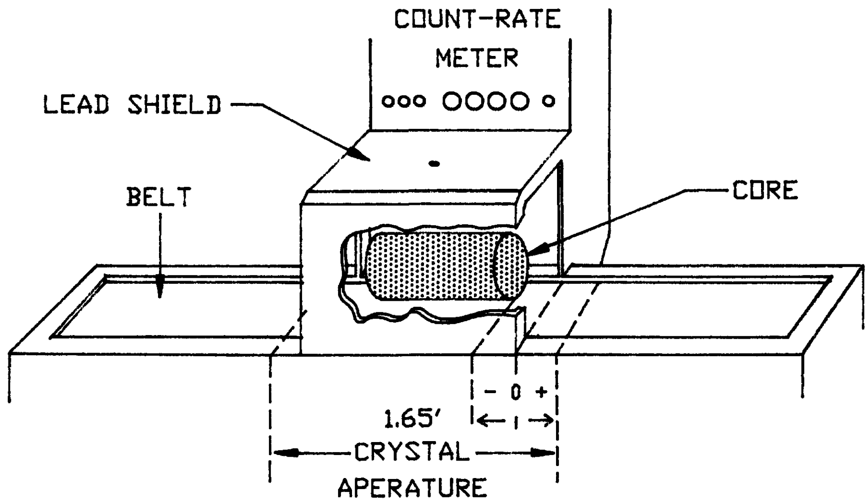


FIGURE 12: Centering short piece of core for gamma ray detection and measurement of "i" ("i" represents the distance from the end of the short core to the edge of the crystal aperature).

The correction is done by first centering the short piece of core beneath the lead shield. The distance "i" (see Figure 12) is measured in tenths of a foot from the shield's edge (zero position) with negative values inside and positive values outside. Next, using the appropriate Length-Deficiency correction curve in Figure 13 (taken from Figure 9) for 4.0" core or equivalent calculated value, the Z_i value is determined for the corresponding "i" measurement. The length correction factor "C", which represents the percent change in the $Y_{4.0"}$ value needed to correct for the loss of mass due to the shortness of a core sample, can then be calculated using the equations:

$C = 34.5/[34.5 - 2(Z_i)]$ (phase I drilling) eq. 2

$C = 19.0/[19.0 - 2(Z_i)]$ (phase II drilling).

The Z_i value from Figure 13 must be doubled because only half of the data from Figure 9 is used for simplicity sake and is justified by the symmetry of the length-deficiency data.

The corrected gamma reading "G", which takes into account all necessary mass corrections is then:

$G = C \times Y_{4.0"}$. eq. 3

Conversion to API Gamma-ray Units

Previously, all gamma readings were measured using arbitrary chart units. Therefore, to be able to compare the core-gamma measurements with those from the down hole gamma logs, the core-gamma deflection values need to be converted to API gamma-ray units. To do this, the average gamma deflection for the large 4.0" standard ($Y_{4.0"STD}$), which was run at the beginning and end of each measurement session, is needed. With this value the API gamma deflection can be calculated using:

$API = (G/Y_{4.0"STD}) \times 222.$ eq. 4

$G/Y_{4.0"STD}$ is the percent deviation relative to the 4.0" core standard for a particular length-diameter corrected gamma reading of a core sample. The 222 value is the gamma-ray emission level for the 4.0" core standard in API gamma-ray units. A set of sample calculations for core diameter, core length deficiency, and API conversion follows.

LENGTH DEFICIENCY CORRECTION CURVES
FOR CAJON PASS DRILLING PHASES I&II

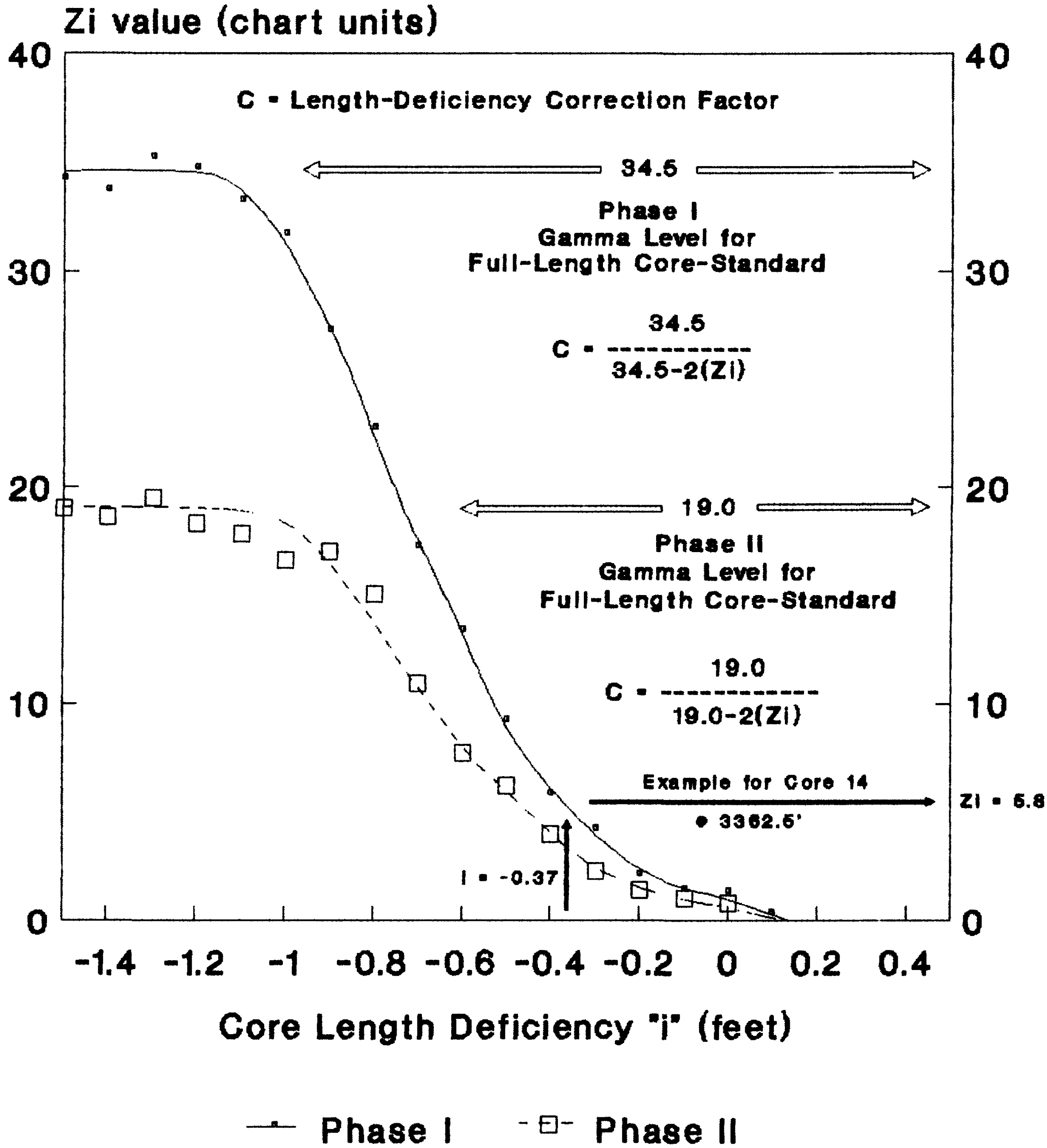


FIGURE 13

Sample Calculation for Core 14 @ 3352.5 ft.:

Core No.	Depth (ft.)	Core Diam. (in.)	Core Length Deficiency "i"(10ths ft.)	Measured gamma activity (rel. to background)	
				Y5.8	Y4.0
14	3362.5	5.8	-0.37	13.5	8.37

Zi	C $\frac{34.5}{34.5 - 2(Zi)}$	G CxY4.0"	Y4.0"std	API gamma-ray units (G/Y4.0"std)x222
5.8	1.51	12.6	33.6	83

1) Because the core dia. = 5.8", convert the measured gamma reading ($Y_{5.8"}$) to its equivalent 4.0" diam. value ($Y_{4.0"}$) using equation no. 1: $Y_{4.0"} = 0.62(Y_{5.8"}) = 0.62(13.5) = 8.37$.

2) Because this core sample was too short, the $Y_{4.0"}$ value must be corrected. The length-deficiency correction curve for phase I drilling in Figure 7 gives a "Z_i" value of 5.8 for i = -0.37". The length correction factor "C" is then determined from equation no. 2: C = 34.5/[34.5 - 2(Zi)] = 34.5/[34.5 - 2(5.8)] = 1.51. Then the length and diameter corrected gamma reading "G" from equation no. 3 is: G = C x $Y_{4.0"}$ = 1.51 x 8.37 = 12.6.

3) The average gamma reading for the 4.0" core standard determined from the measurements taken at the beginning (33.2) and end (34.0) of this core-gamma measurement session is: $Y_{4.0"std}$ = (33.2 + 34.0)/2 = 33.6. Applying equation no. 4 the API gamma-ray unit equivalent is: API = ($G/Y_{4.0"std}$) x 222 = (12.6/33.6) x 222 = 83.

CORE INVENTORY

Each piece of collected rock was documented because much of the core would be consumed during analysis and the principle investigators on the project wanted to have a complete record of the core as it existed before slabbing and sampling.

The documentation process involved weighing, numbering, and recording pertinent information on a "Core Inventory Form" (see Appendix III). Because all data were eventually recorded in a computer, it was important to avoid **duplicate numbers**.

The numbering system was implemented as follows:

1) Using a black waterproof marker, each piece was numbered at its lowest depth with the corresponding unique depth number (to the nearest tenth of a foot). In most cases, the numbering was placed on the outside surface of the core. Where archive lines existed, the numbering was placed, if possible, between the lines (see Figure 14).
2) Where more than one piece was located at the same depth and could be precisely fitted into the core, the assigned depth number was supplemented with a letter (eg. 4221.6-A, 4221.6-B, 4221.6-C, etc.), see Figure 15.
3) Pieces that could not be fitted together but which represented a unique depth were assigned numbers, which were supplemented with an additional number (eg. 2431.8-1, 2431.8-2, 2431.8-3,etc.), see Figure 16
4) Pieces shorter than 2 inches in size were grouped according to the depth interval that they represented and placed into plastic bags. The bags were each assigned a unique depth number (usually the lowest depth represented unless a piece of core already had that number, then the nearest depth number in tenths of feet was chosen from the interval represented). The rubble bags were also labeled with the core number and interval that the rubble represented.

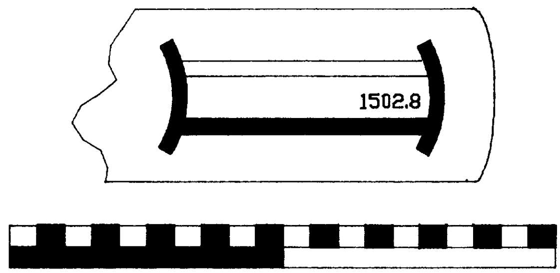


FIGURE 14. Example of application of core inventory number.

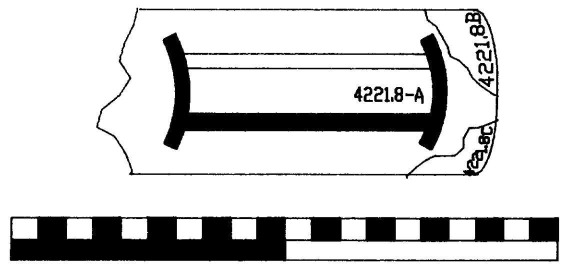


FIGURE 15. Example of application of core inventory numbers with pieces that fit precisely into the core.

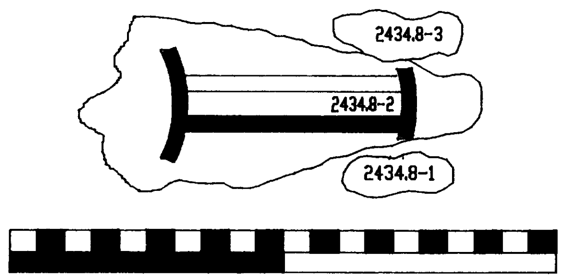


FIGURE 16. Example of application of core inventory numbers on pieces that appear to come from the same depth interval but whose edges do not fit together precisely.

BOXING OF CORE

After initial handling and documentation were completed, the cores 4 inches in diameter or less were placed in boxes. Standard 36-inch long, double faced, non-waxed cardboard boxes were used and had to be constructed prior to use. Each box contained a single segment of core 35 inches in length or less.

Fragile core was boxed appropriately to maintain as much of the original core integrity as possible. This was accomplished by using styrofoam to separate pieces, wrapping pieces in plastic wrap, and/or placing the segment of core into PVC trays with covers secured with fiber tape. Care was taken to preserve surfaces of geologic interest. For example, opposing slickensided fault surfaces or mineralized fracture surfaces were separated by styrofoam to prevent their destruction by rubbing together.

When samples were removed from the boxes and stored elsewhere, a label marker was placed in the box stating the type of sample and interval removed.

All extra open space in the storage box was filled with styrofoam to prevent the core from shifting and causing further breakage.

Large diameter core (greater than 4-1/2 inches) was stored in plastic PVC pipe until it was slabbed. Once slabbed, the sample set was boxed like the smaller diameter core.

The labeling proceedure for the boxes is as follows:
DOSECC
CAJON PASS
Core #____
Interval Cored xxxx.x-yyyy.y
Seg. #____
Footage in Box xxxx.x-yyyy.y
Box __ of __

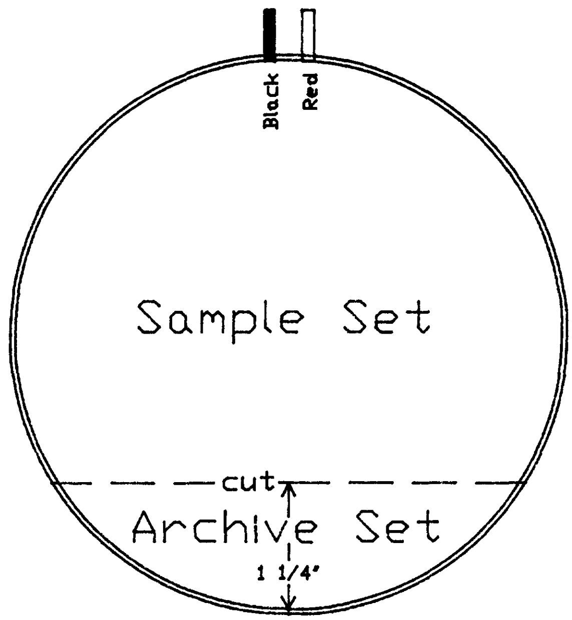
CORE SLABBING PROCEDURES

Cores were slabbed after photo documentation and gamma measurement. Generally, slabbing was done on a regular basis, within one month after recovery. All slabbing was done prior to any sampling with the exception of Physical Properties and some thin-section samples.

The procedure for slabbing depended upon the diameter of the core (see diagrams in Figure 17). For cores 4-1/2" or less in diameter, one slab 1-1/4" thick was cut along the full length of the core and used as the archive set. The archive slab was cut from the face oriented at 180 degrees from the black and red archive lines and was continuous across breaks, fractures, etc. If an oriented core was taken, it was positioned in the saw so that the reference scribe was on the archive slab. After cutting, the archive slabs were marked with depth numbers and arrows pointing in the "up-hole" direction. The archive slabs were then put in standard 1.5"x12"x40" boxes and the remaining sample material was placed into 4.25"x4.25"x36" boxes. Photographs were taken of the boxed archive slabs.

For core greater than 4-1/2" in diameter, two slabs were cut, each 1-1/4" thick, along the full length of the core. The archive slab was cut from the face oriented at 180 degrees from the black and red archive lines, in the same manner as for smaller diameter core. The other slab (designated as the working set) was cut from the face oriented at 90 degrees from the black and red archive lines. The second cut on the larger diameter core (designated as the working set) was necessary to fit the remaining smaple material into available core boxes and provide a convenient slab for on-site scientists to examine. The archive slab was cut **before** the working slab. Both the archive and working sets were marked with "up" arrows and depth numbers and placed in 1.5"x12"x40" slab boxes. The remaining core was designated as sample material and placed into 4.25"x4.25"x36" core boxes. If the core was oriented, it was positioned in the saw so that a reference scribe was on the archive slab and an additional scribe was located 120 degrees counterclockwise from the reference scribe (looking downhole) on the working slab. When the archive boxes were filled, they were photographed in the same manner as the smaller diameter core.

Core diameter < 4 1/2″



Core diameter ≥ 4 1/2″

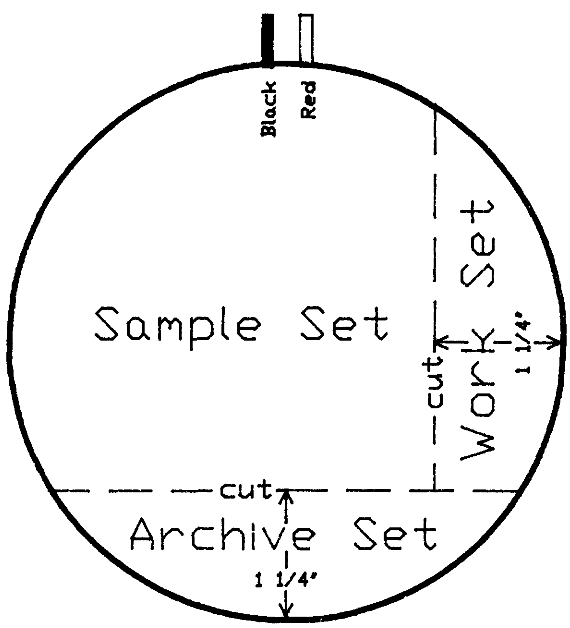


FIGURE 17: SLABBING PROCEDURE DIAGRAMS

During slabbing, it was necessary to clamp the core in place so that it would not move while the saw was being operated (see Figure 18). The optimum rate of operation for the slabbing saw was to set the saw blade feed lever at a rate of cutting that produced a deflection **between 10 and 11** on the saw's amp meter. The saw's manufacturer recommended that the slabbing saw **never be operated** at a speed which produces a amp meter deflection **greater than 13**. Use of hearing protectors was necessary when the slabbing saw was in operation.

SAMPLE ALLOCATION PROCEDURES

The "DOSECC Sample Handling and Curation Protocol" (Appendix II) provides guidelines for sample studies and allocations. The requirements stated below conform to this Protocol.

Core and cuttings samples collected during the first (0 to 6938 feet) and second (6938 to 11,515 feet) phases of drilling at the Cajon Pass site are now archived at the U.S. Geological Survey's Core Research Center in the Denver Metropolitan area. The location of and shipping address for the Core Research Center is:

USGS Core Research Center
Bldg 810, Entrance S-26
Denver Federal Center
Lakewood, CO 80225

Drilling samples returned to the Core Research Center using United Postal Service (UPS) or a commercial trucking firm should be **shipped** to the **above** address.

Please note that any samples, data publications, and other correspondence sent to the Core Research Center through the U.S. Postal Service **must** be mailed to:

U.S. Geological Survey
Core Research Center
Mail Stop 975
Box 25046 Federal Center
Denver, CO 80225

Requests for Samples from Material Stored at the Core Research Center

Sampling and detailed study of the core and cuttings is restricted to Cajon Pass Project Principal Investigators (PI's) for a period of approximately 1 year after the completion of drilling at Cajon Pass. Appointments for sampling or viewing of the material archived at the Core Research Center should be made at least 1 week in advance by calling the USGS Core Research Center at (303) 236-1930.

Any Project PI needing sample material archived at the Core Research Center should submit a completed Sample Request Form to a member of the Cajon Pass Sample Allocation Committee (Mark D. Zoback, Leon T. Silver, or John H. Sass). The Committee will make recommendations to DOSECC for final approval of the requests. For efficient and timely distribution of small, reasonable amounts of Cajon Pass samples, requests from PI's can be approved orally by telephone calls to a Committee member and to DOSECC. A set of 5"x7" photos (~1/3 actual size) covering the length of each core in four rotations is available for viewing at the Core Research Center. Copies of the photos can be made upon request and at the expense of the PI.

Return of Sample Material

Samples collected from the Cajon Pass drilling project are the exclusive property of DOSECC, with the USGS Core Research Center acting as its curatorial agent. All samples allocated to PI's must be returned to The Core Research Center once analyses have been completed. This includes plugs, cubes, slabs, crushed core, any drilling cuttings and all thin-sections made from Cajon Pass materials.

Samples returned must be documented as to depth, sample number, and orientation (if applicable), and a description of the analyses performed on each sample for reference by future investigators. Information needed includes:

1) Type of experiments performed on the samples (eg. paleomagnetics, thermal or electrical conductivity, geochemical analysis, etc.).

2) Materials and conditions under which the samples were subjected (e.g., acid treatments, heating runs, electrical and/or magnetic fields, etc.).

3) The degree to which the samples were subjected under the various conditions (eg. maximum temperature, electrical and/or magnetic field intensities, maximum stress applied, etc.).

4) If samples remain in a solid form (plugs, cubes, etc.), what is the orientation of the sample relative to the red & black archive lines?

Any new markings added for analytical orientation must be adequately defined for possible use by future investigators. For example, if a cube is cut from a section of full diameter core, the orientation and depth of the cube, as well as the unused side portions, should be carefully marked and described so that each piece can be placed back in its original configuration with respect to the rest of the archived core.

Finally, the PI's shall send to the Core Research Center a copy of their final analytical results and any attendant reports or publications for all information gathered from the Cajon Pass core materials.

APPENDIX I

Core
Documentation
Forms

CAJON PASS SCIENTIFIC DRILLING PROJECT

Catwalk Operations

Core No.: _____ Depth Interval Cored: ______ to ______

Date of Core Recovery: / / Time Core Recovered: :

****

Location of core ejection: ______________________________________

Core Receivers: ____

Methods and conditions of core ejection: _________________________

____

____

Marking procedure for core continuity: __________________________

____

No. of trays used & tray #'s from bottom up: __:_________________

____

Initial observations of core and its condition: __________________

____

____

____

____

Methods of core collection (ie was core broken, sawed, etc): ____

____

Preliminary estimate of core recovery in feet: __________________

Notes: ____

____

____

____

CAJON PASS SCIENTIFIC DRILLING PROJECT

Initial Core Examination

Core no.: _____ Depth Interval Cored: ______ to ______

****

Initial cleaning methods: Date: Time: Preparator:

__________________________________ / / __:__ ____________

____

____

Tools and materials in contact with the core: ____________________

____

____

Revised estimate of core recovery in tenths of feet: ___.__

Condition of Core

a) Coherent: _____%

b) Broken-up: _____%

c) Crushed: _____%

d) Other: _____%

Depth of Physical Properties sample in feet: ________.___

Weight of Physical Properties sample in grams: __________

Orientation of black archive line
relative to true north in degrees azimuth: ______

Notes: ____

____

____

____

CAJON PASS SCIENTIFIC DRILLING PROJECT

Core Documentation

Core No.: _____ Depth Interval Cored: ______ to ______

****

Standard archive markings applied by: ___________________________

Date markings were applied: / /

Description of any non standard markings applied to core: _______

____

____

List core segment no.s with their corresponding

segment footage interval.

#____: from________to________ #____: from________to________

#____: from________to________ #____: from________to________

#____: from________to________ #____: from________to________

#____: from________to________ #____: from________to________

#____: from________to________ #____: from________to________

#____: from________to________ #____: from________to________

Labeling sequence for core's footage marks
(top to bottom or visa versa): _________ to ________

Video tape documentation:
(tape # @ count #)

original tape: ____@_______

* 35mm photo documentation:
*
* no. of prints per rotational view
*
* 0 deg. rotation: _____
* 90 deg. rotation: _____
* 180 deg. rotation: _____
* 270 deg. rotation: _____

notes: ____

____

CAJON PASS SCIENTIFIC DRILLING PROJECT

Initial Core Inventory

Page: ___ of ___

Core No.: _____ Depth Interval Cored: ______ to ______

Total Footage Recovered: _______

****

Segment no.: ___ Date boxed: / / By whom: _______________

Segment interval no.	Interval subnumber(s)	Condition of core	Strength of core (w,m,s)	Interval weight	Note

Segment no.: ___ Date boxed: / / By whom: _______________

Segment interval no.	Interval subnumber(s)	Condition of core	Strength of core (w,m,s)	Interval weight	Note

CAJON PASS SCIENTIFIC DRILLING PROJECT

Phase II

Core Gamma Measurements

Page: _____

Core no.	Depth (ft.)	Core diam. (in.)	Core length defic. (ft.)	Measured gamma activity (rel. to backgr.) $Y_{x"}$	$Y_{4.0"}$	Zi	C $\frac{19.0}{19.0-2(Zi)}$	G $CxY_{4.0"}$	$Y_{4.0"std}$	API gamma-ray units $\frac{G \times 222}{(Y4.0"std)}$	Date, Handler(s), and Comments

35mm Photo Log

Page ______

ROLL #	PHOTO #	CORE #	DATE	F/STOP	COMMENTS

CAJON PASS SCIENTIFIC DRILLING PROJECT

Slabbing Record

Core no.	Segment no.	Slab Taken archive	Slab Taken working	Date	Handler(s)	Comments

DOSECC - CAJON PASS PROJECT
Sample Request Form

page 1 of _____

Request by Investigator:

Investigator:________________________________ Phone No:_______________

Address: ____

____

____

Date of Request:___/___/___ Number of Samples Requested:______

Purpose of Request:____

Special Sampling Instructions (continue on separate page if necessary):____

____

____

Complete list of Samples Requested Form (attached)

Recommendation by Cajon Pass Sample Allocation Committee:

(check one) Grant Request ____ Deny Request ____

Comments or Reason for Denying Request ____________________________

____

____

____________________________________ Date: ___/___/___

(*) Signature of Committee Member

Approval by DOSECC:

(check one) Approved ____ Disapproved ____

Comments or Reason for Disapproval ________________________________

____

____

____________________________________ Date: ___/___/___

(*) Signature of DOSECC Staff

Sample Request Filled:

____________________________________ Date: ___/___/___

Signature of USGS Core Library Staff

(*) If recommendation and/or approval made by telephone, print name in blank.

DOSECC-CAJON PASS

List of Samples Requested

page ___ of ___

Investigator:______________________________ Date of request: / /

Core no.	Seg. no.	Sample depth	Sample type (plug,slab,etc.) and size	Description of features to be sampled

CAJON PASS SCIENTIFIC DRILLING PROJECT

Samples Allocated Form

Page: ___

Principal Investigator: ______________________________

Purpose of Samples: ______________________________

Handler(s): ____________________ Date: / / Time: ___:__

Recieved by or shipped to: ______________________________

Date shipped: / / ______________________________

via: ______________ ______________________________

****

Core no.	Seg. no.	Assigned Depth	Size	Weight	Condition	Equiv. retained	Comments

APPENDIX II

DOSECC Protocol

DOSECC SAMPLE HANDLING AND CURATION PROTOCOL

DEEP OBSERVATION AND SAMPLING
OF THE EARTH'S CONTINENTAL CRUST, INC.
(DOSECC)

1755 Massachusetts ave., N.W., Suite 700,
Washington, DC 20036

May 1986

CONTENTS

DOSECC SAMPLE HANDLING AND CURATION PROTOCOL

EXECUTIVE SUMMARY

Studies of samples collected during projects managed and funded by Deep Observation and Sampling of the Earth's Continental Crust, Inc. (DOSECC) as part of the national continental scientific drilling program encompass two time frames: detailed studies during drilling and immediately following hole completion, and reexamination of samples with new analytical techniques and research objectives after project completion. This protocol provides guidelines to ensure that the handling and curation of samples is such to permit these studies. The protocol, along with the project Science Plan, will be the documents governing samples collected for each DOSECC project.

A U.S. Geological Survey (USGS) curation staff at the drill site, under the supervision of a project Sample Manager, will be responsible for initial handling and analyses of drilling samples. The samples will be split at an appropriate time to provide a Working Sample for experiments by the project scientists, and an Archive Sample to be curated at the USGS Core Research Center in Denver, CO.

The protocol describes the responsibilities of the on-site drilling project personnel for sample collection, and lists equipment available for immediate on-site analyses. The project Principal Investigator, working under a DOSECC contract, has the prime responsibility for managing sample analyses and sub-sampling for other investigators as specified in the Science Plan. The Sample Manager and curation staff are provided under an agreement between the USGS and DOSECC addressing sample handling, on-site analyses, and curation as described herein. Responsibilities of archive facilities are specified, and a policy for sample distribution is promulgated.

INTRODUCTION

Comprehensive scientific information acquired during a Deep Observation and Sampling of the Earth's Continental Crust, Inc. (DOSECC) research drilling project will come from core, cuttings, and fluid samples. Careful handling, analysis, and curation of samples are vital in providing the following critical elements of the national continental scientific drilling program:

1) Materials and information required to accomplish the proposed science goals of a research drilling project.

2) Permanent documentation of the geological, geophysical, geochemical, and hydrological environments encountered in the drill hole.

3) Correlation of sample properties with geophysical, drilling, and mud logs to enhance the interpretation of such logs and allow correlation with results of surface geological, geophysical, geochemical, and hydrological studies.

4) Timely information to the drilling staff and project scientists to allow possible modifications to the Science Plan to maximize the scientific value of the project.

5) Preservation of samples and relevant data for future scientific studies.

Scientists from academic institutions, industry, and government laboratories provided comments in the preparation of this document. This protocol, along with each project's Science Plan, will govern the sample handling and curation activities for DOSECC research drilling activities.

OBJECTIVES

For the purpose of this protocol, handling will be defined as the physical handling of samples from the drill rig to the on-site sample processing and laboratory facilities, to intermediate archival facilities, and finally to the USGS Core Research Center in Denver, CO. Analyses of the samples on-site, as described in this document, are considered part of sample handling. Curation refers to the identification, boxing, indexing, filing, accession, and deaccession of drilling samples under the control of DOSECC through principal investigators, intermediate archival facilities, and/or the USGS Core Research Center.

The objectives of this protocol are to ensure that all drilling samples and related data collected during DOSECC funded projects are properly handled and curated, and to provide a permanent physical record of the drill hole for future studies. The protocol provides guidelines for scientists requiring sample material from DOSECC research drilling projects.

Basic concepts for handling and curation of research drilling samples and related data are as follows:

1) Samples and data are owned by DOSECC and represent a present and future national resource.

2) Drilling samples will undergo analyses to determine the source of the material from within the geological section penetrated by the drill, to provide documentation of each drilling project, and to identify in a timely manner certain ephemeral properties that must be measured as soon as possible after the drill penetrates the environment. Most on-site analyses will be conducted on whole-diameter cores prior to slabbing.

3) After appropriate analyses on site, a representative sample (the Archive Sample) and suite of descriptive data from the drilling project will be permanently archived for future access by the public at the USGS Core Research Center. As new scientific ideas and analytical tools become available, the Archive Samples will provide opportunities to restudy the material and hence maximize the value of each drilling project.

4) The remainder of the sample (the Working Sample) will be available for subsampling and analyses by the principal investigators and other contracted scientists. It is the obligation of the scientists conducting experiments for each project to curate the Working Sample and subsamples in such a manner as to preserve their integrity, identity, orientation, and location. Upon completion of the project studies, the remaining Working Sample, with thin or polished sections and analytical results, will be archived at the USGS Core Research Center, or at an appropriate curation facility as designated in the project's Science Plan.

5) A timely and complete record of observations, measurements, and techniques employed will be added to the data base following each step of sample handling and analysis.

6) Deaccession of DOSECC samples and/or related data from archive facilities will occur only with joint approval of DOSECC and archive management.

PERSONNEL AND RESPONSIBILITIES

The final Science Plan for each project, as approved by DOSECC's Science Advisory Committee (SAC), contains detailed information on the sampling program, including sampling intervals, time to be allotted for sampling, and cost estimates. Figure 1 is a general organization chart that indicates individuals having a role in handling and curation of samples.

The Drilling Supervisor is a DOSECC employee, and the Logging Contractor and Principal Investigator work under contract with DOSECC. The Sample Manager, along with other sample handling and curation personnel, are employees of the USGS working under an agreement between the USGS and DOSECC. The intermediate archive managers and DOSECC Acting Curator are responsible to DOSECC for sample management and archiving as defined in this protocol.

The Principal Investigator is responsible for implementing and managing the Science Plan, including supervision of scientific personnel and coordination of downhole science experiments with the Drilling Supervisor and other scientific investigators.

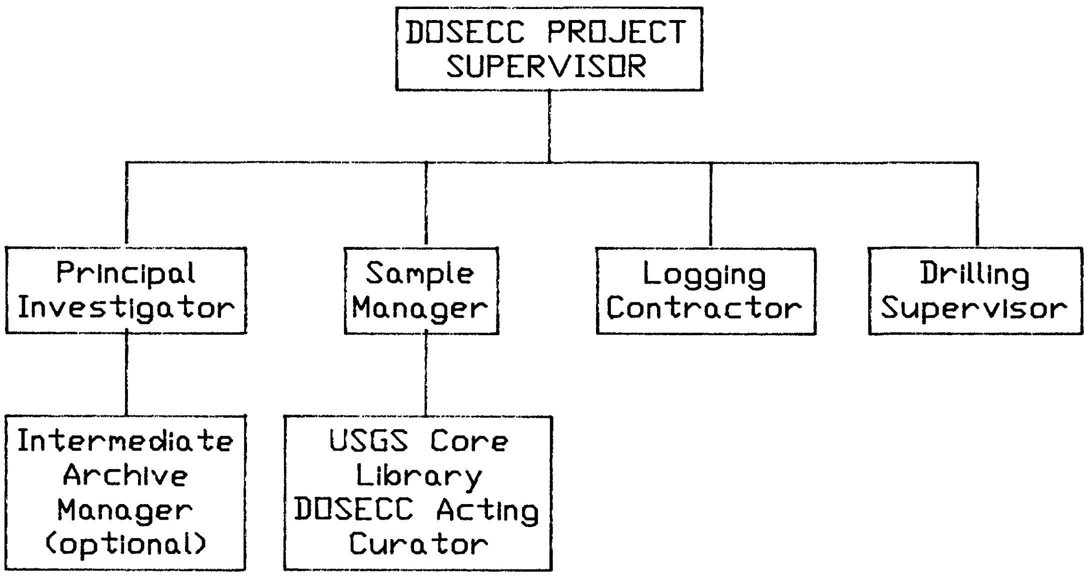
The Drilling Supervisor is resonsible for supervising contractors in all aspects of the operation, including drilling, coring, and logging at the drill rig, and for scheduling and coordination of sample collection activities.

The Sample Manager supervises personnel responsible for receiving samples from the drill rig floor and mud logger, conducting and recording sample preparation (cleaning, marking, orientating, etc.) and specified standard on-site analyses, and preparing the Working Sample and the Archive Sample. The Archive Sample is boxed and shipped to the USGS Core Research Center by the Sample Manager at a time appropriate for optimum conduct of the drilling experiments. At the USGS Core Research Center, the DOSECC Acting Curator (at present, the USGS Curator) is responsible for proper archiving of DOSECC samples.

The Principle Investigator is responsible for handling the Working Sample made available by the Sample Manager, including standard fracture and lithologic logs and project-specific analyses, subsampling, on-site storage, and proper curation at an intermediate curation facility if specified in the Science Plan. Transportation of the Working Sample to an intermediate archive is the responsibility of the Principal Investigator. Other project scientists receiving subsamples are responsible for proper handling and curation to preserve the integrity of these materials. Unused portions of the subsamples are to be returned, along with thin or polished sections and analytical results, to the Principal Investigator or the DOSECC Acting Curator as outlined in the Science Plan.

The Logging Contractor is responsible for correlation of the geophysical logs collected downhole with the geophysical scans conducted on the core samples and the determination of true depth intervals from which the sample was cut.

FIGURE 18. SAMPLE HANDLING AND CURATION PERSONNEL



ON-SITE EQUIPMENT

Facilities and equipment required for handling, standard analyses, and curation of drilling samples on site will be provided by the USGS under the responsibility of the Sample Manager. Sample processing facilities and other temporary buildings or truck trailers will be available for on-site analyses, examination, and storage of archive samples and portions of working samples as required. Housing for the Sample Manager and the handling and curation team during a drilling project will be provided by the USGS.

Table 1 summarizes equipment to be provided by the USGS. Other analytical equipment required for on-site scientific studies will be provided by project investigators.

TABLE 1: ON-SITE SAMPLE PROCESSING EQUIPMENT PROVIDED BY THE USGS.

Facilities

Sample processing
Sample examination and storage
Transport of samples to archive(s)

Equipment

Layout tables with long core trays
core racks
*Core total and spectral gamma analyzer
Sonic scan
*Magnetic susceptibility scan
Video camera and play-back equipment
35-mm cameras for color photographs
Photo table with quartz lights
Binocular microscopes
Sample marking, measuring, and examination (hand lenses) equipment
Sample transport carts
Drill press and plugger with 1-inch diameter standard bit
Slab saw
Trim saw
Exhaust hood for saws
Lapping machine
Sink and water storage tank
Water heater
Core storage boxes
Box stapler
Box banding machine
Desks, chairs, lights, etc.
Vacuum cleaner
Freezer
Hooded chamber

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*To be purchased by DOSECC

ON-SITE SAMPLING PROCEDURES

Most drilling projects undertaken by DOSECC will involve the acquisition of extensive, and often continuous cores. Cuttings and fluid samples will be collected as specified in the individual project Science Plan. A standard fluid sampling schedule may evolve as the DOSECC drilling program develops.

Samples will normally undergo certain standard handling procedures and analyses under the direction of the Sample Manager prior to being transferred to the project Principal Investigator and scientists responsible for project studies and subsampling. Project scientists or their representatives must be on site to accept subsamples when taken by the Sample Manager. Timing is critical when the Science Plan calls for measurement of ephemeral properties by these scientists. A DOSECC Sample Handling Procedure Manual, prepared by the USGS, provides details of specific on-site sampling operations, including numbering, labeling, core aligning, cleaning, marking, on-site analyses, video scans and photography, breaking and slabbing, and data forms.

CORE HANDLING AND CURATION

Since most coring will be conducted using wire-line techniques, handling and curation procedures begin when the core liner (metal inner tube, with or without plastic liner) is removed from the hole. TO accommodate core handling and fluid sampling, use of a triple-tube core barrel with an inner plastic core liner is being considered based on efficiency of core recovery and cost. The core sample handling flow diagram when using a plastic core liner is shown in Figure 2A and will be discussed below. Figure 2B shows the flow diagram when the plastic liner is not used, and will be discussed in the next section. Figures 3 and 5 show continuation of the sample processing flow after slabbing.

<u>Coring Using Plastic Liners</u>. The drilling/coring crew will remove the plastic liner from the inner tube, measure the core recovery, cap each end, and deliver it to the Sample Manager at the on-site sample processing laboratory for initial marking. When transferring the core sample, care will be taken to avoid disturbance or breaking of the core.

FIGURE 19. ON-SITE CORE SAMPLE FLOW DIAGRAM (PLASTIC CORE LINER)
(*,@, and # denote responsible manager - see below)

@ Core liner delivered to sample processing laboratory.

* Mark core liner.

Volatile/fluid sampling (from Science Plan).

* Sonic scan; cut lined core into 1 meter sections and mark.

* Total gamma-ray emission.

* Remove core sections from liner; place in trays.

* Clean, align, and mark core.

* Video tape recording scan.

* Spectral gamma-ray emission; magnetic susceptibility.

& * Sample for ephemeral properties (from Science Plan).

- - - - - - - - - - - Time Pressure Ends - - - - - - - - - - -

& * Whole-core sampling; plugging; special measurements (from Science Plan).

Fracture log; outline lithologic log.

* Slab core.

ARCHIVE SAMPLE

* Mark core.

(see Figure 22)

WORKING SAMPLE

* Mark core.

(see Figure 21)

@ = Drilling Supervisor   * = Sample Manager   # = Principle Investigator

FIGURE 20. ON-SITE CORE SAMPLE FLOW DIAGRAM (NO PLASTIC CORE LINER)
(*, @, and # denote responsible manager - see below)

@ Remove core from inner tube; place in core trays.

@ Transfer core trays to lab.

* Clean, align, and mark core.

* Video tape recording scan.

* Total and spectral gamma-ray emission; magnetic susceptibility.

* Break into 1 meter sections; re-align and mark as necessary.

& * Special sampling for ephemeral properties (from Science Plan).

\- - - - - - - - - - - Time Pressure Ends - - - - - - - - - - -

& * Whole-core sampling; plugging; special measurements
(from Science Plan)

Fracture log; outline lithologic log.

* Slab core.

ARCHIVE SAMPLE

* Mark core.

(see Figure 22)

WORKING SAMPLE

* Mark core.

(see Figure 21)

@ = Drilling Supervisor * = Sample Manager # = Principle Investigator

FIGURE 21. CORE WORKING SAMPLE FLOW DIAGRAM

(Principal Investigator Responsibility)

WORKING SAMPLE

Detailed lithologic log.

Subsampling by sawing or plugging.

Other on-site analyses (as called for by Science Plan)

Sample retained on site until completion of drilling or boxed and sent to intermediate archive or USGS Core Research Center.

Receive at intermediate archive.

Index and file.

Further description, subsampling, analyses.

Send remaining samples to USGS Core Research Center as ARCHIVE SAMPLE.

(see Figure 22)

Receive at USGS Core Research Center as ARCHIVE SAMPLE.

(see Figure 22)

FIGURE 22. CORE ARCHIVE SAMPLE FLOW DIAGRAM
(Sample Manager Responsibility)

ARCHIVE SAMPLE

Color photography (copies to archive, drill site, project scientists, etc.)

Ship to the USGS Core Library.

Index and file at USGS Core Research Center.

Non-destructive study.

Combine with WORKING SAMPLE.

Deaccession procedures.

In the laboratory, the Principal Investigator or a project scientist will collect fluid samples through the plastic liner if called for in the Science Plan and the presence of fluids of interest is recognized from a study of the mud and drilling logs. Then a sonic scan of the liner will be conducted to determine the optimal locations for cutting the lined core into practical lengths for handling (1 meter or less).

When cut, the Sample Manager and his staff will mark the lined core sections and conduct a total gamma-ray emission scan on each section. If sampling for studies of ephemeral properties (e.g., active chemical processes, stress relaxation, special sample preservation) is called for in the Science Plan, preparation for this sampling will be made at this time.

The core section will then be removed from the plastic liner and placed in trays, where it will be cleaned, aligned, and marked. A video recording tape scan of the sample will be conducted, followed by spectral gamma-ray and magnetic susceptibility scans. Then whole-core sampling will be conducted for ephemeral properties as directed in the Science Plan. At this point in the flow diagram, the pressure to collect subsamples from the core to measure time-dependent properties is relieved.

If short sections of whole core or plugs of whole core are required for later analyses, as identified in the Science Plan, such subsamples will be taken by the Sample Manager at this time. Each of the subsamples will be assigned a unique identification number before being removed from the core sample. The scientific investigators receiving these subsamples for analyses are responsible for returning unused portion to the Principal Investigator or the DOSECC Acting Curator upon completion of analyses, along with any thin or polished sections, experimental techniques, and the copies of the analytical results.

Fracture logs will be run before breaking and slabbing the core. This work will be conducted under the supervision of the Principal Investigator and provides an opportunity to begin an outline lithologic log. The Science Plan will identify the responsible investigators. At this point in the core processing flow, the Science Plan may call for occasional delay of one or two days before going to the next step (slabbing of core) to enable project scientists to study the whole core for inhomogeneous textures and composition that may be disturbed by division during slabbing. Some additional whole core subsamples may be required.

An appropriate width longitudinal slab will be made of each core section. The slab will become the Archive Sample and be marked, photographed, boxed, and transported by the Sample Manager to the USGS Core Research Center in Denver, CO. The remainder of the core is marked, and then becomes the Working Sample for distribution and study under the direction of the Principal Investigator as defined in the Science Plan. In special instances, a project Science Plan may specify that, at this point in the processing, all of the whole core will be sent to the USGS Core Research Center for subsequent slabbing and further processing.

Coring without Plastic Liner. If a plastic liner is not used, the drilling and coring crew will remove the core from the inner tube, place it in core trays, and transport it to the sample processing laboratory. When transferring the core sample, care will be taken to avoid disturbance or breaking of the core.

In the laboratory, the core will be cleaned, aligned, and marked. A video tape recording scan will be conducted, followed by gamma-ray emmision and magnetic susceptibility scans. Then the core will be broken into 1 meter sections and realigned and marked as necessary.

If studies of ephemeral properties is called for in the Science Plan, appropriate samples will be collected at this time. The time pressure to collect subsamples from the core is now relieved, and the flow of sample processing becomes the same as for the core recovered in plastic liners.

Working Sample. Normally the Working Sample will be prepared, described, subsampled, and stored at the drill site for a specified period of time. In special cases, the project Science Plan may specify that the Working Sample be transported immediately to an intermediate archive or the USGS Core Research Center.

The Principal Investigator and other project scientists will prepare a detailed lithologic log from the Working Sample (Figure 3), using the standard format described in the DOSECC Sample Handling Procedure Manual. Subsamples for experiments approved in the Science Plan may then be taken. No sample may be removed until assigned a unique identification number. Further on-site analyses as provided for in the Science Plan are the responsibility of the Principal Investigator.

Upon completion of drilling, the Principal Investigator is responsible for delivering the Working Sample to an intermediate archive as specified in the Science Plan or to the USGS Core Research Center for further study and subsampling. If the sample is transferred to an intermediate archive, the Principal Investigator is responsible for the sample and making it available for additional studies.

Two years after completion of the drill hole, the remaining Working Sample and associated thin or polished sections, analyses, data compilations, etc., will be sent by the Principal Investigator to the USGS Core Library to be merged with the Archive Sample unless other arrangements are stipulated in the Science Plan. If the Working Sample is kept at the intermediate sample archive, DOSECC retains ownership of these samples and is responsible for decisions on deaccession of such samples.

Archive Sample. The Archive Sample will be photographed in color on site and shipped to the USGS Core Research Center (Figure 4). This sample will be preserved for visual inspection and examination, and no subsampling will be allowed without written approval from DOSECC. At the USGS Core Library, the

DOSECC Acting Curator assumes responsibility for the maintenance of DOSECC samples, including indexing and filing for availability by the public 1 year after completion of drilling or, for multiyear drilling projects, after an appropriate conference of principal investigators to review interim results for preparation of publications. When the remainder of the Working Sample is received at the USGS Core Research Center, DOSECC and the DOSECC Acting Curator will decide action on requests for subsamples from the Working Sample. Any decisions for deaccession of DOSECC samples will be made by DOSECC.

True Depth Determination and Marking. After geophysical logging is completed in the project drill hole, the Logging Contractor will correlate the gamma-ray emission and magnetic susceptibility scans of the core with appropriate logs to determine the true depth intervals of the core sample. These depth determinations will be sent to the Sample Manager or the DOSECC Acting Curator, who will distinctively re-mark the Archive and Working Samples. If the Working Sample is under the control of the Principal Investigator, the DOSECC Acting Curator will notify him/her as to the proper re-marking. Scientists working on subsamples also will be notified by the DOSECC Acting Curator as to the true depth determinations.

CUTTINGS

During drilling, with or without continuous coring, specified amounts of cuttings will be collected at regular depth intervals as prescribed in the Science Plan. If continuous coring does not provide adequate samples, the Principal Investigator may direct collection of cuttings at more frequent depth intervals. Under the direction of the Sample Manager, cuttings will be collected, washed, described, subdivided, and placed in properly labeled sample bags by the Mud Logger. The Sample Manager will send the Archive Sample to the USGS Core Library for indexing and filing.

The Working Sample of cuttings is described by the Principal Investigator, after which subsamples will be distributed as specified in the Science Plan. Any material remaining from the Working Sample and its subsamples, including thin sections, board-mounted material, and analytical data, will be returned to the DOSECC Acting Curator upon completion of analyses for filing.

FLUIDS

Collection of fluid samples will be identified in the Science Plan and may include samples of drilling fluid and additives to provide information on contamination of formation fluids. These samples will be collected by the Mud Logger under the direction of the Principal Investigator. Fluid sampling from the core will be conducted by the Principal Investigator at a time designated by the Sample Manager. Some fluid analyses may be conducted by the project scientists at the drill site, whereas other chemical and isotopic constituents can be analyzed in laboratories if the samples are appropriately preserved with stabilizing agents and properly stored in containers.

Science Plans that require the collection of fluid samples as part of a project will specify the collection method and the techniques for preservation.

ARCHIVING PROCEDURES

DOSECC, in consultation with the DOSECC Acting Curator and the project Sample Manager, will assign appropriate unique identification numbers to each project sample and subsample. These identifiers will be used by all scientists and archive managers for documentation. Since representatives of the three classes of samples (Archive Sample, Working Sample, and/or subsample) associated with a DOSECC drilling project may be in the process of analysis or storage at several locations, careful records will be taken by the Principal Investigator or intermediate Archive Manager and sent to the DOSECC Acting Curator as to the person responsible for each sample. Scientists receiving subsamples must handle such materials in such a manner that unused portions may be integrated into the Archive or Working Sample upon return to the proper archive.

Procedures for archiving drilling samples will follow those used by the USGS Core Research Center. Upon receipt, the sample and relevant data are cataloged and a permanent data card is entered into a file. Core sample boxes are given permanent labels containing a library number, the number of boxes in each project, the drill hole identifier plus a subsample identifier if appropriate. This information is simultaneously entered into the archive's master file. Core boxes are then stored.

Cuttings, thin sections, photographs, logs, and analytical data are stored in a manner specified by the DOSECC Acting Curator and cross-referenced to samples collected from the same drill hole. Examination rooms with microscopes and photography equipment will be available at each archive facility holding DOSECC samples.

SAMPLE DISTRIBUTION POLICY

The policy for distribution of samples produced in DOSECC-supported projects will follow generally that currently being used by the Ocean Drilling Program (JOIDES, 1985; Ocean Drilling Program, 1985). Samples herein referred to are subsamples from the Working Sample, or short whole-core samples collected on-site before slabbing. The following addresses are relevant to this policy:

Chairman, Science Advisory Committee
601 Elm St., Room 438C
Norman, OK 73019

DOSECC
1755 Massachusetts Ave.,N.W.
Suite 700
Washington, DC 20036

DOSECC Acting Curator
U.S. Geological Survey
Core Research Center
Bldg 810, Entrance S-26
Denver Federal Center
Lakewood, CO 80225

Principal Investigator--
identified for each project
or contacted through DOSECC

Distribution of DOSECC samples is undertaken to provide scientists with material to achieve the scientific objectives of the project, and to provide samples to conduct detailed studies beyond the scope of each DOSECC project Science Plan.

The project Principal Investigator and the DOSECC Acting Curator are responsible to DOSECC for distributing, preserving, and conserving sample materials, and, acting on advice from appropriate DOSECC advisory panels, are responsible for enforcing the provisions of this sample distribution policy. They are responsible for maintaining a record of all samples that have been distributed, both on-site and subsequently from the archives, indicating the recipients and the nature of investigations proposed. This information is available to interested investigators on written request. Distribution of sample materials is made directly by the project Principal Investigator at the drill site or from an intermediate sample archive under his/her control, or from the USGS Core Research Center by the DOSECC Acting Curator or the designated representative(s).

DOSECC-SUPPORTED EXPERIMENTS

Each DOSECC project Science Plan approved by SAC will identify scientists to receive samples for analyses. Other investigators wishing to acquire samples from a DOSECC project may submit a written proposal to the Chairman of the DOSECC Science Advisory Committee (SAC). Requests for specific sample studies must be received at least three months in advance of the project starting date in order to allow time for review of the request and suitable on-site sampling program if the project is approved. The request should include a statement of the nature of the proposed research, size and approximate number of samples required to complete the study, and any particular sampling technique or equipment required. Requests will be reviewed by SAC and the project Science Experiments Panel (SEP). Approval/disapproval will be based upon the scientific merits of the project. The scope of a request must be such that samples can be processed, research be completed, and results described in an appropriate report in time for inclusion in the relevant DOSECC project report.

Except for unusual situations, the total volume of samples removed will not exceed one-quarter of the volume of the total sample recovered, and no interval will will be depleted without written approval of DOSECC. A slab sample of core representing the Archive Sample will be retained at the USGS Core Research Center in a pristine condition.

The project Principal Investigator may invite scientists who are not project participants to perform special studies of selected samples in direct support of on-site project activities. In such instances, a careful record of samples removed will be made by the Principal Investigator and Sample Manager. Such investigations will contribute to the project reports to the same extent as original participants in the Science Plan. All requirements of the Sample Distribution Policy apply to such secondary experiments.

Requests to publish DOSECC drilling project-generated results in other than DOSECC reports within twelve (12) months of completion of the drill hole must be approved by the Principal Investigator and DOSECC in writing. After twelve months, other scientists may submit related papers for open publication provided they have already submitted and had accepted their contributions to DOSECC reports. Investigations which are not completed in time for inclusion in DOSECC reports for a specific project may be published in later DOSECC reports; however, project-related articles may not appear in other journals until the appropriate DOSECC project report has been published.

NON-DOSECC SUPPORTED EXPERIMENTS

Sample Requests. Researchers who wish to use samples for studies beyond the scope of the DOSECC project reports should submit sample request forms to the SAC Chairman for consideration by SAC and the DOSECC Acting Curator. Requestors are required to specify quantities and intervals of samples required, the nature of the proposed research, time required to complete the work and to submit results for publication, funding status, and availability of analytical equipment and space for the research.

Additionally, if the requestor has received samples from DOSECC previously, he/she will account for the disposition of the samples by citing published works, one copy of which must be sent to DOSECC. If no report has been published, the requestor will send a brief report on the status of the research. Unused and residual samples will be returned to the DOSECC Acting Curator when the project has terminated.

Requests for samples from researchers in government, academia, and industry will be honored in a similar manner as original investigators. Such researchers will be subject to the same obligations to publish results promptly in the open literature. Scientists examining DOSECC samples will provide to DOSECC copies of reports published and of data acquired in their research. To insure that all requests for samples can be considered, approval of requests and distribution of samples not indicated in the original Science Plan will be delayed until twelve (12) months after completion of the drilling project, or two (2) months after official publication of the sample descriptions, which ever occurs earlier. The only exceptions to this policy will be made for specific requests involving ephemeral properties. Copies of original core logs and data will be kept on open file at the DOSECC office and at the USGS Core Research Center in Denver.

Sampling Limits. It is anticipated that most sample examinations can be accomplished with sample weights of 25 grams or less. Investigators requesting larger amounts will provide justification for the larger sample sizes or for frequent intervals within the total sample. Requests for samples from thin layers, stratigraphically important boundaries, sections that are badly depleted, or sections in unusually high demand, may be delayed in order to coordinate requests from other investigators. Exceptional sample requests will require more time for processing than routine requests.

Investigators who wish to study ephemeral properties may request a waiver of the waiting period. If approved, the requestor may join the original project scientists and incur obligations noted earlier in the section on DOSECC supported experiments.

Funding. DOSECC project samples will be distributed after the requestor provides DOSECC with evidence that funding for the proposed research is available, or unnecessary. If a sample request is dependent upon pending funding, DOSECC may, at its discretion, provide the proposed funding organization with information on the availability of suitable samples. In exceptional cases, where the proposed research is innovative and highly relevant to the scientific objectives of a project, DOSECC may consider funding part or all of the research.

Responsibilities. Investigators who receive samples incur the following obligations:

1. To publish results promptly; however, project-related reports may not be submitted for publication prior to twelve (12) months following the completion of the relevant project unless it is approved and authored by the original on-site scientists under the direction of the Principal Investigator.

2. To acknowledge in pulications that the samples were supplied by DOSECC.

3. To submit twelve (12) copies of reprints of all published works to DOSECC.

4. To submit copies of all final analytical data obtained from the samples to the DOSECC office and the DOSECC Acting Curator.

5. To return all unused or residual samples, in good condition and with a detailed explanation of any processing they may have experienced, upon termination of the proposed research. In particular, all thin or polished sections manufactured on-site or in the repositories are to be returned to the DOSECC Acting Curator.

Repositories. The Archive Sample will be available for examination by interested parties at the USGS Core Research Center. If the Core Research Center has received the Working Sample from the Principal Investigator or the intermediate sample archive, it may be subsampled with the approval of DOSECC and the DOSECC Acting Curator. Only the DOSECC Acting Curator or delegate will remove samples from the archived materials.

Reference Library. A reference library of DOSECC project generated thin or polished sections, sample photographs, and drilling and analytical data will be maintained at the USGS Core Library for the use of visiting investigators. All thin sections produced on-site, at archives, and in the project scientists' laboratories will eventually be availbale at this library. It is recognized that project scientists may require further use of thin or polished sections in post-drilling studies. These sections must be returned to the DOSECC Acting Curator after a borrowing period of three (3) months.

REFERENCES

Goff, S. 1985. Curatorial policy guidelines and procedures for the Continental Scientific Drilling Program. Draft unpublished report, Los Alamos National Laboratories. 12pp. plus Field Procedures Manual.

JOIDES. 1985. Guide to the Ocean Drilling Program. JOIDES Journal, vol. XI, Spec. Issue No. 4. 93pp.

Michalski, T.C. 1980. U.S. Geological Survey Core Library, Denver, Colorado, Administrative Report. Preliminary unpublished report, U.S. Geological Survey. 20pp.

Ocean Drilling Program (ODP). 1985. Shipboard Scientists Handbook, Ocean Drilling Program, Texas A & M University. ODP Tech. Note No. 3. 170pp.

APPENDIX III

Listing of Cores Numbered from Bottom to Top

LISTING OF CORES THAT WERE **NOT** LABELED
USING STANDARD "TOP TO BOTTOM" LABELING PROCEEDURE

CORE	INTERVAL	DATE RECOVERED	FOOTAGE LABELED
1	870.0- 897.0	12/14/86	BOTTOM TO TOP
2	1053.0-1062.0	12/15/86	BOTTOM TO TOP
3	1062.0-1079.0	12/15/86	BOTTOM TO TOP
5	1710.0-1737.0	12/18/86	BOTTOM TO TOP
7	2290.0-2302.0	12/22/86	BOTTOM TO TOP
8	2302.0-2305.0	12/22/86	BOTTOM TO TOP
9	2308.0-2318.0	12/23/86	BOTTOM TO TOP
12	2823.0-2827.0	12/19/86	BOTTOM TO TOP
16	4209.0-4219.0	01/16/87	BOTTOM TO TOP
17	4432.0-4451.0	01/19/87	BOTTOM TO TOP
19	5419.0-5439.0	02/02/87	BOTTOM TO TOP
21	6050.0-6054.0	02/25/87	BOTTOM TO TOP
23	6063.0-6087.0	02/28/87	BOTTOM TO TOP
26	6240.0-6254.0	03/03/87	BOTTOM TO TOP
28	6502.3-6509.9	03/18/87	BOTTOM TO TOP
31	6740.0-6755.0	03/23/87	BOTTOM TO TOP
34	6924.0-6938.0	03/28/87	BOTTOM TO TOP