RIDGE 2000 IMPLEMENTATION PLAN FOR THE LAU BASIN INTEGRATED STUDY SITE

1. INTRODUCTION

The Integrated Studies theme of Ridge 2000 (R2K) is a program of focused, whole system research of global oceanic spreading-center processes. This component of R2K addresses the complex, interlinked array of processes that support life at and beneath the seafloor as a consequence of the flow of energy and material from Earth's deep mantle, through the magmatic and hydrothermal systems of the oceanic crust, to the overlying ocean. The complex linkages between life and planetary processes at ocean spreading centers can only be understood through coordinated studies that span a broad range of disciplines. Thus, R2K Integrated Studies consists of multidisciplinary research that is focused on a small number of "type" areas that are designed to characterize segments of the global spreading system. The objective of Integrated Studies is to develop quantitative, whole-system models through coordinated and interdisciplinary experiments. It is necessary for scientists to understand the interactions and linkages among the volcanic, tectonic, geochemical and biological systems to achieve this goal.

The Lau Basin Integrated Study Site (ISS) adds a new element to studies conducted under the previous RIDGE program: the integrated study of a spreading center in a back-arc basin. The Lau ISS also offers the opportunity to implement a truly integrated plan at an essentially new site, applying the lessons and data amassed from previous decades of mid-ocean ridge research. Relative to the other active and proposed sites, this ISS on a back-arc spreading center greatly increases the range of biogeographic diversity, fluid and rock compositions, crustal structure, and mantle dynamics, that are available for detailed study. The Lau back-arc site will also provide better compositional and process analogs for the formation of economically significant massive sulfide deposits and ophiolites, and an important link between spreading center studies and on-land geologic observations.

The East Lau Spreading Center (ELSC) is a first order ridge segment that terminates in the north at a large non-transform offset near 19°20'S and in the south near 22°45'S where the basin narrows. The ELSC displays substantial and systematic along-strike variations (from south to north) in: (i) spreading rate (40-95 mm/yr, full rate), (ii) magma source and lava chemistry (andesitic lavas from an arc-influenced source with "Pacific-type" isotopic ratios, to typical tholeiitic basalts from a backarc source with "Indian-type" isotopic ratios), (iii) axial depth and morphology (an inflated axial ridge, 1600-2000 mbsl, to an axial valley with split volcanoes, 2500-3000 mbsl), (iv) melt lens characteristics (a seismically detected melt lens shallows from 3.5 km below seafloor in the Valu Fa area to 2.0 km below seafloor near 20.6˚S and is absent farther to the north),(v) crustal structure (layer 2A is unusually thick in the southern Valu Fa and becomes thinner to the north), and (vi) decreasing proximity to arc magma sources and the subducting slab.

2. LAU ISS BULL'S-EYE: A FOCUS FOR INTEGRATED STUDIES

The Lau Basin ISS will be centered on East Lau Spreading Center (ELSC) between 19°20'S and 22°45'S (Figure 1). As with the other ISS, R2K integrated studies at the Lau site will be carried out at various scales, nested about a designated focal point or "bull's-eye". The spatial scales of particular measurements and experiments will be defined by the scientific objectives of the proposed work, and proponents will be required to demonstrate the relationship of the proposed science to a vertically integrated "type-section" at the designated "bull's-eye". The site can be visualized as a target consisting of concentric bands about a single bull's-eye. For the Lau ISS, the target will be strongly asymmetrical and roughly wedge-shaped, reflecting the asymmetry of the Lau Basin itself. Its northern and southern limits coincide with the ends of the long, continuous ELSC segment from 19°20'-22°45'S. Its eastern and western limits are defined by the pseudofaults along which crust that was formed at the ELSC abuts pre-existing crust formed elsewhere (Figure 1). The bull's-eye location is not defined at the inception of the program and studies leading to its identification will receive highest priority in the initial phases.

The three hydrothermal fields on the Valu Fa Ridge, at the southern end of the ELSC constitute candidate bull's-eye locations. When last visited in 1989, the White Church field (21˚56'S) was relatively inactive with abundant fauna. Vai Lili (22˚12'S) was characterized by high temperature venting with active black smokers and sparse megafauna. Hine Hina (22˚35'S) had low temperature diffuse discharge with diverse and abundant fauna. All three are distinctly different in faunal composition and chemistry from the other ISS (and from well studied MAR sites). These differences, together with the contrasting tectonic and geological characteristics inherent in the back-arc setting, were major considerations in the selection of this area as a R2K ISS and will also be major considerations in the selection of the site bull's-eye.

Along much of the ELSC to the north of Valu Fa, no data relevant to a search for hydrothermal venting have been acquired and it is likely that other active hydrothermal fields are present on this spreading center. The ELSC is poorly characterized in terms of bathymetry, petrology, chemistry and biology compared to other ISS sites, making it impossible to place candidate locations in the context of variability and transitions along the ridge. The principal ***initial*** goal for the Lau ISS is to locate and evaluate significant hydrothermal vent fields along the ELSC, to establish their context within the variability and transitions along the ridge, and to choose the most appropriate vent field for the Lau ISS bull's-eye. This will require a series of ***initial location cruises*** that will allow for assessment and comparison of newly identified candidate bull's-eye sites and the known Valu Fa sites. Final selection of the ISS bull's-eye will be undertaken at a community meeting following these initial cruises.

3.0 FUNDAMENTAL QUESTIONS AND OBJECTIVES

3.1 Fundamental Questions

The goals of the Lau ISS plan can be encapsulated by three main scientific questions that integrate studies ranging from biology to geochemistry to geophysics into the unique (among R2K ISS) global and tectonic setting of the Lau Basin:

- How do the mantle flow pattern and the location of the magma production zone relative to the arc affect the patterns of rock and fluid chemistry, ridge morphology, crustal structure, fluid circulation, and surface and subsurface biological communities?
- How does the along-strike gradient in source-rock chemistry affect the fluid chemistry, and how do the biological communities respond to these differences?
- How does the global and tectonic setting of the Lau Basin contribute to the distinctive biological, chemical and geological characteristics of the Lau basin relative to the other R2K integrated study sites?

3.2 Site Specific Objectives

The supra-subduction zone mantle environment of the Lau ISS is distinct from that at the mid-ocean ridge ISS. For the Lau site, therefore, the key objectives will relate to an understanding of spreading processes with a contrasting suite of driving force variables in comparison with those at the other mid-ocean ridge ISS. Working from the overall goals and objectives of the R2K Integrated Studies program, participants in the R2K Implementation Workshop developed a list of seven interrelated objectives specific to the Lau ISS that will allow these fundamental questions to be answered:

3.2.1. Characterization of the mantle flow pattern and of the magma production and transport regions

Spatial variations in petrology and geochemistry reflect the spatial variability in mantle composition and melting behavior and in patterns of mantle flow. In this region, geophysical methods can be used to study relationships among subduction-related flow patterns, larger scale mantle dynamics, and migration and propagation of the backarc spreading axis. For example, large-scale tomographic imaging of the upper mantle will contribute towards an understanding of mantle flow patterns by constraining both the distribution of partial melt and patterns of anisotropy. These observations will help to determine the depth where melting begins and to understand how melts migrate to the spreading axis. Comparison of these experimental constraints with geodynamic modeling will, in turn, provide insight into the dynamic processes driving plate motions and magma production. These results will clarify the roles of mantle flow and magma transport processes in controlling petrology, hydrothermal chemistry, and biota along the ridge crest.

3.2.2. Understanding the origins and consequences of gradients in source and lava composition along the ELSC

From south to north along the ELSC, a gradation from strongly arc-influenced andesitic lavas to typical mid-ocean-ridge-like back-arc tholeiitic basalts reflects the increasing spatial separation of the ELSC from the arc volcanic front. Systematic variations in virtually all other characteristics of the spreading system are known or expected to accompany this gradation in lava composition. These variable characteristics include: (i) the volumes, emplacement rates and compositions of magmas; (ii) the compositions and production rates of magma-derived volatiles; (iii) the tectonic and volcanic architecture of the crust, including the location and formation of axial magma chambers; (iv) the distribution, location, temperature and composition of hydrothermal vent fluids and their impacts on the overlying water column; and (v) the composition and abundance of hydrothermal vent faunas. The underlying cause of all these variations is likely to be found in the changing nature of the mantle wedge and subducted slab from which the magmas of the spreading axis are derived.

Step-like axial depth variations along the ELSC may reflect discontinuities in the magma source region, in magma supply, or in the spreading process. However, there is a 220 km sampling gap along the central and southern ELSC in the critical region where a major depth transition occurs. Because of this gap, it is not known whether variations in geochemical parameters along the ELSC more closely correlate with axial depth or with distance to the Tofua Arc. Sampling across this critical transition region will allow for the development and testing of competing hypotheses concerning the underlying causes and controls of all the complex variations outlined above.

3.2.3. Understanding spatial and temporal variations in crustal architecture

To understand the variation in axial morphology from south to north along the ELSC, so that the context of the ISS is understood, it will be essential to determine patterns of variation in crustal structure and thickness. Examples of important questions that must be addressed include:

- How do variations in crustal structure relate to axial morphology and segmentation?
- How do physical properties of the ELSC crust and the axial magma chamber compare with those at mid-ocean spreading centers?
- To what extent do crustal structure patterns persist with time?

These questions should be addressed primarily through a well-planned program of 2-D and 3-D seismic imaging. Petrological sampling off-axis (to establish temporal variability) and both on-axis and off-axis IODP drilling will also contribute to this effort by providing samples that document both the temporal evolution of the ELSC in the vicinity of the ISS bull's-eye and by providing "ground truth" for models of shallow seismic structure. Results will improve our understanding of the relationship between crustal structure variables, such as the thickness of layer 2A, and factors such as hydrothermal vigor and chemistry.

3.2.4. Understanding variations in vent fluid and biological community characteristics along a geological gradient

An understanding of how vent field characteristics vary with spreading rate and substrate composition along the ELSC is fundamental to a full understanding of the bull's-eye vent field. Along-gradient studies will enable the recognition of end-members in numerous parameters including: hydrothermal fluid composition, hydrothermal deposit geochemistry, microbial population structure and dynamics, and distribution patterns of biological community dominants. Variations in chemistry of high and low temperature vent fluids provide information on styles of mixing within the crust and within vent deposits, as well as on rock composition at depth.

Correlations of along-axis variations with tectonic and geologic factors will allow for a better understanding of potential driving variables as well as providing the larger context for detailed investigations of the bull's-eye hydrothermal systems.

3.2.5. Determining the detailed geologic setting of the bull's-eye hydrothermal vent field

The ultimate controls on seafloor hydrothermal activity are the heat sources at depth and the permeability structure of the crust. As a first step towards understanding these controls for the bull's-eye field, a thorough characterization of its broader geologic context is essential. For example, the relationships between focused and diffuse hydrothermal outflow, and fissure and fault distribution can be used to define the upper boundary of the crustal fluid flow network. Geological criteria can assist in understanding spatial and temporal linkages between heat sources and permeability structure, for example, by establishing whether fissures are formed by tectonic extension or in response to underlying magma intrusion. Along-axis variations in vent fluid composition provide critical information on rock composition at dept, aiding in geological characterization.

A thorough geological characterization begins with detailed geological mapping of fissures, faults and lava flows, active and inactive hydrothermal deposits and biological communities. It may also include a variety of geophysical measurements including heat flow, near-bottom magnetic and gravity fields, and fluid outflow rates, volumes temperatures and compositions. These observations are required at relatively small scales with resolution ranging from a few tens of meters in some cases to as little as a few centimeters in others.

Drilling in the vicinity of the bull's-eye vent field would greatly enhance this and the following objective, providing access to subseafloor geological and hydrothermal systems and potentially to a subseafloor microbial community. Because of the high volatile content of arc magmas, it is likely that both hydrothermal and biological systems would be distinctly different from those of normal mid-ocean spreading centers. A second, site-specific objective would be to access large sulfide deposits, both actively forming and mature. Compared with typical mid-ocean ridge deposits, these are known to be highly enriched in ore metals such as Zn, Pb, Ag, and Au because they are hosted in felsic rocks. They are more representative of an important group of ancient hydrothermal ore deposits that are mined on land. In fact, the Lau ISS may be uniquely able to exploit existing ODP drilling technology as soon as the IODP comes online. Based on recent drilling successes in the Manus Basin, it is probable that the highly vesicular felsic magmas that characterize the Valu Fa area are much more amenable to drilling than highly fractured pillow basalts at the mid ocean ridge sites.

3.2.6. Understanding the structure and function of biological communities, hydrothermal flow, and chemistry at the "Bull's-eye" site.

Hydrothermal and biological studies that can be co-located in space and time are essential for an overall understanding of a variety of phenomena. This co-location is fundamental to the ISS and bull's-eye concepts. One essential objective is to understand the functional relationships between hydrothermal flow, fluid chemistry and the microbial and megafaunal communities associated with hydrothermal venting and deposits. To achieve this objective, carefully designed studies must encompass the variability within the bull's-eye field, including both high and low temperature, and focused and diffuse vents.

As an essential basis for this type of research, studies must be undertaken as early as possible to establish the distributions of, and correlations among, the chemical and physical characteristics of the hydrothermal systems and the populations of both the macro- and micro-faunas that they support. Following on these basic studies, a suite of experimental studies designed to more fully examine the functional relationships of the biota to the vent conditions and to each other must also begin as soon as possible to allow for time-series observations and for the development of new experiments that build on ongoing discoveries. A key, site-specific component of this objective is to examine the extent to which novel aspects of the hydrothermal and biological systems are a consequence of the distinctive geochemical and geological back-arc setting. For biological systems, a key task will be to understand the relative importance of geological setting and biogeographic provincialism.

3.2.7. Establishing and maintaining integrated time-series studies of hydrothermal processes

To fully elucidate the linkages among magma supply, crustal properties, hydrothermal processes, and the biological communities, rapid and unpredictable perturbations in the system must be captured by real-time or near-real-time interactive studies. To achieve this, instruments must be co-located in time and space and, ideally, be equipped with two-way communication links that enable remote, interactive modification of sampling schemes and manipulation of experiments from onshore. A variety of well-tested instruments may be required, including temperature probes, fluid samplers, cameras and seismometers. Additional instruments that are under development include chemical sensors and biological monitors. The deployment of appropriate surface moorings with power supplies and satellite communications at the earliest opportunity should be a high priority for this and all ISS (See Section 5.1).

4.0 INITIAL STUDIES AND STAGING CONSIDERATIONS

4.1 Initial Objectives

The principal initial objective of scientific studies at the Lau ISS is to locate candidate vent fields and to obtain sufficient information on their characteristics and context to enable the final choice of the ISS bull's-eye. A minimum of three *initial location cruises* will be required to acquire the data necessary for assessment and for the final designation of a bull's-eye. One cruise will carry out high resolution mapping, one will focus on plume detection and rock sampling, and one will focus on identification and characterization of the most promising vent fields. Early completion of these cruises is essential for progress at this ISS.

Because the 2004 field season is the earliest possible time for acquiring the necessary data, final bull's-eye designation cannot occur until late 2004. In the interim, proposals that will lead to the acquisition of data that do not require precise knowledge of the bull's-eye location but will nevertheless provide important background or preparation beyond that of the initial location cruises are encouraged. Examples include (i) acquisition of T-phase seismic data, (ii) acquisition of regional current data, (iii) large scale studies of crustal and mantle structure, and (iv) preparation for deployment of time-series experiments that can be initiated at the earliest opportunity after bull's-eye designation,

4.2 Timeline

4.2.1 Getting Started: Through 2005

The following timetable is recommended:

- *August 2002:* Proposals for critical "Initial Studies" as described in Section 4.3.
- *February and August 2003:* Proposals for background studies as described in Section 4.1 that can be designed without exact knowledge of the bull's-eye location and characteristics. Also, development and preparation of time-series instruments to be deployed in 2005 as soon as the bull's-eye is designated will be encouraged.
- *2004 Field Season:* Implement three initial location cruises (or their equivalents as defined by proposals) as described in Sections 4.1 and 4.3.
- *Late 2004:* Community meeting to evaluate candidate bull's eye vent fields identified by the initial location field studies.
- *February 2005:* First site-specific proposals that depend on knowing the bull's eye location.
- *2005 Field season:* Implement the bull's eye detailed mapping and sampling cruise and large-scale studies.

4.2.2 Substantial Progress: 2005 - 2010

During the five years spanning 2005-2010, priorities for the Lau ISS will be directed to achieving substantial progress toward the site-specific objectives. At the time of the NSF-mandated 3-year program review, there should also be a community review of progress at the Lau ISS leading to a rigorous re-assessment of priorities.

Benchmarks for progress at the Lau ISS coinciding with the mandated 3- and 6-yearly R2K Program reviews should be as follows:

3-year review:

- Initial Objectives as outlined above substantially complete.
- Bull's-eye location and intermediate target outlines identified.
- Mature plans and/or experiments in place for collection and distribution of community time-series data.

- Planning underway for initial site experiments consistent with the Site Specific Objectives

6-year review:
- Substantial progress towards the Site Specific Objectives.
- Completion of fieldwork in support of priorities assigned at 3-year review.

4.3 Initial Field Work

To create a fully functional ISS on the ELSC, a bull's-eye vent field must be designated as soon as possible. The highest priority must be assigned to activities that will locate and evaluate candidate bull's-eye sites along the ELSC. A minimum of three cruises are envisioned to locate candidate vent fields and to gather sufficient data for a decision to be made. A *minimum* set of activities that are required to locate and evaluate candidate sites is described below, with activities clustered to fully utilize three cruises. The following descriptions are intended to be generic with respect to methods and equipment. Exact details will be determined through the proposal process.

4.3.1. High Resolution (DeepTow) Mapping

High-resolution sonar surveys of the entire ELSC are required to define the geologic setting of the axial zone, to aid in locating candidate bull's-eye fields and to provide a geological context for the final bull's-eye selection. Imagery should be sufficiently detailed to clearly document fine-scale (third and fourth order) axial segmentation, axial morphology, fault and fissure distribution, and major lava flow boundaries. This would require a ~30 kHz system or equivalent (~10 m resolution, ~5 km swath width). Ideally, in the same cruise, finer scale mapping should be carried out in selected areas to image fault and fissure distribution, lava flow boundaries and to identify potential sulfide structures. This would require a ~120 kHz system or equivalent (~1-2m resolution, ~1 km swath width). Both systems should collect both backscatter (amplitude) and bathymetric (phase) data.

A highly desirable subsidiary activity of this cruise will be a preliminary survey of water column properties (temperature, salinity, turbidity and others if possible) to monitor for hydrothermal plume signals in the water column. This may require development of a technique to deploy of a sensor array, together with the towed mapping device(s), but below the normal (500 meter) operating depth of current 30 kHz systems. Sensors should be at least equivalent to NOAA's miniature autonomous plume recorders (MAPRs) and deployed across the depth range (100-300 meters above seafloor) where hydrothermal plumes are most likely to be encountered. Sensor data of this type will potentially provide preliminary plume location data to guide later, more definitive CTD/water column surveys and, combined with those data, more fully characterize hydrothermal plume distributions along the ELSC.

4.3.2. Plume Detection and Rock Sampling

In order to locate candidate bull's-eye vent fields and to select the "best" bull's-eye location, hydrothermal plumes, and the vents at which they originate, must be located along the unsurveyed section of the ELSC. Sufficient data must then be obtained to allow for an evaluation of new sites as well as the known sites at the Valu Fa vent field. An essential first step in vent field location will be to conduct a water column survey along the ELSC. Following the survey, an attempt should be made to verify the existence and locations of hydrothermal vents at promising sites using appropriate video or photo imagery. The objective of such a search in this cruise would be to locate specific targets for later more intensive investigations.

Petrological sampling has been limited along the ELSC, and there is a gap of ~220 km in a region where critical petrological and structural transitions occur. To provide context for the bull's-eye selection process, the along-axis gradients in mantle chemistry and lava composition and the relationships of these gradients to tectonic segmentation must be established. Sample spacing of the order of 5-10 km using a combination of dredging and rock wax coring, will be required and the possibility of onboard analysis should be considered.

4.3.3. Vent Field Identification And Characterization

This cruise will focus on up to three of the most promising candidate bull's-eye vent fields identified by the two preceding cruises, by existing knowledge of the Valu Fa area, and by the initial visit to each field. It will conduct preliminary characterizations of these sites that will allow for the final bulls'-eye selection. Vent sites in the most promising areas of hydrothermal activity will be located using a fine scale (sub-meter) imaging system.

Essential objectives of this cruise include:
- Locations and descriptions of active hydrothermal vents.
- Preliminary evaluations of hydrothermal mineral deposits and megafaunal communities.
- Collection of a basic sample suite that includes igneous rocks, vent fluids, vent deposits, microbes and megafauna.

The focus of these evaluations should be a first-order characterization of each candidate hydrothermal field and the principal tools should be an imaging system, capable of overall meter-scale resolution, with local detail to centimeter scale, plus a submarine or an ROV with adequate sampling capabilities.

If technologically feasible, the use of an AUV in one or more of these cruises would greatly enhance the imaging capability and geophysical coverage.

4.4 Background Data Collection

The Lau ISS is completely lacking in certain types of "background" data that are critical for the success of the ISS. High priority should be given to initiating and maintaining the collection of background data that will support a range of potential ISS investigations. Background data should be regarded as community assets and made freely available within a very short time (days to weeks) after they are collected. Two examples of data sets that should be initiated as early as possible are described below.

4.4.1. Seismicity Monitoring by Autonomous Underwater Hydrophones

Acoustic monitoring of seismically generated T-waves can be used to define patterns of seismicity and magmatic activity along the ELSC. Cost effective instruments are available to detect and locate low-magnitude (> 2.5-3.0 M) earthquakes and tectono-magmatic events that cannot be accurately located from land stations. Patterns of low-level seismic activity can be used to identify locations of magmatic and tectonic activity, the type of activity and its relationship to axial segmentation and structure.

A Lau array of 6 autonomous underwater hydrophones (AUHs) would provide time-series acoustic monitoring for the entire ELSC with a location accuracy at least comparable to existing arrays (1-2 km at 68% confidence level). Such an array would likely provide data for adjacent ridge segments and the Tonga arc. Early deployment can potentially guide vent location activities by identifying active areas, while ongoing monitoring will provide important background data for the life of the ISS. To facilitate community use, T-wave derived epicenters, origin times and associated errors should be made available as the data are recovered and processed

4.4.2. Monitoring Circulation in the Lau Basin

Observations of deep ocean circulation patterns around the ELSC both in the local vicinity of vent fields and on the scale of the ELSC will provide information that is fundamental to the design of numerous water-column experiments, and to the understanding of larval dispersal pathways, geochemical transport, and estimates of hydrothermal output. Early knowledge of the regional oceanographic flow field will provide important context for interpretation of near-field flow phenomena including patterns of plume dispersal and tidal flows.

Satellite-tracked floats are among the most promising tested techniques to determine the regional-scale circulation. These floats provide circulation data via satellite in near-real time. These data can be immediately available in various forms including web animations.

5.0 RELATIONSHIP TO OTHER PROGRAMS

Wherever possible R2K ISS research should seek to collaborate with and benefit from other US and international science initiatives.

5.1 International Ocean Drilling Program (IODP)

The International Ocean Drilling Program (IODP) is an international initiative, which is scheduled to resume deep ocean scientific drilling operations in 2005. The IODP is the ideal vehicle for extending ISS studies significantly into the third dimension beneath the seafloor as well as back in time through off-axis drilling.

5.2 US Ocean Observatories Initiative

In response to increasing demands by researchers for sustained observations in the oceans and as a result of recent advances in technology, the NSF has developed an Ocean Observatories Initiative (OOI). The OOI (which has grown out of the DEOS program) would provide the basic hardware and infrastructure needed to establish both relocatable (buoyed) and cabled observatories. It is evident that many of the activities planned for each of the ISS would be greatly enhanced by real-time communication with instruments and potentially by the supply of significant power to the sea floor. In fact, part of the rationale for the OOI is its role in support of initiatives like Ridge 2000 and MARGINS, both of which are planning for intensive integrated studies at a few specific sites. Planning and feasibility studies for both relocatable and cabled observatories have been conducted and several such projects have already begun and have a life of their own. Thus it is both reasonable and prudent to plan on the availability of buoys and in some cases perhaps even a cable providing power and two-way communications to sea floor instruments at Ridge 2000 Integrated Study Sites in the near future.

5.3 InterRidge

InterRidge is an international association of national organizations that promotes collaboration and cooperation in spreading center research. It has had remarkable success in the last decade in coordinating activities along the Southwest Indian Ridge in particular. The Lau Basin is a remote site that requires significant logistical effort for American and European scientists and, to a lesser extent, for Japan and other SE Asian nations. It is less thoroughly studied than the other R2K ISS sites but nonetheless has a history of international collaborative scientific activity. For all these reasons, it is an excellent location for continued international collaboration that can lead to more rapid progress than would be achieved by any single nation.

6.0 INTERNATIONAL CONSIDERATIONS

6.1 Kingdom of Tonga

Much of the ELSC lies within Tongan territorial waters. Efforts must be made to collaborate with Tongan scientists to the maximum possible extent, both in the planning process and as active scientists and observers. As a practical matter, clearance to work in Tongan waters must be obtained from the government of Tonga. The R2K office will ensure that information on appropriate procedures and contacts is developed and maintained. PIs needing clearances and/or wishing to develop relationships with Tongan scientists should coordinate with the R2K office and the Lau ISS Site Coordinator.

6.2 SOPAC

The South Pacific Applied Geoscience Commission (SOPAC), headquartered in Suva, Fiji, is a coordinating body for natural resource and environmental issues as they affect the South Pacific island nations. The R2K office will ensure that SOPAC is advised of plans for the Lau ISS and that an appropriate relationship is developed. SOPAC has been very helpful in making contacts with local government officials in the past. PIs wishing to develop contacts with SOPAC should coordinate with the R2K office and the Lau ISS Site Coordinator.

7.0 Policies and Infrastructure

7.1 Integrated Study Site Policies

Open discussion among the various groups working at an ISS is required to coordinate the program elements. To ensure scientific communication and coordination among R2K investigators, all proponents of R2K proposals are required to publish a brief description of the intended proposal submission on the R2K website at least thirty days before each target date. This moderated online bulletin board will also serve as a forum for communication among R2K scientists working at the ISS. PIs are also reminded that one copy of each proposal submitted for R2K funding must be sent to the R2K office within two weeks of the NSF target date to enable relevancy review. This copy need not include budgetary information.

In addition, PIs of funded programs must provide timely updates on planned field programs so that potential disciplinary overlap, logistical and equipment considerations and other issues related to coordinated field programs at an ISS may be identified and optimized. To further facilitate communication among R2K scientists at each ISS site, a site coordinator is needed. The ISS Coordinator will be a volunteer or person nominated from among the funded PIs at the ISS. The Coordinator may request a moderate supplement to a funded proposal to support this effort.

7.1.1. Integrated Study Site Coordinator Responsibilities

The Lau ISS Coordinator's main responsibility will be to foster communication and to ensure the organization of information and materials important to the Lau ISS community. These responsibilities will include:

- Instigate, facilitate, and coordinate preproposal communication, including the use of a web-based "bulletin-board" hosted by the R2K web server to foster dialog.
- Ensure that PIs provide timely proposal summaries and information concerning study areas, instrument deployments, and timing of field programs to the Ridge 2000 Office at least one month before proposal deadlines.
- Ensure that funded PIs provide timely updates on planned field programs.
- Tabulate goals of pending and funded programs, instrument deployments, and duration of each experiment to facilitate in planning for all PIs.
- Aid in communication through a Lau email list and/or bulletin board by providing notices of cruise opportunities, updates on site relevant programs such as InterRidge and important entities including the Kingdom of Tonga and SOPAC.
- Facilitate annual or bi-annual meetings of active or potential PIs to ensure communication and coordination of experiments.
- Ensure that a transponder/acoustic plan is maintained and that overlapping frequencies and other potential conflicts are avoided.
- With help from the Ridge 2000 Office, maintain an updated Lau ISS bibliography.
- Work with the PIs and Data Management Office to ensure that metadata and data for the ISS field programs are submitted in a timely manner.
- Periodically update the R2K steering committee on the status of the Lau ISS.

7.2 Data Management

The R2K Data Policy will apply to all ISS. It is available from the R2K website (http://r2k.bio.psu.edu/).

Effective data management will be an essential element of the R2K program, to ensure timely sharing of information to the broader R2K community and to facilitate effective multi-disciplinary integration of the broad suite of studies at each site. Well-designed and integrated databases will also enhance outreach to the general public and educators. Eventually, the databases will be an important component of the long-term legacy of the program.

The R2K Data Policy mandates the adoption of a Data Management System (DMS) and outlines its structure. The data management needs listed below build upon this Data Policy and represent priority issues for the DMS. A request for proposals to build the R2K Data Management System and establish the R2K Data Management Office (DMO) has been released by the R2K office, and contains additional information concerning the DMS and DMO. It is also available on the R2K website.

1) A single data management office will be established for all ISS and will serve as the metadata repository for all ISS. The DMO will also archive data not included in discipline specific archives. In general, the DMO will not duplicate existing discipline-specific databases (*e.g*. PetDB, Ridge Multibeam Synthesis, Deep Submergence Lab archives), but it will do so to the extent necessary to permit cross-disciplinary queries.

2) Standardized digital forms provided by the ISS data management office must be used to record metadata for all sampling and station work carried out in the field. These forms should be filled out at sea and submitted to the ISS data portal immediately following each field program. These forms will be developed, with community input, as early as possible.

3) Digital cruise reports are required; a standard digital cruise report format will be provided by the ISS DMS. The NSF MG&G data management workshop held in La Jolla, in spring 2001 strongly endorsed the establishment of a national MG&G metadata catalog that would include basic cruise information (Level 1 metadata), as well as digital cruise reports (Level 2 metadata). The metadata needs for the R2K Program follow those of the broader MG&G community and development efforts will be linked. The MG&G data management workshop report is online at humm.whoi.edu/DBMWorkshop/.

4) A web-based database front end is necessary to provide interactive mapping and search capability for the ISS. Given the multi-disciplinary nature of the Ridge 2000 ISS community, access to easy-to-use interactive tools that permit co-located data to be readily displayed and searched by the non-specialist user will be vital.

7.3 Integrated Study Site Oversight

A subcommittee of the Ridge 2000 Steering Committee will oversee each ISS. The oversight committee will be responsible for ensuring that the scientific program is on track to meet the scientific goals within the stated timeframe.

7.4 Education and Outreach

Education and outreach is essential to success of the Ridge 2000 program. Scientists are encouraged to initiate or collaborate in efforts to convey ridge science to a broader audience, including the scientific community, the general public, educators, and students. The Ridge 2000 Education and Outreach Coordinator will provide guidance and coordination, when needed, to facilitate these efforts. The Coordinator will also actively seek participation by scientists in community-wide education and outreach programs.

7.5 Ridge 2000 Office Support and Resources

The R2K office will continue to host a website that will serve as a clearinghouse for all communications (r2k.bio.psu.edu). Links to the ISS websites, databases, bulletin boards, will be maintained. In addition, ISS bibliographies, presentations and other relevant information will live on the R2K website.