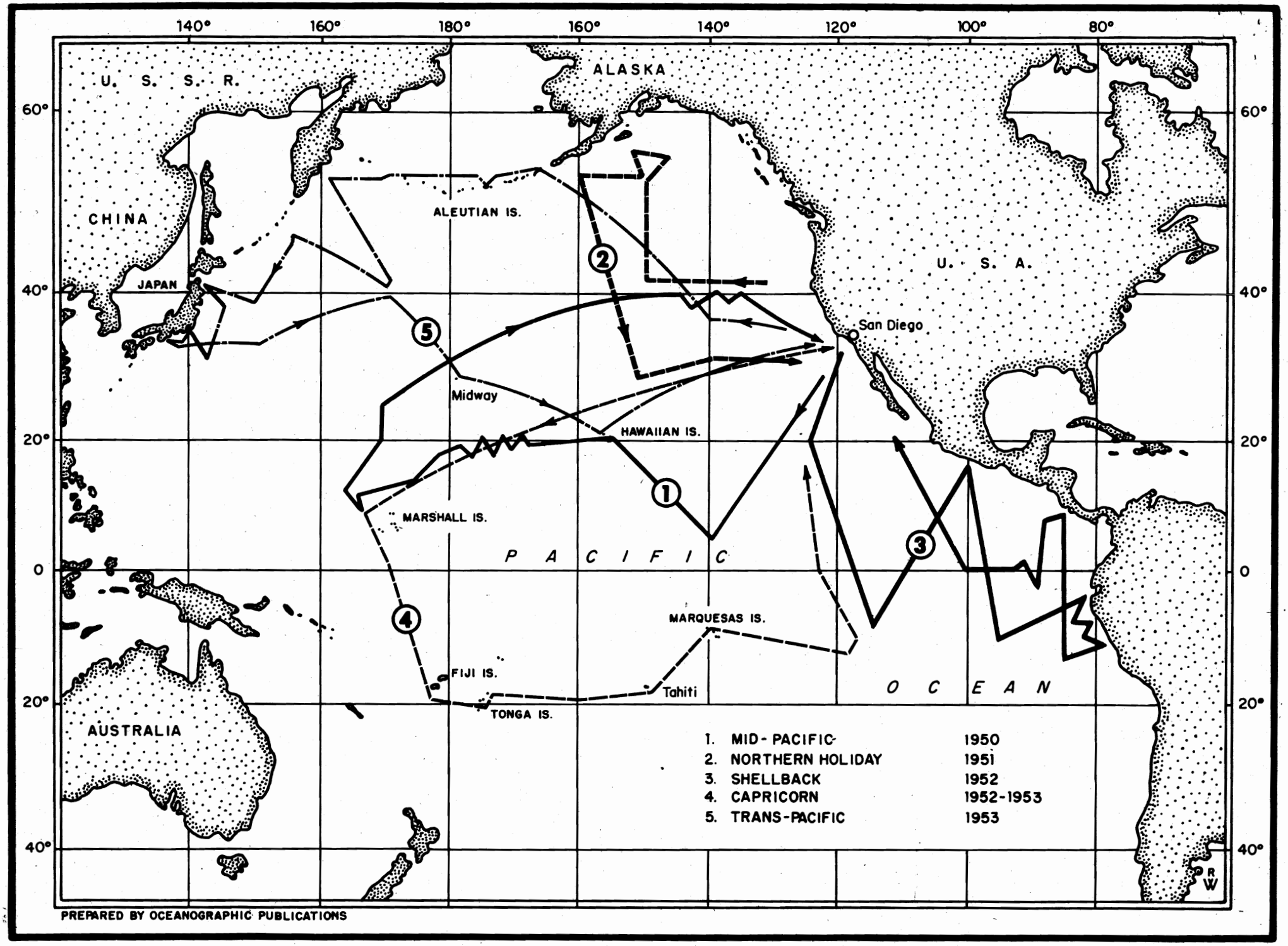
The Venturesome Voyages of Scripps Into the South Pacific Ocean 1950 and 1952

I. 1950: "Mid-Pac" — The First Big Step

II. 1952: "Operation Ivy — Capricorn Expedition

by Edward S. Barr

Discovering the MidPac Mountain Range on my watch!
Edward S. Barr and the fathometer on Horizon
MidPac Expedition, 31 August 1950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1. MID-PACIFIC 1950
2. NORTHERN HOLIDAY 1951
3. SHELLBACK 1952
4. CAPRICORN 1952-1953
5. TRANS-PACIFIC 1953
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Part I.

1950: Mid-Pac — The First Big Step

Dedication to Roger Revelle

who took the time and interest to give a young man a lift, and a fulfilled dream.

In the early spring of 1950, while completing my junior year at Point Loma High School, I decided that it would be a very rewarding experience to work with Scripps Institution of Oceanography. I particularly wanted to be involved in their efforts of collecting data from the ocean. So with my father's encouragement, I made an appointment with Dr. Roger Revelle, then Acting Director of the Scripps Institution, and met with him at his office concerning possible summer employment. To my surprise, I found that Scripps Institution was planning, for the first time, a long and extensive expedition to the South Pacific! This trip sounded very exciting to me, and Dr. Revelle seemed equally enthusiastic. Dr. Revelle indicated, however, that no high school student had ever been employed previously by the Institution to participate with the scientific group on any expedition. In particular, he was unsure as to whether it would be possible for a high school student to be included on such a long trip, particularly since it was the first time that the Institution had ever conducted such an extensive venture. Summer employment had been available at the Institution in various capacities at their shore facilities and, in some cases, they also had hired high school students to work on board ship as members of the crew. My interest, however, centered around being part of the scientific group aboard ship at sea, thereby being exposed to the knowledge and experience of the expeditionary staff and their work of collecting and interpreting the data. Dr. Revelle seemed interested in the possibility of my going and advised me that he would let me know in a short period of time as to what could be done.

In early June, 1950, Dr. Revelle called and said that I was hired! He explained that they did not have a formal budget for my type of employment, so my pay would be limited to $75 a month. For lack of a better description for my employment, they called me a "laboratory helper." I naturally was very excited about what I thought would become a very thrilling adventure. Eager preparations were made for going aboard ship. The expedition, as planned, was scheduled to leave San Diego in the middle part of June, proceed to Honolulu, and then out to the Marshall Islands for some experimentation on Bikini Atoll, the site of the 1946 atomic bomb experiments. From there, the expedition was to go on to Kwajalein Atoll and then on down into the southern latitudes for further experimentation in the deep South Pacific. My part of the expedition only involved the first half; I would be returning by plane to San Diego from Kwajalein, while the ship continued northward. Nevertheless, the time I would spend with Scripps would be for the

month of June through part of October. With enthusiasm and great anticipation, I looked forward to the next four months.

On Monday, June 19, 1950, at the Naval Electronics docks on Point Loma, I boarded, for the first time, the research vessel *Horizon*, a converted Navy tug of steel construction and diesel power. Her length was 143 feet. The ship had a very low profile near the stern which made convenient access to the ocean. Up forward her bow was quite high. Under full power, with twin diesels and a single propeller, the *Horizon* could make about 12 knots. Running on one diesel she could make about 10 knots. Having a family background in yachting, I think it would be proper to describe the *Horizon's* general condition as being a pile of rust covered with some paint. The ship had already been used extensively in oceanographic work. The ability to keep her in bristol fashion was just not possible, considering the amount of time the ship was kept at sea. As a result her metal hull and upper structure were subject to extensive rusting. The best that the crew could do was to keep painting over the rust, occasionally flaking off big slabs and then painting a new coat under that.

The *Horizon* got underway on Tuesday for a practice run, after loading a tremendous amount of gear, including a one-and-one-half-ton generator, various cables, and deck equipment. The sleeping quarters, deep in the ship's forward area, were kept dark in order for people who were up most of the night on watch to have an appropriate compartment in which to sleep during the day. Dark on board <u>this</u> ship meant <u>total dark</u>! In fact, without a flashlight it was difficult to move around. The compartment remained in this condition at all times. As a result, I occasionally found myself fully dressed and up on deck at twelve midnight, thinking it was already the next day! Having no way of telling day from night down in what we affectionately learned to call the "pit," I found it very difficult to determine what day it was, or the time. On such occasions, since I was already up, I frequently would visit the bridge and watch the crew operate the ship and observe how she behaved in the ocean swells. Early Wednesday morning the sea had developed into a choppy condition with approximately 20 to 30 knots of breeze. The ship was awash aft with seas and spray coming over the sides near the stern. "How could any scientist or crew handle heavy equipment over such a pitching, rolling and wet deck?" I wondered.

Soon, in spite of poor weather conditions, preparations were made to begin testing the various equipment which was on board for the long expedition. At the stern of the ship was installed what we called "the rack," similar to what tuna clippers used as a place from

which the fishermen stood to catch fish and pull them aboard. On the *Horizon* we used this rack for getting down very close to the ocean surface to handle the heavy steel equipment which we were lowering and raising in and out of the ocean. "Rack work" was always very wet work. The ship was at rest while we were testing our equipment; she just lay in the sea without forward motion, rolling back and forth in very wide sweeping arcs. The choppy waves would pour into the rack and over the rails onto the deck, placing us in churning water above waist level. Since none of us was very experienced at handling this experimental type of heavy equipment, we had some difficulty controlling its tons of weight. Some of the equipment that seemed to be more easily handled, however, was a water sampler, a pilot weight, various depth-sounding gear, and the bottom-sampling apparatus called the "Phleger Corer." Following the end of this testing period, I worked with the technicians in the bacteriology lab, testing their ocean-bottom samples.

The following day the sea was much more calm. We spent all day preparing for one of the largest pieces of oceanographic testing or sampling equipment that had ever been used. It was referred to as the "Kullenberg Core Sampler," and consisted of drilling pipe in 30-foot sections. The assembled sections of nearly 100 feet in length would be lifted from the deck, hoisted over the side, and rotated into a vertical position, at which time very large weights would be attached to the upper end of these long pipe sections to give it the downward thrust necessary to drive it into the ocean bottom. As a general procedure, this type of equipment could only be used when the sea was extremely flat. The approximate weight of the Kullenberg Core Sampler, when ready for lowering, was in excess of 2,000 pounds. The state of the art in oceanographic deep-sea winches in 1950 left much to be desired. Our winch consisted of a deck-mounted drum around which was wound 20,000 feet of cable. The winch was electrically powered with a 25-hp electric motor. One of the immediate problems with the winch was the clutching mechanism, which also served as a partial brake. With the ship moving up and down over the ocean swells, the pull on the winch cable was very uneven, so the winch tended to get out of control and start unwinding too fast. To solve this, a combined brake and clutch were used to reduce the winch's speed fluctuations. The clutch occasionally got so hot that it emitted clouds of smoke. Obviously, further refinement of this braking system would have to be made after our trial run was completed. It took all day to rig the Kullenberg Core Sampler and get it over the side. Then, all through the night, we let the device down into the ocean depths to the

bottom. When it was winched back on deck, we had obtained a beautiful 28-foot bottom- core sample which was extracted and analyzed. The following day a new device was tested which could record the temperature of the ocean bottom. It was called the "Heat Probe."

Upon completion of this test, the ship headed back for San Diego. We had an amusing time with sea birds, which looked like albatrosses but were dark gray in color. Our cook decided to tie some meat on the end of a long string and trail it astern of the ship. Those birds, being somewhat less than brilliant, would sweep down, pick up the meat and swallow it, not knowing that the line was tied to the food. There was, of course, no hook in the meat. We could pull a bird, while it was flying, down to within about 15 feet of the deck. The bird, frantically trying to fly away, eventually would pull the meat loose. Such a confused-looking group of birds! I am sure they didn't know what to make of all this. Neither did we, except that it developed into a keen sport, each of us trying to land a bird on deck. The same creatures would come back over and over again to pick up the meat, never seeming to grasp the connection between the food and our "bird line."

With the refinements necessary on some of our equipment, there would be a lengthy delay before the expedition could begin.

For the next several weeks, the ship underwent a rather thorough overhaul at the shipyard. I temporarily joined the deck crew in the effort of cleaning, painting, chipping, and hauling vast quantities of stores, piping, wiring, shackles, line, scientific equipment and spare parts aboard. Early in the morning, July 14th, our yard period ended, and we headed proudly from National Steel Shipbuilding back to Naval Electronics Laboratory, looking very trim and pretty. Upon arrival, there were about five tons of food in crates and boxes on the dock awaiting us. Later that day, we received news that the Navy ship, #857, which was to accompany us on the expedition, had failed in her trial runs up in the San Francisco area, and was not fit for sea. The ship had to return to the shipyard for repairs. We were concerned that our expedition would be further delayed. The following Monday we continued to load provisions, with tons of additional food coming on board. I don't believe I have ever seen so much jammed into a ship so small. Where could it possibly fit? My job was to stand at the bottom of a long ladder in the forward compartment and catch the food boxes as they were being slid down planks to the lower level. Once caught, the next move was to throw the boxes to the next fellow in a sort of chain-gang style to the final storage area, deep in the ship's hold.

Ed Barr extracting Kullenberg core

On the 19th, we got underway for a second trial run, again to test our equipment. The sea this time was calm, and by 10:30 we had arrived at our testing location, and commenced drifting as before. First sent down was the Heat Probe, followed by a Phleger corer, from which we obtained a good bottom sample. I spent a great deal of time in the laboratory watching the scientists analyze the cores, determining their composition and characteristics. We also tested the plankton nets which were towed behind the ship to collect micro-organisms. During the evening we decided again to lower the Heat Probe and did so using the big winch. The clutch once again overheated. When we retrieved the equipment, we found 300 feet of the cable hopelessly kinked, which we later had to chop off. Early next morning we moved the ship into shoal waters where we could test the "clam bucket," a glorified way of saying that we wanted to pick up some bottom surface samples by dragging a bucket.

It is well to note that in 1950 the shipboard equipment used in oceanographic research was highly experimental, crude, heavy and terribly unsophisticated. Nearly everything we were working with at sea was equipment designed ashore, with assumptions as to the effectiveness on board ship. In some cases we were trying procedures and using devices for the first time, with no assurance that they would even function at all in the hostile environment of the sea.

Later in the day, the hydrophone lines were streamed astern of the ship, and used to pick up ocean sound waves. The temperature-recording device in the Heat Probe apparently was malfunctioning, so that night it was lowered to the bottom three different times, each occasion with a different set of electronic components. Art Maxwell, our probe expert, put in a very long day, as did the winching and support crew. I, at 17, couldn't keep up with these supercharged situations, so was unable to stay awake for the whole performance. Friday morning, with the tests completed and the recording devices apparently functioning properly, the ship headed back to San Diego.

On Sunday the 23rd, the Navy ship, designated only by number 857, arrived in San Diego from San Francisco, having successfully completed her sea trial. The word was that our departure for the South Pacific was to occur the next Thursday. Tuesday we went down to the Union Oil dock in lower San Diego harbor to take on 26,000 gallons of diesel fuel, and 2000 gallons of lube oil, which topped our tanks to their capacity of 53,000 gallons. Upon returning to our Point Loma dock, we loaded a large amount of explosives and a remarkable quantity of cigarettes. (It seemed to me to be an ironic

combination!) On July 27th, I packed my sea bags — 3 of them, said goodby to the family, got my first butch haircut, and, with my father, drove down to the ship.

At I:30 P.M. we at last were underway on the first deep-sea expedition in Scripps's history, heading southward at 8 knots on one engine. Our reduced speed was primarily to conserve fuel. The ocean is very patient with those who are curious. Besides, since this was an expedition, who was in such a big hurry anyway? We, of course, had the Navy ship in company with us. Immediately, in true Navy tradition, the two ships needed to adopt "pet" military names for each other. The *Horizon* was called "Seclusive," and we referred to the Navy ship as the "Notable 857."

My first night was terrible. Someone had taken my mattress and blanket. In the pitch black of the "pit" there was no way to determine who the culprit was. From the supply locker the problem was resolved: a new blanket and mattress were issued to me. After breakfast the meteorologists decided to send up one of their weather balloons off the foredeck. Life on board the ship in those early days was quite relaxed, generally speaking, with not much visible pressure evident in anyone's activities. Much time was spent by me reading, and assisting in the laboratory in making preparations for the various experiments that would be conducted in the weeks to come. Three albacore and one skipjack were caught on one morning which assisted the cook in making an attractive tasty meal. On the 29th we stopped early in the morning at our first pre-planned station. The experiment involved Russell Raitt's hydrophones and seismic-recording equipment. Three hydrophone lines were cast overboard and strung out astern. The 857 proceeded to move away from us, dropping TNT charges as she went. Raitt's equipment would detect these explosions through hydrophones and record them in the laboratory, thereby getting information concerning the velocity of sound in various ocean bottom layers, and also information about the speed of sound in varied water conditions from the surface to the ocean.

By recording these different velocities, Dr. Russell Raitt was expanding a new seismic technology in correlating the sound velocities to types of material through which the sounds were traveling. By measuring sound, speed, time, and direction through extremely complicated formulations, Dr. Raittt was developing the ability to determine the type of bottom strata (the type of material) through which the sound was traveling. It was during this initial hydrophone set that one of the buoys holding up one of the many microphones came loose. The buoy was about 300 feet astern of the

ship. I decided to swim out to retrieve it. All went well initially, except that I miscalculated the roughness of the ocean. It appears to be a great deal more calm when you are standing on board ship than when you are in the water swimming! Secondly, my perception of distance was highly distorted, because I had nothing to use for a reference. After a ten-minute swimming sprint, the buoy still didn't seem to be much closer. I then realized that the buoy was being moved along away from me by the wind and waves. Looking behind, my ship began to look mighty small. I decided to slow my pace and continue. It seemed like an eternity before I reached that damned buoy! The towing effort back to the ship seemed even longer. I seriously questioned whether I could last. The experience certainly illustrated that decisions involving the ocean should not be made on impulse. The ocean can be most uncompromising on those who have failed to do their homework.

The next day we were underway for our next station (a pre-selected ocean position). During this transit period, I read in the morning and helped Dr. Raitt with his hydrophones. Dr. Raitt developed quite a shipboard reputation regarding his equipment. Without doubt, his equipment was the most messy, the most cumbersome, the most involved pile of wire, buoys, lines and paraphernalia imaginable! Stowing and unstowing his equipment for each experiment took hours. He didn't want this equipment to be a safety hazard for people on deck, and this effort required great patience and a tremendous amount of project dedication. Dr. Raitt was a man of endless energy, and an extremely pleasant man to work with. He always had an unending amount of enthusiasm, optimism, and smiles. Though it was hard physical work, one couldn't help enjoying working in his presence. He seemed never to tire in his dedication to his project. His popularity grew as we headed ever farther from our home port of San Diego.

That evening we viewed one of our "famous" movies — one of the few general entertainments on board. I was curious to know who selected these classic films. I never found out! Where could Scripps find these museum items? Many were over 15 years old. That night we saw the "Bowery Boys." I don't know its age, but I am convinced that the movie was older than I was (17 at the time). The show wasn't really any good, but under the circumstances any entertainment was enjoyed.

The ship's daily routine at this point began to focus on essentially three operating groups: (1) the deck crew, operating the ship from the bridge; (2) the watches in the laboratory; and (3) the engineering group, operating the ship's propulsion and power service

facilities (water and electricity) from below. All three operations continued without interruption around the clock. My initial watch was serving with Dr. Rittenburg. We had a lot of fun from midnight to 4:00 A.M. trying to get the GEK working properly. The GEK is an abbreviation for an electronic piece of equipment called the geomagnetic electrokinetograph. Since the name was a mouthful, we referred to it as the GEK or the "gek." The three groups (deck, lab, and engineering) required constant coordination. The activities of the laboratory and scientific staff would invariably require the services of the deck crew in positioning the ship and helping with the equipment. Also, services from the engineering staff were needed in terms of electrical and power requirements, and winch-operating personnel. The coordinating skill required between these three groups increased as the trip progressed. It is one thing to have a coordinated organization of three very diverse and very specialized types of people on a short-term effort. But it becomes crucial when you schedule intensive projects for almost 30 straight days at sea. With only open ocean to see, personality factors became acute. Now that I look back on it, even a rather small requirement for a little extra personal effort not given, or given begrudgingly — or a change in the personal routine on shipboard — or a change in the operational plans — could generate an amazing amount of tension and/or resentment from those who would be affected. For example, if the scientific group decided to conduct an unscheduled experiment, such as lowering a sampling device, this single evolution would require the coordinated effort of many people. Precise navigation, changes in the watch schedules so that the proper personnel would be available from the three different departments, were all needed in order to carry out the experiment. In general, every time there was any kind of change in the scientific program, it involved changes for everyone on board. I remember our frustrated cook's exasperation while he stood in the galley doorway with a full meal served in the empty messhall, while all the scientists were aft on the stern examining an unscheduled newly-caught sea creature! A great deal of diplomacy and careful judgment were required on the part of the scientific leader and the ship's captain to be able to make these changes occur gracefully. Initially, each expedition is scheduled in detail; i.e., what is to be done each day, and from what location, and where you are going to be two weeks from now. This is all planned out ashore, long before anyone comes on board ship. When you get to sea, however, numerous unplanned things happen, such as rough weather, problems with winch cables, winch breakdowns, power failure, and a multitude of other problems that were not on the

original "master plan." This would mean numerous changes in the original itinerary. Innovation is the key to solutions. It is then up to the coordinator of the expedition to determine and implement whatever changes might be required or be possible. The job of being the managing scientist of the expedition is not easy. It involves dealing in a tremendous complexity of personalities, temperaments, and priorities for different scientific programs. On board ship we had a staff of meteorologists, seismic personnel, chemists, and microbacteriologists. We had the bottom-sampling group, biologists, and geologists — each one with his own specialized expeditionary program, involving problems to which he wanted solution values on this one trip. This expedition might be the last chance for years to collect the data required. To consider all this within the framework of 34 men jammed into a tiny 143-foot ship, it was amazing that so much was accomplished. Many times disagreements would occur about whose project would receive the highest priority at a particular station. In fact, frequently one of the biggest controversies involved discussions as to where the ship should properly be. One scientist would want to be to the west, while another would want to be to the east. Some wanted to stay on the present station for an extra day or two, while another group would want to get underway and head 300 miles south. Also involved were the effects of the ever-changing conditions of the sea. Certain scientific activities could not be conducted at all in rough waters. Other activities could. If it was good weather and calm, coring operations could be conducted. The bottom-coring personnel would naturally wish to take advantage of calm sea conditions and stay longer, whereas the other participants would be anxious to move on. The scientific leader on board a research ship on a long expedition certainly assumes a ticklish and delicate combination of responsibilities, involving both the technical evaluation of problems in addition to the personality factors. It is not a job which is easy, as some might imagine.

One of the blessings for everyone that came out of our smallest specialized sub-groups was the "radio shack" (the radio operator: a group of one). Art Carter provided the entire crew in the morning with a typed-out summary of the news which he would pick up by listening to the overseas radio late at night. He then typed it and presented the single copy for our entertainment and information, with breakfast, and sometimes it included tidbits of shipboard gossip. Thus, we had our own newspaper, which was "published," under a variety of titles, such as "The Horizon Sword of Truth," "The News, Nothing But the News," etc. It was typed on long rolls of

teletype paper. Sometimes our newspaper would be 30 feet long! We would sit side by side in the galley, and slide the long strip of news along, reading each morsel as it slid by. It was probably the most widely read copy in newspaper history.

Much of the ocean that we were now covering was completely unexplored. This was intentional. There seemed little point in steaming directly toward Honolulu, because that is a well-traveled route. We therefore proceeded on a zigzag course pattern across those ocean areas on which ships rarely travel. In this particular case, our general trend was toward the equator. At a certain southerly point the ship would then head for Honolulu. The laboratory watches were alternated daily so that you didn't stand the same evening watches in succession. They were gradually rotated so that everyone had an even chance to get the "mid watch" (the least-favored midnight to 4:00 A.M.). During every watch a consistent and continuous system of record-keeping was maintained. This included frequent monitoring of the fathometers that provided a continuous track of the bottom depth and all the configurations of the bottom as we proceeded. At a later date this information would be used to improve and update the charts of the ocean bottom. We also used the GEK regularly. This device was used to record the variations in the magnetic lines of flux in the earth. The BT winch (an abbreviation for bathythermograph) was used every hour. This device recorded the variation in water temperature on a continuous basis from the surface down to 800 feet. It recorded the temperature gradation on a smoked slide. The readings were obtained when the ship was under way, but a degree of human skill was required. The little BT power winch was operated from the side of the ship. One would lower the recording device — which looked like a rocket — over the side, and let it drop, free-wheeling, to a predetermined depth. Then the brake would be applied, stopping its descent. Winching power was then applied to reel the device back to the surface and aboard. This operation would be done, in most cases, when the ship was underway at 10 knots. At night the BT operator found himself at the side of a rolling ship in total darkness, with the spray and the waves only a few feet below his feet. In any kind of rough weather, this BT position was frequently subject to waves making a clean sweep of the deck. In spite of breaking waves over the side, the operator had to hold his station, because the equipment was already over the side. One could not run for shelter, as the brake and hoisting power were combined in a single hand lever. To let go of this lever would cause all the wire on the winch to unwind, sending the recording device and all its cable to the ocean bottom

forever. It was not at all uncommon, from the protective position of the laboratory door, to look back and see your watch-mate at the BT winch completely disappear from sight as a wave would come crashing over the side of the hull and sweep aft over the BT winch and its operator. We were always very careful in rough water to watch our companion when he was aft on deck. Under those conditions, no one else would be in the stern area. A man washed overboard without an observer would have little chance of survival. We also took turns taking BT readings. It wasn't fair for only one person to get wet consistently — why not alternate the soakings?! At night, the possibility of getting washed over the side was very real. We tried to be very careful on that slippery, heaving deck.

There were several occasions, while operating the BT winch, particularly between midnight and 4:00 A.M., when I would ask myself: "What the devil am I doing out here?" My thoughts at that time would be on my dry, soft stable and warm bed waiting for me at home. I longed for an uninterrupted night's sleep. While standing alone, soaking wet and cold on the back end of the ship, careening through the ocean with my hand on the BT winch handle, I would frequently question the importance of my involvement in data-gathering for scientific evaluation. At age 17, there seemed to be several shipboard scientific activities that did not appear to me to be very relevant to the present world, or important to the extent of the hardships and costs involved. Now that my perspective includes a number of additional years, I can appreciate that one very frequent observation of new scientific inquiries involves considerable skepticism of their merits. In most cases, however, the observer is considering only the short-term view, as was I at 17. New investigations almost always appear, at the time of inquiry, to have little consequence to the "real world." This is particularly true for those who are not personally interested in the subject. How completely senseless our expedition must have appeared at that time to those who were not interested in oceanography, or those who, in general, were not interested in obtaining new knowledge about the oceans! The cost of running a ship at sea with the personnel we had aboard was approximately $1,000 a day. Those that support basic research — learning more about the earth and the universe (particularly those who supply the capital resources for doing so) — have to be either highly perceptive or highly dedicated to the <u>longer</u> term view. American industry has a tradition of looking ahead. It is fortunate, for us, that it does!

On Tuesday, August 1st, we arrived at another pre-arranged station. The Kullenberg core sampler was made ready for descent.

We also rigged our small boat, the "tuna tender," over the side for a trip over to the Navy "857" for a new supply of movies. Actually, the movie exchange between ships consisted of a mid-ocean bargaining session — each side trying to get the best from the other and exchanging for it the worst that they had! Bartering was lively, noisy, and an amusing sight. Involved was our 18-foot "tuna tender" alongside the comparatively huge Navy ship. Scores of Navy men lining the rail were engaged in spirited and enthusiastic argumentation. As the expedition continued in the weeks to come, this movie exchange became an intensely competitive event: Scripps vs. Navy. The all-important question after each session was: "Who got the shaft and how vigorously did our 'ambassadors' represent our interests?"

Hoisting the tender back on board the *Horizon* frequently was difficult. Weighing over one ton, the boat had to be hoisted to the boat deck, which was some 20 feet above the water. As the ship rolled, the boat deck was very unstable as a hoisting platform. The tender would crash into the side of the *Horizon* and then swing far out away from the hull and then once again come crashing in. We had to be very careful not to get caught in the middle.

It was at this station that we first had our encounter with the sport called "Sharks." Late in the evening of August 1st, we discovered a large shark nearby and decided to catch it. A very large shark hook was baited and dropped over the side. The fight was on! And after some struggling, we got the shark alongside and over the rail, aft near the laboratory. I dashed for my camera to get a shot. By the time I had returned, the shark had bitten the steel hook in two! We were amazed at the shark's toughness. Even with the tremendous punishment of being beaten with a fire axe, it was rare that we could penetrate the shark's tough skin. Sharks must be among the most durable creatures in the sea.

After 9 days at sea, many of us were out of clean and dry clothes. Our imaginative engineers rigged a portable scrubbing board for us on the port side at the rail. On the board we would do our washing in seawater and rinse in fresh water. Looking out across the vast expanse of puffy tropical cloud patterns overhanging the sparkling white-capped sea, with sounds of rushing bubbles passing by the ship, presented the most exotic environment for "washday." What a magnificent "bay window" to enjoy while working on domestic chores. These were the moments that offset the BT winch operations after midnight. But even those moments (or hours) in the wind and cold held their unique charm, magic, and fascination, as the stars and the sea blazed in twinkling light.

To those who are unfamiliar with shipboard life, it might appear that a four-hour watch separated by an eight-hour off period would offer a comfortable working schedule. This might be so if one could depend upon this schedule. On a research vessel there is no such thing as a standard day or schedule. The eight-hour so-called "off" period was frequently unreliable. If a bottom core was being lowered or raised, which might take 10 to 15 hours, those responsible for the coring program would, of course, be on hand. If they needed additional assistance, they would call those required, whether they were on or off watch. Everything seemed to evolve into a day-to-day, hour-to-hour continuing evaluation of our activity schedule. When additional assistance was required, one of the less popular tasks was being assigned the job of groping around in the "pit" to wake the wanted man — who just might have been on deck for the past 24 hours. It was very hard on one's popularity to bring those tidings. I dreaded being selected so frequently. Sleep interruption became a way of life. A point was reached when many of us with 15 or 20 minutes to ourselves could lie down anywhere and go to sleep. Soon there were hammocks strung from bulkheads and stanchions — great for cat naps. When mattresses were brought on deck, as the tropical heat set upon us, the captain put his foot down: "No mattresses on the weather decks. They are a hazard to the deck personnel at night, and they will get soaked in salt spray in heavy weather." By now the "pit" was a sweltering 95 degrees, with humidity over 80% (no air-conditioning back in those days). It was a great temptation to sneak a mattress topside in the middle of the night. (The captain's judgment was correct, however.) We in the "pit" envied the meteorologists living in their now-comfortable tent on the foredeck. The cool ocean breeze made their quarters the most desirable of any on board.

An excerpt from my diary revealed on Saturday, August 4th: "We arrived on our new station and scheduled a full planned day. First, 1:00 to 6:00 A.M., we dragged the trolling net, then sent down 2 little Phleger corers, then refueled the 857 from which we hoped to get 3 more movies. We will drag the trolling net again, and after that I will do my wash. Later we will get another core, and to top it off for the day, we will send down the [Heat] Probe. I have the 8:00-12:00 watch on the BT, and we are out of milk. I am going to start using those calcium pills my mom made me take." A rather full day of activities!

On the evening of August 6th, we selected one of the three movies previously obtained from the Navy ship. We naturally hoped that we had the better part of the bargain in this latest round of

exchanges. With great eagerness, we put onto our ancient sound projector the film "Outpost of Morocco." It turned out to be a disaster from the standpoint of entertainment. The sound was absolutely terrible — no one could hear a word of it. The Navy had really done it to us this time!

For the next few days we were on a stop-and-go basis, spending a few hours at each station. At these station stops we performed some coring operations; sometimes the heat probe was sent down; other times we would go very slowly through the sea, dragging our nets behind, trying to obtain biological samples of very small sea creatures. There was also that frequent operation with Dr. Raitt's seismic buoys, his multi-hydrophones, and his multi-miles of cable strung out to sea astern of the ship. It was during one of these brief stops that we had the heat-probe lowered. When it was time to pull the probe out of the bottom, the ship no longer was positioned directly above the instrument. The sea current apparently was unusually strong and the ship had drifted away from the vertical. As a result, a tremendous amount of tension was required in order to pull the probe out of the muddy bottom. In attempting to do so, the cable snapped, resulting in 5,200 meters of cable being lost and the probe itself. What a disappointment for "Mr. Probe" — Art Maxwell — to lose his instrument. Fortunately he had a spare. The cable loss, however, represented a very high percentage of what we had on the drum (5,200 meters is approximately equivalent to 15,600 feet). The decision was made to splice together end to end the wire from the ship's other smaller winches. In this manner, all of the various cables would be combined onto the big winch. The splicing operation took the better part of a whole day, as every strand had to be joined carefully together. Cables of various sizes were spread along the entire length of the ship. Weaving each wire strand was tedious and cumbersome work. When the job was completed, the main winch drum had a combination of 5/32, 9/16, and 1/4 inch wire. The total length was now 5,500 meters, or about 16,500 feet.

The temperature range had become very steady and typical of the tropics (between 80 and 90 degrees). The humidity was quite high, probably near 80%. We continued to develop new shipboard diversions that generally occurred late in the afternoon about sunset. Sunsets and cloud formations in the trade-wind tropics are glorious sights to behold. One of the crew, Mike, had a Spanish guitar on board. We frequently would congregate on the stern late in the afternoon and sing various songs until the sun went down. These were also the occasions when we would have bull sessions relating

to the way-out theories held by some of our scientists and crew members. I imagine that one might today classify those sessions as being the 1950 versions of what is presently called "brain-storming" sessions. Needless to say, at 17, I was tremendously impressed by some of the scientists' views. For example, Dr. Revelle seemed to be most interested in the feasibility of towing icebergs into temperate parts of the world, as a new source of refrigeration and fresh water. He would calculate in his head the estimated pulling force required to drag an iceberg at 2 knots. On one occasion the captain attempted to explain celestial navigation to some of us. I didn't hear all of his explanation nor did I understand very much of it.

On Friday, August 11th, we arrived at Point Able, which was our most southerly position. From this point we turned and began heading northwest toward the Hawaiian Islands. The 857 stayed behind so when we arrived at our next station on Sunday, she would be quite a distance astern of us. This arrangement made it possible for us to experiment with those hydrophones again. As the Navy ship proceeded toward us, they dropped and exploded small TNT charges in the sea. We would then pick up the sounds through the ocean from the explosions. Dr. Raitt was very hopeful of obtaining excellent long-range sounding records of the bottom profile, and the approximate density and composition of the bottom sediment layers. Maybe even the hard-rock structure under the soft bottom sediments could be detected. Sunday, August 13th, was our 18th day at sea. We had not seen another ship, other than the 857, nor any land, nor plane during that period. From my diary of Monday, August 14th, this combination of entries was made: "I had the 12:00 - 4:00 midnight watch. . .how gay! Last night we caught an 80 pound shark and watched the movie 'Kiss the Blood Off My Hands.' It was a good picture but the sound was lousy. Tonight I have the 8:00 - 12:00 watch. No sleep. We fueled the 857 and again tried our luck at the movie exchange. It rained all afternoon. Also the 857 reported that she had burned out another clutch. I have been very careful in rationing my candy. So far, a crew member, Buck, and I have been splitting it. There is only 1/3 left. There is no station today so not much doing. I certainly need that! Dr. Revelle sent home a message on radio telephone concerning our well being. I am having trouble getting my laundry, reading, watch standing, deck work, sleep, and all the odd jobs done and still have time to learn more about trigonometry and physics."

The following day at another station we were taking a core. The weather was so warm and the sea so flat that we all decided to go for a swim — in spite of all the sharks. This type of research ship

is an excellent platform for diving, as much of the scaffolding and high super-structure make it possible for very large leaps through the air into the ocean. Some of us managed to dive from the top of the A-frame, a drop of some 30 feet. We all had fun talking underwater near the hydrophones, which would amplify the sound of our voices and broadcast it over loud speakers on board ship. Human voices under water sound like monsters of the deep! Poor Dr. Raitt — What is this expedition coming to?! Those hydrophones were so sensitive that one could hear over the loudspeaker the sound of a nickel being tapped on the deck of the ship, even though the microphone pick-ups were some 300 feet astern. One could imagine the sound volume our voices must have had as we shouted and screamed under water near those microphones. We weren't too popular as we boarded the ship. It was during this swimming party that Robert Dill decided to use some soap for personal washing. In this case we were using Dreft. The idea caught on: a good salt-water bath with Dreft soap. We found later that it was extremely hard to get the damned soap off, and we all ended up feeling terribly greasy. As it turned out, Dreft was never intended to be used in salt water. That evening there was a very strong odor of smoke near the room where all our explosives were stored. We rushed down below and found that it was the fathometer, which was overheating.

Continuing from the diary: "The sea condition ever since Point Able has been completely flat. There has been no wind, but very heavy rains occur off and on periodically. When it is possible, Captain Faughn frequently chases rain clouds so that the ship can get a fresh water wash down, and we can get some laundry and bathing done — including washing our hair in that nice soft fresh water. The rain chase episodes are always lots of fun. An interesting feature is the fact that once we get in one of these tropical downpours, the visibility becomes nearly zero. One can't see too far, so it's very difficult to stay under the rain cloud. We often use full power and a tremendous amount of maneuvering rudder just in time to discover the ship is emerging into bright sunlight, going in the opposite direction from the cloud. We then have to use our full rudder and wide-open power to reverse the ship's direction in order to re-enter the cloud for another deluge.

"The scientists are trying to teach me how to use the slide rule as an improvement over long-hand mathematics. I am finding that over a period of time I can use the slide rule with some degree of confidence. Since our period at sea is now in the 3rd week, it has been decided that now is the time to bring out the beer and make it available in limited quantities for an hour or so late in the afternoon

at the traditional sunset get-togethers. The charge is 15¢ a can (12 ounces). Our movie last night turned out to be another grand slam for the Navy. It was by far one of the worst. 'Northwest Stampede' was terrible, both sound and picture. Since movies generally last till 10:00 P.M. I wasted quite a bit of sleep for that stupid nothing, and had to stand the midnight watch to boot! The crew always seems optimistic that the next movie will be better. The captain announced that we should be able to sight the island of Hawaii tomorrow."

The excitement aboard the ship in the anticipation of seeing land after almost a month of blue ocean produced a very festive spirit. On Monday, August 21st, I got up at 7:00 A.M., and found outside the ship the magnificent and beautiful island of Hawaii only 5 miles away. What a staggering sight. I remember being thrilled at the sight of land and all the greenery on that island. How lovely and how colorful! It just didn't seem possible that the earth had any land — we were so used to just seeing water. I kept looking back at that island, expecting that it would not be there. The city of Hilo was directly in front of us and Mauna Kea to the right and Mauna Loa to the left. Such gorgeous, fertile countryside. For the first time in 26 days we saw an airplane fly by — a DC-3. Everyone wanted to go ashore, but the decision was not to do so. The ship was allowed to drift just off the coastline. We spent the day washing, cleaning, diving and swimming. The current slowly brought the ship down the side of the island, giving us a slow-motion view of its entire expanse. How beautiful this place is! So many waterfalls, descending over the big cliffs and falling with great spray directly into the ocean.

The next day we headed out to sea for one last station from which the island was barely visible. Then at 3:00 P.M. we got underway and headed under full power for Honolulu. That night we saw one of the very few good movies. It was "Command Decision." Everyone thoroughly enjoyed it. At 10:00 A.M. the following day, we picked up a pilot and docked at Pier 27 in Honolulu. This island is fertile and green also. Soon the crew members were scattered all over the island in pursuit of their own personal points of interest. I found myself spending a good deal of time on Waikiki Beach, seeing the aquarium, and consuming great numbers of banana splits and ice cream and all those things which were not available on ship. At one time or another during the day or evening, I saw almost every shipmate at various spots on the island. In port for the first evening, many crew members returned to the ship feeling no pain. They were in a very festive mood. We ended up with a great

firecracker display occurring on the fantail, which gradually expanded to include inside areas. Even the "pit" was not immune to firecracker explosions. It wasn't until after 2:00 A.M. that things settled down and we could all get a little shut-eye. The following day we moved the ship to Pearl Harbor, and stayed there for our remaining stay at Honolulu. I took a guided motor tour of the island, all the way around, and enjoyed watching the surfing regatta which was being conducted that weekend. Then began my stocking-up program: collecting all those goodies that on board ship are so much in demand at sea — such as a very substantial quantity of candy and chewing gum.

At 2:00 A.M. on Sunday, August 27th, we once again got underway and departed from Pearl Harbor for Kwajalein Atoll, part of the Marshall group of island some 2,500 miles west. On Monday, we planned to lower the huge Kullenberg core sampler. The flat bottom, which we had passed the day before, was exactly what we wanted to sample. The decision was made to backtrack, to retrace our path to find this ideal flat bottom. We all got a very good chance to see what an ocean-going tug was like in a rather mountainous ocean. The *Horizon* was a converted Navy tug and as we went crashing into those trade-wind seas she sure threw a lot of spray and was very jerky in her motion. Ocean-going tugs are rather blunt-shaped ships. When we found the proper flat spot, the large core-sampler was laboriously lowered over the side and the cable payed out. At first everything went smoothly. After 3,600 meters of cable were out, the clutch started slipping, and the winch started to run wild. All the brakes were jammed on full. The winch drum came to a squeaking halt. We noticed that this motion had also caused the core sampler to trip itself — which meant that the "audible ball-buster" was now hanging in a position that would not give us warning as to when the core rig was near the bottom. (In order not to ensnare the coring rig after it reached bottom with additional unwinding cable, someone invented the "audible ball-buster," which upon tripping would send out sound waves which could be heard on the shipboard hydrophones.) Under the circumstances, the only thing that we could do was to pull the Kullenberg core-sampler back aboard. Much to our dismay, the attempt to hoist revealed a slipping power clutch. Our engineers tightened the clutch several times. In doing so, they got the clutch to hold, but now the motor could not pull the load. Finally, our chief engineer, John Massey, tried a method that worked. He put full power on the electric motor in neutral, and then jammed the clutch into gear, and in the same instant released the winch brake. In doing

so, the core rig gradually began to come up. Once the rig was back on board, we investigated the cause of our difficulty. We discovered that the tension of the cable on the drum due to weight accumulation had bowed the flanges of the winch drum outward in such a way that the bolts holding these drum flanges were now rubbing and jamming on the surrounding structure. This winch was completely inadequate for this type of oceanographic use. We were sure that in subsequent expeditions a greatly improved type of winching system would have to be designed!

At 4:00 A.M. the next morning, August 29th, electrical storage batteries high up on the boat deck broke loose. As the ship wallowed in the trough of the seas, they slid from one side to the other, throwing battery acid over the deck. One battery eventually disappeared over the side. The wind continued to blow at approximately 30 miles per hour and shipboard life was somewhat uncomfortable with all the pitching and rolling. One of our biologists, Robert Huffer, passed out cold with no warning. He seemed to be quite sick. We found him lying in the scuppers at the rail on the main deck. During our evening meal he passed out again at the dinner table.

The following day — Wednesday, August 30th — we were underway until 2:00 P.M. Dr. Revelle decided that he wanted to let out all of the cable on the big winch. (Through some ingenious persuasion, Dr. Revelle had arranged for a new supply of cable to be installed on the large winch while we were in Honolulu.) By emptying the drum of all its cable, Dr. Revelle was hopeful that the release of accumulated tension of all that wire around the drum would allow the flanges to straighten. He reasoned that this might stop the binding that occurred on the previous occasion. The procedure was commenced. It was 10:00 P.M. before we were able to unwind all the cable into the sea and then wind it all back up again. The operation did produce the results Dr. Revelle had envisioned. The flanges were now straight again so we had the main winch back in operation. The next morning we came across what we hoped was a flat-topped sea mount, known in geology as a guyot. All day we ran a zigzag pattern across the ridge. The depths would vary from 2,700 fathoms up to 850 fathoms. Early in the morning we maneuvered to a high spot on the ridge. We then prepared to lower the dredge. This awkward piece of equipment consisted of chains, acting as a sack behind the steel framework. The purpose of the dredge was to drag the bottom to pick up whatever samples could be trapped. The first time we lowered it we retrieved nothing. The second time it buried itself in the mud and we couldn't extract it. Finally we pulled so

hard that the cable broke. What an empty feeling when one sees the cable tension go limp — knowing that the whole rig is lost. We then lowered a Phleger corer to try to obtain a bottom sample. The sample turned out to be a small quantity of Globigerina ooze. In order to obtain more coarse material, we lowered what we called snappers. These small retrieving devices obtained very little. A smaller core sampler was lowered. It had poor results. These operations continued throughout the night. A second dredge was rigged and lowered. This time several large rocks were recovered. To our surprise, they were basically nodules of pure manganese dioxide. The dredge again was lowered. This time we received a haul of a large quantity of rocks, all with the black composition of manganese dioxide, with a scattering of white-colored coral-like sponge, long and thin in shape. In one of these manganese dioxide nodules a rather exciting discovery was made. One of the scientists observed a shark's tooth protruding out of the black composition. A process of dating the age of the formation and the shark began. The next day the dredge was lowered again. We obtained several large rocks that had petrified Foraminifera included in the manganese-dioxide rock mass. These rock structure samples were new discoveries. The scientific staff was working at an accelerated pace, trying to obtain all of the samples possible. We moved the ship in search of a flat spot, in order to obtain a core sample of sediment rather than the rock-like structure we had recently retrieved. During the night the wind came up to 30 knots. The ship began to pitch. A big wave lifted the bow far out of the water and then she dropped. Her nose completely buried into the next wave. As I opened the laboratory door to look out along the main deck, a green wave of water went rushing by, carrying with it many articles, such as paint cans, shoes, clothing, etc. Those "lucky" meteorologists occupying their comfortable tent at the bow were getting a real soaking now! Some lost much of their personal clothing and equipment. After that the ship was slowed down. By noon it was calm again. We rigged the Kullenberg core sampler as a flat spot had been located. There had been very few flat spots since Honolulu, and those that we were able to see on the fathometer tracings were very small in size. The core was brought up late that night. It had produced only a 3-foot sample containing rough gravel. Trolling nets were lowered late that night. We towed these nets for plankton samples throughout the evening. It was now September 5th. We were still looking for a good flat place to do some coring. Since Honolulu, a zigzag course pattern in general had been followed, covering as much untraveled area as possible. In this irregular

manner, we were slowly working our way out toward Kwajalein Atoll. While this search for flat spots continued, Dr. Raitt's seismic equipment was called into service.

We detonated small charges of TNT off the ship while Dr. Raitt's hydrophones were strung out to sea astern. This effort was to determine whether the bottom below the ship would have a soft covering of sediment or whether it would be rock. On one occasion, a TNT charge was picked up by a shark. When the explosion went off, it made a rather substantial red patch in the ocean, but there was nothing to be seen of the shark. A promising position was located through seismic methods, and a Phleger corer was lowered. From this we obtained a 7-inch core composed of red clay and gravel.

In the evening I assisted Dean Carlson in preparing a numerous series of bottles with messages in them in several languages, to be dropped over the side at different intervals. By this procedure, it might be possible to know more about the ocean currents. These bottles would disperse over many many months, possibly years, to locate on far-away shores. Who knows, some swimmer or shore stroller in a foreign country might pick up one of these bottles, read its message, and write a letter to Scripps! From such a response, the general course of the ocean's surface currents could then be computed.

For the next several days we continued our zigzag course, taking dredge hauls as frequently as we could. In one haul we brought up some fossil coral which meant that at some ancient time the ocean floor at this point was near the surface of the sea. Ed Hamilton was very enthusiastic about this discovery. He was working on his doctoral thesis, and the subject was on the origin of the truncated or flat-topped sea mounts (guyots). This discovery was crucial to the theory that truncated or flat-topped sea mounts became truncated as the result of surface ocean action during some period many millions of years ago when these mountains were at the ocean surface and after truncation were submerged. During their period of time at the ocean surface, coral accumulation did occur. Our obtaining fossil coral on these truncated mountains, many thousands of feet below the ocean surface, would prove their origin.

I spent several evenings working in the bacteriology laboratory. With all these bottom samples now accumulating in the lab area, a great deal of analytical and chemical analysis was being made. I assisted in making silica tests, washed and sterilized many test tubes, and did the other odd jobs that were necessary to the procedures. On Tuesday, September 12th, our plans were changed. Instead of going to Kwajalein Atoll, we would first go to Bikini

Atoll. The 857, also referred to (by us) as "the great greyhound of the sea," left Honolulu on September 11th, after having her propeller shafts relined. Now we could look forward to getting back into the movie exchange business, and of course were eager for our mail. The laboratory procedures relating to all this coring work and bottom-sampling work were beginning to assume a most organized structure. On the 12:00 - 4:00 A.M. watch I started in the bacteriology laboratory in preparation for a coring operation. We hoped to start in the early morning. It was very much similar to preparing a surgical operating room for a major operation. The laboratory was thoroughly cleaned, as was all the testing equipment to be used in the various chemical, biological and geological analyses. A significant amount of research information would be lost if the samples obtained were allowed to become dry or to age. Certain tests had to be performed immediately. A dimension of urgency and speed seemed to be present.

In the morning a Phleger core was obtained and extracted. It was then described in detail, while notes were being taken. A dissection was then performed wherever layers of different materials were observed. Tests for iron, phosphate, nitrate, silica, hydrogen, iron content, and oxidation and reduction content were made. My job was mostly to clean and sterilize the instruments, bottles, and test tubes. Also I added, very carefully, measured amounts of acids and bases into different solutions. At last my "official" job description as "Laboratory Helper" was being fulfilled in practice. It was exciting and interesting work. We worked at these procedures day and all night. For this type of operation the clock would not stand still — the work must be performed now.

The following day I got up for one meal and then crashed to sleep. The day and night procedures, however, continued in the laboratory for another 24-hour period. In a dredge haul the eardrum of a whale or porpoise was found. We did have our relaxation moments within this rather pressing schedule. In the galley on the evening of September 14th, Mike had his guitar and was playing to the voices of 10 enthusiastic singers. Dr. Revelle was really booming out the notes. Frank Vaughn, our head cook, stole the show by blowing a tune on a gallon cider jar. He wore his glasses which made his eyes look twice their normal size, and he had a ruddy complexion. While blowing high notes on that jar he looked like a bomb about to explode. What good times we had!

On September 15th we obtained a core barrel of Globigerina ooze. Our work in the laboratory then became almost frantic. This

sample was some 20 feet in length. The numerous steps in analysis of this core sample had us working for another 24-hour period.

The following day, late in the afternoon, the 857 appeared slowly over the horizon. It was certainly good to see her again. It was nice to see anything floating! We lowered our lifeboat. Bob Dietz, Carl Shipek, and William Menard were taken back aboard the 857. They had been on board our ship temporarily while the Navy ship had been undergoing repairs. In exchange for these fine gentlemen, we were able to bargain and get two movies. These were the first we had seen since Honolulu some 21 days earlier. We also got mail, which stopped everything on board the ship until it was read. Promptly at 8:00 P.M. we warmed up our ancient movie projector to view a movie called "Scene of the Crime," starring Van Johnson. In spite of the great sales pitch by the Navy regarding Van Johnson's acting ability, the film and picture were quite poor. If it hadn't been for such high expectations before each show, we probably would have given up attempting movies on board ship a long time earlier. (Hope springs eternal...) With so little in the way of major diversions to experience, the movies were about the only universally controversial subject on board ship in which all participants had equally bad information! The members on board ship had almost equal vocal opinions. Fortunately, none of these opinions could ever be proved in advance. So blind hope became our ultimate sanctuary. There we would be, all crammed into the sweltering eating area adjacent to the galley, watching the flickers, as the ship rolled slowly back and forth, while her diesels roared out their monotone. Attendance was nearly 100% for each showing, except for the watch-standers. Another curious thing about movie time on board ship was that, in spite of how bad they got, no one seemed ever to get up and leave in the middle. We all seemed to be hypnotized at seeing on the screen automobiles and on-shore activities. We became fascinated by the possibilities of an improvement in the film as the movie progressed. But, as on so many previous occasions, the movie did not improve and the hour became late. It was my fortune to have the midnight watch from 12:00 till 4:00 and my new watch partner was Robert Huffer. The 857 was with us again, so Dr. Raitt was really back in his business. As usual he was raring to go. An intensive seismic program called the "leapfrog technique" was started. This required that the Navy ship approach us from astern and proceed on ahead, dropping TNT charges at periodic intervals. Then in the evening we would chase after her while she lay motionless. By morning we would be many miles ahead. Then we would stop, string out the hydrophones for listening purposes, and

Eating lunch at Bikini Island encampment "Little Petunia." L to R: Edward Barr, Bob Dill, Duane Carlston, George Brayton, Wayne Runyon

Quarters below on R/V SPENCER F. BAIRD, Alan Jones, top bunk, Ned Barr, center and John MacFall lower bunk.
Capricorn Expedition