# Scripps and NOAA-
# 90 Years of Intertwining Efforts

By

Captain Albert E. Theberge
NOAA Corps (ret.)
Acting Head of Reference
NOAA Central Library

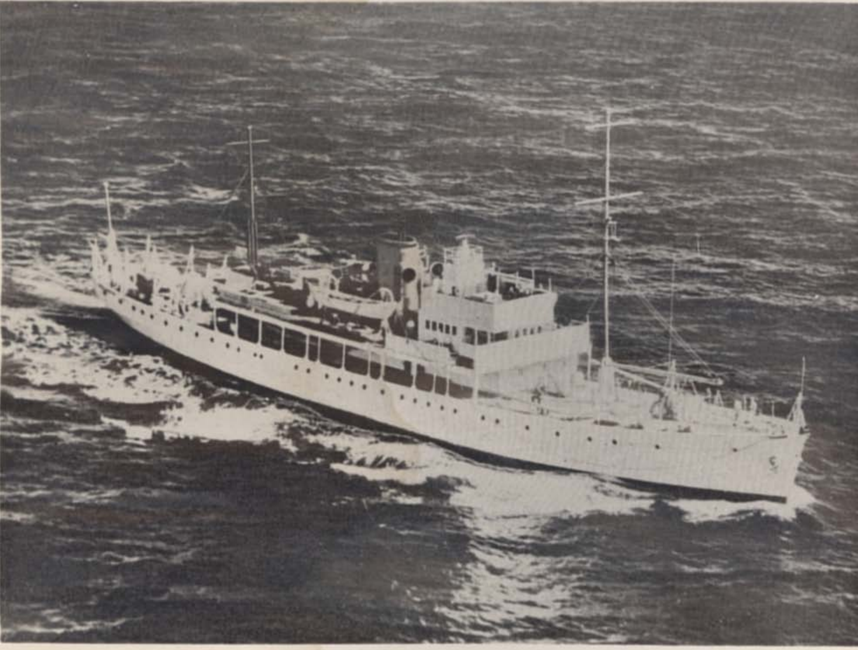
Presented at: GEBCO Science Days
October 4, 2011

Scripps 海洋研究所全景

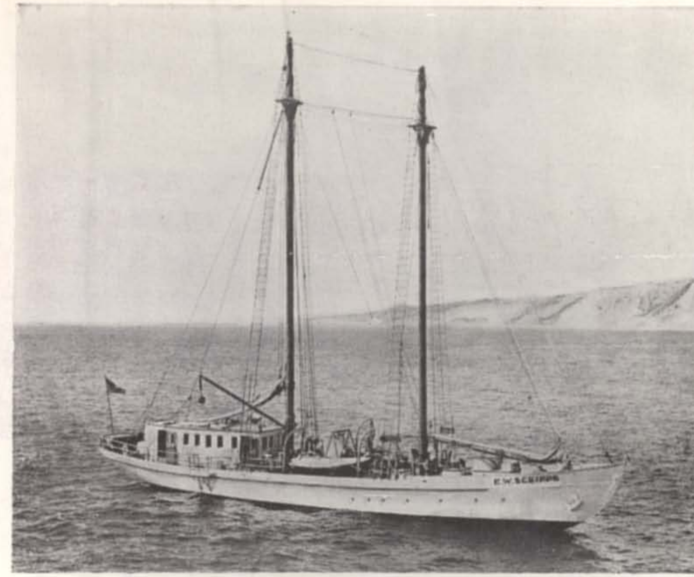

（全面積 177 エーカー）

1 さんばし（長さ 1,000 ft, 幅 20 ft）
2 電気工場
3 機械工場
4 学生寄宿舎
5 本　館
6 博物館（階下）・図書館（階上）
7 実験・研究室
8 水族館
9 ここにコンクリート建ての水族館・博物館を建築中、他の小屋は所員住宅（26 戸）

Scripps Institution of Oceanography – Highlighted in the Hydrographic Bulletin of Japan in 1950.  This underscores that the mapping of the Pacific Ocean has been an international and inter-organizational effort involving representatives from many nations including  the United States, Japan, Australia, New Zealand, Germany, Russia, Peru, Chile, Mexico and others.  Besides academic and hydrographic agencies of many nations, the United States Navy, the USGS, and other organizations have been involved.



日 本 を 訪 れ た *Challenger* 号



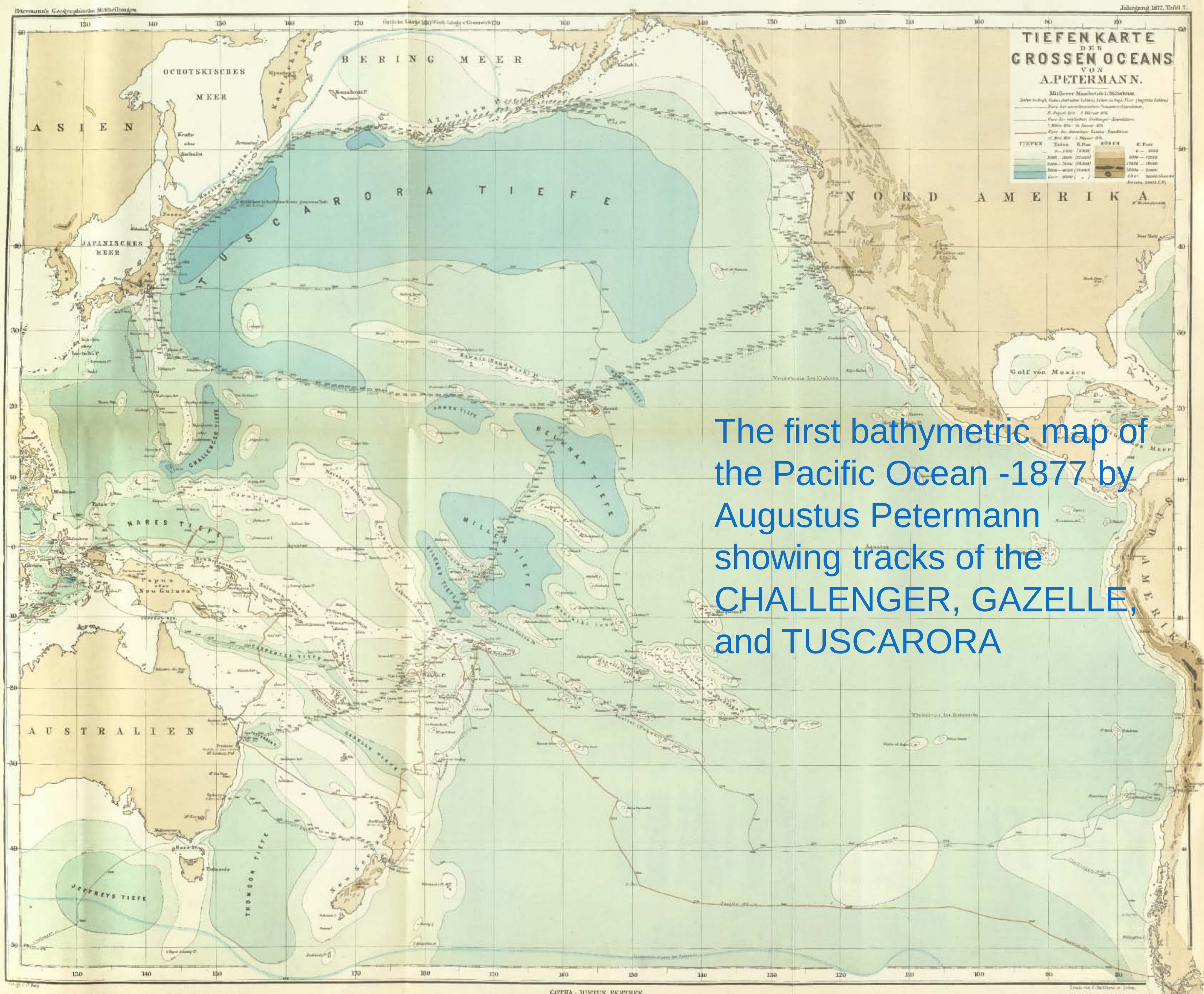
第 8 図　Scripps 海洋研究所の観測船 〃*Scripps*〃 号（長さ 104 ft, 幅 21.3 ft, 深さ 12 ft, 185 馬力)。研究所創立当時に建造されたもので、船中の実験室が素晴らしいです。

第 9 図　San Diego 湾内の Scripps の観測船。右から

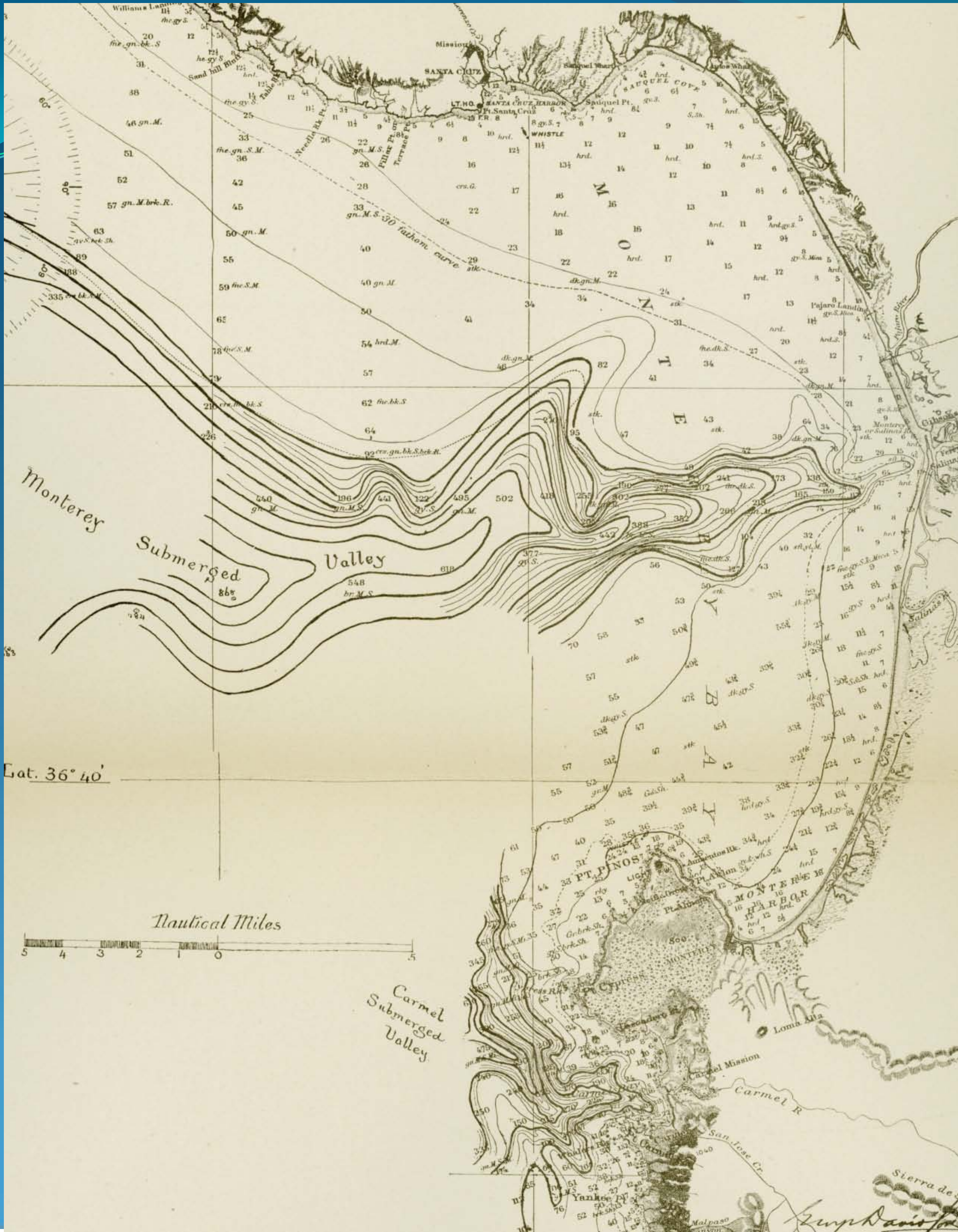
*Crest*　（長さ 136 ft, 幅 24.6 ft, 深さ 16.1 ft, 500 馬力 2 台）
*Paolina T.*　（長さ 80.3 ft, 幅 22 ft, 深さ 9 ft, 250 馬力）
*Horizon*　（長さ 143 ft, 幅 33 ft, 深さ 13.5 ft, 1,500 馬力）

第 10 図　米国水路部の海洋観測船。おそらく世界で最も完備しているもの。

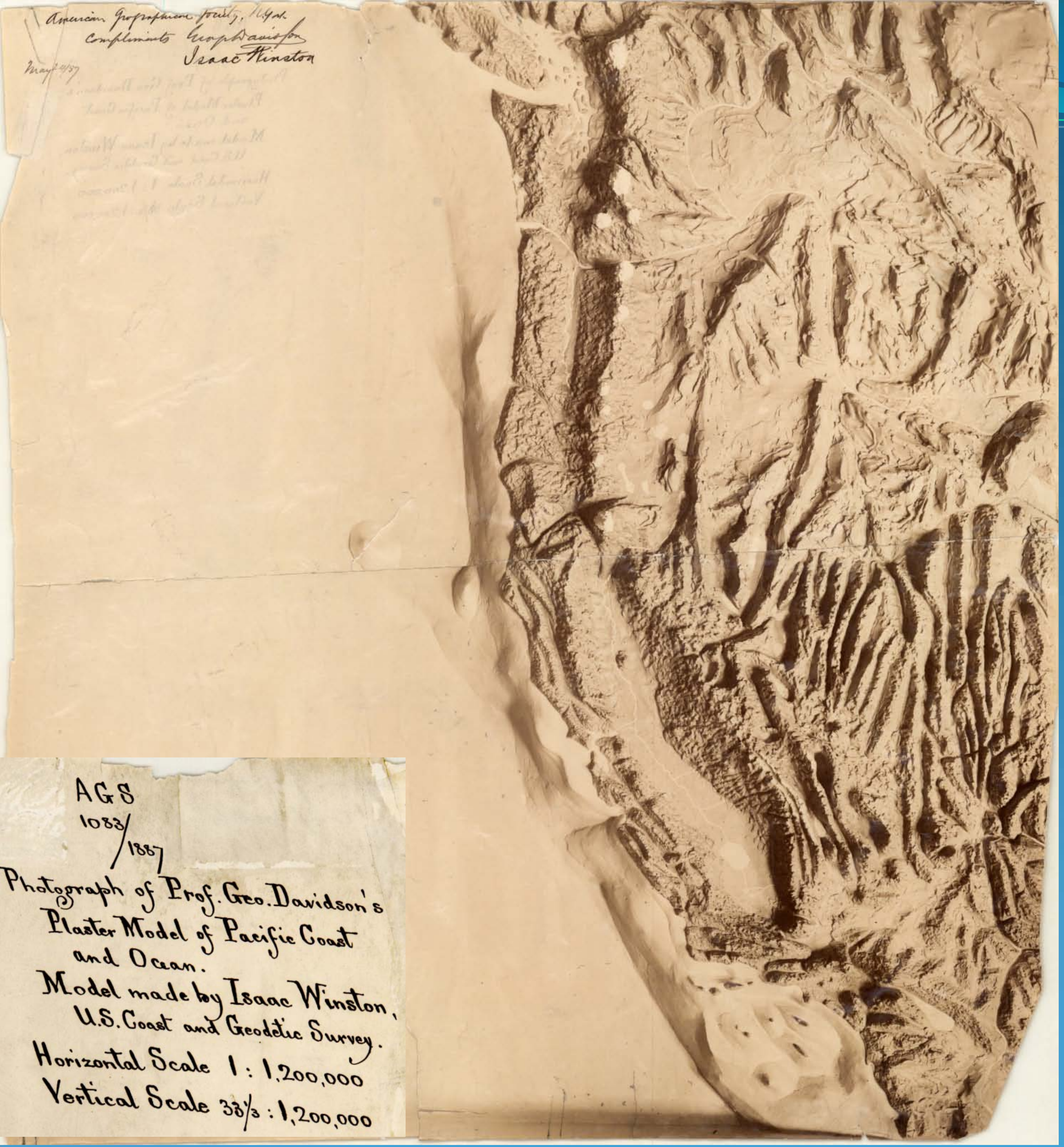
50　U. S. S. *Rehoboth*　(1,766 排水トン、18 kt)
30　U. S. S. *Sanpablo*　(1,766 排水トン、18 kt)



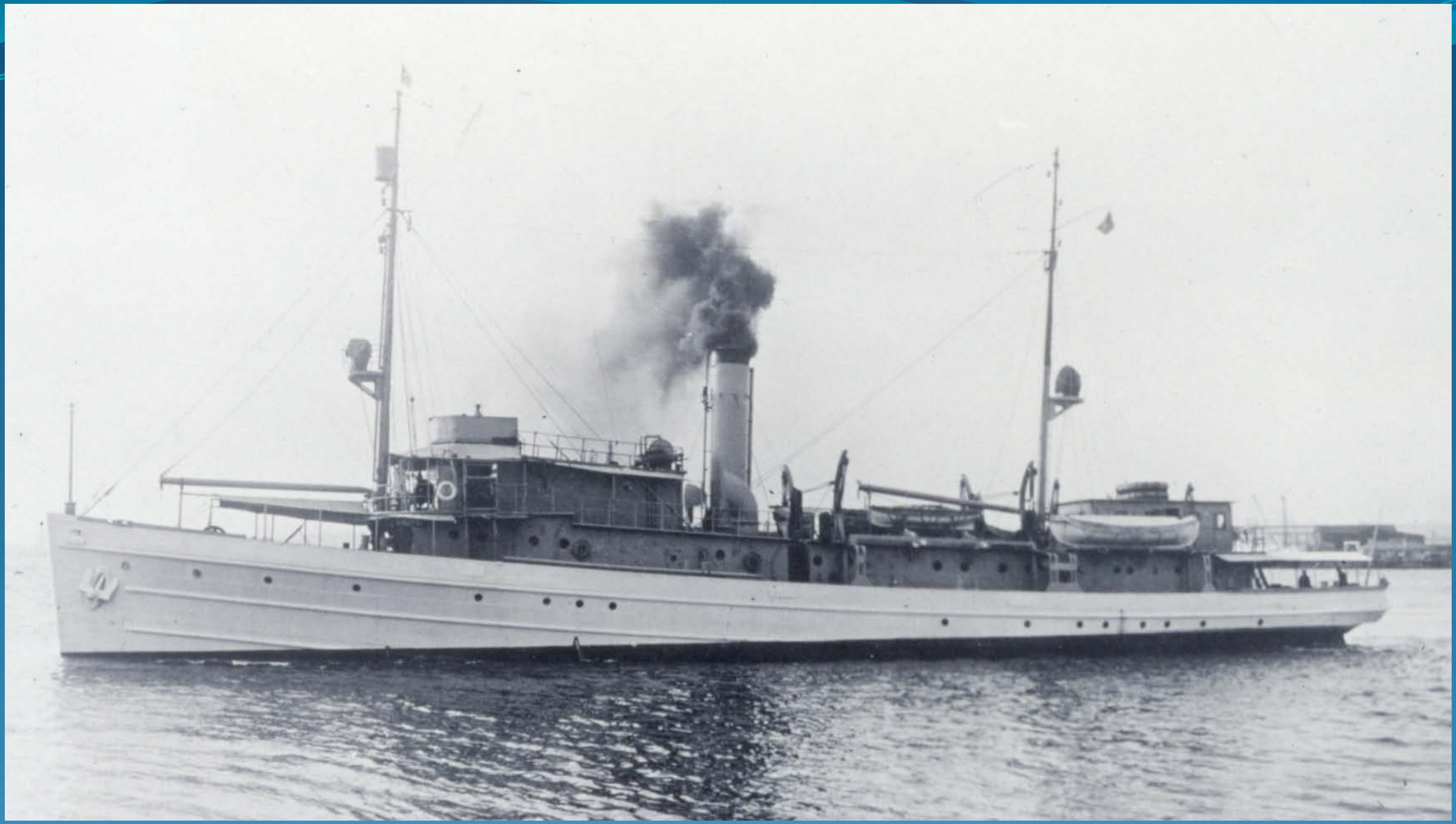

The first bathymetric map of the Pacific Ocean -1877 by Augustus Petermann showing tracks of the CHALLENGER, GAZELLE, and TUSCARORA




**George Davidson's map of the Monterey submerged valley, published in: Davidson, George, 1897. The submerged valleys of the coast of California, U. S. A., and of Lower California, Mexico. Proceedings of the California Academy of Sciences, pp. 73-103.**



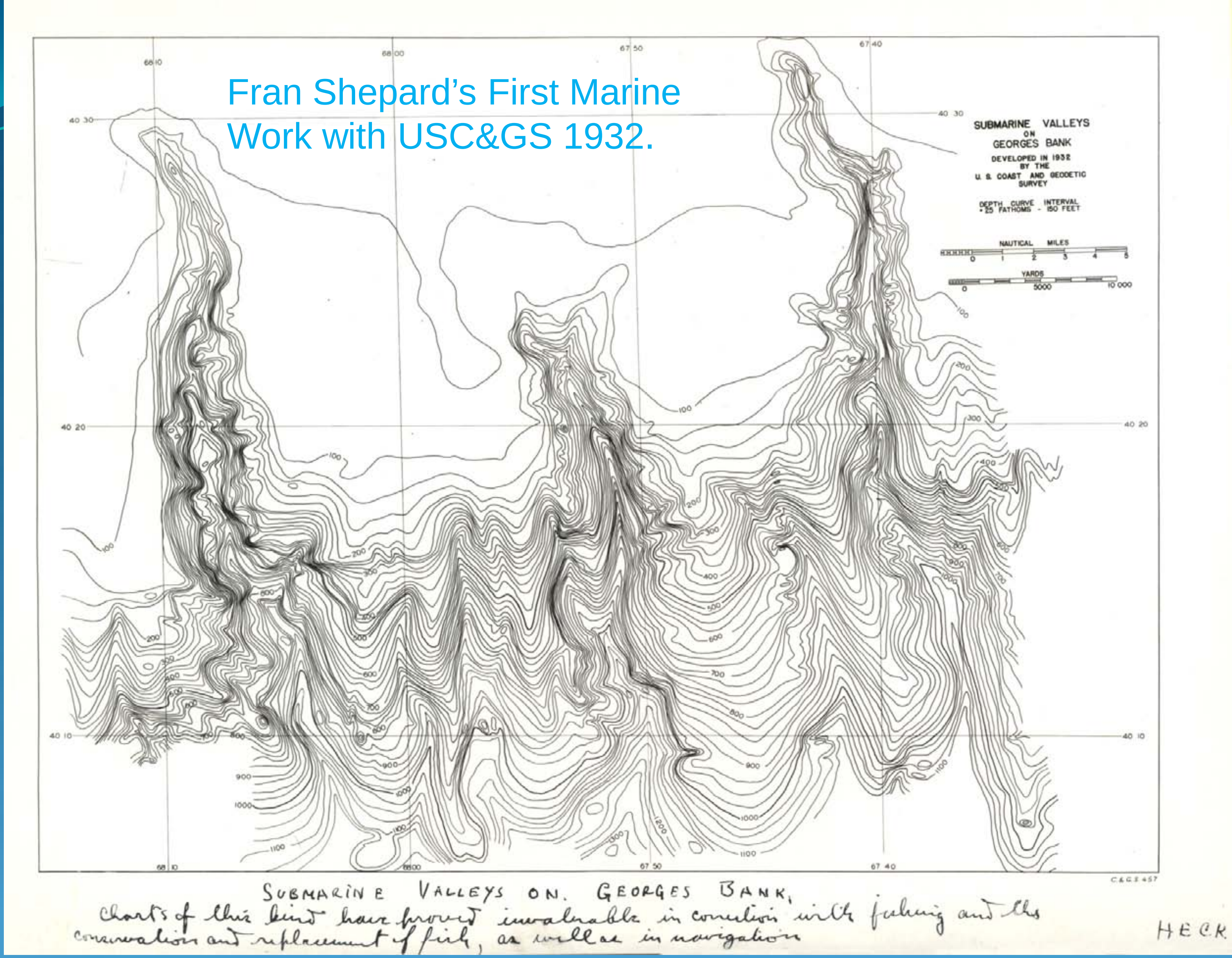

**First 3-D image of part of continental shelf and slope in Pacific Ocean. Sent to American Geographical Society on May 24, 1887. Note highs to west of Cape Mendocino, Monterey Canyon and borderlands. Also escarpments off Oregon coast. Produced by Isaac Winston of the Coast and Geodetic Survey.**



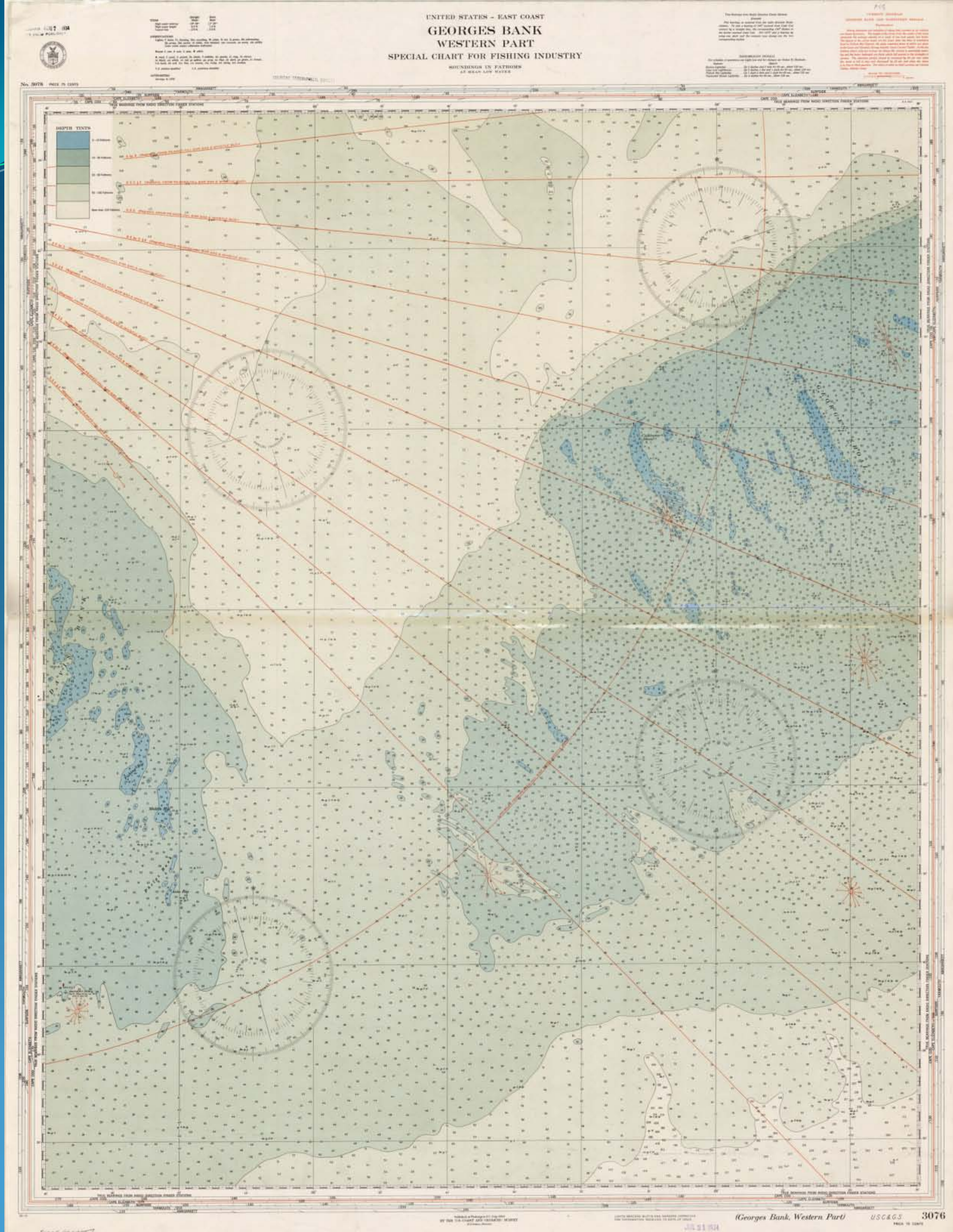
1924 C&GS Ships GUIDE , DISCOVER, and PIONEER proceed to West Coast – conduct oceanographic work for Scripps during San Diego inport s- conduct radio-acoustic ranging experiments– George McEwen of Scripps analyzes water samples for salinity helping develop first velocity tables- install automatic tide gauge and RAR station on Scripps Pier

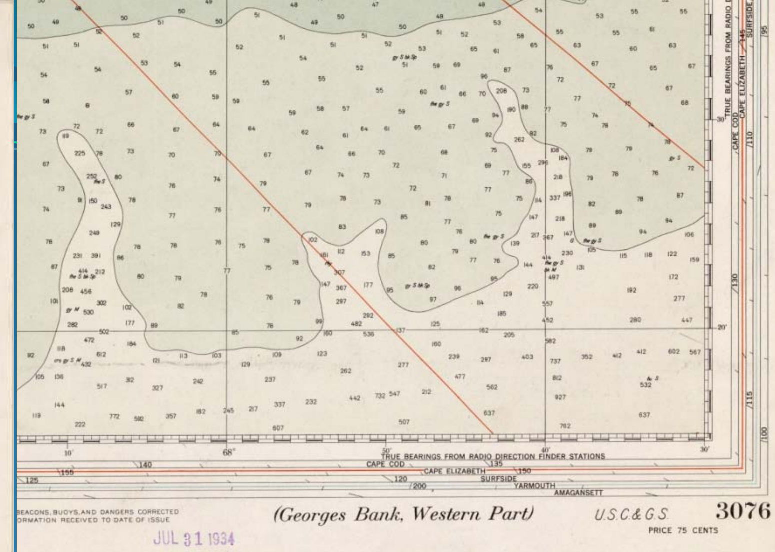
Francis Parker Shepard 1897-1985 . Pioneer Marine geologist, mentor of Dietz, Dill, Stewart, Menard and others. Longtime friend of Coast Survey – used data from Coast and Geodetic Survey and accompanied survey ships for over thirty years of career. Made huge contributions to mapping and interpreting seafloor.

# Fran Shepard's First Marine Work with USC&GS 1932.




Map accompanying: Shepard, F. P. 1932. Canyons South of Georges Bank. Pp. 39-40. Bull. Assoc. of Field Engineers U.S. Coast and Geodetic Survey.




**Georges Bank Western Part Special Chart for Fishing Industry. Published July 1934. Unique for inclusion of colored bathymetry – inverse of most color schemes. Dark is shallow. First electronic (radio direction finding) chart produced by C&GS. Included generalized canyons contoured by Shepard.**

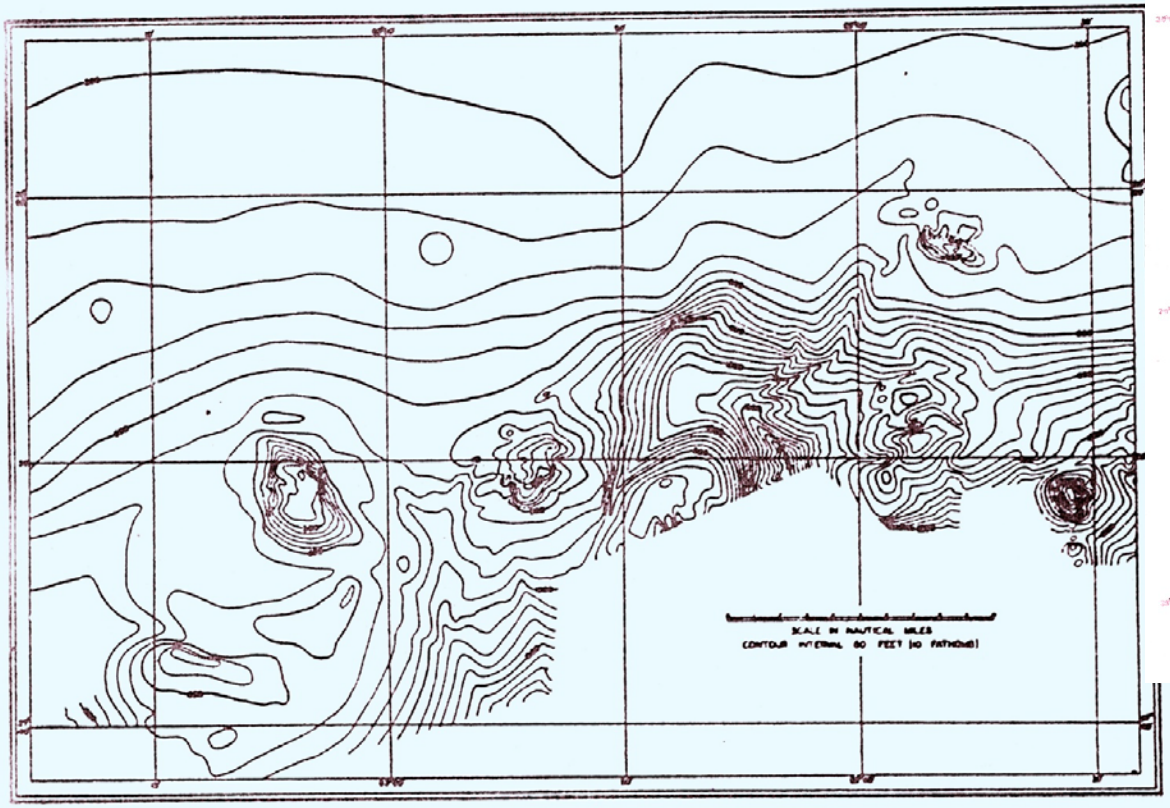


FIGURE 5.—*A group of "salt domes" and submarine valleys*

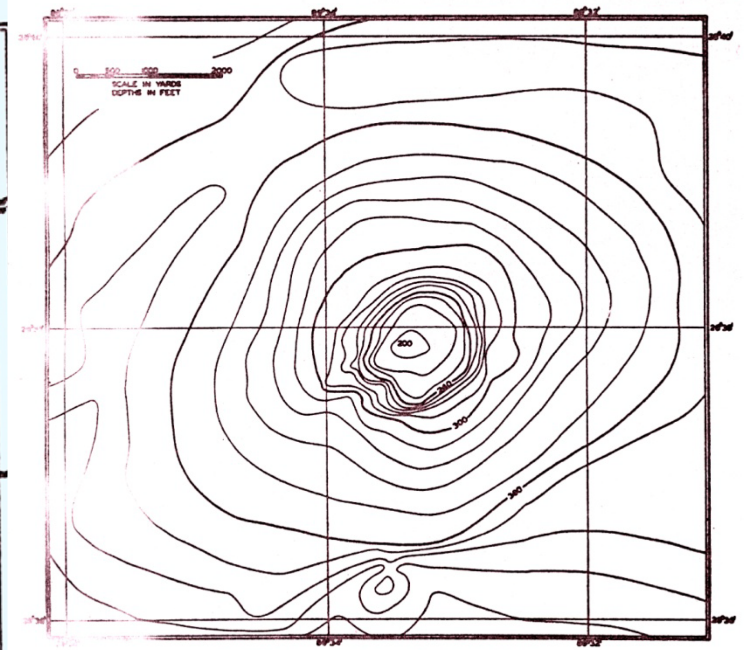



FIGURE 4.—*Dome near Southwest Pass*

Based on detailed soundings by U. S. Coast and Geodetic Survey.

**Shepard, F. P. 1937. GSA Bulletin, Vol. 48, no. 9, pp. 1349-1361. First offshore salt domes discovered by C&GS , interpreted by Francis Shepard.**

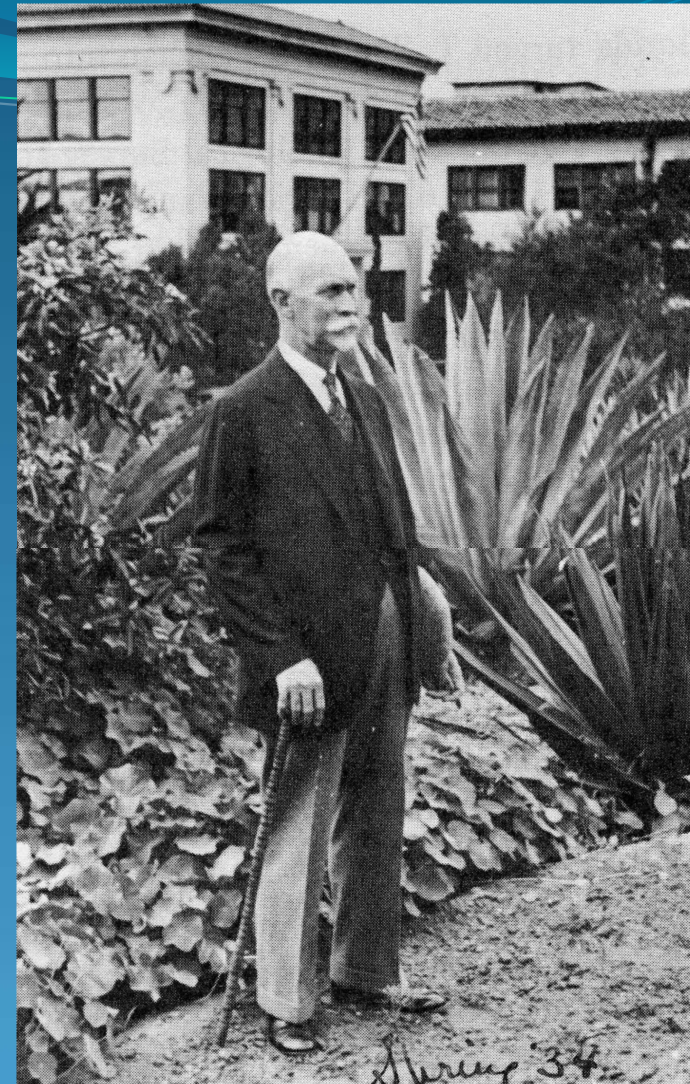
INTERNATIONAL ASPECTS OF OCEANOGRAPHY

The remarks so far made apply to the larger features of bottom configuration, but before leaving the subject some consideration should be given to the more minute features of relief. It would require considerable searching of literature to discover who was the first to recognize that there are on the ocean floor earth-forms that are trench-like, others that are precipitous and simulate fault-scarps, et cetera, but we do know that the invention of radio-acoustic position-finding and the invention of echo-sounding devices has made possible the recognition of minutiae of sea-bottom configuration that was entirely impossible only a few years ago. While in sight of land, by making closely spaced line-soundings it is possible to develop the side walls and floor of a trench, as Shepard has done,[3] but when farther out at sea other methods of successive place-finding are essential. It has now been convincingly shown that the continental shelf off the east coast of the United States is incised by numerous trenches which can be traced to depths of 1,800 meters or more.[4] The origin of these features is one of the great enigmas of geology and oceanography. They are mentioned here in the hope that research on them may be extended to other parts of the world.

[3] Shepard, F. P., Continued exploration of California submarine canyons: Amer. Geophys. Union, meeting 1936, Trans. pp. 221–223, 1936.
[4] Smith, Paul A., Submarine valleys: U. S. Coast and Geodetic Surv. Field Engineers Bull. No. 10, pp. 150–158, Dec. 1936.

In: Vaughan, 1937. *International Aspects of Oceanography*. U.S. National Academy of Sciences.

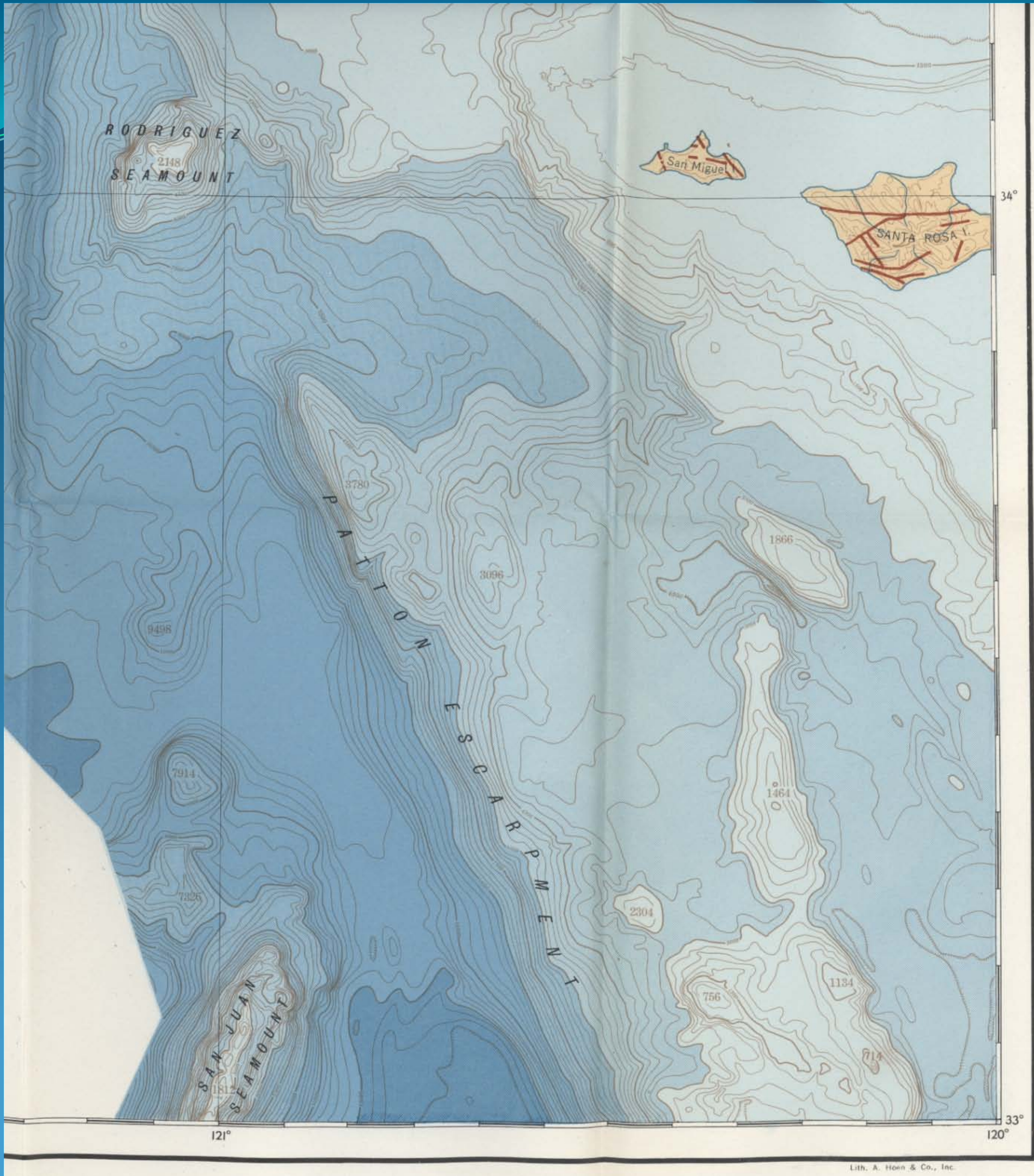
Note: Vaughan uses “trenches” to mean “canyons”.

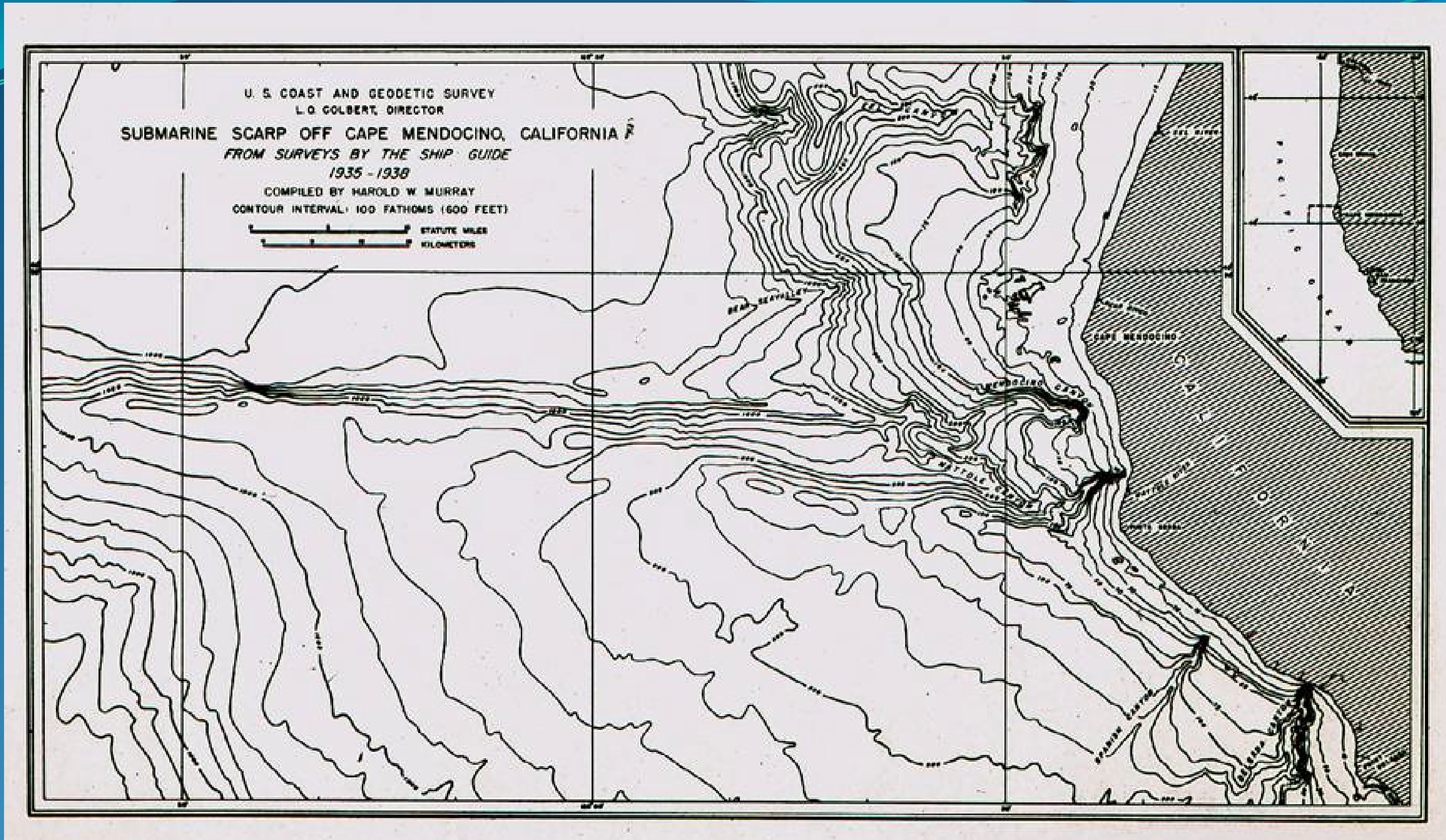



T. Wayland Vaughan, second director of Scripps – 1924-1936 – C&GS tide gage on Scripps pier;

C&GS ships PIONEER, GUIDE, and DISCOVERER provided Scripps water, bottom, and plankton samples; special survey of Scripps Canyon


1939 - Prototype C&GS bathymetric navigation chart 5101A.

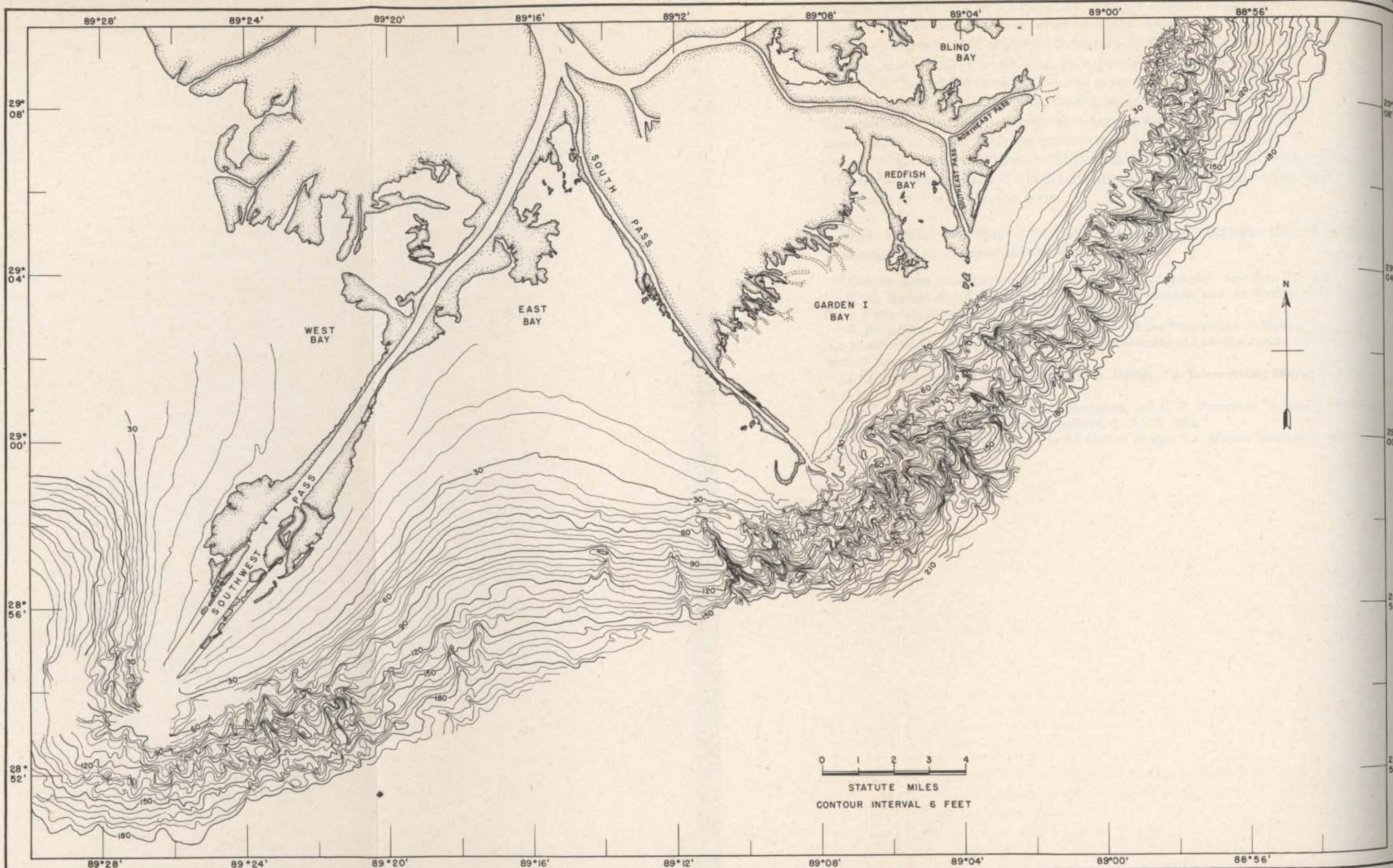

RODRIGUEZ SEAMOUNT
2148
San Miguel
SANTA ROSA I.
34°
3780
PATTON ESCARPMENT
3096
1866
9498
7914
7326
1464
2304
1134
756
714
SAN JUAN SEAMOUNT
1812
33°
121°
120°
Lith. A. Hoen & Co., Inc.


U. S. COAST AND GEODETIC SURVEY
L. O. COLBERT, DIRECTOR
SUBMARINE SCARP OFF CAPE MENDOCINO, CALIFORNIA
FROM SURVEYS BY THE SHIP GUIDE
1935 - 1938
COMPILED BY HAROLD W. MURRAY
CONTOUR INTERVAL: 100 FATHOMS (600 FEET)
STATUTE MILES
KILOMETERS
CAPE MENDOCINO
MENDOCINO CANYON
MATTOLE CANYON
SPANISH CANYON
CALIFORNIA
PACIFIC OCEAN


Humboldt Bay
3150
2304
Eel Canyon
Eel R.
Cape Mendocino
Mendocino Canyon
GORDA ESCARPMENT
4608
Mattole Canyon
Mattole R.
Punta Gorda
Spanish Canyon
Delgada Canyon
Pt. Delgada
Shelter Cove

Bull. Geol. Soc. Am., vol. 66

Shepard, Pl. 1




SUBMARINE TOPOGRAPHY OF UPPER SLOPE OFF MISSISSIPPI DELTA, SOUTHWEST TO NORTHWEST PASSES

Based on unpublished hydrographic sheets of the U. S. Coast and Geodetic Survey

In: Shepard, 1955. Delta-Front Valleys Bordering the Mississippi Distributaries. Bulletin of the GSA, Vol. 66, pp. 1489-1498. Scripps Contribution No. 997.

C&GS Ship DISCOVERER plowing across the Gulf of Alaska – 1925
Beginnings of a 15-year program to systematically map the northeast Pacific Ocean – Led to discovery of linear chains of seamounts and first study of characteristics of an oceanic trench

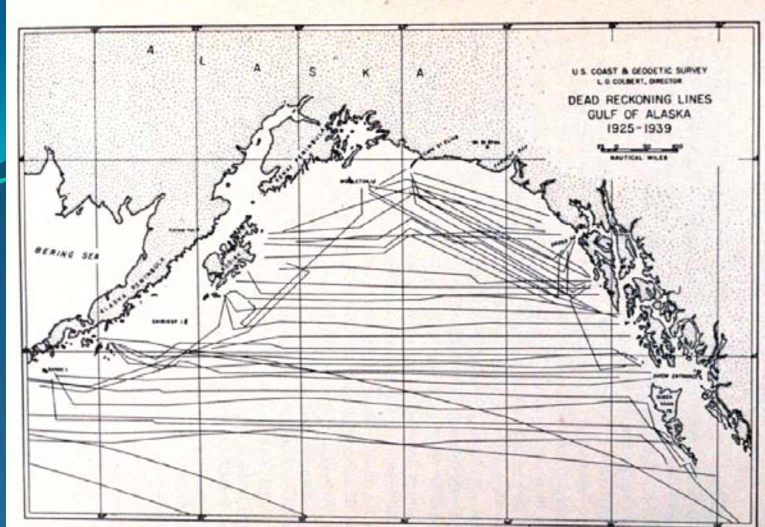
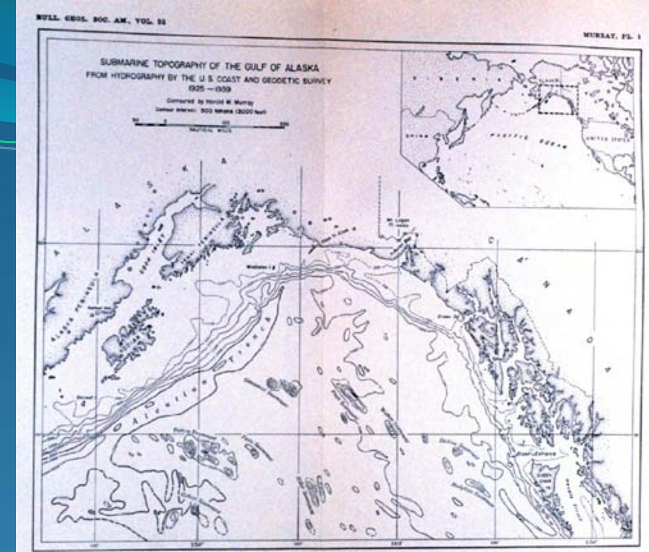



FIGURE 1.—*Dead reckoning lines across the Gulf of Alaska*
Showing courses followed by Survey vessels while obtaining soundings.




SUBMARINE TOPOGRAPHY OF THE GULF OF ALASKA

H. W. Murray, 1941. Submarine Mountains in the Gulf of Alaska. GSA Bulletin, Vol. 52. Murray was first to publish detailed maps of groups of seamounts, first to study physiography of a trench, first to draw attention to Mendocino Escarpment.

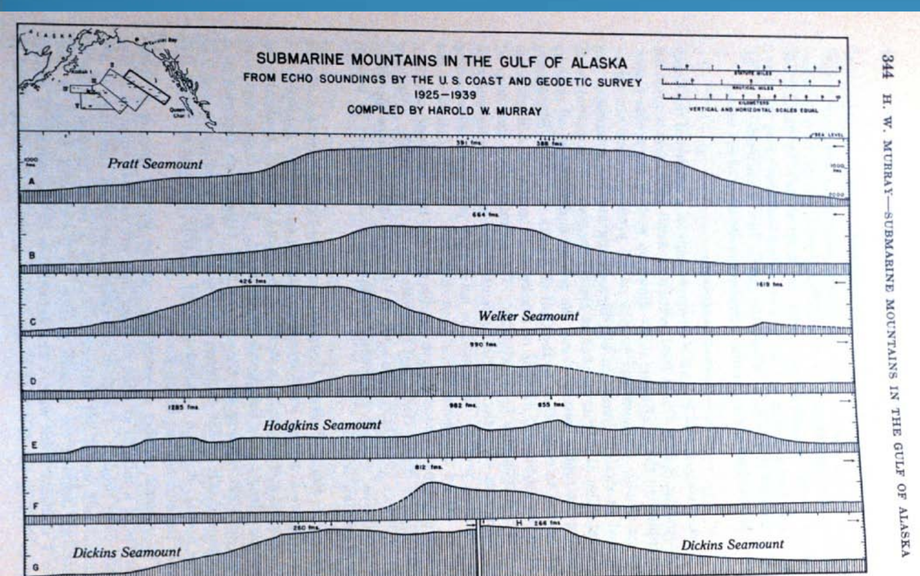



FIGURE 5.—*Group I. Pratt, Welker, Hodgkins, and Dickins Seamounts*

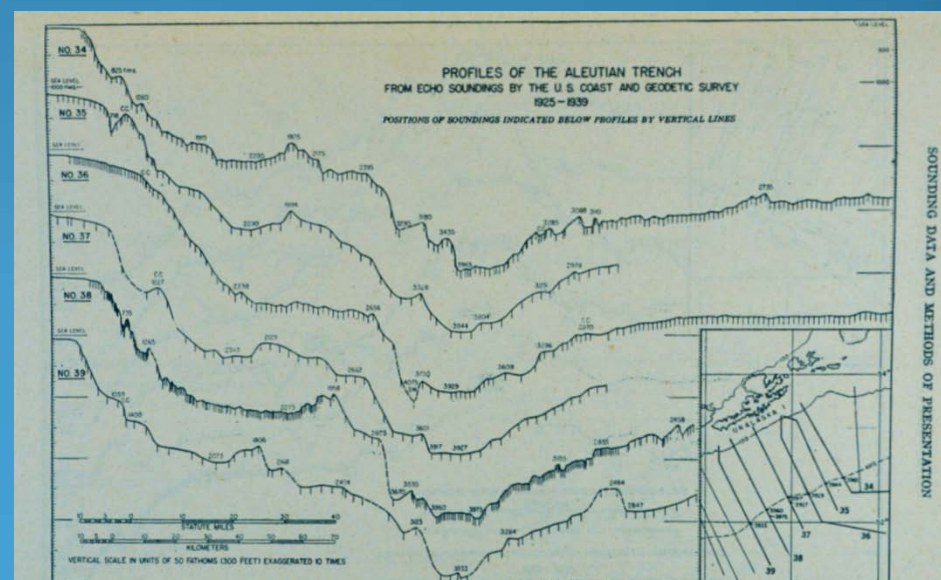



FIGURE 8.—*Profiles, Group VII. Off Unalaska Island*


3-D model of Seamounts in the Gulf of Alaska 1947. Harold Murray and Roy Elkins

NOAA OAR AOML Special Publication 2004-001

# HARRIS B. STEWART, JR.:

## Northern Holiday Expedition 1951

January 2004

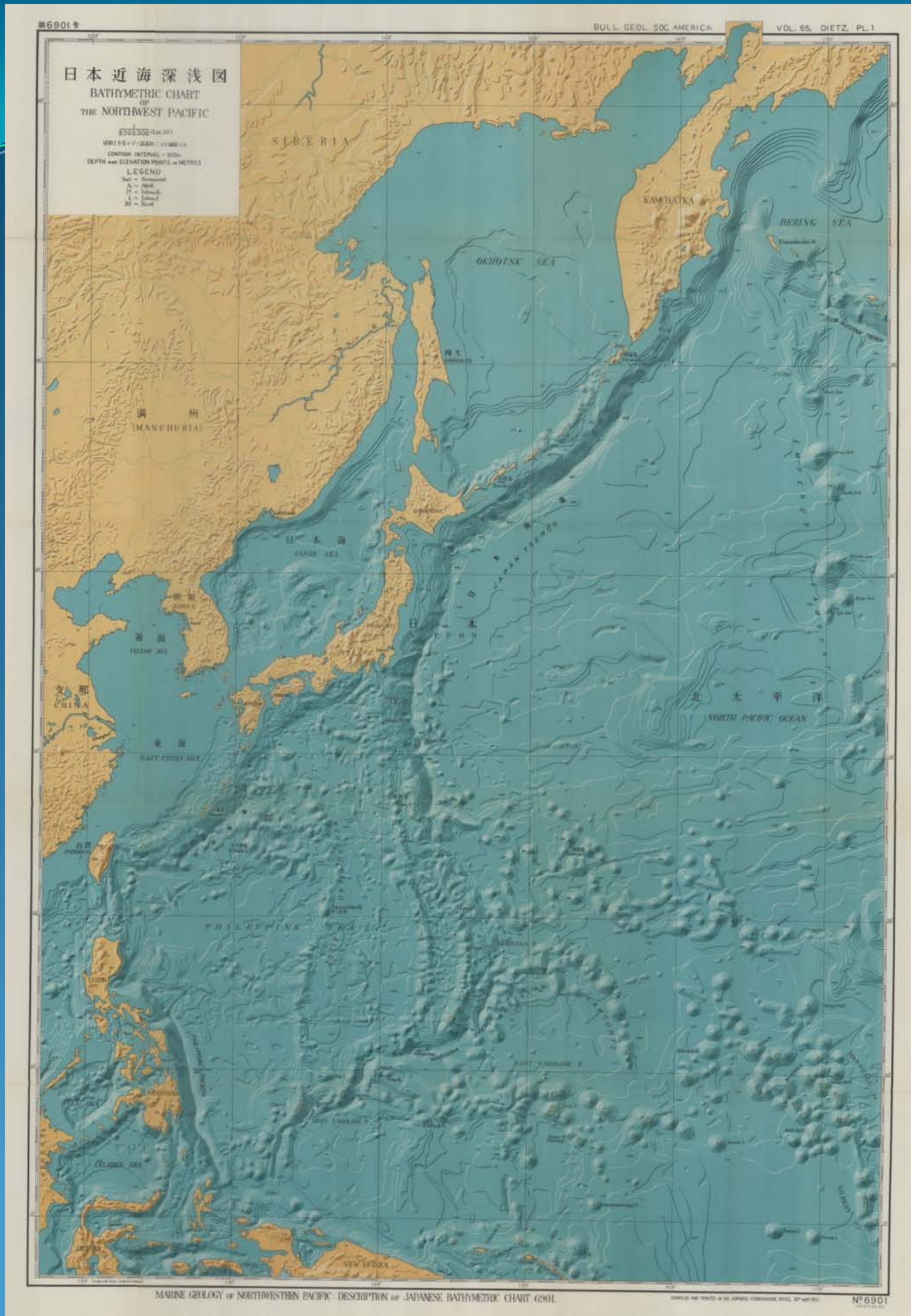
US Department of Commerce

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

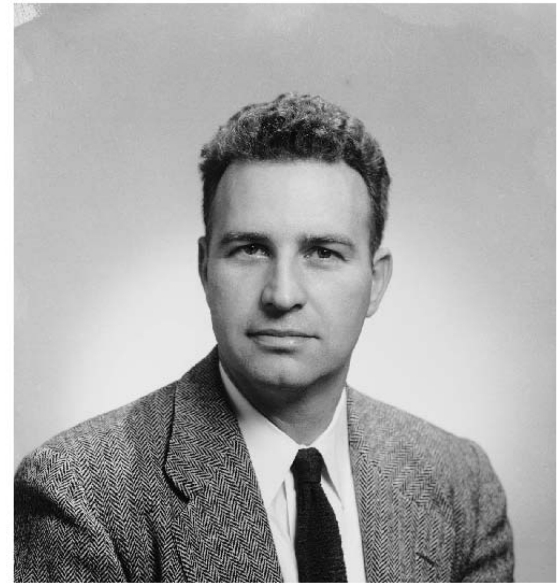
Oceanic and Atmospheric Research
Atlantic Oceanographic and Meteorological Laboratory
Miami, FL

Northern Holiday proved the western extension of the Mendocino Escarpment and the discovery of the Murray Escarpment, leading directly to Menard coining the term “fracture zone”. Menard recalls that due to rough weather, Harris B. Stewart was lashed to a stool for 19 hours straight while making crossings of the Mendocino Escarpment. Stewart also directed the first survey of what became known as the Murray Fracture Zone at the end of this expedition.

Scientists from Scripps Institution of Oceanography empty a chain dredge (left) pulled from the waters off the Aleutian Islands. The rocks are then studied for clues to the composition of the ocean floor.

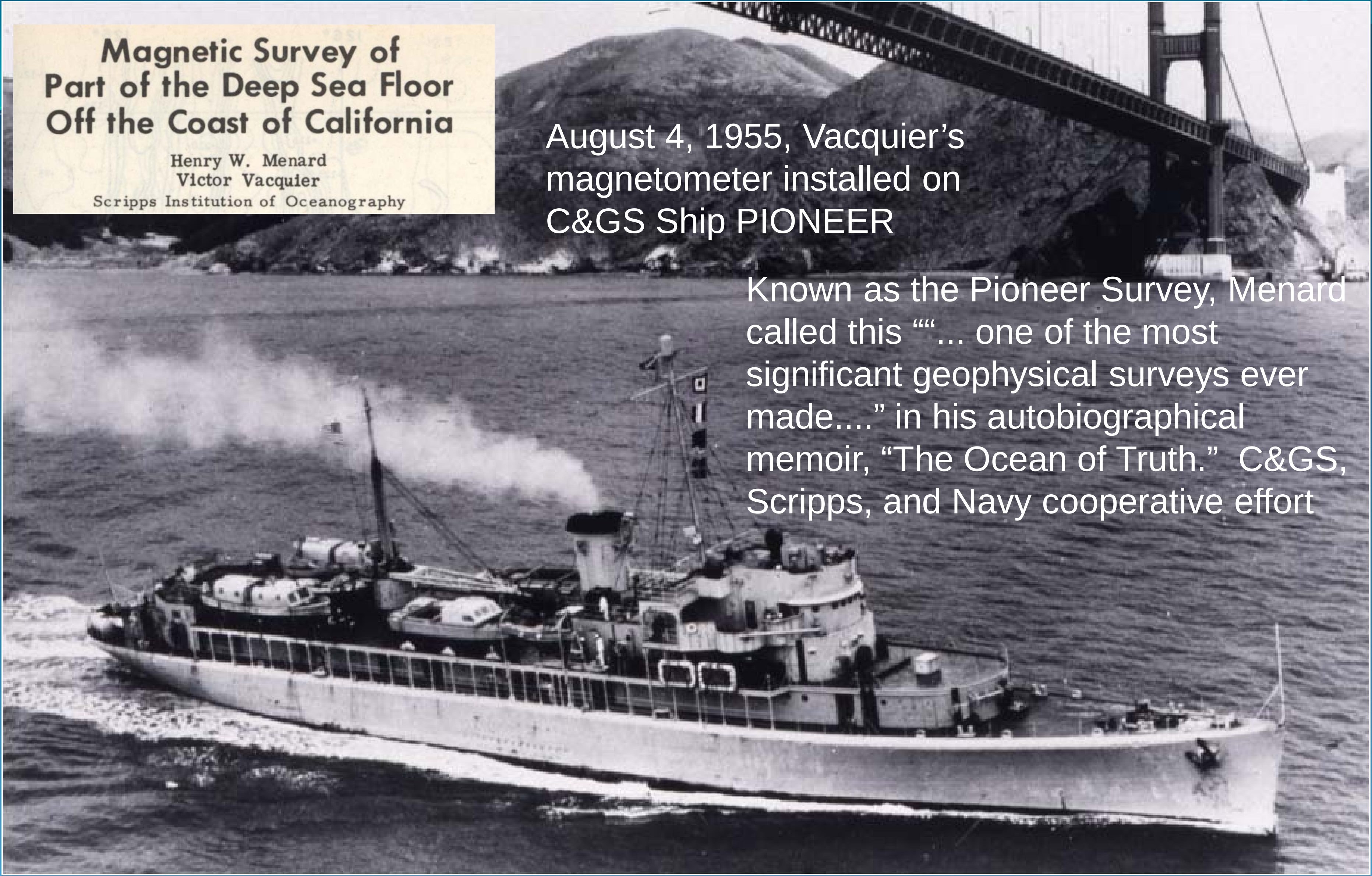



**Robert Sinclair Dietz Biography**



Robert Sinclair Dietz was born in Westfield, New Jersey, September 14, 1914, a son of civil engineer Louis Dietz and Bertha Dietz. He was educated at the University of Illinois from 1933- 1941 where he received B.S., M.S. and Ph.D. degrees in geology with a minor in chemistry. He joined ROTC his junior year. While Dietz's degrees were from the University of Illinois, most of his doctoral work was done at the Scripps Institution of Oceanography (SIO) under the direction of his mentor, Francis P. Shepard, who had faculty positions at both institutions before the war. While a student in Illinois, Dietz became interested in the Kentland structure in

Robert Dietz –Adjunct Professor at Scripps 1950-1963. Navy Electronics Laboratory 1946-1963. NOAA AOML with Harris B. Stewart 1963-1975. Coined term “seafloor spreading”, named Emperor Seamounts 1953 as result of year of study in Japan.



**Magnetic Survey of Part of the Deep Sea Floor Off the Coast of California**

Henry W. Menard
Victor Vacquier
Scripps Institution of Oceanography

August 4, 1955, Vacquier's magnetometer installed on C&GS Ship PIONEER

Known as the Pioneer Survey, Menard called this "“... one of the most significant geophysical surveys ever made....” in his autobiographical memoir, “The Ocean of Truth.” C&GS, Scripps, and Navy cooperative effort

Deploying Victor Vacquier's marine magnetometer. Acknowledged Mason and Raff – Mason and Raff acknowledged Vacquier and Menard

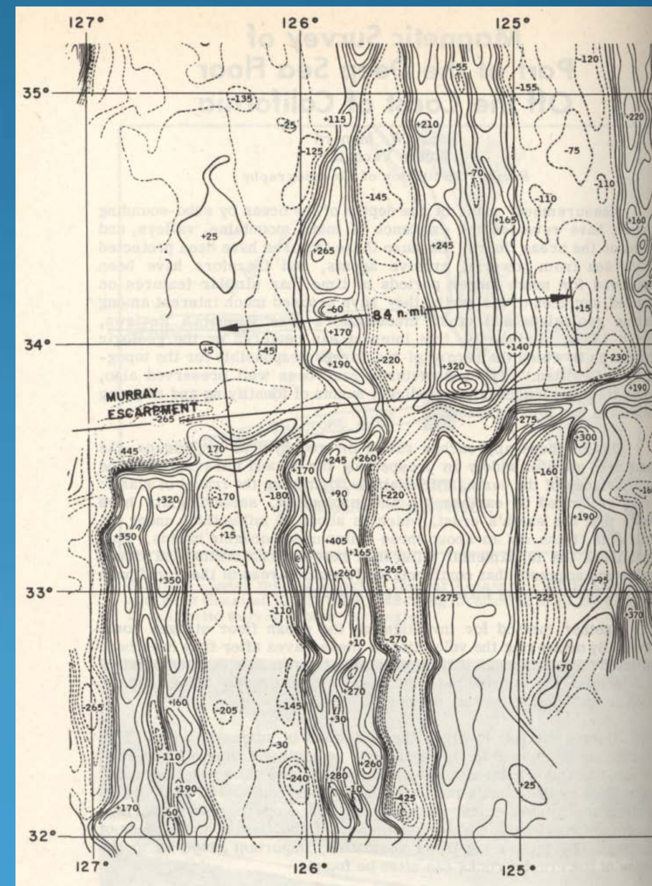
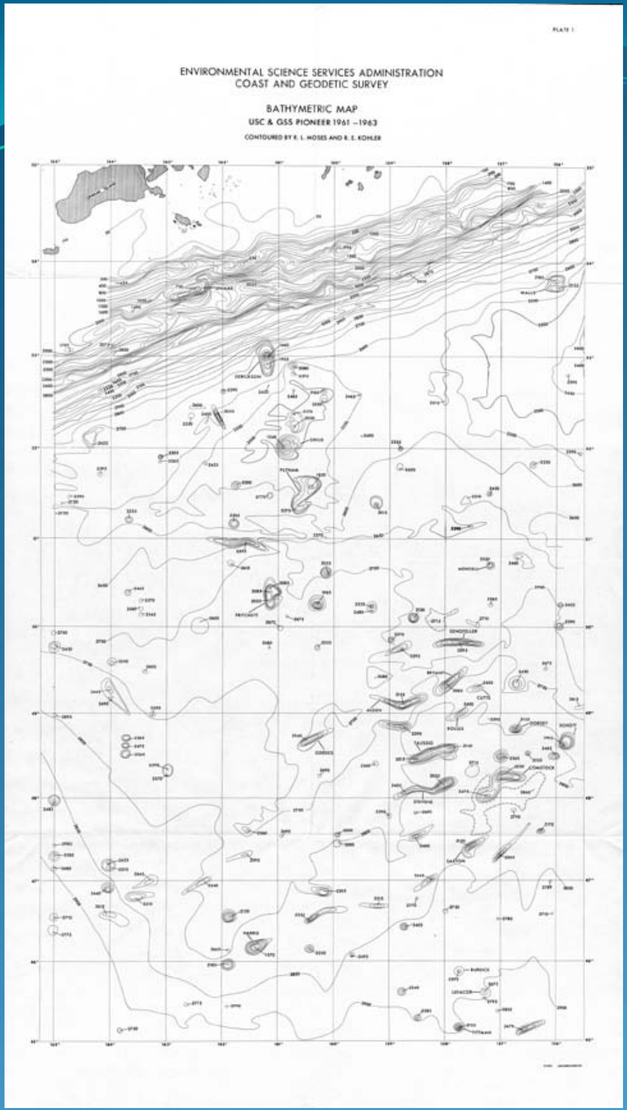
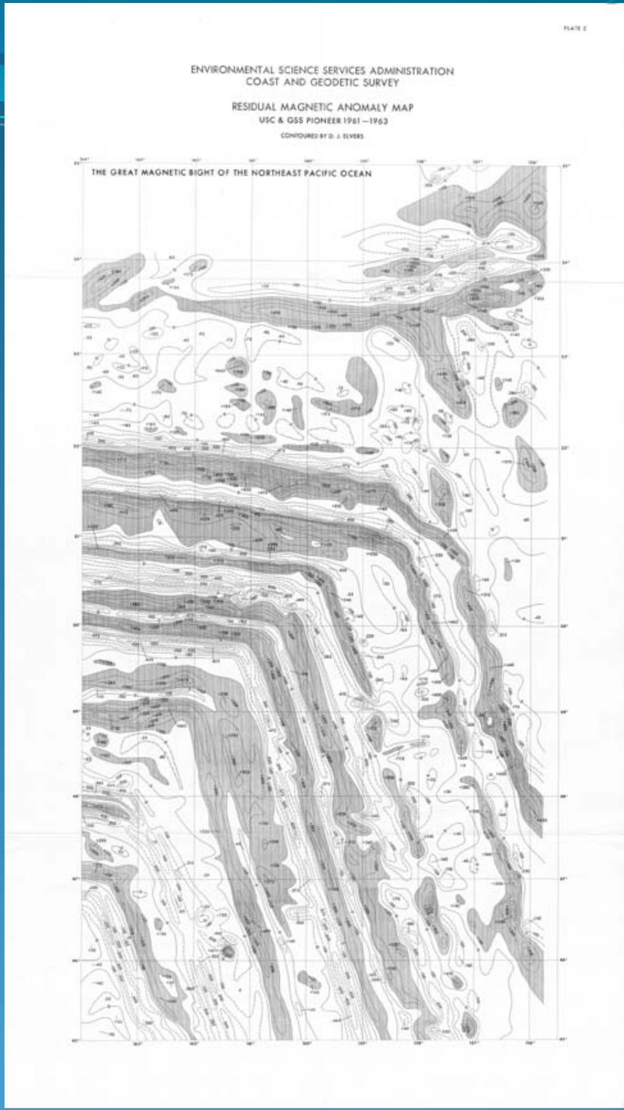
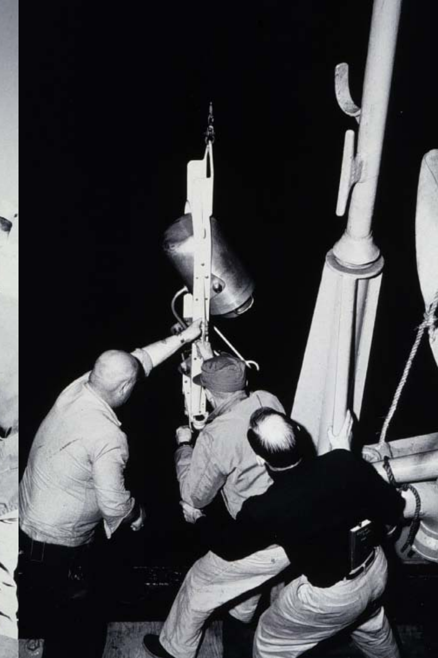



Figure 3 - Map showing the total magnetic intensity of the area outlined in Figure 1. The contour interval is 50 gammas (1 gamma equals $10^{-5}$ gauss). The north-south trending features are interpreted as being lava flows that fill the linear depressions of old topography. Note the horizontal shift along the Murray escarpment.

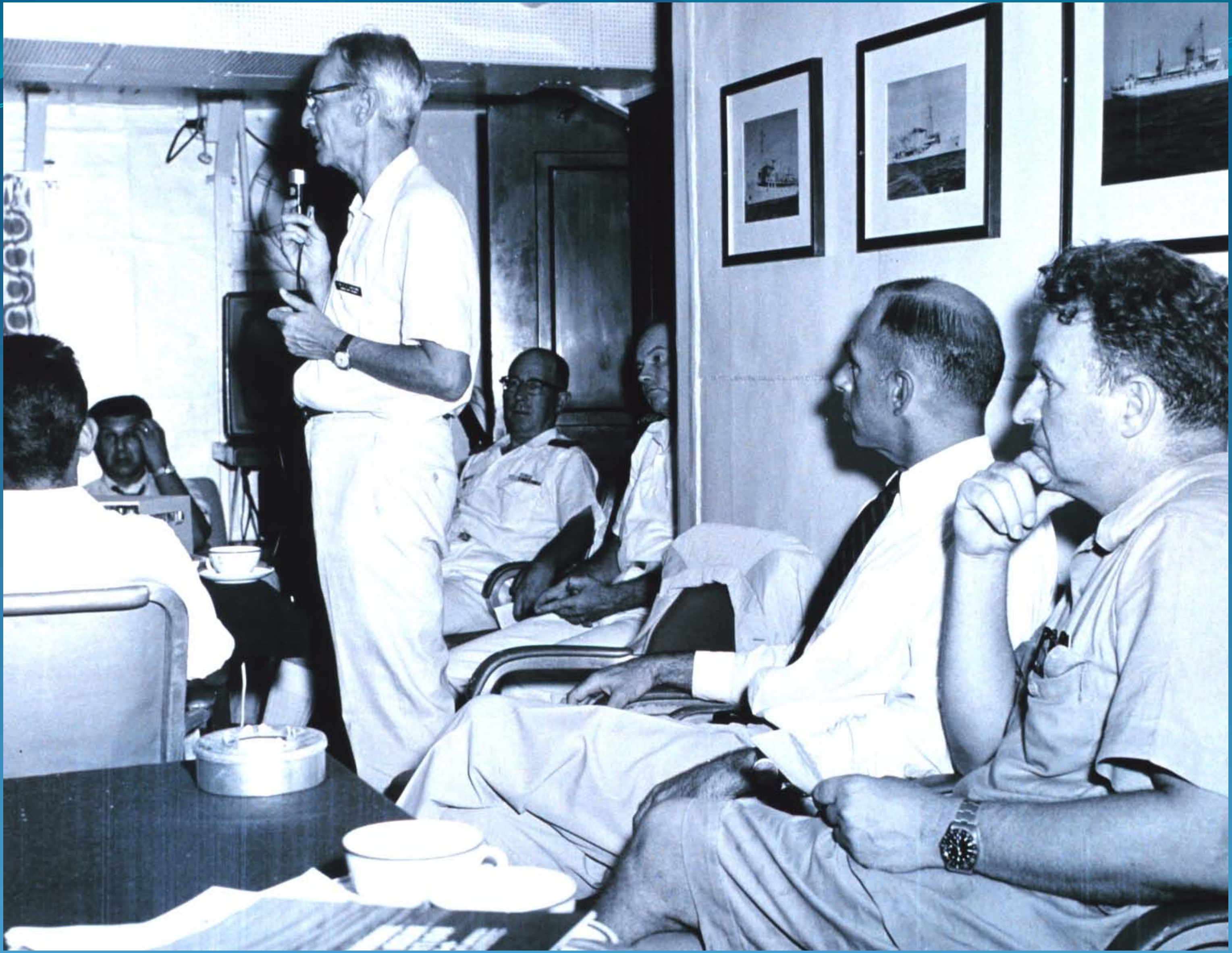


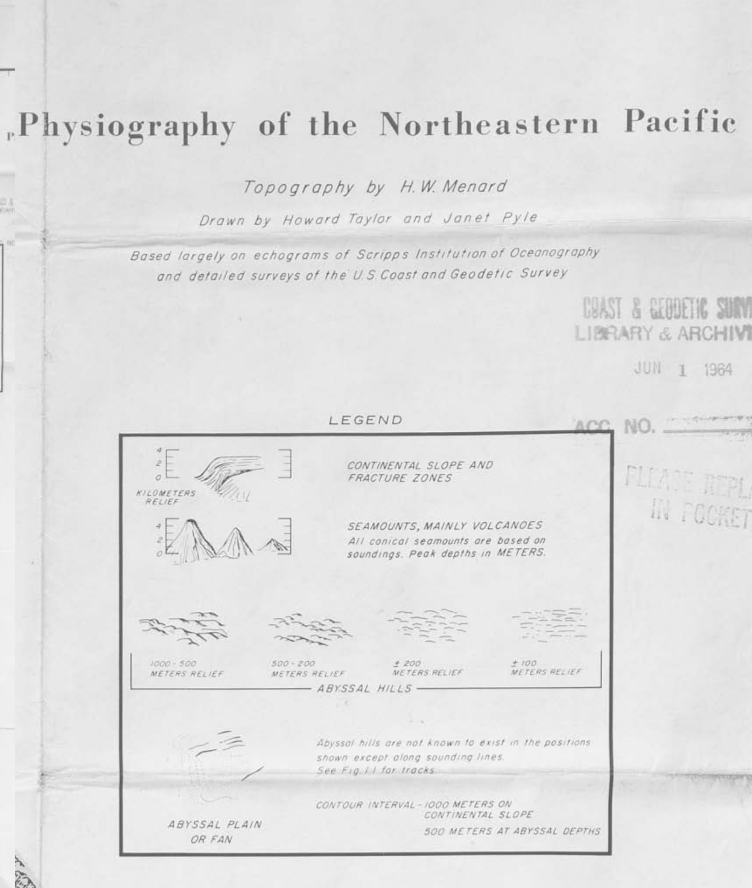

SEAMAP – Result of NAS/NRC Report "Oceanography 1960-1970". Systematic ocean surveys championed by Harry Hess, carried out by C&GS Ships PIONEER and SURVEYOR 1961-1973. 10-mile line spacing, LORAN-C and satellite navigation.



Harris B. Stewart, the greatest of the Scripps/Coast and Geodetic Survey/NOAA personnel. First Chief Oceanographer of C&GS, brought scientific diving to NOAA, first director and founder of NOAA's AOML, IOC delegate – a Shepard student



Fran Shepard on the USC&GS Ship PIONEER – Indian Ocean 1964.
Harris B. Stewart and Robert Dietz looking on.




From: Menard, H. W. 1964. Marine Geology of the Pacific .

Robert Dietz and Robert Dill on USC&GS OCEANOGRAPHER south of Australia 1967 – Both students of Shepard.

# Sea Floor Topography of the Central Eastern Pacific Ocean

By

THOMAS E. CHASE, Geologist[1]

*Bureau of Commercial Fisheries; Fishery-Oceanography Center*
*La Jolla, California 92037*

## INTRODUCTION

The Bureau of Commercial Fisheries Tuna Resources Laboratory, La Jolla, Calif., in cooperation with the Institute of Marine Resources, University of California, La Jolla, has prepared and issued a series of sea floor topography charts of the eastern Pacific Ocean. The Bureau of Commercial Fisheries has been studying the environment of the eastern Pacific Ocean as part of a long-range plan to forecast the availability of tuna and to increase the efficiency of the nation's domestic tuna fisheries. The Institute of Marine Resources has been investigating the mineral content and the geology of the sea floor. Knowledge of the topography of the sea floor is important to both investigations; the charts presented here summarize available sounding data collected over 15 years by many institutions and agencies. These charts represent a first attempt to describe the topography of this vast oceanic province in detail.

Most marine charts published today are printed with the depths plotted as isolated sets of numbers and occasional contours. Such charts give water depth at a particular fixed point or along a single contour line but are misleading because the depth may change rapidly within a short distance. Existing marine charts of the eastern Pacific Ocean are inadequate for describing most deep-sea geological features. Fishermen cannot interpret many of the features because the charts do not show the configuration of the sea floor.

To portray the sea floor in detail, depths must be plotted as closely as possible so that contour lines can be drawn through points of equal depths to give expression to heights and depths, and to show gradients of slopes. In recent years, continuously recorded echo-soundings along numerous ship tracks have provided the data necessary for preparation of contour charts.

The main effort of the tuna fisheries in the eastern Pacific Ocean has been concentrated near continental shelves, slopes, and shoal areas around islands. Since the inception of the temperate zone fisheries in 1903 and the tropical zone fisheries in 1915, vast quantities of tuna have been caught in shelf and shoal regions. In 1957, Hurricane Bank, later named Shimada Bank, was discovered by the tunaboat Hurricane at lat. 16°52′ N., long. 117°32′ W. (see fig. 1 and chart 11, Appendix A). Through 1964, a total of 16,398 tons of tuna had been caught at this bank.[2] The large catches of yellowfin and skipjack tuna at Shimada Bank led to the question of the existence of other unknown submarine features that would offer new and productive fishing localities.

The Scripps Institution of Oceanography, University of California, San Diego, has conducted extensive oceanographic and geological expeditions since the early 1950's. Many of these expeditions have been specifically for the investigation of the eastern Pacific, and others have traversed this region enroute to other areas (fig. 2). Most of the vessels were equipped with echo-sounding devices that recorded the depth of the sea floor while the ships were underway. These expeditions have provided a wealth of high-quality sounding data from which many new geological features have been discovered. Many of these features have been illustrated in various scientific publications, but the enormous accumulations of sounding data have never been compiled onto regular charts.

Although most of the sounding information for our charts came from expeditions of the Scripps Institution of Oceanography, other organizations also provided valuable data. Charts of the U. S. Navy Oceanographic Office contain spot soundings and the 100-fathom contour; these have been incorporated on many of our charts. Additional sources of data were the British Admiralty, the International Hydrographic Bureau in Monaco, and vessel masters of the southern California tuna fleet.

The purpose of this circular is to present the complete series of topographic charts under one cover for ease in referencing the floor of the eastern Pacific Ocean as it is known at the present time. The 26 individual charts are included in the Appendix, reduced to one-half of the original size. The original topographic charts were issued at a standard size of 22 by 34 inches and distributed by the Bureau of Commercial Fisheries Tuna Resources Laboratory, P. O. Box 271, La Jolla, Calif. 92037.

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[1]Present address, Department of Earth Sciences, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, Calif. 92037.

[2]Unpublished report, Inter-American Tropical Tuna Commission.

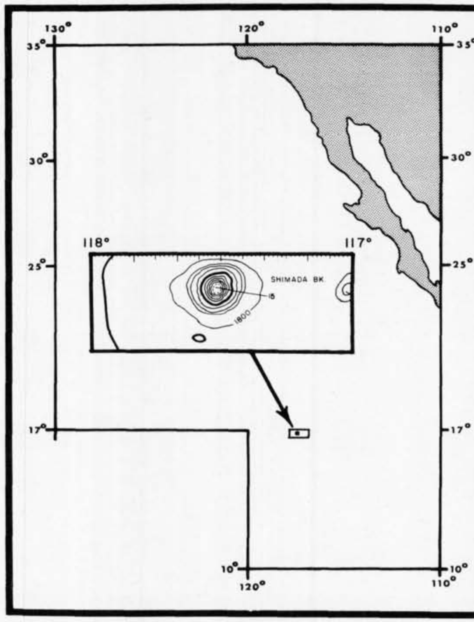


Figure 1. Location map of Shimada Bank (formerly Hurricane Bank). Contours are in fathoms.

The charts are not intended to represent definitive configurations of the sea floor but to provide a general picture of the major topographic features in the eastern Pacific Ocean. Regional features have been labelled for ease of identification. Reported shoal positions were checked against known accurate depths close by. All could not be surveyed and checked, however, owing to the time limitations of the project. Consequently, some reported positions have been labelled as "existence doubtful" or "reported" where verification was not possible. These charts are not designed for coastal navigation because the limitations of scale prohibited locating of all dangerous rocks and shoals on them. Publications of the U. S. Navy Oceanographic Office and the U. S. Coast and Geodetic Survey should be used for navigation in coastal regions.

## CHART PROJECTION AND SCALE

The Mercator Projection was used for all charts. The nautical scale at lat. 20° N. is about 1:195,000.

## AREA COVERED

The area of the eastern Pacific Ocean covered by the charts exceeds 4,530,000 square miles (fig. 3). Each chart covers 10° of longitude and 6° or 7° of latitude, except charts 12, 16, and 19, which cover 3° of longitude. A 1° overlap of latitude occurs between charts 1 and 3, to give a complete portrayal of Guadalupe Island.

A special, detailed chart of the Galapagos Islands area covers 7° of longitude and 4° of latitude. An additional chart was prepared to cover the area to the southwest of Clipperton Island (long. 110° to 120° W.; lat. 3° to 10° N.). This chart may also be requested from the Director, Bureau of Commercial Fisheries, Fishery-Oceanography Center.

## METHODS

Preparation of a topographic chart involves the following steps: (1) collecting the sounding data by echo-sounding; (2) correcting the ship's navigational track to determine its true course; (3) plotting the soundings at appropriate time intervals along the ship's track; (4) compiling all available sounding data for the region to be entered on a single compilation sheet; (5) determining an appropriate scale and contour interval; and (6) contouring and preparing the chart. Discussion of these operations is given in detail so that the seagoing reader can interpret his own echograms and charts. Miles referred to on the topographic charts are nautical miles.

### ECHO-SOUNDING

Echo-sounding is a method by which a sound impulse is transmitted from an instrument on the hull of a vessel, reflected from the sea floor, and received by an instrument on the ship as an echo. The length of time for the sound impulse to reach the sea floor and return to the ship as an echo is an accurate measure of depth at a given instant. With recording echo-sounding gear, depths of the sea floor may be recorded continuously while a ship is underway.

Development of echo-sounding devices in the 1920's marked the beginning of detailed portrayals of the sea floor. Few of the early models were capable of sounding the deep ocean, and detailed explorations were restricted to shallow regions until sophisticated instruments were developed during World War II. Today, accurate depth measurements can be taken anywhere.

Prior to 1956, the echo-sounder used by the Scripps Institution of Oceanography was the Edo Corporation Sonar Sounding Set AN/UQN-1B.[3] The device was equipped with a transmitter-receiver, transducer, and a recorder which was modified to produce an echogram 9½ inches wide, with a scale in multiples of 600 fathoms. Two other models, the RCA NMC-1 and the Submarine Signal Company NMC-2, were also used.

In 1956, Scripps vessels were equipped with the Timefax Mark V Precision Depth Recorder (PDR). This recorder, coupled with the Edo transmitter-receiver and transducer, gives a readout in multiples of 400 fathoms on an echogram 19 inches wide (fig. 4), thus permitting greater resolution of sea floor details.

The frequency of the sound impulse leaving the Edo transducer is usually set at 12 kilocycles per second. Some soundings are taken with frequencies of 14 kilocycles per second but they constitute a small percentage of the total. The 12-kilocycle frequency allows the sound impulse to reach any depth of the ocean, whereas higher frequencies sometimes dissipate and do not attain the depths required for detailed topographic investigations.

The speed of sound in sea water varies with the density of the water. The greater the density, the faster sound travels. A change in temperature or salinity, or both, causes variations in density and changes the speed of sound. The charts presented here have been prepared from uncorrected soundings, and incorporate an assumed constant average velocity of sound in sea water of 4,800 ft./sec. (800 fm./sec.). Maximum depth errors are 47 fathoms at depths of 2,000 fathoms.[4] (Information concerning the correction values to be applied to echo-soundings is given by Matthews (1939).

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[3]Trade names referred to in this publication do not imply endorsement of commercial products.

[4]Errors are conservative (i.e., depths recorded are too shallow) because the assumed sound velocity is slightly less than field experience indicates.



Tom Chase's first Pacific Atlas – BCF Circular 291 published 1968

Dr. Townsend Cromwell, Scripps Ph.D. , BCF Scientist Discovered Pacific Equatorial Undercurrent

Dr. Bell Shimada, Colleague of Cromwell, BCF scientist, pioneer Fisheries ecologist

John Knauss, 1960.

John Knauss
Scripps Ph.D 1959
Administrator of NOAA 1989 -1993
Dean of Graduate School of Oceanography of University of Rhode Island 1962-1987
Emeritus Professor of Oceanography URI

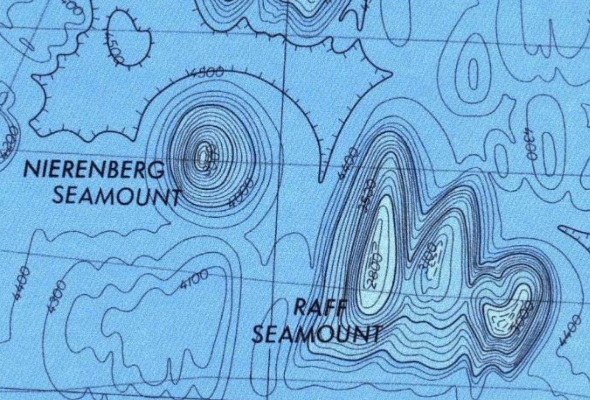
John Knauss 1958 - “We have succeeded in measuring the flow of the Pacific Equatorial Undercurrent…. Measurements at different depths were made by suspending a modified Roberts current meter from a drifting ship…. Measurements were made from two ships, HORIZON of Scripps… and HUGH M. SMITH of Pacific Oceanic Fisheries Investigation, Fish and Wildlife Service….

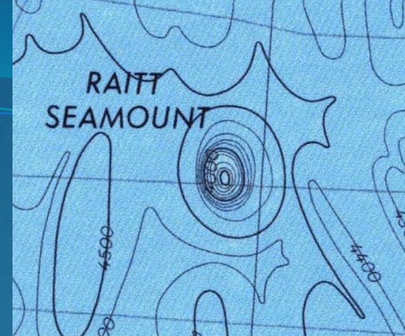
“Three days after the completion of these measurements, Townsend Cromwell, who discovered the Pacific Equatorial Undercurrent in 1952 and gave it its present name, was killed in an aeroplane crash near Guadalajara, Mexico, on June 2, 1958, on his way to join another Scripps Institution oceanographic expedition at Acapulco. We would like to suggest that this current be called the Cromwell Current.”

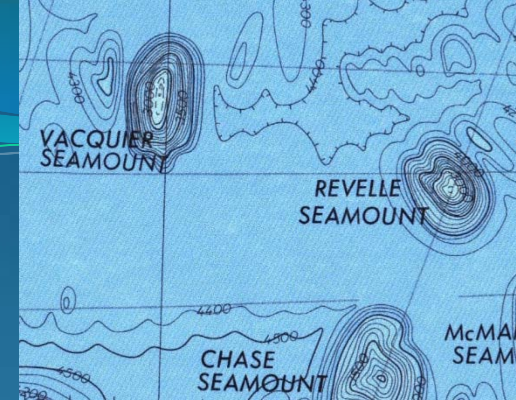
Scripps and Fisheries ships, C&GS technology. Bell Shimada also killed in this crash and had Shimada Seamount named for him. John Knauss was on the Stratton Commission forming NOAA and was NOAA Administrator from 1989-1993.

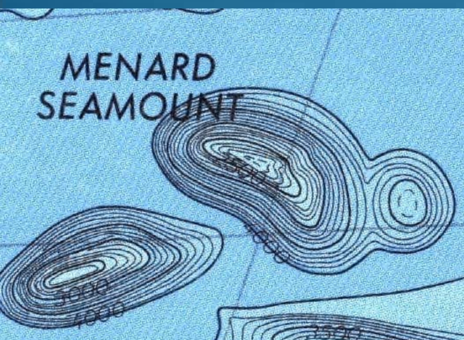

Plaque placed on Shimada Seamount by officers and crew of NOAA Ship BELL SHIMADA on its maiden voyage in 2010 - Possibly the only instance of a seamount receiving a commemorative plaque.


George Sharman, Scripps Ph.D. 1976.   Member of Menard, Chase, bathymetric mapping team.  GEBCO member, former head of NGDC Marine Geology and Geophysics, presently Special Assistant for Communications.  Shown here as judge of 2006 Intel International Science and Engineering Fair.



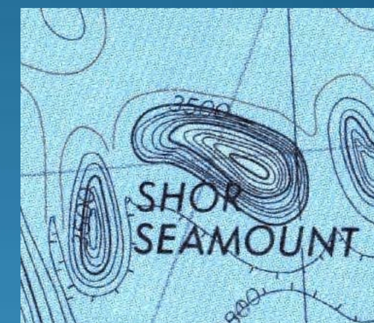



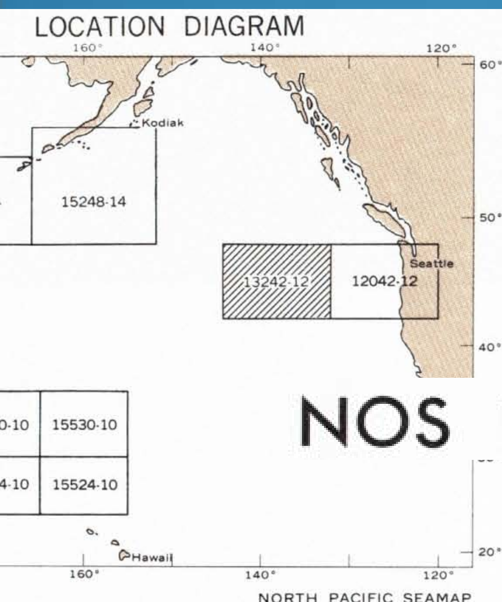




# NOS SEAMAP SERIES

## NORTH PACIFIC OCEAN

Published at Washington, D.C.
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY
1973

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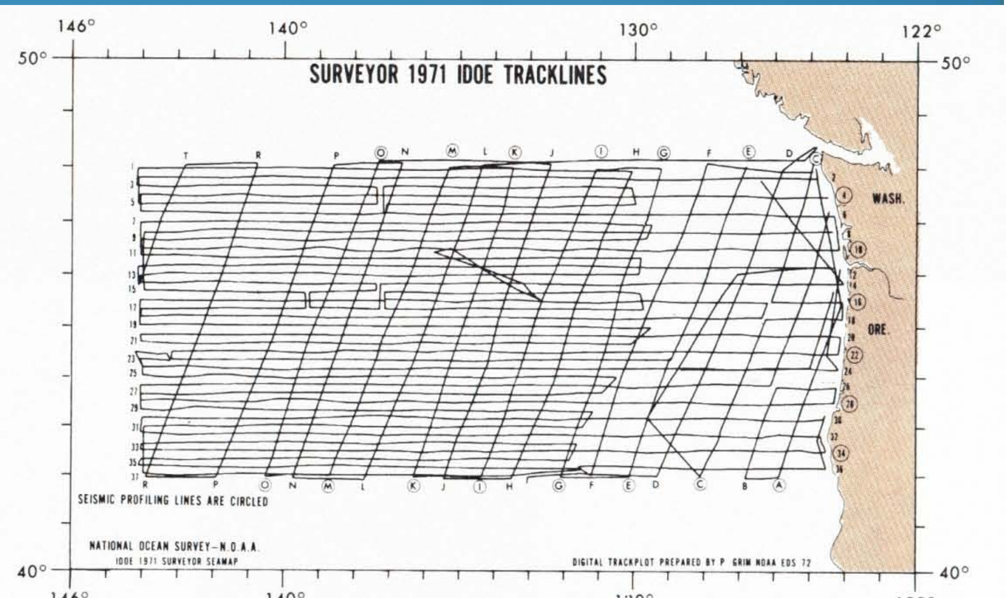
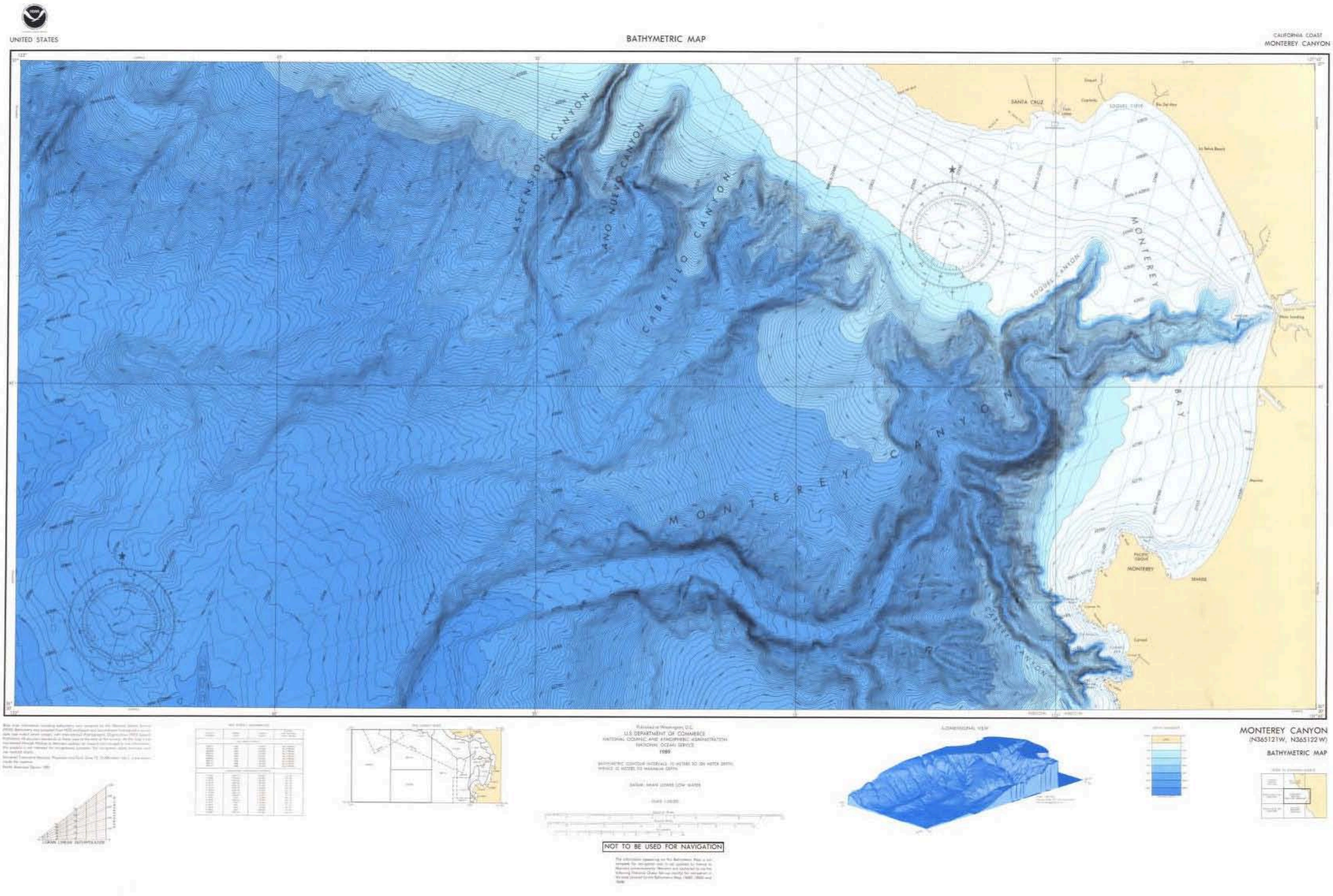
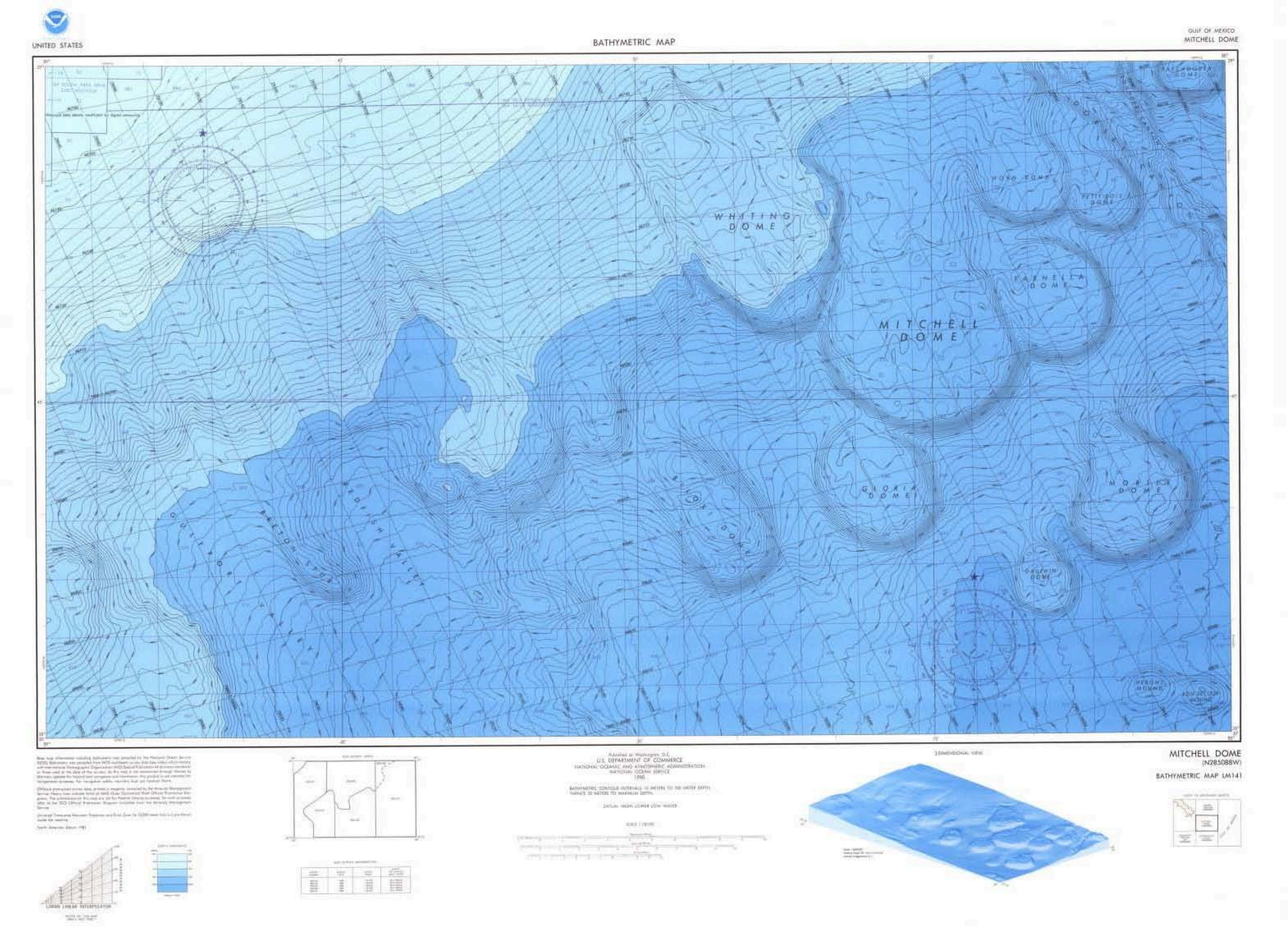



NOAA'S ARK 63000 MILES
SINCE LEAVING
SEATTLE MAR 3RD
70


NOAA
S 132

1983 -First GPS controlled Sea Beam survey lines. Off Scripps R/V THOMAS WASHINGTON. Dick Hey and Bob Tyce Co-Chief Scientists. I was NOAA liaison to Scripps MPL and asked by Tyce to see if I could get John LaBrecque's Magnavox Y-set GPS going for navigation purposes. I did through hours of button-pushing and got navigation solution to converge. 4-hour satellite availability each day. This experience led directly to NOAA's EEZ mapping project. My assignment at Scripps was due to Mike Loughridge (Harvard Ph.D. but Scripps field work) and Bob Dill who then was chief geologist for NOAA's Ocean Minerals and Energy


UNITED STATES
BATHYMETRIC MAP
CALIFORNIA COAST
MONTEREY CANYON
ASCENSION CANYON
ANO NUEVO CANYON
CABRILLO CANYON
SOQUEL CANYON
MONTEREY BAY
MONTEREY CANYON
SANTA CRUZ
MONTEREY
MONTEREY CANYON
(N36512IW, N36512 2W)
BATHYMETRIC MAP
NOT TO BE USED FOR NAVIGATION

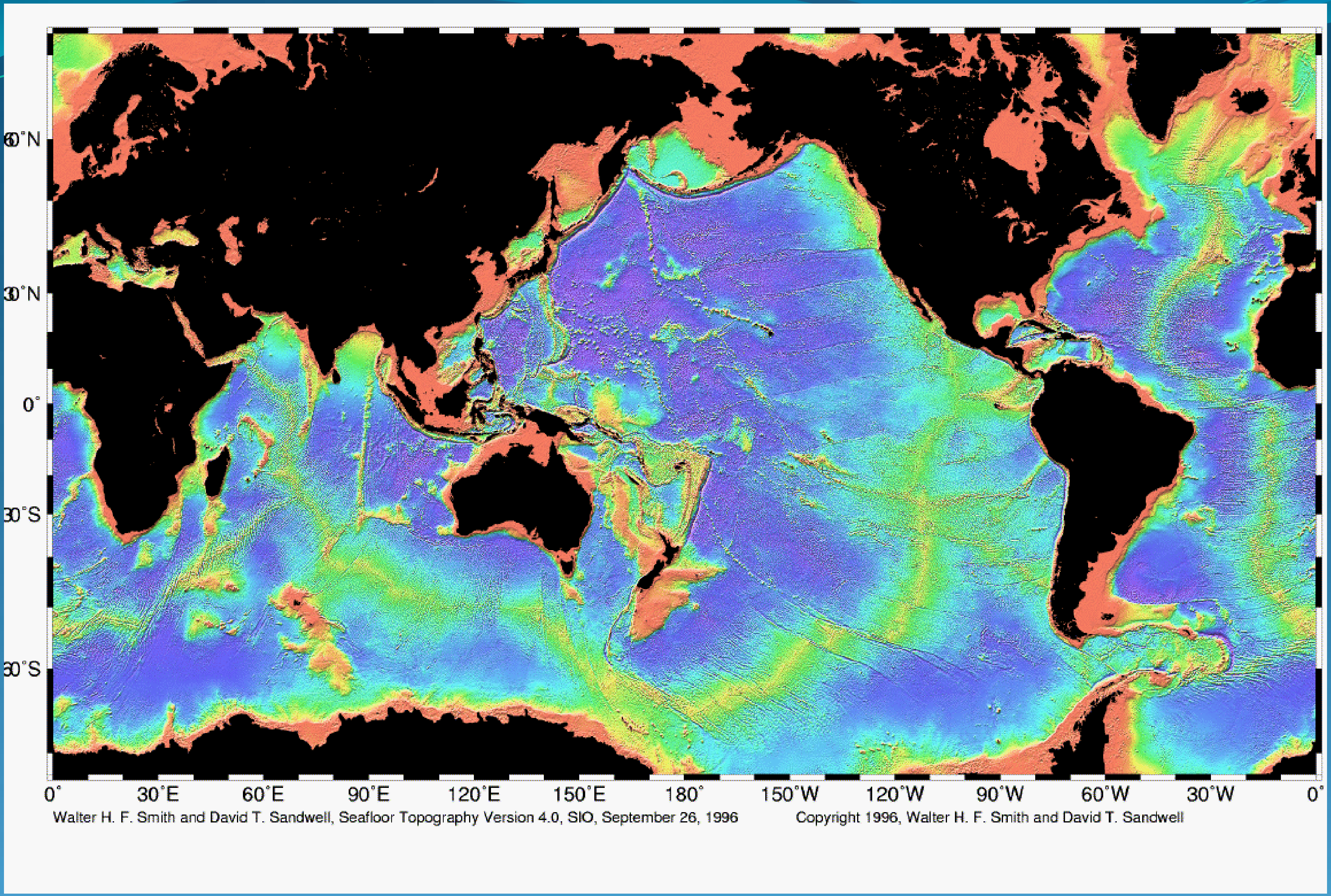



50 years later - The continuation of Francis Shepard's/C&GS discovery of Gulf of Mexico salt domes

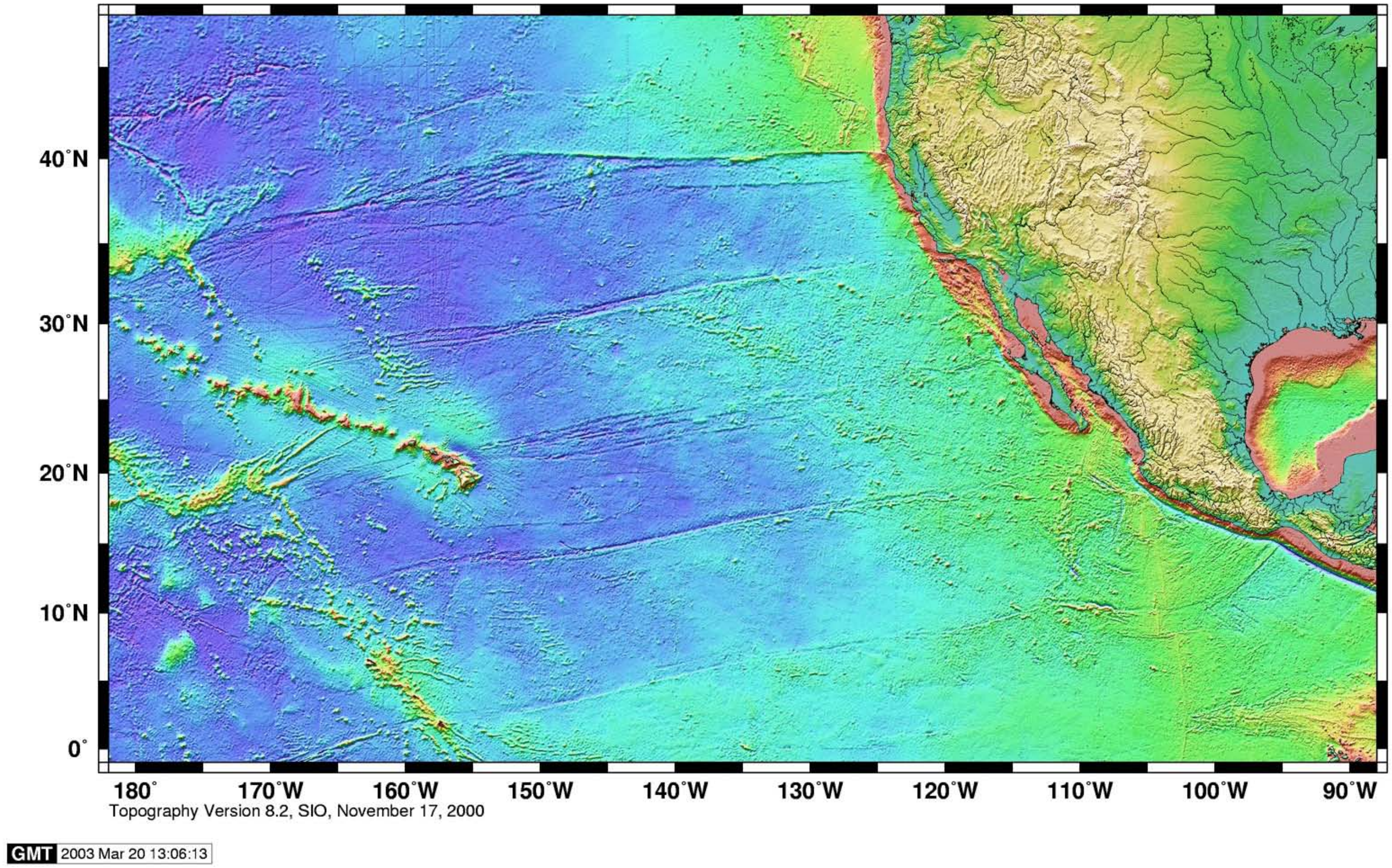
Smith – Lamont Ph.D, pre-Scripps Post-doc years

The Smith-Sandwell Connection – Scripps/NOAA/National Geodetic Survey/Satellite Altimetry Lab

Sandwell – A Coast Surveyor – first post Ph.D work with NOAA/National Geodetic Survey/descendant of old C&GS - President Section of Geodesy of AGU – Bowie Lecturer AGU - Bowie C&GS captain/first president of AGU, chief of geodesy




Smith-Sandwell satellite-derived Seafloor Topography Version 4.0 1996




Satellite-derived bathymetry – Version 8.2 2003


Hopefully there will be no end to the cooperative spirit between NOAA and Scripps that was epitomized by Francis Shepard and the old Coast and Geodetic Survey

# Thank You!