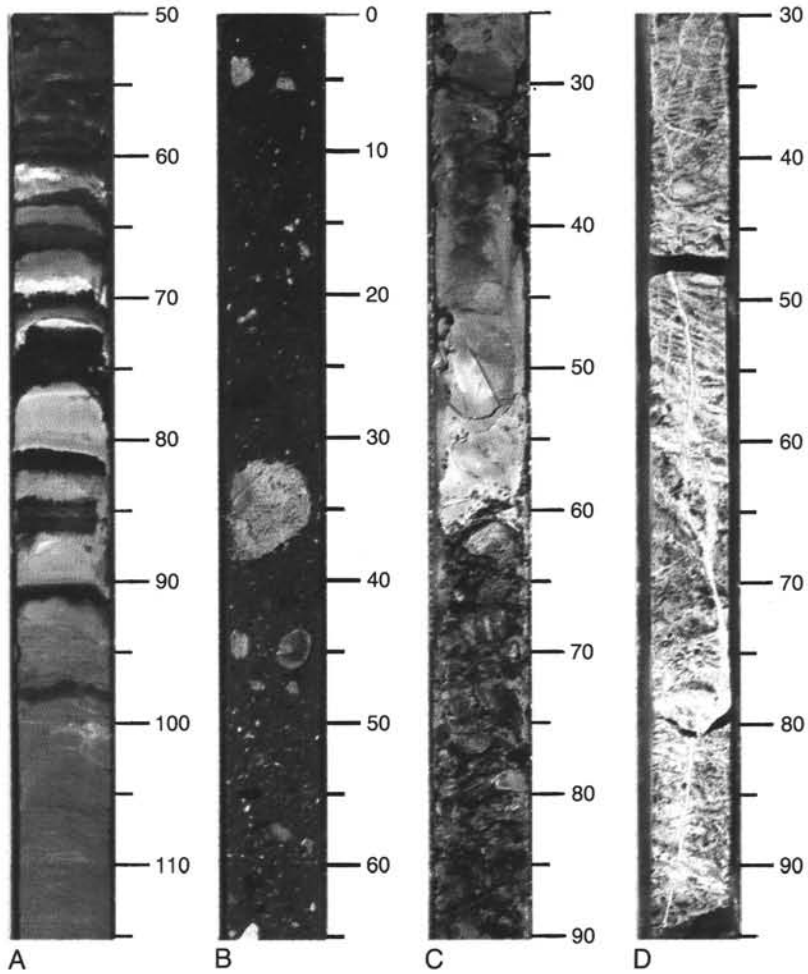


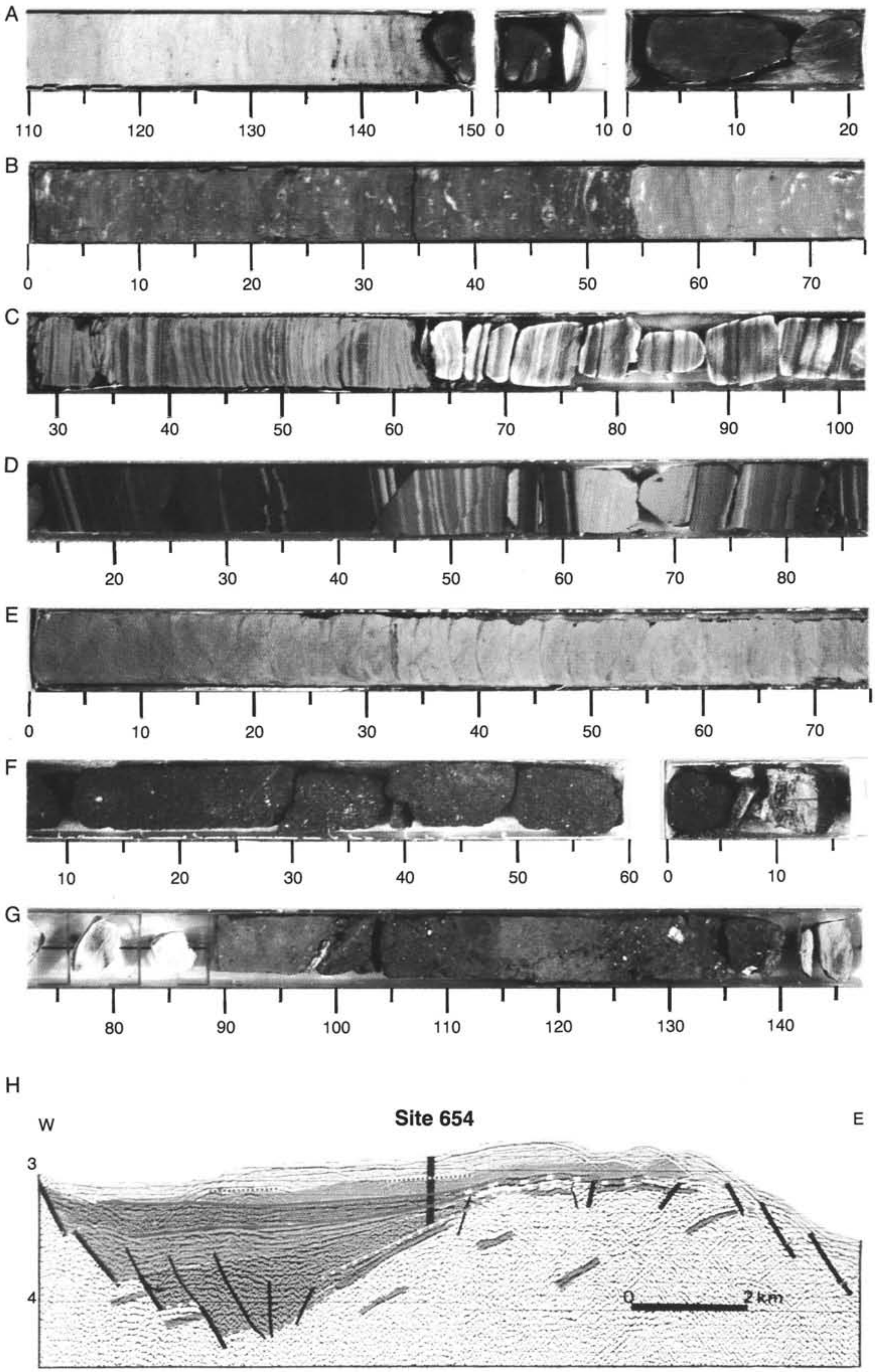
Leg 107 has investigated a wide range of geological questions including passive margin and back-arc basin evolution, crustal heterogeneity, protrusion of upper mantle material to the seafloor, chronology of circum-Tyrrhenian eruptive volcanism, cyclic evaporite deposition, origin of sapropels, origin of metaliferous basal sediments, as well as definition of the Miocene/Pliocene boundary. This color frontispiece illustrates some of the large variety of sediments and rocks recovered during the leg.

A. Transition between Pliocene and Messinian, Interval 652A-20R-6, 50–115 cm. The alternation of red to grayish green clay and mud layers constitutes the transition between the marine planktonic foraminifer and nannofossil ooze of Pliocene age at the top and the gray gypsiferous dolomitic clays of Messinian age at the bottom.

B. Subaerial Messinian(?) clastics, Interval 656A-9R-7, 0–65 cm. Note the red to brown color of the claystone and mudstone embedding the clasts in a true matrix-supported conglomerate. The large white clast is made essentially of huge fibrous crystals of amphibole (actinolite-tremolite group) deriving from alteration of a mafic rock.

C. Sediment/basalt contact, Interval 650A-66X-2, 25–90 cm. Note the 10-cm pale green/blue dolomitic layer which separates the vesicular basalt from the overlying reddish/brown nannofossil ooze.

D. Serpentinized peridotite, Interval 651A-57R-1, 30–95 cm. Note the white veins of chrysotile criss-crossing the dark green serpentinized peridotite.


A
110 120 130 140 150 0 10 0 10 20
B
0 10 20 30 40 50 60 70
C
30 40 50 60 70 80 90 100
D
20 30 40 50 60 70 80
E
0 10 20 30 40 50 60 70
F
10 20 30 40 50 60 0 10
G
80 90 100 110 120 130 140
H
Site 654
W
E
3
4
0
2 km

Site 654 is located on a fault-bounded tilted block on the upper margin of Sardinia (H). The lower portion of Site 654 (E, F, G) shows a classic example of a progressive transgression which is attributed to the subsidence of the Sardinia margin during block-faulting and extension. In this context, the Messinian desiccation event (C, D) appears as a short-term regression superimposed on the subsidence-driven transgression.

A. Gray marly foraminifer-nannofossil ooze (Interval 654A-9R-3, 110–150 cm) and dark gray aphanitic basalt (Sections 654A-9R-4 and -CC) lying near the Pliocene/Pleistocene boundary. Depositional environment: Open marine sea.

B. Foraminifer-nannofossil ooze, Interval 654A-26R-5, 0–75 cm. This section is early Pliocene in age and lies immediately above the Messinian sediments. Note the change of color from dark yellowish brown to light olive brown, and the white bioturbations. Depositional environment: Open marine sea.

C. Interval 654A-30R-1, 27–102 cm: Gypsum-rich light olive brown to olive brown mudstone, claystone and sandstone overlying pure balatino-type finely laminated white alabastrine gypsum and green gypsum of Messinian age. Depositional environment: Possibly well stratified sea, never totally desiccated.

D. Interval 654A-38R-1, 12–87 cm: Pyrite-bearing claystone alternating with dolomitic mudstone; the color ranges from very dark gray to light gray on millimetric to centimetric parallel laminations; age Messinian. Depositional environment: Open marine waters probably with high organic productivity.

E. Interval 654A-43R-5, 0–75 cm: Gray nannofossil and calcareous ooze of Tortonian age with abundant *Chondrites* burrows. Depositional environment: A relatively shallow, well ventilated, fertile open marine sea.

F. Intervals 654A-46R-1, 7–60 cm and -CC, 0–17 cm: Dark gray glauconite-rich polymictic sandstone and gray marly calcareous chalk. Note the presence of broken thick-walled oyster shell in the core-catcher. Depositional environment: Nearshore setting.

G. Interval 654A-50R-1, 72–147 cm: Matrix-supported conglomerate. The matrix sediment is reddish to dark red, the rock pebbles are metalimestone/dolostone and metacalcirudite. Most probable depositional environment: Braided alluvial fan.

H. Multichannel seismic line ST06 IFREMER-IFP-CNRS showing Site 654 location and tectonic setting. Light yellow: Pleistocene; mauve dots: Basalt layer; dark yellow: Pliocene; red lines: high-amplitude reflectors at the top and bottom of the main Messinian evaporitic interval; purple: upper Messinian evaporites; orange: lower Messinian(?); blue: upper Tortonian; white dots: Top of continental conglomerate; green: High-amplitude reflectors in the basement.

PROCEEDINGS OF THE OCEAN DRILLING PROGRAM

VOLUME 107
PART A—INITIAL REPORT

TYRRHENIAN SEA

covering Leg 107 of the cruises of the Drilling Vessel *JOIDES Resolution*,
Malaga, Spain, to Marseille, France, Sites 650–656,
26 December 1985–18 February 1986

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in cooperation with the
NATIONAL SCIENCE FOUNDATION
and
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Foreword

By the National Science Foundation

The scientists of the Ocean Drilling Program (ODP) have embarked on what could prove to be one of the most important earth science initiatives of the decade—an initiative rivaling in scope and impact the exploration of the frontiers of outer space. The program explores our planet's last frontier—the Earth's structure and history as it is revealed beneath the oceans. The scope of the program's scientific goals excites the imagination, challenges the intellect, and enhances the spirit of cooperation among peoples in countries around the world.

Between 1872 and 1876, HMS *Challenger* undertook the world's first major oceanographic expedition. That expedition greatly expanded man's knowledge of the world's oceans and revolutionized our ideas about planet Earth. From 1968 to 1983, another ship named *Challenger* logged more than 375,000 miles on 96 voyages across every ocean for the Deep Sea Drilling Project (DSDP), operated by Scripps Institution of Oceanography. Among the project's many remarkable discoveries were the confirmation of seafloor spreading and the establishment of the relative youth of the seafloor, thus verifying the dynamic and changing nature of the Earth's crust.

Today, the Ocean Drilling Program, which began in 1983, brings new resources to bear on scientific ocean drilling. A new drillship is in operation—the *JOIDES Resolution*—one of the world's most modern and best equipped drillships with enhanced capability for drilling and coring in polar areas and rough weather, expanded laboratory space, facilities for more scientists, and a major drill-hole logging program. The name of the ship was derived from the international scientific partnership that directs the program—the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES)—and from the flagship of Captain Cook's second voyage to the Pacific Ocean in the late 18th century. Texas A&M University is responsible for science operations in the program, and Lamont-Doherty Geological Observatory is responsible for the logging program.

The Ocean Drilling Program truly has international participation. In 1975, the International Phase of Ocean Drilling began with member nations—the U.S.A., U.S.S.R., the Federal Republic of Germany, Japan, the United Kingdom, and France—all providing funds and scientific guidance for the project. Today, ODP partners include the U.S.A., Canada, France, the Federal Republic of Germany, Japan, the United Kingdom, and the European Science Foundation, which represents Sweden, Finland, Norway, Iceland, Denmark, Belgium, the Netherlands, Spain, Switzerland, Italy, Greece, and Turkey. The National Science Foundation, with funds contributed by the United States and international partners, supports the scientific operations and planning for the ODP through a contract with Joint Oceanographic Institutions, Inc. (JOI).

The information gained by the program leads to a better understanding of the Earth and its dynamic processes. Drilled sediment cores and logs reveal clues to past climatic history and tie into parallel studies of paleoclimates from glacial ice cores drilled on the continents. Understanding these sediment cores will enable scientists to complete the map of major geologically active regions of the Earth, and to identify processes that lead to dynamic change such as earthquakes, volcanic eruptions, and mountain and continental growth. We are far from being able to predict such changes accurately now; but with the new tools and understanding, the accuracy of such predictions can be improved. This better understanding of the Earth's system(s) will allow us to identify regions of potential mineral and energy resource development, an issue of worldwide human interest. The Ocean Drilling Program is not in itself aimed at finding resources, but the knowledge of the Earth's processes that is gained through such a basic research program will inevitably provide pieces of information required for such resource discovery and exploitation.

The program is fully under way in its aim to further the understanding of the Earth's dynamic systems. People of our planet will benefit directly and indirectly from this research in both their daily living and work activities. This multinational endeavor will perhaps foster other cooperative efforts in science or among societies. The Ocean Drilling Program has distinguished ancestors in the original *Resolution* and *Challenger* expeditions and the Deep Sea Drilling Project. The National Science Foundation is proud to be playing a leading role in this program, and we are looking forward to significant and innovative science for many years to come.

Erich Bloch
Director
National Science Foundation

Washington, D.C.

Foreword

By Joint Oceanographic Institutions, Inc.

This volume presents results from the Ocean Drilling Program (ODP), where scientists use a specially equipped ocean drilling ship to sample and measure the properties of the submerged part of the Earth's crust. These data are then synthesized with other information to yield new insights into earth processes.

These results address the scientific goals of the program, which include providing a global description of geological and geophysical structures and materials, studying in detail areas of major geophysical activity such as mid-ocean ridges and the associated hydrothermal circulations, and studying passive and active continental margins. In addition, the ODP data support the study of sea-level and ocean-circulation changes, the effects of the Earth's orbital variations on climate, and the study of processes and mechanisms of evolution from the biological records in the cores which are recovered from drilling.

The Ocean Drilling Program is a partnership of scientists and governments. Overall scientific policy and management guidance is provided by Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), which consists of committees and panels made up of representatives of the participating institutions and other scientific and engineering experts. The JOIDES Executive Committee (EXCOM) provides general oversight; the JOIDES Planning Committee (PCOM) is the focal point for all scientific planning for the ODP and is key to the scientific success of the program.

The PCOM has a network of panels and working groups which screen drilling proposals, evaluate instrumentation and measurement techniques, and assess geophysical survey data and other safety and siting information. PCOM uses the recommendations of these panels and committees to select drilling targets, to specify the major scientific objectives of each two-month drilling segment or leg, and to provide the science operator with nominations for co-chief scientists. The science operator, Texas A&M University, in turn is responsible for planning the detailed ship's operations, actual drilling schedules, and final scientific rosters, which are developed in close cooperation with PCOM and the cognizant panels.

Many of the scientific goals can be met only with new technology. Thus the program has identified engineering goals, which include the ability to start a hole and to core on bare rock at mid-ocean ridge sites, to drill in high-temperature and corrosive regions typical of hydrothermal areas, and to core in high latitudes with minimum interference from high seas and sea ice. To meet these needs, the program operates a specially equipped drillship, the *JOIDES Resolution*, which contains laboratories and equipment that are state-of-the-art, and carries a major new logging program.

The ship, registered as SEDCO/BP 471 after her owners and her length in feet (144 meters), is 70 feet (21 meters) wide, and has a displacement of 16,595 long tons. Her derrick towers 200 feet (61 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 50 and a ship's crew of 65.

Logging is a major part of the overall operation. The program 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 well-bore wall, 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 well bore, and a vertical seismic profiler records reflectors from below the total depth of the hole.

Texas A&M University serves as science operator for the Ocean Drilling Program. In this capacity, they operate and staff the drillship to collect cores from JOIDES-designated sites from around the world. The science operator also ensures that adequate scientific analyses are performed on the cores by maintaining the shipboard scientific laboratories and by providing logistical and technical support for shipboard scientific teams. Onshore, Texas A&M manages scientific activities after each leg, is curator for the cores, distributes samples, and coordinates the editing and publication of the scientific results. Lamont-Doherty Geological Observatory (LDGO) of Columbia University manages the program's logging operations, which include processing the data and provision of assistance to scientists in 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 Texas A&M University, ODP and DSDP Atlantic and Antarctic cores at Lamont-Doherty Geological Observatory, and DSDP Pacific and Indian Ocean cores at Scripps Institution of Oceanography.

International oversight and coordination are provided by the ODP Council, a governmental consultative body of partner country representatives, chaired by the United States, which periodically reviews the general progress of the program and discusses financial plans and other management issues. Joint Oceanographic Institutions, Inc., a nonprofit consortium of U.S. oceanographic institutions, serves as the National Science Foundation's prime contractor and manages the ODP. JOI is responsible for seeing that the scientific objectives and plans are translated into scientific operations consistent with JOIDES recommendations and budgetary constraints.

Scientific achievements of the ODP already include new data on early seafloor spreading and how continents separate and their margins evolve. We have new insight into glacial cycles and the fluctuations of currents throughout geological time. Technical achievements include the first bare-rock coring, and logging data more accurate and complete than ever before. JOI is pleased to have played a facilitating role in the Ocean Drilling Program.

D. James Baker
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Joint Oceanographic Institutions, Inc.

Washington, D.C.

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University of Texas at Austin, Institute for Geophysics

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VOLUME 107—PART A

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