

U.S. Department of the Interior
U.S. Geological Survey

SAMPLE HANDLING AND CURATION PROTOCOL
FOR THE
CREEDE CALDERA MOAT SCIENTIFIC DRILLING PROJECT

by

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¹Reston, Virginia

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EXECUTIVE SUMMARY

Studies of samples collected during the U.S. Geological Survey (USGS) Creede Caldera Moat (CCM) drilling project, undertaken by the Interagency Coordinating Group for Continental Drilling (ICG) as part of the U.S. Continental Scientific Drilling Program encompass two time frames: 1) detailed studies during drilling and for two years following hole completion, and 2) later re-examination of samples with new analytical techniques or research objectives. This protocol provides guidelines to insure that the handling and curation of samples is such to permit studies in both time frames. This protocol, together with the project Science Plan, govern sample collection, curation, allocation and archiving for this project.

An on-site USGS Curation Team, under the supervision of the project Sample Manager, will be responsible for initial handling, documentation, and integrity of drilling samples, and for preparation of samples for shipment to the USGS Core Research Center (CRC) in Denver, Colorado. The samples will be split at the CRC to provide a *Working Split* for experiments by scientists in both time frames, and an *Archive Split*, both will be curated at the CRC. Access to Samples and Data from the drilling program shall be limited to Principal Investigators and *ICG approved* Secondary Investigators for a period of two years following completion of drilling.

This protocol describes the responsibilities of the various on-site drilling project personnel for sample collection, establishes on-site handling and curation procedures, lists equipment available for immediate on-site analyses, establishes archiving procedures, and establishes procedures for sample distribution to Principal Investigators following the policy for sample allocation established in the project Science Plan.

INTRODUCTION

Comprehensive scientific information acquired during the Creede Caldera Moat drilling project will come from core, fluid samples, and down-hole geophysical logs. Careful handling, analysis, and curation of all samples and data are vital to the following critical elements of the U.S. Continental Scientific Drilling Program:

- 1) Materials and information required to accomplish the science goals of the 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.

This protocol was modified from DOSECC's "Sample Handling and Curation Protocol" (Appendix 1 [dated May, 1986] in Michalski and Linenberger, 1990) and the "Core Handling Procedures Used for the Cajon Pass, California, Deep Drilling Experiment" (Campbell and Gay, 1989) to meet the specific needs of the USGS Creede Caldera Moat drilling project. That protocol, in turn, was based extensively on curatorial policy guidelines and procedures for the Continental Scientific Drilling Program (Goff, 1985).

DEFINITIONS

For the purpose of this protocol, *samples* are defined to include drill core, mud logging samples, and fluid samples and subsamples collected from the drill holes. *Data* includes lithologic logs and notes, geophysical logs, mud logs, driller's logs, and other measurements or data collected on-site, and results of analyses, notes of observations, etc. collected by Principal Investigators during scientific study of samples following drilling. *Core handling* is defined as the physical handling of samples from the drill rig to the on-site sample processing and laboratory facilities, to any intermediate archival facilities, and finally to the USGS Core Research Center in Denver, CO. *Core characterization* includes peicing, marking, boxing and special handling such as waxing, lithologic logging, physical property measurements, core description, etc. made on-site prior to shipment of samples to the CRC. *Curation* refers to the identification, splitting, boxing, indexing, filing, accession, and deaccession of drilling samples under the control of the USGS both on-site and at the CRC. *Principal Investigators* include those scientists whose proposals for study of core or fluid samples or to conduct downhole experiments have been approved by the ICG Science Panel and funded by one of the Agencies, and who are identified in the Science Plan. *Secondary Investigators* include those scientists not included in the Science Plan, but to study core or fluid samples or conduct downhole experiments whose proposals have been approved by the Science Steering Group for the Creede Caldera Moat Drilling Project.

OBJECTIVES

The objectives of this protocol are to insure that all drilling samples and related data collected during the CCM drilling project are properly handled and curated, and that a permanent physical record of the drill hole is provided for future studies.

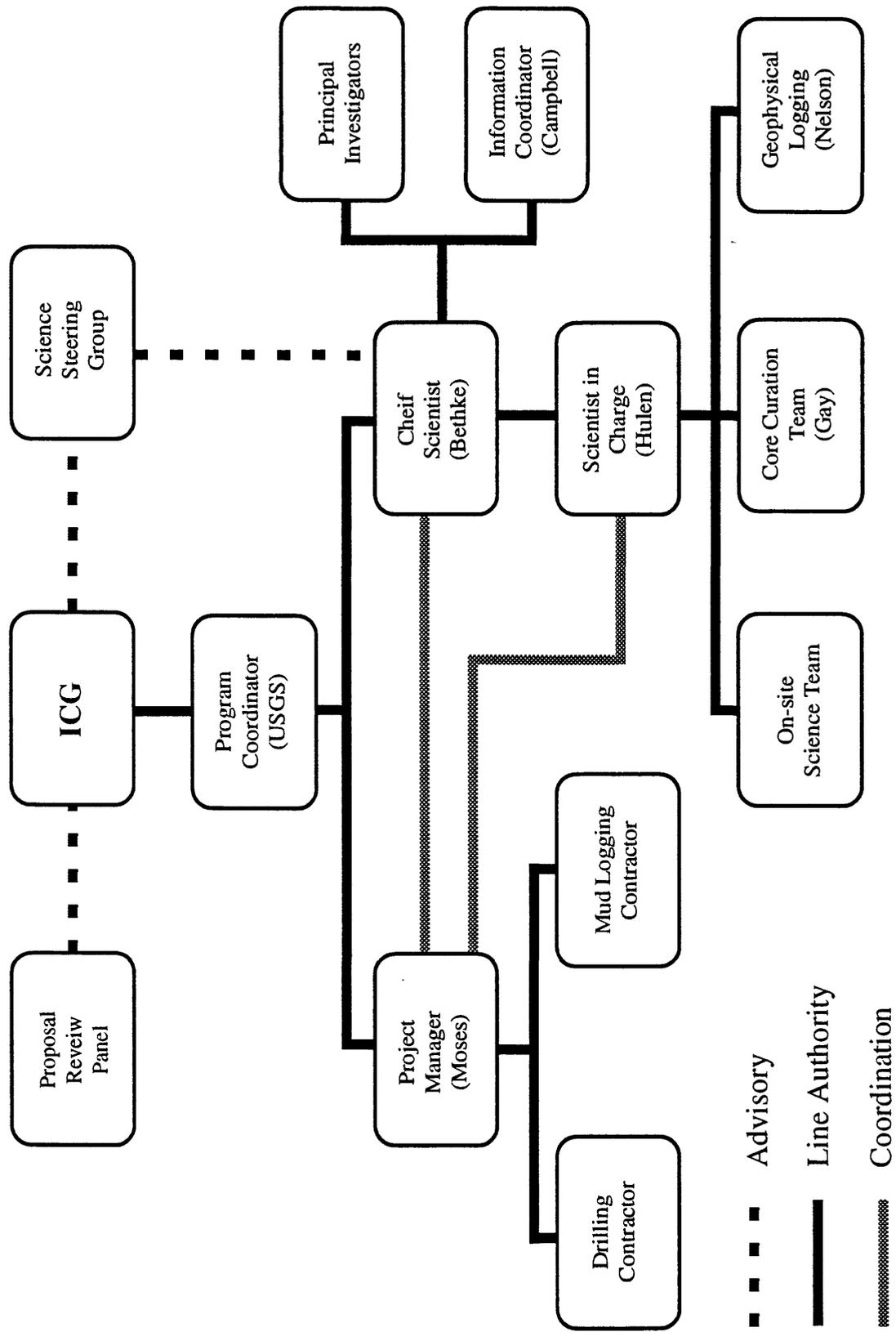
Basic concepts for handling and curation of Scientific drilling samples and related data are as follows:

- 1) Samples and data are owned by the USGS and represent a present and future national resource.
- 2) After appropriate analyses on site, the samples along with a suite of descriptive data from the drilling project will be permanently archived for future access at the USGS Core Research Center. As new scientific ideas and analytical tools become available, the archived splits will provide opportunities to restudy the material and hence maximize the value of this drilling project.
- 3) A portion of the core (the *Working Split*) will be available for sampling and analysis by the Principal Investigators and Secondary Investigators or their delegated representatives. It is the obligation of all scientists conducting experiments for this project to curate samples in their possession in such a manner as to preserve their integrity, identity, orientation, location, and minimize the amount of sample destroyed. Upon completion of the project studies, all remaining samples, with thin or polished sections, analytical results, notes and descriptions, and photographs will be archived at the USGS Core Research Center.
- 4) A timely and complete record of observations, measurements, and techniques will be added to the data base following each step of sample handling and analysis.
- 5) Deaccession of project samples and/or related data from archive facilities will occur only with joint approval of the USGS, ICG designated Science Panel, and CRC management.

PERSONNEL AND RESPONSIBILITIES

The final Science Plan for the CCM drilling project, as approved by the ICG, contains detailed information on the sampling program, including sampling priorities and intervals, as well as time to be allotted for down-hole sampling and logging. Figure 1 is a general organization chart (from the Creede Caldera Moat Drilling Project Management Plan) that indicates the responsibilities of and relationships between the various individuals for this project. Those responsibilities as they affect sample and data collection and handling are described below.

Figure 1: Creede Caldera Moat Research Drilling Project's Management Plan



The **Project Manager** has overall responsibility for the successful completion of the drilling program. As such he is responsible for supervising contractors in all aspects of the operation, including drilling, coring, down-hole geophysical and mud logging, and for scheduling and coordination of sample collection activities. The Project Manager has authority over all on-site activities as they affect the drilling/coring operation.

The **Chief Scientist** is responsible for implementing and managing the Science Plan in such a way as to maximize its benefits and to insure that the requirements of all Principal Investigators are satisfied, and are consistent with drilling and engineering requirements.

The **Scientist-in-Charge** is responsible for the coordination and operation of all *on-site* scientific activities as described in the CCM Science Plan. These activities include: 1) the initial characterization of project samples made available by the Sample Manager, 2) downhole geophysical logging and other downhole experiments, 3) fluid sampling and mud sampling, 4) maintenance of a drilling log, and 5) through the Sample Manager, on-site handling and curation of the core, fluid, and mud samples.

The **Sample Manager** supervises the Core Curation Team responsible for receiving samples from the drill rig floor and mud logger, and conducting and recording sample preparation (cleaning, marking, orientating, etc.), sample integrity, boxing, on-site storage, and shipment of samples to the USGS Core Research Center.

The **On-site Science Team** is responsible for conducting and completing those on-site scientific activities for which the Scientist-in-Charge is responsible. This includes the initial lithologic logging and characterization of drill core. Additionally, the On-site Science Team will assist the Sample Manager with on-site collection, handling, and curation of the core, fluid, and mud samples whenever necessary.

The **USGS Core Research Center Curator** is responsible for the preparation and documentation of an Archive and Working Split; procurement, distribution, and documentation of project samples from the Working Split; and curation of all project cores, samples, thin and/or polished-sections etc., and data acquired from project samples. The CRC Curator also has the authority and responsibility to solicit return of project samples, data, and associated documentation.

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 cores were taken. The Logging Contractor is to provide a copy of all logs and depth determinations to the CRC Curator to be archived with the project samples.

The **Science Steering Group**, appointed by the Chief Scientist with the concurrence of the ICG, will provide guidance to the Chief Scientist, Project Manager, Scientist in Charge, and CRC Curator concerning changes in the Science Plan. It will be responsible

for establishing the guidelines and the order of sampling based upon the priority (non-destructive before destructive, time-dependent before time-independent tests), nature, and analytical techniques of an experiment as detailed in the project's Science Plan. The Science Steering Group will evaluate and approve or deny all requests for samples or data from *Secondary Investigators* during the 2 year period following drilling. Any sampling requests not in accordance with the Science Plan, or questions and concerns about sampling priorities will be addressed by the Science Steering Group in coordination with the CRC Curator.

Principal Investigators or **Secondary Investigators** receiving samples are responsible for proper handling and curation to preserve the integrity of these materials. Unused portions of the samples (this includes, but is not limited to, unprocessed sample portions, powders and mineral separates, notes and descriptions, and photographs), thin and/or polished sections and analytical results, along with documentation of sample handling and processing history of each sample, are to be returned to the CRC Curator as outlined in the Science Plan.

ON-SITE EQUIPMENT

Facilities and equipment required for sample 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 samples.

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

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

Facilities

Initial core handling facility (temporary layout shed)

Core Characterization and storage facility (two USGS trailers)

Equipment

Layout tables with long core trays/core racks

Core total gamma analyzer

Magnetic susceptibility analyzer

35-mm cameras for color photographs

Photo table with quartz lights

Binocular microscopes

Sample marking, measuring, and examination (hand lenses) equipment

Water-cooled trim saw
Sink and water storage tank
Core storage boxes
Box stapler
Box banding machine
Core drying equipment (hair dryers)
Impliments for cleaning core (brushes, sponges, etc.)

ON-SITE HANDLING AND SAMPLING PROCEDURES

GENERAL STATEMENT

The CCM drilling project will involve the acquisition of continuous cores. Cuttings and fluid samples will be collected as specified in the project Science Plan. Fluid sampling will proceed after final temperature measurements have been made (at least 6 months after completion of drilling). Samples will undergo certain standard handling procedures under the direction of the Sample Manager prior to being transferred to the Scientist-in-Charge and the Science Team for core characterization, and thence to the USGS Core Research Center Curator for splitting, archiving, and sampling for project studies. Principal Investigators requiring on-site samples for ephemeral properties must make any sampling arrangements and detail any special sampling procedures with the Sample Manager prior to core recovery. Figure 2 is a flow chart which summarizes core handling and curation activities.

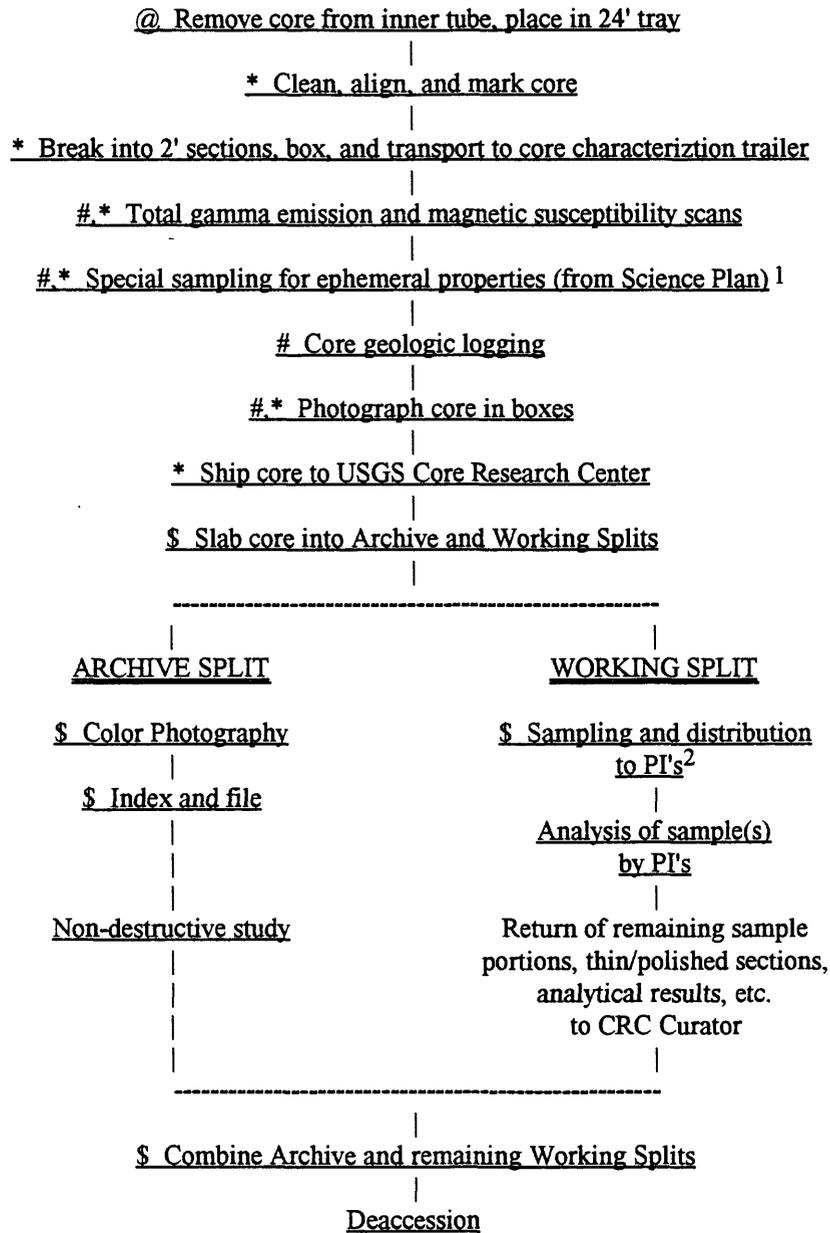
CORE HANDLING PROCEDURES

Since coring will be conducted using wire-line techniques, handling and curation procedures begin when the core-barrel liner is removed from the hole. Under the supervision of the Sample Manager, or her delegate, the drilling and coring crew will remove the core from the inner tube and place it in the 24' PVC tray in the on-site core handling shed. When transferring the core sample, care will be taken to avoid disturbance or breaking of the core. Documentation for the various procedural steps will be maintained. Copies of documentation forms can be found in Appendix A.

In the on-site core handling shed, the core will be cleaned with water, pieced together and aligned, marked for up/down orientation, broken into 2 foot sections, and placed in core boxes or, when deemed necessary, in short PVC core trays for transport to the Core Characterization Trailer. The short PVC core trays are numbered sequentially and marked to distinguish top from bottom. Sections of core are to be placed so that the top or shallowest part of each coring run is in tray #1. Core up/down orientation will be indicated by drawing two parallel lines on the core - one color line and one black line

Figure 2: Flow diagram for core handling and curation.

(\$, @, *, and # denote responsible manager - see below)

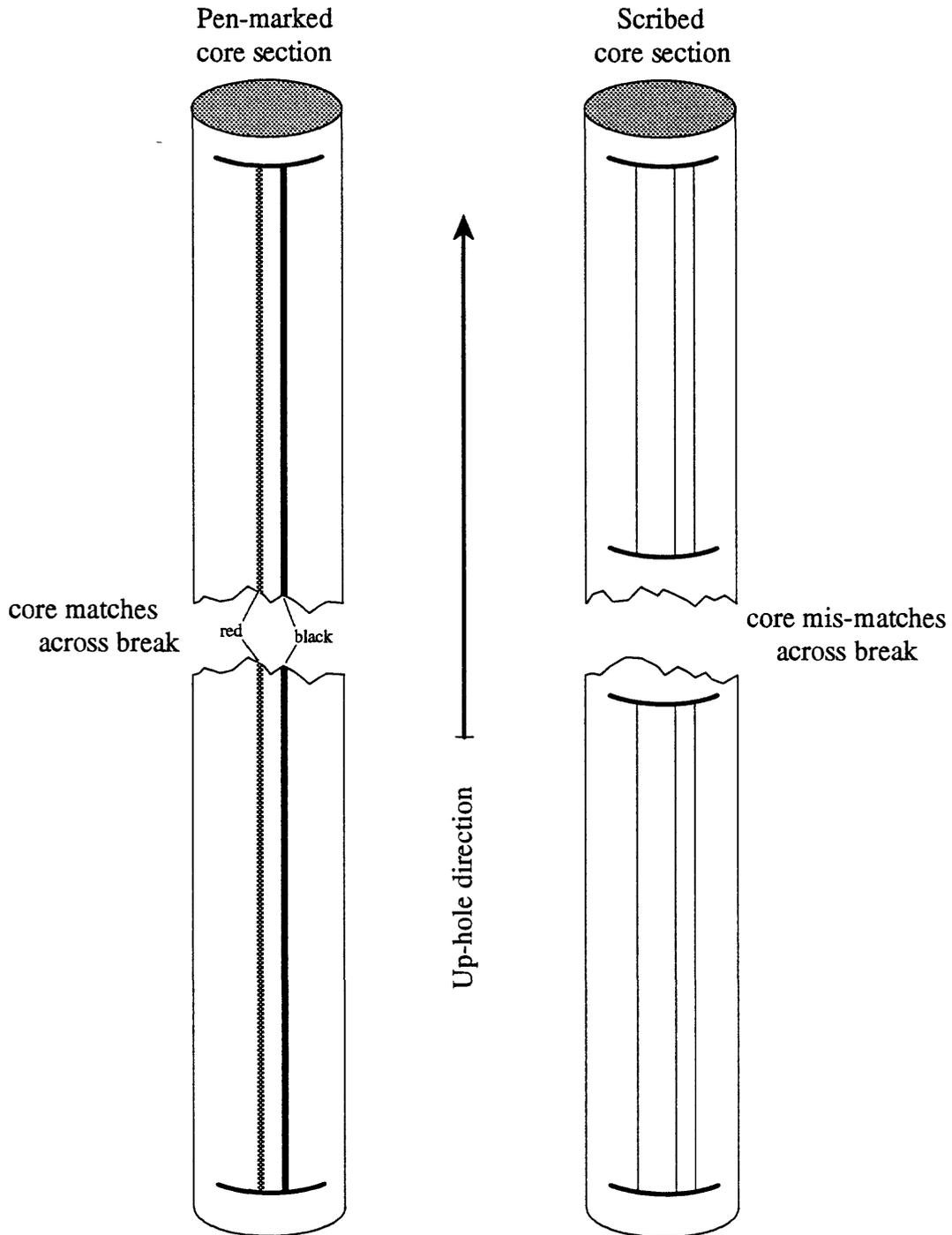


\$ = CRC Curator, @ = Project Manager, * = Sample Manager, # = Scientist-in-Charge

¹ To meet special requirements, as approved in the Science Plan or by the Science Steering Group, samples taken on-site may be taken earlier in the handling sequence.

² The Principal Investigators receiving these samples for analyses are responsible for returning the unused portion(s) to the CRC Curator upon completion of analyses, along with any thin or polished sections, a description of experimental techniques and methods applied to the sample(s), and copies of all analytical results.

Figure 3: Examples of pen marks vs scribed lines to indicate core up/down orientation (gray line represents colored pen line).



which is to the right when looking up the core. For those sections to be sampled for organic materials the core up/down orientation will be indicated by three parallel scribed lines, two set close together and one far apart, such that when looking up the core the two close-set scribed lines are to the right, see Figure 3. Any rubbled, non-coherent sections of core will be bagged and marked with the estimated relative footage for the interval.

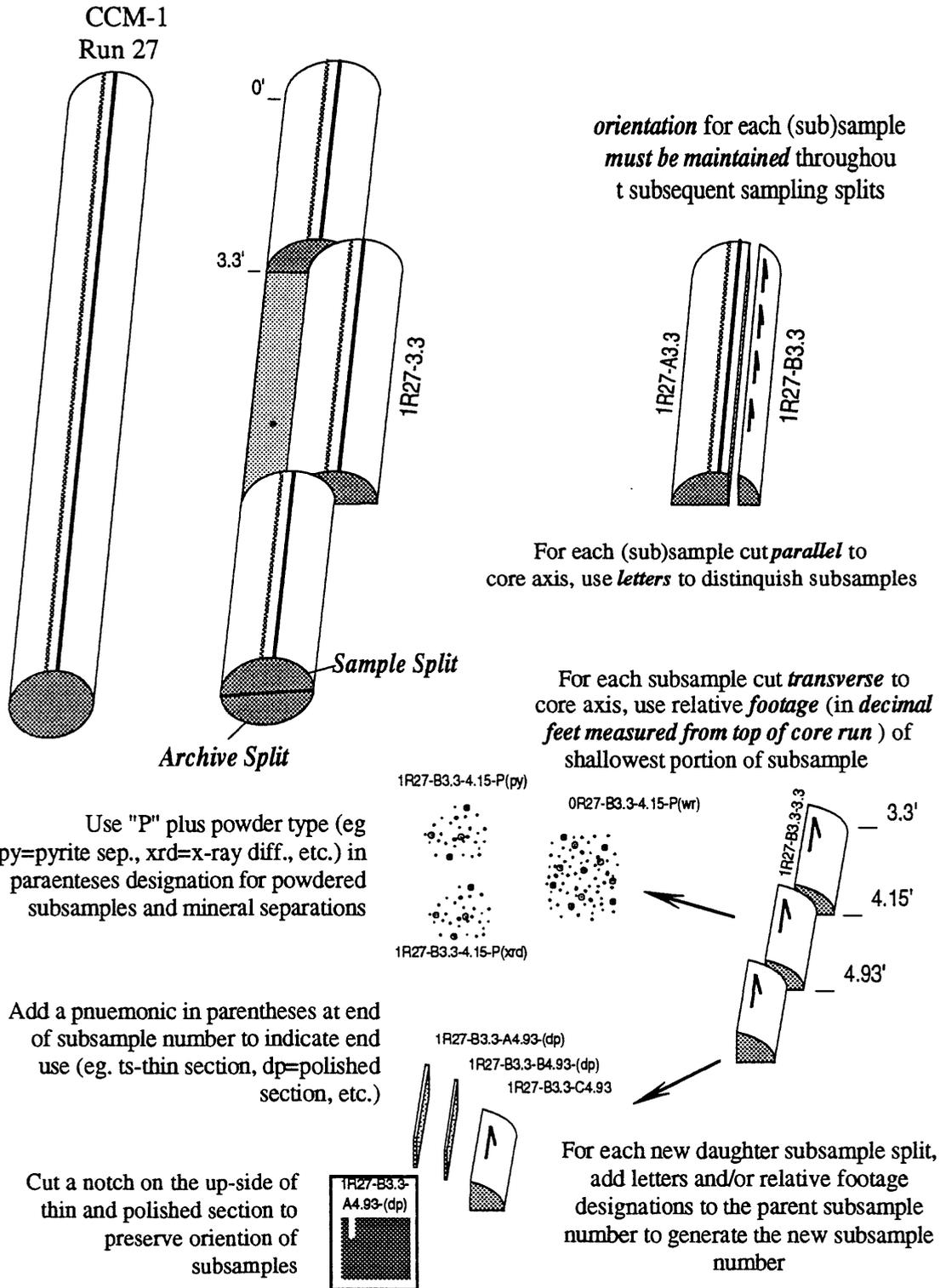
Once in the Core Characterization Trailer the core will be put through the core-gamma and magnetic susceptibility units for later correlation with the down-hole gamma and magnetic susceptibility logs. The two foot core lengths will then be (re)placed into the core boxes. Since true-depth footages for the core sections will be determined at a later time the core sections will be labeled with relative footages, as described below.

Each coring run will be given a sequential number starting with the number "R1" for the top of the hole. Within each coring run, footages will be measured in feet relative to the shallowest point of the coring run starting at 0.0' (eg. 1R3-4.6 for a relative footage at 4.6' down from the shallowest part of coring run #3 from drill hole #1). Correspondingly, all samples taken from the core will be identified by the the drill hole and coring run number designation followed by the shallowest relative footage number (ie. for a one foot long sample taken between 4.2' & 5.2' of run #5, drill hole # 1, the sample ID would be 1R5-4.2). For samples with the same relative footage an alphabetic designation will be added to distinguish the samples (ie. 1R5-A4.2). If samples are to be split further, a letter and/or relative footage number should be added to the parent sample ID. Except for samples collected to be crushed and powdered, orientation data is to be maintained for all samples and subsamples. Figure 4 details this sample numbering system.

When placed in the core boxes each piece of core will be labeled with the core run number and relative run footage. In the case of core sections to be sampled for organics the run number and relative footage will not be written on the core but on a tag to be kept with that section. A 35 mm photograph of each complete core box will be taken for documentation.

If studies of ephemeral properties are called for in the Science Plan, appropriate samples will be collected at this time. Each of these samples will be photographed (if sample is whole core, then both front and back will be photographed) and assigned a unique identification number before being removed from the core sample set. Spacer blocks, with the run number and relative footage for both the top and bottom of the sample noted, will be placed to fill any sections where whole core has been sampled. Following completion of the core handling operations the core will be turned over to the On-site Science Team for core characterization.

Figure 4: Core sample numbering protocol for the Creede Caldera Moat Drilling Project



CORE CHARACTERIZATION PROCEDURES

Upon receipt of the core from the Sample Manager the Scientist-in-Charge and the On-site Science Team will prepare a lithologic and fracture log with as much detail as time permits. Logging will be on standard forms (see Appendix A) designed with input from the Principal Investigators to include those characteristics, readily identified in hand specimen, that will provide guidance in later sampling for project studies. At a minimum, on-site logs shall include general lithologic features such as color (as judged against GSA color chart), grain size, sorting, induration, etc.; veins and vein-related alteration; and presence of organic material. Appendix B, Figures B1a & B1b are examples of how the core logging sheets should look once they have been completed. Symbols, abbreviations, and lithologic types used in the core log can be found in Appendix B.

If a section of core contains special or oriented features that the On-site Science Team deems should be preserved within the archive slab, at least in part, they will mark such sections of core for slabbing orientation once the core logging has been completed. The slabbing orientation is to be designated by marking a line with slash marks pointing up-hole on the outside surface parallel to the core's axis. The slabbing cut will then be made perpendicular to the plane containing this surface line and the core's axis as illustrated in Figure 5.

As the Scientist-in-Charge deems necessary, the Sample Manager will load the core boxes on pallets, wrap and strap them and arrange for their transportation to the USGS Core Research Center in Denver, CO.

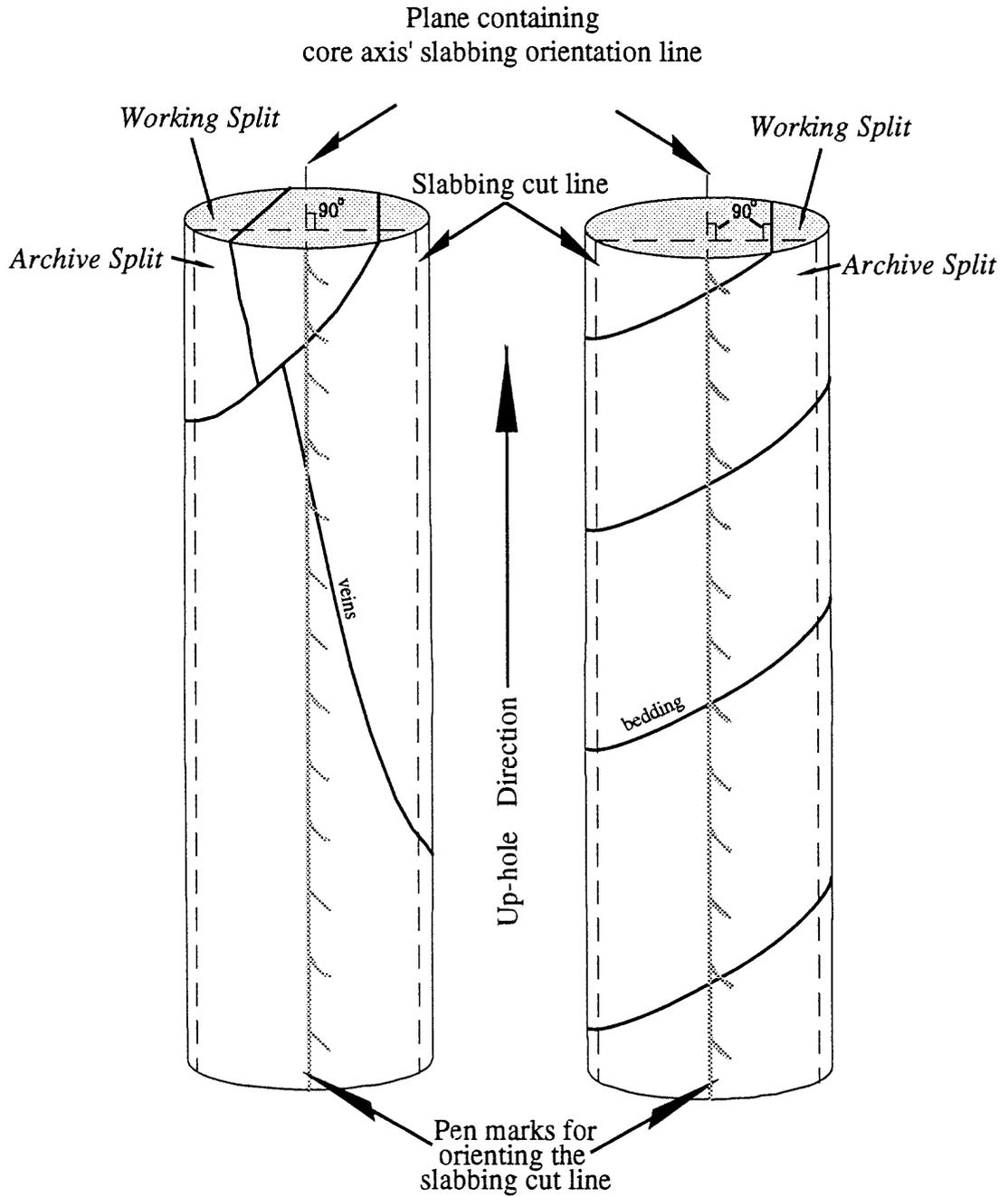
ON-SITE CORE SAMPLING PROCEDURES

On-site sampling of core will be done only as directed by the Science Plan when necessary to preserve ephemeral properties of the core. On-site sampling may be done by appropriate Principal Investigator or by the on-site science team, but must be done under the supervision of the Sample Manager who shall assign a unique sample number to each sample and shall make careful records of the interval sampled, nature of the sample, time of collection, prior handling, name and location of the Principal Investigator, and purpose of sampling.

CURATION AND ARCHIVING PROCEDURES

At the CRC a longitudinal slab along the side of the core, at least 1 inch thick, will be made of each core section. This slab will become the *Archive Split* and be marked, photographed, and boxed by the CRC Curator or his delegate. The remainder of the core will be marked, and then become the *Working Split* for distribution to investigators under the direction of the CRC Curator as defined in the Science Plan.

FIGURE5: Examples of pen marks to designate slabbing cut orientation.



Working Split

After the entire core is slabbed and a set of Archive and Working Splits prepared, samples for experiments approved in the Science Plan or by the Science Steering Group may be taken according to the sampling priority and guidelines established by the Science Steering Group. No sample may be removed until assigned a unique identification number as described above.

For a period of two years following completion of drilling the project samples shall be protected from general distribution to allow Principal and Secondary Investigators to complete their studies. At the end of the two year protected period the Science Steering Group shall establish a policy and set of procedures for general distribution of samples to other investigators with the approval of the ICG. Within two years after distribution of samples all investigators shall return all samples and associated thin or polished sections, analyses, data compilations, etc., to the USGS CRC Curator to be merged with the Archive Split unless other arrangements are stipulated in the Science Plan or approved by the Science Steering Group. In the event that written permission is obtained from the Science Steering Group to keep samples at an intermediate sample archive, the USGS retains ownership of these samples and is responsible for decisions on deaccession of such samples.

Archive Split

The Archive Slab will be photographed in color and archived according to procedures described below. This slab will be preserved for visual inspection and examination, and no sampling will be allowed without approval from the ICG. At the USGS Core Research Center, the CRC Curator assumes responsibility for the maintenance of both Archive and Working Splits including indexing and filing for availability by the public 2 years after beginning of distribution to Principal and Secondary Investigators. Any decisions for deaccession of project samples will be made by the ICG.

True Depth Determination and Marking

After geophysical logging is completed, the Logging Contractor will correlate the gamma-ray emission and any other appropriate project-specific scans of the core with appropriate logs to determine the true depth intervals of the coring runs. These depth determinations will be sent to the CRC Curator, who will distinctively re-mark the Archive and Working Samples. Scientists working on samples distributed prior to true depth determination will be notified by the CRC Curator as to the true depth determinations. Samples should not be renumbered after true depth has been determined to reduce confusion and preserve consistency of sample numbering scheme.

CUTTINGS

During drilling, specified amounts of cuttings may be collected at regular depth intervals as prescribed in the Science Plan. If continuous coring does not provide adequate samples, the Scientist-in-Charge may direct collection of cuttings at more frequent depth intervals. Under the direction of the Sample Manager, cuttings will be collected, washed, and placed in properly labeled sample bags by the Mud Logger. The Sample Manager will send these samples to the USGS Core Research Center for indexing and filing.

FLUIDS

Collection of fluid samples will be identified in the Science Plan and may include samples of drilling mud and additives to provide information on contamination of core and formation fluids. Mud and additive samples will be collected by the Mud Logger under the direction of the Scientist-in-Charge. 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 study will specify the collection method and the techniques for preservation.

ARCHIVING PROCEDURES

The CRC Curator and the project Sample Manager, will assign appropriate unique identification numbers to each sample. These identifiers will be used by all scientists and archive managers for documentation. The CRC Curator will keep a careful record of the identification number, nature and size, date of allocation, name of Investigator, and name and location of facility for each sample allocated for scientific investigation. Since samples associated with this drilling project may be exchanged between investigators at several locations, careful records will be taken by the appropriate Principal Investigator or intermediate Archive Manager and sent to the CRC Curator, whenever such exchange occurs. Scientists receiving samples must handle such materials in such a manner that unused portions so that they retain their proper vertical orientation and may be integrated into the Archive or Working Sample upon return to the Core Research Center.

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 boxes are given permanent labels containing a library number, the number of boxes from each drill hole, the drill hole identifier plus a sub-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 CRC Curator and cross-referenced to samples collected from the same drill hole.

SAMPLE DISTRIBUTION POLICY

GENERAL STATEMENT

The policy for distribution of samples produced in the Creede Caldera Moat drilling project will be set by the Science Steering Group, and will follow generally that currently being used by the Ocean Drilling Program (JOIDES, 1985; Ocean Drilling Program, 1985). The following addresses are relevant to this policy:

John Sass, Chairman, Science Steering Group
Creede Caldera Moat Drilling Project
US Geological Survey
2255 North Gemini Drive
Flagstaff, AZ 86002
602-527-7226

U.S. Geological Survey
Core Research Center
Creede Caldera Moat Project Curator
Bldg 810, Entrance S-26 (shipping address)
Mail Stop 975 (mailing address)
Denver Federal Center
Lakewood, CO 80225
303-236-1930

Distribution of samples is undertaken both 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 the CCM project Science Plan.

The CRC Curator is responsible for distributing - in accordance with the sample distribution guidelines established by the Science Steering Group - and preserving, as well as conserving, sample materials. The CRC Curator is 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 will be made from the USGS Core Research Center by the CRC

Curator or designated representative(s). To meet special requirements, and with permission from the Science Steering Group, distribution may be made at the drill site by the project Scientist-in-Charge in consultation with the Sample Manager. In such instances the Sample Manager is responsible for maintaining a record of all samples so distributed.

Sampling Limits

Unless specified otherwise in the Science plan all core samples will be limited to one half of the Working Split and 6 inches in length. Investigators requesting larger amounts will provide justification for the larger sample sizes or for frequent intervals within the core. Such requests must be approved by the Science Steering Group in coordination with the CRC Curator.

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.

No interval of the Working Split will be completely depleted without approval from the ICG Science Steering Group. A slab sample of core representing the Archive Split will be retained at the USGS Core Research Center in a pristine condition.

SCIENCE PLAN EXPERIMENTS

The project's Science Plan approved by the ICG will identify scientists (Principal Investigators) to receive samples for analyses. Allocation of samples to Principal Investigators will be done in accordance with the guidelines set up by the Science Steering Group. Principal Investigators wishing to acquire additional project samples not detailed in the Science Plan may submit a written proposal to the Science Steering Group. The request should include a statement on 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. Approval or disapproval will be based upon the scientific merits of the project and degree of overlap with studies by other investigators.

NON-SCIENCE PLAN EXPERIMENTS

Provision in the Science Plan is made to allow allocation of samples to investigators not identified in the Science Plan (Secondary Investigators)

The Science Steering Group may invite or approve applications from scientists who are not Principal Investigators to perform studies of selected samples. 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.

Sample Requests

Researchers who wish to use samples for studies beyond the scope of the CCM project's Science Plan should submit sample requests to the Science Steering Group for consideration in coordination with the CRC 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 previously, he will account for the disposition of the samples by citing published works, three copies of which must be sent to the CRC Curator. 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 CRC Curator when the project has terminated.

Requests for samples from secondary investigators in government, academia, and industry will be honored in a similar manner as those from original investigators. Such researchers will be subject to the same obligations to publish results promptly in the open literature. Scientists examining CCM project samples will provide to the CRC Curator copies of reports published and of data acquired in their research.

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 supported experiments.

Funding

Creede Caldera Moat project samples will be distributed after the requestor provides the ICG Science Panel with evidence that funding for the proposed research is available, or unnecessary. If a sample request is dependent upon pending funding, ICG may, at its discretion, provide the proposed funding organization with information on the availability of suitable samples.

Responsibilities

Investigators who receive samples incur the following obligations:

- 1) To publish results promptly.
- 2) To acknowledge in publications that the samples were supplied by the USGS as part of the National Continental Scientific Drilling Program.

- 3) To submit three (3) reprints of all published works to the CRC Curator.
- 4) To submit copies of all final analytical data obtained from the samples to the CRC 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 CRC Curator.

REPOSITORIES

The Archive and Working samples will be available for examination by interested parties at the USGS Core Research Center. The Working Sample may be sampled with the approval of the ICG Science Panel and the CRC Curator. Only the CRC Curator or delegate will remove samples from the archived materials.

REFERENCE LIBRARY

A reference library of CCM project-generated thin or polished sections, sample photographs, and drilling and analytical data will be maintained at the USGS Core Research Center for the use of visiting investigators. All thin sections produced on-site and in the project scientists' laboratories will eventually be available 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 CRC Curator after a borrowing period of three (3) months.

REFERENCES

- Campbell, W.R., and Gay F. 1989. Core handling procedures used for the Cajon Pass, California, Deep Drilling Experiment: U.S. Geological Survey Open-File Rept. 89-496, 77 pp.
- 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.
- Michalski, T.C., and Lineberger, W., 1990, Design and construction of a Mobile Core-Processing Facility: USGS Open-File Report 90-344, 41 p.
- Ocean Drilling Program (ODP). 1985. Shipboard Scientists Handbook, Ocean Drilling Program, Texas A & M University: ODP Tech. Note No. 3. 170pp.

APPENDIX A

Core Documentation Forms

Creede Caldera Moat Scientific Drilling Project

Core Log for Hole "CCM-1" (sheet 1 of 2)

RELATIVE CORE RUN DEPTH	LITHOLOGY (graphic log)	BEDDING CHARACTERISTICS	SEDIMENTARY STRUCTURES	GRAIN SIZE	SAND GRAIN SIZE	ROUNDNESS	SPHERICITY	RX FRAGS	ACCESSORY MINERALS	ORGANIC CONTENT	INDURATION	CEMENT	ALTERATION TYPE	ALTERATION INTENSITY	ALTERATION EXTENT	COLOR - WET (GSA chart)
				clay silt sand pebble cobble boulder	vt f fs vs	0.1 0.3 0.5 0.7 0.9	0.1 0.3 0.5 0.7 0.9	lithics pumice	pyrite biotite FeOx	low medium high	poor moderate good	carbonatic silica other	argillic bleach silicific propylitic	weak moderate strong	pervasive silvage other	
100																
90																
80																
70																
60																
50																
40																
30																
20																
10																
0																

Run No. _____ Box No. _____ Driller's Depth for Run: top _____, bottom _____

Date: / / 91 Time (military): _____ Amount Drilled: _____

Logger(s): _____ Amount Recovered: _____

% Core Recovery for run: _____

Page No.: _____ a

Creede Caldera Moat Scientific Drilling Project

Core Log for Hole "CCM-1" (sheet 2 of 2)

RELATIVE CORE RUN DEPTH	VEINS/FRACT.S (graphic log)	VEINING INTENSITY	VEIN MINERALOGY	ON-SITE SAMPLES TAKEN	DESCRIPTIONS & NOTES
	fractures ↓ veins → weak moderate strong pyrite anh-yp carbonate quartz			sample type, sample no., & PI's name	
Run No. ____ Box No. ____ Comments:					
					Page No.: __ b

CREEDE CALDERA MOAT SCIENTIFIC DRILLING PROJECT

Sample Request Form

Investigator: _____

Phone No.: () ____-_____, FAX No.: () ____-_____

Mailing address for samples:

Date of Request: / /

Purpose of Request (eg. petrography, geochemistry, etc.):

Type of analytical method (circle): Destructive - Nondestructive

Special sampling instructions (continue on separate page if necessary):

Complete and attach a copy of the Sample Request/Taken Form

Sample Request Filled By:

Name of USGS CRC Staff Member

Date: / /

Page 1 of ____

CREEDE CALDERA MOAT SCIENTIFIC DRILLING PROJECT

Sample Request Form

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 publications that the samples were supplied by the USGS as part of the National Continental Scientific drilling program.
- 3) To submit *three (3) reprints of all published works* to the CRC Curator.
- 4) To submit *one copy of all final analytical data* obtained from the samples to the CRC 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 CRC Curator.

APPENDIX B

Core Logging Sheets, Lithology Index, Symbols, Class Definitions and Abbreviations

Figure B1a: Example of a completed core log for the Creede Caldera Moat Research Drilling Project

Creede Caldera Moat Scientific Drilling Project
Core Log for Hole "CCM-1" (sheet 1 of 2)

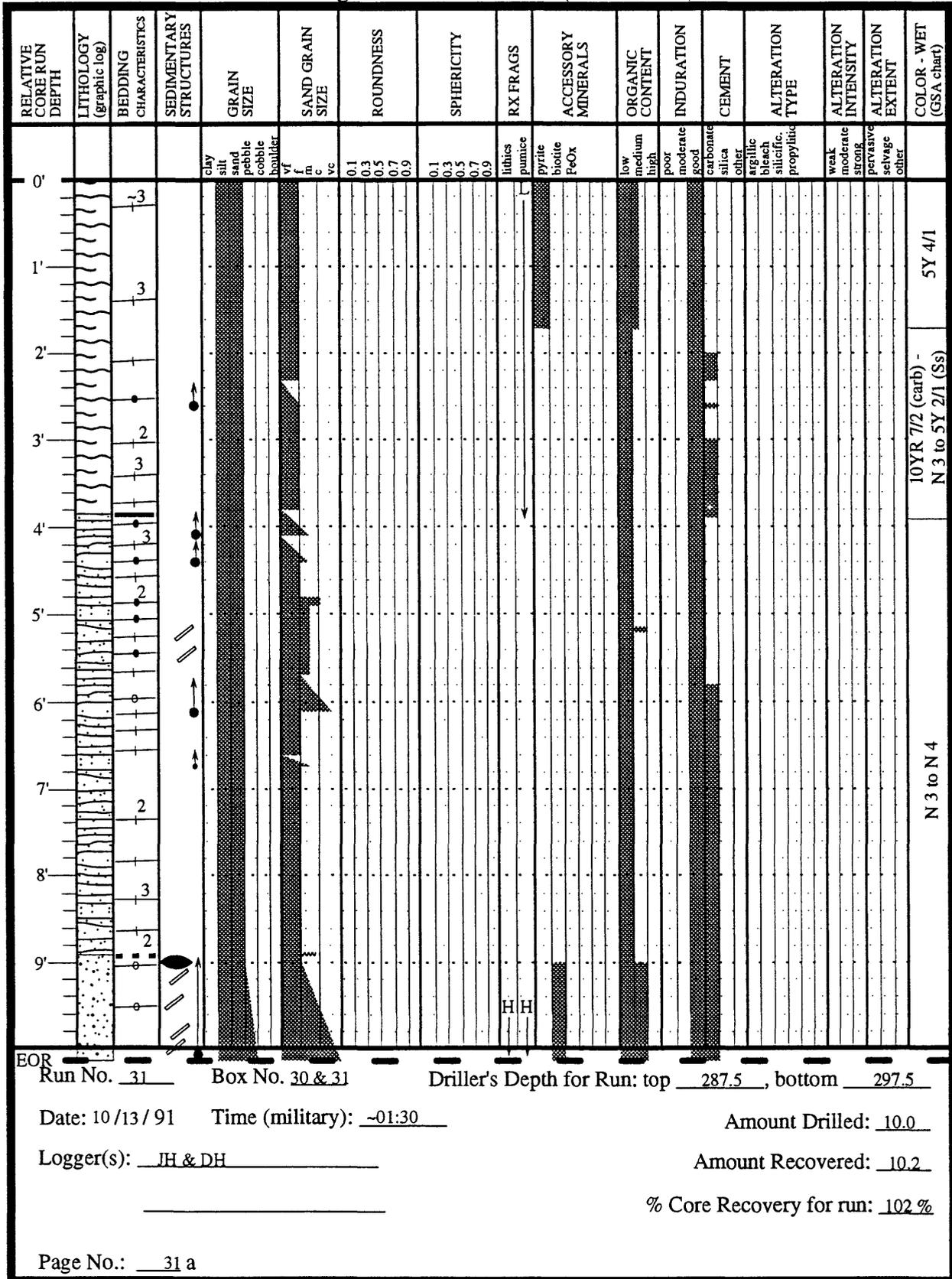


Figure B1b: Example of a completed core log for the Creede Caldera Moat Research Drilling Project.

Creede Caldera Moat Scientific Drilling Project
Core Log for Hole "CCM-1" (sheet 2 of 2)

RELATIVE CORE RUN DEPTH	VEINS/FRACT.S (graphic log)	VEINING INTENSITY	VEIN MINERALOGY				ON-SITE SAMPLES TAKEN	DESCRIPTIONS & NOTES
	fractures veins weak moderate strong		pyrite anh- gyp carbonate quartz				sample type, sample no., & PI's name	
0'								<p>Interstratified sndy sltst & slty ss (fg) w/scattered carb. laminae & prom. pyritic laminae; also scatt. pumice (?) clasts up to 2.5 x 1 cm, which are argillized & over which laminae are draped; org. content notably higher than above</p> <p><< 1.35': distinctive scalloped, light gray, mottled band w/abundant pyrite & probable sanidine & biotite xls (deformed tuff horizon?)</p> <p><< 2.8-3.5': interlam slty ss & scatt. prominent carb. laminae</p>
1'							Organic IR31-O.6 Leventhal	
2'								
3'								
4'								
5'								
6'								
7'							Organic IR31-6.9 McMahon	
8'								
9'								
<p>EOR Run No. <u>31</u> Box No. <u>30 & 31</u></p> <p>Comments:</p>								

Figure B2: Creede Caldera Moat Drilling Project lithologic patterns and number index for the core log sheet "Lithology" column.

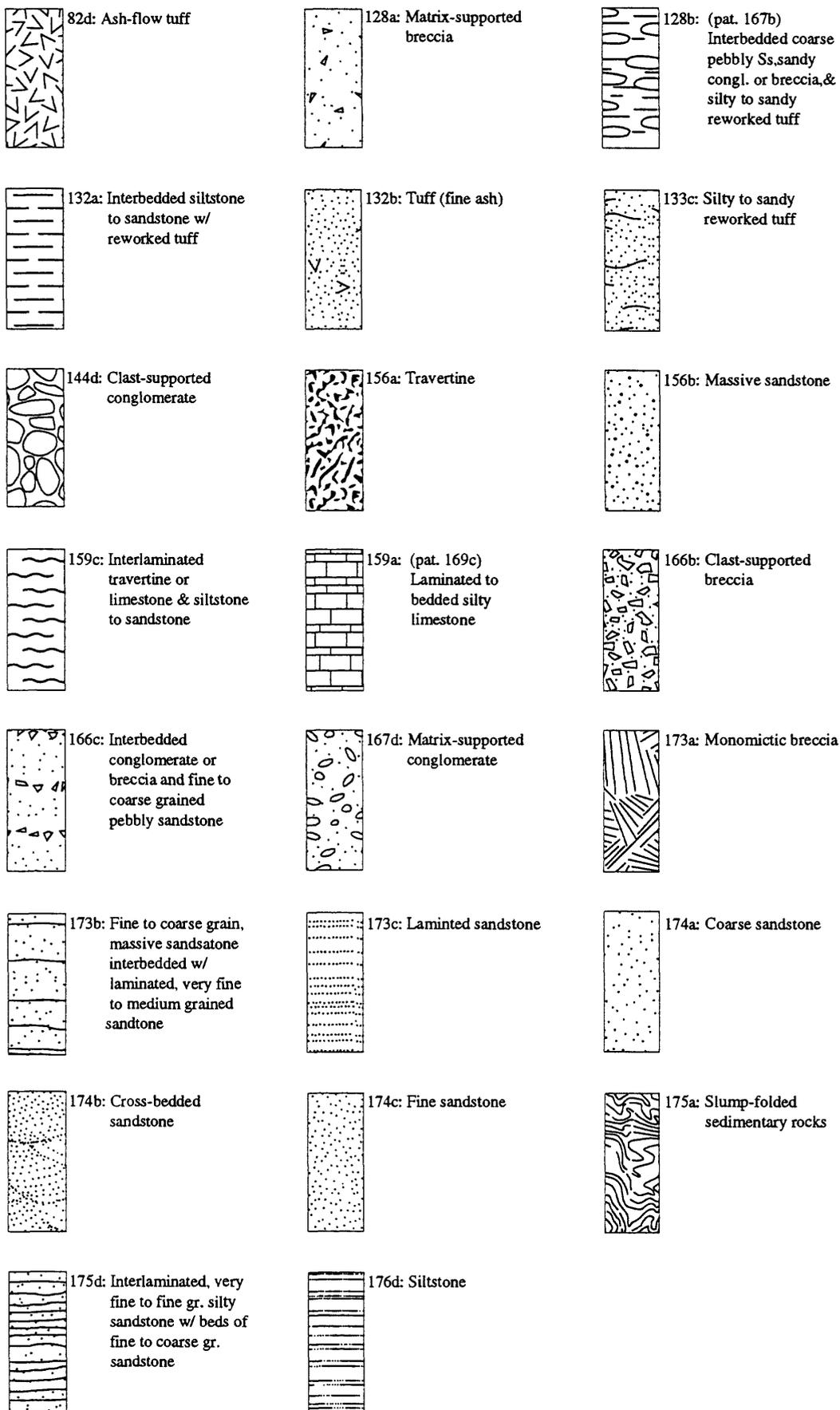


Figure B3: Explanation of symbols and patterns in core log column entries for the Creede Caldera Moat Research Drilling Project.

"Relative Core Run Depth" Column Symbols

- EOR End-of-run marker
-  Break in core
- BAG Bagged rubble interval

"Bedding Characteristics" Column Symbols

Bedding Type

-  Laminated bedding (<1cm)
-  Thin-bedded (1-10cm)
-  Medium-bedded (10-30cm)
-  Thick-bedded (>30cm)
-  Massive bedding
-  Indistinct bedding
-  Wavy bedding
-  (number indicates dip of bedding or contact relative to core's axis)

Bedding Contact

-  Sharp contact
-  Unconformal contact
-  Gradational contact
-  Indeterminate contact
-  Fault contact

"Vein" Column Symbols

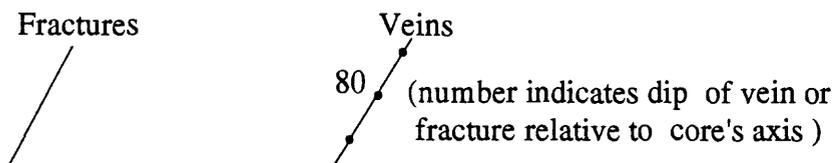


Figure B3 cont.: Explanation of symbols and patterns in core log column entries for the Creede Caldera Moat Research Drilling Project.

"Sedimentary Features" Column Symbols

Structures

	Load cast		Concretion
	Flute cast		Styolites
	Groove cast		Vugs
	Cross bedding		"rice-grain" pseudomorph (calcite after Ikaite?)
	Convolute bedding		Autoclast
	Injection structure		Autoclast (calcareous)
	Flame structure		Penecontemporaneous faulting
	Geopetal structure		Scour-and-fill
	Imbrication	?	Questionable feature
	Mudcracks		Graded bedding
	Rain-drop impression		(arrow points in direction of fining; add a "P" for pumice grading or "L" for lithic grading next to the ball end of the symbol)
	Ripple marks (non-directional)		
	Ripple marks (directional)		
	Rip-up clast		Reverse graded bedding
	Rip-up clast (calcareous)		
	Breccia		

Fossils

	Root casts
	Animal fossil
	Plant fossils
	Bioturbation
	Algal bumps
	Burrows

Figure B4: Grain characteristics charts used in Creede Caldera Moat Research Drilling Project core logging sheets.

"Grain Size" & "Sand Grain Size" Columns
Nomenclature & Size Range

Grain (mm) size	Clastic-rock name	Volcanic-rock name	
		Consolidated material	Unconsolidated material
256	boulder	volcanic breccia, agglomerate, agglutinate	blocks, bombs, spatter
64	cobble	volcanic breccia, agglomerate, agglutinate	blocks, bombs, spatter
32	pebble	lapillistone lapillite or	lapilli
4		coarse	
2	sand	coarse	medium
1		medium	
0.5		medium	fine
0.25		fine	
0.125		very fine	silt
0.062	very fine		
0.004	clay		

"Roundness" & "Sphericity" Columns
Shape Ranges

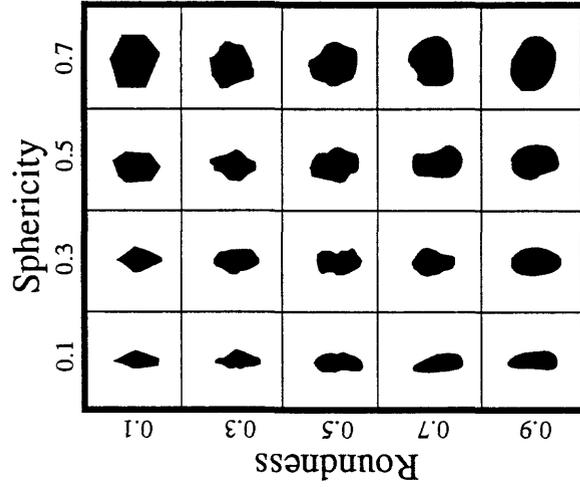


Table B1: Abbreviations for the Creede Caldera Moat Research
Drilling Project geologic logs.

GENERAL TERMS

aggregate	AGGR
amoeboid	AMOE
anhedral	AHN
apparent(ly)	APP
average	AVG
banded	BNDD
becoming	BEC
bladed	BLDD
blocky	BLKY
botryoidal	BOT
casing	CSNG
cavity	CAV
centimeter	CM
coarse	C
columnar	COLM
concentrated	CONC
crack	CRK
crooked	CRKD
definitely	DEF
densely	DNS(LY)
diameter	DIA
disseminated	DISS
dominant(ly)	DOM
dominated	DOMTD
downward	DWNWD
drilling	DRLNG
elongate	ELNGT
equant	EQNT
escape	ESC
especially	ESP
ehedral	EUH
except	EXC
fiber(s)	FIB
fine	F
foot	FT
for example	E.G.
form	FRM
frequently	FREQ
generally	GEN
grease	GRS
intermediate	INTM
irregular	IRREG
least	LST

lost-circulation material	LCM
magnetic	MGTC
major	MAJ
mark	MK
massive	MSV
medium	MED
metal	MET
metallic	METLC
millimeter	MM
moderate(ly)	M
mold	MLD
most	MST
mottled	MTLD
narrow	NAR
occupied(ing)	OCC
opaque	OPQ
partly	PTLY
pervasive	PVSV
pitted	PTTD
polished	POL
porcellaneous	POR
possibly	POSS
powdery	PWDRY
primary	PR
prismatic	PRSM
probably	PROB
prominent(ly)	PROM
punky	PNKY
rounded	RDD
scattered	SCTD
separate(d)	SEP
sequence	SEQ
several	SEV
shape	SHP
sharp	SHRP
shavings	SHV
sinuous	SNS
slight(ly)	SL
soft	SFT
sorted	STD
sorting	STNG
steel	STL
straight	STRT
strong(ly)	S
structure	STRUC
stubby	STBY
surface(icial)	SURF

Table B1 (cont.): Abbreviations for the Creede Caldera Moat Research Drilling Project geologic logs.

texture	TEXT	clay	CLY
thick(ly)	THK(LY)	clinoptilolite	CLPT
thin(ly)	THN(LY)	cobble	CBL
trace	TR	conglomerate	CGL
translucent	TRANSL	covellite	CV
transparent	TRANSP		
truncated	TRUNC	debris	DEB
		dolomite	DOL
upward	UPWD	dolostone	DLST
very	V	evaporite	EVAP
wavy	WVY	feldspar	FSP
weak(ly)	W	fluorite	FL
wispy	WSPY	fluvial	FLUV
with	W/	formation	FM
without	WO/	fragment	FRAG
cross	X	galena	GN
crystal	XL	gaylussite	GAYL
crystalline	XLN	glass	GLS
crystallized	XLZD	goethite	GOE
		gravel	GRVL
feature eludes charac.	#@**%++!	gypsum	GYP
		hematite	HEM
		ignimbrite	IGNM
		ikaite	IK
		illite	IL
		jarosite	JAR
		jasperoid	JASP
		kaolin	KA
		lacustrine	LAC
		landslide	LSLD
		lapillus, lapilli	LAP
		latite	LAT
		leucoxene	LEUC
		limestone	LS
		lithic	LTHC
		littoral	LITT
		magnetite	MT
		marcasite	MARC
		metamorphic	MET
		mineral	MINRL
		mordenite	MORD
		mudstone	MDST
		opal	OP
		organic	ORG

LITHOLOGY AND MINERALOGY

alkali feldspar	KF
alluvium	ALLUV
amygdaloidal	AMYG
analcime	ANC
andesite	AND
anhydrite	ANH
argillaceous	ARG
ash-flow tuff	AFT
barite	BA
basalt	BSLT
biotite	BIOT
boulder	BLDR
breccia	BX
calcareous	CALC
calcite	CAL
carbonaceous	CRBN
carbonate	CARB
chalcedony	CHAL
chalcocite	CC
chalcopyrite	CPY
chert	CHT
chlorite	CHL
clastic	CLSTC

Table B1 (cont.): Abbreviations for the Creede Caldera Moat Research Drilling Project geologic logs.

phenocryst	PHENO	breccia	BX
plagioclase	PLAG	brecciated	BXTD
plutonic	PLUT	channel	CHNL
porphyritic	PPYTC	clast	CLST
porphyry	PPY	coarsening	CRSNG
pyrite	PY	concretion	CNCR
pyroclastic	PYR	contact	CTCT
		convolute	CVLT
quartz	QTZ		
		deformation	DEFM
rhodochroicite	RHOD	densely welded	DW
rhyolite	RHY	deposit(ed)	DEP(TD)
rock(s)	RX	dessicated	DESS
		devitrified	DEVIT
sand	SND		
sandstone	SS	extrusive	EXTR
sandy	SNDY		
sanidine	SAN	fiamme	FIAM
sediment(ary)	SED	fining	FNG
sericite	SER	fissile	FSL
shale	SH	flarne	FLM
shard	SHD	foliation	FOLN
siliceous	SIL	fossil	FOS
silt	SLT	fragment	FRAG
siltstone	SLTST	frosted	FRSTD
silty	SLTY		
silver	Ag	graded	GRDD
sinter	SIN	grain(ed)	GR
smecite	SM		
sphalerite	SPH	intrusive	INTR
stibnite	STIB	iron oxide	FeOx
talus	TAL	laminae(ted)	LAM
tetrahedrite	TET	lenticular	LENT
travertine	TRV	lineation	LIN
tuff	TF		
		mantle	MNTL
vitric	VTT	mod. welded	MW
volcanic	VOLC		
		porphyritic	PPYTC
zeolite (itized)	ZEOL		
		raindrop	RNDRP
		ripple	RPL
		scoured	SCRD
		slumped	SLMP(D)
		vesicle, vesicular	VES
		weakly welded	WW
		cross (e.g. X-bdd)	X

PRIMARY FEATURES

accretionary	ACCR
armored	ARM
ball-and-pillow	B & P
bedded	BDD
bedding	BDNG
bipyramidal	BIPYR

Table B1 (cont.): Abbreviations for the Creede Caldera Moat Research Drilling Project geologic logs.

<u>SECONDARY FEATURES</u>		veinlet	VNLT
alteration	ALTN		
altered	ALT		
argillized	ARGLZD	weathered	WTHD
		<u>COLORS AND VALUES</u>	
breccia	BX	black	BLK
brecciated	BXTD	blue	BL
		brown	BRN
calcareous	CALC	gray	GRY
cement(ed)	CMT(D)	green	GRN
chloritized	CHLTZD	pink	PNK
clast	CLST	purple	PPL
coated	CTD	red	RD
		yellow	YEL
diagenesis(tic)	DIAG	white	WHT
drusy	DRU	orange	ORNG
		dark	DK
faulted	FLT(D)	light	LT
flooding	FLDNG	medium	MED
fracture(d)	FRX(D)		
		*(add "SH" to color designation when used as modifiers)	
gouge	GG		
hydrothermal	HYD		
indurated	IND		
manganese oxide	MnOx		
mineralized	MINRLZD		
oxidized	OXDZD		
pseudomorph	PSDM		
rubble	RBL		
rubblized	RBLZD		
replaced	RPL		
replacement	RPLMT		
selvage	SLVG		
sericitized	SERCTZD		
siliceous	SIL		
silicified	SILCRD		
slickensides	SLX		
solution	SOLN		
stained	STN(D)		
stockwork	STKWK		
unoxidized	UNOX		
vein(ed)	VN(D)		