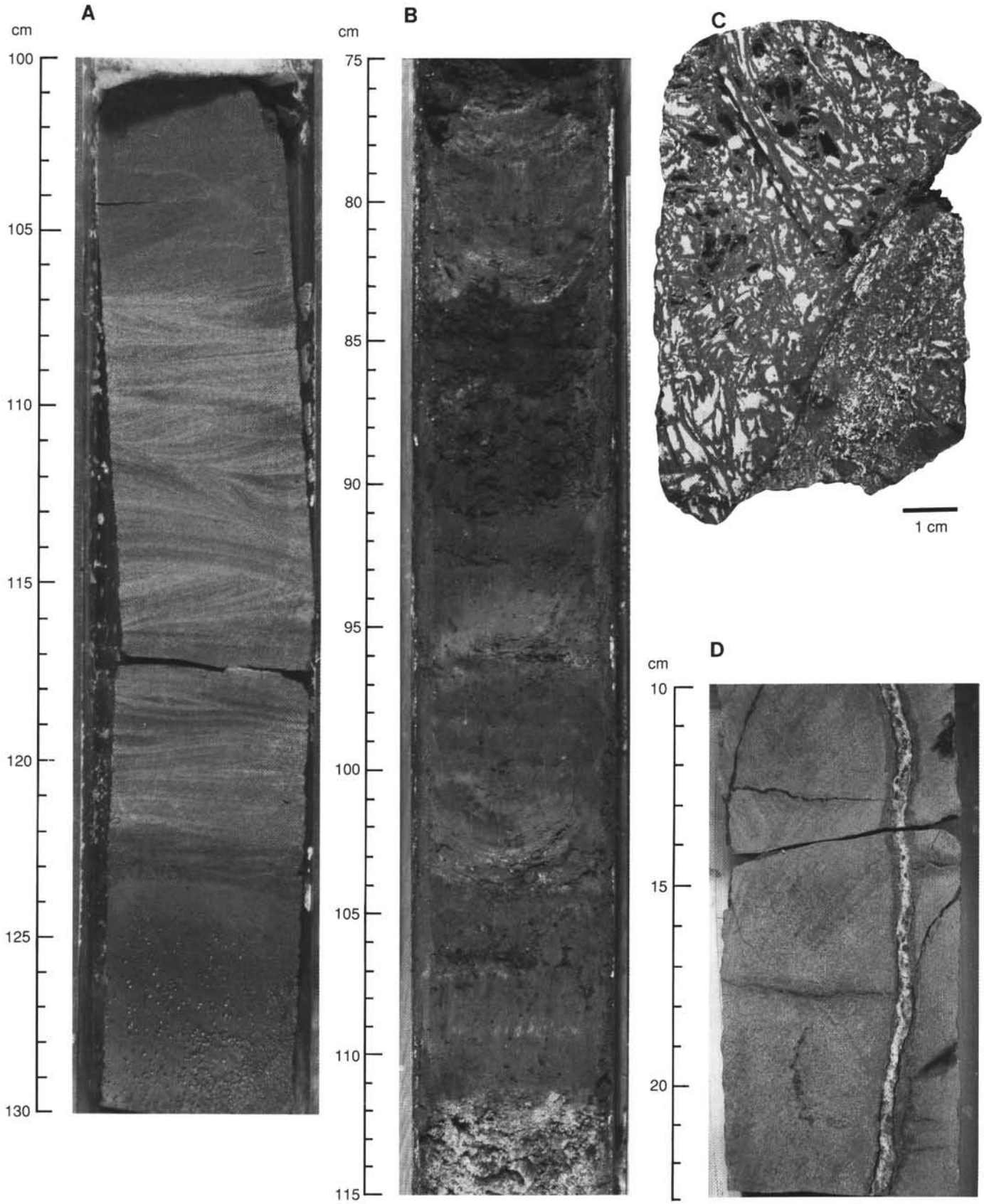

A. 858A-21X-2, 100–130 cm: Cross-bedded, turbiditic sandstone. **B.** 858B-2H-3, 75–115 cm: Hydrothermally altered hemipelagic and turbiditic silty gray clay, mineralized with pyrite (83–90 cm) and anhydrite (112–117 cm). **C.** 856G 7R-1, Piece 9 (64–75 cm): Pyritic massive sulfide with reticulate box-work texture. The large voids are partly filled with white amorphous silica and hydrothermal clay. **D.** 857C 59R-1, Piece 1 (10–25 cm): Altered diabase sill cut by vein filled with wairakite, quartz, and sphalerite.

PROCEEDINGS OF THE OCEAN DRILLING PROGRAM

VOLUME 139

INITIAL REPORTS
MIDDLE VALLEY, JUAN DE FUCA RIDGE

Covering Leg 139 of the cruises of the Drilling Vessel *JOIDES Resolution*,
San Diego, California, to Victoria, British Columbia, Sites 855–858,
4 July–11 September 1991

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NATIONAL SCIENCE FOUNDATION
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JOINT OCEANOGRAPHIC INSTITUTIONS, INC.

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Foreword

By the National Science Foundation

The Ocean Drilling Program (ODP) is a major component of the National Science Foundation's continuing commitment to the study of the geologic processes that have shaped our planet and modified its environment. The scientific problems being addressed range from the geologic history and structure of continental margins to the processes responsible for the formation and alteration of the ocean's crust. In a time of enhanced public and scientific interest in problems of global change, ODP provides critical data on changes in ocean circulation, chemistry, and biologic productivity and their relation to changes in atmospheric circulation and glacial conditions. The Ocean Drilling Program has a unique role in addressing these problems, since it is the only facility for continuously sampling the geologic record of the ocean basins, which cover 70% of our planet.

The ODP is the successor to the Deep Sea Drilling Project (DSDP), which was a global reconnaissance of the ocean basins. DSDP began operations in 1968 at Scripps Institution of Oceanography, using a 400-foot drillship, the *Glomar Challenger*. DSDP was supported initially by only the National Science Foundation, with extensive involvement of international scientists who were invited to participate on drilling cruises. As this international interest continued to grow in the early 1970's, formal participation in the project was offered to the international geoscience community. In 1975, five nations (France, the Federal Republic of Germany, Japan, the United Kingdom, and the Soviet Union) accepted this commitment to joint planning and conduct of the project, as well as to financial support for operations. This International Phase of Ocean Drilling (IPOD) continued to 1983. Although the *Challenger* had reached the limits of her capabilities, the remarkable scientific success of the DSDP and the new questions it had generated demanded a continuing capability for drilling in the oceans.

The Ocean Drilling Program was organized, international participation was coordinated, a new drillship (the *JOIDES Resolution*) was contracted and outfitted, and her first cruise sailed in early 1985, within 18 months of the retirement of the *Challenger*. This is a remarkable accomplishment that reflects the efforts and excellence of the Joint Oceanographic Institutions, Inc. (prime contractor for ODP), Texas A&M University (science and ship operator), Lamont-Doherty Geological Observatory (logging operator), and the international science community in organizing and planning the new program. It was argued in planning for the ODP that a larger drillship was required to provide space for the increasing U.S. and international demand for shipboard participation, improved and expanded laboratory capabilities, and improvements in coring and logging systems. A larger and better equipped vessel would also provide better stability and working conditions in high-latitude regions of the oceans. The success of the *JOIDES Resolution* has proven the wisdom of these early arguments.

ODP now has operated in all oceans except the ice-covered Arctic. We have drilled above the Arctic circle and within sight of the Antarctic continent. Over 1000 scientists from 25 nations have participated in the initial ODP cruises. The larger scientific parties have allowed an increased emphasis on student participation and training aboard ship. The state-of-the-art laboratories support rapid and complete initial analyses of samples that provide both scientific results and guide subsequent shore-based studies. Nearly 1000 additional scientists have used these data and requested samples from the program's core and data archives for continuing study. The geochemical and geophysical logging capability is unsurpassed in either academia or industry and has provided remarkable new data with which to study the Earth. New experiments to measure and monitor geologic processes have been deployed in ODP boreholes.

The international commitment to ocean drilling has increased in the ODP. In addition to our five partners in IPOD—France, the Federal Republic of Germany, Japan, the Soviet Union, and the United Kingdom—two consortia have joined ODP: Canada-Australia and the European Science Foundation (representing Belgium, Denmark, Finland, Greece, Iceland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey). The 20 countries of the ODP represent the community of nations that have a global interest in the geosciences and oceanography. This global scientific participation has assured the program's scientific

excellence by focusing and integrating the combined scientific knowledge and capabilities of the program's 20 nations. It has allowed problems of a global nature to be addressed by providing databases and background studies which are openly shared for planning and interpreting drilling results. It has eased problems of access to territorial waters, allowing comparative studies to be done among oceans. Finally, the international sharing of program costs has allowed this important and large program to proceed without detrimental impact to the research budgets of any one nation.

The Ocean Drilling Program, like its predecessor, DSDP, serves as a model for planning, conducting, and financing research to address problems of global importance. The National Science Foundation is proud to have a leading role in this unique international program, and we look forward to its continuing success.

Walter E. Massey
Director
National Science Foundation

Washington, D.C.

Foreword

By Joint Oceanographic Institutions, Inc.

This volume presents scientific and engineering results from the Ocean Drilling Program (ODP). The papers presented here address the scientific and technical goals of the program, which include providing a global description of geological and geophysical structures including passive and active margins and sediment history, and studying in detail areas of major geophysical activity such as mid-ocean ridges and the associated hydrothermal circulations.

The Ocean Drilling Program, an international activity, operates a specially equipped deep-sea drilling ship, the *JOIDES Resolution* (Sedco/BP 471), which contains state-of-the-art laboratories, equipment, and computers. The ship is 471 feet (144 meters) long, is 70 feet (21 meters) wide, and has a displacement of 18,600 short tons. Her derrick towers 211 feet (64 meters) above the waterline, and a computer-controlled dynamic-positioning system stabilizes the ship over a specific location while drilling in water depths up to 27,000 feet (8230 meters). The drilling system collects cores from beneath the seafloor with a derrick and drawworks that can handle 30,000 feet (9144 meters) of drill pipe. More than 12,000 square feet (1115 square meters) of space distributed throughout the ship is devoted to scientific laboratories and equipment. The ship sails with a scientific and technical crew of 51 and a ship's crew (including the drill crew) of 62. The size and ice-strengthening of the ship allow drilling in high seas and ice-infested areas as well as permitting a large group of multidisciplinary scientists to interact as part of the scientific party.

Logging, or measurements in the drilled holes, is an important part of the program. ODP provides a full suite of geochemical and geophysical measurements for every hole deeper than 1300 feet (400 meters). For each such hole, there are lowerings of basic oil-industry tools: nuclear, sonic, and electrical. In addition, a borehole televiewer is available for imaging the wall of the hole, a 12-channel logging tool provides accurate velocity and elastic property measurements as well as sonic waveforms for spectral analysis of energy propagation near the wall of the hole, and a vertical seismic profiler can record reflectors from below the total depth of the hole.

The management of the Ocean Drilling Program involves a partnership of scientists and governments. International oversight and coordination are provided by the ODP Council, a governmental consultative body of the partner countries, which is chaired by a representative from the United States National Science Foundation. The ODP Council periodically reviews the general progress of the program and discusses financial plans and other management issues. Overall scientific and management guidance is provided to the operators of the program by representatives from the group of institutions involved in the program, called the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES).

The Executive Committee (EXCOM), made up of the administrative heads of the JOIDES institutions, provides general oversight for ODP. The Planning Committee (PCOM), with its advisory structure, is made up of working scientists and provides scientific advice and detailed planning. PCOM has a network of panels and working groups that screen drilling proposals, evaluate instrumentation and measurement techniques, and assess geophysical-survey data and other safety and siting information. PCOM uses the recommendations of the panels and committees to select drilling targets, to specify the location and major scientific objectives of each two-month drilling segment or leg, and to provide the science operator with nominations for co-chief scientists.

Joint Oceanographic Institutions, Inc. (JOI), a nonprofit consortium of U.S. oceanographic institutions, serves as the National Science Foundation's prime contractor for ODP. JOI is responsible for seeing that the scientific objectives, plans, and recommendations of the JOIDES committees are translated into scientific operations consistent with scientific advice and budgetary constraints. JOI subcontracts the operations of the program to two universities: Texas A&M University and Lamont-Doherty Geological Observatory of Columbia University. JOI is also responsible for managing the U.S. contribution to ODP.

Texas A&M University (TAMU) serves as science operator for ODP. In this capacity, TAMU is responsible for planning the specific ship operations, actual drilling schedules, and final scientific rosters, which are developed in close cooperation with PCOM and the relevant

panels. The science operator also ensures that adequate scientific analyses are performed on the cores by maintaining the shipboard scientific laboratories and computers and by providing logistical and technical support for shipboard scientific teams. Onshore, TAMU manages scientific activities after each leg, is curator for the cores, distributes samples, and coordinates the editing and publication of scientific results.

Lamont-Doherty Geological Observatory (LDGO) of Columbia University is responsible for the program's logging operation, including processing the data and providing assistance to scientists for data analysis. The ODP Data Bank, a repository for geophysical data, is also managed by LDGO.

Core samples from ODP and the previous Deep Sea Drilling Project are stored for future investigation at three sites: ODP Pacific and Indian Ocean cores at TAMU, ODP and DSDP Atlantic and Antarctic cores at LDGO, and DSDP Pacific and Indian Ocean cores at the Scripps Institution of Oceanography.

Scientific achievements of ODP include new information on early seafloor spreading and how continents separate and the margins evolve. The oldest Pacific crust has been drilled and sampled. We have new insights into glacial cycles and the fluctuations of ocean currents throughout geological time. Many of the scientific goals can be met only with new technology; thus the program has focused on engineering as well as science. To date, ODP engineers have demonstrated the capability to drill on bare rock at mid-ocean-ridge sites and have developed techniques for drilling in high-temperature and corrosive regions typical of hydrothermal vent areas. A new diamond coring system promises better core recovery in difficult areas.

In addition, ODP is cooperating closely with other geological and geophysical programs; for example, in 1991 the first hole was drilled by ODP for emplacement of a seismometer near Hawaii for the Ocean Seismic Network. JOI is pleased to have been able to play a facilitating role in the Ocean Drilling Program and its cooperative activities, and we are looking forward to many new results to come.

D. James Baker
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Joint Oceanographic Institutions, Inc.

Washington, D.C.

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University of Rhode Island, Graduate School of Oceanography

Texas A&M University, College of Geosciences and Maritime Studies

University of Texas at Austin, Institute for Geophysics

University of Washington, College of Ocean and Fishery Sciences

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France, Institut Français de Recherche pour l'Exploitation de la Mer

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SECTION 6: POLICY

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Leg 139, Sites 855–858: Bathymetric map of the northern Juan de Fuca Ridge, side-scan acoustic image mosaic of the northern Juan de Fuca Ridge, and multichannel seismic reflection profiles crossing Middle Valley.

Back-Pocket Microfiche

Formation microscanner images for Leg 139:

Hole 856H: Pass 1, scale 1:40, depth range 16—74 mbsf
Pass 1, scale 1:6, depth range 16—73 mbsf
Hole 857D: Pass 1, scale 1:40, depth range 56—784 mbsf
Pass 1, scale 1:6, depth range 560–784mbsf
Pass 1, scale 1:40, depth range 790–935 mbsf
Pass 1, scale 1:6, depth range 790–936 mbsf
Hole 858F: Pass 2, scale 1:40, depth range 58–269 mbsf
Pass 2, scale 1:6, depth range 58–269 mbsf

ACKNOWLEDGMENTS

Much credit is due to a large number of individuals and institutions for the resounding success of Leg 139. All members of the Shipboard Scientific Party gratefully acknowledge their contributions. Planning for this program had its formal beginnings at a small northeast Pacific workshop funded by USSAC and organized by H. Paul Johnson. Despite the technical challenges of the proposed program, it was enthusiastically supported by the Planning Committee and by the JOIDES thematic panels. The Lithosphere Panel established a Detailed Planning Group whose chairperson, Bob Detrick, and members carried the planning of the program a step further toward full maturity. Many people have been involved in various stages of planning and in a wide variety of geophysical and geological surveys of the area, and can share credit for the level of knowledge that we all now possess about the processes that occur at sedimented seafloor spreading centers.

Many individuals are also thanked for their roles in the unusually rigorous preparation for the leg. Lou Garrison and others of the Ocean Drilling Program's administrative, engineering, technical, and logistics staff organized early and continuing discussions about the various difficulties anticipated, and called in outside expertise whenever necessary. Their response to requests for special engineering was timely and expert, and their products, such as the CORKs and the modified pressure core sampler and gas extraction system developed and successfully deployed by Tom Pettigrew, were exemplary. Tim Francis filled Lou Garrison's shoes well and provided continuing support as the departure day drew near. With Phil Rabinowitz's backing, he signed the checks for the special core liner and drill bits, safety equipment and training, core storage and handling facilities, and shipboard ventilation modifications which were necessary for the leg. We also acknowledge the Pollution Prevention and Safety Panel, chaired by Mahlon Ball, who helped to make the approval of the leg and its safe execution remarkably painless.

Several individuals and agencies not directly associated with the program provided (at substantial risk!) special high-temperature tools through ODP and the Borehole Research Group at Lamont-Doherty Geological Observatory. We extend our appreciation to them, in particular Peter Lysne, who provided the workhorse tool for high-temperature measurements during the leg, and Paul Worthington, who helped ensure that several high-temperature tools were ultimately on board.

Many people devoted long hours during the two months of the drilling leg itself and contributed to making the shipboard operations impressively smooth and trouble-free. Captain Edwin Oonk and his crew provided confident leadership for the leg and created a very pleasant working environment. The daily challenges posed by high winds and waves, high formation temperatures, high-density sulfides, and high expectations of the scientific party were always willingly and professionally taken on by Glen Foss, Ken Horne, Lew Weingarth, and all members of the ODP and SEDCO shipboard drilling and technical crews.

Vital support throughout the planning, execution, curatorial, and publication phases of the program has been provided by the very efficient and professional staff of ODP. Their continuing help and hospitality have contributed greatly to the success achieved by the leg and to the pleasure of carrying out the work. We also thank the agencies of ODP member nations through which individuals of the scientific party received support, especially the Canadian Secretariat and others who organized an efficient and enjoyable port call after the cruise.

To all who were directly or remotely involved, we extend our wholehearted thanks, and dedicate the following Leg 139 cruise brief (next page).

Dead-dog Doggerel

High thoughts and deep hopes prevailed as we sailed
From the shores of La Jolla, to mysterious Middle Vale.
We left with the blessing of PCOM and JOIDES
To search for thrice-boiled *Globigerina bulloides.*

We left with more guidelines than any before us,
The blue book, the green book–quite frankly, they bored us.
H_2S vapor! keep safely upwind;
This wasn't a problem, for the wind didn't end.

Triple-guard door-locks which no one, even those
Who were given the combo, could open or close.
Greenpeace was with us, protecting the clams;
(Please don't replay Foss's drill-string grand slam!)

Heat flow and seismic, they led our way there,
They made handsome maps, but those depth scales, beware!
How hot and how deep were perplexing questions,
Not very well answered by our seismic sections!

The cores told the truth about what lay below,
But even with cores, the fiction still flowed.
Spiraling forams, spiraling core,
And magnetic low zones triggered stories galore.

Nodules and veins from super-critical flash,
Filled with copper and zinc, it was better than cash!
Greenschist and goldschist! The grade! The potential!
The tonnage went up core by core, exponential!

While the tonnage went up, the water flowed down,
Cooling the hot rocks for miles around.
The loggers made stoppers, but most were too slim,
Tom's corks were more rotund, and jammed themselves in.

Nicknames and rignames profusely abound,
They kept things well oiled, and turning around,
Kelleys and mouseholes, sub-bumbers and packers,
Where would we be without V-doors? Piperackers?

And where would we be without all the good crew
Who helped with the things that we dreamed up to do?
Without What-a-hand Hal? Without Horney or Yo-Yo!
Without Bubba or Dude, without Meat or Potato?

And thanks go to many cooped up on the beach,
Keeping safe distance from Death Leg's long reach.
They provided much effort, much time, the right touch,
But no less important, they provided the bucks
To let us go do what had never been tried,
To spud in the drill string and let it be fried!