ODP REPOSITORY COOKBOOK

TABLE OF CONTENTS

1) INTRODUCTION AND SAMPLE REQUEST PROCESSING

This document outlines the procedures followed during ODP to process sample requests in the repositories, from the time they are submitted to the ODP Curator to the time they are finished, and to document repository procedures for curating and sampling cores and other materials.

A major change in the sampling policy occurred in 1997, when a new policy was created that allowed for more access to sampling of DSDP and ODP core material, both working and archive halves, than the previous policy, which had been in place since DSDP. A procedural change for reviewing and approving requests was also made in 1997 in order to speed up the sample request approval and completion process. Instead of the Supervisor of Repositories (a job position which was eliminated in 1996) reviewing and approving all requests, each of the four repository superintendants were given this responsibility for requests specific to their repository. The Curator would review all shipboard requests, along with the Leg Project Manager and Co-chief scientists (according to the new 1997 ODP Sample Distribution, Data Distribution, and Publications Policy). The Curator would also give guidance to repository superintendants on sample request issues as needed.

Procedures outlined below are what have been standard since 1997.

Curator

The Curator's office receives all sample requests, enters them in the database, and distributes them to the appropriate repositories. The Curator scans all requests that come in, and reviews in detail all shipboard sample requests, but assigns the Repository Superintendents the task of first reviewing in detail each of their requests, and communicating with investigators and with the Curator to resolve questions or problems before completing them. When requests are submitted for core material form more than one repository, one superintendant is assigned to review it and communicate their decision to the other repository superintendants. When requests are submitted for core material for educational purposes, including museum loans, most of these are first reviewed in detail by the Curator, who communicates with the investigator and repository staff to choose the best material to meet the educational needs. The Curator then forwards the request to the appropriate repository to complete the request.

The Curator also receives reprints of papers published according to the ODP Sample Distribution, Data Distribution, and Publications Policy (http://www-odp.tamu.edu/publications/policy.html), and maintains a database of those reprints received.

- Procedures for review and approval of requests:

  If the samples requested follow the ODP Sample Distribution, Data Distribution, and Publications Policy (http://www-odp.tamu.edu/publications/policy.html).

  If the samples requested are in accordance with the stated scientific or educational objectives of the request.

Previous publication performance on sample requests may be reviewed if an investigator is suspected to be oversampling while not fulfilling publication obligations. In such cases where this had occurred, new requests by those investigators were rejected unilt previous publication obligations were fulfilled.

Requests for sampling the permanent archive halves after 5 years post-cruise are sent to the Curatorial Advisory Board for approval, with the Curator's comments and any other supporting information (past sampling and publication history, etc.) to help the CAB decide.

<u>Curator's Assistant</u>

• Procedures for processing sample requests:

Check the curatorial email account each day for new sample requests and any other important mail such as address updates, completion letters, and general questions for the curator.

Update addresses in the Gate program (see Gate Program User's Guide) print completion letters and file them with the corresponding sample requests, and forward any questions to the appropriate people.

Print the sample requests.

Assign the request a number. Check to see if the investigator has indicated that the request is related to a previous request. If no, it is a new request and it will follow in the sequence listed in Gate under "New Request" and should be assigned as part ‘A’ of that number. If yes, search for the request number in Gate and find the last letter that was assigned to it (ex: 18,880C). Give the new request the same number with the next letter in the sequence (ex: 18,880D).

Determine Leg/Repository/Status of the request. Look at the sample request and under "Leg" the scientist will have listed the legs requested for sampling. The correct repository to send the request to will depend on the Leg requested. Look at the ODP website (http://iodp.tamu.edu/curation/repositories.html) to find where each leg is stored. There are three options for the status of the request:
Shipboard- the request is made while the ship is at sea.
Moratorium- the request is made within 12 months of the end of the cruise.
Post-Moratorium- the request is made after 12 months of the end of the cruise.

Input data into the Gate program. Go through the Gate program and fill in the necessary fields. All of the required information should be found on the sample request form.

Send an acknowledgement email.

Reply to the scientist who sent the sample request, and make sure to include the original message received. Copy and paste from the acknowledgement emails and fill in the blanks. (scientist name, sample request number)

Copy the email to the Curator's personal email account and to the appropriate people at the correct repository.

After the email is sent, open the "Sent Mail" folder and move acknowledgement email into the correct sub-folder according to the Leg requested.

Each sample request is filed in a folder. If it is an 'A' request, make a green hanging file folder, as well as a manila file folder. If it is a subsequent part to a request, only make a manila file folder. On the folder include the names of the requestors, the request number, the date of the request, the repository, the leg and the status.

Repositories

• Procedures for completion of sample request records.

After sampling is completed, a completion letter is written to the investigator detailing how many samples in how many boxes have been taken and shipped to them. In addition, any explanation about sampling problems or other information that relates to the fulfillment of the sampling that is important for the investigator to know is included in the letter. This additional info is first stored in the Completion Letter Notes field of the Gate program for each request. The Gate completion letter export function will automatically insert these notes into a pre-formatted completion letter that can be exported into MS Word. The date of completion of the request is the date of the completion letter. The paper copy of the completion letter is included in the sample shipment.

An electronic copy of the completion letter is emailed to the Curator's Assistant (Curator's official email account), who prints it and files it int he paper sample request record. The electronic copy is stored in a folder within Groupwise as a second archive.

This completion date is filled into the Gate program for each repository by the repository staff. For multi-repository sample requests, the last repository to complete their part also fills in the final completion date for the request into the Gate program.

2) STORAGE OF MATERIALS

Core Storage

Cores are usually received from the ship already cut into 1.5-m-long sections, each of which has been split lengthwise into two equal halves, one archive and one working half. They arrive already individually packed, each section half in a plastic tube ("d-tube") that is 159 cm long, 8.5 cm wide, and 4.5 cm high. The d-tube is sealed closed on one end and has a black (working half) or red (archive half) cap closing the other end. The d-tube cap has a label with leg, site, hole, core, and section information both as printed numbers/letters and in barcode format.

• Storage Racks

In the repository, the core sections are stored in racks erected inside large refrigerated rooms ("reefers"). The racks consist of two vertical mesh grids of galvanized metal, one at the front and one at the back, standing about 85-90 cm apart. Cores are stored so that the archive halves are in the top half of a rack unit and the corresponding working halves are in the bottom half of the same rack. This allows easy access to the working halves, which are more often used for sampling, and the archive halves can be reached with a ladder when they need to be removed for non-destructive analysis, description or photography.

• Storage Environment

Ideally, the deep-sea cores should be maintained as nearly as possible at in situ conditions so that any subsequent analyses, even those carried out years after the cores are retrieved, will be as reliable as possible. However, it is not feasible in the repositories to duplicate conditions that exist below the sea floor. While the global average sea-bottom temperature of about 4°C is maintained in the repository reefers, it is impossible to duplicate many other environmental factors. Preservation methods have always been followed to try to retard the loss of moisture from soft sediment cores, the growth of mold, and geochemical changes. Refrigeration helps with all of these. In addition, through DSDP and ODP until 1998, wet sponges were placed in each d-tube and were rewet every three years to try to maintain a water-saturated atmosphere within the d-tube, thus retarding evaporation of water from the soft sediment. However, the sponges did not hold enough water to maintain humid conditions, were not re-wet often enough, and did not stop the loss of water vapor through the very porous polystyrene d-tubes in which each core is stored. Because of this, a new procedure of wrapping the individual sections within their liners with plastic wrap was initiated. This procoedure has been followed by various other marine core repositories for decades, with good results. The plastic wrap is highly impermeable to wateer vapor, and its contact on soft sediment surfaces prevents areas for mold to continue to grow. Most recently, at the Gulf Coast Repository, the manual plastic wrapping procedure for old cores was replaced by using an industrial heat shrink-wrapping machine, with thicker, water and oxygen impermeable plastic film. This new technology has greatly speeded up the process of wrapping old and new cores, and has provided an even better sealed environment for the cores, especially for preventing future oxidizing induced geochemical changes.

<u>Residues</u>

Residues are samples that have been sent back to the repository by an investigator. Many of these have undergone some kind of processing, and so their usefulness will usually be limited to certain kinds of future studies. It is therefore important that an accurate database of residues is maintained, not only to catalog and determine what samples are available, but also to document the treatment they have undergone for assessing whether they are appropriate for later investigations. So it is necessary to obtain information about the treatment of the samples from the scientist who is returning them.

• Storage

> Residue samples are stored on shelves in the reefer, in boxes labeled with the physical interval contained in the box, for example, with the hole and range of cores and/or sections. The individual samples may be sediments in plastic bags or glass vials, or interstitial water samples in plastic or glass vials.

• Database

> When residues are received each individual sample is entered into an Excel database with location information (leg, site, hole, core, section, interval) as well as a complete-as-possible description of any treatment the sample has undergone (or a statement that it was not treated). If no description of the treatment is available, the original requestor and request number are given so that the original request can be referred to and possible implications drawn about how the sample has been treated.

<u>Thin Sections</u>

Most thin sections are produced on the ship for hard-rock intervals, and at the end of the cruise they are usually sent to the repository with the cores in slide boxes. Thin sections are available to scientists as loaned material for up to one year, after which time they must be returned to the repository or an extension must be requested. An Excel database is maintained of the thin sections out on loan in order to keep track of when they are due back at the repository.

<u>Smear Slides</u>

Lithologic smear slides from teh ship are also sent tot eh repositories with their corresponding cores, and are available for future analysis by investigators. Smear slides are recorded in the database using the SS sample code.

<u>Evaporite Cores</u>

Evaporite cores (salt or gypsum) are stored in non-air conditioned, dry humidity containers, to avoid moisture condensation on them which can dissolve the evaporite sediments. Some are split, and some have been kept as whole round sections.

<u>Frozen Whole Rounds</u>

Frozen whole rounds were routinely taken from cores in DSDP and ODP through Leg 134. All of these are stored at the GCR in the -20°C freezer room. These were archived for future organic geochemical studies, but have rarely been used for such.

<u>Frozen Microbiology Samples</u>

Beginning with Leg 201, the first dedicated microbiology ODP cruise, ODP decided to take archive frozen whole round samples next to those taken by shipboard microbiologists, in order to provide future microbiologists access to some microbiological analyses from Leg 201 cores. These samples were immediately frozen in LN_2 on the catwalk, and then transferred to storage in -86°C freezers. Similar archived whole rounds were taken from Leg 204, which had heavy geochemical and microbiological interest in gas hydrate bearing sediments.

Frozen Gas Hydrate Samples (LN_2)

Archive whole round sections of gas hydrate bearing sediment were stored in LN_2 on ODP Leg 204, and remain in LN_2 dewars within the GCR. These dewars need to be refilled every 2-3 days owing to boil off of the LN_2. A 400 gallon LN_2 container in the GCR warehouse is used for manually refilling the dewars.

Pressured Gas Hydrate Samples (4°C and pressured methane)

36 section length PARR pressure vessels were filled with 1.5 m of gas hydrate bearing sediments during ODP Leg 204. These vessels were immediately pressured to between 500-600 psi with bottled (thermogenic) methane (which contains a different C isotopic signature than hydrate methane) and stored in a 4° C container. These vessels were transported in this condition to the GCR and are stored in a Hazardous Materials Refrigerated Container at 4°C, with methane, fire, and temperature alarm systems, in a walled enclosure outside the loading dock. The pressures vary from 475-650 psi, and have decreased over 2 years by 25-100 psi.

3) LABORATORY CURATION PROCEDURES

Core Volume Description And Implication For Sample Volumes

When completely full, a one-cm wide slice of a half core (i.e. Archive or Working) should contain approximately 17.5 cc of material. In practice the cores are often either not completely full or there can be a considerable amount of 'rind' (sediment and/or drilling mud smeared along the sides of the liner during the coring process). Therefore, a more conservative estimate of available material should be in the range of 15 cc/cm, depending on the extent of the rind, etc. Rotary drilling of lithified rock cores commonly results in narrower diamter cores which do not fill the core liner, because of wearing of the roller cones on the coring bit.

• Sampling

Soft sediments are sampled using plastic sampling tubes and scoops, which allow one to accurately calculate sample volumes. For sampling more lithified sediments and igneous/metamorphic rocks, knives/chisels/saws are used to cut samples. Because of the inherent lack of precision with this sampling method, we generally round off to the nearest 5-cc and 1-cm value in estimating sample volumes cut in this way. For example, approximating volumes for quarter round wedges: 1 cm = 5 cc; 2 cm = 10 cc; 3 cm = 15 cc. For more precise quarter round sampling of softer sediment, varying sizes of stainless steel quarter round shaped 'cookie cutter' sampling tools are used. These tools are quite useful when one is looking for a consistently accurate larger sample volume from unlithified sections of core.

• Core length check/editing

There are times when inconsistencies are found between the core lengths in the database and the cores themselves. This can be the result of desiccation and shrinking of certain cores or conversely the slow expansion of certain clay rich intervals over time, as well as simple clerical errors made at the time of data entry. It is therefore important to check that the section lengths correspond to what is in the database, and when inconsistencies are found, to correct them using the Core-Section Editor. It is important to note that any section length edits will result in new mbsf values assigned to the base of the edited section, as well as to all points in any subsequent sections within a core. This could potentially lead to confusion with regards to correlation between samples taken at times before or after the edit has been made.

• Recuration

Older cores are often in need of recuration, primarily because of the above-mentioned expansion/desiccation of the cores, as well as simple deterioration of curation materials over time. Most common is the case that an end cap has simply come off and needs to be re-attached. However, heavily sampled cores, or cores that have dried out and shrunk considerably, often have large voids allowing room for material to shift in the core liner, and require much more attention. Such void spaces need to be filled with an appropriate size etha-foam plug, and loose pieces secured in their proper location. The archive halves and/or the original core photos and descriptions are used as a reference to help determine the original location of material that is suspected to be out of place. When needed, shrink-wrap helps to further secure loose pieces. Cores that have been recurated and shrink-wrapped in this way can then be further sampled quite efficiently. To re-sample a core that has been shrink-wrapped, cut a flap through the plastic, remove a sample, and then simply tape the flap back over the core. Heavy sampling of a core section requires replacement of the shrink-wrap afterwards. Upon any major recuration and/or shifting of material, it is wise to make notes (dated) on the d-tube of the section itself, inside the section, and on file describing any repositioning of material that has occurred.

- Scraping surfaces

There is often considerable growth of mold and/or minerals (most commonly gypsum) on the surface of the cores. This can usually be removed quite easily by simply scraping the surface of the cores with the straight edge of a metal spatula. When the cores are more lithified (approaching limestone for example) use a wet sponge to wipe away any surface growth. Gypsum growth can often be embedded quite firmly into the sediment, and it can often cause much more damage than it is worth by trying to scrape it away.

4) SAMPLING PROCEDURES

This section describes the standard types of procedures used in ODP for sampling deep-sea cores in the repositories. There is, however, considerable flexibility that must be allowed for special sampling (scientific) needs as well as for unusual core-material conditions. For all samples taken, the upper and lower depths of the sample within the section, as well as the sample volume, are recorded in the database. After each sample is removed a styrofoam "plug" (of variable shape corresponding to the material removed) is inserted into the resulting void to prevent subsequent movement or disturbance of the remaining material.

Soft-Sediment Sampling

Generally, the uppermost sedimentary units retrieved during drilling are relatively soft, and samples can be taken by fairly simple removal methods.

• Plastic tubes

Plastic cylinders are inserted by hand vertically into the sediment and then removed with the sample material inside. Tubes used during ODP have inside diameters of either 1.0 cm or 2.4 cm, resulting in sample volumes reported as 5 cc and 10 cc, respectively, when the core liner is full and when the sample is pushed to the entire depth at the center of the liner. The void remaining defines a circle in the middle of the exposed cut core face.

• Plastic scoops

These scoops are used in the same way as the tubes, and differ only in their shape and, of course, the shape of the resulting void in the remaining sediment. They are rectangular in cross section with sides that conform to the curve in the core liner as they are pushed into the sediment on one side of the liner. They have inside widths of either 1.0 or 2.0 cm, giving sample volumes, again, of 5 and 10 cc, respectively. The scoops have the advantage of being able to take two samples at the same depth interval in a core section, one from each side, and even leave a small amount of material in the middle for further sampling in that interval. When a 10 cc *tube* sample is taken from the center of a section, on the other hand, it is not possible to get another 10 cc tube sample from the same depth interval, because of the curvature of the plastic liner on both sides of the sample. A minor disadvantage of taking the scoop samples is that there have not been mass-produced styrofoam plugs in the correct shape to fill the void as there are for the tubes. More time is therefore necessary to cut styrofoam to fit the voids created by sampling with scoops.

• Metal scoops

These are similar in shape to the plastic scoops, but are made of steel and the two curved sides are farther apart, for taking an individual sample that is 3, 6, or 12 cm in length. The two sides of this tool are also wider to take a complete half of the core half (1/4 round sample) instead of leaving some material in the middle. These are also different in that the sample is removed from the scoop, which is then cleaned and reused, as opposed to the plastic scoops, which are disposable and generally sent out with the sample still in them.

• Slab sampler

This is a rectangular metal chamber, open on one side, that takes a sample parallel to the long axis of the core. The opening is 1 cm wide and 15 cm long, and the chamber is deep enough so that the tool can be inserted to the total thickness of the sediment in the center of the core section (~3.3 cm deep). There is a sliding metal bar filling the inside length and width of the chamber and this bar rests on the sediment as the tool is pressed in, sliding up into the chamber as the chamber fills with sediment. The bar is connected to two handles that extend out of the top side of the chamber opposite to the open side. The presence of the bar helps to hold suction as the sample is removed from the core section, and it is used to press the obtained slab sample out of the chamber, ideally with its structure intact. Extruded slab samples are then wrapped carefully in plastic wrap, with their tops marked, and placed within plastic boxes for shipping.

• Spatulas

Spatulas (or small putty knives) of various sizes and shapes are used to simply cut and dig out different sized samples, usually if the sample volume needed is relatively small. For various geochemical reasons relating to contamination, spatulas may be metal, plastic, or teflon-coated metal.

• Toothpicks

Some samples require only a very small volume, for example smear slides for sediment description or nannofossil slide samples. For these a wooden toothpick can be used to scoop out or scrape off a small amount of material from the surface of the sediment, usually much less than 0.5 cc.

• Paleomagnetic cubes

These are for taking accurately shaped and oriented cubic or semi-cubic samples, with undisturbed structure, for paleomagnetic analyses. The basic cube is a 2x2x2-cm plastic cube that is open on one side. The open side is placed on the sediment surface and the cube is pressed into the sediment. A small hole (ca. 2 mm) is predrilled into the opposite (top) side of the cube to allow air to escape as it is pressed in. Also, an arrow is drawn or etched onto the top side to indicate the "up" direction in the core. Because the cube doesn’t reach the liner surface below when it is completely pressed in, it is necessary to insert a u-shaped wire tool along the side of the cube that can then be pulled across the open side at the bottom to cut through the sediment and release the sample from the remaining sediment and pull it out. The full cube is then covered with a plastic top, wiped clean, and labeled. Variations on the cube shape and size include a Japanese model, which has the four vertical corners beveled, and a smaller 1x1x1-cm plastic cube.

• U-channel samples

These are long, continuous samples, 2x2 cm square in cross section, that often extend the total length of, and are usually taken from the center of, a section. These are usually taken for continuous paleomagnetic measurements, although they have also been used for high-resolution geochemical analyses and non-destructive measurements such as X-ray or XRF scanning. The sampling tool is a three-sided plastic form cut to the desired length. The open side of the form is placed on the sediment surface, and the form is pressed in along its length. Then a thin wire or fishing line is inserted beneath the form at one end and pulled along the length to separate the bottom of the sample from the remaining sediment. The sample in its plastic hull is then carefully removed from the section.

Semi-lithified Sediment Sampling

As sampling continues down a hole, the sediments often begin to get harder and more difficult to sample. As a rough definition, semi-lithified sediments occur when they are firm enough that it is difficult to press the plastic tubes and scoops in, and excessive force causes the tubes, scoops, and sediments to deform. The transition from soft to semi-lithified is usually gradual. At this stage "biscuits" are also often encountered. These are relatively hard clods of more-or-less in-place material that are surrounded by slurry that is sometimes caused during Extended-Core-Barrel drilling (XCB). In this case it is usually important to take samples from the "biscuits" to insure that a series of samples represents a true stratigraphic sequence. In these harder sediments, alternate sampling techniques are generally required. The following tools are useful in this kind of material:

• Cast-cutter saw

This is a standard medical saw that has a round vibrating blade rather than a rotating blade, and is designed for cutting through plaster casts without cutting a patient’s skin. It is particularly well adapted to cutting through firm sediments because a rotating blade would considerably disturb the material. It is often used for the precision work required for p-mag cubes and u-channels. In these cases the plastic sample form is pressed onto the sediment to create a surface impression of the sample shape and size. The saw is then used to cut along the lines into the sediments. Then the plastic p-mag cube or u-channel form can be pressed into the cut sediment and the sample of the correct and accurate size can be removed.

• Mallet/spatula

For most normal sampling in semi-lithified sediments, that is, when the precise size and shape are not critical, a spatula (stiff putty knife) can be used to cut down into the sediments and break off a sample of the required volume. Depending on the hardness of the sediments a mallet may be useful in driving the spatula into the sediments.

• Knives

Thin-bladed knives of various sizes can be used to cut a sample in semi-lithified sediments if they are not too firm. The choice of spatula, knife, or perhaps even a small spoon will depend on the hardness and texture of the material being sampled and is usually decided by trial and error.

Lithified/Hard-Rock Sampling

Lithified sediments are defined here as those that are too hard to easily break with a mallet and spatula, and a saw or drill must be used to cut samples out of the material. Again, the transition from semi-lithified to lithified sediments is often gradual. The same techniques must be used for igneous or metamorphic rocks. Owing to the scientific goals often related to these kinds of samples, the material is generally marked for orientation with an arrow pointing upward in the section, either with a red wax pencil or scratched into the core before cutting.

• Mini-cores

> A drill press with cylindrical bits for rock cutting is used to cut circular samples. Variable inside bit diameters are used depending on the needs of the scientists. The bits are supplied with water for lubrication during drilling. A foot-pedal on-off switch is used to operate the drill, and this also simultaneously turns the water supply on and off. There is a specially built plastic basin below the drilling table to catch and run the water off.

• Rock saw

> The rock saw is used to cut hard specimens in various shapes and sizes. A double-bladed saw with parallel blades 2 cm apart is used in some repositories and on the ship for cutting the precise sizes to fit into p-mag cubes. Different diameters and thicknesses of blades are used depending on the hardness, texture, friability, and composition of the material being cut. Water is generally used to lubricate the saw blade, again switched on and off with the saw by using a foot pedal. There are some cases, however, where it may be desirable to try cutting without water, for example, in cases where the water tends to dissolve some component of the rock causing it to fall apart during wet sawing.

5) CONCISE GUIDE TO REQUESTING SAMPLES

In submitting a sample request please be as concise as possible.

Please be clear and thorough with all personal contact information (i.e. phone, fax, address, etc) as we may need to contact you to discuss your request, and certainly detail and accuracy for shipping purpose is required.

A well conveyed (<4000 character) description of your request purpose (proposed research) will serve as a valuable historical record as to what work has been done on the cores and can help to shape further research.

The most important technical information to convey in your sample request is precise sample LOCATION and VOLUME (see Table for guide as to appropriate sample volumes for particular data types).

In submitting a specific list of sample locations, always specify:

Leg – Site – Hole – Core – Sect – Interval Top – Interval Bot – Volume

For example: 174 – 1073 – A – 5H – 2; 12-14 cm; 10 cc

Alternatively, one can request samples taken at regular intervals by clearly stating an interval, sample spacing, and a volume, for example:

FROM: Leg 174 – 1073 – A – 5H – 2, 30 cm. TO: 7H – 4, 60 cm; samples every 20 cm; 10 cc

Note that for DSDP sites there can sometimes be confusion in correctly designating the first Hole at a particular Site. During DSDP the first Hole at a Site was not given a letter designation. For example, at DSDP Site 552 there were two Holes, 552 and 552A (the first hole is designated by an * in the database today, 552*).   For ODP Sites this is not the case, and the first hole is designated A, the second B, etc.

Finally, please be very specific if there are any special handling or sampling procedure needs for your study. For example: to not use certain types of metal or plastic sampling tools for fear of sampling contamination.

6) TYPICAL SAMPLE VOLUMES

The following volumes are guidelines, not limits.

Thin-section billets 10 cm^3 up to 50 cm3 for large-grained plutonic rocks
Alkenone (Uk37) 5 cm^3
X-ray diffraction 5 cm^3
X-ray fluorescence 20 cm^3 (sediments), 20-50 cm^3 (igneous/sulfides—varies depending on grain size and homogeneity of rock)
Carbonate 2 cm^3
Paleomagnetism 7-cm^3 cubes, 12-cm^3 minicores, 600-cm^3 U-channels
Moisture and density 10-20 cm^3
Grain size 10-20 cm^3, depending upon coarseness
Planktonic foraminifers 10 cm^3
Benthic foraminifers 10-20 cm^3
Nannofossils 2 cm^3
Diatoms 5-10 cm^3
Radiolarians 10 cm^3
Palynology 10-15 cm^3
Organic samples 20 cm^3
Interstitial porewaters whole rounds 5-20 cm long, based on water content
Inorganic geochemistry 10 cm^3
Organic geochemistry 10 cm^3
Sedimentology 10-20 cm^3
Slabs (for laminae studies) 25-50 cm^3, depending on slab length
Slabs (large-grained plutonic rocks) 50-100 cm^3, often shared by scientists for multiple analyses
Stable isotopes (C, O) 10-20 cm^3