

# **SIGNIFICANT NSF-SPONSORED OCEAN RESEARCH AT SIO, 1950-2000**

This list was developed by Archivist Deborah Day as background for the symposium, "Fifty Years of Ocean Discovery at the National Science Foundation," held October 28-30, 1998 at the National Academy of Sciences in Washington, D.C. It represents a selection of very important research sponsored largely, but not exclusively, by NSF and conducted largely at SIO or by SIO investigators. This is not a comprehensive list of all NSF sponsored research at SIO/UCSD, but rather a sample of very significant research projects funded by NSF at SIO during the last fifty years.

## **DECADE: 1950-1960**

Project: Carbon Dioxide Research Group  
Dates: 1957-present  
Scientists: C.D. Keeling, Peter Guenther

The Carbon Dioxide Research Group began with the International Geophysical Year (IGY) measurements on Mauna Loa by Charles David Keeling. Keeling set up the Carbon Dioxide Research Group at SIO beginning in 1958 entirely with NSF support. Beginning in the 1970's support was diverse, half from NSF the other half from such sources including DOE, NOAA, EPA, NASA, EPRI.

Project: Mohole/Deep Sea Drilling  
Dates: 1958-1987  
Scientists: Melvin N.A. Peterson, J. Winterer, many others

The idea of drilling to the Mohorovicic discontinuity was conceived by Walter Munk and Harry Hess in 1957. NSF funding began in 1958. The first hole was drilled March 1961 by the drilling vessel CUSS I with many SIO scientists aboard. The Deep Sea Drilling Project (DSDP) was born out of Mohole's ashes in 1964, when JOIDES (Joint Oceanographic Institutions for Deep Earth Sampling) was organized and in 1966 when SIO signed a contract with NSF to administer the project. D/V GLOMAR CHALLENGER was acquired in 1968. Cores, papers, and dramatic findings issued forth regularly for the following twenty years which added profoundly to knowledge of earth science. For instance, DSDP samples collected on Legs 13 and 42A proved that the Mediterranean dried up near the end of the Miocene. Results from ocean drilling and other work in earth science during the last two decades have begun to shift geologists from their centuries-long convictions in gradualism toward an uneasy acceptance of some examples of catastrophism.

Project: Kelp Studies  
Dates: 1958-1990  
Scientists: Wheeler North, Paul Dayton, Mia Tegner

Kelp studies initiated at SIO in 1948 with Kelco support were continued by Wheeler North through the Institute for Marine Research, a UC-wide institute at SIO in 1958 and

received NSF support beginning in 1960. This work was continued by Paul Dayton and Mia Tegner beginning in 1970. This long term comprehensive study of kelp forests especially the Point Loma kelp forest off San Diego, is a model ecological study. Kelp forests have been shown to be a complex ecosystem sensitive to biological changes induced by fishing and large-scale physical changes in the ocean.

Summer Science Training Program

Dates: 1959-1972

Scientists: Ted Walker, Elizabeth N. Shor

Ted Walter administered this program at SIO which brought high school students to campus and introduced them to oceanography. The program was funded by NSF.

### **DECADE: 1960-1970**

Project: Physiological Research Laboratory/Alpha Helix Program

Dates: 1961-1980

Scientists: Per Scholander, Andrew Benson, and others

Per Scholander won NSF support to design and build a floating biological laboratory, R/V ALPHA HELIX and take it on a series of expeditions to remote areas where biological studies could be done on site. The first expedition occurred in 1966, the last in 1979. Gerry Kooyman was chief scientist on some cruises. NSF support paid for the construction of the PRL building.

Project: BOMEX

Dates: 1969-1971

Scientists: C.H. Gibson

NSF funded the first ever turbulence measurements in open ocean and the atmospheric boundary layer for the BOMEX Experiment (Barbados Ocean Mixing Experiment). Gibson and other researchers used digital data acquisition and spectral calculations at sea in 1971 on R/V THOMAS WASHINGTON cruise to the Cromwell Current (Pacific Equatorial Undercurrent).

Project: International Indian Ocean Expedition: Monsoon, Lusiad, and Dodo

Dates: 1960-1965

Scientists: R.L. Fisher

The International Indian Ocean Expedition (IIOE) was a large, international program, conceived at the first International Oceanographic Congress in 1959 as a means of gathering information on the least studied ocean in the world. SIO's portion of the program consisted of three expeditions undertaken during the period 1962-1965, Monsoon, Lusiad and Dodo. R/V HORIZON sailed around the world on Lusiad.

Project: SUBMARINE CANYON STUDY

Dates: 1960-1967

Scientists: Francis Shepard, Joe Curray

NSF, ONR and BuShips sponsored Francis Shepard's pioneering long term study of submarine canyons and currents in submarine canyons which resulted in two books and many papers on the subject. This opened the new field of submarine geology.

Project: Antarctic Diving

Dates: 1967+

Scientists: James Stewart

The first safety standards for research diving were developed at SIO during the 1950's and 1960's. From 1967-1991 SIO Diving Officer James Stewart was responsible for training and evaluating scientists who dive in the Antarctic through the NSF Office of Polar Programs.

Project: EASTROPAC Expedition

Dates: 1967-1968

Scientists: W. Thomas

This multi-ship survey of the Eastern Tropical Pacific collected biological, nutrient chemical and physical data in a million square mile area off the American coast. Funding was diverse but included NSF.

## **DECADE: 1970-1980**

Project: GEOSECS

Dates: 1971-

Scientists: Harmon Craig, D. Lal

Geochemical Ocean Sections Study (GEOSECS) was conceived as an NSF International Decade of Ocean Research (IDOE) project to make detailed measurements of the physical and chemical characteristics of ocean waters the Atlantic, Pacific and Indian Oceans. Craig was the SIO member of the executive committee of the project.

Project: Wax Ester in Copepods

Dates: 1971-1973

Scientists: Andrew Benson

NSF funded Benson's discovery of the importance of wax ester in copepods revealing wax as the major source of energy for most animals of the sea.

Project: MANOP

Dates: 1975-

Scientists: James Greenslate, Gustaf Arrhenius

The Manganese Nodule Project began at Lamont-Doherty Geological Observatory in 1972, but was shifted to SIO in 1975. Greenslate was the administrator at SIO. The project was originally developed to study how manganese nodules form, but a wider study called MANOP grew out of it in 1977.

Project: NORPAX

Dates: 1972-1982

Scientists: John Isaacs, Chip Cox, David Cutchin, and many others

NORPAX grew out of the ONR sponsored North Pacific Study initiated by John Isaacs to study air-sea interaction in the North Pacific. The principal objective of the North Pacific Study was to understand the nature of the relationship between large-scale sea-surface temperature anomalies and subsurface events, and the relationship of both of these to meteorological events in the atmosphere. NORPAX received substantial NSF funding beginning in June 1973. It grew into a multi-institutional international project funded under NSF's IDOE program. It was the first major research program that brought meteorologists and oceanographers together to analyze interactions between ocean and atmosphere over long periods of time in large areas of ocean with the goal of learning the causes of low frequency fluctuations of the ocean-atmosphere system. Cox's mixing studies were begun under NORPAX.

Project: Microbial Loop Dynamics

Dates: 1976-present

Scientists: Farooq Azam, R. Long

ONR has long supported work at SIO on food web research including the development by Farooq Azam of the concept of microbial loop which has changed the scientific view of the ocean foodweb and biogeochemistry. This new view has implications for fisheries, marine pollution and global change research.

Project: Deep Sea Biology

Dates: 1978-present

Scientists: Art Yayanos, George Somero

NSF funded Art Yayanos' work which included the successful effort to retrieve the first samples of live amphipods from depths of 5700 meters in the Marianans Trench on June 8, 1977. In 1978, he retrieved live bacteria from a depth of 10476 meters. George Somero's work concentrated on biology under pressure and thermal adaption.

Project: Antarctic Benthic Ecology

Dates: 1970-1980

Scientists: Paul Dayton

NSF sponsored Paul Dayton's seminal ecological studies of benthic communities in the Antarctic started in the 1960's when Dayton was at the University of Washington and continued when he moved to SIO in 1970.

## **DECADE: 1980-1990**

Project: RISE: Hydrothermal Vents

Dates: 1979+

Scientists: Fred Spiess, Ken MacDonald, and others

Black Smokers were first discovered on RISE Expedition in 1979 on the East Pacific Rise by chief scientists Fred Spiess and Ken MacDonald. Hydrothermal fields were documented in photographs taken by a combination of D/S ALVIN and DEEP TOW. During RISE SIO scientists discovered a magma chamber under a mid-ocean ridge for the first time. The discovery of the hydrothermal vents can be traced back to studies of the geochemical features of Pacific ridge begun on the Swedish Deep Sea Expedition of 1947-48 and continued by Gustaf Arrhenius and others with NSF support through the 1960's and 1970's.

Project: RIDGE Program

Dates: 1980's-present

Scientists: John Orcutt

RIDGE grew out of RISE and continued its work.

Project: Krill Program

Dates: 1981-1993

Scientists: Osmund. Holm-Hansen

This is not really a program in the sense of GEOSECS, but rather the theme for a series of studies conducted by Osmund Holm-Hansen with NSF under the title, Biological and Oceanographic Studies of the Southern Ocean. Holm-Hansen's studies at SIO began with Vulcan Expedition in 1981 in which he studied "superswarms" of krill, and include the Ross Ice Shelf Program in the late 1980's in which he studied the Ross Sea.

Project: Global Climate Research

Dates: 1980-1990

Scientists: Tim Barnett, Nick Graham, others

NSF support for climate research at SIO began in the 1960's and expanded when Jerome Namias arrived in 1968. Namias essentially opened the new field of global climate change and demonstrated the key role of the oceans in climate. Tim Barnett, Nick Graham and colleagues developed new long range forecasting techniques based on global climate models and coupled ocean atmosphere models. This work and that of others laid the groundwork for the first predictions of the global climate effects of El Nino events beginning in 1995. The largest event of this century, the 1997-98 El Nino was predicted by SIO developed tools about a year in advance, as were its global impacts.

## **DECADE: 1990-2000**

Project: CEPEX  
Dates: 1993-  
Scientists: V. Ramanathan

In 1993, the Central Equatorial Pacific Experiment (CEPEX) tested the hypothesis that convective-cirrus clouds act as a thermostat of ocean-surface temperature in the tropical Pacific. V. Ramanathan, who along with W.D. Collins proposed the thermostat hypothesis, directed CEPEX field studies conducted by investigators from 15 institutions between March and April 1993. Research results were published on heat transfer from ocean to air and cloud formation, and discuss why the western Pacific warm pool ocean does not heat excessively and create a runaway greenhouse effect. The experimental data also revealed that the atmospheric solar absorption exceeded model predictions by as much as 8% of the solar insolation. This project formed the basis of INDOEX. CEPEX grew out of the NSF funded SIO Center for Clouds, Chemistry and Climate (C4).

Project: INDOEX  
Dates: 1995-

Emerging from CEPEX, the Indian Ocean Experiment (INDOEX) aims to study ocean-atmosphere interactions in the Indian Ocean, assess the significance of sulfates and other continental aerosols for global radiative forcing, assess surface and atmospheric solar absorption including ICTZ cloud systems. Building on data collected from 1995-1998, investigators used multiple aircraft, ships, and satellites over the Arabian Sea and Indian Ocean to collect field data beginning in 1999. Field data will be integrated with satellite radiation data to obtain a regional map of the aerosol cooling effects in global warming prediction models.

Project: WOCE  
dates: 1991  
Scientists: Lynne Talley

The World Ocean Circulation Experiment (WOCE) is an enormous international program which seeks to understand ocean circulation and its relation to climate and to collect data on long term behavior of the ocean. Scripps played a substantial role in WOCE observations, developing instruments (i.e. ALACE/PALACE float), improving surface drifters, and contributing to the technical aspects of hydrographic measurements.