ROGER REVELLE

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Roger Revelle, 1939, La Jolla, CA.

Roger Randall Dougan Revelle is key to understanding Scripps of the post World War II period—its contributions and its contributors. As director he built Scripps into a world class institution. He gathered a staff from around the world, many of whom knew little about the ocean when they arrived. Together they broadened and deepened our understanding of the ocean, and in the process redefined the term "oceanography."

Someday Roger Revelle will have a scholarly biography; this is not it. I became an oceanographer because Roger pointed me to a job opportunity that in time convinced me that this was the career I wanted. He was my major professor, and he was my key professional mentor. When faced with a tough problem or difficult decision after I became director of the marine program at the University of Rhode Island I would often ask myself, what would Roger do? Much of whatever success I have had I credit to his influence. You will find few warts on the picture of the Roger Revelle that follows. Finally, I limit myself to his career as an oceanographer at Scripps. His role in building UCSD, his contributions to helping Pakistan solve its water problems, his long period at Harvard working on population issues, his role as senior science statesman, I leave that to the professional biographer.[1]

Early Days at Scripps

Like nearly all of his generation, and mine for that matter, Roger Revelle became an oceanographer almost by chance. A 1929 Pomona College graduate, he was a U.C. Berkeley graduate student when the then Scripps director T. Wayland Vaughan came visiting.

Vaughan was looking for someone to help sort, catalog, and analyze sediment samples gathered by scientists aboard *Carnegie* which was on the last of its world-wide cruises with the primary purpose of mapping the earth's magnetic field. Roger volunteered, moved to Scripps in 1931 with his bride, Ellen Clark, switched his major professor, and some five years later, defended his dissertation. On page 5 one reads,[2] "... in the fall of 1931 Dr. Vaughan offered me the opportunity of making an extended study of the deposit samples. It was expected that my report would be completed at the end of about a year, but ..."

Amongst the reasons were two that are key to much of what follows in his career. His bibliography lists five papers published prior to his dissertation, most co-authored; all relate to the role of carbon dioxide in seawater. He was on familiar ground and ready to play a leadership role some 20 years later when the rate at which the oceans absorb increasing amounts of atmospheric CO_2 generated by burning fossil fuels became first an important scientific question, and later one of significant social and economic importance.

The second reason was that Roger enjoyed going to sea. The name had been changed from the Scripps Institution for Biological Research to the Scripps Institution of Oceanography in 1925, but ten years later there was little in the way of ship support, and only a few of the senior staff had any seagoing experience. In 1933 Revelle spent ten days on *Pioneer*, a research vessel of the U.S. Coast and Geodetic Survey, and a year later he made a longer cruise on the Navy vessel *Bushnell* running between Hawaii and the Aleutians. Urged by the *Bushnell* skipper, and believing that if one is going to work from a naval vessel one might fare better if in uniform, Roger applied for and received a commission in the naval reserve. As a consequence he found himself called to active duty in 1941, five months before Pearl Harbor. He spent the next six years in uniform, but none as a ship's officer.

Washington and World War II

For most of his Washington time he was assigned simultaneously to both the Bureau of Ships and to the Hydrographic Office. Revelle was not the only oceanographer to help convince the Navy of its need to know more about the medium in which it operated, but being in uniform and in Washington, he was in a better position than most to bring problems and problem-solvers together. From letters in his file from senior naval officers of this period, he must have been effective. One can assume that the combination of being able to listen carefully to questions raised, combined with far-ranging curiosity, and a willingness to devote as much time as necessary to resolve an issue or solve a problem—a combination of traits that served him well throughout his career—was already in evidence. The Navy came out of World War II knowing it needed to better understand the ocean in which it operated. I am sure it would have realized this whether or not Roger had been their point man in Washington as a combination naval officer/oceanographer, but I believe the strength and breadth of that support in the years immediately following the war were in no small part the result of Roger Revelle's wartime service.

At war's end the military also wanted to know about the newly invented atomic bomb that had brought the Japanese conflict to an abrupt close. Arrangements were made to explode two atomic bombs on Bikini Atoll in the Marshall Islands, one in the air, the other under water. Revelle and others were concerned about the underwater explosion generating

a tsunami-like wave, and he was asked to put together a small group to make calculations before the blast and to measure wave height in and around the atoll at the time of the blast. As word spread about Operation Crossroads, as the exercise was called, others, including commercial fishermen, became concerned. Revelle arranged for the Deputy Chief of Naval Operations to write the hydrographer asking for information about currents in the area. The hydrographer, to whom Roger also reported, made Revelle his representative. Roger had met most of that small wartime group of oceanographers during his time in Washington, and he was quick to call upon them. What began in January 1946 as a relatively small group concerned about a possible tsunami-like wave, had grown by detonation time in July to some eighty officers and civilians along with a support group of several hundred enlisted personnel. The scientific agenda had expanded beyond concern about waves to concern about damage to the atoll resulting from the blast, to prediction, and later measurement, of the dispersion of radioactivity both within and beyond the atoll, and to the possible effect of the blast on both commercial fisheries and local biota. Cdr. Roger Revelle was in overall command of the entire group, a team that included Martin Johnson, Walter Munk, and Marston Sargent from Scripps and Gifford Ewing and John Isaacs who would soon be a part of Scripps. Typically, Roger attempted to use the atomic blasts as a seismic experiment to learn about the geologic structure of the atoll.

A major goal of Norwegian Harald Sverdrup, who succeeded Vaughan as Scripps Director in 1936, was to get Scripps to sea. With the acquisition of the 104-foot auxiliary schooner *E. W. Scripps* a year later, he had at least a beginning. Sverdrup began a series of systematic cruises running about a hundred miles offshore from the coast of California. *E. W. Scripps* also made two trips into the Gulf of California, on both of which Revelle participated, but with the coming of World War II, *E. W. Scripps* was assigned first to the Navy Radio and Sound Laboratory at Point Loma and soon thereafter to the University of California Division of War Research (UCDWR) that was associated with that Navy laboratory.

Revelle at winch on R/V *E.W. Scripps*, 1938. Photo by Eugene C. LaFond.

Because of the German occupation of Norway, Sverdrup remained at Scripps longer than planned, but in 1947 he announced his intention to retire as of March 1948 and return to Norway. He left Scripps with a big new program and the Scripps senior staff with a big problem. In 1946, some time after collapse of the California sardine fishery, the state agreed to a major effort to try to understand why. The agreed-upon program included a continuing systematic survey of the physical, chemical and biological characteristics of the California Current, a survey that extended several hundred miles offshore and from the mouth of the Columbia River in Oregon in the north to some distance down the coast of Baja California in Mexico to the south. It was patterned after the longstanding program in the North Sea under the auspices of the ICES (International Council for the Exploration of

the Seas), a program with which Sverdrup was very familiar, and he saw to it that this part of the program (the California Cooperative Oceanic Fisheries Investigations [CalCOFI]) would be centered at Scripps. Suddenly Scripps was going from an institution with a single, poorly funded research vessel to one with a well funded seagoing program and a number of ships (soon *Crest, Horizon*, and *Paolina T* were added to the fleet). The only member of the resident faculty with significant seagoing experience, let alone the only one with any experience in managing a large field program, was Sverdrup; but he would be returning to Norway. Sverdrup was less concerned. He believed Roger Revelle, still on leave in the Navy, had both the seagoing experience and, after Operation Crossroads, the experience of running large programs. More importantly, he believed Revelle had the imagination, drive, and intelligence to be his replacement, an opinion not universally shared by the senior Scripps faculty.

The end of the war also left Scripps with a University of California neighbor down the coast on Point Loma. Most wartime scientists returned to peacetime activities at the war's end; many of the military facilities closed, and those remaining were reduced significantly in size. Two that remained were the Navy Radio and Sound Laboratory, soon to be reborn as the Navy Electronics Laboratory, and its neighbor, and wartime partner, UCDWR. The two had worked together during the war on problems of underwater sound. The UCDWR director of the Point Loma lab at the end of the war was Carl Eckart. Revelle and Sverdrup agreed it was a good idea to keep the UC facility, and Eckart indicated his willingness to remain as Director. Revelle worked on the Navy in Washington to commit to long-term continuing support. Sverdrup and Eckart attempted to convince the University of California administration to continue to sponsor the laboratory. Both succeeded and in July 1946 the Marine Physical Laboratory (MPL) was established with Eckart, Russell Raitt, and Leonard Liebermann its senior members.

Return to Scripps

Although not prepared to recommend Revelle as Director (a number of the senior faculty were strongly opposed), there was general agreement that Scripps needed someone to manage this big new field program, a program that all thought would dominate Scripps, at least for the near term. In a letter to University of California President Robert Sproul the faculty group suggested an additional administrative position be established at Scripps, "Head of the Division of Physical Oceanography and Director of Marine Operations," and that Revelle be offered that position. The search committee, mostly UCLA faculty (for many administrative purposes Scripps was then part of UCLA) recommended Carl Eckart as Director. Revelle was made Associate Director with the understanding he would have primary responsibility for the ships and Scripps's seagoing programs. Eckart continued as Director of MPL in addition to serving as Scripps Director. He, Raitt, and Liebermann became members of the Scripps faculty.

Eckart was not comfortable as Director of Scripps and five months later signified his intention to resign. Most believe it was never his intention to remain director for long, expecting in time to relinquish the position to Revelle. Although Roger had gained many supporters amongst the Scripps staff during his tenure as associate director (and apparently amongst nearly all of the search committee, all but one of whom were from UCLA), four

senior faculty (Denis Fox, Carl Hubbs, Francis Shepard, and Claude ZoBell) remained opposed to him. In a letter to Sproul[3] they noted their reasons; amongst them, "... some glaring administrative faults ... marked inconsiderateness of the time and convenience of others ... almost no conception of the time either in making appointments or in closing meetings ... making sudden changes of assignments, sometimes with hardly any notification...often organizes meetings poorly.... By his own admission Dr. Revelle is not a very efficient administrator, a fault which has been recognized by both Dr. Sverdrup and Dr. Eckart." The new search committee moved slowly; Eckart stayed longer than planned, not returning to MPL until February 27, 1950, at which time Revelle became Acting Director and MPL became part of Scripps.

At the same February 1950 Board of Regents meeting at which Revelle was made Acting Director, the Regent's passed the infamous loyalty oath, required of all faculty. It read, "I do solemnly swear (or affirm) that I will support the Constitution of the United States and the Constitution of the State of California, and that I will faithfully discharge the duties of my office according to the best of my ability; that I am not a member of the Communist Party, or under any oath, or a party to any agreement, that is in conflict with my obligation under this oath." Failure to sign the oath would result in dismissal from the university.

To those who did not live through the McCarthy era it is difficult to understand how strong the feelings were on both sides of this issue. The faculty were dismayed and outraged. It was a major political issue on all University of California campuses, and Acting Director Revelle got into the middle of the fight. Returning from a UCLA meeting where he was made a member of the key UC "southern division" coordinating committee, he established a similar Scripps group to fight the loyalty oath with 11 subcommittees. Members included faculty, staff, graduate students, and spouses. Their responsibilities ranged from countering media charges, to speaking before community groups, to mounting letter campaigns. Roger wrote more than a dozen personal letters to others urging them to write UC President Sproul or individual Regents, often including a draft of a letter they might wish to send. By early March he had a letter to Sproul signed by 52 members of the La Jolla establishment protesting the Regents action. Given the very conservative nature of the La Jolla community at the time, that was no mean feat. He also had a statement protesting the loyalty oath signed by all members of the Scripps faculty. He addressed several groups in San Diego and spoke in San Francisco at a meeting of the key alumni committee that fashioned the compromise accepted by both faculty and Regents.

Afterwards in a letter to Carl Ebling, vice-president of the UCLA section of the Academic Senate and a leader in the protest movement, Roger wrote,[4] "By arduously sleeping ten hours a night and soothing application of routine administrative work, I am slowly getting back to normal after our long adventure." The loyalty oath issue was an early example of his administrative style. If the matter was important, Roger would devote the necessary time whether it was a couple of hours or a couple of months. In the meantime meetings were delayed, paperwork would pile up, and occasionally other deadlines could be missed. The loyalty oath was important, and for his first eight weeks as Acting Director, Roger must have devoted to it almost all of his time. I expect this episode provided strong evidence to each side, those staff members who believed he was an excellent administrator by

concentrating on the important issues, and those who thought he was a poor one for neglecting the day-to-day needs of the institution.

Getting Scripps into the Pacific was also important. Sverdrup left Scripps with a well-funded Marine Life Research program, but MLR was constrained by geography and, to some extent, by mission. There were fewer constraints on the contracts written by the Office of Naval Research with major oceanographic institutions. The first one with Scripps in 1946 included,[5] "Conduct surveys and research, analyze and compile data and technical information, prepare material for charts, manuals and reports, and foster the training of military and civilian personnel in the following fields of oceanography: interaction of the sea and atmosphere (including wind waves, swell, and surf); the distribution of physical properties; the distribution of chemical properties; the distribution of organisms; the characteristics of the sea-bottom and beaches; tides, tidal currents, and destructive sea waves; the physics and distribution of sea and terrigenous sea ice. Such a program shall include both geographical investigations (surveys), experiments in the laboratory and at sea, pertinent theoretical studies and necessary travel."

As head of ONR's Geophysics Branch where all oceanography contracts were written, I presume Roger had a hand in the wording. Some years later in recalling that period, he said,[6] "We decided oceanography was somewhat different than say physics, or chemistry, or most kinds of geophysics because ships were such expensive instruments. Consequently as far as oceanography was concerned we tried to support a broad institutional program rather than specific individual projects." It was assumed that not all tasks in this contract were to be tackled at once, and some might be completely ignored. The contract was a shopping list from which the institution could pick and choose. Given that the ONR contract with Scripps at that time was for $125,000 a year, picking and choosing was clearly necessary.

I came to work at ONR in 1949 with responsibilities for administering the contract with Scripps, and similar ones with Woods Hole, Columbia's Lamont Geological Observatory, and other oceanographic centers. Because of the Korean War the Scripps and Woods Hole contracts were soon doubled to $250,000 a year. I do not remember the Lamont figure, but Lamont was new and the amount was less. My job was not to second guess the directors of those institutions about how they thought the funds allocated to their institutions could best be spent, but to facilitate their efforts by clearing paperwork, making travel arrangements on military transport, helping to track down surplus military equipment that might be useful, and doing similar chores. Even those more senior than I were loath to second guess a lab director or senior scientist on how best to spend the allotted funds. As an ONR staff member I could argue for more funds for oceanography, but once the size of the financial pie had been determined, the most one could do was to make recommendations on the slicing of the pie. The director had considerable flexibility in how those funds were spent within the institution.

Building Scripps

Roger wanted to get Scripps beyond the California Current, and he used ONR support to get it there. Five months after becoming Acting Director, he left the institution in the hands of Norris Rakestraw as "acting acting director" and led Scripps on a four-month,

12,000 mile scientific expedition into the central North Pacific as far west as the Marshall Islands. The 1950 Midpac Expedition was a two-ship affair in order to accommodate the seismic profiling work of Russell Raitt. Scripps used its largest and most long-legged vessel, the 141 foot, 900-ton former Navy seagoing tug, *Horizon*. The Navy Electronics Laboratory at Point Loma provided its much more limited *PCE(R)-857* as the "shooting ship," the one that dropped the explosives. Given Roger's tenuous situation amongst the senior faculty, I have often thought his leaving Scripps and going off for four months, with the limited radio communications available at that time,[7] showed either great courage or some foolhardiness; but again it demonstrated Roger's style. Making Scripps a major seagoing institution was a high priority. For Roger high priorities often took precedence over political discretion.

In conjunction with the 1951 dedication of the newly built Thomas Wayland Vaughan Aquarium-Museum Revelle arranged a two-day conference, "The Position of the Scripps Institution of Oceanography in the University, the State, and the Nation." Keynote speakers at the dedication were U.C. President Sproul and Detlev Bronk, then president of the National Academy of Sciences. Of the fifty members at the conference half were from outside of Scripps including the Director and Associate Director from Woods Hole, Columbus Iselin, and Alfred Redfield respectively; G. E. Hutchinson and Dan Merriman from Yale, and several from various University of California campuses. The unedited, fragmented transcript of that conference[8] reads like a continuous, three-day, intellectual bull session. Along with good food and drink in a very pleasant setting the participants apparently had a wonderful time. President Sproul remained for the entire conference.

Jim Snodgrass and Roger Revelle lowering a probe overside, Midpac Expedition, 1950.

A few months after the conference, the search committee recommended to Sproul that Roger be appointed Director. Roger believed the conference was what tipped the scales in his favor. After examining a number of files to which he did not have access at the time, my own view is that two other factors may have been at least as important in winning over two of the four recalcitrant senior faculty. Denis Fox was the first to signal his change of position, and my sense is that Roger's stand on the loyalty oath played an important role in that shift. Carl Hubbs was the next to write Sproul indicating his change of position, a shift that coincided with a campaign by the fishing industry on behalf of Wilbert M. (Wib) Chapman, former dean of University of Washington's school of fisheries and more recently in charge of fisheries issues with the U. S. State Department. I suspect that if the choice was to be between Revelle and Chapman, Hubbs preferred Roger. Whatever the reason, or reasons, with two of the four no longer opposed, Sproul sent Revelle's name to the Regents. As of July 1, 1951, "acting" was no longer a part of the title.

I got my job in the Office of Naval Research because of a chance meeting with Walter Munk and Roger in the halls of the Navy Hydrographic Office in 1949. I had known Walter from sharing a trip to the Arctic on the Navy submarine tender *Nereus* in 1947 when I worked at the Navy Electronics Laboratory. I was "between jobs" and Roger, whom I did not know, told me about a temporary position at the Office of Naval Research. The temporary job became permanent, but after some eighteen months I decided I would rather do oceanography than hand out money to oceanographers, and resolved to get a Ph.D. Roger invited me to come to Scripps, and someone suggested that perhaps I could earn my assistantship by helping out in the Director's office. Watching Roger at work was an important part of my education.

On important issues such as recruiting new faculty or opening up new avenues of research, he was thoughtful, imaginative, and very effective. On almost everything else, including routine paperwork and maintaining a schedule, he was pretty bad. My job was to spend a few hours each day going though Roger's telephone log and in-basket and to try to get him to focus on those items that really needed addressing. In time I got to know his style and began to answer some of the more routine requests myself. I later learned this caused some concern amongst a few of those senior faculty who had fought Roger's appointment in the beginning. They already knew he was a lousy administrator, and now they thought the place was being run by a young graduate student. Warren Wooster remembers a time when Roger somehow neglected to sign certain documents, and as a consequence paychecks to a number of staff, including Wooster, were delayed for about a month. Roger's solution was to provide interest-free personal loans to all who needed them.[9] But he was also very good at delegating authority. Fred Spiess remembers that after becoming director of MPL in 1957 he found himself acting as stand-in on a number of subcommittees for Roger who was a member of the Navy Research Advisory Committee; "you could be sure he would stand behind you and would not second guess your course of action."[10]

My experience in the Director's office was the basis of a fantasy play I wrote. During this period even the smallest proposal for new activities required approval of the Board of Regents, and the Regents met only once a month. The story for the play was that Roger had arranged for a major oceanographic expedition. He had done all of the important things like gathering the scientists together and had the equipment ready and working, but, as usual, he had ignored the paperwork. He had forgotten to file a request with the Board of Regents, and therefore did not have permission to go to sea. But Roger being Roger took his scientists to sea and left it for someone else to take care of the paperwork.

All went well at sea where the important work was being done, but back on land, deadlines were missed, the Regents spent too much time worrying about Communists and not enough on running the university; paperwork was delayed. The ship was ready to return but had not yet received permission to depart. And for some obscure reason, there was concern at Scripps about having the ship return until it had received permission to depart. The cruise just went on and on. It was all rather silly, but it struck a chord, and the play was actually produced one evening at the Revelle home.

Roger led his second Scripps expedition two years after Midpac. Capricorn was another two-ship, four-month affair, but this time *Horizon*'s companion was *Spencer F. Baird*, a sister ship to *Horizon*, recently acquired by Scripps. Capricorn was Roger's last time

at sea on a major oceanographic expedition; but he had accomplished his original goal. Scripps was now a seagoing oceanographic institution.

The instigator, chief scientist, and overall planner on nearly half of the 30 or so expeditions made during Revelle's tenure as director was a graduate student or recent post doc. Early records of who led which expedition are not as well documented as one might hope, but at least three of us (Bob Fisher, Warren Wooster, and myself) wrote our Ph.D. dissertations based wholly on work we had done as expedition leaders. A quick survey of the Scripps Ph.D. dissertation list suggests that during this period about half were based primarily on observations made at sea, although in some cases much of the data and original samples were collected by others. Roger had not only gotten Scripps to sea, but he, along with Maurice Ewing at Lamont, was responsible for the first generation of U.S. scientists who began their careers as seagoing oceanographers. In a 1976 oral history interview with Robert Calvert, he said,[11] "If I had an epitaph as Director of Scripps I would say, 'He sent Scripps to sea'." Bob Fisher, Revelle student and longtime colleague, likens him to the fifteenth century Prince Henry the Navigator, who sent one expedition after another from Portugal, pushing ever further the reaches of the known world.[12]

Roger's view of oceanography was broader than most. I doubt if any of the other major oceanographic centers would have felt comfortable inviting Seibert Quimby Duntley and his MIT Visibility Laboratory of more than twenty to come to Scripps as Roger did in 1952. Before the group finally closed its doors some 35 years later, in 1987, it had rewritten the book on the transmission of electromagnetic energy in the ocean. In 1953 Roger invited the Italian geneticist, Adriano Buzzati-Traverso, then a visiting professor at U. C. Berkeley, to join the faculty with the goal of widening the Scripps view of oceanic biology. Buzzati-Traverso was instrumental in Scripps receiving a million-dollar grant from the Rockefeller Foundation, that in turn made possible the hiring of E. W. Fager, Per F. Scholander, Benjamin Volcani, and Ralph Lewin. They had wide-ranging interests, but little knowledge of the ocean when they first arrived. Although Buzzati-Traverso eventually returned to Italy, before he left he arranged a week-long international conference, "Perspectives in Marine Biology," in March of 1956 that attracted some 120 scientists from 15 nations.

In 1955 the young University of Chicago geochemist, Harmon Craig, and the Austrian professor, Hans Suess, arrived on campus, and the following year the physicist Walter Elsasser. Some, such as Suess and geochemist James Arnold, eventually made their academic homes on the new U.C. San Diego campus but continued to maintain a strong interest in matters oceanographic. Scripps and oceanography are richer for Roger seeking them out and convincing them to join forces in the study of the ocean.

In the early years of Scripps most of the staff lived in some twenty-plus small, single-wall construction wooden cottages that ringed the campus. They enjoyed the advantages of a short walk to work, but the cottages were marginal and maintenance was not a high priority. As La Jolla grew northwards after World War II (and closer to Scripps), several of the staff began to look for ways of finding home sites close to campus where they could erect their own homes. Finding off-campus homes for Jewish staff members was a second reason for attempting to establish a subdivision for Scripps staff. Although some years previously the courts had struck down the deed restrictions that had been a part of an earlier La Jolla tradition, there was still a very effective "gentlemen's agreement" amongst the La Jolla

real estate group. In time the project succeeded, and Scripps Estates Associates (SEA), a 42-lot subdivision bordering the eighteen acre Sumner Canyon was established in 1951. Several Scripps members including Doug Inman, Jeffery Frautschy, Walter Munk, and Helen and Russell Raitt played important roles in the development of SEA, but a reading of its early history indicates that Roger was key to its establishment. Without his leadership it is questionable whether the group would have succeeded.[13]

Roger

A review of Roger's publications would suggest that his own research was limited. That is not to imply either a lack of interest or lack of understanding of science. He led both Midpac and Capricorn, and he clearly understood in some detail the contributions of others. Richard Von Herzen, a new graduate student on the Revelle-led Capricorn Expedition, remembers Roger as "continuously discussing and debating the science of all that was being done."[14] Arthur Maxwell, another graduate student on both Midpac and Capricorn worked closely with Roger in measuring the flow of heat into the ocean from the ocean floor. He did his Ph.D. dissertation under Roger and co-authored several papers with him. He remembers showing up at the Revelle house night after night at dinnertime and then working with Roger until about 2 am. He felt he was a member of the family during this period.[15] John McGowan, then a graduate student of Martin Johnson's and later a Scripps professor, credits Roger with giving him an appreciation of scale in both time and space. "You must understand that most biologists are trained as reductionists (even now)."[16] As a leader, Roger was generous and trusting. As Robert Fisher said, "With Roger, credit was not a zero-sum game."

Walter Munk, with whom he collaborated on sea-level change and the effect of glacial melting on the rotation of the earth, has said,[17] "Roger's way of working was anything but analytical; rather he followed a Sherlock Holmes procedure of eliminating one hypothesis after another." Some years after his retirement Roger once said,[18] "I'm really better as a scientific administrator or a scientific leader than as a scientist. I had some scientific ability that was of a rather peculiar kind. I had somehow an ability to get to the heart of the matter, what was the real question, not the apparent question, but the real question, and also the ability to see how you might do that, how you might answer the real question instead of the apparent question."

If, along with arranging for the measurements of atmospheric carbon dioxide noted below, he had published nothing but the single 1957 *Tellus* paper with Hans Suess,[19] he would have made a more significant contribution to science than most of us with much longer publication records. The two calculated the atmospheric residence time of carbon dioxide, calling attention to the problems of determining its exchange rate between ocean and atmosphere, and the probable increase of CO_2 in recent times resulting from the burning of fossil fuels. In this paper one finds the statement (page 19), which in future years was often paraphrased by others, about the important, never to be duplicated, geophysical experiment which society had begun. "Thus human beings are now carrying out a large scale geophysical experiment of a kind that could not have happened in the past or be reproduced in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks of millions of years. This

experiment, if adequately documented, may yield a far-reaching insight into the processes determining weather and climate. It therefore becomes of primary importance to attempt to determine the way carbon dioxide is partitioned between the atmosphere, the ocean, the biosphere, and the lithosphere." In that paper they note, for what I believe was the first time, the possible positive feedback of increased atmospheric carbon dioxide on warming the atmosphere by increasing the water vapor content of the atmosphere and reducing the earth's albedo by melting polar snow and ice.

In 1957 there was no well-documented time series showing the increase of atmospheric CO_2 with time. Many believed they could see the trend, but as Harmon Craig has pointed out, seeing that trend required some selectivity and being prepared to throw out a significant amount of doubtful data.[20] Making accurate measurements of atmospheric CO_2 was difficult in the fifties, but such data were an important part of this extraordinary experiment launched by our industrial civilization. Roger, along with Harry Wexler of the United States Weather Bureau, arranged for Charles David Keeling to begin the systematic recording of atmospheric carbon dioxide at Mauna Loa as part of the 1958 International Geophysical Year. The saw-toothed plot of CO_2 as a function of time begun in 1958 now stretches back nearly a half century and is compelling.

Gustaf Arrhenius and Roger Revelle with core, Capricorn Expedition, 1952.

In time Roger became a good, even inspiring, classroom teacher. Former vice president Al Gore credits Revelle with sparking his interest in environmental issues while at Harvard. It was not always so. The first course Roger taught at Scripps was the introductory physical oceanography course that he shared with Bob Arthur. We students soon learned that if Roger had taken time to prepare the night before, he was adequate. Quite often, however, he showed up, chalk in hand, and the class watched as he struggled to remember relationships, worked at the board, back to class, mumbling, sometimes starting from first principles.

He was "Roger," and not "Dr. Revelle," to most of the staff, including students. He enjoyed socializing, and, if invited to a student party, he and Ellen would come if possible. He knew the students and the students knew him. Colm O'hEocha, a student from Ireland in the early fifties, was tall, as tall as Roger, and he remembers one occasion with Roger out of town, his wife, Ellen, asking him to crawl into Roger's tuxedo and serve as her escort.[21] Roger was famous for working late hours, and, of course, students have been known to work late also. Bob Norris remembers being in the lab after midnight with Paul Horrer trying to make a deadline when Roger, seeing their lights, showed up with a tray of sweet rolls and some hot chocolate.[22] But he could be intimidating at student seminars, and at faculty seminars too. His favorite question was a simple, "why?" and if the answer was not satisfactory, the "why" could come again, and again, as Roger dug deeper and deeper into the

issue. He learned early what all teachers know, the best way to learn a subject is to teach it. More than once I was on the receiving end of a recapitulation of a lecture or explanation he had recently heard. If he could explain it to me it meant he understood it; if he got stuck somewhere along the line, he would thrash about until he either figured it out, or if not, he would sometimes go back to the original source for further illumination.

His ability to concentrate on a subject to the exclusion of all else was legendary. While he was in uniform, Ellen apparently kept him out of some trouble by giving him a wrist watch with an alarm he could set to remind him of when he should be at a meeting, lateness being less tolerated in young naval officers than in young professors. It was often difficult to get his attention, but once you had it, he was yours. Doug Inman recalls getting Roger to review a manuscript he had given him sometime previously. A knock on the door indicated it was time for Roger to leave for Point Mugu north of Los Angeles, and the driver was ready. Inman had barely time to call home before getting in the car for a trip north and more review of the manuscript en route.[23]

National and International Influence

His influence on oceanography extended well beyond La Jolla. He was a member of the 1957 National Academy of Sciences Committee on Oceanography (NASCO). He was the key figure in the US oceanography program for the International Geophysical Year of 1958-59. He was president of the first International Oceanographic Congress held in the United Nations building in New York in 1959. He was largely responsible for starting SCOR (Scientific Committee for Oceanographic Research) in 1958 and served as its first president. He was also largely responsible for the formation of the IOC (Intergovernmental Oceanographic Commission) in 1961 that is housed in UNESCO (United Nations Education Science and Cultural Organization).

The ten member National Academy of Sciences Committee on Oceanography (NASCO) was chaired by the California Institute of Technology geochemist Harrison Brown. Maurice Ewing and Columbus Iselin, Directors of Woods Hole and Lamont respectively, were also members. The timing of their February 1959 report, *Oceanography 1960-1970* was propitious. NASCO was formed in November 1957, one month after the launch of the first Russian satellite, which served as a wake-up call for the need of a U.S. science policy and the needs of U.S. science. President Eisenhower established the position of President's Science Adviser. The NSF budget doubled in two years. However, even in propitious times the National Academy of Sciences reports can gather dust. Harrison Brown and his colleagues took the report to Congress, where they and their report were well received. Ed Wenk, whose book *The Politics of the Ocean* covers this period,[24] describes in some detail the effect of the NASCO report. Hearings were held and resolutions on the importance of oceanography were passed with near unanimity. Next came legislation. One authorized the Coast and Geodetic Survey to conduct activities beyond the narrow coastal area it had been confined to for the first century of its existence. Another gave the Coast Guard explicit authority to conduct oceanographic research.

And in due time both the U.S. House and U.S. Senate took up the question of how the administration was organized to meet the challenges of the NASCO report. The result was legislation establishing the Commission on Marine Science, Engineering, and

Resources, the so-called Stratton Commission whose 1969 report led to the establishment of NOAA (National Oceanic and Atmospheric Administration), passage of the Coastal Zone Management Act, the establishment of UNOLS (University-National Oceanographic Laboratory System) and a number of other ocean measures.

International Geophysical Year (IGY). There was no oceanography program in the planning documents of the first meetings in 1953, and the closest to an oceanographer on the original U.S. planning committee was Elliot Roberts of the Coast and Geodetic Survey. Two years later Roger Revelle was not only a member of the national committee, but a very active member, giving talks to lay audiences, chairing a major subcommittee, and testifying before Congress. Oceanography was well represented in the eighteen-month IGY (July 1957-December 1958). Two major components were the installation of many new tide gauges around the world, particularly on islands central in ocean basins, a program crafted primarily by Walter Munk, and studies of ocean circulation in both the Pacific and Atlantic.

The National Science Foundation provided the major support for the IGY, and the IGY marked the passing of the torch of primary support for oceanography from the Office of Naval Research to the National Science Foundation. It was not that ONR support declined, but rather that NSF support increased. There was a big jump in the level of NSF support for oceanography with the IGY, and that support continued after the IGY had folded its tent.

Scientific Committee for Oceanic Research (SCOR). The IGY was organized through the International Council of Scientific Unions (ICSU), and the movers and shakers of the IGY became convinced that the ICSU was not well organized to develop international ocean programs that included the variety of disciplines incorporated in a typical oceanography endeavor. This was not a new concern; prior to World War II, at least one International Union of Geodesy and Geophysics committee attempted to address this issue, but the IGY brought the issue center stage.

ICSU established a new "biological/geophysical" committee in 1954 whose members included Sverdrup and Revelle. Matters moved quickly by ICSU standards. Structure and terms of reference of the proposed Special Committee for Oceanographic Research (SCOR) were agreed to and negotiated with the ICSU hierarchy. SCOR was to cut across a number of the ICSU unions and a number of its members were nominated by those organizations.

Roger was made the first chair of SCOR.[25] As chair he was not beyond exercising influence when given the opportunity to choose who might best represent the different ICSU unions. Most of the original members were not strangers to him. For example, the Scripps chemist, Norris Rakestraw, represented the International Union of Pure and Applied Chemistry, and Woods Hole Director, Columbus Iselin represented the International Geographical Union.

The primary argument for SCOR was the belief that international cooperation in the study of the oceans should continue after the IGY, so it was perhaps natural that the major result of that first SCOR meeting in Woods Hole in August 1957 was to launch the International Indian Ocean Expedition, the least explored of the major oceans. But Roger

soon saw a second reason for SCOR, that of sponsoring the International Oceanographic Congresses. Because no ICSU organization but SCOR had a mandate to include oceanography in the broad terms Roger used to define the field, none could be expected to sponsor international meetings and conferences of the scope Roger saw necessary. When plans for the first International Oceanographic Congress came along, Roger saw to it that SCOR was a sponsor. Later Congresses became a primary responsibility of SCOR.

Intergovernmental Oceanographic Commission (IOC). International committees of scientists working within their academies and through ICSU may be well designed to plan programs such as the International Geophysical Year but funding for such a program could come only from national treasuries. SCOR might be well suited to plan an International Indian Ocean Expedition, but it required another kind of organization to make the formal commitments of ships, personnel, and funding. Roger and others originally hoped to establish a separate ocean organization, like the World Meteorological Organization, but that was not to be. Oceanography may have grown after World War II, but in 1960 nations were not prepared to take on the expense of a free standing World Oceanographic Organization.

The next best was an organization with as much independence as possible but attached to another UN body. As a U.S. member of the UNESCO International Advisory Committee on Marine Sciences, and later as member, and eventually, vice-chair of the US National Committee for UNESCO Roger was well positioned to make the IOC a part of UNESCO. In 1960 Revelle, John Lyman of the US National Science Foundation, George Deacon, head of the UK Institute of Oceanography, and Vladimir Kort, director of the Institute of Oceanology, USSR Academy of Sciences met, first alone in Paris to hammer out what they wanted, and later in Copenhagen with a group of UNESCO delegates. What emerged was a semi-autonomous Intergovernmental Oceanographic Commission (IOC) within UNESCO. For example, one could be a member of the IOC and not UNESCO, and vice versa. The IOC would choose its own secretariat and would have at least some control over its own budget, but UNESCO in Paris would provide the necessary housekeeping activities. SCOR may have overseen the planning of the International Indian Ocean Expedition, but it was the IOC that was charged with its overall coordination.

Roger continued to maintain interest in these organizations as long as he was associated with Scripps. Warren Wooster had ample opportunity to watch him in action because at one time or another Wooster served as Director of the UNESCO Office of Oceanography, Secretary to the IOC, and President of SCOR. In a remembrance of Roger at the time of his death Wooster wrote,[26] "Those who attended meetings of such groups will well remember the scenario. Often Revelle traveled from far away, arrived late, and slept through the early discussions. Sometimes he then awakened and requested a recapitulation that could be slow and frustrating to the other players. More often, it seemed to me, he signaled being awake by asking a penetrating question that suggested he had somehow absorbed what had been said. The process usually led to an outcome quite different—and usually more fruitful—than that we had been approaching."

The First International Oceanographic Congress. The original idea was Dael Wolfle's of the American Association for the Advancement of Science (AAAS), but the nine members

of the organizing committee soon recognized that without Mary Sears of Woods Hole as chair, the congress could be a disaster. Instead this 1959 conference, August 30-September 12, was an extraordinary success, attended by about 1200 oceanographers from more than thirty countries. Roger was a very active member of the organizing committee. He helped bring aboard both UNESCO and ICSU/SCOR as cosponsors, which in turn influenced the UN to allow the conference to be held in its magnificent headquarters building in New York. The steering committee elected Roger President of the Congress.

It was his kind of conference. All of oceanography was to be discussed; not just the water, but the biology within the ocean, and the bottom beneath the ocean. In his opening address to the congress he returned to a theme he had long felt strongly about. "But it is now more true than ever that oceanography is the meeting place of all the sciences, and that much of the fun of it—the sheer excitement of oceanography—comes when people of different backgrounds talk together about common problems in which ideas and knowledge of biologists, geologists, chemists, physicists, mathematicians, and engineers must be combined if a solution is to be found."[27]

Building the Institute of Engineering and Technology and UCSD

I suppose Scripps graduated more Ph.D.'s in oceanography while Roger was director than all other programs in the country combined. Yet if Roger ever thought through carefully what a graduate education in oceanography should encompass I have found no record of it, perhaps for good reason. When asked to define oceanography, he would sometimes joke that oceanography is what people at Scripps do, and given the manner in which he reached further and further afield to bring scientists into Scripps so, one must assume, did his definition of oceanography continue to expand. The quote in the previous paragraph from his opening address to the 1960 first International Oceanographic Congress says it rather well.

What follows from his definition of oceanography was his view that oceanographic institutions would become sterile in one or at most two generations unless new ideas from other sciences were continuously fed into the program. Reaching ever farther afield for faculty at the cutting edge of their science and convincing them to apply their knowledge to the ocean was one way to insure oceanography remained vibrant, and Roger succeeded admirably; but he may have seen this way as a short-term solution. Another way was to insure that Scripps was physically attached to a grouping of faculty in those sciences Roger thought of as being more fundamental and upon which oceanography draws. By some form of intellectual osmosis oceanography students and faculty would be able to draw upon a continuing source of new knowledge and techniques for studying the ocean. That, I believe, was one important reason for his effort to develop a broadly based graduate program in science and engineering adjacent to Scripps, an effort that generated widespread support in the growing technological community of San Diego in the mid-fifties when these ideas were first discussed.

As this proposed Institute of Engineering and Technology was working its way through the tangle of university and regent committees, an even grander scheme came forward. California was going to grow. Either the campuses of U.C. Berkeley and UCLA were going to become huge, or the University of California system would require more

campuses. The Regents opted for the latter, and San Diego, the third largest population center, was an obvious choice. The Regents approved San Diego as the site for a new University of California campus in 1957. Roger fought hard to insure the new campus was adjacent to Scripps, and the Regents approved the site in 1959. The Institute of Engineering and Technology with Roger as Director had begun hiring faculty in 1958 and quartering them on the Scripps campus. As the School of Science and Engineering with Roger as Dean it became the first increment of the University of California San Diego, later to be called Revelle College.

Roger might have continued to be Director of Scripps as well as running the Institute of Technology and Engineering, but there was no way he could be the new UCSD Chancellor and still direct Scripps. All of us at Scripps expected him to be Chancellor. Instead Herb York was chosen in 1961, rather than Roger. The prevailing opinion of those of us at Scripps at the time was that in the process of insuring the new UCSD campus would be in La Jolla adjacent to Scripps rather than more centrally located in San Diego, Roger antagonized the chairman of the Board of Regents, and the University of California administration lacked the courage to fight for Roger.[28] With York's appointment, Roger accepted a two-year appointment in the Department of Interior in Washington. He returned briefly the summer of 1963, and divided his time between Scripps and Berkeley where he held the position of Dean of Research for the entire University of California system. He left Scripps for Harvard in September of 1964, not returning until 1976 to base in La Jolla.

However, in 1959, the year of Roger's 50th birthday, we at Scripps were convinced he would be Chancellor, and we would soon lose him as director. My wife, Lynne, thought we should have a proper celebration, and we did. The invitation included the following:

> "When the *Cannery Row* friends of Doc decided to give him a party, there was no need for invitations—everyone just knew and everyone showed up. Unfortunately Scripps is a bigger place than Steinbeck's Monterey and we got cold feet about being so haphazard in letting all of you know that we think it would be a good idea if all of you just decided to give Roger a party on his 50th birthday, March 7. We will expect you about 8:30 at our house.... Presents we believe are in order—homemade, or at least something you yourself found or caught ... and in best Monterey tradition, we plan to dump everything you bring into one punch bowl. Rum, gin, liqueurs, brandy, soda, ginger ale, pineapple and grapefruit juice, etc., are all welcome and will be added at random.... Suggestions are in order. This is your party. Roger has a 50th only once and this is his last year as Director of Scripps....
> Lynne and John Knauss."

It was a glorious affair and many helped. Anne Revelle Shumway and her husband George arranged for a family birthday party at their home down the street from ours. Someone had the bright idea we should all go to the Shumway house and bring him back in style. George Shor found a calliope on a trailer and arranged to get it here. Charles David Keeling figured

out how to play it and led the parade. Walter and Judith Munk, Bill Menard and others fashioned a palanquin. There were other musical instruments and there were banners.

And somehow this was all kept a secret. I remember a call from Ellen Revelle that afternoon saying Roger had another prospective faculty member for the new campus in tow. Because a drive through our Scripps Estates subdivision was usually a part of Roger's seduction tour (on occasion there was even a stop at our house on the canyon to show a typical home of an assistant research professor) so there was some scrambling to hide what we could.

We assembled at our house, walked to the Shumway's. Roger was hoisted on the palanquin, and the parade was off. It was a good party. Fred Spiess watched over the punch to insure it was not too lethal. The presents were imaginative, and Roger stood on our raised hearth and opened many. But I expect there is only one everyone still remembers. Texas Bobbie Roberts "six foot one of Texas fun" was a San Diego institution at a local burlesque house. Leonard Liebermann, Bill Van Dorn, and Harmon Craig visited and arranged for her to come to our party. Somehow she managed to fit into the box of a recently delivered Liebermann refrigerator and was brought in with great flourish. Roger opened the box. Texas Bobbie uncoiled and came out, complete with G-string. Roger said something to the effect, can you really fit in there? She said yes, there is plenty of room; then got back in and Roger followed. The lid was slammed shut, and the two were carried off. A few minutes later the box was returned, and both crawled out, Texas Bobbie Roberts with the immortal words, "I didn't know there was so much to oceanography."

She put it well. Roger Randall Dougan Revelle expanded the meaning of the term oceanography, and he made it a much more interesting field for those of us who followed in his wake.

The launching of R/V *Roger Revelle* on the Escatawpa River, 1995.

Footnotes

1. I have benefitted from suggestions from a number of Roger's colleagues to whom I have shown various drafts of this piece. They include James Arnold, Harmon Craig, Robert Fisher, Francis Haxo, Douglas Inman, Leonard Liebermann, Arthur Maxwell, John McGowan, Walter Munk, Ellen Revelle, William Van Dorn, and Warren Wooster. In particular I would like to acknowledge the assistance of Deborah Day of the Scripps archives, who helped me find my way through its various holdings.

2. Revelle, Roger, 1936. *Marine Bottom Samples Collected in the Pacific Ocean by the* Carnegie *on its Seventh Cruise.* Ph.D. Dissertation, University of California, Berkeley. 317p.

3. Denis Fox, Carl Hubbs, Francis Shepard, and Claude ZoBell to University of California President Robert Sproul, May 12, 1950. Carl Hubbs papers, Manuscript collection MC5, box 33, folder 45, University of California, San Diego, Scripps Institution of Oceanography Archives, La Jolla, Ca.

4. Roger Revelle to Carl Ebling, April 29, 1949. SIO Subject File Records (1890-1981), Archival Collection AC 6, box 11 folder 32. University of California, San Diego, Scripps Institution of Oceanography archives, La Jolla, California.

5. ONR Progress report No.1. SIO Reference Series 46-7, 1946. Scripps Institution of Oceanography Library, University of California, San Diego.

6. Oral history interview (unedited) with Roger Revelle by Robert Calvert, Texas A&M University, July 4, 1976, pages 34-35. Copy in Roger Revelle Papers, MC6, box 1, folder 33. University of California, San Diego, Scripps Institution of Oceanography archives, La Jolla, California.

7. Once more than a few miles from shore all radio communication was by Morse code.

8. The Position of the Scripps Institution of Oceanography in the University, State and Nation, March 5, 1951. Transcript of Tape Recording, (unedited), SIO Subject files, University of California, San Diego, Scripps Institution of Oceanography archives, La Jolla, California.

9. Warren Wooster, personal communication, July 2001.

10. Fred Spiess, personal communication, July 2001.

11. Oral history interview (unedited) with Roger Revelle by Robert Calvert, Texas A&M University, July 4, 1976, page 67, copy in Roger Revelle Papers, MC6, box 1, folder 33. University of California, San Diego, Scripps Institution of Oceanography archives, La Jolla, California.

12. Robert L. Fisher, personal communication, June 2001.

13. Knauss, John A., *Scripps Estates Associates—the early history.* University of California, San Diego, Scripps Institution of Oceanography archives, La Jolla, California. 2001.

14. Richard Von Herzen, personal communication, June 2001.

15. Arthur Maxwell, personal communication, June 2001.

16. John McGowan, personal communication, June 2001.

17. Munk, Walter, 1997. Tribute to Roger Revelle and his contributions to studies of carbon dioxide and climate changes. *Proceedings of the National Academy of Sciences,* v.94. pp.8275-8279.

18. Oral history with Roger Revelle by Sarah L. Sharp, 3-4 November, 1984. "Observations on the Office of Naval Research and International Science," page 23. Bancroft Library, University of California, Berkeley. Copy also at University of California, San Diego, Scripps Institution of Oceanography archives, La Jolla, California.

19. Revelle, Roger R. and Hans E. Suess, 1957. Carbon dioxide exchange between atmosphere and ocean and the question of an increase in CO_2 during the past decades. *Tellus,* v.9, no.1. pp.18-27.

20. Harmon Craig, personal communication. December 2001.

21. Colm O'hEocha *in* Scripps Stories: Days to Remember. Kittie Kerr Kuhns and Betty Shor editors. SIO Ref no. 93-35, 1993. 145p.

22. Robert Norris in Scripps Stories: Days to Remember, Kittie Kerr Kuhns and Betty Shor editors. SIO Ref. no. 93-35, 1993. 145p.

23. Douglas Inman, personal communication, March 2001.

24. Wenk, Edward A., 1972. *The Politics of the Ocean.* Seattle, University of Washington Press. 590p.

25. George Deacon of the UK was vice chair and Günter Böhnecke from Germany was named secretary.

26. Wooster, Warren S. "Roger Revelle, 9 March, 1909-15 July, 1991." *Ocean Yearbook,* v.10, Elisabeth Mann Borgese, Norton Ginsburg, and Joseph R. Morgan editors. Chicago, University of Chicago Press, 1993. pp.xvii-xviii.

27. Opening address to the International Oceanographic Congress, August 30, 1959. *Oceanus,* v.6, no.3, March 1960. pp.2-4.

28. An opinion essentially verified by the UC President Clark Kerr in his history of his time at the University of California; Kerr, Clark, *The Gold and the Blue,* v.1. Berkeley, University of California Press 2001. 537p.