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RIDGE and InterRidge: Cooperative interdisciplinary studies of mid-ocean ridges

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ABSTRACT

RIDGE (Ridge Inter-Disciplinary Global Experiments) is a major research initiative in the United States designed to complement existing research on spreading centers. RIDGE has been designed to integrate exploration, experiment and theory into a major, decade-long effort to understand one of the primary processes that have shaped the evolution of our planet. Its objectives are twofold: (1) to provide a focus for a coordinated, interdisciplinary research program directed at geological, hydrothermal and biological processes associated with the formation of oceanic crust, and (2) to provide a framework within which a rich diversity of investigator-initiated research can be undertaken. The RIDGE initiative has led to parallel efforts in other nations which have recently joined together to form InterRidge, an international collaboration of some sixteen countries focused on ridge crest studies.

Key words: Mid-ocean ridge. Spreading center. Oceanic crust. Plate tectonics. Hydrothermalism. Magmatism. Event. Segment.

RESUMEN

RIDGE (Ridge Inter-Disciplinary Global Experiments) es una importante iniciativa investigadora estadounidense acerca de los centros de expansión oceánica. RIDGE incorpora exploración, experimentación y teoría en en el seno de un esfuerzo de envergadura, de una década de duración, cuya finalidad última es la comprensión de uno de los procesos primarios que han determinado la evolución de nuestro planeta. Sus objetivos son dobles: (1) vertebrar un programa coordinado de investigación multidisciplinaria dedicado a estudiar los procesos geológicos, hidrotermales y biológicos asociados a la formación de corteza oceánica, y (2) proporcionar un marco en el que pueda desarrollarse una amplia gama de tareas investigadoras promovidas desde la base por los propios científicos. Recientemente, científicos de dieciseis países interesados en el estudio de las dorsales oceánicas se han agrupado en torno a la iniciativa transnacional InterRidge.

En los últimos quince años, la visión científica de las dorsales oceánicas y de los procesos que en ellas ocurren han experimentado un cambio sustancial. Las nuevas tecnologías, como los sistemas batimétricos de barrido de multihaz, proporcionan imágenes del fondo marino con una resolución sin precedentes en la historia. En parte, el cambio mencionado se debe a la constatación de que, en realidad, las dorsales medio-oceánicas constituyen un único y complejo sistema dinámico (la "dorsal medio-oceánica"), y que sus procesos magmáticos, tectónicos, hidrotermales y biológicos están estrechamente relacionados.

RIDGE e InterRidge articulan sus actividades en cinco líneas de investigación: (a) Estructura global y flujos, cuyo objetivo es caracterizar la estructura, la geoquímica, la biología y los flujos de energía en la dorsal medio-oceánica a escala global; (b) Variables de la acreción cortical, con la finalidad de identificar las variables que, además de la tasa de expansión, controlan los procesos de acreción cortical en la dorsal, y desarrollar modelos cuantitativos; (c) Flujo mantélico y formación de mezclas fundidas, centrada en dilucidar la naturaleza de estos procesos, y de los procesos responsables de la focalización magmática hacia las estrechas zonas neovolcánicas del eje de la dorsal; (d) Detección y respuesta a eventos, con la que se pretende desarrollar una capacidad real y fiable para identificar, localizar, caracterizar y evaluar las consecuencias de los fenómenos transitorios que ocurren en las dorsales, tales como erupciones volcánicas, liberaciones catastróficas de calor o material en la columna de agua, y enjambres de terremotos; (e) Variabilidad temporal de los fenómenos en las crestas de las dorsales, que permita comprender la naturaleza de los cambios en las actividades magmática, hidrotermal, tectónica y biológica dentro de una escala temporal que va desde el segundo a la década.

Se está, en definitiva, en el umbral de una década en que la comprensión global de nuestro planeta experimentará cambios trascendentes gracias, en buena medida, al estudio de la dorsal medio-oceánica en el marco de los programas RIDGE e InterRidge.

Palabras clave: Dorsal medio-oceánica. Centro de expansión. Corteza oceánica. Tectónica de placas. Hidrotermalismo. Magmatismo. Evento. Segmento.

INTRODUCTION

Since the advent of plate tectonics in the late 1960's, the global mid-ocean ridge system has been recognized as the surface expression of convective processes in the earth's mantle that have controlled the origin and evolution of the ocean basins, the movement of continents, and the physical and chemical evolution of our planet. The importance of mid-ocean ridge processes on planetary evolution are hard to overstate. Volcanism along ridge crest creates 20 km^3 of new crust each year, forming seafloor that covers more than 60% of the earth's surface. The creation of oceanic lithosphere at ridge crests and its subsequent recycling into the mantle at subduction zones have also played a major role in the geochemical evolution of the earth's mantle. The emplacement and cooling of oceanic lithosphere contribute two-thirds of the heat lost annually from the earth's interior, a major factor controlling the thermal history of the planet. One-third of this heat is lost by sea water circulating through hot, fractured volcanic rock. This hydrothermal activity has been important in the regulation of the chemistry of the oceans, the release of volatile gases from earth's interior, and the alteration of the oceanic crust. Submarine hydrothermal vents also provide the energy and nutrients to support diverse and unique biological communities based on bacterial chemosynthesis, in contrast to the photosynthetic-based food chain upon which most other life on earth depends. These communities may have played an important role in the evolution of life on earth.

Understanding the transfer and fluxes of mass and energy along the global ridge system requires an interdisciplinary approach and the development of models that include all of the subsystems and their interactions. This is the philosophy which has been adopted by the U.S. RIDGE Initiative, the primary goal of which is *"to understand the geophysical, geochemical and geobiological causes and consequences of the energy transfer within the global rift system through time"*. First formalized in 1987 at a workshop sponsored by the Ocean Studies Board of the U.S. National Academy of Sciences (Anonymous, 1988), the RIDGE program has begun moving from the planning stages into the implementation phase, with the first RIDGE-funded field programs being conducted in 1991. It was recognized very early in the development of RIDGE that characterization of the global mid-ocean ridge system will require a coordinated effort by many nations that have programs focusing on ridge-crest studies. This has led to the development of InterRidge, a coordinated, international mid-ocean ridge research effort which currently involves sixteen nations (Australia, Canada, France, Germany, Iceland, Italy, Japan, Korea, Mexico, Norway, Portugal, Russia, Spain, Sweden, U.K., U.S.).

This paper discusses the scientific objectives of the U.S. RIDGE Program, and the aspects of this program that will be carried out over the next five years in collaboration with international partners through InterRidge. We begin with a review of the scientific rationale behind the RIDGE and InterRidge programs. We then outline the major goals of RIDGE and describe in some detail two ambitious RIDGE experiments that will be undertaken in the next few years; the MELT experiment and the establishment of the first seafloor ridge crest observatory. We conclude with a brief discussion of InterRidge and the links between this emerging international research effort and the U.S. RIDGE program.

THE GLOBAL MID-OCEAN RIDGE SYSTEM: OUR CHANGING VIEW

Over the past 15 years our view of the mid-ocean ridge and the processes associated with the creation of new oceanic crust have changed significantly. This new thinking has been stimulated in part by the availability of new instrumentation, such as high-resolution swath mapping systems, that have allowed us to image the seafloor with unprecedent resolution. In part, this changing view has arisen from the realization that the mid-ocean ridge should be considered as a single, complex dynamic system and that magmatic, tectonic, hydrothermal and biological processes are intimately linked.

Crustal formation, once viewed as a relatively steady-state, two dimensional process controlled by the large-scale separation of the plates, is now recognized as a truly three-dimensional, temporally variable process closely linked to the geodynamics of the underlying mantle. The global ridge system is now known to be divided into discrete accretionary segments that are separated from each other by a hierarchy of ridge axis discontinuities, ranging from transform faults, which are large (tens to hundreds of kilometers long), relatively stable features linking ridge segments along strike-slip fault zones, to unstable ridge axis discontinuities, such as propagating ridges, overlapping spreading centers, and small non-overlapping offsets (Macdonald *et al.*, 1988). These boundaries create spatially distinct ridge segments of variable length (a few tens to hundreds of kilometers) that are now considered, in many respects, to be the fundamental unit of crustal accretion (Schouten *et al.*, 1985). Spreading rate, once considered to be the primary variable that controls the morphology and tectonics of spreading centers, is now recognized as just one of several important factors (mantle temperature, magma supply, etc.) that affect crustal accretion (Sempéré *et al.*, 1993). Ridge crest magma chambers, once viewed as large, molten bodies, have now been shown to be volumetrically small, largely crystalline bodies at even the fastest spreading rates (Detrick *et al.*, 1987). Perhaps most significantly, the ability of ridge crest scientists to make increasingly detailed observations, and to reoccupy sites over periods ranging from a few weeks to several years, has lead to a new appreciation of the mid-ocean ridge as a complex, dynamic system with considerable variability over a range of temporal and spatial scales (Delaney *et al.*, 1992).

RIDGE PROGRAM ELEMENTS AND THEIR GOALS

The long-term strategy of the RIDGE program is to obtain a sufficiently detailed spatial and temporal definition of the global mid-ocean ridge system to construct quantitative, testable models of how this system works. The program requires at least three basic types of research over the coming decade: (1) spatial (mapping and sampling) studies to establish an adequate three-dimensional definition of the mid-ocean ridge on a global scale, including the key variables that affect the crustal accretion processes, (2) time series measurements on the scale of a decade of ridge crest magma-hydrothermal systems to characterize variation and covariation among ridge-related processes, and (3) the development of models that integrate these spatial and time series measurements into realistic and testable models of the mid-ocean ridge system.

Five major research elements have been identified as an initial focus for the RIDGE program (Anonymous, 1992). These areas of research represent those components of mid-ocean ridge science that can most effectively be treated within the framework of a long-term, coordinated program. These five elements are briefly described below.

Global Structure and Fluxes

To date, only a small fraction (<10%) of the global ridge system has been studies in any detail (Fig. 1). The goal of this element of the RIDGE program is to characterize the tectonic structure, geochemistry, biology and

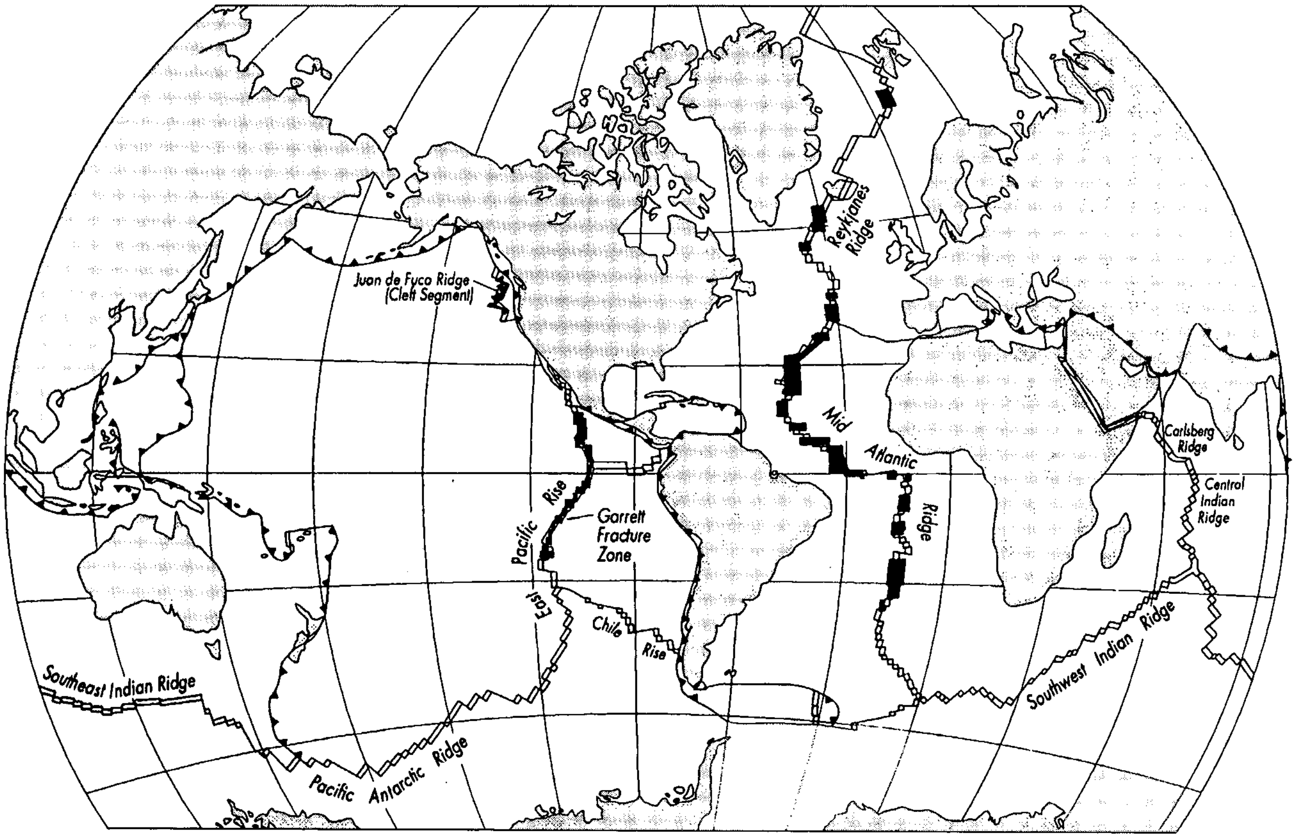

Figure 1.- Map showing the distribution of multibeam bathymetric data currently available along the global mid-ocean ridge system. Only a small fraction of the ridge has been mapped in detail. The spreading ridges in the Indian Ocean and in the Southern Oceans remain virtually unexplored. Characterizing the mid-ocean ridge on a global scale within the next decade is a major goal of the RIDGE program.

Figura 1.- Situación geográfica de los datos batimétricos de multihaz actualmente disponibles a lo largo del sistema global de la dorsal medio-oceánica. Menos del 10% de la dorsal ha sido cartografiado con detalle. Los centros de expansión del Océano Indico y de las regiones oceánicas del hemisferio sur están prácticamente inexplorados. Uno de los principales objetivos de los programas RIDGE e InterRidge es la caracterización global de la dorsal medio-oceánica en el decurso de la próxima década.

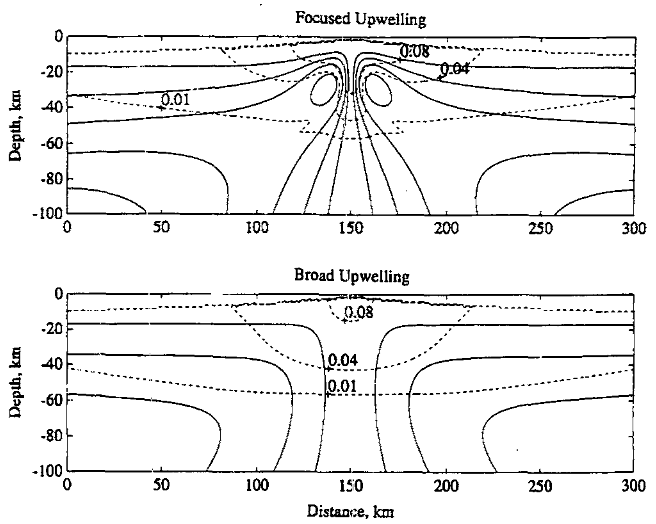

Figure 2.- Comparison of two models of mantle upwelling at mid-ocean ridges. Focused upwelling (upper figure) is driven by viscosity and compositional effects during mantle melting. Broad upwelling (lower figure) is plate-driven flow with a small component of compositional buoyancy. Dashed lines are melt fraction in percent; solid lines are flow lines (from an unpublished study by V. Faul, D. Toomey, E. Humphreys, R. Buck and D. Caress). The goal of the RIDGE MELT experiment is to provide new geophysical constraints on the mantle flow and melt migration beneath a fast spreading ridge.

Figura 2.- Comparación entre dos modelos de afloramiento mantélico en las dorsales medio-oceánicas. El afloramiento focalizado (dibujo superior) está impulsado por la viscosidad y por efectos composicionales durante la fusión del manto. El afloramiento extenso (dibujo inferior) responde a un flujo impulsado por las placas con una pequeña componente de flotabilidad composicional. Las líneas discontinuas representan el porcentaje de fracción fundida; las líneas contínuas representan líneas de flujo (de un estudio no publicado de V. Faul, D. Toomey, E. Humphreys, R. Buck y D. Caress). El objetivo del experimento MELT de RIDGE es la acotación de nuevos parámetros geofísicos en relación con el flujo mantélico y la migración de la mezcla fundida debajo de una dorsal rápida.

energy fluxes of the mid-ocean ridge on a global scale within the next decade. The magnitude of this task makes this program element a natural focus for a cooperative international effort coordinated through InterRidge. Consequently, the global objectives of both RIDGE and InterRidge are inextricably linked. Many countries, including Spain, now have research vessels equipped with modern, high-resolution multibeam bathymetric systems and thus can make important contributions to this effort.

Global-scale studies as envisioned by RIDGE will involve bathymetric and structural mapping, reconnaissance water, rock and biological sampling, and the analysis and synthesis of large datasets from a global perspective. The general approach for field studies will be to identify 1000-2000 km long "super segments" of the global mid-ocean ridge that are still largely unknown and to conduct a 3-4 leg program of mapping and sampling to characterize each of these segments. Candidate "super segments" for studies in the 1994-1997 time frame include the Pacific-Antarctic Ridge, the southwest and southeast Indian Ocean Ridges and the southern East Pacific Rise. Priorities for global-scale studies will be established by InterRidge early in 1994.

In a related effort, RIDGE has funded the compilation of a global synthesis of multibeam bathymetric data from mid-ocean ridges. This synthesis, which will be completed in 1994, will be available not only in map form, but as on-line database accessible across Internet by all interested ridge crest scientists.

Crustal Accretion Variables

It is now recognized that spreading rate is only one of the many variables that control the crustal accretion process at mid-ocean ridges. The long-term goal of this portion of the RIDGE program is to identify these variables and develop quantitative, testable models of the interaction of magmatic, tectonic, hydrothermal and biological processes at ridge crests. These investigations will naturally focus on processes at the scale of an individual spreading ridge segment (10s-100s of km). These studies will thus provide a critical link between efforts to understand spreading processes on a global scale and highly site-specific studies, such as those envisioned in the establishment of seafloor observatories.

The RIDGE program has chosen to focus initially on the interplay between spreading rate and magma supply as two first-order crustal accretion variables. The primary goal in the 1992-1995 time-frame is to obtain comprehensive, comparable datasets in at least two areas with contrasting spreading rates and magma supplies. The areas chosen for these studies are the East Pacific Rise between 9°N-16°N and 14°S-18°S and the Mid-Atlantic Ridge between 15°N-40°N (Fig. 1). The latter area is also the site of the French-American cooperative program known as FARA, as well as ongoing or planned studies by British, Russian, Japanese and Portuguese scientists. The central North Atlantic has thus become a prototype area for InterRidge investigations at the segment-scale. Over the lifetime of the RIDGE program it is expected that 5-10 phased and integrated multi-segment scale investigations will be required to examine the range of potentially important crustal accretion variables.

Mantle Flow and Melt Generation

One of the more remarkable discoveries at mid-ocean ridges is the narrowness of the actual zone along which new crust is formed -this zone typically is only a few hundred meters to 1 or 2 kilometers wide (Macdonald, 1982). In contrast, upwelling and melting in the underlying mantle occur over a very broad zone 50-100 km wide (Fig. 2). The goal of this portion of the RIDGE program is to understand the nature of mantle flow and melt generation beneath mid-ocean ridges and the processes responsible for the focusing of magmatism into such a narrow neovolcanic zone.

A three-pronged approach has been devised to address this problem involving field, laboratory and theoretical studies. The centerpiece of this effort will be a major seismic and electromagnetic experiment currently planned for 1995-96 along the southern East Pacific Rise near 17°S, one of the fastest spreading portions of the mid-ocean ridge system. Known as the MELT (Mantle ELectromagnetic and Tomography) experiment, it will involve 40 or more ocean bottom seismometers (OBS) deployed for up to a year and up to 20 sets of electrometers and magnetometers for a passive electromagnetic experiment. P and S wave velocities and seismic attenuation (1/Q) are sensitive to temperature and melt fraction, S wave velocity and perhaps Q are sensitive to the shape of the melt inclusions, while electrical conductivity is particularly sensitive to the connectivity of the melt. Thus by combining electromagnetic observations with a seismic experiment it will be possible to obtain an important independent constraint on the size and geometry of the melting region.

Figure 3 shows a possible intrument layout for MELT that has been developed at several RIDGE-sponsored workshops (Orcutt and Forsyth, 1989; Phipps Morgan, 1992). A linear array of ≈30 OBS would be deployed symmetrically across the ridge axis extending up to ≈500 km off-axis on either side. A dense sub-array, located within 100 km of the ridge axis, would consist of 20 instruments spaced 5-15 km apart. This sub-array, which has dimensions comparable to the width of the expected melt generation zone beneath the ridge, would primarily be used for body wave tomography studies from distant earthquakes occurring along the Pacific rim. Flankward of this P-wave delay array, instrument spacing would be increased to ≈100 km in order to in-

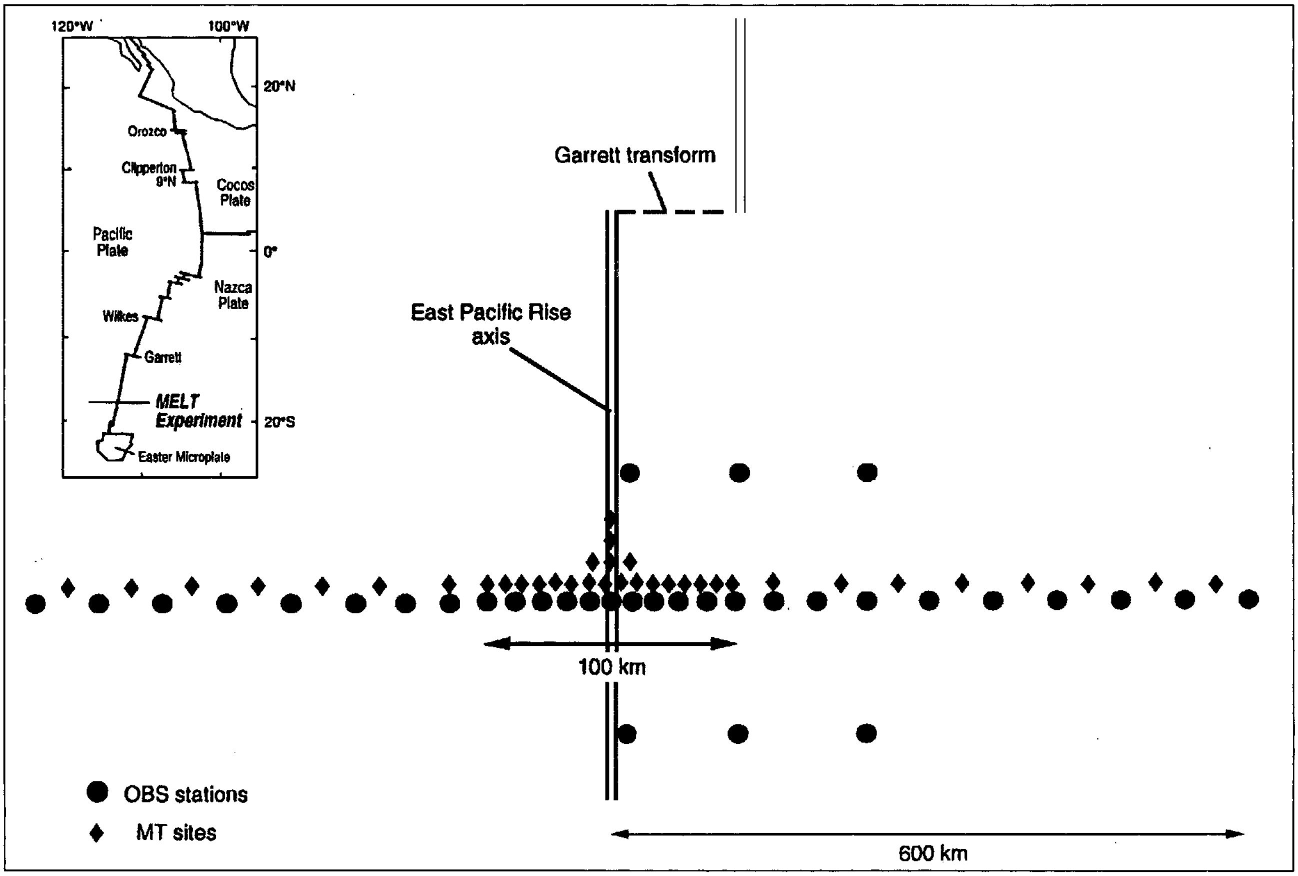

Figure 3.- Possible experimental geometry for the MELT experiment at 17°S along the East Pacific Rise.

Figura 3.- Posible geometría operacional del experimento MELT, a 17°S en la Dorsal del Pacífico Este.

vestigate the broader-scale flow regime beneath the ridge axis using Rayleigh waves. To address along-strike variations in mantle flow, ≈12 instruments would be deployed ≈50 km apart in three shorter (≈200 km long) arrays located off-axis and parallel to the rise axis. The instruments for the passive electromagnetic experiment will be deployed along the same line as the OBS, and will record natural variations in the earth's magnetic field at periods of 100-10,000 s over a 6-12 month period in order to determine the electrical conductivity structure of the upper 100 km of the earth's mantle beneath the ridge axis.

Preparations for this experiment are moving ahead rapidly. RIDGE funded a major two-ship multichannel seismic and OBS experiment in this area in 1991 that has determined the axial crustal structure and the dimensions of the crustal magma chamber present along this section of the ridge. A bathymetric and side-scan sonar survey of the corridor proposed for MELT was completed in late 1992 along with a pilot study to determine if a sufficient number of teleseisms can be recorded in this area in a one year deployment. Model studies have been completed and an optimum design for the experiment will be settled on later this year. During 1994 and 1995 modification and construction of the necessary instrumentation will be completed, and it is hoped the experiment can be conducted during a 12 month period beginning in late 1995.

Event Detection and Response

The goal of this element of the RIDGE program is to develop a practical and reliable capability for identifying, locating and characterizing transient ridge crest phenomena such as volcanic eruptions, catastrophic release of heat or mass into the water column, and major earthquake swarms. The detection of transient ridge crest events and implementation of an effective response strategy represent a new direction for ridge crest research. For event detection the RIDGE program has chosen to rely primarily on acoustic/seismic methods for identifying events on a regional or global scale. A significant first step was made in the fall of 1991 when the National Oceanic and Atmospheric Agency's (NOAA) Pacific Marine Environmental Laboratory installed and began using a system to continuously record hydrophone data from the U.S. Navy deep hydrophone arrays in the Northeast Pacific (Fig. 4). Working in collaboration with the Naval Research Laboratory, it is foreseen that RIDGE should have expanded this effort to the North Atlantic in 1993. In parallel with this acoustic monitoring program. RIDGE is supporting data analysis and theoretical studies to determine ways of discriminating volcanic events from tectonic earthquakes, determining the space-time pattern of event sequences, and recovering source characteristics from T-phases.

The discovery of an eruption along the northern East Pacific Rise in the 9°45N to 9°52N area in April, 1991

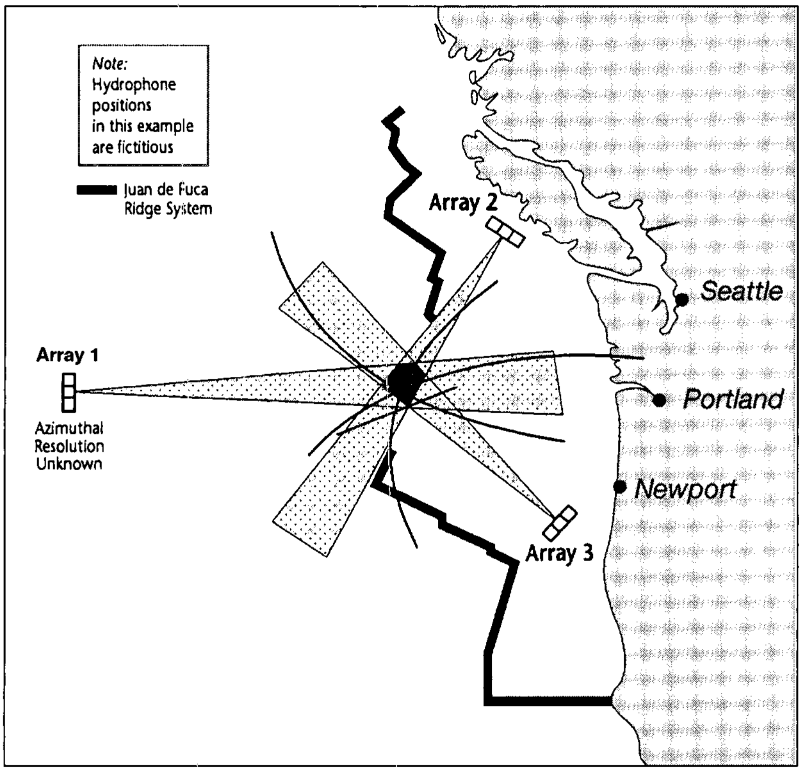

Figure 4.- Cartoon showing how ridge events (e.g. earthquakes) along the Juan de Fuca Ridge can be located from T-phases recorded at hydrophone arrays. The preliminary position is estimated from intersection of arrival azimuths based on cross-correlations within arrays. The final location is obtained using time delays between widely-spaced arrays and oceanic sound speed models. Monitoring using such a system was begun in 1992 by NOAA's Pacific Marine Environmental Laboratory (figure courtesy of C. Fox).

Figura 4.- Esquema ilustrativo del procedimiento de localización de eventos (p.e. terremotos) en la Dorsal de Juan de Fuca a partir de fases acústicas T registradas en sartas de hidrófonos. La posición preliminar es estimada a partir de las intersecciones de los azimuts de llegada para cada sarta. La posición definitiva se obtiene utilizando los retardos entre sartas y modelos de velocidad del sonido según las direcciones fuente-receptor. Este tipo de seguimiento se inició en el Laboratorio Marítimo Ambiental del Pacífico de la NOAA (dibujo cortesía de C. Fox).

(Haymon *et al.*, 1991) presents a major opportunity to study the evolution of a hydrothermal-biological system in a case where "time-zero" is well established. RIDGE is supporting return visits to this area to observe how these rapidly evolving systems are changing in the first few months and years after an eruptive event. The lessons learned from these studies should guide future response efforts.

Event response is an area where coordinations with the broader InterRidge community will be extremely important. As our ability to detect activity along the global mid-ocean ridge system improves, mounting a rapid response to these events will be critically dependent on the availability of resources (ships, instrumentation, and scientists) from the international community. The InterRidge Science Plan has identified this area as a major focus of international cooperation in the next few years.

Temporal Variability of Ridge Crest Phenomena

A major long-term goal of the RIDGE program is to begin to understand how magmatic, hydrothermal, tectonic and biological activity varies temporally on time scales of seconds to decades. Attainment of this goal will require the development and use of instruments that can make time series observations of submarine magma-hydrothermal systems, in effect the establishment of a seafloor observatory (Fig. 5). RIDGE has committed itself to establishing a pilot seafloor observatory an the Cleft Segment of the Juan de Fuca Ridge in the Northeast Pacific by the mid-1990's (Fig. 1). This effort will be an international one, and will represent the first major, coordinated experiment involving multiple arrays of instruments deployed in a localized volcanically and hydrothermally active area for periods ranging from months to years. Although the design of this pilot observatory is still under discussion, it will probably include:

- In situ, long-term measurements of the physical, chemical and biological properties of venting and bottom water fluids using sensors emplaced on the seafloor or in the overlying water column.
- Seafloor geodetic systems (e.g. tiltmeters, pressure sensors, extensiometers, gravimeters) for measuring and recording seafloor deformation.
- Seismometers for making long-term (>1 year), continuous records of seismic activity.
- High-resolution, low light-level cameras and other optical or acoustic instruments for long-term observations of geological and biological activity.
- Repeat detailed, high-resolution sonar, photographic and sampling surveys of limited areas within the observatory.
- Data telemetry systems for transmission of data in real-time to shipboard or shore-based laboratories.

In parallel with this effort RIDGE is also organizing a combined InterRidge/Ocean Drilling Program (ODP) experiment to characterize the TAG hydrothermal system on the Mid-Atlantic Ridge. Plans call for drilling the TAG hydrothermal deposit in late 1994. RIDGE and a number of our InterRidge partners are coordinating the deployment of a suite of sensors to document the characteristics of this active hydrothermal system before, during and after drilling. These observations will not only aid in the interpretation of the drilling results, but it also hoped to use drilling-induced changes in hydrothermal activity as a tool to constrain some of the fundamental physical properties of this system.

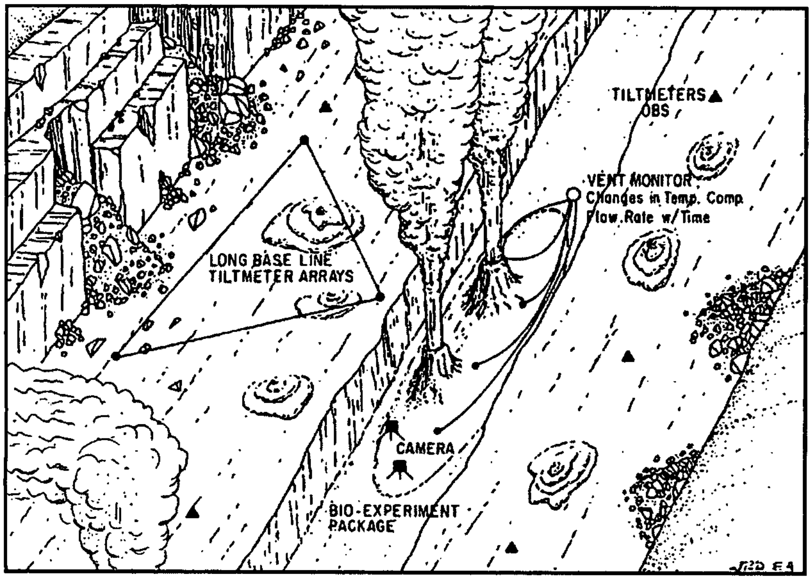

Figure 5.- Schematic view of the seafloor observatory proposed for the Cleft Segment of the Juan de Fuca Ridge. The observatory will include a variety of instruments including temperature sensors, flow meters, strainmeters, cameras and seismometers to monitor volcanic, tectonic, hydrothermal and biological activity along this section of ridge crest over periods ranging from a few days to many years (figure courtesy of J. Delaney).

Figura 5.- Caricatura del observatorio del fondo oceánico propuesto para el Segmento de Cleft de la Dorsal de Juan de Fuca. El observatorio incorpora sensores de temperatura, flujómetros, medidores de deformación, cámaras y sismómetros con el fin de seguir la actividad volcánica, tectónica, hidrotermal y biológica en dicho segmento durante períodos comprendidos entre unos pocos días y varios años (dibujo cortesía de J. Delaney).

INTER-RIDGE

The scientific excitement stimulated by the development of RIDGE has lead to similar initiatives in several other nations. InterRidge is an international, interdisciplinary program that has been designed to encourage scientific collaboration in ridge crest studies among these various national programs, with a particular focus on problems that cannot be addressed as efficiently by nations acting alone or in limited partnerships.

The need for a broader, long-term approach to international collaboration in ridge crest studies was first discussed in July, 1989 in Washington, D.C. at a meeting organized by the U.S. RIDGE Office. This was followed by a workshop held in Brest, France in June, 1990 which was attended by 35 scientists from 10 countries. At that meeting, a scientific framework for InterRidge was developed which emphasized both a spatial characterization of the mid-ocean ridge and monitoring of temporal variability through an international event detection and response program and the stablishment of seafloor observatories. In March, 1992 representatives from ten countries met in York, U.K. to adopt a formal scientific program for InterRidge and to develop an implementation strategy.

The InterRidge science plan approved at that meeting identifies three major themes:

- Acquiring a reconnaissance knowledge of the mid-ocean ridge on a global scale.
- Monitoring active processes at selected locations on the mid-ocean ridge to quantify the fluxes of mass and energy and their biological consequences.
- Meso-scale studies that investigate the interplay of accretion processes at temporal and spatial scales between the global and observatory scales with a specific effort in marginal (back-arc) basins.

A series of planning meetings in 1993 have helped to identify specific InterRidge objectives within these three areas. At least initially, the role of InterRidge is expected to primarily center around communication, fostering international cooperation, coordinating multinational field programs and experiments, and exchanging data.

National representatives have now been identified for sixteen countries (Australia, Canada, CIS, France, Germany, Iceland, Italy, Japan, Korea, Mexico, Norway, Portugal, Spain, Sweden, U.K., U.S.) and an InterRidge Steering Committee under the chairmanship of Drs. John R. Delaney (U.S.) and David Needham (France) has been established to oversee the implementation of the InterRidge Science Plan. An InterRidge Office has been temporally set up at the University of Washington in Seattle, although it is expected that this office will move outside of the U.S. by the end of 1993. In order to broaden InterRidge's international linkages, and assist smaller countries in becoming involved with the program, an InterRidge working group has been established by the Scientific Committee on Ocean Research (SCOR) which will be chaired by Dr. Martin Sinha (U.K.). The groundwork has thus been laid for a substantial international program of ridge crest research in the 1990's. The U.S. RIDGE program expects to work closely with InterRidge scientists in achieving the various program goals outlined above.

SUMMARY

We are on the threshold of a very exciting decade of research on mid-ocean ridges. Through programs such as RIDGE and InterRidge we hope to develop a much better understanding of the way the physical, chemical and biological processes associated with ocean crust formation have shaped the evolution of this planet.

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