

# Gorda Ridge

Gregory R. McMurray  
Editor

# Gorda Ridge

*A Seafloor Spreading Center  
in the United States' Exclusive  
Economic Zone*

Proceedings of the Gorda Ridge Symposium  
May 11–13, 1987, Portland, Oregon

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Dr. GREGORY R. McMURRAY  
Oregon Department of Geology and Mineral Industries, 910 State Office Building,  
Portland, Oregon 97201;  
Dames & Moore, 1750 SW Harbor Way, Portland, OR 97201, USA

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# Foreword

This volume is the product of an innovative intergovernmental scientific investigation of Gorda Ridge, an ocean floor spreading center in the north-eastern Pacific Ocean which is marked by dynamic geologic and biologic processes. The papers contained herein summarize the results of the investigation as reported at a symposium held in Portland, Oregon, in May 1987. The sections in this volume contain papers that describe the mineral potential of the study area, the technology used in the search for ocean floor minerals, and the benthic ecology of Gorda Ridge and other spreading centers. The interdisciplinary nature of the studies makes this volume especially valuable and comprehensive as a case history of recent study of an active ocean spreading center.

The studies reported in this volume are an outgrowth of the creation by Presidential proclamation of the Exclusive Economic Zone (EEZ) of the United States in March 1983, followed by a proposal to consider leasing of minerals in a broad area encompassing Gorda Ridge offshore of the states of Oregon and California. Gorda Ridge is the only known spreading center wholly within the EEZ of the United States. Important previous scientific discoveries of geologic processes and mineral deposits at other spreading centers suggested that Gorda Ridge might be the locus of potentially important mineral resources.

Public comments regarding the proposed lease sale led to the creation in 1984 of a technical task force appointed by federal and state government officials. The mission of the task force was to investigate the mineral and living resources along Gorda Ridge in order to ascertain the economic and environmental impacts of mineral leasing and possible subsequent development. The task force undertook a series of investigations between 1984 and 1988 using a combination of surface and submersible platforms to locate and sample massive sulfide deposits and associated biologic communities at multiple locations along the 300-km length of the ridge. The research program was designed by the task force during public meetings and involved cooperation among federal agencies, state governments, several universities, and individuals from numerous scientific disciplines.

Federal government agencies from the United States included the U.S. Geological Survey, Minerals Management Service, U.S. Bureau of Mines, National Marine Fisheries Service, National Oceanic and Atmospheric Admin-

istration, Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Coast Guard, U.S. Army Corps of Engineers, and U.S. Navy. Oregon members represented state government organizations including the Oregon Department of Geology and Mineral Industries, Oregon Department of Land Conservation and Development, and Oregon Coastal Zone Management Association. California state agencies were the Division of Mines and Geology and the Office of the Secretary of Environmental Affairs. Academia was represented by scientists from Oregon State University, Scripps Institution of Oceanography, the University of California at Davis, Woods Hole Oceanographic Institution, the University of Washington, and the University of Hawaii.

The task force is especially grateful to the U.S. Navy, which provided both surface vessels and the deep submersible vehicle *Sea Cliff*. Surface-based oceanographic research was conducted from the *S.P. Lee*, which was made available by the U.S. Geological Survey; the NOAA ships *Surveyor* and *Discoverer*; and the *Wecoma*, which was provided by Oregon State University. The task force's mission could not have been successful without the logistical support of these organizations.

DONALD A. HULL, Cochair  
Gorda Ridge Technical Task Force

# Preface

The Gorda Ridge Symposium was conceived by the cochairs of the joint federal/state Gorda Ridge Technical Task Force during September 1986. The task force membership voiced support for the symposium idea at a December 1986 meeting in San Francisco, the general concept being that of an exposition of recent Gorda Ridge research results supported by synoptic reviews with which to develop a context for the Gorda papers. Telephone conferences among the task force cochairs, members, and myself resulted in this formal statement of the purpose of the Symposium:

The purpose of the Gorda Ridge Symposium is to present the results of marine polymetallic sulfide mineral resource investigations and biological studies conducted over the past three years. The objectives of the Symposium are to: (1) provide a forum for presentation and discussion of scientific results of recent studies and discoveries; (2) provide for public awareness, information and involvement; (3) provide industry with an awareness of the nature of the mineral discoveries so that they can appraise the leasing potential of the Gorda Ridge and advise the Task Force accordingly; (4) provide for an awareness in the scientific community of the significance of the discoveries and opportunities for future research; and (5) provide a set of recommendations to the Secretary of the Interior and to the Governors of California and Oregon regarding the leasing potential of mineral resources on the Gorda Ridge and the respective roles industry, government and the scientific community can play in further evaluating these resources.

The Symposium is intended as a series of progressive sessions. The first day, May 11, is designed to report the germane research results and set them into the appropriate context. The second day, May 12, is designed to examine the practical aspects of this new information and to review existing and future technology for conducting mineral exploration programs on the Gorda Ridge. The third day, May 13, is designed to elicit responses from the public on the leasing potential of the mineral resources, economic and environmental impacts of leasing, and the respective roles government, industry and the scientific community should play in conducting future programs on the Gorda Ridge. The Gorda Ridge Technical Task Force will convene on Thursday, May 14, in order to discuss the results of the Symposium and to draft a set of recommendations for the Secretary of the Interior and the Governors of the States.

This volume follows the general format of the symposium. The Introduction section is a review paper on the geology and geophysics of Gorda Ridge. The Gorda Ridge Mineral Potential section reports the major results of the task force exploration program. It includes two papers on northern Gorda

Ridge, one on Blanco Fracture Zone, and two on Escanaba Trough. To put the Gorda deposits into some perspective, this section also contains a paper comparing the Gorda Ridge and other known seafloor deposits with the Beshi deposits of Japan, one describing the Atlantis II Deep deposits in the Red Sea and one giving an economic perspective on the Gorda deposits. The Technology section covers developing technologies for undersea mineral exploration and also contains a forward-looking paper on possible mining technologies. The exploration tools include hydrography and geochemistry, passive and active geophysics, and deep-sea drilling. The papers in the Benthic Ecology section address both the preliminary results of work on Gorda Ridge and adjacent nonvent fauna, and summarize vent faunal investigations at other vent and seep areas. An update paper has been added that gives preliminary biological results of 1988 dives which discovered active hydrothermal vents in Escanaba Trough. Lastly, a paper summarizing the symposium results and reporting the recommendations and findings of the five symposium workshops comprises the Conclusions section.

Acknowledgement is due many persons who helped to scope and plan the Gorda Ridge Symposium and consequently this volume. I thank John B. Smith, James F. Davis, and Donald A. Hull, the task force cochairs, for their insightful guidance, patience, and support during the entire project; William R. Normark, Jack Dymond, and James M. Franklin for their assistance in scoping the geology sessions; Fred N. Spiess for helping to plan the technology session; and William G. Percy for assistance with the biology sessions. I am grateful to the session chairs for their guidance and editing efforts: TS Ary, Andrew G. Carey, Michael J. Cruickshank, Robert F. Dill, Sylvia A. Earle, James M. Franklin, J. Fred Grassle, John A. Hildebrand, Mark L. Holmes, Ray G. Hunter, Randolph A. Koski, Janet L. Morton, William G. Percy, Joseph L. Ritchey, Peter A. Rona, Craig R. Smith, and Gary L. Taghon. The manuscript benefited greatly from review comments supplied by Jo Alexander, Sandra Ridlington, and Joseph S. Cone. I especially thank Kari B. LaPorta for her administrative assistance and support during this project. I thank the National Coastal Resources Institute for administrative support during the final phases of publication. Finally, I acknowledge the support and advice of the editorial and production staff of Springer-Verlag New York, Inc.

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GREGORY R. McMURRAY

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# Contributors

EDWARD T. BAKER

Pacific Marine Environmental Laboratory, NOAA, Seattle, WA 98115-0070,  
USA

MICHEL BOUDRIAS

Marine Biology Research Division, A-002, Scripps Institution of Oceanogra-  
phy, La Jolla, CA 92093, USA

ANDREW G. CAREY JR.

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

ALAN D. CHAVE

AT&T Bell Laboratories, Murray Hill, NJ 07974, USA

DAVID A. CLAGUE

Branch of Pacific Marine Geology, U.S. Geological Survey, MS 999, Menlo  
Park, CA 94025, USA

ROBERT W. COLLIER

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

MICHAEL J. CRUICKSHANK

Marine Minerals Technology Center, University of Hawaii, Look Labora-  
tory, Honolulu, HI 96814, USA

DANIEL DESBRUYÈRES

IFREMER, Centre de Brest, 29273 Brest Cedex, France

MARTIN R. FISK

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

CHRISTOPHER G. FOX

NOAA Marine Resources Research Division, Mark O. Hatfield Marine Sci-  
ence Center, Newport, OR 97365, USA

**J. FREDERICK GRASSLE**

Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

**ROGER HART**

College of Oceanography, Oregon State University, Mark O. Hatfield  
Marine Science Center, Newport, OR 97365, USA

**BENJAMIN W. HAYNES**

Division of Environmental Technology, U.S. Bureau of Mines, Washington,  
DC 20241, USA

**ROBERT R. HESSLER**

Marine Biology Research Division, A-002, Scripps Institution of Oceanogra-  
phy, La Jolla, CA 92093, USA

**JOHN A. HILDEBRAND**

Marine Physical Laboratory, A-005, Scripps Institution of Oceanography, La  
Jolla, CA 92093, USA

**JOCHEN HOEFS**

Geochemisches Institut der Universität Göttingen, D-3400 Göttingen, West  
Germany

**MARK L. HOLMES**

U.S. Geological Survey, Oceanography WB-10, University of Washington,  
Seattle, WA 98195, USA

**KATHERINE J. HOWARD**

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

**S. KIM JUNIPER**

Department of Oceanography, University of Quebec at Rimouski, Rimouski,  
Quebec G5L 3A1, Canada

**RANDOLPH A. KOSKI**

Branch of Pacific Marine Geology, U.S. Geological Survey, MS 999, Menlo  
Park, CA 94025, USA

**GREGORY R. McMurray**

Dames & Moore, Portland, OR 97201, USA

**JANET L. MORTON**

Branch of Pacific Marine Geology, U.S. Geological Survey, MS 999, Menlo  
Park, CA 94025, USA

**WILLIAM R. NORMARK**

Branch of Pacific Marine Geology, U.S. Geological Survey, MS 999, Menlo  
Park, CA 94025, USA

**ROSEMARIE F. PETRECCA**

Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

**DOUGLAS PYLE**

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

JOSEPH L. RITCHEY

Western Field Operations Center, U.S. Bureau of Mines, Spokane, WA  
99202, USA

PETER A. RONA

NOAA Atlantic Oceanographic and Meteorological Laboratories, Miami,  
FL 33149, USA

STEPHANIE L. ROSS

Branch of Pacific Marine Geology, U.S. Geological Survey, MS 999, Menlo  
Park, CA 94025, USA

PATRICK J.C. RYALL

Department of Geology, Dalhousie University, Halifax, Nova Scotia B3H  
3J5, Canada

SCOTT A. STEBBINS

Western Field Operations Center, U.S. Bureau of Mines, Spokane, WA  
99202, USA

DAVID L. STEIN

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

GARY L. TAGHON

College of Oceanography, Oregon State University, Corvallis, OR 97331,  
USA

VERENA TUNNICLIFFE

Department of Biology, University of Victoria, Victoria, British Columbia  
V8W 2Y2, Canada

CINDY LEE VAN DOVER

Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

NICHOLAS WETZEL

Western Field Operations Center, U.S. Bureau of Mines, Spokane, WA  
99202, USA

ROBERT A. ZIERENBERG

Branch of Western Mineral Resources, U.S. Geological Survey, MS 901,  
Menlo Park, CA 94025, USA