IODP INTERNATIONAL OCEAN DISCOVERY PROGRAM

JOIDES Resolution Science Operator

Responsibilities and Lab Duties of Shipboard Scientists on the *JOIDES Resolution*

A. General Responsibilities

Each scientist participating in an IODP expedition implemented by the *JOIDES Resolution* Science Operator (JRSO) has a number of responsibilities that contribute to the expedition's success.

Expedition objectives

Participants are expected to familiarize themselves with the scientific objectives and operations plan of the expedition as outlined in the *Scientific Prospectus* before the start of the expedition.

Precruise research plans and sample/data requests

Each participant is required to submit an expedition-specific research plan (with a data and/or sample request) that contains an outline of their proposed postcruise research. This is typically submitted by a deadline that is ~6 months before the expedition. These requests are used to define and coordinate the research plans of all participants and allocate core samples and data according to core recovery and success in meeting all expedition scientific objectives. Note that postcruise research plans are <u>not</u> limited by the shipboard lab assignments.

Work schedule
Work shifts are 12 hours a day, 7 days per week for the duration of the expedition, and typically extend from noon to midnight or from midnight to noon. During their shift, scientists process cores and samples in their labs and assist in the writing of reports. Occasionally, shifts extend longer than 12 hours, when science meetings or other activities require it.

Data collection and analysis
Shipboard scientists collect, analyze, and compile data that conform to procedures and formats established for each laboratory. Data collected during an expedition are archived in the JRSO database (LIMS) or servers. All data, including data collected with third-party instruments, are the property of the entire science party and IODP. Data and sample access is limited to the science party for up to 18 months postcruise (see **Moratorium**).

Scientific reports
During the expedition, scientists present their findings in science meetings organized following each drill site. Each lab group is responsible for documenting their findings in scientific reports. These reports are combined in site chapters in the *Proceedings* volume, which is published 12–18 months postexpedition. Scientists also assist the Co-chief Scientists and Expedition Project Manager in writing summary reports such as the Weekly Science Report, Site Summary Reports, and the *Preliminary Report*, which is usually published 2 months postexpedition. All shipboard scientists are co-authors of the *Preliminary Report* and the *Proceedings* volume. The *Proceedings* volume is edited on shore 3–6 months following the expedition by a subset of the science party.

Sampling
Sampling is performed mostly by scientists. When a core is ready for sampling, all the samples approved for shipboard analyses are collected by scientists and/or technicians. For expeditions where all personal sampling is done on board, most samples are collected by scientists during assigned ~2 hour sampling shifts. For high-recovery expeditions or when the science objectives require it, most personal samples (except those taken for ephemeral properties) are collected during postcruise sampling parties with the assistance of the majority of the science party.

Cruise evaluations
At the end of the expedition, all scientists are encouraged to submit a cruise evaluation. These evaluations guide the JRSO in making laboratory upgrades and improving shipboard life.

Moratorium
A moratorium of 12 to 18 months allows only shipboard and approved shore-based scientists to have access to expedition data and cores. The moratorium extends 12 months after personal samples are collected (either on the ship or during shore-based sampling) but cannot extend more than 18 months after the end of the expedition. All cores and shipboard data become available to other researchers and the public following the moratorium.

Postexpedition scientific publications
Scientists who accept expedition samples and data incur the obligation to analyze them and to publish the results according to the agreements made with other members of the science party.

Details of this obligation are described in the IODP Sample, Data and Obligations Policy, which is available at http://www.iodp.org/top-resources/program-documents/policies-and-guidelines.

B. Lab Duties

Scientists are invited to sail in different labs and are expected to perform specific tasks to ensure the scientific success of the expedition. The optimal mix of expertise is based on the expedition objectives, safety considerations, and IODP initiatives. Scientific participants are selected by the Co-Chief Scientists, the Expedition Project Manager, and the JRSO Supervisor of Science Support. Each scientist's expertise is taken into account as much as possible when lab assignments are made. However, a one-to-one relationship between an individual's primary expertise and the shipboard lab assignment does not always exist. In such cases, scientists should be aware that they are expected to complete their assigned lab duties before they pursue their personal scientific interests. As already stated, research plans are not limited by lab assignments.

Scientists should also keep in mind that depending on the number and variety of scientific objectives of each expedition, some labs may be better staffed than others. In such cases, scientists should be prepared to assist in their lab and/or other labs as needed.

Core description

Core description requires a variety of expertise depending on the expedition objectives and material to be recovered. Scientists are typically invited to sail as sedimentologists, petrologists or igneous petrologists, alteration petrologists, structural geologists, volcanologists, etc.

Core description involves the following primary tasks:

- macroscopic visual description of core section halves;
- microscopic examination of smear slides and thin sections;
- description and measurement of deformational structures;
- observations are entered in a custom-built core description application;
- JRSO staff help generate graphic summary reports that combine core description data with core images, physical properties, age, and other data;
- preliminary interpretations of depositional, diagenetic, alteration, and/or deformational processes may be possible.

Core description also involves the following tasks in support of the primary tasks:

- operation of the section-half image logger (SHIL);
- operation of the section-half multisensor logger (SHMSL) to acquire color reflectance and magnetic susceptibility data (also see **Physical Properties** below);
- operation of the X-ray image logger (XMSL) if needed for the expedition objectives (also see **Physical Properties** below);
- preliminary interpretations of depositional, diagenetic, alteration, and/or deformational processes may be possible;
- selection of samples for shipboard carbonate (coulometry), mineralogy (XRD), or elemental analysis (ICP-OES; pXRF; also see **Inorganic Geochemistry** below).

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Core+Description.

Micropaleontology
Micropaleontologists collect microfossil assemblage data to interpret the age and (sometimes) the paleoenvironment of sedimentary cores, including volcaniclastics and baked sediments interbedded with igneous rock when possible. The micropaleontologists use the biostratigraphic age data, often working with the paleomagnetists, to develop an age model for each site. The most common microfossil groups analyzed on the ship are calcareous nannofossils, planktonic foraminifers, diatoms, radiolarians, and dinoflagellates (primarily for age determination). In some cases, expertise in terrestrial palynomorphs (pollen and spores), benthic foraminifers, silicoflagellates, and ostracods may also be needed. Full assemblage analysis is not required on the ship and it is impossible in most cases. Rather, the primary emphasis is placed on identification of useful microfossil datums for constructing preliminary age-depth models and computing sediment accumulation rates.

Microfossil samples are primarily taken from the bottom of each core (core catcher samples) as soon as possible after each core is recovered. Additional samples may be examined to provide as complete a biostratigraphic model as possible or to characterize critical intervals such as unit boundaries. Micropaleontologists are responsible for processing samples for examination via light microscopy. A benchtop scanning electron microscope is also available. Slides, sieves, mounting and picking media, and maceration chemicals are available for all major microfossil groups. The data are entered in a custom micropaleontology application.

A reference library with some books and journal articles is available to help paleontologists identify microfossils. Because of limited shipboard space, the library is not comprehensive and micropaleontologists should check before the cruise to confirm reference availability. DSDP and ODP Micropaleontology Reference Collections (http://iodp.tamu.edu/curation/mrc.html) are also available at a number of institutions worldwide. Scientists may visit these before sailing.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Paleontology and https://wiki.iodp.tamu.edu/display/LMUG/Microscopy.

Paleomagnetism
Paleomagnetists measure the magnetization direction and intensity of core section halves and discrete samples of sediments and rocks to provide a magnetostratigraphy for each site. These measurements are made with a longcore cryogenic magnetometer or a spinner magnetometer. Paleomagnetists work with micropaleontologists to develop an age model for each site when possible. Paleomagnetists may also be asked to provide orientation data for deformational structures, when possible. Limited rock magnetic properties can also be acquired on the ship, which is particularly useful if any magnetic properties are ephemeral (e.g., post-recovery oxidation of magnetic minerals). Paleomagnetists should be aware that the lab is not shielded and the measurements of magnetically weak sediments can be challenging.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Paleomagnetism and Technical Note 34 (http://www-odp.tamu.edu/publications/pubs_tn.htm).

Physical properties and downhole measurements

Scientists invited as physical properties and/or downhole measurements specialists collect and analyze physical properties data acquired from core samples, in situ formation measurements, and downhole logging tool strings. Scientists are typically invited to sail as physical properties (PP) or downhole measurements specialists or both. All physical properties and downhole measurements scientists are expected to contribute, as needed, to data acquisition and report writing based on the expedition scientific objectives, core recovery rate, extent of downhole logging operations, and scientific expertise. This expectation also extends to the stratigraphic correlators (see **Stratigraphic Correlation** below), who often operate some of the physical properties instruments and are an integral part of the physical properties lab.

Physical Properties

Typical measurements include the following:

- gamma ray attenuation bulk density, magnetic susceptibility, and P-wave velocity using a whole-round multisensor logger (WRMSL) (also see **Stratigraphic Correlation** below);
- natural gamma radiation using a whole-round logger (NGRL) (also see **Stratigraphic Correlation** below);
- interpretation of magnetic susceptibility and color reflectance data acquired with the section-half multisensor logger (SHMSL) (also see **Core Description** above);
- moisture content and grain density of discrete core samples (MAD analysis) using a helium pycnometer and dual-balance system;
- P-wave velocity of core section halves and/or discrete core samples;
- thermal conductivity of core sections and/or discrete core samples;
- vane shear and compressive strength of core sections if needed to meet the cruise objectives;
- X-ray images using the X-ray multisensor logger (XMSL) if needed for the cruise objectives (also see **Core Description** above).

Note that the core description group typically operates the SHMSL for practical reasons. When stratigraphic correlators sail (see below), they help operate the WRMSL and NGRL loggers. The physical properties group as a whole interprets and presents all these data in their reports.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Physical+Properties and Technical Note 26 (http://www-odp.tamu.edu/publications/pubs_tn.htm).

Downhole Measurements

The following measurements may be acquired:

- formation temperature measurements during coring operations;
- formation pressure measurements during coring operations;
- wireline logging of physical properties that typically involves two tool strings: (1) triple combo (bulk density, neutron porosity, electrical resistivity, magnetic susceptibility, and natural gamma radiation); (2) FMS-sonic (Formation MicroScanner resistivity imaging; sonic velocity, and natural gamma radiation). The triple combo may be configured differently, depending on expedition requirements. A third tool string may be deployed to acquire a checkshot survey or vertical seismic profile, provided the necessary environmental permits have been obtained precruise;

- logging while drilling (LWD) is used in limited cases when the safety or success of the expedition requires it and the JRSO budget allows it; these measurements are rare.

Formation temperature/pressure and wireline logs (and in rare cases LWD logs) are acquired by the JRSO staff and Schlumberger logging engineer, respectively. The shipboard tasks of the downhole measurements specialists are to provide specifications for data acquisition and to interpret and present the data in their reports. Although downhole measurement scientists usually interpret the logging data, all PP specialists should participate in the integration of core and logging data.

For additional information, see http://iodp.tamu.edu/tools/logging/index.html and https://wiki.iodp.tamu.edu/display/LMUG/Downhole+Logging.

Core-Log-Seismic Integration

If the integration of precruise seismic data is important, this may require construction of synthetic seismic profiles. In addition, some PP specialists may need to focus on integrating core, log, and seismic data and are staffed as core-log-seismic integration specialists.

Stratigraphic correlation

Stratigraphic correlators are essential on expeditions where complete stratigraphic sections are a primary expedition objective. Complete stratigraphic sections are achieved by coring multiple holes at a site and correlating logs from several data types captured across several labs. Generation of a core composite depth below seafloor (CCSF) scale in near-real time guides coring operations and ensures complete recovery of the sediment section. A spliced section that encompasses the best core intervals from multiple holes is typically created to guide postcruise sampling and establish a common reference for postcruise studies. For maximum efficiency, two correlators are typically staffed to cover 24 hours and to guarantee rapid feedback for coring operations. Data correlation is done using the custom-built software Correlator, and we ask scientists to familiarize themselves with this software before the expedition. Stratigraphic correlators are also expected to operate the WRMSL and NGRL when possible (also see **Physical Properties** above), since these are common data used for correlation. Stratigraphic correlators should therefore expect to work closely with physical properties scientists. Additional data acquired after core sections are split may also prove useful for correlation.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Stratigraphic+Correlation .

Geochemistry and microbiology

Scientists who sail in the chemistry lab have expertise in a wide variety of fields and are typically invited to sail as organic geochemists, inorganic geochemists, igneous geochemists, and microbiologists. On expeditions where both sediments and igneous/metamorphic/sedimentary rocks are cored and organic, inorganic, and igneous geochemists are sailing, all geochemists are expected to assist each other as needed. In such cases, each group is responsible for analyzing and presenting the relevant data in their reports. Precruise coordination is required to ensure the lab is ready.

Organic geochemistry

The primary responsibility of organic geochemists is to monitor cores for hydrocarbon content and to implement the JRSO safety protocol. In this capacity, they analyze gas samples at a frequency of one sample per ~10 m core using a gas chromatograph, and advise the Operations Superintendent, Expedition Project Manager, and Chief Scientists when hydrocarbon levels in the cores may constitute a potential safety or pollution hazard, which may require suspension of coring operations. In addition, nonhydrocarbon gases such as hydrogen sulfide, oxygen, nitrogen, carbon dioxide, and carbon monoxide can be analyzed at the same time.

Organic geochemists also analyze sediment samples for carbonate content using a coulometer; and for total carbon, nitrogen, and sulfur using an elemental analyzer. The type and maturity of organic matter may also be identified using a pyrolysis technique.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Chemistry and Technical Note 30 (http://www-odp.tamu.edu/publications/pubs_tn.htm).

Inorganic geochemistry

Interstitial water and fluid geochemistry

Inorganic geochemists conduct analyses of interstitial water and rock fluid samples. Pore water is extracted from core samples by applying pressures with a Carver hydraulic press. Immediately after extraction and filtration, aliquots are analyzed for salinity using a hand-held refractometer and for pH and alkalinity using a titrator. A variety of nutrients and other interstitial water constituents (e.g., ammonium, silica, phosphate, nitrate, and nitrite) are determined by spectrometry, and chloride is determined by titration. Numerous cations and anions (e.g., calcium, magnesium, sulfate) can be analyzed with an ion chromatograph. A variety of other elements can be determined by inductively-coupled plasma optical emission spectrometry (ICP-OES). A typical suite of elements for interstitial water samples includes Sr, Li, Fe, Mn, B, and Ba.

On expeditions that deploy the Kuster Flow-Through Sampler (FTS) tool (or other third-party tools) for taking fluid samples from the borehole, the geochemists are responsible for extracting the samples from the FTS tool in the Downhole Measurements lab in addition to analyzing them.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Chemistry and Technical Notes 15 and 29 (http://www-odp.tamu.edu/publications/pubs_tn.htm).

Bulk rock geochemistry

Inorganic or igneous geochemists can analyze igneous, metamorphic, and sedimentary rock samples for volatile contents with a CHNS analyzer, for major, minor, and some trace elements with an ICP-OES instrument (that can be operated in AES mode), and for elemental abundances with a portable XRF (pXRF) scanner if the expedition objectives require it.

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Chemistry and Technical Note 29 (http://www-odp.tamu.edu/publications/pubs_tn.htm).

Microbiology

Microbiologists do not sail on all expeditions. Depending on the scientific objectives and number of microbiologists sailing, microbiological sample collection and analyses may range from basic to extensive. In general, microbiologists are responsible for the contamination testing program. Extensive precruise coordination between the microbiologists and JRSO staff is required to ensure the lab is ready.

Typical tasks and measurements include the following:

- conduct onsite contamination tests by using highly sensitive perfluorocarbon tracers added to the drilling fluid to evaluate extent of contamination of cores by the drilling process;
- conduct sampling for shipboard and shore-based microbiological analyses (including daily samples of the drilling fluid for postcruise contamination testing);
- collect and preserve samples for shipboard or shore-based cell enumeration;
- analyze thin sections of sediments or rocks for preliminary interpretations on contamination and bacterial activity;
- start cultures and incubation of samples using different media;
- conduct stable or radioactive isotope tracer experiments to study microbial metabolism;
- participate in the chemical analysis of interstitial water samples as needed, including non-standard chemical analyses relevant to microbiological interpretations (e.g., oxygen).

For additional information, see https://wiki.iodp.tamu.edu/display/LMUG/Microbiology and Technical Note 28 (http://www-odp.tamu.edu/publications/pubs_tn.htm).

Other scientific activities

In rare cases, scientists may be needed to assist with more complicated tasks, such as:

- downhole hydrologic (packer) or other geotechnical experiments;
- installation of borehole observatories (e.g., CORKs, temperature loggers);
- deployment of seismometers.

These require multiyear, detailed planning by the JRSO and are implemented infrequently.

Third-party instruments

Scientists may opt to use their own third-party instruments, if the ship's lab infrastructure allows this. This needs to be coordinated with the Expedition Project Manager and other JRSO staff well in advance of the expedition. Third-party equipment must be shipped to the expedition's starting port and the JRSO is not responsible for shipping or custom import fees.

For additional information, see http://www.iodp.org/top-resources/program-documents/jr-facility-policies-procedures-guidelines.