

# InterRidge Program Plan

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Revised  
1994

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## **InterRidge Program Plan**

### Summary

Mid-ocean ridges, including those in marginal basins, are the primary sites of volcanic activity on the earth and the primary sites of creation of new crust. In addition to exerting a major influence on the evolution of the solid earth, they affect the chemistry of the ocean and support unique forms of life. Nonetheless, because they lie beneath the sea, ridges remain poorly understood. We know less about volcanic activity on the seafloor than we do for many other planetary bodies in the solar system.

**InterRidge is an international and interdisciplinary initiative concerned with all aspects of ridges. It is designed to encourage scientific and logistical co-ordination, with particular focus on problems that cannot be addressed as efficiently by nations acting alone or in limited partnerships.**

The existence and functioning of mid-ocean ridges depend upon intra-planetary (mantle) processes, as opposed to processes driven by external (solar) energy. The scientific purpose of the InterRidge initiative is to discover the inter-relationships among the diverse manifestations of the ridge system and to integrate growing understanding of ridge dynamics with knowledge about the functioning of the earth as a whole. Achieving these objectives concerns many subjects, from seismology to bacteriology, and a variety of approaches at many different scales.

This report presents an initial research plan consistent with current national priorities and strategies and with present-day perceptions of the most important scientific problems at hand. The plan recognizes that these problems can change rapidly and is correspondingly flexible.

Principal InterRidge activities are grouped under three major themes, or Integrated Projects, the objectives of which are to:

- Acquire a balanced set of global-scale data on the entire mid-ocean ridge system, which implies notably a concerted effort of exploration in high latitudes where data are extremely sparse.
- Observe, measure and monitor active processes at individual ridge sites in order to begin to quantify the fluxes of mass and energy involved and their biological consequences.
- Investigate the interplay of mantle processes at temporal and spatial scales that bridge the gap between the global perspective and fine-scale studies of active processes. These "meso-scale" studies focus on magmatic and tectonic patterns as well as on fluxes, and include a specific effort on ridges in marginal (back-arc) basins.
- Understand the evolution, reproduction strategies and dispersion paths of hydrothermal vent biota and determine their relevance to and interaction with physical, chemical, and geological processes at the ridge-crest.

InterRidge is defined as a decadal program divided into three phases:

- Phase 1 (1992-1994), devoted to improving co-ordination of on-going independent national and international (principally bi- and tri-lateral) activities, encouraging exchange and communication through the facilitation of international symposia and workshops, and to planning specific future InterRidge actions;
- Phase 2 (1995-1997), involving in-depth studies of temporal variability and broadened spatial characterization, in the form of major interdisciplinary field efforts conceived and co-ordinated by InterRidge, and development of a database information catalogue accessible to the international ridge sciences community via the Internet;
- Phase 3 (1997-2003), including continued mapping and sampling coverage of the global ridge system, intensive development and deployment of seafloor instrumentation, and an international symposium to consider progress and future directions.

There will be a mid-term review of the program in 1997-98.

# InterRidge Program Plan

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## I. OVERVIEW

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### 1. INTRODUCTION

#### 1.1 Context of InterRidge

##### 1.1.1 New perceptions of the Mid-Ocean Ridge

The mid-ocean ridge is now fully recognized as an extensive province of focused mass and energy exchange that affects the entire earth. The 50,000-km-long mid-ocean ridge dominates the Earth's volcanic flux and creates an average of 20 km<sup>3</sup> of new oceanic crust every year. The processes of generation and cooling of oceanic lithosphere contribute two-thirds of the heat lost from the Earth's interior. One third of the heat flux in oceanic lithosphere is carried by the circulation of seawater through fractures in hot oceanic crust. This hydrothermal circulation causes important chemical exchanges between seawater and oceanic crustal rocks, and ultimately with the atmosphere, and acts as an important regulator of the chemistry of the oceans and of the volatile content of the Earth's interior.

Recent discoveries show that not only many fundamental geological and chemical processes, but also biological processes, are concentrated within a relatively narrow band centered on these zones of crustal divergence at the ridge crest. For instance, biological communities associated with hydrothermal vents flourish in a highly unstable, nutrient-rich environment, in sharp contrast to the previously well-established precept that deep-sea benthic communities are the product of stable, relatively nutrient-poor environments. The study of bacterial and animal populations associated with hydrothermal activity has generated fundamental questions about physiology and ecology, and concerns basic aspects of molecular biology and the origin of life on earth.

Challenging new hypotheses have been generated by the recent period of discovery and analysis. Topics of particular interest include the following.

- Submarine heat and mass fluxes may significantly influence the chemistry of the

planetary ocean, and may affect its circulation.

- Ridges may have served as refuges for—or even sources of—early life forms.
- Processes of metal deposition may be studied *in situ* at ridge crests.
- The structure and geochemistry of ridges offers still unexplored access into mantle dynamics.
- The biology of unique deep-sea communities is supported by chemical energy released from hydrothermal vents.

In general, the mid-ocean ridge provides a unique opportunity and a unifying theme to address a fundamental scientific problem: the mechanisms by which mantle processes find expression in the geology and biology of the planetary surface. Whereas on the continents these expressions are typically indirect and complicated by interaction with other continent-forming processes, in the oceans they are direct and dominant. Yet even in the oceans, we are remarkably ignorant of the details of how mantle processes operate. For instance, the discovery of structural and petrological features of the ridge not intrinsic to the plate tectonics model has demonstrated that there are serious gaps in our understanding of the formation of crust associated with the growth of ocean ridges. Volcanoes at the ridge are expressions of the predominant type of volcanic activity on the planet, and have quite different structural and petrological manifestations than volcanoes that erupt on land, which are much better studied. Undersea volcanoes are a vast, unexplored frontier.

At still another scale, analysis of measurements from satellites and recent advances in seismic tomography have served to emphasize the full scale of ultimate objectives in ridge research, which are concerned with the role the mid-ocean ridge plays as an integral part of the dynamic Earth.

### 1.1.2 Technological developments

Technological progress provides strong support for the scientific impulse to pursue investigations of the ridge. We can now plan ambitious sea-going investigations previously impossible or logistically unrealistic. In the early nineteen-seventies, at the time of the French-American project called FAMOUS, no civilian ships were equipped with swath bathymetric systems. Today's seafloor mapping systems make it possible to cover about 200 km<sup>2</sup> of seafloor per hour for typical mid-ocean ridge depths, opening the way to effective global mapping coverage of the ridge crest. The Global Positioning System came into routine use in the 1980s. Powerful seismic imaging systems have only in the last few years been used to explore subseafloor structure of the ridge. Deep diving submersibles, which had hardly been used for scientific exploration before the 1970s, are now operated routinely by four countries engaged in ridge research. Deep operating instrument packages have evolved considerably. Hard-rock drilling capabilities can be expected to mature significantly in the coming years. High-performance computers have radically improved possibilities for digital data manipulation, imaging and theoretical modelling.

### 1.1.3 Role of InterRidge

The opportunity for scientists and engineers of different countries to advance cooperation in ridge research is timely from several perspectives. Major new directions for development are now available as a result of convergence between current insights and rapidly developing technology. The ridge is a complex network of interlinked physical, chemical and biological processes that has given rise to an extended family of interdisciplinary problems at a range of spatial scales from microns to thousands of kilometers, and temporal scales of seconds to millions of years. Solutions to many of these problems require a level of commitment, a breadth and depth of scientific expertise, and a technological framework that no one country can offer.

Furthermore, the capabilities and motivation of nations taking an active interest in mid-oceanic ridge exploration have grown rapidly in recent years; the total number of scientists involved and the number of at-sea operations have also increased. One outcome of these developments is that most researchers

and agencies can no longer even keep informed about where and when new cruises are scheduled to enable more effective program planning.

The convergence of scientific motivation, technological progress, and the increased complexity and cost of addressing ridge problems invites the dispersed global community of ridge researchers to reach beyond the limits of its usual investigative boundaries and to create stronger international linkages. InterRidge is designed as a decadal program to improve co-ordination at the international level and facilitate the pursuit of stimulating new ideas and projects. Each country brings to InterRidge its particular investigative emphasis, which reflects the interests of its scientific community and which is used in defining priorities at a national level in that country.

### 1.1.4 Development of InterRidge

Ridge-crest research was pursued actively and successfully by several nations from the early 1970s into the 1980s. In France, the creation of the Programme National de l'Étude de l'Hydrothermalisme Océanique (PNEHO) represented a recognition of the importance of the subject. A 1985 report by the U.S. Bureau of Science and Technology policy, "Earth Sciences Research in the Civil Space Program," led to the creation of the National Academy of Sciences (NAS) Committee of Earth Sciences (CES) and the Committee for the Study of Global Change Research Issues. CES was to examine the possibility of broadening the focus of Global Change issues to include efforts other than climatic change. The U.S. RIDGE Initiative took form in 1987 with *The Mid-Oceanic Ridge: A Dynamic Global System*, an NAS-sponsored, interdisciplinary workshop held at Salishan, Oregon, USA. The U.S. program RIDGE is now a formal part of the U.S. National Science Foundation's Global Change Research Program.

Following the recommendation made at the Salishan workshop that RIDGE be international in scope, scientists from eight nations gathered in July 1989 at the NAS in Washington, D.C. They agreed that the concept of an international initiative should be further developed, and identified four general areas for initial efforts: fostering communication among scientists of member nations, co-ordinating survey work, encouraging international research co-operation, and data exchange. National correspondents were designated, and *In-*

terRidge was adopted as the name for this effort.

The first formal InterRidge meeting was held at Ifremer in Brest, France in June 1990, and was attended by scientists from eleven countries. Participants considered various possible objectives of and approaches to an international initiative. An interim steering group was created to help advance the project in the immediate future and to help prepare a second international meeting. Based on the conclusions of the Brest meeting, the steering group prepared a draft program plan to be considered at the second international meeting, which was held in York, UK, in March 1992. The draft plan was examined and endorsed with various modifications, which were incorporated in this Program Plan.

The British ridge-studies consortium BRIDGE was initiated in 1987 to help national co-ordination of ridge research. Since the Brest meeting in 1989, French scientists have created a "Comité Dorsales" to strengthen research efforts on mid-ocean ridges not covered by the PNEHO, and Japan has moved to identify ridge research activities under its "InterRidge-Japan" working group, which consists of scientists from universities and research institutes. More recently DeRidge has come into being in Germany and CANRIDGE in Canada.

InterRidge is now endorsed by fifteen countries, which were invited in the summer of 1992 to become founding members of the initiative.

In October of 1993, the members of the Steering Committee agreed that an updated version of the program plan be drafted incorporating development of InterRidge during the 18 months since the York Meeting. It was decided that an overview of InterRidge Science and Organisation appear as the main body of the document and that the evolution of the program be chronicled in a series of yearly addenda.

## 1.2 Overall program design

### 1.2.1 Major research foci

The outstanding opportunity available to InterRidge is to use the collective intellectual and technological resources of member countries to address major scientific research problems that would not be dealt with as effectively by countries acting in isolation or in limited partnerships. At the same time, it is neither feasible nor necessarily desirable for InterRidge

to attempt to be involved equally in all actions relevant to ridge-crest research. A multi-component approach is proposed, with principal initial emphasis on three major themes, or Integrated Projects, and on improving co-ordination of existing research efforts. The aim of this approach is to accomplish selected compelling scientific objectives that could not be achieved without well-co-ordinated international efforts.

Objectives chosen for InterRidge Integrated Projects should be:

- of major scientific interest;
- unlikely to be developed without international planning and co-ordination;
- interdisciplinary;
- globally or thematically defined, rather than regionally-based;
- relevant to active on-going efforts of participating countries.

It was recognised at the outset that new projects would undoubtedly emerge and be refined as the program proceeds. Three specific study areas were originally retained as the major near-term emphases of InterRidge

*I. Patterns of global variation: Global ridge systematics.* The objectives of global reconnaissance studies are: (a) to define the general (large-scale) spatial characteristics of the global ridge system, and (b) to understand the origin and evolution of the patterns of variation, to determine how the patterns of structure, rock composition, volcanism, hydrothermalism, and biological activity are interrelated. This work requires, in particular, a sea-going effort in high latitudes where there are few data compared with most other areas of the ridge.

*II. Meso-scale ridge processes.* To understand first-order aspects of the crustal accretion process and its related fluxes, a wide range of interdisciplinary investigations must be carried out on a scale encompassing along-axis distances ranging from a single segment to several hundred kilometers, and extending tens to hundreds of kilometers off-axis. Many relevant investigations are currently being conducted by InterRidge member countries. InterRidge seeks to develop and, as the program progresses, to co-ordinate investigations concerning three key aspects of meso-scale ridge dynamics:

- Segment-scale variations in fluxes;
- Crustal accretion in back-arc settings;
- The interplay between tectonic and magmatic processes and the relationship of this to ridge segmentation.

