

# ROGER RANDALL DOUGAN REVELLE BIOGRAPHY

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Scripps Institution of Oceanography Archives



Roger Randall Dougan Revelle was born in Seattle, Washington on March 7, 1909. His parents, William Roger Revelle and Ella Robena Dougan Revelle were both graduates of the University of Washington. Ella Revelle taught briefly before her marriage. William Roger Revelle practiced law in partnership with two of his brothers. The family was completed with the birth of a second child, Eleanor, in 1911. The Revelles moved to Pasadena, California in 1917 when Ella Revelle was diagnosed with tuberculosis. William Roger Revelle established a law practice there and taught for twenty years in Pasadena junior high schools. While in school in Pasadena, Roger Revelle was among students tested and identified by psychologist Lewis M. Terman as a gifted student.

Roger Revelle entered Pomona College in Claremont, California in 1925. His initial interest in journalism faded when Professor Alfred Woodford aroused his enthusiasm for geology. Revelle met Ellen Virginia Clark in 1928. She was a member of the first class of the neighboring Scripps College and a grandniece of Scripps College founder and patroness Ellen Browning Scripps. Revelle received his A.B. from Pomona in 1929 and remained at the college for a year of graduate study. Ellen Clark and Roger Revelle were married in Pasadena on June 22, 1931. (1)

Revelle entered the University of California in 1930 as a graduate student in geology under geologist George Davis Louderback. One of Louderback's broad geological interests was sedimentation.

In 1931, John A. Fleming, director of the Department of Terrestrial Magnetism at the Carnegie Institution of Washington, contacted Thomas Wayland Vaughan, director of the Scripps Institution of Oceanography, in La Jolla, California requesting that Scripps examine sediment cores taken on the seventh cruise of the nonmagnetic brig CARNEGIE. In April of that year, Vaughan visited Professor Louderback in Berkeley and requested that he recommend one of his graduate students for this work. Louderback recommended Revelle, and both Louderback and Vaughan urged Revelle to register as a graduate student at Scripps, which is part of the University of California.

Revelle did so and received an appointment as a research assistant in oceanography, with a stipend of \$1200 per year. The Revelles arrived in La Jolla on August 15, 1931 and soon moved into a small resident cottage on the campus of the institution. (2)

The arrival of the Revelles in La Jolla was something of a homecoming. Ellen Clark Revelle had been born in La Jolla and her parents maintained a summer home in the village. Her great-aunt Ellen Browning Scripps was a generous patron of La Jolla civic and cultural institutions, including the Scripps Institution of Oceanography, which she had endowed and supported for many years. Revelle speculated that the Scripps family connection may have hindered rather than helped him establish a reputation as a serious scientist during his early years at the Scripps Institution. (3)

In 1931, the Scripps Institution was a small marine station with one main laboratory building, a library, one small research vessel, a staff of twenty-six and an unstable annual budget of approximately \$75,000. It had been established as the Marine Biological Association of San Diego in 1903, and had been a part of the University of California since 1912, when its name was changed to the Scripps Institution for Biological Research. It was renamed the Scripps Institution of Oceanography in 1925 to reflect a broadened research focus.

Oceanography was itself a young science in 1931. Most of the great oceanographic expeditions had hitherto been British, German, and Norwegian, not American. The research center for meteorology and physical oceanography up until that time was Bergen where Vilhelm Bjerknes, his son Jacob, Harald Sverdrup, Carl Gustaf Rossby and other scientists labored at the Geophysical Institute. European nations and their navies supported oceanographic research, but

in America the few young marine stations were supported by individual patrons, the largesse of private foundations and small research grants from industry. The American navy supported little basic oceanographic research. (4)

Scripps Director Thomas Wayland Vaughan reported in July 1932 that Revelle was engaged in describing the samples of marine sediments from the Pacific collected by CARNEGIE and other research vessels. Revelle's assignment was to assemble and correlate all the data on these samples and study and analyze the components of the sediments. However, Revelle rapidly became interested in an investigation of calcium carbonate sediments initiated by Vaughan and chemist Haldane Gee and in studies of carbon dioxide and the buffer mechanism in sea water. Revelle conducted research and published papers on this subject with Erik Moberg, David M. Greenberg, Richard H. Fleming and Esther Allen. Revelle and his coauthors found that only half of the carbon dioxide released by fossil fuel and other anthropogenic activities went into the ocean, not ninety eight percent as had previously been thought. (5) Revelle later cited this work as the beginning of his interest in the carbon cycle which eventually led him to an interest in measuring atmospheric carbon dioxide.



Norris Rakestraw, Richard H. Fleming, Kurt Karl Wilhelm Buch, Roger Revelle, Eric Moberg in front of Scripps Aquarium, 15 May 1935

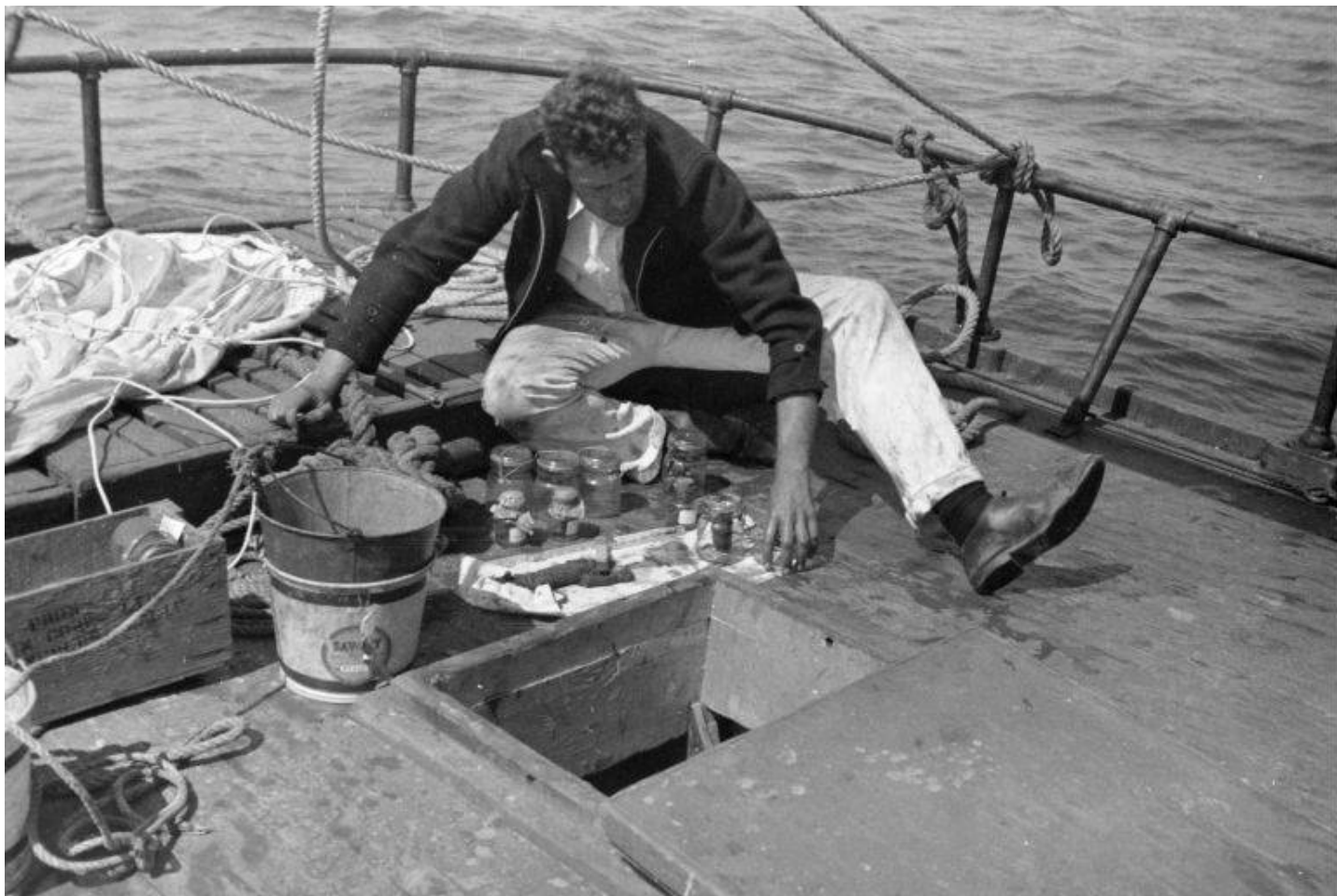
Revelle participated in a number of expeditions and coastal collecting trips in the 1930s on SCRIPPS, the small research vessel of the Scripps Institution of Oceanography, and as a guest on ships of the U.S. Coast and Geodetic Survey and the U.S. Navy. He loved and valued his work at sea and later remarked,

“I have had many jobs in my life, but I think my proudest moment was when I obtained a small boat operator's license and became part-time captain of SCRIPPS.” (6)

Revelle decided to become an oceanographer after his first cruise on SCRIPPS. (7)



Roger Revelle collecting sample from E.W. SCRIPPS, 1936



Roger Revelle on deck of E.W. SCRIPPS with specimens, 1936

During the summer of 1935, Revelle joined USS BUSHNELL, flagship of the navy's submarine force, on a cruise in the Pacific. Revelle supervised the collection, tabulation and preparation of data, and he promised to report on the cruise to the Navy Hydrographic Office. Revelle impressed BUSHNELL Captain Abel T. Bidwell, who urged him to apply for a commission in the Naval Reserve. Revelle wrote,

“My reasons for applying for such a commission were the result of the Bushnell experience; I felt that in any future oceanographic work on board a naval vessel it would be best to be able to give and take orders, rather than being in the anomalous position of a paying guest. This rather slight liaison with the Navy may also be of some future value to Scripps Institution; and in any case is good fun.” (8)

Thomas Wayland Vaughan planned to retire as Scripps director in 1935 and solicited the advice of the distinguished Norwegian oceanographer, Bjorn Helland-Hanson on his successor. Helland-Hanson visited Scripps in 1935 and wrote,

“Amongst the young oceanographers, I have especially noted Mr. Roger Revelle whom I regard as a coming man, but he is probably too young for such a position now.” (9)

Helland-Hansen recommended the renowned Norwegian physical oceanographer and polar explorer Harald Sverdrup for the directorship.

Revelle completed his dissertation, "Marine Bottom Samples Collected in the Pacific Ocean by the CARNEGIE on its Seventh Cruise," and was awarded a doctorate in 1936. He was appointed instructor in oceanography at Scripps just as Harald Sverdrup arrived to assume the directorship. Ironically, just as Sverdrup brought modern physical oceanography to the United States, Revelle and his family embarked for Norway where Revelle had planned a year of study at the Geophysical Institute with Bjorn Helland-Hansen.

On the way to Norway, Revelle stopped in Washington to meet with representatives of the Navy Hydrographic Office to discuss the report of the BUSHNELL cruise. He related his conversation to Harald Sverdrup in a letter which foreshadowed his naval career and his subsequent role as spokesman for federal support of basic oceanographic research:

“I spent considerable time in the Hydrographic Office, going over the status of the Bushnell report with Mr. McManus and discussing the general program of dynamic sounding work of the Navy with him and the officers assigned to the Office. They were particularly interested in the "practical" value of the work to the public in general and the Navy in particular. I found it rather difficult to give many reasons why the work is of direct value to the Navy itself, outside the usual ones[:] the correction of sonic sounding observations...; and the determination of the depths and character of discontinuity layers within subsurface waters, which are important in the super-sonic method of detection of submarines. With regard to the value of the work to the public in general, I mentioned the possible application to long range weather forecasting of a knowledge of change in oceanic circulation; the various ways in which physical and chemical oceanography may aid fisheries and allied industries; and the value of a knowledge of oceanic circulation to geologists in their interpretation and understanding of problems of marine sedimentation, particularly the search for petroleum... They all apparently agreed that one of the chief functions of the Hydrographic Office is to "promote the general welfare" insofar as man's battle with the sea itself,...but they were looking for arguments to use with the Bureau of Navigation in order to secure ships for this type of work.” (10)

Upon his arrival in Europe, Revelle attended a meeting of the International Union of Geodesy and Geophysics in Edinburgh. There he met some of the most prominent oceanographers and geophysicists of the day including Jacob Bjerknes, Columbus Iselin, Joseph Proudman, Carl-Gustaf Rossby, Seymour Sewell, and Georg Wust. These contacts served him well after the war when he became active in international scientific affairs.

During their year in Europe, a trust established by newspaper magnate James Scripps, Ellen Revelle's grandfather, was dissolved and the Revelles received a bequest which made them

financially independent. Revelle received a commission in the U.S. Naval Reserve, and the Revelles observed the growth of fascism in Europe. Revelle studied oceanography with Helland-Hansen in Bergen, and they became friends with Jacob Bjerknes. Revelle also gained additional sea experience on cruises of the M/S ARMAUER HANSEN.

The Revelles returned to California in September 1937. Revelle taught Marine Geology at Scripps in 1937/8 and Introduction to Physical Oceanography at UCLA in 1939/40. In February 1938, Revelle received a grant for \$1200 from the Geological Society of America to study sediments from the floor of the Pacific. Sverdrup recommended him for promotion,

“Dr. Revelle has shown great ability as an independent worker. He has an unusually clear mind and ability of applying knowledge from other fields to the specific problems which he studies.” (11)

Revelle first met his lifelong friend Walter Munk, then Sverdrup's graduate student, at Scripps during the summer of 1939. He also gained sea experience. In the spring of 1939 and again in 1940, Revelle participated in expeditions to the Gulf of California on R/V E.W. SCRIPPS.

In February 1941 Revelle was called for training duty as a sonar officer on USS RATHBURNE. On July 10, 1941, he reported for active duty in the navy and was assigned to the U.S. Navy Radio and Sound Laboratory in San Diego. From this date until October 1942, Revelle participated in research on radar propagation and sonar performance. He also served as a project officer for the University of California Division of War Research (UCDWR) in San Diego. In October 1942, Revelle was reassigned to the Navy Hydrographic Office in Washington.

Revelle was at the Hydrographic Office for two months, conducting research on the deep scattering layer. In December 1942, he was appointed Officer-In-Charge, Subsection on Water Studies, Sonar Design Section, Bureau of Ships. Commodore J.B. Dow later commended Revelle for his work:

“The intelligent and forceful direction of your work since January 1943 constituted a valuable contribution to the success of the electronic program in the war. As Special Assistant on sonar analysis and oceanographic investigations with the Sonar Design Section, yours was an important role in the Division's job of providing, installing and maintaining the best possible designs of radio, radar, sonar and other electronics equipment aboard ships and at shore activities [sic] during the combat. From my own point of view and that of the Division, the discharge of your responsibilities met the highest standards of performance.” (12)

Revelle received an official commendation for this work from Secretary of the Navy James Forrestal after the war. Revelle's contributions were also recognized with promotions. In 1942 he received a temporary presidential appointment to the rank of Lieutenant commander, and two years later he was appointed a commander. Revelle's reputation and influence in the navy grew during the war and enabled him to substantially influence the navy research program in

oceanography. (13) He served as the principal liaison officer between the navy and those divisions of the National Defense Research Committee (NDRC) which dealt with oceanography, including Woods Hole Oceanographic Institution, the U.S. Navy Underwater Sound Laboratory in New London, the University of California Division of War Research in San Diego, and the Harvard University Underwater Sound Group. Revelle's principal NDRC colleague was Lyman Spitzer, Jr., later a world leader in astronomy and nuclear fusion research. Rear Admiral T.A. Solberg commented on Revelle's service in the Bureau of Ships and his influence in the navy:

[In 1944, Revelle's] "...duties in the Bureau of Ships were enlarged to include the technical planning and guidance of all oceanographic and related research under the cognizance of the Bureau. These involved research on ocean waves and surf, the effects of surf and beach conditions on the performance of landing craft, the use of smoke at sea for deception purposes, the effects of wind and currents on life rafts and the effects of subsurface density gradients and other oceanographic factors on submarine operations. All of these projects yielded important results which were brought to practical use during the later part of the war. For example, the Bureau of Ships research on life rafts formed the basis of search procedures for air sea rescue throughout the Pacific Theater. The research on waves and surf led to the development of surf forecasting methods for amphibious operations and to means for estimating the percentage of casualties to landing craft under different surf conditions...[Revelle] was to a considerable degree responsible for the formulation of the research projects; for stimulating scientists to undertake the work; for guiding their work towards problems of Naval importance; and for translating the results obtained into Naval terms. It is no exaggeration to say that the large role which oceanography now occupies in the Navy research program is in part due to Dr. Revelle's effectiveness and foresight in planning and promoting the Bureau of Ships research during the war." (14)

In May 1945, Revelle traveled to the Pacific where he served on Admiral Raymond Spruance's staff. He was then assigned to the staff of the Commander, Amphibious Forces, Pacific Fleet, and worked on operations Olympic and Coronet, the planned invasion of Japan. He returned to Washington when the war ended and on January 30, 1946, he was assigned to Joint Task Force One, the joint military command which was to supervise the first postwar atomic test on Bikini Atoll, Operation Crossroads. Revelle led the oceanographic and geophysical components of the operation. His assignment was to study the diffusion of radioactive wastes and the environmental effects of the bomb at Bikini. John Isaacs later wrote,

"The Crossroads Scientific Program was Revelle's idea and he organized it singlehanded. Basic scientific understanding of many of the effects of atomic weapons still rests on this one, truly scientific operation." (15)

Revelle's Crossroads team included many old acquaintances from Berkeley, La Jolla, Woods Hole, and the Navy Radio and Sound Laboratory: Kenneth Emery, Gifford Ewing, William



Ford, John Isaacs, Martin Johnson, Eugene LaFond, Walter Munk, Marston Sargent, William von Arx, Allyn Vine.



Roger Revelle and Jeff Holter, Operation Crossroads, 1946

Revelle organized a second team which resurveyed Bikini in 1947. During the survey, cores were drilled from the atoll to a depth of 800 meters:

“The sediments at the bottom were about 30 million years old and all of the

samples above the bottom were reef limestone that had been laid down in shallow water. This proved Darwin's conjecture correct - that atolls are sunken volcanic islands on which enormous layers of skeletons of reef-building organisms accumulated during the sinking process.” (16)

In addition to this proof, the resurvey team found evidence for intermittent submergence of the central Pacific floor throughout the last epic of geologic time. This changed scientists' image of the sea floor.

The Crossroads experience was a very important one for Revelle. He remarked many years later that he learned a great deal about the relationship between science and policy in the course of his work at Bikini. (17)

The wartime navy research program was so successful that an expanded postwar research program was established. Revelle was one of a small group of officers who formulated the navy's postwar policy with regard to oceanographic research. He planned and initiated the organization of the Oceanographic Section of the Navy Hydrographic Office (18) and participated in the planning for the Office of Naval Research. (19)

While still on Operation Crossroads, Revelle was transferred to the Office of Naval Research in August 1946 and appointed head of its Geophysics Branch. His assignment was to

“administer, coordinate, and direct research in the field of geophysics; principally oceanography, meteorology, and geology; as applied to scientific warfare. ...He will evaluate reports as received from research institutions and contractors and will advise cognizant Bureaus and Offices of the Navy Department of their possible application in the naval organization.” (20)

Throughout the war, Scripps Director Harald Sverdrup and Revelle worked closely together to develop and interpret oceanographic research. Sverdrup was very much impressed with the success of Revelle's efforts to persuade and encourage the navy to support both basic and applied oceanographic research. Revelle considered Sverdrup the greatest oceanographer of the century. (21) Both men viewed the postwar period as one of great potential growth for geophysics and oceanography and anticipated increased research support from government. The potential was quickly realized. In 1946, the Office of Naval Research signed contracts with Scripps assuring the institution of its interest and pledging funds to support basic research. The government also made two former naval vessels, rechristened HORIZON and CREST, and a former fishing vessel, PAOLINA T, available for the long term use of the institution. Sverdrup and Revelle pressed the University of California and the U.S. Navy to conclude an agreement to support postwar oceanographic research which led to the organization of the Marine Physical Laboratory, later a part of the Scripps Institution of Oceanography.

Funding from the state of California was also provided to support oceanographic research. In 1947, a precipitous decline in sardine yields led the California Legislature to appropriate

\$300,000 to establish the Marine Life Research Program at Scripps, part of an enormous coordinated oceanographic and fisheries research program which became known as CalCOFI (California Cooperative Oceanic Fisheries Investigations). CalCOFI enlarged and profoundly changed fisheries research and reunited marine biologists with physicists, chemists and meteorologists to study the ocean environment as a whole. (22) Revelle's subsequent emphasis on the managed use of earth's resources owes much to the CalCOFI studies.

On January 30, 1947, Harald Sverdrup announced that he planned to resign as director of the Scripps Institution and return to Norway. He favored the appointment of Roger Revelle as his successor, and his conviction was well known to the faculty. A number of senior members of the faculty, including professors Francis Shepard, Carl Hubbs and Claude ZoBell, opposed Revelle. They wrote directly to University of California President Robert Gordon Sproul on June 15, 1947, opposing Revelle's candidacy and recommending other candidates. (23)

Sverdrup favored Revelle for a number of reasons, including Revelle's extensive experience at sea. (24) Sverdrup was anxious to take Scripps out of the laboratories and into the oceans. Both Revelle and Sverdrup agreed that Scripps and the Marine Life Research Program should be directed by a physical oceanographer, rather than by a biologist, as urged by Carl Hubbs. (25) A search committee was appointed to find a new director in 1947.

In January 1948, Sverdrup and Revelle had several serious discussions about Revelle's future at Scripps. Revelle expressed a desire to return to Scripps, concluding that,

“...in the long run I would be happier if I had more to do with the actual conduct of scientific research rather than with its over-all planning and coordination at the rather remote level of Washington.” (26)

He became Associate Director of the Scripps Institution and professor of oceanography in 1948 and succeeded Carl Eckart as Director in 1950.

Revelle's appointment as Director of the Scripps Institution of Oceanography came in the midst of a university crisis. On February 24, 1950, the Regents of the University of California passed an ultimatum ordering the dismissal of faculty members who refused to sign a special loyalty oath, which disavowed membership in the Communist Party. The Academic Senate passed resolutions condemning the action of the Regents as a violation of faculty privilege and tenure. Revelle opposed the original form of the oath and lobbied within the university and the greater academic world for support of the faculty position. This was one of many occasions when Dr. and Mrs. Revelle drew the attention of the San Diego community and their acquaintances in scholarly, military and political circles to academic issues of great importance. Ultimately, the Regents and faculty of the University of California reached a compromise. Revelle wrote,

“I believe the solution...is basically a very good one, and is certainly the best that could have been hoped for in these hysterical times. While it is disappointing to many faculty members, who believe that men should be judged by their acts and

not their beliefs and that political tests should not be a qualification for membership on a Faculty, this solution nevertheless re-establishes the principle of tenure, without which a true university cannot exist.” (27)

Privately, Revelle was not entirely satisfied with the compromise and was particularly critical of the role of Regent John Francis Neylan in the crisis.(28) Revelle felt that the governance of the university should be changed to allow the faculty and regents to jointly establish and carry out academic policies.

Revelle undertook some of his most creative work in science during the 1950s. (29) He expanded the Scripps Institution to include new laboratories, research institutes, shops and programs. Under his leadership, SIO received significant grant support from several government agencies and attracted the interest of foundations. Revelle convinced Warren Weaver that Rockefeller Foundation should provide a million dollars in grant support to expand and strengthen marine biology at the institution. Revelle even planned a subdivision, Scripps Estates Associates, to make affordable housing available to faculty in La Jolla, and along the way he convinced local real estate agents and members of the community to break the anti-Semitic and racially biased "gentlemen's agreement" that had hitherto prevented some families from living in the town. (30) He eventually came to the conclusion that Scripps could only reach its full potential by growing in close proximity to a graduate school with programs in basic science and began working to establish a graduate school of science and engineering in La Jolla.

Revelle considered the 1950s as a great new age of exploration and often remarked that it was difficult to go to sea during the decade without making a discovery, because there was still so much to learn. He worked strenuously to fulfill his ambition of taking Scripps to sea. In 1950, Revelle served as expedition leader of the University of California-Navy Electronics Laboratory Mid-Pacific Expedition (MIDPAC), which explored the central Pacific. The expedition resulted in the discovery of the submerged Mid-Pacific Mountain Range. As director, Revelle fostered other large scale oceanographic expeditions including NORTHERN HOLIDAY (1951), SHELLBACK (1952), CAPRICORN (1952), TRANSPAC (1953), NORPAC (1955), DOWNWIND (1957), and NAGA Expedition (1959). (31) These expeditions resulted in a number of important discoveries including the extreme thinness of deep sea sediments, the high upward heat flow through the sea bottom, the young age (about 60 million years) of sea mounts, and the existence of enormous fault zones, now called transform faults. These discoveries brought then prevalent conceptions of earth history and seafloor structure into question.



Milton Bramlette and Roger Revelle with core sample, Capricorn Expedition 1952

Revelle examined heat flow with his graduate student, Arthur Maxwell and with Sir Edward Bullard. Revelle and Maxwell measured the heat flow through the sea floor and found it to be about equal to measurements of heat flow on land. This contradicted the common conception that heat flow beneath the ocean should be much lower than heat flow from the continents. Revelle and Maxwell concluded that the heat must come from the decay of small amounts of radioactive materials throughout a thick column of rock and that heat must be carried outward by a slow convective churning of the rocks of the earth's mantle (32).

These findings about the character of the ocean floor did not fit easily into the fundamental geological theory of the time. (33) Revelle encouraged Victor Vacquier's magnetic surveys and studies of transform faults and provided opportunities for other scientists including Arthur Maxwell, Sir Edward Bullard, Robert Dietz, Ronald Mason, and Russell Raitt to undertake fundamental geophysical research at sea. Heat flow, magnetic observations and other data served as the empirical basis for the conception of sea floor spreading and plate tectonic theory. At the end of the decade, Revelle had a very different understanding of earth science than what he had learned as a student:

“The fundamental doctrine of American geology in the late 1940's was that the continents and ocean basins had been permanent features of the earth's surface,

almost since the beginning of geologic time. The crust of the earth beneath the sea was unimaginably old, and the continents had always been about where they are today, though they had probably grown in size over several billion years. ...These doctrines received an abrupt shock in 1950 when shallow-water reef corals only about a hundred million years old were found on the flat-topped sea mounts of the Mid-Pacific Mountains at a depth of two kilometers, and when Russell Raitt's seismic refraction studies indicated that the deep sea sediments over vast areas are only one or two hundred meters thick. ... Now fifteen years later, we know that none of these doctrines even faintly resemble the truth." (34)

During the postwar period, Revelle became active in national and international organizations, professional associations and advisory committees concerned with geophysics, oceanography and basic scientific research. His activities in this sphere are almost too numerous to cover in a brief biography. In 1948, Revelle became a member of the National Research Council's Pacific Science Board. The following year, he joined the NRC Committee on UNESCO and its Committee on Amphibious Operations. From 1948 to 1951, he served on the Department of the Interior Arctic Research Advisory Board. From 1949-1951, he served as a member of the second National Academy of Sciences Committee on Oceanography. He became a member of the Joint Chiefs of Staff Joint Commission on Oceanography in 1951. In 1957, Revelle organized the Special Committee on Oceanic Research (now the Scientific Committee on Oceanic Research, SCOR) of the International Council of Scientific Unions and became its first president. In 1950, Revelle became vice president and later president of the Oceanography Section of the American Geophysical Union. He assumed the chairmanship of the Department of Defense Research and Development Board on Oceanography the following year. In 1955 Revelle became a "founder" of the American Miscellaneous Society (AMSOC) and through the society participated in planning and test drilling operations for Project Mohole. (35) He was elected to the National Academy of Sciences in 1957. He served as a member of the Academy's delegation to all International Council of Scientific Unions general assemblies from 1958 to 1984. In 1958 he was selected as a member of the United States National Commission for UNESCO. He was later elected Vice Chairman of the Commission and Chairman of its Committee on Natural and Social Sciences. Revelle also helped UNESCO plan its Office of Oceanography.

UNESCO formed its International Advisory Committee on Marine Sciences in 1955. The committee consisted of representatives of nine nations; Revelle represented the United States. UNESCO became increasingly interested in marine sciences in subsequent years. UNESCO convened a meeting in Paris of four oceanographers, George Deacon, Vladimir Kort, John Lyman and Roger Revelle. They were asked to plan a conference to be held in Copenhagen during the summer. The conference created UNESCO's Intergovernmental Oceanographic Commission, modeled in part on the World Meteorological Organization. Revelle attended the meeting as one of the U.S. Representatives and later chaired the U.S. Delegation to the Commission in 1962. He was a member of the U.S. Delegation to the General Conference of UNESCO in 1960. Revelle worked very closely with and through UNESCO beginning in 1955 on projects, conferences, and discussions concerning oceanography, economic development,

population, food resources, and technology transfer.

In 1956 Revelle became chairman of the Panel on Oceanography of the U.S. National Committee on the International Geophysical Year, the culmination of several years of dedicated work to promote the IGY. During the planning phase for the IGY, Scripps was designated as a participant in the Atmospheric Carbon Dioxide Program. Charles David Keeling joined the Scripps staff in July 1956 to head the program, and began measurements of atmospheric carbon dioxide at Mauna Loa and in Antarctica. Scripps became the principal center for the program. Initially, Revelle's interest in the program was general. He planned to investigate the general carbon cycle and the solubility of calcium carbonate. (36) His interest in the subject grew, however.

In 1957 Revelle and Hans Suess demonstrated that carbon dioxide had increased in the air as a result of the use of fossil fuels in a famous article published in *Tellus*. (37) They and other researchers suggested that the "greenhouse effect" would have a profound effect on the climate. Revelle's interest in atmospheric carbon dioxide was to engage his attention for the rest of his life. He brought the subject to the attention of the public as a member of the President's Science Advisory Committee Panel on Environmental Pollution in 1965. The committee under Revelle's leadership published the first authoritative U.S. government report in which carbon dioxide from fossil fuels was officially recognized as a potential global problem. (38) Revelle chaired the NAS Energy and Climate Panel in 1977 which found that about forty percent of the anthropogenic carbon dioxide has remained in the atmosphere, two-thirds of that from fossil fuel, and one-third from the clearing of forests. (39)

Revelle influenced public opinion on the issue through a widely read article in *Scientific American*. (40) His research addressed issues such as the rise in global sea level and the relative role played by the melting of glaciers and ice sheets versus the thermal expansion of the warming surface waters, and his international scientific contacts did a great deal to disseminate research findings and to foster discussion about the data, environmental and social effects of increased atmospheric CO<sub>2</sub>, and governmental policy and action. (41) Revelle considered this work very important. He once estimated that he spent twenty percent of his time keeping current with the issue. When he received the National Medal of Science in 1990 Revelle told a reporter, "I got it for being the grandfather of the greenhouse effect." (42)

Revelle enjoyed an international reputation as an oceanographer in the 1950's, but became better known to the greater scientific community and to the public through his work for the National Academy of Sciences as a science spokesman with broad knowledge of the environment. Building on the Crossroads resurvey, Revelle continued to contribute to the understanding of the environmental effects of radiation as chairman of the Oceanography and Fisheries Panel of the NAS Biological Effects of Atomic Radiation (BEAR) Committee. Along with other issues, Revelle's panel considered the question of disposal of atomic wastes in the sea. Revelle contributed substantially to the influential final BEAR Report, *The Biological Effects of Atomic Radiation: A Report to the Public*, released in 1956.

Revelle was a founding member of the third National Academy of Sciences Committee on Oceanography (NASCO). This committee had a profound influence on the direction of oceanographic research and the allocation of national resources to support such research. Richard Vetter has noted that during the first four years the committee met, the government budget for oceanography jumped from \$12 to \$97 million. (43) NASCO met on a bi-monthly basis beginning in November 1957. It issued reports of its panels and working groups over the next few years and gathered twelve of them in a publication entitled *Oceanography, 1960-1970*, issued in 1959. Revelle personally contributed to four of the twelve chapters, including reports on artificial radioactivity in the marine environment and international cooperation. The NASCO reports presented national goals for oceanography which were eventually integrated into a national oceanographic program endorsed by President Kennedy and commended by Congress.

A number of bills concerning oceanography and marine resources were introduced into Congress during the late 1950's and early 1960's, partly in response to the NASCO report, but also part of the great public and congressional reaction to Sputnik. In 1958, Revelle was chosen a member of a nine-man group which advised the Congressional Subcommittee on Military Applications of Atomic Energy. Two House Committees and one Senate committee were interested in the NASCO report and in support for basic oceanographic research: the House Subcommittee on Oceanography of the Committee on Merchant Marine and Fisheries, the House Committee on Science and Astronautics and the Senate Committee on Interstate and Foreign Commerce. Revelle was named to a twelve-man scientific advisory panel to the House Committee on Science and Astronautics in 1959. He quickly became a respected science advisor and spokesman. He influenced a number of legislators including Senator Warren G. Magnuson and Congressman Emilio Q. Daddario. (44)





Roger Revelle and United States Senator Warren G. Magnuson, during Revelle's testimony before the Senate committee on Interstate and Foreign Commerce, 16 March 1961

The House Committee on Science and Astronautics, later renamed the Committee on Science and Technology, and its advisory Panel on Science and Technology had a profound influence on the way legislators viewed science and the way scientists viewed legislators. Panel members were scientists of impeccable reputation. In addition to Revelle, the group included Lee DuBridge, Harrison Brown, Athelstan Spilhaus, and Thomas F. Malone. The panel held formal sessions and invited the testimony of a large and distinguished group of scientists from 1959 when the panel was created until 1972 when it was disbanded. Ken Hechler has commented that:

“The panel sessions helped to identify spheres of scientific and technological research which offered exceptional promise for the welfare and security of the Nation, and which needed legislative attention. The committee was exposed to updated methods of conducting research, and the assembling and analysis of data...Through the panel meetings [the committee] received updates on issues such as the availability of scientific manpower and educational and training needs;

international cooperation and organizations concerned with science and technology; and a general appraisal and assessment of the priorities being followed in the committee's work.” (45)

Revelle, Harrison Brown and Philip Handler formed a steering committee to organize a panel meeting entitled "Government, Science and International Policy," held in January 1967. Hechler notes that,

“This steering committee assisted the committee in assembling and assessing information from eleven federal departments and agencies, analyzing their international science programs, the limitations and potentialities of each, the funding, problems, and possibilities.” (46)

Revelle, Brown and Handler formed another steering committee in May 1967, to organize a panel executive session on improving the management of international scientific affairs by federal agencies. Their recommendations were particularly critical of the role of the Department of State. Revelle was selected to advise the Subcommittee on International Cooperation in Science and Space (the Daddario Subcommittee) which was created in 1971.

Revelle had long been interested in encouraging international cooperation in scientific and oceanographic research. In 1950 he wrote to encourage the National Research Council to establish fellowships for students in oceanography,

“The importance and value of international exchange of ideas, data, and scientific personnel and of international research cooperation in oceanography and other earth sciences cannot be over-emphasized. By their very nature the oceans of the world are international.” (47)

In the late 1950s Dael Wolfe, Roger Revelle and other scientists affiliated with the American Association for the Advancement of Science conceived a plan for an international oceanographic meeting. Revelle became a member of the planning committee for the meeting. The chairman of the planning committee was Mary Sears who had worked with Revelle in the navy during the war and had subsequently joined the faculty of the Woods Hole Oceanographic Institution. The planning committee elected Revelle president of the meeting which became the first International Oceanographic Congress. The congress met in 1959 at the United Nations. It was tremendously successful, attracting support of UNESCO, the National Science Foundation, the Office of Naval Research, SCOR and several foundations. Over a thousand registrants from fifty four nations attended the congress and several countries sent research vessels, which were displayed in New York harbor. It is interesting to note that the possibility of an international expedition to explore the Indian Ocean, first introduced in SCOR, was discussed by Revelle with scientists at the congress. Columbus Iselin chaired a congress panel on the Indian Ocean expedition idea. The International Indian Ocean Expedition that resulted from support garnered at the congress was the beginning of Revelle's great and enduring interest in the Indian subcontinent.

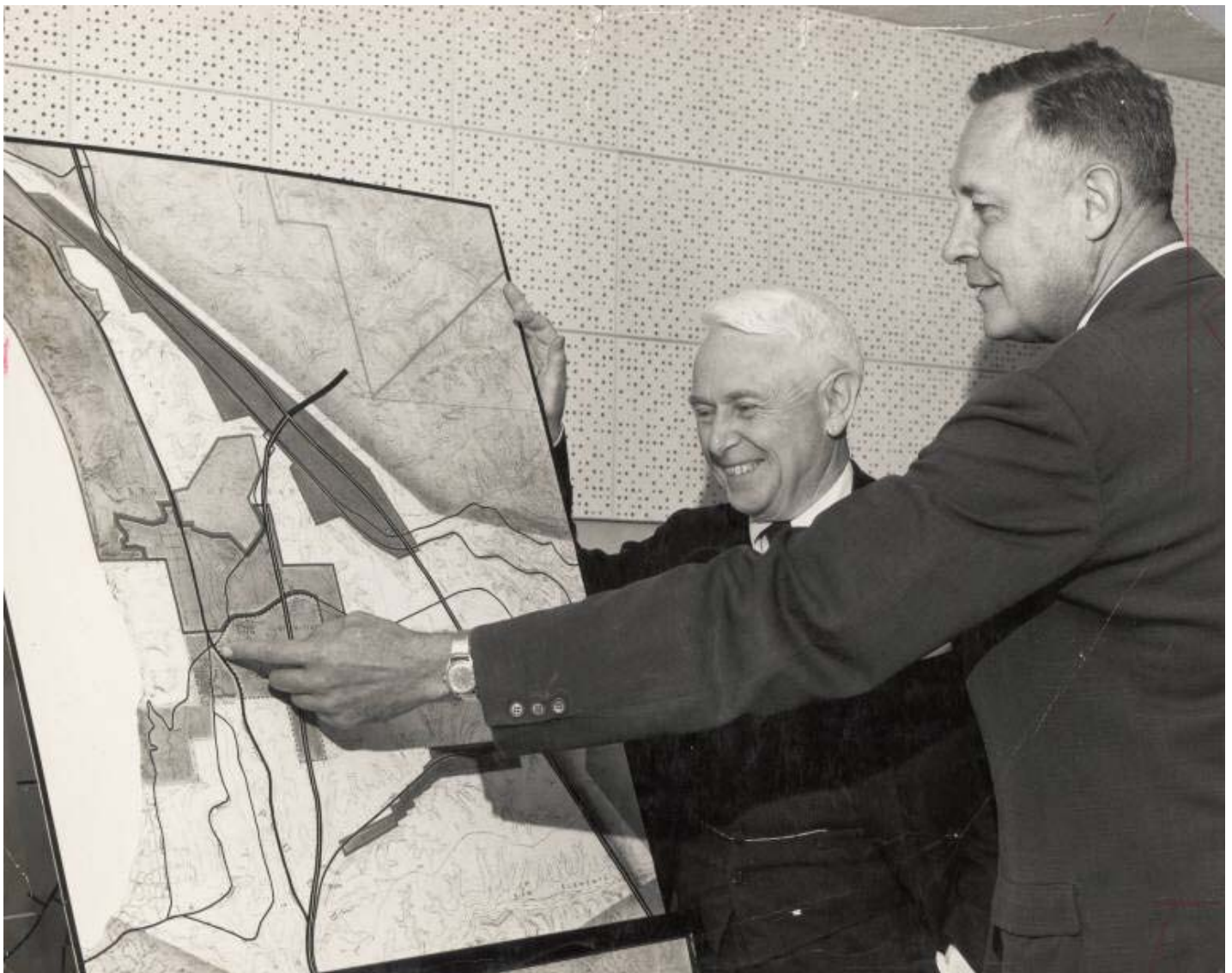
Throughout his life, Revelle considered himself first and foremost a teacher. He taught courses in oceanography and geophysics from 1948 until his departure from Scripps. Revelle influenced the new generation of oceanographers studying at Scripps through his teaching, publications, and expeditions. Several of the young men he knew as students at Scripps later attained distinction and influential positions at other institutions. Robert O. Reid received his master's degree at Scripps in 1948. In addition to his position as a professor of oceanography at Texas A&M, Reid also served as editor of the *Journal of Physical Oceanography*. Harris Bates Stewart, Jr. received his masters and doctorate at Scripps. After serving as chief oceanographer for the U.S. Coast and Geodetic Survey and at the Environmental Sciences Service Administration, Stewart directed the NOAA Atlantic Oceanographic and Meteorological Laboratories and directed the Center for Marine Studies at Old Dominion University. Warren Wooster received his doctorate at Scripps in 1953. He directed the UNESCO Office of Oceanography from 1961-1963, and subsequently directed the Rosenstiel School of Marine and Atmospheric Science at the University of Miami and the Institute of Marine Studies at the University of Washington. Arthur Maxwell received his graduate degrees at Scripps and measured heat flow with Sir Edward Bullard and Revelle. From 1955 to 1965, Maxwell served first as head oceanographer and then directed the Geophysics Branch of the Office of Naval Research. He served as associate director of the Woods Hole Oceanographic Institution and directed the Institute of Geophysics at the University of Texas at Austin. Donald Pritchard received his masters and doctorate at Scripps. He was the first director of the Chesapeake Bay Institute of Johns Hopkins University and served on the National Academy of Sciences Committee on Oceanography. John Knauss received his doctorate at Scripps in 1959. After serving as an oceanographer at Scripps, the Naval Electronics Laboratory and the Office of Naval Research, Knauss became dean of the Graduate School of Oceanography at the University of Rhode Island and chaired the National Advisory Committee on Oceans and Atmosphere from 1981-1985. Revelle also influenced several senior members of the Scripps faculty and staff. Robert L. Fisher, Douglas Inman, Joseph Reid and Gifford Ewing all studied under Revelle at Scripps.

Both as a professor and director of Scripps, Revelle was concerned when several Scripps graduate students did not perform well in answering basic science questions posed during doctoral examinations. Revelle felt that Scripps student academic performance would improve if courses in the basic sciences were offered in La Jolla. At the same time, a demographic study of California predicted a rapid increase in the population of the state. This convinced Revelle that the University of California should consider a proposal to establish a new graduate school of science and engineering at La Jolla.

On February 19, 1954, Revelle attended the President's Administrative Advisory Conference in Berkeley which considered the long range educational policy of the university. University expansion and the creation of new campuses were implicitly discussed. Revelle was asked to prepare a statement of educational policy for La Jolla which considered plans for expansion. He did this in a memorandum which was distributed to Scripps staff on March 11, 1954. (48) This was the beginning of the long, difficult but ultimately successful effort to found the University

of California, San Diego (49). Revelle's time and energies between 1954 and 1961 were focused on the arduous task of creating a new campus of the university. He forged a coalition of proponents including California congressmen and state legislators, university regents, administrators and faculty, San Diego county and city officials, prominent citizens and distinguished scholars. Revelle attracted a stellar faculty for the new campus including Nobelist Harold Urey. University President Clark Kerr later wrote Revelle,

“[I]t was you more than any other person who visualized the development of San Diego as a general campus and it was your leadership that was instrumental in developing plans for the large and distinguished educational facilities that would be required by a growing San Diego...” (50)



UC Regent Donald H. McLaughlin and Roger Revelle examine map of proposed UCSD campus, 1959

Revelle was named Director of the Institute of Technology and Engineering of the new university on August 15, 1958. He became Dean of the School of Science and Engineering and chief administrative officer of UCSD on July 1, 1960. It was generally assumed that he would be named first chancellor of UCSD. The community was therefore shocked when the regents

announced that they had selected Herbert York for the position. Revelle informed the Scripps faculty of the regents' decision on February 15, 1961, and flew to Washington to assure Dr. York of his support. (51) Ellen Revelle later recalled her husband's disappointment when he received the news. "It was a terrible blow, naturally..." she said, the university "was his baby and it was sad not to be chancellor of it." (52) UCSD's first college was named Revelle College in Roger Revelle's honor in 1965. Looking back on his career late in his life, Revelle often commented that starting UCSD was the most important thing he ever did. (53)

Revelle was offered the position of chancellor of the Washington University in St. Louis and spent the summer of 1961 considering the matter. He had some reservations about the position, and Ellen Revelle influenced his decision not to take the position. Washington University wanted a quick decision, and Ellen Revelle felt that he should not make such a major decision so soon after his disappointment at UCSD. (54)



Ellen Clark Revelle and Roger Revelle, 1961

Revelle was granted a leave of absence in September 1961 and became the first science advisor to the Secretary of the Interior. (55) He became a member of the Federal Council for Science and Technology and chairman of its Committees on Natural Resources, Water Resources Research, and Use of Nuclear Power for Sea Water Conversion. During this period, Revelle was also appointed by the Secretary of State as chairman of a special U.S.-Japan Panel on Scientific Studies of the Pacific Basin. His greatest assignment as science advisor was his presidential appointment as chairman of a distinguished twenty-man White House-Interior Panel on Waterlogging and Salinity in West Pakistan. Revelle embraced this assignment. Congressman Daddario later commented that Revelle

“...loves that part of the world..., and he was most convincing, during that time,

about the need to show the American flag in the Indian Ocean area- "not in a military way," he would say, but by helping them to develop a simple science in an internationally cooperative way that would be of practical benefit to those teeming populations." (56)

President John Kennedy created the panel at the request of Pakistani President Mohammed Ayub Khan who was concerned about conditions in the great basin of the Punjab and Indus rivers. Agricultural yields from this fertile area were diminishing as a result of a rise in the water table and soil salinity due to irrigation canal leaks. Agricultural production was inadequate for the needs of the rural population and would not meet the nutritional needs of the projected population of Pakistan. Harold Thomas described the work of the Panel:

“The Panel proposed that a network of large tube wells be drilled. The water pumped out of the wells would be used for irrigation, at the same time lowering the water table, and the percolation back into the ground would wash the salt below the root zones. Saline soil water would then be removed by a system of drains. It was necessary to introduce fertilizers, new varieties of cereals, pest controls, and better farm management if the potential of the land was to be realized. Revelle and his colleagues estimated that, if these were done, agricultural production could be increased fourfold within a generation.” (57)

Revelle worked closely with presidential science advisory Jerome Wiesner and the President's Science Advisory Committee on this project. The report of the panel was accepted and its recommendations were followed by the Government of Pakistan. In consequence, agricultural production in the region increased about seven percent per year for the next decade. Revelle was decorated with the order of Sitara-i-Imtiaz by the President of Pakistan for "conspicuously distinguished work in science" for this project.

While still in Washington, Revelle was appointed as the first chairman of the U.S. National Committee for the International Biological Program and overcame some White House opposition which initially threatened the program. (58) His work as science advisor carried him increasingly to international forums. He was chairman of the U.S. Delegation to the Intergovernmental Oceanographic Commission in 1962. He served as a member of the U.S. delegation to the Pugwash meeting that same year. In 1963, Revelle served as one of the U.S. representatives at the Vienna meeting of the General Assembly of the ICSU. During the same year, he served as a U.S. delegate to the United Nations Conference on Science and Technology for Developing Countries. Revelle was one of four international advisors at a conference in Beirut on organizing national scientific efforts in the countries of North Africa and the Middle East. Revelle served as a member of the International Science Panel of the President's Science Advisory Committee, of the Naval Research Advisory Committee, and Research Advisory Committee of the Agency for International Development, as well as the Advisory Board to the Foreign Secretary of the National Academy of Sciences.

Revelle had a great influence on the Department of Interior in ways both large and small.

Interior Secretary Stewart L. Udall later recalled that Revelle was at Interior at a crucial time. The environmental movement began with Rachel Carson's controversial book, *Silent Spring*. Udall and Revelle discussed the book, and Stewart recalled Revelle's advice,

"'Well the evidence isn't all in, Stewart, but... she fits your department, you ought to back her.' We did back her and President Kennedy backed her, and that gave her message a resonance.." (59).

Walter Munk has noted that as the environmental movement developed, Roger Revelle advocated the sensible use of the environment for the benefit of human beings, but did not ally himself with conservationist and environmental societies. (60)

As Revelle prepared to leave his post as science advisor after twenty months of service, Interior Secretary Stewart L. Udall wrote him.

"You undertook a most difficult task with no patterns or guidelines before you, and to me it is remarkable that in less than two years you have upgraded Interior's standing in the Washington scientific community to a point where the research of this Department is now respected in every quarter. " (61)

Revelle returned to the Scripps Institution of Oceanography in July 1963. In addition to his work as director, he was appointed University Dean of Research for the entire University of California and maintained an office at University Hall in Berkeley. He left the university in September 1964 to become Richard Saltonstall Professor of Population Policy and first Director of the Center for Population Studies at Harvard.

Revelle's approach to his position at Harvard's Center was unique:

"Most of the other, similar institutions created by American universities concentrated on ways and means of lowering the high birthrates then prevailing throughout the world. The Harvard Center emphasized a different view, attempting to gain understanding of the consequences of population change on human lives and societies, and of the biological, cultural, and economic forces that influence human fertility." (62)

Harvard noted that Revelle's

"...primary interest has been in the use of science and technology to assist the less developed countries with particular emphasis on the study of the interactions among rapidly growing populations, their resources, and their environment." (63)

These interests are reflected in Revelle's publications during the 1960's and 1970's which investigated world food and energy use and resources, nutrition and social factors affecting human fertility and the role of science in developing nations, and pollution. They are also



reflected in his 1965 service on two important panels of the President's Science Advisory Committee, the Panel on World Population and Food Supplies and the Panel on Pollution. The report of the latter, *Restoring the Quality of Our Environment*, was released in 1965.

During his years at Harvard, Revelle traveled frequently and was particularly active as an advisor to the governments of the United States, India and Pakistan on environmental and population questions concerning the Indian subcontinent. He was appointed a member of India's Education Commission from 1964-1965 by India's Parliament and worked to improve higher education in India. Revelle forged contacts with the Ford and Rockefeller foundations, the Agency for International Development, the U.S. State Department and their representatives in India, including Ambassador Chester Bowles. Revelle traveled widely in India, visiting universities and research centers and meeting university administrators and faculty. A number of the Indian scholars he met studied at the Harvard Center. Revelle felt that improvement of higher education in India

“...must be based on an appraisal of the objectives and functions of universities; although research, public service, and the education of teachers, research workers, and professional men and women are all essential, it seems to me that the most important objective of Indian higher education is to foster in the students and through them in society certain habits of thought, certain attitudes, certain intellectual and moral values, that are needed for the development of a modern industrialized society. These include problem-solving ability, self-discipline, a belief in experimentation and empiricism, a willingness to make decisions, and a strong sense of public morality and public responsibility.” (64)

During the 1960's the Center for Population Studies under Revelle's direction undertook a series of studies of land and water development in East Pakistan with the support of the International Bank for Reconstruction and Development, the United Nations Development Program, and the Government of East Pakistan. The resulting studies of the Ganges-Brahmaputra River Basin contributed to an understanding of the problems of that region.

In 1971, Revelle helped organize and participated in a seminar entitled, "Water in Man's Life in India," sponsored jointly by the national academies of science of India and the United States. The seminar was held in New Delhi in September. It considered water quality, supply, floods, erosion, siltation of lakes, waste disposal and water pollution in India. Revelle headed the twelve-member American group which attended the seminar.

While Revelle increased his research, publication, teaching and professional activities in global resources and population during this period, he continued to be actively involved in oceans and atmospheric science, international cooperation, and science policy. In 1973, Revelle became President-elect of the American Association for the Advancement of Science and spoke out on the broad science issues of that period.

Revelle extended his work on the region to Nepal in the late 1970's. In 1977 he urged the

Agency for International Development to support a seminar on small scale hydropower and fertilizer production for the development of Nepal. Revelle chaired the seminar, held in Pokhara in February 1977.

In 1976, Revelle returned to the University of California, San Diego where he received the title of Professor of Science and Public Policy and joined the Department of Political Science at UCSD, working chiefly with the Program in Science, Technology and Public Affairs. For the next two years, the Revelles divided their time between Cambridge and La Jolla, and in 1978 they settled in La Jolla year round.

Revelle taught undergraduate seminars on Technology and the Poor Countries and on Marine Policy, and a lecture course on biological technology during the last decade of his life. He continued to be an active proponent of international scientific cooperation, he served on national and international scientific committees and he spoke and wrote papers up until the time of his death. Revelle served as a member of the NASA Advisory Council from 1985-1988. He served on AAAS committees throughout the decade and traveled to annual meetings until the year of his death. He continued to serve as a member of the NAS delegation to ICSU general assemblies until 1984.

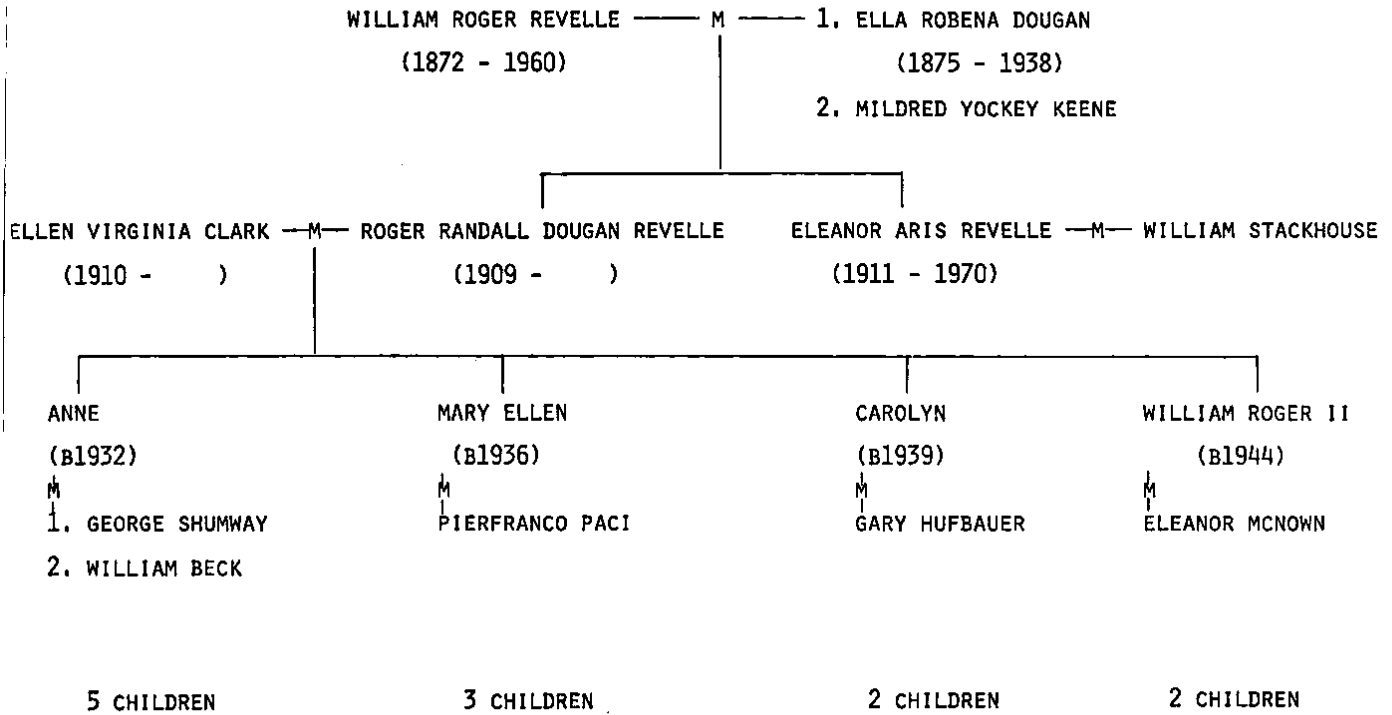
When heart trouble finally restricted his international travel, Revelle increased his national and community service. He served as a member of the 1985 Search Committee for the Director of the Scripps Institution of Oceanography and the committee that successfully proposed a new UCSD Graduate School of International Relations and Pacific Studies. He accepted the invitation of SIO director Edward A. Frieman to return to the Scripps campus, and he moved into an office next to that of the director. He participated in the Woods Hole Oceanographic Institution *Oral History Colloquy: The War Years* in 1991. He spoke out in opposition to a federally-mandated four billion dollar sewage treatment system in San Diego. In his last scientific communication, Revelle wrote a letter to the editor of *Science* defending Walter Munk's ATOC project. (65)

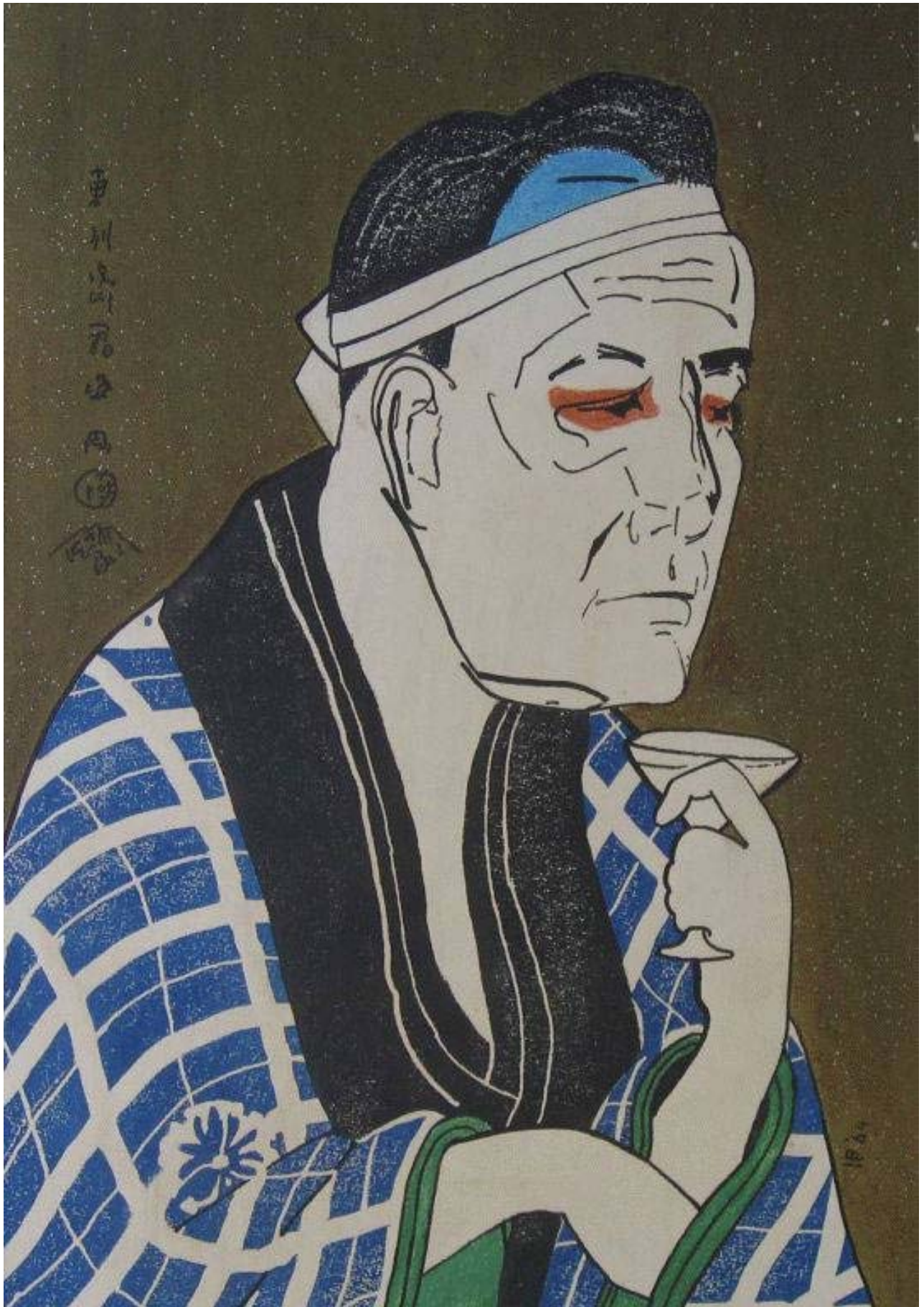
Revelle served as a trustee of the Theatre and Arts Foundation of San Diego County from 1958 to 1985 and served on the Board of La Jolla Playhouse until 1988. He served on the Claremont University Center Board of Fellows through 1987 and served on panels of the Harvard School of Public Health Visiting Committee. The Revelles attended a seminar celebrating the Center for Population Studies at Harvard in October 18, 1990 when its headquarters at 9 Bow Street were renovated and renamed the Roger and Ellen Revelle Building. The family got back into the newspaper business with the purchase of the *San Diego Daily Transcript* in 1986. Revelle received three singular honors during this period. He received the prestigious Tyler Ecology Energy Prize in 1984. He received the 1986 Balzan Foundation Prize which honored his entire scientific career, but especially recognized his research in oceans and atmosphere. He received the National Medal of Science from President Bush in 1990. (66)

Roger Revelle died on July 15, 1991. He was survived by his wife of sixty years, Ellen Clark Revelle, three daughters, a son, twelve grandchildren and three great-grandchildren. In 1995,

the Scripps Institution of Oceanography launched a new research vessel, R/V ROGER REVELLE.

REVELLE FAMILY





Roger Reville as Matsumoto Koshiro playing GROBE THE FISHMONGER. Wood block in the style of Sharaku - Hugh Bradner, 1964

## NOTES:

1. When Roger Revelle read the first draft of this paper in 1985, he justifiably complained that it said too little about Ellen. "I think Ellen Clark Revelle deserves more than passing mention," he wrote on July 5, 1985, "She has been a trustee of Scripps College since 1936...She was a trustee of the LaJolla Art Center (now the La Jolla Museum of Contemporary Art), the Bishop's School, and Citizen's Coordinate for Century Three. She was editor of Oceanids' Journal *Bear Facts* from 1981 through 1984..."
2. Revelle describes the events which led him to La Jolla in an oral history interview conducted by Texas A&M in 1976. The original taped interview is available to researchers at the University Library, Texas A&M University, College Station, Texas. A copy of the transcript of this interview can also be found in the Roger Randall Dougan Revelle Papers (MC6) at the Archives of the Scripps Institution of Oceanography, UCSD, La Jolla, California in Box 1, folder 38. Several letters dated July 3, 1931 describe Revelle and his arrival at Scripps. These can be found among the records of the SIO Office of the Director (Vaughan), (AC11), Box 1, folder "Correspondence Outgoing, July-December 1931" in the SIO Archives.
3. Mary Harrington Hall, "Revelle," *San Diego and Point Magazine* 13, no. 7 (May 1961): 132.
4. George E.R. Deacon and Margaret B. Deacon, "The History of Oceanography," in Richard C. Vetter, editor, *Oceanography: The Last Frontier*. New York: Basic Books, 1973.
5. E.G. Moberg, D.M. Greenberg, Roger Revelle and E.C. Allen, "The Buffer Mechanism of Sea Water," *Scripps Institution of Oceanography Bulletin* 3 (1934): 231-278.
6. Roger Revelle, "The Adolescence of the Elephant, Talk Given at the 75th Anniversary Banquet of the Scripps Institution of Oceanography," Roger Revelle Papers (MC6A), Box 159, folder 16, SIO Archives, UCSD.
7. Roger Revelle, "How I Became an Oceanographer and Other Sea Stories," *Annual Review of Earth and Planetary Science* 15 (1987): 5.
8. Revelle to Harald Sverdrup, October 26, 1936, page 2 in Roger Revelle Papers (MC6), Box 1, folder 54, SIO Archives, UCSD.
9. Bjorn Helland-Hansen, "Scripps Institution of Oceanography," typescript memorandum, November 18, 1935, page 4, SIO Subject Files (81-16), Box 10, folder 47, SIO Archives, UCSD.
10. Revelle to Sverdrup, October 26, 1936, Revelle Papers (MC6), Box 1, folder 54, SIO Archives, UCSD.
11. Sverdrup to University of California President Robert Gordon Sproul, July 12, 1938, in Records of the SIO Office of the Director (Sverdrup), Box 1, SIO Archives, UCSD.
12. Dow to Revelle, February 1, 1946, Revelle Papers (MC6), Box 1, Folder 31, SIO Archives, UCSD.
13. Roger Revelle, "The Age of Innocence and War in Oceanography," *Oceans* 1, no. 3 (1969), p. 10.
14. Solberg to Carl Eckart, March 22, 1948, Records of the SIO Office of the Director (Revelle), Box 1, SIO Archives, UCSD.
15. John Isaacs, "To an Era," *Bear Facts* (October 1964): 1.
16. Harold Thomas, "Roger Revelle: President Elect, 1973," *Science* 179 (February 1988): 818.

17. Interview Roger Revelle, " *Omni* (March 1984): 112.
18. G.S. Bryan, "The Oceanographic Activities of the Hydrographic Office During June 1, 1944 to May 31, 1945," *Transactions, American Geophysical Union* 26, no. 2 (October 1945): 319 and R.O. Grover, "Recent Developments in Oceanography at the United States Navy Hydrographic Office," *Transactions, American Geophysical Union* 27, no. 4 (August 1946): 561.
19. The formation of the Office of Naval Research is recounted in The Bird Dogs, "The Evolution of the Office of Naval Research," *Physics Today* 14 (August 1961): 30. A more general appraisal of naval research during the period can be found in Harvey M. Sapolsky, "Academic Science and the Military: The Years Since the Second World War," in *The Sciences in the American Context: New Perspectives*, edited by Nathan Reingold. Washington, DC: Smithsonian Institution Press, 1979.
20. Hargett, June 28, 1946, Revelle Papers (MC6), Box 1, folder 31, "Navy Service, 1946-1947," SIO Archives, UCSD.
21. Revelle, "How I Became an Oceanographer and Other Sea Stories," *Annual Review of Earth and Planetary Science*, v. 15 (1987): 7.
22. A large body of scholarship on fisheries research has been written in the last decade. See especially Arthur F. McEvoy and Harry N. Scheiber "Scientists, Entrepreneurs, and the Policy Process: A Study of the Post-1945 California Sardine Depletion," *Journal of Economic History* XLIV, no. 2 (June 1984): 393; Scheiber, "California Marine Research and the Founding of Modern Fisheries Oceanography: CalCOFI's Early Years, 1947-1964," in *California Cooperative Oceanic Fisheries Investigations Reports*, 31 (1989): 63; and Scheiber, "Modern U.S. Pacific Oceanography and the Legacy of British and Northern European Science," in *Man and the Maritime Environment*, edited by Stephen Fisher. Exeter: University of Exeter Press, 1994: 36-75.
23. The original memorandum was apparently not retained in Sproul's files. A copy of it can be found in the Denis Llewellyn Fox Papers, Box 2, folder 61, "Sverdrup," SIO Archives, La Jolla, CA. Sverdrup rebuked the authors of the memorandum in an outspoken memorandum dated September 18, 1947, which can be found in the same file. Several files at the SIO Archives document the 1947/1950 search for a new director. The Carl Leavitt Hubbs Papers (MC5), Box 33, folders 44-46, "SIO Director," document the search process. The Records of the UC Office of the President (Sproul) at the Archives of the University of California in Berkeley, Bancroft Library, Berkeley include a folder entitled "Scripps Institute of Oceanography. Part 1. Directorship. 1947-1950."
24. Sverdrup to Revelle, September 25, 1947, Records of the SIO Office of the Director (Sverdrup), 82-56, Box 1, SIO Archives, UCSD.
25. Revelle to O'Brian, November 7, 1947, in Records of the SIO Office of the Director (Revelle), box 1, "Correspondence, April-December 1947.
26. Revelle to Sverdrup, January 6, 1948, Records of the SIO Office of the Director (Revelle), 81-23, Box 1, SIO Archives, UCSD.
27. Revelle to Hepner, April 29, 1950, SIO Subject Files, 81-16, Box 11, folder 32, "Loyalty Oath, April 17-30, 1950," SIO Archives, UCSD. A full account of the controversy is provided in David P. Gardner, *The California Oath Controversy*. Berkeley: University of California Press, 1967.
28. SIO Subject Files, 81-16, Box 11, folder 34, "Loyalty Oath, Notes by Roger Revelle, c1950," SIO Archives, UCSD. See also Revelle to Epling, April 19, 1950, SIO Subject Files, 81-16, Box 11, folder 32, "Loyalty Oath, April 17-30, 1950," SIO Archives, UCSD.

29. Walter Munk has written about Revelle's leadership at Scripps in "The Revelle Years," *Scripps Institution of Oceanography 1991 Annual Report*. La Jolla: SIO/UCSD 1992: 7-12.
30. See Roger Revelle Papers (MC6A) Box 90, folder 27 and Box 91, folder 1 "Scripps Estates Associates," SIO Archives, UCSD and Sanford Lakoff, Walter Munk and S. Jonathan Singer, "Roger R. Revelle," *University of California in Memoriam* (1991): 165 .
31. These expeditions have been described by Elizabeth Shor in "Scripps in the 1950's: A Decade of Bluewater Oceanography," *Journal of San Diego History*, XXIX, no. 4 (1983): 247-261 and in her history, *Scripps Institution of Oceanography: Probing the Oceans 1936 to 1976*. San Diego: Tofua Press, 1978.
32. E.C. Bullard, R. Revelle and A.E. Maxwell, "Heath Flow Through the Deep-Sea Floor," in *Advances in Geophysics*. New York: Academic Press, 1956, volume 3, 153-181.
33. MidPac is discussed in Harold Thomas, "Roger Revelle" President Elect, 1973," *Science* 179 (February 1973): 818 and in an article entitled "Roger Revelle" in *McGraw-Hill Modern Scientists and Engineers* (1980).
34. Roger Revelle, "The Past and Future of Ocean Drilling," 1975, p. 1-2 in Roger Revelle Papers (MC6A), Box 159, folder 3, SIO Archives.
35. The American Miscellaneous Society is identified by *Science* as a "mildly looney" organization of oceanographers founded in 1952 to "look on the lighter side of heavier problems." It has no officers, dues, meetings or membership. Its journal *Otherwise* has never been published. Those loosely recognized as belonging to this group are all called founders. Revelle's role in Project Mohole is described in Willard Bascom's *A Hole in the Bottom of the Sea: The Story of the Mohole Project*. Garden City, NY: Doubleday, 1981.
36. SIO Subject Files, 81-16, Box 24, folder 61, "International Geophysical Year, SIO Programs, 1956-1958," SIO Archives, UCSD.
37. Roger Revelle and H.E. Suess, "Carbon dioxide exchange between Atmosphere and Ocean and the Question of an Increase of Atmospheric CO<sub>2</sub> during the Past Decades," *Tellus* 9, no. 1 (1957), pp. 18-27.
38. R. Revelle, W. Broecker, H. Craig, C.D. Keeling and J. Smagorinsky, "Atmospheric Carbon Dioxide," in: *Restoring the Quality of our Environment: Report of the Environmental Pollution Panel, President's Science Advisory Committee*. Washington: The White House, 1965: 111-133.
39. R. Revelle and W.H. Munk, "The Carbon Cycle and the Biosphere," in *Energy and Climate*. Washington: National Academy of Sciences, 1977: 140-158.
40. Roger Revelle, "Carbon Dioxide and World Climate," *Scientific American* 247, no. 2 (August 1982): 35.
41. Revelle served on numerous committees and panels concerned with increasing atmospheric carbon dioxide and its environmental effects. During the 1980's he was Chairman of the joint IOC/SCOR Committee on Climate Changes and the Ocean and Chairman of the AAAS Committee on Climate. He served on many NAS committees, including the Board on Atmospheric Sciences and Climate, the Panel on Sea Level of Geophysics Study Committee, the Committee on Carbon Dioxide and Climate, and the Ocean Studies Board.
42. San Diego Magazine first applied this term to Revelle. Tom Dammann, "Grandfather of the Greenhouse," *San Diego Magazine* (August 1989): 120 et. seq. The quotation is from a newspaper interview, Pricilla Lister, "Revelle Awarded National Medal of Science '90," *San Diego Daily Transcript*, June 27, 1990, p. 1A.

43. Richard C. Vetter, "Federal Coordination of Oceanography," *Gulf and Caribbean Fisheries Institute. Proceedings of the 14th Annual Session* (November 1961): 56. See also Vetter, "NASCO: National Academy of Sciences-National Research Council Committee on Oceanography," in *Ocean Sciences*, edited by E. John Long. Annapolis: U.S. Naval Institute, 1964: 173.
44. Daddario wrote about Revelle's influence on government and his style as a science advisor in a speech presented at a symposium celebrating Revelle's 75th birthday at Scripps in March 1984: "Remarks by the Hon. Emilio Quincy Daddario," SIO Archives, 84-14, UCSD.
45. Ken Hechler, *Toward the Endless Frontier: History of the Committee on Science and Technology, 1959-1979*. Washington: GPO, 1980: 59.
46. Ibid.
47. Revelle to Whitaker, January 3, 1950, Records of the SIO Office of the Director (Revelle), 81-23, Box 1, "Correspondence January 1950," SIO Archives, UCSD.
48. Memorandum from the Director to the Staff, 11 March 1954, Denis Llewellyn Fox Papers (MC10), Box 3, folder 137, SIO Archives, UCSD.
49. The founding of UCSD is told in Nancy Scott Anderson, *An Improbable Venture: A History of the University of California, San Diego*. La Jolla: UCSD Press, 1993.
50. Kerr to Revelle, January 22, 1965, Roger Revelle Papers (MC6), Box 16, folder 33, "UCSD 1963-January 1965," SIO Archives, UCSD.
51. The chancellorship of UCSD was much discussed in the press at the time. See Mary Harrington Hall, "Revelle," *San Diego and Point Magazine* 13, no. 7 (May 1961): 41; Hall, "Bad Day at UCSD: the Kerr and Revelle Thing," *San Diego and Point Magazine* 16, no. 9 (July 1964): 42. Anderson discusses the matter in her history, *An Improbable Venture: A History of the University of California, San Diego*, pp. 74-79.
52. Ellen Revelle quoted in *Roger Revelle: Statesman of Science*, a production of KPBS Television, San Diego, taped August 17, 1992, transcript, p. 16, SIO Archives, 92-39, UCSD.
53. Revelle repeated this statement to several reporters during a series of interviews given when he received the National Medal of Science. See Priscilla Lister, "Revelle Awarded National Medal of Science '90," *San Diego Daily Transcript*, June 27, 1990, p. 1.
54. Revelle discusses this offer in an oral history interview conducted by Sarah Sharp, Roger Revelle, *Director of Scripps Institution of Oceanography, 1951-1954*. La Jolla, CA: SIO Reference Series 88-20, November 1988, 120-121. Ellen Revelle Eckis discussed her role in the decision with the the SIO archivist May 10, 1995.
55. Revelle recounted in an oral history interview that he decided it would be best to leave San Diego for a while. He contacted Jerome Wiesner, an old friend and then science advisor to President Kennedy who arranged the job at Interior. Sarah L. Sharp, "Roger Randall Dougan Revelle: Director of Scripps Institution of Oceanography, 1951-1964." La Jolla: SIO Reference Series 88-20, 1988, 103 . This is one of four oral history interviews conducted by Sharp with Revelle in a series entitled "Oceanography, Population Resources and the World" available at the SIO Archives, UCSD.
56. Daddario, p. 8, SIO Archives. 84-14, UCSD .



57. Harold Thomas, "Roger Revelle: President Elect, 1973," *Science*, 179 (February 1973): 819-820.
58. Daddario, p. 7, SIO Archives, 84-14, UCSD .
59. *Roger Revelle: Statesman of Science*, transcript, p. 19.
60. Ibid, p. 10.
61. Udall to Revelle, March 5, 1963, Roger Revelle Papers (MC6), Box 2, folder 21, "General Correspondence, January-May 1963," SIO Archives, UCSD.
62. *McGraw-Hill Modern Scientists and Engineers*. New York: McGraw Hill, 1980, s.v. "Revelle, Roger."
63. Harvard University Press Release, March 1977 .
64. Revelle to Clanton Williams, December 8, 1965. In Roger Revelle Papers (MC6), Box 22, folder 48, "India, Education Commission, 1965," SIO Archives, UCSD.
65. Roger Revelle, "Munk's Experiment," *Science* 253, no. 5016 (12 July 1991): 118.
- 66 Dr. Revelle received the Albatross Medal, the Agassiz Medal, the Bowie Medal, the Vannevar Bush Award and many other honors that meant a great deal to him. It is simply impossible to list them all in such a brief biography.

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