EXPLORING THE DEEP PACIFIC

By HELEN RAITT
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INTRODUCTION

ROGER REVELLE

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Have you ever asked yourself: “Why is there an ocean?” This question probably would not occur to a fish. Immersed all his life in his watery medium, he would think the universe must be made mostly of water, and that such a state of affairs is natural and proper. Nor, unless we give special thought to the matter, is the question likely to be asked by us human beings. The ocean is so incomprehensibly big, so noisily uncommunicative, so alien to our human affairs, that we are likely to take it for granted as simply one of the background facts of life. But to a man from Mars, on Earth for his first visit, our ocean would be a major mystery. His own planet is dust-dry; there is scarcely enough water on its surface to make a little cap of hoar frost around the poles in winter. The Venusians, Saturnians and Jovians would be equally puzzled, for Earth is the only planet with seas and dry land. So far as we know, there is no water at all on Venus. There is plenty on Saturn and Jupiter, but it is frozen in great shells of ice and snow that cover their entire surfaces. Only on Earth are the waters gathered together in a world-girdling...
ocean, surrounding the great islands that we call continents.

The pattern of sea and land on Earth makes our own lives possible, and it provides diverse environments for the wonderful variety of living things that share our planetary home. The scientists who study Earth, and try to decipher her long history, are convinced that this pattern is no accident. In part it may have originated when our globe was being formed, four or five billion years ago. But to begin with, the oceans were probably small; the mighty flood of waters we see today may have grown almost drop by drop, throughout the lifetime of our planet, from water seeping out of the interior. We oceanographers have never been able to make up our minds as to what actually happened, because in fact we know so very little about the ocean.

If you pick up in your hands a terrestrial globe and hold it so that Tahiti and the surrounding islands are directly in front of your nose, you will see almost an entire hemisphere of blue, with only bits of North America and Australia cutting into the edges. This is the Pacific. The German geographers used to call it “der Grosse oder Stille Ozean”—the Great or Quiet Ocean—in blissful ignorance of its roaring gales and terrible hurricanes. The very existence of the Pacific has been known to white men for only a few hundred years. Less than 200 years ago, say at the time of the Boston tea party, most of the islands that dot its surface had never been seen by a European or an American. Today all the islands are on charts, though often the chart makers are not quite sure about their size or shape or exact location. But the land beneath the waters is still largely unknown. There are many areas of tens of thousands of square miles without a single sounding. One can hardly go out over the deep Pacific in modern oceanographic ships without discovering
several previously unknown submerged mountain peaks, and sometimes even a mountain range beneath the sea.

This ignorance is not for want of trying. Beginning with the great British *Challenger* Expedition in 1872–1876 there have been many oceanographic and hydrographic expeditions into the Pacific. But the scale of effort was inevitably small in comparison with the giant size of that ocean. Moreover, until the last few years, the methods for penetrating beneath the sea surface were inadequate to give more than a vague, and in many respects a quite erroneous, picture. The only way to find the bottom depth was to lower a long wire into the water with a weight at the end, and to measure the length of wire paid out when the weight touched the bottom. It was as if surveyors were trying to make a map of the United States by flying in a blimp above a cloud layer and lowering a wire from the blimp once or twice a day!

One day during World War II, I received a telephone call from a young lady in our Navy’s Bureau of Ordnance. “What is the bottom of the ocean like?” she asked. “I need to know for a classified development project.” As an oceanographer masquerading temporarily as a Naval officer, I was shocked. How could anyone ask such a simple question about such a complicated subject? I told her that if she would come over to my office I would give her a lecture of several hours’ duration. But she said she was in a hurry and hung up the phone after I told her that in some places the deep sea floor is rough, hilly, and rocky, while elsewhere it is flat and muddy. Over the succeeding years I have occasionally thought about this young lady. I have slowly come to realize that in fact she extracted from me in that one sentence all I knew at the time about the floor of the deep sea. It is only because of the oceanographic research that began
on a large scale during the war, and has been continued more intensively since, that we are beginning to
get a real picture of the broad features of the deep-sea floor, and some idea of the curious and characteristic
ways in which it differs from the familiar surface of the land.

The development of electronic art has made possible new methods of oceanic exploration. For example,
with the aid of a marvelous gadget called the recording echo sounder, we are able to send a short, sharp
sound straight down toward the sea bottom (somewhat like clapping our hands through a megaphone) and
to measure the time required for the echo to return from the bottom to the ship. Such depth measurements
can be made quickly and continuously, and recorded automatically on a chart, so that we can make a
profile or cross section of the shape of the sea floor along the ship’s track. By putting the cross sections
from many cruises together we shall eventually have a map of the land under the sea almost as accurate
and detailed as our present-day maps of Mexico and South America.

The Scripps Institution’s Capricorn Expedition, which Mrs. Raitt has described in this book, was one
of a series of exploring expeditions into the deep Pacific sent out by many countries since 1946. Other
expeditions, some of them much longer and more ambitious in scope, have been carried out by the Swedes,
the Danes, the British, and the Russians. All these cruises had essentially the same purpose: they were
voyages of discovery in which new instruments for oceanographic exploration were pitted against the vast
unknown of the Pacific Ocean. Our expedition differed from the others chiefly in the variety of instruments
used and in the greater diversity of interests of the scientists on board.

Some of the members of the expedition were interested in the electric currents in the atmosphere; others
wanted to
measure the speed and variability of the water motions in the sea, or to collect the tiny floating plants and animals called plankton. But most of us were marine geologists and geophysicists, and our ultimate objective, to be attained only after many expeditions and much working up of the results obtained, was nothing less than to write a history of the ocean, extending back through the long reaches of geologic time.

Like any other historical research, the problem of deciphering the history of the ocean is a detective problem. The historian of human affairs can often use the confessions made by historical personages. The geological historian has no such advantage. There are no written records. His evidence must be entirely circumstantial, a patient piecing-together of many kinds of clues into a convincing case. What are the clues that may tell us something about the history of the ocean? One of the most dramatic are the coral islands or atolls, which lie like carelessly tossed necklaces on the velvet sea throughout the western tropical Pacific. Each atoll, though it reaches only a few feet above sea level, represents the summit of a mountain peak higher than Mount Shasta, rising steeply from the deep sea floor. In the atolls that have been examined carefully during the last few years, there has been found an ancient volcano at the core, 70 to 100 million years old. The top of the old volcano is now thousands of feet below the sea surface, although at one time it was an island rising above the sea. Above the volcanic rock is a great bone pile, the skeletons and shells of plants and tiny animals that lived in water less than 100 feet deep. We can deduce that for nearly 100 million years the sea level has been rising continually, relative to the old volcanoes, but we can not tell as yet whether the volcanoes sank back into the crust of the earth like corks...
being pushed into bottles, or whether the whole floor of the central Pacific has slowly subsided as water was squeezed out from the earth’s interior.

The great trenches or deep submarine gashes that surround the central Pacific floor give other clues. A major objective of the *Capricorn* Expedition was to study one of the most majestic of these, the Tonga Trench, 15 to 30 miles wide and over a thousand miles long, striking nearly due north and south between Samoa and New Zealand, and extending downward beneath the sea nearly a mile further than Mount Everest rises above it. This black and rocky chasm, as steep-sided as the Grand Canyon and seven times deeper, must have been formed by giant stresses deep within the earth’s interior. That these stresses are still violently active is evidenced by the volcanic explosions and earthquakes that every few years rack the Tonga Islands.

Other clues come from measurements of the heat flowing continuously out of the earth through the bottom sediments into the ocean, and from the sediments themselves. These are deposited so slowly, and each sediment layer reflects so accurately the conditions in the overlying waters at the time of deposition, that they constitute the best available record of events on the earth during the great ice ages of the last million years.

A most significant clue comes from the character of the rocks far beneath the ocean floor. One of the remarkable scientific discoveries of the postwar years has been the finding that the rocks which underlie the continents down to depths of 20 miles form only a thin veneer, about four miles thick, beneath the oceans. Below twenty miles under the continents and four miles under the oceans there is a sharp change to a rock of unknown character. Some scientists think that this subcrustal material is like the rock of the
diamond pipes of South Africa, others that it is like stony meteorites. We know from measurements of the earth’s density and the speed of earthquake waves that this rock must be very heavy and very hard. It probably has a high percentage of iron and magnesia.

The very shape of the sea floor gives evidence for our history. In the eastern north Pacific there are long narrow zones of parallel high ridges and deep troughs, somewhat like the great north-south ridges and valleys of East Africa. These are zones of fracture, where the earth has crumpled under great stresses. Around the volcanic islands of the Pacific, for example Tahiti and the Marquesas, the sea bottom is a flat, nearly level plain, sloping gently outward from the islands for several hundred miles. These plains may yield evidence of great volcanic outpourings that have shaped large parts of the sea floor.

But I am not writing a book about the history of the ocean. This is supposed to be an introduction to a book about the historians themselves and how they go about their job. Mrs. Raitt has attempted, gallantly and honestly, to describe the life of an oceanographic ship. To a considerable extent she has succeeded in reproducing the noise and uncertainty, the small triumphs and tragedies, the mistakes in judgment and execution, the lucky chances and hard-won successes of scientific work at sea.

Of course, our expedition was in a wonderfully romantic part of the world, the islands of Melville and Gauguin, of Loti and Maugham. To all of us there was something bitter-sweet about the contrast between the hard and rather grim work at sea and the lotus lives of the islands. This also is one of the ingredients of this book.

Oceanographers are essentially just sailors who use big words. One of my land-loving scientific colleagues is fond of
quoting Dr. Samuel Johnson, who said “No man need go to sea who has the wit to get himself in jail.” My own belief is that Dr. Johnson was a congenital landlubber. The fact is that most sailors when they are on the beach look forward longingly to being at sea (when they are at sea, of course, they can hardly wait to hit the beach). I have often wondered why it is so pleasant to be on a small, oily, and uncomfortable ship, far from the nearest land. This is true even in the midst of a vicious storm, let alone on one of those wonderful days in the tropics when the sea and the air are smiling and calm. I am convinced that it is because on shipboard both the past and the future disappear—only the present is left. You can’t do anything about your mistakes of yesterday; the future depends so much on the unpredictable whimsies of ships and the sea that planning for tomorrow is futile. It seems to me that Mrs. Raitt has succeeded in capturing this spell of the present, which is the essence of being a sailor. Reading her manuscript has given me a great deal of pleasure because it has helped to recapture many things that were among the most real of my experience.
ACKNOWLEDGMENTS

An expedition to study the ocean is a joint effort of many: the men on ships who have gone to sea before us; the oceanographic institution that sends out the ships; the crews, the technicians and the scientists aboard. On Expedition Capricorn the Navy Department was also a partner in the enterprise.

In like manner this book was the work of so many people that it is difficult to know whom not to thank. First of all I should thank my companions of Expedition Capricorn for accepting me aboard the ship and assisting me in the preparation of this manuscript. My apologies in advance to them for any mistakes I have made in reporting their work.

I am also greatly indebted to two people, Roger and Ellen Revelle, who helped make it possible for me to go. Nor could I have gone on the journey or finished the book without the love, cooperation and patience of my family, all of them.

Sam Hinton, curator of the T. Wayland Vaughn aquarium-museum of the Scripps Institution of Oceanography, has provided this manuscript with illustrations and maps, and John MacFall, expedition photographer, has furnished many photographs. I am indebted to them and to the Scripps Institution for use of this material.

For careful and generous reading and criticism of the
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But I could not have finished the book as it is today without the able assistance of oceanographer John Knauss.

Thank you, everyone,

“Ofa atu,”

Helen Raitt
1. SOUTH SEA MEETING

I suppose I shouldn’t have come. All the cautious people said No. This is a foolish venture.
I can hear their voices: “We told you it couldn’t be done. Meeting an oceanographic husband for Christmas! Stupid woman, give your husband a break. You shouldn’t go to the South Seas anyway. That’s a world of brown women. Have you read Michener?” “Yes, I know, I know.”
But . . .
Other oceanographic wives have met their husbands in Mexico, Panama, Italy, England. Why shouldn’t I meet Russell in the South Seas?
The expedition on which my husband had embarked, with other University of California scientists, was the largest yet undertaken by the Scripps Institution of Oceanography. Our men had previously made trips (in cooperation with the Navy Electronics Laboratory at San Diego) up in the Arctic, on a long shuttle down South America way, and out as far west as Bikini. Now it was Expedition Capricorn. This would involve two ships, the Horizon and the Spencer F. Baird—the ship Russ was on as Senior Geophysicist. They were to travel together exploring the ocean depths through
the South Pacific over a course of 20,000 miles, stopping at Suva, Pago Pago, Tahiti, and the faraway Marquesas. This was a wonderful trip, straight across the great South Seas.

Both ships had been at Eniwetok during the atomic tests. They had made an oceanographic survey of the area and Russ had made some seismic measurements to learn about the structure of the coral atoll. Scripps had also, I knew, designed and built a large amount of special equipment for making observations during the actual tests.

When I knew for certain that my husband would be in Suva, Fiji Islands, on December 3 and in Samoa for Christmas, I secretly resolved to be in those two ports with him. For years the job of raising four children had more or less prohibited such excursions. But this fall seemed to be an auspicious occasion to spend Christmas away with Russell. My eldest daughter was married. One son had graduated from college and entered the Navy. Another son was in love, at college, and working. He said, “I can only be home one day.” And Martha, aged thirteen, had said, “I want to go to Grandmother’s for Christmas.” So my trip wasn’t impossible from the point of view of family considerations. And, in a way, it seemed it was now or never. A geophysicist studying the earth beneath the Pacific sails to many parts of the ocean, not at times that fit his (or my) wishes, but as opportunities arise. My enterprise began to take shape. When Russell left early in October, I said “I’ll see you at Christmas!”

My only chance to meet the expedition was to fly to Suva and then come home by freighter. I secured my passports and visas, took all sorts of shots in the arm, and on Thanks-giving Day I was at the San Diego airport with my friends and family who had come to see me off. I was heavily laden with clothes for roughing it on coral reefs with Russ, clothes
for being the proper lady in the tropics, a white hat and dress for church in Samoa. I was carrying a bulky camera, a portable typewriter, and even planned to buy a ukulele in Hawaii. I was sorry to be leaving alone, that the two other wives I had hoped would accompany me could not go. But I was on my way.

Now I was in Fiji, 6,000 miles from home, waiting for the *Horizon* and the *Spencer F. Baird* to show up. Was it only a month before that I had left La Jolla, California, on a cold winter’s day? Now it was summer, although December, and I had not brought a sweater, nor would I need one.

Suva, I soon discovered, was a town with sights, sounds, and smells that appeal to all the senses—especially the pungent smell of copra. This was a world where fuzzy-haired, lovable, courteous, husky Fijians lived side by side with sad-faced Indians. Here was the typical white man in the tropics, dressed in white shorts, white shirt, and high white wool socks, sipping his tea or gin fizz served by a tiny Indian boy. On the street, the strongest specimens of men I’d ever seen, the Fijians, passed by.

But no ships, no husband, no news! Imagine my chagrin when I called on our ship’s agent in Suva and got more questions than answers.

“We heard that your two ships were coming to port November 25. Then we heard December 3. Now it’s December 7. Where are they?”

“I wish I knew,” I said wistfully.

“What are they doing?”

“Studying the ocean,” I replied.

“They wrote months ago that they would need fuel and supplies here,” the ship’s agent from the Burns Philp company told me. “We’d like to know their needs.”
“I’m sure I’ll receive a cable by the first of the week,” I had answered, with conviction I did not really feel.

I couldn’t tell these Fijians what I suspected to be the situation. This Scripps-University of California expedition had not originated in the same way as other globe-encircling trips of this century, such as the ones made by the English, or the Swedes or Danes. On those expeditions, plans had been made several years in advance; notices, articles had been sent ahead, and finally the *Challenger*, the *Albatross*, and the *Galathea* had arrived in ports amidst great fanfare.

All I could state was that our ships would leave Kwajalein atoll in the Marshall Islands about the middle of November. A plan had been publicly announced. But no mention was made of how the ships got there. I couldn’t state that our oceanographers had been gone a long time and were engaged in secret work of top priority to our country and that perhaps they had been delayed. I couldn’t describe the activity all last winter when the men had worked feverishly for months, day and night, in their labs at Scripps, getting their equipment ready for some project that was hidden with the strictest secrecy.

Nor could I reveal how they had quietly disappeared last fall, two or three at a time, with no fanfare, bound for the Pacific, destination unknown, no address.

The men in Fiji said our ships were two weeks late, but they had been lost to me for months. I had no idea in what condition the ships would arrive, what they had seen, or what their needs would be at this port.

I knew only that they left behind at Scripps this fall many homes with lonely women, the men vanished for months. Finally, the newspapers told us that a thermonuclear bomb had been exploded at Eniwetok. Our anxious
days of haunting newspapers and radio were over. But when asked, “Where is your husband?” our answer had been simply, “Away in the Pacific.” This was still the only answer I was permitted to give the officials of the Fijian government.

Of course, I knew that when the tests were over, our ships were to take a Scripps expedition for the first time into new areas of the South Pacific. The little 143-foot white ocean-going tug, the *Horizon*, had been on our earlier expeditions, and it quietly left first for its unannounced destination this fall.

One day, Len Usher, Public Relations Officer for the Fiji government, had news for me.

“We have traced your ships to Ocean Island, but have no idea where they are now,” Mr. Usher said.

“You know, we expected them two weeks ago.”

Again I made an attempt at an explanation. “Yes, our ships have been delayed, have had real difficulties with equipment,” I invented. “Our long cable was late in arriving at the dock in San Diego.” And I told the story of our fabulous winch, which has a cable that can stretch 40,000 feet down into the ocean, the longest cable on any American ship and especially designed for Expedition Capricorn.

“You know, the Galathea was here,” Mr. Usher said with his eyes glowing. This was a statement I had heard more than once. I had been in La Jolla when the round-the-world Danish oceanographic vessel, the *Galathea*, arrived. I had been a guest aboard the slim white vessel and well remembered the cordial reception we were given. They had set an all-time high in international oceanographic entertaining. Could our ships meet their challenge?

I visualized our two little work-weary tugs pulling into
port, tired and dirty after nearly three months away from all civilization. How could we have an open house for this hospitable British-Fijian-Indian town?

Yet Roger Revelle, director of the expedition, had said before leaving La Jolla that we must give a party aboard and that if I arrived in Suva first, I should see what could be done.

I had begun to like Fiji. It had that beautiful combination of enough civilization for the fastidious, but many inaccessible, out-of-the-way places for the curious. Although Suva was hot this time of the year, there was often a cool breeze, and who would go to the tropics, anyway, if he were not willing to accept heat? The temperature rarely went above 90° or below 60°. The hot season was from October to March and the cool from April to September. It was hot and rainy now. Hurricanes were also the subject of conversation this time of year. Suva had recently been hit by a hurricane which ended the life of one of the hotels and blew off the roofs of many houses.

I liked the Grand Pacific Hotel, known as the GPH, where I was eventually able to find accommodations. This hotel appealed to me, perhaps, because I’m the romantic, impractical type anyway. It was a large, squarish two-story building with a huge hall in the center and the dining room at one end. Winding carpeted stairs led up to a balcony that ran around the center hall. When a guest wished to find the bathroom or the phone booth, he looked down on all those below and was visible at the same time to everyone present in the lobby.

The bedrooms had tall green-shuttered doors leading onto a huge veranda that encircled the outside on both floors. A quick tour around the outside balcony early in the
morning revealed what bedrooms were occupied and how. It would be too hot to sleep with these balcony doors closed.

I liked to have my tea out on this balcony in the cool early morning. Here I could look out at the green lawns, the palm trees, and the blue bay beyond. Some morning I would see Russ’s ship coming straight toward me in this direction. How long would I have to wait?

And then I finally received the long-awaited cable:

HELEN RAITT GRANPACIFIC SUVA
Baird Horizon arrive Suva eleventh x Revelle
Kibr

Here at last had been definite news for all the curious in Suva and for me, who was beginning to wonder if I should ever have tried to meet the ship in the first place. I had not known the ship’s call letters, nor had anyone else in Suva. In reply I sent the ship a message and received this answer:

HELEN RAITT GRANPACIFIC SUVA
Hope depart fourteenth x glad give cocktail party on board x you arrange dates and invitations x arriving early morning twelfth Pago Pago Christmas x

Roger

Christmas in Pago Pago! My excitement and relief at the cable’s arrival were offset by the bad news this second wire brought me. Would I be stranded in Fiji and have to spend Christmas alone in Suva?

Russell had been right when he said that meeting oceanographic ships would be a difficult feat. Our ships’ delay had been fatal to my well-laid plans. Now, although I knew the Horizon and Baird would arrive and refuel and we’d
give some kind of a party aboard, I would be left on the dock when they departed for Samoa on December
14.
For I probably couldn’t get to Samoa. I had thoroughly canvassed the possibilities of traveling from
Suva to Pago Pago, Samoa. I had been told there was an inter-island New Zealand steamer called the
Tofua.
After receiving the wire I went aboard the Tofua and made inquiries. From Suva each month it made a
ten-day trip to Nukualofa, Vava’u, Niue, Pago Pago, Apia, and then back to Suva. All for $70. But this
December the Tofua was not going toward the islands until after Christmas—which meant I could not be
with Russ on Christmas!
I canvassed all the shipping offices and finally resorted to buying the Fiji Times and Herald, which gave
me news each day of ships in ports. One day I noticed a little squib about the Tielbank, a copra steamer of
the Bank line, which was bound for Tonga and Samoa.
I went immediately to the company representing the Tielbank, only to be told, “This freighter isn’t a
passenger ship. The accommodations would not be suitable for you, Mrs. Raitt.” I wondered, whatever
could be so wrong with this ship?
“But I’m willing to accept any accommodations in order to be with my husband on Christmas,” I had
answered.
He had been firm. “I’m sure you can find a better way. Have you tried Teal Airways?”
It was useless to explain that I had tried every way out of Suva that had been suggested, even the New
Zealand Air Force.
“Will you give me the name of the Captain of the Tielbank? I would like to invite him to our ship’s
party.”
One day I went to Mr. Usher’s office behind the large room where the legislative council convened,
there to address
the invitations to the long list of officials he had given me.

I wrote on the envelopes: Ratu Sir Lala Sakuna and Lady Maraia, Ratu George Tuisawaii O.B.E. and wife, Ratu G. K. Cakobau and wife. Chief Ratu Cakobau was a direct descendant of Fiji’s famous Cannibal King of earlier days. In addition to these Fijian chiefs, chosen for their positions of trust in the colonial government, I wrote other names: Vishnu Deo, J. Madhaven and wife—leaders of the Indian population. I was inviting all members of the legislative council, which, together with an executive council, governs this British Crown Colony.

The problems of this colony revolve about its racial division. In 1946 the Indian population surpassed the Fijian. Of the total population of about 300,000 people, 47 per cent are Indian and 44 per cent Fijian. The rest are Chinese, Rotuma Islanders, Europeans, and islanders from all the other parts of the Pacific.

Luckily for me, I had received help with my problems. I had met young Granger Johnson on the plane coming from Nandi, and he had introduced me to his family. His father proved to be the head of one of the large trading companies of Fiji, and one of the able men on whom Suva depended. Although of New Zealand parentage, Mr. Johnson said proudly, “I’m a Fijian. I was born here.” He was a short, thick-set man, briskly energetic, with a tanned, ruddy face. Everyone in Suva called him Tui, which means “chief.” He was of the greatest help to our expedition and its problems.

Then two days before the ships arrived, Winter Davis Horton, Jr. (nephew of the actor Edward Everett Horton), showed up in Suva. Winn was acting as purser for the expedition. With him came the Swedish geologist, Gustaf
Arrhenius, and Ronald Mason, English geophysicist, all just in the nick of time to go with me to the reception at the Governor’s, to which we had been invited. I had been afraid that I would be the lone representative of a seventy-man expedition.

Finally Friday, December 12, arrived. I was unable to sleep. I was up several times during the night, dashing to the veranda to look out on the ocean where I hoped to see the *Baird’s* lights. At five-thirty A.M. I started down to the dock to see if our ships had come to port. I found, not the *Spencer F. Baird*, but Tui, his two sons and Rhodes Fair-bridge, a geologist from Perth, Australia, who was joining our ships at Suva.

Some of us went back to have breakfast at the hotel. It was after breakfast when I heard a shout from Winn. “Helen! There she is!”

I rushed out to the back veranda. I had looked longingly in this direction for so many days. Could I believe my eyes? The *Spencer F. Baird* was slowly steaming into the harbor. Grabbing my blue plastic raincoat and wishing I had a black Fijian umbrella instead, I started out with Winn on the ten-block walk to the dock.

What a reception in the pouring rain! The ships came closer and closer. Not even the Fijian stevedores were on the dock for atmosphere, it was so wet. Only our small group eagerly awaited their arrival. The *Horizon* was following close behind the *Baird*. Winn let out a loud call resembling the bark of a seal and was answered.

Now I could see Russ, hale and hearty, standing on the deck. He was brown, slightly thinner, but with that happy twinkle in his eye, obviously glad to see me. This was worth all the waiting.

I saw other friends: tall, blond John Isaacs, near the bow,
watching the docking operation with a quizzical eye, his unruly hair standing on end as always. There was Roger Revelle, standing on deck in his khaki shorts and shirt, a six-foot-four, 200-pound man, smiling down at us with his all-inclusive loving smile and saying, “It’s good to see you.”

The ships tied up to the dock, but no one was allowed aboard yet. I called out to Bob Dill, “Here’s a letter for you from your beautiful wife.” (Gloria had asked me to deliver it as she saw me off at the airport.) Bob for once didn’t clown, but grabbed the letter. Then I handed Walter Munk the slide rule he had forgotten and I had been commissioned to bring him. He had been a friend of ours for many years and fired questions at me in rapid succession.

Standing beside Walter was Bob Livingston, our doctor, a professor at the School of Medicine of the University of California at Los Angles, who had joined the ship at Kwajalein. He was a vital member of the expedition, in charge of the aqualung divers and of the health of all. Soon he was conferring with the Port Doctor.

Fijian government officials finally pronounced the ship clean. They didn’t like Spencer, the ship’s hound. “You have diseases in your country we want to keep out of Fiji,” they said, referring to rabies. After Spencer was locked up, we on the dock were allowed to go aboard.

I knew again, by the way Russ greeted me, that he was glad I had come. We had much to talk about as he packed to go ashore with me to our living quarters at the GPH.

There was not sufficient dock space that day for the two ships, so the Horizon moved alongside the Baird. This meant that the entire party would have to take place on the Baird. How 250 guests would ever get aboard the ship I did not know.

Our men somehow managed to find clean clothes, and
they really looked quite presentable as our guests began to arrive.

On our one little ship there came such an assortment of people! Large Fijian chiefs with their bushy hair, dressed correctly in white suits; small Indian officials, their wives wearing colorful saris; the Catholic bishop, the Protestant ministers; ship captains; New Zealand Air Force officers; government officials; businessmen of the town; doctors—everyone.

Our guests, after being welcomed to our ship by Roger Revelle and Walter Munk, climbed down a narrow, steep ladder to the fantail where I greeted them and suggested food and drink. We also proposed tours of the ship, guided by our oceanographers. The lab was a very hot place in which to try to explain our equipment, yet the guests were eager listeners as our perspiring oceanographers answered their many questions.

Late in the afternoon, when the party was at its peak, the High Commissioner for the Western Pacific, His Excellency, Mr. R. C. S. Stanley, and his daughter arrived, followed by the Governor and his wife, Sir Ronald and Lady Garvey. Suva was receiving us most warmly indeed! I was hopeful that the party was a success even though crowded, and I still marvel that nobody fell into the sea.

The shipboard party was only the beginning of a whirl of luncheons, dinners, and parties that never stopped—a luncheon at Harold Gatty’s, the feast and night at Deuba, the party at the Hedstroms’ home. I can’t remember when I slept. Finally on Sunday night, after a supper served on Tui Johnson’s porch, we went into a huddle over the future plans of the expedition.

It was taking longer than anticipated to repair the broken
cable on the *Baird*. Obviously the ships could not reach Samoa by Christmas and carry out the program at sea that had been planned. Yet Roger wished to have Christmas on land somewhere.

“What better place to be at Christmas time than Tonga?” said Tui. “Why don’t I cable Prince Tungi for permission?”

Tui, it seems, was the Tongan government representative in Fiji. He and Roger disappeared from the party for a time and then came back with the following cable. Tui was certainly a man of action.

**WIRELESS: HRH TUNGI NUKUALOFA**

Scripps Institution of Oceanography of University of California ships *Baird* and *Horizon* at present in Fiji in charge of Director Roger Revelle conducting geophysical and oceanographic research intend making scientific survey of Tonga deep within next two or three weeks. Director Professor Revelle in view of long time expedition will be away from United States desires do utmost maintain morale of scientists and crews by spending three days over Christmas under most congenial conditions available. I have taken liberty of informing him that I would communicate with your Highness seeking permission vessels to remain Nukualofa during that time. Expedition is fully authenticated and Revelle believes his men are well behaved and trustworthy. Mrs. Raitt wife of a senior scientific member requests permission land Vava'u ex Tielbank then proceed Nukualofa by local vessel if available or expedition ship there await husband then depart Tofua 29th December kindly telegraph if permission
The next day we heard that our request had been granted by Prince Tungi, and I found that luckily the Tielbank would take me, so I purchased a ticket for Vava’u for $17. I packed one suitcase for Russ to take on the Baird and the other for Vava’u. The Baird’s cable was still not repaired, and I found that my ship would be leaving at daybreak. I would leave Russ and the Spencer F. Baird still in port.

But it was hard to part from Russ when there were so many uncertainties about when we would meet again. I stood on the deck of the Tielbank among an Indian crew and waved goodbye to him as we pulled quietly away from the dock at 5:30 in the morning.

As we went out into the harbor, I also waved to the Baird, now anchored well out from shore. I wondered when I would see her again. I was off on the second leg of my Expedition South Pacific.
2. MY TONGAN FAMILY

Friday, December 26

The freighter Tielbank was a tramp which, after picking up cargo all over the South Seas, was on her way home to Glasgow after a year away. Although she had been partly loaded with copra meal and copra oil, we still rode high in the water. Captain Aitkin expected to take on more copra at Vava’u.

The whole ship was permeated with its smell. At first, in Suva, I thought the smell of copra unpleasant; it even seemed to me slightly unclean. By now it had become a friendly odor associated with this world I’d begun to love.

I was told by Captain Aitkin that a rhinoceros-beetle infestation had come to Vava’u in Tonga. This was a pest greatly dreaded by coconut growers, and rigid means have been devised to fight it.

Beetle-free ports will not receive ships that might bring them the beetle in a copra cargo. For instance, the Tielbank could not go to Nukualofa in Tonga or to Suva after loading copra at Vava’u. But she could go from Vava’u on to Samoa, where they have the beetle, and then deliver the copra from both these islands to England.

“If it weren’t for the beetle, we wouldn’t be going to
“Tonga now,” he had told me. “We would have been there.” So I had the rhinoceros beetle to thank for all my adventures.

On the *Tielbank* there were Indians to fetch me to come and eat the heavy English meals we were served, and Indians who said their prayers facing Mecca each sunset and dawn. My fellow passengers were the Stephens family, who promptly adopted me. “Mum,” Sela Stephens, was a Tongan matriarch of seventy-five, returning to her own land after forty-five years away in the New Hebrides.

Forty-five years ago she had left Tonga with her English husband and had traveled over a thousand miles of water in a small 28-foot ketch. Now she owned a New Hebrides island where she lived, surrounded by the forty-four members of her family, counting sons-in-law, daughters-in-law, and grandchildren. Her English husband had recently died, and her half-Tongan son Oliver and his New South Wales wife were taking her back to see her family in Tonga.

They gave me lessons in the Tongan language. I typed out vocabularies for each day and learned to say *malo a lelei* (Good day) and many other words. In the evenings I got out my ukulele to play for Mum, and we persuaded Oliver to sing. These were the first Tongan songs I’d heard.

The early morning when Mum and I stood on the *Tielbank*’s deck together and saw our first glimpse of the little islands of Vava’u was memorable. The ship wound its way up a channel through clusters of small palm-covered islands. We proceeded slowly up the tortuous course, and I began to see small villages on the water’s edge. Surely this was one of the most beautiful harbors in the world.

Around the final bend, so small a distance that some could swim it, we saw Neiafu, the chief village of Vava’u. People were walking toward the dock. Mail and news from
the outside world came here only once a month on the island steamer, Tofua, or on an occasional tramp copra ship such as the Tielbank that makes this a port of call.

A Tongan medical practitioner who had boarded our ship pointed to a large frame house near the shore, saying that it was run by a woman named Ana Falekava and that she had taken guests before. Perhaps I could stay there. The ship tied up to the dock and preparations began for loading copra.

I stepped down the long, treacherous gangplank and went up the street toward the village green. It was very hot for midmorning. Many barefooted Tongans were already busy at the stores. Both men and women wore a ta‘ovala, or the “fine mat,” tied around their waists with a kafa cord. Some of the women wore a long vala (a sarong-type wraparound) under their dresses. The men wore shorter valas.

I had walked about two blocks when I came to Falekava’s, a faded frame house with a long veranda across the second story. I entered the hall and stepped into a room, bare except for a table in the center. Here I met Lisiate. He was a tall, lean, barefooted Tongan wearing a white shirt and a black vala about his waist.

He had an unusual face, one that caught my attention immediately. The lines etched in this countenance showed a life of thoughtfulness for others. He must have been in his forties.

He spoke to me quietly in English. “Won’t you sit down?” He found me a chair. “Tell me your problem.”

I explained to him about the expedition, my husband, meeting the ship in Tonga, and that I needed somewhere to stay until I could get to Nukualofa.

“We didn’t know you were coming. We would have been ready. We will take care of you,” he said gravely. He took
me up some steep stairs to the second story and showed me a room in which there were a bed and a small wooden table. The bed was a mattress laid on tapa and fine mats, and resting on springs.

“This is fine,” I said. “Now I should perhaps go back to the ship and get my bags?”

“I will meet you there with a lorry,” Lisiate said. Getting my possessions through the customs was a long, hot and complicated business. Fortunately Lisiate worked in the customs office, and he was most helpful.

He loaded my belongings in the truck along with those of the Stephenses. I said goodbye to Captain Aitkin and others and we were all off to Falekava’s. I had left my ship. I belonged to the village now. A little fearfully I tried out my Tongan vocabulary.

“Malo a lelei,” I said when I reached my Tongan home, and met Lisiate’s wife, Kaufoou. I put out my hand and she took it in a friendly manner and smiled at my greeting.

“Malo a lelei,” she said.

I soon became the fine eiki amelika (American married woman) of this village. That is what they called me in their conversation. In less than an hour after we arrived, the town, I am sure, had any particulars about me they needed. There was no necessity for newspapers or radios in this village.

Lisiate had brought his family to live with Ana Falekava, his aunt—a portly, quiet-speaking woman—when her husband had died. Now eleven or more lived there with her. To wake up in the morning and find that Kaufoou and her young sons had been sleeping on a mat on the porch floor beside me was a new experience.

In Vava’u it was very hot, as Vava’u was closer to the equator than Suva, and there was no breeze from the sea.
in this village. One wiped the perspiration from his face every five minutes. Doors were never closed—it was too hot—and there was no privacy. Nor would one expect privacy in Tonga. Life had form here, conventions, dignity—but not privacy.

Members of the Falekava household would come to my room, squat on the floor, and happily watch me at whatever I was doing.

Each day I could hear Kaufou’s soft voice call to me as I went by: “Where you going?”

They were my family, and I felt that I belonged to them.

Among the 10,000 Tongans on these eighteen or more islands was one American woman from San Francisco, Pat Matheson. She had come out here, married a Scotch doctor, Farquhar Matheson, who was connected with the tiny hospital. This couple had a three-month-old baby, the only white child in Vava’u. Pat became my friend, and through her I met a Tongan woman, Tu’ifu’a, for whom they had named their daughter.

I enjoyed the hours each day I spent with Tu’ifu’a, a young unmarried educated Tongan woman about thirty years old, who spoke English and had high rank in the village. Her father was related to Prince Tungi’s wife, Princess Mata’aho. Tu’ifu’a was not a plump Tongan woman, but stood straight and thin, about my height, 5 feet 6 inches, and had dark brown hair and lovely, sensitive eyes which showed great compassion and understanding.

When Tongans walk together hand in hand they do it in a slightly different manner than we do. They intertwine the two little fingers rather than the whole hand. It was thus that I walked down the street with Tu’ifu’a when she took me to a cowboy movie at the Funga Lelea theater, and to
church with her on Sunday. As we walked, she told me about the life of women in a Tongan village.

Women in Tonga are responsible for cooking the meals, washing the clothes, making mats and baskets, and preparing feasts. Also, women are truly respected in this kingdom ruled by a woman, Prince Tungi’s mother, Queen Salote.

When Tu’ifua told me that no woman has to go to work for money in Tonga, I asked her “Why do you suppose Vivi helps Kaufoou at Falekava’s? She comes every day, and, as you know, sometimes helps serve our meals.”

“Kaufoou probably asked her to come and help her,” said Tu’ifua.

Here everyone works together. Kaufoou was never alone in her kitchen. Perhaps this was one of the secrets of Tongan life, part of the happiness of their women. No woman is shut up alone in her house as in our world. There are no lonely widows, unhappy spinsters. Everyone is part of a family group. They belong to the family, whatever its size, share in the events and work of that family and that village. They have a feeling of kinship, of belonging, that we have lost. All children are loved. There are no orphanages or insane asylums in Tonga.

Had I known definitely when I would next see Russ, I think I would have enjoyed my days in Vava’u even more, for it was a most beautiful spot. But it was strange to be waiting there for some ship to come take me away. I could not communicate directly with the Baird, and had no real knowledge of what had happened to her.

On my fifth day there the Tongan government ship Hifofua was at the dock and I, with many other Tongans, purchased my $5.00 ticket to go to Nukualofa for the holidays.
My fond farewells were colored with many promises to return on the interisland steamer, the Tofua, after the holidays. In the customs shed my typewriter, ukulele, camera, books, suitcases, and all possessions were given a sticker which said:

“This is to certify that this package has been inspected by — and is entirely free of eggs, larva, and adult stages of rhinoceros beetle.” I was now officially beetle-free.

When our ship pulled away from the dock, I smiled to myself and thought of all the American friends who had said, “You won’t mind what kind of a ship you travel on.” I didn’t. But they should have seen me on this ship, a native interisland schooner 90 feet long. On the deck with us were several pigs that became seasick and added their vomit to the conglomeration of other smells. We had chickens, babies, and perhaps sixty or more deck passengers, who swarmed all over the little schooner. Soon the stern was completely covered by mats and each inch of space appropriated. Here these experienced travelers prepared to eat, cook, sleep, and live for twenty-four hours. I joined the pigs, the crew, and Betty, the village nurse, out on the bow. My ukulele was immediately appropriated by the crew with my permission, and we began to sing. From that moment on, the crew, from the Captain down to the cook, took me on as their personal responsibility.

I have never had such attention on any ship, nor a chance to hear native Tongan songs for so many hours on end. Obviously, American women do not often travel on this Tongan government boat, as there are only a handful of Americans in the whole kingdom of Tonga. I met three.

Apparently a singing papalangi (white person) from faraway America was a novelty. As we became friends, I showed them all my pictures of Fiji, told them of my love for
Vava’u and how no other port could be so beautiful. I brought out song music I had collected on other islands. Later Captain George showed me his charts of the ocean, and we discussed our course to Nukualofa.

At supper time I was called to come below and eat with the cabin passengers, my friends the Stephenses, a meal of hardtack, canned beef, rice, and canned fruit. I found that the man to whose cabin I had been assigned was a Tongan Mormon missionary who had joined the ship above Vava’u.

Not feeling up to sharing the tiny cabin with a man and not knowing what is done in Tonga, I thought the simplest solution would be to stay up all night. I did not realize that this presented a problem to the polite Tongan crew.

“We take care of our women first,” said Captain George to me. And I looked at Betty and her friends already stretched out on the deck below, apparently fighting off seasickness. But they were set for the night. They had brought mats and were prepared. Even had I wanted to stretch out on the deck, there was no space by now.

“I’d like to stay up and watch the sea and stars,” I said. “I don’t travel at sea very often.”

“You are welcome to come up on the bridge,” he said. “But I will give you my bunk below.” I thanked him and assured him that he was not to worry about me. I stayed awhile below and saw all the crew go in and out of his tiny hole-in-the-wall cabin where apparently ship’s supplies were also kept. I thought I’d try the bridge.

Here I had a cool ride on this strange moonlit night, and music, and long chats with the few who spoke English. I learned again the Tongans’ lack of fear of sharks.

“If you are not afraid of them, they won’t bite you,” said Harold, one of the crew.

Up here also were forms stretched out on every foot of
free space. If one put out a hand, one touched a sleeping body in the dark. From my board seat on the
bridge I could look down at my friends lying on their mats on the fantail. They made a fascinating picture,
one I wish I could have recorded—men, women, babies, grandmothers, an Oriental in purple trousers, a
very few half-white little Tongan children, but all quiet and uncomplaining. Mum, too, was there on the
deck below, sitting erect, smoking, wide awake.

On the bridge, perched next to the Tongan boy at the wheel, was a native girl whose metallic voice
added to the music of those of the crew as we sang late into the night and early morning.

Finally at three in the morning we came in sight of Kao, a volcanic island in the shape of a perfect cone.
Nature seldom produces such symmetrical forms as this on so grand a scale. No one was left awake on the
bridge but the man at the wheel and myself. Deciding I’d risk the cockroaches below, I went to the cabin
and slept soundly for two hours on Captain George’s bunk. Since he had made himself as comfortable as
possible on the bridge deck, I thought I’d better use his bunk. I never saw a cockroach.

The kindness of all on the boat—to me, a woman from a foreign land—made me reflect again on
this unique little kingdom of Tonga and marvel at these curious, intelligent, friendly people. Among all
Polynesians they are said to be the strongest and fiercest. They are certainly wonderful physical specimens.
But why had I not heard more of Tonga?

The hidden, unknown, nearly landlocked harbor of Vava’u had not been described, at least to my
knowledge, in tourist literature, geologic literature or even in the National Geographic, yet it must be
one of the ten most beautiful harbors in all the world—of this I was sure.
From the Tongans I learned about the antiquity of their country. They have preserved the names of their rulers for over 1,000 years. They told me the legend of their origin, how the great Maui from the underworld went to Samoa to obtain a fishhook from an old man there, Toga Fusifonua, and then, using the hook, pulled up Tongatabu and the low islands of Ha’apai, Vava’u and the Niuas. The high islands of Kao and Tofua were made of chips thrown from the sky by the stonemason god, Tagaloa Tufuga.

“Where did you Tongans come from?”

“Samoa,” was the answer. The language, customs, and stories are more like the Samoan than any other Polynesian culture. *Tonga* means “south.”

The Tongan government, alone of all the Polynesian peoples, has maintained for over a hundred years an enlightened policy of “Tonga for Tongans.” Here in Polynesia is a monarchy which is financially solvent, has no public debt, is ruled by a Queen, a Prime Minister, and an elected parliament of cabinet ministers and commoners. The British Consul acts as adviser to the Queen in matters of financial administration and foreign affairs.

After breakfast we were back on the bridge singing. The guitar and my ukulele changed hands, and always the next man in any group seemed able to play. Finally the second mate, the ship’s best singer, joined us. He proudly sang what American songs he knew. Most Polynesians seemed to know “You are my sunshine, my only sunshine.”

Quite to my surprise he said “I’ll sing ‘I’m dreaming of a White Christmas!’” It was nearly Christmas, so many miles away from home for me. I said this would make me homesick and cause me to cry, and it did.

The Tongans took great delight in singing me into Nukualofa Harbor in the late afternoon so that I
really leave their ship with a feeling of nostalgia. They were so proud of their land! They pointed out the course we would follow as we went toward the large, low coral island with its fringe of Norfolk Pines. This was Nukualofa, “Land of Love.”
3. POLYNESIAN CHRISTMAS

The next day, Christmas Eve, I stood on the dock, waiting for our ships to come in. I had received a wire saying that the Baird was to arrive first, the Horizon later. I had a fancy purple-and-green sisi (Tongan version of a hula skirt) around my waist, just handed me as a gift from the friendly Tongan cook of the Hifofua.

A grim-looking Tongan official in khaki ordered me off the dock, but seeing tears in my eyes, relented and allowed me to hide in the shed. There I stood waving my red sarong in greeting. The Baird was flying a beautiful newly made red Tongan flag as she sailed into port and our little tug looked imposing. I was proud.

As the ship came closer to the dock the Hifofua cook asked: “Which is your mari (husband)!”

Fortunately for me, Russ was standing in a position of prominence on the bridge. This was pure chance. My friends from the Hifofua would never know a senior geophysicist of an expedition if they saw one, and they were always convinced that my husband must be Captain. We never managed to make it clear to all that he was not.

The ship was no sooner docked than the Horizon was alongside, and we were all soon lost in the excitement of a tropical Christmas Eve in this kingdom. What a Christmas! The whole island was alive. Lorries full of singers, musicians,
and dancers from every village on Tongatabu ushered in Christmas by serenading all over the large island the whole night through. I can still hear the high, metallic voices of the women singers combined with the deep harmonies of the men . . . haunting music. It must be that plaintive combination of primitive music overlaid with missionary hymn singing.

Also on this Christmas Eve we had an audience with Prince Tungi in his palace. Roger, Russ, and I walked across the green lawn to the *Palasi* (palace), a large white building two stories high, red-roofed, with towers and architectural gingerbread trimming. A Tongan government official of high rank, a nobleman, ushered us into a grand Victorian parlor where, in a large chair of state, sat Tungi, Prince and Premier. Over six feet tall, he is a huge, well-proportioned man with dark brown hair and a dignified smile. He says he weighs 323 pounds.

This was a prince who could trace his descent from ancient chiefs. His forebears ruled the Tongans before the Norman conquest of England.

Tungi’s mother, Salote, born in 1900, was the beloved and wise six-foot-three queen who had come to the throne when she was eighteen years old. She married a Tongan noble, Ulime Tungi, who became the queen’s consort and premier. He died in 1941. Queen Salote was away in New Zealand this Christmas, purchasing clothes to wear to the coronation in England.

Crown Prince Tungi, the elder of the two sons of this couple, was in his early thirties. The heir apparent had gone to college in Sydney and had taken an honors degree in jurisprudence at Sydney University. He became premier in 1945. He was married to the daughter of a noble family, Mata’aho, and had two small children.
Prince Tungi was dressed for our audience in crisp white cotton with his coat buttoned up to the chin. Around his waist he wore a wide, clean matting, *ta'ovala*, worn by Tongans. After chatting about our mutual friends and his visit to Washington, we told him how happy we were to be allowed to come to Tonga this Christmas.

Our audience was suddenly interrupted when the national anthem of Tonga was played outside on the lawn. Prince Tungi said,

“All the bands of Tonga are serenading the palace this Christmas Eve.” We rose and stood solemnly as the serenading band played the song to its end. I thought of Tungi repeating this act time after time through the evening. There are some disadvantages to being a prince.

While we were served tea in cups of delicate china on a glistening silver tray, Prince Tungi asked about the work of our ships in Tonga. Roger told him about surveying the deep Tongan Trench which lay parallel to the length of his island kingdom on the east.

“We are planning to cross this Tonga Trench about 25 times before we leave this area, and to take other geophysical measurements that have not yet been made.”

“How deep did you find the Trench?” Tungi asked.

“South of here we have found it to be about 35,000 feet deep,” Roger answered. “Your trench is one of the deepest spots in the world.”

Christmas day itself began with a church service, then a shipboard turkey dinner, and an afternoon of sightseeing and fun. The Tongans had loaned us two lorries which we piled into and drove about the island, even stopping for a swim on a coral beach this Christmas day.

The day after Christmas was Boxing Day. Prince Tungi and Princess Mata’aho had invited us to a great feast. What
trouble I had collecting an oceanographic family for the feast! It was more difficult than getting my own family of six to a wedding on time. To round up scientists in the middle of the day, when some are out “geologizing” and some are out diving, is a hopeless task, regardless of the occasion. Some of our men were already lost. With their usual cocksureness, the geologists said as they rode off in a lorry in the morning, “We’ll find the feast, somehow. Don’t worry, Helen.” And the divers, who wanted desperately to attend the event, were delayed by boat trouble. I hated to have any of our ships’ complement miss this great occasion.

We were taken out towards the sea to a little village where a canopy of mats had been erected on a white, sandy hill not far from the pounding surf, by the British Consul and his wife, Mr. and Mrs. J. E. Windrum. Here Prince Tungi and Princess Mata’aho and the entire village had prepared to entertain us.

Being the only woman of the expedition, I was given a pillow to sit upon next to Prince Tungi and across from Princess Mata’aho. When more of our group arrived, we made two long, straight lines facing each other, the men sitting cross-legged, Tongan fashion, on the mats on the ground. I was given an unusual floral neckpiece and a sisi for my waist, and every man was presented with a garland. Suddenly, off to our right, we saw natives bringing in huge litters of food. The first litter was placed in front of Tungi and Mata’aho and then another and another was brought in until all our mats were covered with a massive array of food.

In each seven-foot stretcher were golden-brown roasted pigs (with heads attached). Interspersed were large pink crabs, stalks of yellow bananas, large slices of red watermelon,
raw fish, whole golden pineapples, giant purple yams, white taro, orange-colored kumalas, food wrapped in green cooked banana leaves, red tomatoes and pale-green drinking coconuts. The whole gorgeous array was placed on large banana leaves.

We had been given tapa cloth napkins which had a cutout border design around the edge. Behind every guest stood or knelt a Tongan maiden to wait upon him and hand him any delicacy he desired from the lavish feast set before him.

Tungi for a time did not partake of any food but chatted with us. Later Mata’aho pulled some crisp pieces of brown skin from the pig in front of us and handed these to her husband.

I soon saw that we would never make even a dent on the tremendous quantity of food. The native villagers appeared in the background, and when we had finished they carried off the huge trays of food for the whole village to gorge upon. At the close of our meal a small kava bowl, filled with water in which floated tiny flowers, was served each guest for a finger bowl.

Natives beautifully dressed in flowers and sisis, their bodies shining with oil, began to dance for us to the music that a group of Tongans had been playing and singing throughout the feast. They danced in the sun on the white sand against a setting of pandanus trees, blue sky and ocean. Their rhythms were both like and unlike traditional hulas—more lusty, if anything.

Later, ladies of the village, regardless of age or figure, spontaneously joined in the dance. Everyone dances in Tonga. Dancing and singing are as much part of their life as are eating and sleeping.

Who would ever wish to leave such a kingdom? Not I. This feast, the many presents that had been given me, the
room-sized tapa cloth Prince Tungi had handed me—all showed great kindness and courtesy. At the party on our ship, later, each Tongan noblewoman asked if she could come, call, and bring me a gift.

But on this last day had come complicated decisions. My plans for future travel were again upset. I had expected to leave Tonga on the interisland steamer, the *Tofua*, to go on to Samoa where I could again meet the *Baird*.

But one of our men, John Isaacs, needed to return to California. Prior commitments had made his departure necessary. He, too, wanted passage on the *Tofua*. But only six Europeans could leave on the *Tofua* after Christmas, and many more were trying to go. If John and I both sought passage on the *Tofua*, it would place the Tongans in a difficult position, as I knew the *Tofua* was crowded with applications for passage. I had not quite bargained on being stranded a month in Tonga. But obviously it was more important to get John home than to get me to Samoa.

Roger said to me, “Since John has to return, why don’t you come aboard the *Baird* and go with us to Samoa? If the *Tofua* takes only six Europeans from this port, I doubt if you and John can both leave Tonga on the same trip.” Roger was right. I must either take the proffered ride on the *Baird* or be stranded in Tonga.

I was strongly tempted. I had always wondered how men work at sea. What were their habits? Cooped up for days in close quarters, did the men’s dispositions suffer? What were the difficulties of work at sea that Russ had mentioned? Here was my chance to find out.

But if I went on the *Baird*, would I get in their way? And I had said that I did not believe women should travel on oceanographic ships.

The expedition had originally planned to take a woman
correspondent. Rachel Carson, author of *The Sea Around Us*, had been invited to go along, but had been unable to come. Women had gone on Scripps’ ships for two-week cruises. But Expedition Capricorn . . . there had been opinions on both sides of the matter many months ago. No one wanted to be a guinea pig. If I traveled on the *Baird* now, I would be the experiment. My whole sex would be on trial.

There was no clear-cut, easy decision to make. At Fiji it had been possible to say “I’m going on by myself.” But here other people were involved . . .

What of the men who said bluntly, “Women don’t belong on oceanographic ships?” And Russell—would I put him in a difficult position by being aboard?

I thought of my difficulties in explaining to the crew of the *Hifofua* why I didn’t ride on our ship.

“Why don’t you travel with your *mari* on your ship? Why don’t your men take care of you?” the Tongan crew had repeatedly asked me.

“No women on ships” was a concept out of their world. Interisland schooners all through the South Seas had women aboard. On a big rich American ship like ours, of course there was room for me!

“What a strange American custom!” Did these strange American customs lose their importance out here so many thousands of miles from home?

Roger wanted to know my answer. “Will you join us?”

“I’ll go,” I said.
Saturday, December 27

Was it only this morning that I stood on the deck and watched the men cast off the lines as we prepared to leave Nukualofa, this land of love? I was sad. I hated to leave this lovely, clean little town that reminded me of a huge park. The cool green carpet of the unending lawn was set off by many flowering trees and shrubs, pink South Sea oleanders, red and yellow kaute (hibiscus), scarlet-blossomed flamboyants.

I looked at the Hifofua, the little 90-foot schooner in the harbor, and waved goodbye to the ship where the crew had sung to me for nearly twenty-four hours on end. Some of my friends from the Hifofua were clustered on the dock waving to me, as our ship slowly began to pull away.

“Nofoa, Lino. Nofoa, Harold.” I called out. I couldn’t hear their answering “Alua” but I know that is what they said. “Alua” is the goodbye spoken by the one left behind. It means “I stay.” Nofoa means “I go.”

Left behind by his ship was scientist John Isaacs below us on the dock, waving to us. I am sure he had mixed emotions, as did I, for he was leaving the ship, his home for the past three months, and I was leaving a land I had grown to love.
But a bunk is a bunk where you find it out here, I had come to realize.

Now I find myself traveling in luxury, on this “best oceanographic ship afloat.” To me, she’s an oily, greasy, rough-riding tug, the 760-ton, 143-foot Spencer F. Baird. I see already from my first day aboard how she rolls and pitches. But here we have cold drinks really cold and hot coffee hot, not tea. My first adventure was to have one of the Baird’s fabulous breakfasts: fruit, cereal, waffles, bacon or ham and eggs, right in the heart of Polynesia. I hadn’t had menus like this for a long time. Russ and I stood in the galley and waited for the waffles to bake.

Kenny, the cook, with his cheerful smile, white cap and apron, stood there kidding me. “So you think you’ll try traveling with us for a change?”

“Yes. This chow looks good to me.”

“If those scientists give you trouble, you come to the galley,” he said. And I could see Kenny was going to be my friend. He is a good-natured cook, something quite unusual in ship’s cooks, I’m told.

With a steaming hot waffle on each of our plates, we went to the ward room where Frank, the tall, silent messman, served us the rest of our breakfast: papaya, cereal, coffee.

Luckily for me, the ward room was not crowded this time of day and I didn’t have to take the stare from fifteen pairs of eyes as they surveyed their new female passenger. Roger Revelle was already in the ward room.

“We’ll indoctrinate you right now, Helen,” he said. “You put your plate down, like this;” he said, suitig the action to the words, “and then go under the table.”

I watched this huge, lanky man slide under the long table secured to the deck and pull himself up through the narrow
slit onto the bench between the table and the wall. If he could do it, I could. It was a technique that
avoided disturbing anyone who was eating. Breakfast is not the time of day to inconvenience the opposite
sex—ever.

Down I went under the table, miraculously missing the deck, and up on the other side. Russ followed.
So far, all was well.

After breakfast I realized that I was no longer in Tonga where I must conform to the standards of Queen
Salote, who prefers skirts on women at all times. Skirts are an impediment, treacherous and out of place
on this ship. Quickly and happily, I pulled out my yellow shorts and shirt, discarding shoes in favor of
sandals.

In the first free minutes aboard I tried to stow away my gear in our cabin on the boat deck. I didn’t
want feminine problems to interfere with the business of the ship. I packed away shore-going clothes and
put shirts, shorts, and jeans in the handy drawers below my bunk. With Russ I wrapped the large Tongan
tapas and pandanus mats I’d been given and tied them to the overhead. It was difficult to get our tiny cabin
in shipshape condition. There were ship’s boxes of medical supplies, extra suitcases piled on the deck,
giant fluted tridacna clam shells in the corner, brightly colored sisis and leis hanging from the pipes on the
overhead. I soon discovered that the real problem was to stow my belongings so that when the ship rolled,
everything would not crash to the deck.

Russ led me up the ladder to the bridge directly over our cabin to talk to Captain Larry Davis. This
dark-haired, conscientious, quiet man made me feel at home at once.

“Did you go aboard the *Hifofua*?” he kidded Russ, “and see what your wife’s been traveling on?”
“It was probably a good introduction to the Baird,” Russ answered. Then Larry proudly showed me his orderly chart room, the instruments, how the boat was steered.

“Do you get seasick?” he asked with a sympathetic twinkle in his eyes.

“I hope not,” I answered.

“She rides like a cork,” said Davy (Cleveland H. Davis), second mate, who had been all over the world in ships.

The Baird is a converted U.S. Army sea-going tug, which came from the mothball fleet at Olympia, Washington. She is Navy-owned, but operated by the Scripps Institution of Oceanography. This four-month trip in the South Pacific was her first major oceanographic voyage for Scripps. Larry showed me the log book where the sea and weather are described each day, and I learned about the routine checks that are kept on compasses, gyro, and barometer.

“The Baird’s navigational equipment is far superior to that of other ships of this size,” Larry said. “She has a gyro pilot, compass, radar, loran, and sonic depth finders.”

“What about her engines?” I was sure this was a question I was supposed to ask.

“She has a twin diesel-electric propulsion engine totaling 2,000 horsepower.”

I was told that on the bridge they stand three watches with two men always on duty. Navigation is particularly important aboard these oceanographic vessels. First mate and navigator Bob Haines tried to explain it to me.

“It isn’t enough to finally get a good star sight after four days of bad weather and to know where you are now. These scientists need to know where they’ve been for the last four days.”

“I get it. They need the exact latitude and longitude of every station for their records?”
Profile of the Scripps Oceanographic vessel Spencer F. Baird, showing her main features. Horizon had a similar hull but differed somewhat in her superstructure.
“Yes. So we have to work backwards, correcting our dead-reckoning positions where we think we’ve been in the past four days, on the basis of this new star fix.”

And since there are no loran (long range electronic navigation) stations in this part of the Pacific, the navigators must rely on star and sun sights for the ship’s position at all times.

Leaving the bridge, Russ and I climbed down the steep ladders to the lab, two decks below.

The lab area extends from the midship section to within approximately 40 feet of the stern. It is about 16 by 27 feet in size. There are sinks, work benches, a chart table, and a desk, a circular Nansen-bottle rack and enough instruments to keep me asking questions from here to Samoa. Every inch of available space seems to house some delicate piece of equipment. I see less than two feet of passageway through the complicated maze that these geophysicists have managed to make of their lab. Each man annexed a cubbyhole where he has some drawers and a bench on which to work.

Here in this congested room the men were working, propped on stools or boxes if handy, also standing, either tinkering with their equipment, making measurements, or working on records.

At the chart table three men were huddled over a map of the ocean bottom. Weighty decisions as to the ship’s course were apparently under discussion.

When he saw me, Roger stopped his work and handed me the log book that John Isaacs had been keeping and turned it over to me.

“Read this,” he said. “We’ll begin work on it tonight after dinner;” and he told me that later I would be taught to stand the four-hour scientific lab watches which were around the clock, day and night.
“Let me learn one thing at a time,” I begged. “No lab watches yet. I’m not very mechanical.”

“Everyone stands watches on this ship except Kenny, Frank, and the mess boy,” he said.

The lab room was very hot, as the ventilation was poor, even though there were a few portholes open on either side and the door was open onto the stern. The men wore shorts, their bodies were covered with sweat. To get a breath of cooler air, I went out on the deck to the stern of the ship, which is called the fantail.

There on the stern was the large “A” frame which rises 32 feet above the deck and is designed to handle loads of equipment up to thirty tons.

Right behind the main deck laboratory were the large drums of the winch. Over a sheave of the “A” frame it was paying out a length of the eight-mile-long tapered steel cable carried below decks on a storage reel.

“When this spool is uncoiling the steel cable, you must stay off this part of the ship,” Russell cautioned me. I listened meekly.

And I began to worry. I knew I would have difficulty explaining how I ever happened to be connected with this two-ship expedition of seventy men. This trip of mine violates all American oceanographic traditions. Famous European oceanographers have taken their wives on parts of their globe-encircling travels. Professional women oceanographers have gone to sea. But I wonder if any other woman in America has ever joined a prolonged deep-sea geophysical exploration of the Pacific?

I hope they will believe me at home when I say it is a man’s world, not for women, this cruising about studying the earth beneath the sea. It’s not simple or safe. On this first day a
The crisis seems to appear every few hours. The huge instruments that swing crazily from the tall A-frame on the stern of the ship seem about to hit a man each time they are lowered or raised.

I want to learn everyone’s name on this ship—the seventeen scientists and seventeen crew members. Luckily for me I’ve known most of the scientists for a long time: Roger since college days, our friend Walter Munk, my La Jolla neighbor Willard Bascom, and the young men—Dick Von Herzen and Alan Jones, who work with Russ, have been visitors many times at our home.

Gustaf Arrhenius and Henri Rotschi, newly arrived from Europe, I had known ashore, as well as physical oceanographers Art Maxwell and Ted Folsom.

New to me were Dick Blumberg, University of California engineer, and many of the men on the Horizon. Horizon had fifteen scientists and twenty crew members, and was much the same size as our Baird, but had no big winch like ours. The men aboard the Horizon had different measurements to make, and from their conversation I learned that weather balloons were released around the clock, hauls of plankton and fish were made by nets, and the sea bottom was dredged for samples.

Russell had been right when he had said, “You have no idea what our work or life at sea is like.”

There are no books or movies about geophysical deep-sea explorations for wives such as I. But now I’m learning. I’ve stumbled on to that once-in-a-lifetime opportunity of seeing Russ’s work at sea.

Some scientists are fortunate and marry women with scientific backgrounds. Not Russell. My college degree was in English literature and my newspaper training included such topics as society, early California rancho history, and writing
a page for poultrymen with a column called “Chick Chat” . . . a far cry from oceanography.

Now I’ll be taking a sea-going course in beginning oceanography. But I’ll not receive a grade or a diploma when I get home. I do have one certificate now, which I received at Scripps Institution—for counting grunion. In studying these mysterious fish the biologists once tagged a certain number of them as they made their regular spring migrations to the shore, laying their eggs on the beach in the spring at high tide. I helped the marine biologists count the tagged grunion in the midnight hours and so became initiated as a life member of the “Society for the Investigation of Non-Gastronomical Characteristics of the Grunion,” with permission to spawn on the beach at high tide.

But the work on this ship does not seem to involve such simple tasks as grunion counting. We have geologists, chemists, geophysicists, engineers, and divers doing highly complex work aboard.

I look about our ship and see weird, intricate oceanographic equipment. Huge instruments suspended on a long cable disappear into the sea below for hours on end. Bottles in yellow cases with thermometers attached go overside, like a kite in reverse, only the bottles are fastened along the kite string at regular distances and this long wire penetrates far down into the water below. When these Nansen bottles have reached the correct depth a little “messenger” is sent down the wire and trips the bottles. They fill with water and come back laden with valuable samples of H2O at various depths.

Near the stern of our ship three men are examining a torpedo-like instrument which Russell says is usually towed when the ship is underway. Today our sister ship, the Horizon, 50 miles away, is dropping TNT charges. These make
miniature earthquakes at regular intervals as she is coming towards us, and our lab records on a moving tape the path of the shock from these explosions.

This is a fascinating new world, and though there is much I do not understand, still, I’m learning. These men are exploring the depths below the surface. They’re describing the shape of the ocean floor and what lies beneath it.

“We are gathering information so that we can write a history of the ocean,” explains Roger Revelle, Director of Scripps Institution of Oceanography and expedition leader.

I thought of the illustration I had seen of an area of the ocean bottom near Hawaii, the underwater Mid-Pacific Mountains. One looks at the picture and imagines that the ocean has been rolled away.

Every day, every hour with our instruments we are examining the sea beneath us . . . what is below?

And I am learning that there are many unanswered questions about our oceans. Have the oceans always been as they are now? Have the oceans grown through geologic time? Is part of the ocean getting deeper or shallower? Are the subcontinents sinking or rising towards the surface?
I’m still catching my breath on this dizzy, busy ship. Although it’s only my second day aboard, I’m wondering if I ever dare go to sleep—I might miss something. When I arrived in the lab to struggle with the ship’s log, I saw all sorts of activity. The men on watch had their eyes glued to the echo sounder, the magnetometer was “streamed” behind the ship, and BT’s (bathythermographs) were being taken every couple of hours. BT’s are vertical temperature profiles of the upper few hundred feet of ocean. Some of these things I know a little—very little—about.

“We crossed a seamount last night,” Walter Munk said.
“I wish I’d seen it.”
“There’ll be more, don’t worry, Helen.”

I must find out how a ship learns about underwater mountains it can’t see. Today perhaps we’re going to a mountain we can almost see, and just a few years ago could have seen. We are cruising along one of the greatest chains of active and dormant volcanoes in the world. This is a line of weakness in the earth’s crust, where we can expect an island to appear. Last night in the ward room we had a discussion about Falcon Island, a submerged volcano near here, 50 miles
north of Nukualofa. This island has done an appearing-and-disappearing act three times in the last seventy-five years.

Its Tongan name, Fonua Fo’ou, means “new land.” In 1928 our friend Harry Ladd had visited the island, which was then 2 miles long and 600 feet high. The island erupted in 1933 and in 1936. It was only 30 feet high, but still 1 ½ miles long in 1938. Not often do islands go up and down in the sea with such speed.

“How did Falcon look when Harry Ladd and Tungi’s father were there?” I asked Roger.

“It was a black, desolate, treeless waste with two craters. There were trench-like gullies and steep cliffs, 100 feet high. They had a difficult time landing and had to swim through the surf. Tungi’s father swam ashore carrying a barometer and other small gear tied on his head in a cloth.”

“I remember,” I said. “Tungi told us more about it . . . the sulphurous gases that made their eyes smart, and the hot climb to the summit to plant the Tongan flag.”

They had walked over to the crater and had seen a boiling lake whose surface was hidden by clouds of steam. Harry Ladd has written about the sputtering and whistling steam vents that came out of the orange, yellow, and gray walls surrounding the lake. The water tasted vile, he said, and the ground was very hot.

“Was there anything alive on the island?” I asked.

“Only a bush, but all sorts of things had washed ashore: a whiskey bottle, a coral head, coconuts, I think. This is one way life begins on a new island.”

“But what happened to this island if it is completely submerged now? Did it sink?”

“Perhaps as the lava column cooled,” Roger answered, “it contracted, and this may have caused the island to sink. A geologist would call it a withdrawal of subterranean lava.”
But it’s more likely that this island consisted only of volcanic ash and chunks of lava which were easily washed away by the waves. And each time the wind and rain attacked it, part of the island was eaten away. Time and conditions were not favorable for the growth of a protective fringing reef of coral, such as exists around the Fiji Islands and many volcanic islands in the tropics.”

“All the more reason to stop and let us dive over it,” said Bob Livingston, with that diver’s gleam of anticipation in his eye. “When have any divers ever explored a submarine volcano? This is worth doing!”

I could sense Roger’s reluctance to say yes. To him this diving was a very new tool and one in which the safety factors were largely unknown. Just yesterday afternoon we had watched the divers attempt to study a barrier reef, the ridge of a submerged plateau, while we were towing them at the end of a line from the ship. Willard Bascom had been in trouble when he rose to the surface. Apparently his cylinder had run out of compressed air. Bob Livingston stripped off his trousers and like lightning dived into the water to help Willard. No calamity occurred, but we were all uneasy.

But this morning I saw the divers testing the valves on their yellow aqualung cylinders which held the compressed air. Roger had given the permission to survey the shoal.

The cylinders, when strapped on the divers’ backs, allowed them to go below, swim freely about wherever they wished down to depths of about 200 feet, and stay below for 15 to 30 minutes. At shallow depths they could stay below much longer. This self-contained underwater breathing apparatus was based on the French Cousteau model and was being used for the first time by a Scripps deep-sea oceanographic expedition.

The entire equipment consisted of the bottle of air, compressed
to about 140 times atmospheric pressure, and a demand-valve pressure regulator which was attached to
the bottle and from which air was led to the mouth by means of flexible tubing. When the underwater
swimmer needed to breathe, he simply sucked air from the breathing tube, and when he exhaled, the air
was expelled through the same mouthpiece and rose in bubbles to the surface.

“Let’s go up and watch from the bridge,” Russ said. It was a brilliant day. My log said that we were at
latitude 20° 19’ S and longitude 175° 25’ W.

Standing on the bridge, we heard Larry say, “I don’t think I dare go any closer. We’re at seven fathoms
now—42 feet—bad! This ship can drift.”

We all stared ahead at a light yellow-green patch of water less than a mile away. This patch looked
exactly like the shallow water over a reef, an area of the ocean that ships carefully avoid.

We watched the skiff being lowered from the port davits. Aqualungs, underwater cameras, masks, and
flippers were all put into the boat. Before jumping into the skiff, Bob Livingston came up to the bridge to
arrange signals with Larry. The divers would row to the green patch right over the volcano.

“If we’re to the left of the center of the green patch, blow the ship’s whistle once; if to the right, twice,
and three times if we’re dead on the center,” said Bob.

“Yes,” said Larry.

All hands aboard stood by the rail and watched our four divers pull away from the ship. We wondered
what the men would see below the surface. The green water indicated that the top of the volcano must be
very close. Would there be corals growing there?

Larry, watching the skiff through his binoculars, signaled by blowing two whistles, and soon afterward
sent a message
that the skiff was over the center. We watched the divers explore the green patch and then return halfway to the ship and begin diving operations.

While the divers were away and the ship was drifting, “grab” samples of the bottom were taken on the hydro winch, the small winch on the boat deck that let a cable down into the sea on the starboard side. Grab samples are samples of the top few inches of the bottom sediment scooped up by a double-jawed affair, like a clam shell digger; the jaws, about six by four inches, are held open as the instrument is lowered and clamp shut as it hits the bottom and the tension in the wire is released. “Grab samplers” can bring up bottom material from gravelly or sometimes even rocky areas, such as here at Falcon Island, where a coring tube would come up empty. On the first trip down the sampler brought up black volcanic rocks the size of marbles and then later black and dark gray volcanic pebbles which showed evidence of rounding and faceting (geologists’ lingo).

Staring out at Falcon Shoal, I tried to imagine what early ships had seen when they reported a large fire in the ocean right here. How does an island come out of the sea?

Does the water become disturbed violently and does steam rise several thousand feet? Does it begin to boil, as the missionary accounts described? Perhaps, Russ said, there was a terrific burst resembling what we have seen in pictures of the atomic bomb, accompanied by a roar and huge mushrooming black clouds swirling skyward, maybe lightning, and then cataracts of water falling back into the ocean. There might be volcanic bombs, incandescent chunks of lava thrown into the sky, which solidify before they fall. Harry Ladd had found volcanic bombs two feet long on Falcon. Steam might spread out horizontally and hot pumice fall back hissing as it dropped into the water. The seas might make a great wave which could have tossed any missionary ship relentlessly if it
were too near at the time of the eruption. These eruptions may happen not only once but many times.

Looking out at our ocean today, I was glad that all was quiet.

Soon we saw our divers proceeding toward the ship. By eleven o’clock they were back with the startling news that the green patch which we thought to be a shoal area was not shallow. The water deepened there to about 300 feet, according to measurements made with their sounding line, and was discolored by a suspension of fine volcanic particles.

“We’ve got to go back to make some temperature measurements,” said Bob, as Walter began to hunt the equipment.

Roger, a worried expression on his face, stood talking to Bob. Finally, he said, “Make it snappy; we’ll wait for you.”

Off again they went to the undersea volcano and this time they towed two divers under water on a line from the skiff.

The captain paced nervously back and forth on the bridge. He could hardly wait to get his ship off this uncharted shallow spot.

Just a few months before, on September 24, nine scientists and twenty-two crew members had been blown to bits on the Japanese hydrographic vessel, the Kaiuo Maru 5, over another volcanic island, Myojin sho, which was making a dramatic series of appearances and disappearances in the area south of Japan.

This explosion occurred along a ridge of undersea volcanoes similar to this Tongan area.

Myojin Sho had been rumbling since 1896. No one witnessed all the dramatic events that occurred as the volcano exploded, but the sofar recording stations in California,

*A sofar station is one which has a hydrophone planted under the sea at a favorable depth in order to hear undersea sounds at great distances. Sofar channel is a word given to a layer of the ocean several thousand feet deep where sound travels great distances because of the favorable temperature gradients at that depth.*
with which our scientists were familiar, told the story of more than one hundred eruptions at this time. Following the tragic destruction of one ship, a second Japanese scientific vessel had arrived at the volcano the next day and had taken many photographs of Myojin Sho in action.

When our divers finally returned, the *Baird* had drifted to a spot where the depth was only 30 feet. With all haste, the engines were started and the ship proceeded to leave Falcon Shoal. When the depth had increased to 700 fathoms, those on the bridge were a far happier lot.

“That was the most beautiful and awe-inspiring diving we’ve ever had!” said Bob, all enthusiasm.

“Let’s get this all down on a recording,” said Roger, and so later we met in the wardroom to hear about Falcon as it is today. I quote from Bob Livingston’s report:

“We dived first at a point where solid volcanic rock is only 35 to 40 feet beneath the sea surface. We discovered black and rugged pinnacles rising precipitously from a broad dike.

“The ruggedness of this volcanic skeleton reminds us of mountain crags, up and down which we were able to swim with the greatest of ease, like strange birds flying around precipitous summits.

“On the less steep surfaces of the submarine volcano were colonies of thriving coral taking the form of bouquets of bright colors scattered around on the black surface…”

“The only disconcerting part of the diving was that we were not the only sightseers. Two sharks, ranging about five feet in length, were also cruising about. One of the sharks exhibited what we hoped was curiosity by looking over Dr. Munk’s shoulder while he made temperature measurements on the rocks. Walter was concentrating on what he was doing. He was attempting to steady himself against the surging motion of the water in order to make an accurate reading of his thermometers. Suddenly, a shadow drifted across the instruments and he turned
his head to look directly into the face of a shark hovering about five feet away. Walter continued his work, and when he had finished, the shark swam slowly away. We saw a school of tuna, a few large groupers, and in among the coral were many types of brightly colored tropical fish, including a school of the spectacular angel fish.”

Walter Munk made an educated guess as to the rate of erosion of the island. Considering the amount of sediment in the water samples taken from the area of the green water, and the velocity of current, he estimated that present erosion would lower a square mile of Falcon bank at the rate of about four feet a year. But also at the same time, the corals are growing upward from the hard volcanic rock skeleton of the bank and would ultimately rise from the sea unless interrupted by another eruption. Since the corals observed must have begun growing after the last eruption, Walter could estimate the rate of growth. They might reach the surface in about 10,000 to 15,000 years.

(On December 23, 1954, Falcon Island was again said to be above the ocean. Prince Tungi, who was away in England at the time, has promised us some pictures and description of the appearance.)

After the conference and much later that evening I cornered Roger. He was a night owl; the later it got, the wider awake he became.

“Look,” I said, “if I’m going to write a log of this expedition, I think I had better know a little more about it.”

“Good idea,” he said.

“Just because I am married to Russ doesn’t mean that I can report on what I’ve seen today. I’ve never been to sea on an oceanographic ship before. Everyone is busy at work, but they seem to be working at different things. I’ve seen instruments
towed, instruments lowered while we are under way. I’ve seen them lowered when we stop. This morning I saw the divers go out with their aqualungs. I’m even beginning to learn the names of the instruments, because I’ve asked.”

“Do you know what kind of measurements they make?”

“Just sort of. Sometimes I even think I’m beginning to know why they’re doing what they’re doing—but not really. Over-all . . . after one day at sea on this oceanographic ship I realize I know nothing at all.”

“Where do you want to begin?” asked Roger.

“To start with, although this is a naive question, what’s the purpose of this cruise? What are we trying to find out?”

Roger immediately began to pace back and forth, his mind concentrating on the answer.

“Most of the members of this expedition can be broadly classed as marine geophysicists,” he began.

“The geophysicist’s task is to describe systematically what actually exists in the earth and to determine why things are the way they are. For instance, why are there any oceans at all? Do you know that this is the only planet in our solar system which had an ocean? Some of them do not even have moisture. Why?

“This next week we will be working in the Tonga Trench. This is the deepest area in the southern hemisphere. It’s a long, narrow trench, maybe 1,500 miles long, 30 miles wide, and five to six miles deep. Why does it exist? How long has it been here? Is it a fairly new feature of the earth, like our Rocky Mountains, or is it comparatively old, like our Appalachian Mountains?

“One of the strangest things about this trench is that there are several others which seem surprisingly similar from what little we know of them . . . the Aleutian Trench, the Japanese
Trench, and the Puerto Rico Trench (which is the only one in the Atlantic) all have similar characteristics.”

“Is this one purpose of this cruise, then, to find out why this Trench is here?”

Roger paused again before he answered. Someone handed him a cup of coffee, and he was completely unaware of the steaming hot drink in his hand. “We’re going to study several different features of the Pacific on this expedition. There is never time or money enough to do everything you want to, so we have to ration our time. We spent a few days out here before we came in for Christmas.”

“And we’re going to be ten days over the Trench before we head for Samoa?” I asked.

“That’s our tentative schedule. But even if we had six months here, I doubt if we could answer your question. If the present is the key to the past, as geologists believe, then we’ll have to learn more about this Trench and this ocean before we can answer the question of why things are the way they are. Geophysical problems don’t seem to have simple, straightforward answers. We’re like detectives in that we go about hunting for evidence, gathering what information we can. Like detectives, we’ve learned some new techniques in the past fifteen years, and these give us a lot more information than we had formerly.”

“Like Russ’s seismic work?” I asked.

“Yes, and Ronald Mason’s magnetometer, and our echo-sounding instruments, our big piston corers, and our temperature probes; but even with all these new techniques we still have a long way to go and a lot to learn. And there is another angle, Helen, to this detective business . . . it’s all circumstantial evidence.”

“How do you mean?”

“No matter how much we improve our techniques for
gathering evidence, and no matter how much we learn about the Trench as it now exists, this Trench began
to be formed many millions of years ago.”
“...trail was a bit cold.”
“...geophysical events such as this happen on such a grand scale that we might with luck someday
learn at least when in geologic history this one occurred.”
6. NIGHT EXPLORATION

Sunday, December 28—again

I’m not sure what date to use tonight. We crossed the international date line today, so it is again December 28. On the other hand, it is long after midnight as I sit writing this.

I watched Russ begin his seismic run today for the first time. How do they stand the noise and heat without much of a break for 14 long hours? He’s told me that someday I must watch it from start to finish. I want to do this. I also saw the coring tubes go to the bottom in the attempt to bring up a tube full of sediment. All kinds of work are going on. I was asked to type a special-duties list today, and I made an extra copy for myself. This was some help. It reads as follows:

SPECIAL DUTIES LIST

1. *Overside Crew—Dill, Maxwell, Blumberg, Jackson.*
   
   In order to assure the safe and efficient handling of heavy gear as it is put overside and when it is brought back aboard, these men are to regard gear handling as their *primary* responsibility. They will be assisted by the man whose gear they are handling. *At all times* when the main cable is overside, *at least one* of this crew is to be on the after deck to watch for cable troubles, keep an eye on the accumulator, listen for the ball breaker, and help the winch operator with any problems that may arise. When
additional assistance is needed the following men should be summoned: Bascom, Von Herzen, MacFall. This crew will also rig the piston corer in accordance with the plan previously decided upon by Revelle, Arrhenius, Dill, and Silverman.

2. **Coring**—Arrhenius, Jackson, Rotschi. All matters connected with the coring except the rigging and handling of the gear will be the responsibility of Arrhenius. He will see that (1) adequate data are recorded (time, depth and position), (2) the core is extruded, handled, treated, and labeled properly, and (3) examined physically and chemically. In the extrusion of the core he will be assisted by Jackson and Rotschi.

3. **Bottom Photography**—Dill, Jones, Blumberg. The intermediate depth camera is to be kept in readiness to operate on 30 minutes’ notice. Jones will be responsible for keeping it in this condition (batteries charged, contacts clean, film at right temperature, etc.). Dill and Blumberg will be thus free to give their attention to the very deep camera.

4. **Seismic Work**—Raitt, Von Herzen, Jones. The seismic program will continue about as it has, with the exception that Jones will have other maintenance duties.

5. **Temperature Probe**—Maxwell, Blumberg. In-the-bottom temperature measurements will be made on the major stations as soon as the large corer is retrieved.

6. **Near-bottom Water Samples and Temperatures**—Folsom, Rotschi, Munk. (Except in the Tonga Trench) on the major stations these measurements will be made using the hydrographic winch. This can be done at the end of the coring and temperature probe work or when there is a delay before or between those measurements.

7. **Diving**—Livingston and lung-men Dill, Bascom, Munk, Jackson, MacFall.

When the situation is appropriate, the bottom will be inspected, sampled, and photographed by aqualung divers. Accent on still photographs for reproduction.

9. **Aerosol Collection**—Arrhenius, Folsom, Munk.
   Collection of fine particles out of the air and analysis of same.

10. **Record Photography**—MacFall.

11. **Chemistry of Water Samples**—Rotschi, Arrhenius.

12. **Magnetic Measurements**—Mason, Blumberg.

13. **Gek**—Munk
    An attempt will be made when possible to measure current velocities and direction. [Gek = geomagneticelectrokinetograph, a current recorder]

This evening I was so weary I almost fell asleep when Bob Livingston lectured to us on the “Physiology of Aqualung Diving.” Then Roger said to me, “We’re going to explore another volcano tonight, Helen, after we finish coring.” Big instruments were still going up and down in the ocean although it was past midnight.

The volcanic island Roger referred to is called Kao and rises nearly 4,000 feet out of the water. Obviously (or at least it is obvious to me now) it must extend out under water until it reaches the bottom. The difference between an underwater

![Profile of Kao, volcanic island in Tonga.](image-url)
seamount such as we crossed by chance the first night I was aboard and an island such as Kao is often only one of height. A seamount just isn’t tall enough to be an island. Then, of course, there is Falcon, which is right on the edge of being both a seamount and an island. And lastly there are the coral atolls, which, I’ve been told, are seamounts that were once at the surface and have slowly sunk, the coral building up as the volcano sank.

The part of Kao that we were going to explore was under water. We were going to do it with our echo sounder. Later we stood in front of our echo sounder in the fluorescent-lit laboratory. All I could see was a gray box about 28 inches high and 18 inches wide which said, “DANGER 400 volts.” An echo sounder is just what its name implies: A small, short sound pulse is generated by this machine every few seconds. The sound pulse travels to the bottom, is reflected and is recorded by the echo sounder when it returns to the surface. If you know how fast sound travels in the ocean, you can know how far away the bottom is by measuring the length of time it takes for the echo to return. The instrument for transmitting the sound was on the bottom of the ship. The men called it the EDO, which is the trademark name of the company that makes this particular echo sounder. What I was looking at was the recorder. By sending out a signal every few seconds, one could obtain a continuous record of the depth of the bottom. This depth was marked on a roll of paper slowly pulled through the recorder. This paper is marked with a grid of fine blue lines upon which a stylus makes a broad black line recording the bottom echo.

During the last 25 years this tool, the echo sounder, has begun to reveal the true shape of the sea bottom to man. Scientists aboard the first Challenger expedition (1872) found the bottom by laboriously dropping a lead on a line. This
same measurement today is being made every minute the ship is in motion by means of sound transmission.

“This is just one of the techniques that can be described as a means for extending the mind of the scientist into regions he can never see,” said Roger. The scientific explorer of the earth beneath the oceans must rely on observations at a great distance.

“The scientist probes into the dark with long fingers of steel, or listens for sounds made far away, or studies other phenomena that reflect the invisible character of the buried rocks. Here, look at this sketch,” and Roger pulled out some sheets of drafting paper that the men had been working on.

“This is a picture of the ocean bottom last night when we crossed that seamount. It was made from the echo-sounding records. This seamount will eventually be put on the charts and maps that show all we know now of the topography of the sea floor.” He pulled out a large chart and pointed out where the seamount would go.

This map to me is like a puzzle which is never wholly pieced together. Each new item of information—a deep trench here, an undersea volcano there—is a piece which these oceanographers assemble on their drafting boards to make a more complete chart of the ocean bottom.

I can remember one of the exciting pieces in this Pacific Ocean puzzle . . . the discovery of a long chain of mountains under the sea directly west of Hawaii by the Scripps-Navy Mid-Pacific expedition of 1950. By the conclusion of next week we will know more about the Tonga Trench than men have ever known before. Echo sounders on our two ships will produce a new chart of this great chasm.

But tonight—or rather, this morning—I could already begin to see the wiggly lines on the echo sounder starting steadily upward. I was torn between the fun of watching our
echo sounder show the bottom steadily shoaling and my desire to go up to the bridge and see how close we had come to the part of the volcano that showed above the water. I reluctantly left the instrument and climbed to the bridge. There was the island, very close and dead ahead.

Kao is a cone-like volcanic peak like Fujiyama, with its summit nearly always obscured by clouds. In fact, kao in Tongan means “cloud.” Tofua is the volcanic island close by. Its name means “to bake yams whole.” I thought of the old Tongan poem I had found in the Bishop Museum in Honolulu:

“Oka taulomaki e Tonga
Tepe he mounga o Tofua
Mo tokona Kao kuo kaina.”

When the south wind blows
The mountains of Tofua are seen
And the summit of Kao seems peopled.

Standing on the bridge this moonlit night, I watched as the *Baird* came closer and closer to the volcano. Through the binoculars I could actually see the waves breaking against the beach. When we had reached 750 fathoms, our engine slowed to a speed of 5 knots. We were barely moving through the black water. Finally, the *Baird* was about 400 yards from the shore at a depth of 205 fathoms and Larry said in a worried voice, “I think this is as close as I want to come.”

We were close enough to launch a skiff. It was a temptation to try to land, but such was not the plan. Our job was to use our echo sounder to make a picture of this volcano as she appeared beneath the sea.

*Monday, December 29*

Today we had an interesting exchange of telegrams.
HRH TUNGI NUKUALOFA

THE MEN OF CAPRICORN WILL ALWAYS REMEMBER THE BEAUTY OF YOUR COUNTRY AND THE FREELY GIVEN FRIENDSHIP OF ITS PEOPLE STOP WE ARE DEEPLY GRATEFUL TO MATA’AHO AND YOURSELF FOR YOUR GENEROUS HOSPITALITY STOP OUR FIRST TASK AFTER LEAVING NUKUALOFA WAS EXPLORATION OF THE THIRTY TO FIFTY FATHOM ISLAND SHELF STOP UNFORTUNATELY IT APPEARS RATHER BARREN OF FISH LIFE STOP DIVING OVER FALCON ISLAND YESTERDAY FOUND ABUNDANT FISH OVER THREE FATHOM SHOAL STOP NOW MAKING SEISMIC RUN NEAR TOFUAA

ROGER REVELLE

WE ALL HAVE HAPPIEST MEMORIES OF YOUR VISIT STOP MY WIFE AND I WISH EXPEDITION EVERY SUCCESS AND GOOD FORTUNE STOP MANY THANKS INFORMATION RE FISH LIFE

TUNGI
7. WE CROSS THE DEEP

Tuesday, December 30

The talk in the ward room now always turns to the subject of the Trench, for we are exploring one of the most dramatic parts of the Pacific Ocean, the Tongan area, with its long row of volcanic islands paralleling a row of coral islands, the Tofua Trough between them, and a great, deep trench to the eastward. Yesterday, at lunch, we were trying to devise ways of describing this deep gash in the earth’s surface. Over 30,000 feet straight down . . . it is hard to conceive of its dimensions.

Brownie, the cowboy bos’n, suggested, “How about sayin’ it’s as deep as a lot of Grand Canyons?”

“If we could pile seven Grand Canyons one above the other in the Trench, the uppermost rim would still be beneath the sea,” said Roger. “If we could pile thirty Empire State buildings on each other, the TV mast wouldn’t break the surface. That’s the Trench!”

If I imagine I am on the moon, and the water on the earth is rolled away, one of the most striking features on the earth’s surface and definitely the deepest in the southern hemisphere would be this Tonga deep.

It is 1,500 miles long and 15 to 30 miles wide, extending
in a nearly straight line across the sea floor between New Zealand and Samoa. The bottom of its narrow central gorge is in places over 35,000 feet beneath the ocean's surface. The only other spots where nearly equal or greater depths are to be found are the similar long narrow trenches off the Philippines, off Japan, and east of Guam and Saipan in the Marianas Islands.

The Tonga Trench is deeper than Mt. Everest is high.

This Trench, like the other great trenches of the ocean, is rimmed on one side by a series of volcanic islands. It is these volcanoes, Falcon, Tofua, Kao, and our new seamount we crossed on the 27th, that we have been studying these past few days, while our sister ship Horizon has been studying the Trench proper.

In some way the line of volcanoes running along the west side of the Trench is related to the Trench itself. Scientists believe (but are far from understanding how) these volcanoes are the result of the forces that caused the crust of the
Map showing the Tonga Trench region and a perspective cutaway drawing of the Trench.
earth to fold downward to form the Trench. In my own simple fashion I can see how if you suddenly bend the crust of the earth downward to form a narrow, seven-mile-deep Trench, something would have to give somewhere, and perhaps it would be the pushing up of hot lava to form a series of volcanoes.

I can also see why this combination of trench and volcanoes should be unstable, or geologically active. This is one of the earthquake centers of the world; I’ve been told that many of the earthquakes in the region have their origins far beneath the earth’s surface. I’m sure they must be bigger than the ones back home in my own state of California.

Five volcanic eruptions have also occurred in this area in the past fifty years. But I am anxious to see the Trench, or see it as best we can, which means watching the record of the bottom as it is slowly traced on the echo sounder in the laboratory.

Now tonight we are to make our first crossing of the Trench since I have come aboard. We shall be crossing approximately at the middle of the 1,500-mile-long chasm. On the route we’ve selected we shall pass south of the limestone island of Lifuka to reach a point beyond the eastern side, which we have designated as Point How, about 100 miles east of Lifuka. Russell wanted a seismic station here. He had to know more about the earth under the ocean on the east side of the Trench as well as on the west side of the Trench, where we’ve been. Someday, I knew, we’d be running up and down the axis of the Trench itself, but not tonight.

There is always the slim chance that on some crossing of the Trench we, or the Horizon, might find the deepest place yet to be discovered on the earth.

For a long time the Emden deep, located in the Philippine
Trench, was believed to be the deepest. And then just last year H.M.S. Challenger from England had found the greatest depth yet to be recorded—35,640 feet—in the Marianas Trench. Our ship, the Horizon, came very close to this, perhaps within 200 feet, when they crossed the Tonga Trench before Christmas, recording a depth of 35,400 feet.

Maybe tonight will be our lucky night. Who knows? One night when the Horizon was crossing the Trench I had heard Bob Fisher say excitedly to us over the radio, “Call us back later. Can’t talk now. We’re still going down—we’re taking soundings on the audible on both fathometers.”

Fisher’s main interest is trenches. He studies them whenever he can find them—anywhere in the Pacific Ocean. They are as exciting to him as bull-fighting, his other great passion. It is his responsibility to make the topographic chart of this great trench. It isn’t just a hole, as our American oceanographer Alexander Agassiz had described it at the beginning of this century. Men have known about its existence for sixty-five years, but there has been very little exploration of the area with modern techniques. A remarkable and tedious job was done in 1888–1890 by H.M.S. Egeria, when three hundred wire soundings were made.

The most recent exploration was made by the Danish ship Galathea, which left us a picture of soundings going more or less straight along the Trench axis. Now we are to join the Horizon in her systematic survey that will make nearly twenty-five crossings of the Trench and amass records covering over 4,000 miles.

The Horizon’s job is to zigzag across the Trench diagonally and to dredge up samples when she can. Our ship is to do most of the coring and to take temperature and water samples. This combined information, when pooled together with the seismic records, may yield important facts.
We were all standing in front of our echo sounder when the bottom slowly began to recede.

“We’re starting down,” I said, thinking how much more simple this was than going down the Grand Canyon on mule-back. The men smiled at my excitement, but I know they, too, were keenly interested. Walter Munk and Bob Livingston had this watch and were in charge of the measurements.

“We’ll be going down gradually for quite a ways,” said Roger, “before we really take a dip.”

“If it’s 1,500 miles long it must be shallower in some places?” I asked, hoping secretly that we were crossing at a very deep spot.

“Yes. In the south, below 25° latitude, where we were before Christmas, the Trench is shallower and wider in cross section,” said Roger. “Now, farther north, the Trench has become deeper, and so far it has stayed deeper. In a little while you’ll see.”

Roger spoke truly. Suddenly our echo sounder began to take a downward path with a vengeance. The slope became progressively steeper and more irregular as the depth increased.

“Bob Fisher and the others have discovered a fact not previously known, that in the center of the Trench there is a deep, steep-walled inner gorge only two to four miles wide,” said Roger. “The deeper we go, the steeper it gets.”

At the rate our little black wavy line was going down, I guessed the Trench must be steep. The 3,000-fathom contour was passed, and then soon the trace showed 4,000 fathoms—24,000 feet, nearly five land miles.

We were coming closer to the center. Many echoes were being received simultaneously because the bottom was so rough. These echoes grew progressively weaker and harder to identify as we still went steadily downwards.
“This trench is so steep and narrow that it is difficult with the echo sounder to sort out a true picture of it. Sometimes the echoes from the sides show up before the bottom echo and we are not able to tell which is which without a lot of work,” said Roger.

“Is this what Bob Fisher will be spending months doing when he gets home, trying to find the real profile?” I asked.

“Yes,” answered Roger.

“Then it isn’t just Russ who doesn’t like to commit himself on shipboard about his findings!”’

Roger laughed. “We’re all alike about that, Helen. Look now, we’ve reached the 5,000 fathom mark,” he said.

That’s 30,000 feet straight down. How much further could it go? I looked at the clock. It was 3:45 in the morning. Suddenly the little black line was staying constant, not going down any more. We were at the bottom of the Trench.

“How deep, how deep?” I asked.

“Approximately 5,160 fathoms—30,960 feet,” said Walter, writing busily on a scratch pad. “We’ll have to do some computing and correction.”

Now, in a few minutes, we had started up, and it began to shoal just as rapidly as it had dropped before.

I hurried out to the fantail. Dawn had come. Our little white ship plowing her way through the water looked as she always does—as did the ocean beneath. It was difficult to believe that we were over an area of water nearly six miles deep and that below us were shattering pressure, glacial cold, and unending night.

I thought of this least-known region of the sea, the icy desert where life barely survives, and I wondered at its great age. Why should this deep water be so close to freezing here in the tropics? Most of the water in the oceans flows down from the Arctic and Antarctic. How old is this water?
And what kinds of marine life are found in this world of unrelieved darkness, pressure, and cold? The pressure increases nearly 15 pounds per square inch for every 33 feet of depth. That means there’s about 15,000 pounds per square inch in a place like the bottom of the Tongan Trench.

What strange creatures can withstand such pressure? There is evidence that marine life exists at all depths and everywhere in the ocean. The bottom muds of this deep Trench teem with bacteria. The *Galathea* brought up sedimentary bottom animals such as sea anemones, sea cucumbers, worms, mollusks, and such in its trawls. The Danish scientists aboard who had explored several trenches just two years earlier, had reported that trench fishing was best in this Tonga deep and that they caught fish in their trawls at a depth of 3,660 fathoms. And yet just a hundred years ago scientists believed that no life existed in the deep ocean water where no sunlight penetrates. The Danish ship had a big winch and long cable, as did ours, which enabled their men to bring up living bacteria and sea slugs from the very bottom. In one of their trawls at a depth of 4,500 fathoms they found a thousand specimens of one kind of sea slug and two hundred of another.

They had fished in these same waters for the eerie creatures they thought might inhabit deep water, just as we are fishing for rocks, sediments, and sand. They hoped to find a relic of prehistoric life, an ancient monster. This Trench yielded no fifty-million-year-old creature, but many strange fish were caught in their huge nets—fish with large protruding eyes that do not perceive color but only dim light. Many fish are blind and have large antennae or feelers with which they grope their way about in the unending night. Except for prawns, which are brilliant red, most of the fish are
brown, black, or deep purple. Many species are luminescent. 

In this deepest world the fight for existence is keenest. Consequently, the fish below are armed with saber-toothed jaws, immense mouths, and distensible bodies. They can even swallow a creature larger than themselves.

I went back to the echo-sounder. I saw that we were now climbing somewhat less steeply.

“The west flank or shoreward flank is steeper than the slope we are climbing,” said Roger. Then as the fathometer went down again to 4,700 fathoms at six o’clock, I realized that we had crossed a little ridge.

“The Horizon found this 600-foot ridge at the eastern edge of the Trench too,” Roger explained.

Now we were climbing the eastern slope again and had crossed into the area of the great deep Pacific basin. It was nine o’clock in the morning. We had traveled 45 miles in crossing the Trench. Some trench crossings had only been 15 miles wide, Roger explained. And we have not found the deepest spot. The Horizon is still ahead of us with her depth of over 35,000 feet.

The seismic crew is busy on the fantail paying out the hydrophones for another loud day of receiving explosions from the Horizon. Weather is rough, there is no sun, and “the noise level caused by the storm resulted in instrumental difficulties,” says my log. By 10 o’clock Bob Dill and his coring crew of Phil Jackson, Dick Blumberg, and Art Maxwell were back on the job, putting down a large corer. Will they be successful this time in bringing up a long tube of mud?

So it has gone all day—combination of the storm, the lurching boat, the terrific clatter of gears as the winch rolled out its 6,158 meters of wire, and the loud announcements over the radio from the Horizon. It is nerve-racking. It makes
me realize again that bad weather or need for sleep—nothing stops these men. They are pounding at the ocean all around the clock. Even after this long, hard day they had a conference in the ward room—subject, the Tonga Trench.
8. THE BIG WINCH

December 31—New Year’s Eve

I began to understand the source of tension on the ship. Each day as the men grew more worried I’d been trying to discover the cause. To me they seemed secretly keyed up, as football players before the game. They worked, waiting for the zero hour.

They said I was brought aboard the ship to bring them luck. Obviously, I was no lucky penny. The gods had it in for me, too.

From the first day I came aboard, the geologists held long conferences. They went about the ship preoccupied, always with one worry apparently uppermost in their minds. Aboard the ship no one had been injured yet, but I sensed the same sort of silence and concern as though someone had been.

I, as well as everyone aboard, knew the problem, the source of the trouble. These men are suffering from an acute anxiety neurosis over the behavior of their huge, new, expensive winch and cable.

Most oceanographic ships have three types of winches that uncoil cable into the sea: a BT, a hydrographic, and a dredging winch. But the Baird has the biggest, strongest,
and newest dredging winch of any oceanographic ship from the United States. It is supposed to have the longest deep-sea wire cable in the country. And the winch was not operating as they wished it to.

This specially designed, 60-ton, cable-reeling machine with electric-hydraulic drive and approximately 100-horse-power capacity carries 40,000 feet of steel cable in two lengths. The cable is stored on a huge spool below decks. From there it passes to the rollers of the winding machine aft of the main deck laboratory, around the rollers several times, and out over a pulley suspended from the apex of a huge steel tower, called the A-frame because of its shape. The A-frame, mounted on the stern, rises about 32 feet above the deck. The winding machine is controlled from the boat deck above by a large box studded with a great number of switches, gauges, and knobs.

“When the rollers of the winding machine are uncoiling the wire, everyone must stay off the stern;” Roger had said, always fearing the wire cable could snap at any moment and kill a man.

I remember the Sunday night in San Diego the previous fall when the 40,000 feet of tapered steel wire arrived at the dock. Photographers were there, and many of us went down to see how this nearly 8-mile cable could be wound on the drum that was ready to house it in the engine room of the Baird. The cable had been delivered on a huge spool, bristling, strong, greasy steel wire, the same greasy wire that was rattling noisily over the stern tonight. Engineers had worked night and day, carefully winding this wire on the drum in the ship.

Under any other circumstances equipment of this type would have been given a shakedown cruise and the machinery adjusted after a series of tests at sea. But a railroad
strike had delayed the delivery of the steel cable. All dates for Expedition Capricorn hinged on the atomic tests out at Eniwetok. So the *Baird* had to leave to rendezvous with the *Horizon* in the Marshall Islands, with no time to try out this exciting, expensive, new piece of equipment.

It was hoped that any troubles and tangles in operating this new winding machine could be solved out in the South Pacific. Before reaching Fiji, trouble had occurred, and at the dock in Suva the cable had been spliced in three places. Now, with problems of operation still paramount, we were at the expedition’s zero hour over the Tongan Trench. We were about to put down this long cable which can stretch to the deepest spots in the ocean, seven miles below.

It is like climbing Mt. Everest in reverse, except we were climbing down by sending steel fingers below to clutch samples from the bottom of this Trench. Measurements greatly desired by a number of men aboard were all dependent on the operation of this huge winch. Yet conditions were certainly not in our favor.

A new, untested steel cable, eight miles long . . . one of the deepest spots in the world . . . but this new cable, to become trustworthy, must go up and down a number of times in the ocean. Some engineers feel that the twist in the wire becomes a problem the first time it goes overside.

If anything did happen to this longest cable on its longest trip to the bottom, it might mean that part of the whole program of geophysical exploration for the next two months would be washed up.

The life expectancy of a cable swinging deep in the sea at a crazy angle, with heavy gear suspended, is not too great. The cable can become tangled on the jagged volcanic outcrops below. More often it is worn out by the tremendous
tensions it has to maintain in pulling out the heavy equipment.

If we lost the precious long pipes, corers, or dredges, we could replace them on another try. Not so our cable. If the cable wire were to become badly snarled, it would have to be sacrificed and left on the bottom of the sea.

The men had encountered such problems on two other expeditions from Scripps. If the motor breaks down when miles of cable are out, the cable can’t always be wound in and has to be sent to the bottom of the sea.

Russ described to me the day on the Mid-Pacific expedition when the motor had serious trouble and the wire was way out. Only the patience and cleverness of Captain Jim Faughan saved the cable. He wound it in foot by foot for twelve long hours, using various devices and the cargo winch.

Besides the large winch and long cable, there is a hydrographic winch on the starboard boat deck which can take little samples whenever the bottom is not too deep. But this hydro winch could never send a corer to the very bottom of the Trench.

Yet we wanted to know more about this Trench. We wanted to actually penetrate the Trench bottom proper with our instruments. We wished to know about the heat flowing out of the earth at this great depth. We needed samples of water and most of all, cores to give us sediments we could touch, smell, and feel.

This can be done only by the successful operation of the coring devices attached to the end of the cable. These are of two types. The gravity corer is a simple device consisting of a hollow pipe with an open end and a weight in the upper end which forces the pipe into the bottom,
filling up the pipe with a sample from the bottom. The inside is lined with a plastic tube which is withdrawn when the core barrel reaches the surface. The core is retained in this plastic tube for future study.

The piston corer, on the other hand, is a more complicated contraption, invented by the Swedish oceanographer, Kullenberg. This device contains a piston inside the core barrel which is held at the nose of the core barrel during the descent. When it reaches the bottom, a trigger device releases the core barrel and at the same time the piston is stopped at the bottom surface by stopping our winch motor. Heavy weights attached to the upper end of the core barrel then push it down into the mud, and the core is drawn into the pipe by the sucking action of the stationary piston. This instrument can take much longer cores in the bottom than the gravity corer.

Regardless of the complexity, both of these instruments can bring back what these geologists want, a long sample of the undisturbed sediments from the ocean bottom. By studying these samples in minute detail, they are able to learn something about the time and manner in which this sediment was deposited on the ocean floor and hence learn more about the history of the ocean. Naturally they want as long a core as possible, because it will take them further back into geologic time.

“These upper layers of deep-sea sediments give us the detailed records of climatic conditions during the last million years,” I learned from Roger. They will help us describe the Trench as it is and begin to assist us in answering some of the why’s about this great structure.

Since I had come aboard we had been most unlucky with our cores. Long tubes of mud, 18 to 30 feet long,
had been obtained in the Fiji basin, but now we were over the Trench, where cores had never been taken before, and the fates seemed against us.

On my first night aboard, Max Silverman had been loaned to us from the Horizon. Coring was his specialty, but he was also irreplaceable on the Horizon, being the shooter of Russ’ seismic group. Max and Bob Dill put down the piston corer that night without much luck. Max suggested a short leather-cupped piston instead of the rather loose-fitting all-metal piston we used. The next day we had tried this method and put 650 pounds of weights on the core. Still no success.

My log tells the sad story on December 28 when a new core barrel was rigged, a free fall of 30 feet given, and what came aboard? “A few pebbles of black vesicular lava.” Following our exploration of Kao a piston corer was again put down to a depth of 12,000 feet. No core that day off the big winch. Finally they brought up a six-inch gray volcanic-sand core off the hydrographic winch.

Today, with the heavens overcast, the seas high, Bob Dill and his coring crew had been up since three o’clock to pick the spot on which to lower the corer. It was the last day of the year. Perhaps a “relatively flat abyssal sea floor” of a depth of 2,943 fathoms would deal more kindly with our instruments.

“We’re 85 miles east of the axis of the Trench,” Roger had said this morning. “You pick the spot, Bob.” If just one time we were lucky enough to obtain a good core in this more shallow water, we could tackle the deep Tonga Trench.

“This is going to be it,” answered Bob, his eyes on the echo sounder; and he phoned the bridge.

“Lab to Bridge, will you slow down to 30 turns.”
“Bridge, ay, ay,” we heard. Then began the routine preparations of lowering a corer off the stern. From three A.M. until late that night the men worked, putting cores up and down off our two winches. They even put overside the temperature recorder. The flat abyssal sea floor was definitely unfriendly, and we only obtained a few inches of brownish-gray mud with sand and silt. My ship’s log says:

“In spite of all precautions taken (short piston core barrel, short Phleger corer, vertical wire lead of the gravity corer hanging level with the mouth of the piston core barrel) a very short core was obtained.”

As to the temperature probe, which told us about the heat escaping through the upper sediments, my log is even more uncomplimentary. I’ll quote:

“The probe was bent as it usually is, indicating that it completely penetrated. After the instrument section was removed and the records examined, it appeared as though the instruments had operated erratically during the operation. Records may show some useful information.”

The probe, too, was behaving erratically on New Year’s Eve. Who wouldn’t?

Oh-oh! Down went the corer again. They don’t even know it’s New Year’s Eve.

One of the tenets of my creed is, “Be a woman. Act like a woman. Dress like a woman. Have fun being a woman. Don’t deny your sex.”

Of course, women are different from men. That’s the fun of it. But here I am, on a ship of men, working like a man, living like a man, and trying to bottle up the woman in me.

On New Year’s Eve I want to be a woman. Long associations of New Year’s Eve . . . happy times in my life
New Year’s Eve with Russ on Hollywood Boulevard ... dancing the New Year in ... reaching for a ceiling in a mountain cabin ... Auld lang syne!

But these men don’t even know it’s New Year’s Eve, or they are probably deliberately blanking out. If they can’t be at home, “To hell with it!” they say.

New Year’s Eve over the great Tonga Trench. To me it’s one to remember ... but I want to put a skirt on, a necklace, a blouse, and be a woman.

A strange situation to ask myself, “Do I have the courage to do this? Can I bear to go down that ladder into chow as a woman, just this one night?” I pulled out our suitcases. I tried on one dress. No, it wouldn’t do for a rusty old tug. I tried another. The ship would ruin this dress for good and all. I tried the black and yellow Polynesian skirt I’d made before I left, which I’d worn to Tungi’s feast. This, with a blouse and necklace, might do.

But do I have the courage? Not until Russ came up to the cabin. His eyes lighted up with pleasure as he saw me.

“Not bad!”

“It’s New Year’s Eve,” I said. “I want to forget oceanography this one night.”

“Sure. But let’s go to chow. I’m hungry.”

I couldn’t tell him how I felt, the silly, silly thoughts that run through women’s heads ... my fear of appearing in a skirt. What would the men say? It was too stupid. We are in a serious battle with the oceans.

“Okay,” I said. “Let’s go.” And down the ladder I went, skirt and all. New Year’s Eve on the Tonga Trench.

The skirt was a momentary distraction only, for we were busy hauling up the core when the New Year came.
9. NEW YEAR’S DAY ON THE TONGA TRENCH

January 1, 1953

This day began like every other, too early for me. Crawling out of bed, pulling on my jeans on a lurching ship, bumping, knocking myself every time I moved. Where was my comb, my brush? On the floor? What a rough sea today! Russell was tense before his seismic run, telling me to hurry. Men don’t worry about their faces. Women do, even at five o’clock in the morning.

A quick glance down the corridor at the head. It is the only one that isn’t out of bounds for me. Someone had beaten me to it. Oh, well! Down the ladder for that drink of coffee and then to the lab.

We were standing looking at the echo sounder, in the early-morning quiet. For me it was a momentous occasion. I was seeing my first seismic run from start to finish. Russ was sending the seismic run right up the axis of the Trench.

And this could be our lucky day. It was the New Year. We were going to make the test on the winch’s new long cable and try for a core in the Trench. We were selecting the deep point on which to stop, forevermore to be known as Point Item.
The echo sounder was giving us a picture of the bottom. At five o’clock the depth was 4,450 fathoms and then it went down almost vertically to 4,750 fathoms. Roger and Bob Dill had to agree with Russ on the station.

“Will you buy that?” asked Roger, when the echo sounder had reached nearly 30,000 feet. Nearly six miles down would be deep enough for anyone, I should think.

“Right,” said Russ. Then into the intercom, “Bridge from Lab. Please slow down to 30 turns to retrieve the magnetometer.”

“Bridge, ay,” came the reply. In a minute we heard the engines slow down, and all hands who were awake at this early hour formed a deck crew to pull in the instrument nicknamed “Sir Ronald,” the magnetometer which was towed by the ship to record variations in the earth’s magnetic field.

At the same time the seismic crew of Russ, Dick Von Herzen, and Alan Jones were busy unscrewing the lids from the three deck bins containing their hydrophones and cable. Each hydrophone is a six-foot-long, narrow aluminum-rubber contraption (Russ shudders at this word) held near the surface by large yellow tin floats about eight feet in length attached to the black rubber cable. These hydrophones must float about 600 to 800 feet away from the ship and are watched solicitously all day. Russ acts about these instruments the way a mother cat behaves about her kittens. Their ability to receive seismic waves is of major importance for his project.

The ship was under way at 30 turns, just fast enough to maintain headway, when the hydrophones were launched. Then they were neatly fastened to the 32-foot A-frame at the stern so that they would not tangle with any gear or cables aboard.
The ship was now stopped on station and all the necessary equipment, oscillographs, and radio sets were made ready in the lab. The gain controls on the receiving stack were adjusted so that proper amplitude was recorded on the 15-channel oscillograph. The paper had been unloaded from its black boxes and put in the machine and was ready to roll when turned on. Russ lifted up the radio phone which called the Horizon, waited one minute, and said, “Nan Peter Love Fifteen Uncle. Over.”

After a minute we heard the answer. “Nan Peter Love Fifteen William. William, this is Uncle! Happy New Year! We were still dredging at five o’clock. I’ll see if Max is ready. We’re under way and on course 025.” Willard North, on the other ship, then continued. “Are you ready, Max?” We heard shooter Max Silverman’s muffled, “Yes,” through the Horizon intercom and then Will reporting, “We’ll fire a shot in 15 seconds, William, Over.”

“Uncle from William. Go ahead.” Russ, Dick, and I stood at the oscillograph, ready for the first wave. In a minute we heard the beginning of a standard patter that continued all day like a phonograph record. Will’s loud, dramatic, radioannouncer’s voice said, “Fifteen seconds . . . ten seconds . . . five seconds . . .” and then with real drama in his voice, although he has said it 3,000 times, “The fuse is lit.”

Max on the Horizon sent the charge into the water from his little booth on the fantail, and Willard shouted, “Mark!” as the charge hit the water. Dick on the Baird started the oscillograph going by pressing a button. Then we heard the blast over the radio and knew that our sister ship was rocking with the huge vibration of the explosion and that none aboard her would be able to sleep from this moment on. We saw one of the oscillograph pens begin to wiggle as
the radio shot was recorded and then the second pen began to oscillate on the moving paper as the seismic wave transmitted through the sea bottom arrived at the hydrophone. Then came a large gyration and Russ happily said, “There’s the water wave.”

After the record was received, Will’s cheerful voice was heard giving data which Dick recorded on a neat sheet fastened to a clip board. “Data for the first shot. Number 1630. Time 0732½. Charge 80 pounds. Fuse length 35 inches. Firing time 68 seconds. Depth 4770 fathoms.”

Russ was watching the oscillogram with a wary eye, then doing some quick calculation from the seismogram record. Distance = Time × Velocity.

“Uncle from William,” he said over the speaker. “Got the firing mark, very weak, but all right. Head waves are rather weak. We didn’t get a good bottom echo. You’re 52 miles away.” He gave the position of the \textit{Baird}, checked all equipment again with Dick and Alan and stated, “Uncle, this is William. I think we can receive shots now. Are you ready to fire? Over.”

The \textit{Horizon} was indeed ready to fire and began her long run up the Trench, firing shots at regular intervals of fifteen minutes each. We heard the announcements repeated with clocklike regularity, “30 seconds . . . 15 seconds . . . 5 seconds . . . the fuse is lit . . . mark,” and the crash of the explosion. There was an exodus from the \textit{Baird}’s lab, the activities were so nerve-racking. The gain on the radio was turned so loud to offset the clanking and rattling of the cable that before long one’s impulse was to scream at Russ, “Can’t you turn that radio down?” But of course he couldn’t. It was horrible! Throughout all this clamor and intense heat in the lab, the seismic crew held to their jobs with great calmness and precision. As the
Horizon came closer to the listening ship, the shots came oftener—ten minutes apart, then five minutes, and finally three. When the ocean wave showed up at the same time as the radio sound wave, Russ stopped the firing, and there was the Horizon, zooming past us as close as she could come.

Captain Ferris, who maneuvered his little ship like a motor boat, took delight in seeing how close he could safely approach the Baird, which was stopped on station. Sometimes, when the seas were not too rough, transfers of personnel and equipment were made. Once, this week, Captain Larry announced that it was too rough to put the Baird’s skiff overside and Captain Ferris replied on the radio, “I’ll come fifty feet from the Baird and if anyone wants to come over, he can swim over.”

The Horizon passed us about noon. Within a few minutes more shots were being dropped and recorded. This continued for at least five more hours. How did the seismic crews stand this long day? At noon, I, only an observer, was dead tired.

There was constant attention to detail. On the Horizon, explosives were being handled. No carelessness could be allowed here. Max Silverman, in charge of this hazardous job, had Ed Taylor as his assistant. Will North was relieved at times by electronics expert Richard Smith, called Smitty.

Then today, with our big winch lowering the corer, the hydrophones must not get tangled with the cable. Twice the ship needed to be turned to reduce the wire angle on the winch’s cable. This endangered the hydrophones floating out aft, but was accomplished without incident.

What did they expect to learn from this difficult work? What it is like underneath, the thickness of the sediments underlying the ocean, and what is the depth to the base of
the earth’s crust? I can quote Russ for the best description of this. He has written:

“One of the most powerful geophysical tools in studying the nature of the earth’s crust is the explosive charge used to create a seismic wave whose propagation through the earth’s crust yields clues as to the nature of the material.

“The basis of the method lies in the relationship between the nature of the rock and the velocity of propagation of seismic waves generated by the explosion. In general, the harder the rock, the faster the waves travel through the rock.

“For years seismologists in observatories all over the world have been studying the interior of the earth by analyzing the seismic waves produced by earthquakes. From this study they have been able to determine the seismic velocities as a function of depth from the surface of the earth to its center. This information has yielded knowledge of the earth’s interior obtainable in no other way. The use of the explosive waves in the study of the ocean bottom reproduces in miniature the earthquakes the seismologist utilizes as a natural phenomenon.”

My statement to the Tongans of Russ’s work wasn’t so far wrong when I had explained that my mari (husband) made his own earthquakes in the ocean and studied them.

The subject of earthquakes reminds me of the cartoon that hangs on the bulkhead of the Horizon. The shooter, Max, was also the artist on his ship. The cartoon shows a charge of TNT that has not properly exploded in the ocean. Rather, it has set off all the TNT stored in the afterhold. One end of the Horizon is completely blown to bits, and the unhappy ship is sinking fast. But over the radio comes Russ’s cheery voice from the Baird, “Uncle from William. That was a fine shot, Will. Send us another just like it.”

Quite late in the afternoon after a day of many crises we heard over the radio, “William from Uncle. We’ve only
Profile of the Tonga Trench area showing the layers revealed by the seismic runs.
got enough TNT left on deck to set off three more shots. Shall we make the last one an 80-pounder? I think we can do that. Over.” By now our sister ship was nearly 78 miles north of us along the Trench.

“Uncle from William. That’ll be fine, just three more, counting this one coming up. Yes, make the last an 80-pounder. Out,” said Russ.

And as the first shot was momentous, so was the last shot, marking the end of a long day for the group. Except for the tedious job of pulling in the hydrophones, the work was finished. I have watched Russ haul in the hydrophones on other evenings. Whoever was near assisted him. Clad only in his frayed, sawed-off blue jeans he would haul in the cable with the intensity of a man pulling a drowning person to safety. These were his hydrophones, coming back at the end of a long day. They were his treasures.

But today of all days the hydrophones could not be stored in their bins. Great trouble had occurred with the big new dredging cable. The gods haven’t been good to us after all.

I have never been so frightened. The worst had happened! Our nearly seven miles of cable were hung up over the Trench.

The heavy wire with its weights and corer at the bottom could go neither up nor down. These twelve tons were fastened at the top to what seemed to be a tiny ship in the deepest, most powerful ocean. On this black and stormy day I wondered what those strong currents would do to our equipment.

Would the A-frame and fantail of the Baird suddenly catapult into the sea if our drifting cable became entangled or caught on the jagged bottom?

Or would the cable snap, as has happened on a ship in
the Atlantic? The broken wire might fly back, at any moment, killing some of those aboard, and the cable fall into the sea—an end to important work; a dreadful thought, but one we all had to face in this crisis.

If only this winch and cable had not been so new and untested when we had sent it to the deep bottom of the Trench.

This is what had happened: In the morning when the cable was going down, it had been tested at successive points: at 6,500 meters, 7,000 meters, and 7,500 meters to be sure it would rewind. As the absolutely new wire uncoiled slowly over the large drum on its first long trip into the sea, naturally the engineers were apprehensive as to the result. Finally at 1125, when 9,000 meters were overside, the winch was reversed to test its ability to retrieve the steel wire. On this last attempt it slipped out of gear, with the result that the spooling drum paid out about 40 meters of wire on the ‘tween-deck and in loose wraps on the storage drum. Friction on the winding rollers held the load successfully, however.

This put a sudden load on the winch and jammed the accumulator so that it falsely appeared to be taking the tension between the winding and storage drums. All aboard rushed to the deck!

We waited as Obie (Richard O’Brien, chief engineer) dislodged the cable with a hammer blow. This did the trick. The crisis was averted as the loosened cable on the storage drum was pulled out onto the deck by hand and then wound back on the drum again.

But no one rested easily any more as the winch’s gear began very slowly to pay out the wire. This wasn’t a good omen. Had we reached bottom? Bob Dill and Art Maxwell were listening for the sound at the speaker on the boat deck.
that would tell when we had reached bottom. With 9,510 meters out, Art shouted, “There it is!”

Bob Dill signaled to Buddy King, second engineer, to stop the winch. But wait! This turned out to be a mistake. The sound was a small explosive charge fired by the nearby Horizon in the seismic run. So more wire was paid out. The wire angle during all this was 10° to 15° from the vertical; it was large, but this could not be changed without taking a chance of fouling the hydrophone lines.

Finally, by all calculation, we were surely at the bottom of the Trench. We had 9,800 meters of cable out, almost 30,000 feet. The men conferred, and at eight minutes to two in the afternoon reached the decision to retrieve the wire. Only 80 meters of cable had been rewound when I heard a shout.

“Hold it!” Bob Dill called to Buddy at the winch control. The drums stopped instantly. All men rushed toward the fantail except the seismic crew, busy recording shots.

What now? A series of bad kinks! And 6 miles of wire out . . . Roger, whose face had worn a worried expression all morning, now looked white under his tan. The usually jolly engineers gazed speechlessly at the problem. The captain came down from the bridge. Willard Bascom, that human dynamo, climbed down into the engine room to study the kinks.

What to do? Ted Folsom, the man with clever hands, who looked like a taller edition of Groucho Marx, and Brownie, the Bos’n, the one man aboard who could make a long splice in the cable, were both thinking fast.

Time was important. It was already nearly three o’clock in the afternoon, the wind was increasing, and a storm could come up any moment, from the looks of the sky.
Even if we could repair this emergency, we still had many long hours of winding to bring the core the six miles up through the ocean to the ship.

As my log describes it, “... there was a large hard knot of wire on the accumulator pulley and two large loose loops at the guide idler between the winding drum and the lead pipe through the deck.” To me, it looked like stiff, tangled wire that would have to be cut off. The winch could obviously not rewind this mess.

There was quiet agony on all faces. On this black and stormy overcast day, the ship was pitching unmercifully on station. The currents of the ocean were very strong here and were causing us to drift into the wind at a rate of one and a half knots. Even the black clouds seemed ominous, and the occasional flashes of lightning and thunder barked a warning.

At last a decision had been reached. First, we had to make some cable clamps. No quick process. We were going to be hung up for hours.

Brownie and Ted set about making cable clamps from one-inch square bar stock. These were then used to fasten the overside lead to another three-quarter-inch wire secured to the cargo winch on the boat deck. All possible tension was taken on the cargo winch and it was then dogged down. If the clamps slipped, the men on the fantail could be killed so quickly. We prayed that the clamps would hold the twelve-ton cable. They did.

Now to get the kinks out. It was late in the day and I was beginning to realize that night would come while we were still hung up over the great deep. Conversation was practically nil as most of us watched the work on the cable. We watchers had been ordered off the fantail, but
we could see from the boat-deck rail what occurred. My ship’s log best describes what happened:

“With the chain fall, tension was exerted on the tight kink below, and the knot was pulled into a basket which could pass the sheaves; the loose kinks on the deck were held in tension with a chain fall and unwound with a crowbar. Then two additional lengths of bungee were added to the accumulator. The weight on the chain fall was released as the tension increased on the storage drum and the upper kinks were eased back onto the sheaves. Once tension between the spools was taken up, the stopper wire to the cargo winch was removed and we were ready to begin winding in the cable.”

At last the cable began to wind, the noisy clankings and rattlings of cable were heard again, and the corer was on its way up. This time the sound was good to the ears. As long as we heard the grinding of the gears we relaxed, but any stop would send us all fearfully towards the fantail.

Nor were we to be lucky and haul it in without interruptions; for when 7,202 meters were still out, two additional kinks developed. We dashed to the fantail again. However, these kinks were not serious and were straightened out enough to allow them to be spooled.

It was now past midnight, and we had been stopped on this station 22 hours, but none of us could sleep until we were safely off and away from Point Item. Finally at 0230 the coring apparatus was brought aboard. The men examined the core barrel with interest. The coring tube and the suction valve had been broken off, the heavy steel bail holding the instrument was badly bent, and the lead weight looked as if it had been beaten by a demented blacksmith armed with a heavy hammer and chisel. Several small
fragments of volcanic rock were imbedded in the lead. Evidently the equipment had bounced along a hard, rough bottom for a considerable distance.

By three o’clock in the morning the magnetometer was streamed and we had three hours of sleep before the *Baird* was to stop on Point Jig when again the seismic crew would be out on the fantail to make a “reversed profile.”

I was weary!
10. UNDERSEA EVEREST

Friday, January 2

It was a typical evening in our lab . . . evening, when work is supposed to be over for the day—but not here. The bright fluorescent light over the workbenches gave this jam-packed laboritory a feeling of daytime. It was still hot, and not a man had his shirt on. All of us had that more or less let-down feeling after a rather grim week, and that never-to-be-forgotten New Year’s Day. If anything, the lab was more silent than usual.

Today our ship, the listening ship, had sat perched again over this deep and stormy Trench, while the Horizon made a reverse profile running back up the Trench, passing us a little after noon. Perhaps to revive our low spirits she had put out a huge advertisement along the boat deck which she gaily flashed as she went by—a big sign, “EAT AT CALLAHAN’S.” Callahan was the name of their cook.

But nothing much could cheer up this group aboard the Baird. Many of our men were exhausted. I knew Russ planned turn in early.

Willard Bascom, diver and oceanographic engineer, was deeply engrossed at the small desk at the entrance to the lab. He was working on a chart and speaking to no one.
Close beside him were geologists Roger Revelle and Bob Dill, huddled over the chart table. I could see from their expressions they were involved in some minor disagreement.

“But we didn’t get a core there either,” said Bob. “Let’s try here.” He indicated a point on the chart.

“Fisher and Menard want us to jog 20 miles east to complete their survey of that seamount they found yesterday,” answered Roger.

“But that fouls up the position for the beginning of the seismic run,” said Bob.

“What’s that?” says Russ, suddenly interested. Endless discussion continued, the men’s eyes always on the chart. In Roger’s hand was a pencil and divider, drawing the suggested courses.

Russ stood marking his records at the bench opposite the echo sounder and close to the phone which calls the *Horizon*. Though dead tired, he and his assistant Dick Von Herzen were examining their records of the two days’ shooting up and down the Trench axis.

This was only a very preliminary examination of the seismic records of the day. The major part of the reading and interpretation comes when he gets home. I thought of the girls back at the lab in San Diego who were constantly working on Russ’s records. He must have enough rolls of records to paper a large house with them.

Dick put down his work and said, “Think I’ll go outside for a minute.” We realized he might be off to the upper boat deck where he regularly takes setting up exercises, even if he’s been on job for 13 hours. Dick is our best skin diver, a very tall, handsome, blond young graduate from the California Institute of Technology, who was trained in seismology and is considering oceanography as a career (that is, after the Army has a chance at him).
“How are your records today?” asked Roger of Russ.

“Mediocre. The noise level was high, and we got weak refraction waves, possibly because the Trench is so very deep and the bottom rugged. Think we got the Moho and it was probably pretty deep. In a few days I’ll know more.”

That word Moho, I know, stands for Mohorovičić discontinuity. Some night soon when Russ wasn’t so tired I’d get him to explain this to me. Each day of shooting the men always asked him, “Did you get the Moho?”

Suddenly all our attention was arrested. The Horizon was calling.

“Hello, Roger. We need Alan Jones over here. When is the soonest we can get him?”

“What’s the trouble?” asks Roger.

“Our echo sounder’s out of commission. Can Alan come over?”

I looked at Alan, this red-haired, bushy-bearded, white-skinned, freckled-faced young man who was sitting at the bench with oceanographer Art Maxwell, helping him wire up some equipment. Alan has been our friend for years and after college had chosen to work with Russ at Scripps. His hobby is photography, and he was prepared to take over 1,500 pictures on Capricorn. Every man aboard respects his nimble fingers and fix-it genius. Alan is indispensable. Alan struggles against chronic seasickness, yet in spite of this he carries on during long, tedious hours of careful work.

I watched him leave his work and go over to Roger as negotiations were concluded about sending him to the other ship. It was a dark, black, rough night in which to launch the skiff and ride over to the Horizon, and the decision was made to make the exchange on the next day. Gustaf Arrhenius and Henri Rotschi (our French oceanographer
who had come from Paris to go on this trip) had been busy at the chemical lab bench speaking French quietly together. They went immediately to confer with Alan, for they wanted some sample bottles stored on the other ship. Their lab already possessed its maximum of equipment for the space available, with a microscope, centrifuge, a filtering apparatus, spectrophotometer for chemical analysis of water samples and sediments, and many many small sample bottles and distilled water.

After this brief radio conversation with the *Horizon*, the lab returned to its routine. My typewriter was clanking away on the board over the ice chest where I was copying the log of that never-to-be-forgotten New Year’s Day. I had struggled with the account all day with Roger and Willard’s help.

Now Walter Munk came into the lab on the double.

“Roger, I have just come across something most exciting.” I watched them huddled together, Walter with pencil and paper, demonstrating a new idea on why we were not bringing up samples from the bottom of the Tongan Trench.

Walter is to our ship as baking powder is to a cake. He really keeps things stirred up, is alive with ideas. No one aboard makes me feel so at ease. I’ve known him since he graduated from the California Institute of Technology. Walter is in his thirties, has a tanned, ruddy face, light brown hair, deep blue-gray eyes. He is Austrian by birth, educated in England and our country. His life has never been dull. He likes to ski, scale mountains. He is an intense, loving, kind young man who brings more enthusiasm to living than perhaps anyone else I know. This quality makes him of great value aboard ship. He has already made a record as a brilliant oceanographer, is interested in every
phase of the work whether it is GEK measurements, temperature tests, bathymetric surveys, or air sampling. Always he seems eager to dive with the aqualungs.

“Aren’t you afraid of the sharks?” I asked him that day he’d encountered them over Falcon volcano.

“I couldn’t dive if I were,” he answered.

Walter’s bunk mates are Bob Livingston (not in the lab tonight) and Ronald Mason, our Englishman who usually turns up in the lab about midnight to work on his magnetometer records. He is a lone wolf, working late at night when there is more space on which to spread out a twenty-three-foot-long record.

One night he asked me just at twelve o’clock, “Helen, are you hungry?”

“Yes.”

“What’ll you have? Sardines? Apple? Egg?” He pulled three hard-boiled eggs out of his pocket. These he had boiled in the galley after supper to fortify himself for the long night.

Another night prowler is John MacFall, our tall, lanky photographer-diver. He is always pleasant, but never seems to sleep. When not on watch he is usually in the ward room.

“Are you this way at home?” I once asked Mac, father of four children.

“No, just at sea.”

On this ship of men I can’t help but speculate on whether scientists are different from other men. Some psychologists study this problem, I know. Hollywood too often depicts the scientist as a bore with spectacles and beard, absent-mindedly peering through a microscope. Not these shipmates around me. They are physically rugged, extraordinarily well equipped to cope with that restless antagonist, the sea. They all like to swim. At the island of Serua in
Fiji, twenty of them plunged into the water near the reefs to explore the environment. They are completely at home in the ocean.

Their outstanding quality is curiosity. They have no time for card-playing, at least on this ship, but seem to be either working, studying, reading, or talking. They seem to have no sense of time, do not like regimentation, and work any hour of the day or night as needed.

As to the little things that perhaps only a woman would notice: our men differed from the Tongans in that we have fewer smokers. Their cigarette rations seemed to be the one commodity used as gifts everywhere. Of the scientific personnel aboard the Baird, only about one-third of them smoke.

Also my companions have absolutely no interest in their appearance while on the job. If they continue to lose their shirts and pants to the natives in trading as they did in Nukualofa, what will they be wearing on the long stretch home? Pants legs are cut off short, leaving frayed edges, and ropes are used for belts. A towel, if a pair of pants is not handy, will do. There is only one rule aboard: “shirts at meal time”—but what shirts! They are hanging on a Nansen bottle in the lab or on a core barrel, to be grabbed up and donned for the occasion only.

And what a struggle in ports, meeting the clothes problem. When our men were requested to appear in their best, wearing coats, a number of them usually failed to show up, regardless of the occasion. It’s too hot to wear a coat.

At Tonga the European women said to me, “It’s unbelievable how tall your men are.” Our expedition possessed many many men six feet and over and whenever we appeared en masse this fact was always noticeable.

But enough of this. I’m to type up and post the plan for
the next day. The plan is usually not decided upon until midnight. It is a schedule of operations, what is
to be done at each stop (or station as we call them) during the day or night.

And now for tomorrow (which begins at midnight), we are going to have a station at three o’clock in
the morning. Ted Folsom and Walter Munk will send bottles and pressurized thermometers below, off the
big winch at the stern, in an effort to recover samples of very deep water. In my log for today I’ve written
“Plans provide for a rather complete hydrographic cast of the water in the Tonga Trench. This cast should
yield information concerning the basin-like structure of the Trench.” They began this project today at ten
o’clock and apparently will continue all night. Ted Folsom is using some newly designed thermometers
that can withstand the great pressures in the Tonga deep.

Also on the plan for tomorrow are some more cores. These men are gluttons for punishment.

Saturday, January 3

“Hello, William, this is Uncle.”
“Uncle, this is William. Go ahead.”
Harris Stewart’s voice came over the air from the Horizon. “Ran into a pretty interesting seamount last
night. Would you like to hear about it? Over.”
“That’s swell, Stew,” said Roger.
“We’d just made another crossing of the Tonga Trench and suddenly, whammie!—the bottom kept
coming up. It didn’t level off at 3,000 fathoms as we’d expected it to. Instead we got a seamount four and
a half miles straight up,” said Stew. “A grand-daddy of a seamount.”
Everyone on the Baird stopped his work and gathered around the loudspeaker in the lab.
“That’s as tall as Mt. Everest,” someone said.
“The bottom came up so steeply we thought we’d lost the trace. But putting the fathometer on audible, we knew it was the bottom and could really hear it. We wondered if it were ever going to stop going up. We were laying all sorts of bets as to when the top would come. It made a 12° angle coming up from 4,600 fathoms, over five miles down.”
“Good, Stew! At what depth was the top?”
“Two hundred twenty fathoms, Roger. When it started going down on the other side, we knew it was a seamount. So we made several passes over it and have it fairly well explored.”
“Was it flat-topped?”
“No. A couple of pinnacles. Fisher, Menard, and I all said, ‘We gotta dredge here.’”
“How deep did you dredge?”
“Wait one, Roger. We’ll get the log book. Do you want the whole long story now?”
“Give us the high spots. We’ll get the details later.”

The geologists were deeply intrigued by the news and the possibility of getting rock samples from the Tongan Trench area. Dredging for rocks is an exciting business. Perhaps nothing in oceanography better exemplifies the problem of the marine geologist in comparison to the land geologist.

On land, when a geologist wants rocks from a certain mountain he can take his hammer and collecting bag, hike to the mountain, and collect to his heart’s content. He can see where his rocks come from; he can tell at a glance whether at another few hundred feet up the mountain he would be collecting from the same or a different type of formation. A blindfolded geologist could do his collecting by pulling a large open bag behind him, collecting only
those rocks that were scooped in or that he could pull loose when his bag got hung up on an outcropping rock. He might spend all day pulling his bag over the slumped face of a mountain where sediment had collected and flowers grew and sheep grazed and not scoop a single rock into his bag because all the rocks were hidden under this thick layer of sod and sediment.

The marine geologist is blindfolded. His dredge is a steel mesh sack which lets the sand, mud, and water flow through, but keeps the rocks. This bag is lowered to the side of a mountain under the sea and dragged slowly across it, usually by just letting the ship drift. A dynamometer measures the tension in the wire and a large spring arrangement (called an accumulator) takes up the strain of sudden jerks on the wire in case the dredge gets hung up on a rock formation and doesn’t immediately break loose.

The marine geologist is torn between the desire of hoping the dredge will catch an outdrop and break off a good piece to bring home, and the fear that it will, and the cable will break. With luck, when this happens the wire can be slacked off fast enough so that the wire doesn’t break.

Dredging for rock is exciting, dangerous, and frustrating. A successful dredge haul is an event—and a successful one from the Tonga Trench would be a big event.

But Stew was back on the air. His voice came over clearly. “Here goes. I’ve got the log book,” he said. The men on the *Baird* settled back against the workbenches and prepared to listen. Not a word was spoken.

“Starting at two o’clock yesterday afternoon we had a bottom of 580 fathoms, and it was coming up fast. We stopped and put over the dredge. We like to dredge upslope, so we don’t have to keep putting wire out. When we had 1,400 meters out, we felt it should be on the bottom.
“Drifting up-slope, the bottom reached 220 fathoms and we hadn’t felt a nibble, no tug at all. Then
suddenly the ship went down in the rough sea and stayed down. A crash! Ship vibrating like mad.
Everyone came tumbling out of his bunk onto the deck. What’s up? The pointer on the dynamometer
spun around like a pinball machine. Then the ship went back to its normal movements. So we started
hauling. All we had on the end was a frayed cable and no dredge.

“We had a partially made dredge aboard. While some of us were putting that together to try again, Bill
Reidel put overside two cores with no result at all. We couldn’t get a damn thing off that mountain.”

Then Stew described the feverish excitement on their fantail with everyone working against time under
the bright night light to build this dredge from wire and chain.

“By ten-twenty that night we finally had the new dredge built.” continued Stewart. “The ship was rolling
badly, the conditions were really too rough for dredging, but we called in marginal conditions and dredged
anyway, because this seamount was important and we really wanted a sample.”

“What happened?”

“Well, we dredged until one o’clock with this dredge, and it came up empty. We hadn’t even felt a tug.
We were mad.

“So we lowered it again at two o’clock in the morning to 510 fathoms. Heck, we’ve often dredged
deeper than that on the Alaskan seamounts and brought stuff up. We thought we’d surely get it this time.

“At three-ten, after a few nibbles, it hung up, but the tension was low, so we weren’t too worried. At
three-twenty-five we had the wire aboard, but all we had was the wire.”

“What did the dynamometer read, Stew?”
“The log says three and a half tons. I didn’t see it myself. Evidently what happened, Roger, was that the wire broke on an upsurge of the ship. That’s the long, sad story. We didn’t get a sample and we have two less dredges than we had when we started. And that’s our news from here. Do you have any better news from the Baird? Over.”

“No news, Stew. You did the best you could. Out.”

Roger put down the receiver and looked at the despondent faces of those about him.

“I guess this Tonga Trench doesn’t like us.”

_Sunday, January 4_

I like the crew of this ship. I think they co-operate with these “screwy scientists” no end. I am continually impressed by the comradeship and the high morale they possess. The happy, laughing taunts, the noisy sounds of fun continually prevail, and a great regard for their Captain and each other is evident.

Years ago I once traveled on a small Mexican tramp coastal freighter for 47 days where the engineers, filled with hate, threatened to damage the ship. I escaped from the freighter by riding steerage on a Japanese ship with polite Orientals, and I’ve traveled on floating hotels. But give me the _Spencer F. Baird_.

The engineers aboard are a unit unto themselves. They are up any hour of the day or night operating winches, plus keeping the ship’s engines working and in engine-room temperatures definitely unbearable from anyone’s point of view.

Tonight at eleven o’clock we were stopped on station to put down the gravity core off the big winch, and these engineers will be watching this ticklish operation through many hours of the night.
Yet Chief Engineer Richard J. O’Brien, a young, jolly, plump, ex-Navy man, does not complain. His sidekick and second engineer, Buddy King, is also good-natured. When I said, “What did you do before you came on this ship, Buddy?” I got a prompt answer.

“I left my mother’s arms for seven years in the Navy.” Buddy has told me stories about the others: electrician Ed Proulx, husky, smiling Don Derringer and pleasant-faced Albert Chapman.

Our philosopher aboard is the third engineer, another old Navy man, Jim Hayden, who claims Spencer, our hound. “Jim was on one of the PT boats in the war, one of the expendables,” said Buddy.

Spencer, the hound, is often produced at sunset hour on the fantail, and Jim and the others have taught him to do tricks. When the divers are outside, Jim sometimes decides that Spencer needs a bath, and so Spencer is put over without an aqualung. Although the water is warm, Spencer never seems to enjoy these aquatic excursions as much as we who are watching.

First mate on the *Baird* is the young, handsome Bob Haines, with wavy black hair and a beautiful black mustache. He is as brown as any Polynesian and is without doubt the neatest man aboard. His cabin on our deck is always immaculate. This room he shares with Cleveland Davis (Davy), the second mate, who has been to sea ever since he was thirteen years old. He was with Byrd on Operation High Jump in the Antarctic. Helping these two on the bridge are seamen Vince Lilly and seventeen-year-old Dick Rathbun.

Perhaps our ship is like a huge family, only relationships are in some ways more simple than in an American family. We are more like a Polynesian family, in which there is a
place for everyone and each has his appropriate role in the regime and little chance for privacy.

Everyone aboard, including me, has a job to do. Our shipmates are more or less happy about their roles. We are a sea-going unit, each dependent on the others, and this makes for a unique spirit among us. If we have a broken toe, we see the ship’s doctor; if we have a broken icebox, the ship’s engineers and our instrument men. I am not envious of anyone else’s job, just happy to be part of the group.

I have never been surrounded by a group more able to handle any situation that arises, whether it be exploring under water, landing on islands through reefs, throwing explosives overboard, or mending equipment under dangerous conditions.

We are sharing beauty, danger, and drudgery. Perhaps this gives us a feeling of belonging to each other. For better or worse, we’re sailing the seas together. This welds us into the self-contained unit we’ve become.

We live in a world of time unlike anything on shore. When we have left port, the entire ship loses all sense of the passing days. I can ask at chow, “What day of the week is this?” And no one but Kenny, the cook, can give the answer right off. But nearly everyone knows the day of the month, for records are kept and watch lists are posted for January 1, 2, 3, etc.

The days melt into nights. Our ship never goes to sleep as a house or a village goes to sleep. Watches come and go and men are in the galley and ward room any hour of the day and night. Regardless of when I see a shipmate for the first time each day, even if it is three o’clock in the afternoon, I usually say, “Good morning.”
I have never been on any other ship where there is so much going on and so many busy people.

“Helen . . .”

“Yes?”

It is Brownie. “Russ says you know something about leather work and grommets. We’re trying to make a canvas sleeve. Come and take a look.”

“Russell, what is under the ocean?” We were standing on the deck of the bridge at dusk.

“Mud.”

“How did the mud get there?”

“That’s what we want to know. The mud is sometimes a red ooze or clay or tiny fragments of fossils, shells, the final remains of all forms of life in the sea. These sift down eventually to the bottom, making our ocean floor.”

“But what’s underneath the mud?” I asked.

“Hard rock, the earth’s crust.”

“What do we know about the earth’s crust?”

“It may be olivine basalt. We’ve measured the speed of sound through this crust, and we find in general that it’s 6 to 7 kilometers per second. Rocks on the earth’s surface that have a comparable velocity are rocks rich in a mineral called olivine. The name for such rock is basalt.”

“How deep is this crust?”

“The depth varies. Here in the Pacific we think it is six and one half miles below the sea level. That’s what our seismic surveys tell us.”

“And below this?”

“Under this crust we find a different velocity, indicating another rock, the earth’s mantle.”

“What is that?”
“Baedeker’s” Guide to the interior of the earth.
“We think it could be a dense rock with the rigidity of steel. It might be made of iron, magnesium, silicon, and oxygen, or probably may be much more complicated, like stony meteorites.”

“Then, what’s the Moho?”

“The discontinuity where the earth’s crust meets the mantle, so called for its discoverer, Mohorovičić. You could say the Moho is just the top of the mantle.”

“How thick is the mantle?”

“The mantle is 1,800 miles thick. Beneath it, the earth is liquid. We know this from earthquake studies. This rock extends about halfway down to the center of the earth, and inside it is the part of the earth we call ‘the core.’”

“Is this central core liquid, then?”

“We think so.”

“How hot is this liquid?”

“Somewhere from 6,000° to 9,000° F. We don’t really know.”

“What do we know about the nature of this liquid?”

“It is believed to be metallic.”

“No one has seen the earth’s core?”

“No.”

“Nor the earth’s mantle?”

“No.”

“Yet, that’s what we are studying?”

“Yes.”
11. NOFOA TONGA

Monday, January 5

I HAD one great wish: that Expedition Capricorn should visit Vava’u, since it was on the chain of islands we were to observe as we went northward.

“There is a sunken ship which went down, full of bottles of whiskey,” I told the divers, “and I can find you a Tongan who knows just where. If you don’t believe me, it’s marked on the chart.”

The divers were skeptical but curious. I plied them also with true stories of Mariner’s Cave, a cave reached only by diving, where the entrance is 6 feet below the surface of the water. The cave itself is 50 feet high. History records that a beautiful maiden was once hidden there by her lover. Lord Byron wrote a famous poem about it. Prince Tungi himself had recently dived down to this cavern.

I had told Roger that there was an island here that resembled an old crater.

“But Vava’u is supposed to be a limestone island,” he had replied.

“There is a 450-foot high mountain peak named Talau that no Tongan would let me climb by myself,” I said. “I
think they said it is an old volcano.” It had looked like one to me, but I was probably wrong. At least today we would see.

For now we were headed toward Vava’u. Our marine geologists were going to be land geologists.

The Tongan Islands are west of the Tonga Trench. They run north and south, paralleling the Trench . . . and they are all supposed to be land-type, or continental islands. The purpose of our island visits is to collect rock samples and see whether the supposition is correct. Are these ocean-type islands or continental-type islands? The distinction is made by the kind of material or rock that goes into making the islands.

The rocks that make up the Rocky Mountains, the Andes, the Himalayas—the rocks that from our continents and extend downward some 20 miles or so—are different somehow from the rocks on the floor of the ocean, that push up to make islands like Hawaii, Samoa, and Tahiti.

For one thing, continental rocks are lighter—not much, only about 5 to 10 per cent, but this is enough for continents to float up higher than the floor of the ocean. The average difference in height between the continent and the ocean floor is 15,000 feet.

Some geologists have suggested that in the western Pacific the dividing line between the trenches and the island arcs should be called the andesite line, because the volcanoes on the islands seem to consist of a rock called andesite, which is more like continental rocks than like the basalts of the ocean. This andesite line doesn’t correspond to the shore line. As we sail west from our California coast, the depth of the ocean fluctuates between 300 and 2,000 feet until at 150 miles from the coast line, these depths suddenly increase to about 12,000 feet and we are in the deep ocean.
This might be the dividing line between the oceans and the continental platform. Similarly this area of the Tonga Islands and the Tonga Trench might be the dividing line between the “continent” and “ocean.” However, to look at the map, we are practically in the middle of the ocean.

Other geologists think that the boundary between the oceans and continental rocks in the western Pacific is much closer to the continents. We are trying to gain information which will help us to decide about the boundary of the continents and deep ocean. This is why we all hoped that Stew and the men on the *Horizon* would be able to bring up rocks from their seamount on the eastward slope of the Tonga Trench. This is why we are going rock-hunting on the islands to the west of the Tonga Trench. Does the andesite line run down the Tonga Trench?

But now this morning we were actually headed toward Vava’u. I was worried lest the others wouldn’t find this harbor as interesting as I had.

My anxiety was needless. As the *Baird* entered through the Fa’ihava Channel by the green terraces, caves, and steep, undercut sea cliffs, I saw nearly every man at the rail as intrigued as I by the mysterious course our vessel followed through the maze of islands. Their faces and remarks clearly indicated that even the most seasoned sailors aboard found this harbor unique.

“It reminds me of fiords of Norway, only the green here is the green of coconut trees,” said Roger.

It was early in the morning, and Larry maneuvered the ship quietly up the intricate channel without calling for the pilot boat.

We had radioed ahead to Dr. Matheson and his wife, and as we passed the point at Utulei, my good friends were waving
to me from their veranda. Soon we saw Farquhar Matheson set out in his boat to overtake us. Larry
decided to anchor in the inner harbor near Neiafu.

“We expected you yesterday,” said Farquhar, after greeting us and being introduced. “You must have
crossed the dateline and changed your time.” This was precisely what we had done on leaving Nukualofa,
and we were chagrined to have made the mistake, for he had arranged launches to meet us on the day
previously.

But we were here, if only for a few hours. Shore parties were quickly organized, and the divers rowed
off in the direction of the sunken ship.

Farquhar invited us to his home for the afternoon, then kindly took us ashore with gifts and greetings
for the family at Falekava’s: Lisiate, Kaufoou, and my friend Tu’ifu. I was at last able to introduce Russ
to them and to show him the Tongan house where I had stayed. I was happy to see “my family” again.

“We wanted you for the New Year’s feast. We hoped you would come,” said Lisiate. I explained
that John Isaacs had gone on the interisland steamer, the Tofua, instead of me. They remembered him
in Vava’u. It seems that John had borrowed a motorcycle and ridden off for seven hours to explore the
island. He had gotten lost, and being unable to speak Tongan, he couldn’t get proper directions back to
the ship. When it was time for the Tofua to sail, he had not yet reappeared. A friend finally removed all
his belongings from the ship. Then, ten minutes before the Tofua weighed anchor, up rode John.

“We are having a birthday feast at noon. Will you come?” asked Kaufoou. Roger, Russ, and I agreed
to meet her at one o’clock. Parting from Farquhar, we went on a geologic
field trip—nine of us in a jeep. Ben Apon, the Dutchman, newly arrived from Nukualofa, had arranged this trip. We wanted samples. First to Talau, the peak no Tongan wished to climb. We failed to find the trail, but we found rock specimens and went on the 14-mile road trip to the Ano lagoon, a stillwater brackish lake.

In Tongan fashion, a pretty young girl in the village of Longomaba prepared some leis of greens and shyly put these around my neck before we started back towards Neiafu and our feast.

At Falekava’s, Kaufoou with her black umbrella and Maria the dancer met us and walked quietly with us through the village to the house of the feast. I found Tu’ifua there to greet us, for it was her little niece who was having her first birthday, and it was being celebrated by more than fifty Tongans. Here a baby’s first birthday is the most important one, for the child has lived through the dangerous first year.

It was a typical Tongan birthday party served under a long green palm canopy—roast pig, taro, kumala, pineapple, watermelon, fish, colorful sweet drinks, and a beautiful cake with candles.

At the end of the feast, Tu’ifua’s father, a respected 72-year-old Tongan in Neiafu, delivered a speech in our honor which Tu’ifua quietly translated. Then Roger, representing the expedition, arose and in simple words replied to the greetings. At the end of each of his sentences, Tu’ifua in her low, rich Tongan voice, carefully translated what he had said to all the guests. This was followed by singing and dancing and of course they played the song “Ke ke ilo,” which I had sung with them before. We all smiled as we sang it again. We hated to leave, but Farquhar was waiting with his launch to take us to Utulei. Roger was also still
on the hunt for more rock samples; so far he had found no evidence of volcanic rocks on the island.

At Pat and Farquhar’s home we went swimming and hunting for corals in the outrigger. Then the villagers arrived, squatted on the veranda, and sang their Christmas music for us. I wished that all the ship could have been there and we could have made recordings, but Larry was anxious to negotiate the tortuous channel before dark, and in the rush to get geologic information we had been unable to plan a visit for all to Utulei.

The Mathesons, Tu’ifua, Vei, the pretty girl who helped Pat, and the baby went back to the ship with us. There I found Lisiate with gifts for me and laundry they had done for the sake of kindness. It was hard to say a final goodbye to them all. Reluctantly our boat sailed out of the harbor blowing its whistle in salute as we passed the village of Utulei—“Ofa atu.”

Tuesday, January 6

We came today to the last of the long chain of Tongan islands. Last night we concluded a tape recording on our observations and descriptions of samples taken at the Vava’u group of islands. These apparently consisted entirely of limestones; no volcanic rock was found. But the two islands we planned to see today were the volcanic islands of Niuatobutabu and Tafahi. So far as we knew, these two islands had never been examined geologically, and it was our intention to land a party on one of them and obtain a representative collection of igneous rocks.

Our sailing directions told us that Tafahi, an island of volcanic origin that attains a height of 2,000 feet, is difficult to reach, although “sailing vessels visit Niuatobutabu at irregular intervals, but during the hurricane season (December
to April) this service is suspended. The anchorage is situated to the west of the island and is a poor one. The population is somewhere around 800.”

Approaching the island, we were interested to discover how much the cone of Tafahi resembled the volcanic cone of Kao. It was quite evident as we approached Tafahi from the southeast that the windward side of the island had a much steeper slope than the leeward side. Then, as we came into the channel between the two islands, Tafahi appeared a truly symmetrical cone. There was very little evidence of a sea cliff around it, indicating either that the rock is quite hard or that the island is pretty well protected by the coral reef which, according to the chart, extends all the way around Tafahi.

The decision had been made to try to land some men on Niuatobutabu. This island now lay on our starboard side. It is three and a half miles long and about half a mile wide. Niua means coconut palm and tabu signifies something sacred.

It was here that Tonga was first discovered by the Dutchmen, Schouten and Lemaire, in 1616. Between these two islands the Tongans in twenty-three large canoes and forty-five small ones surprised the Dutch explorers with an attack of stones.

We were standing on the bridge staring out at these historic islands when I heard someone say, “I see a sail.”

“Where?”

“Dead ahead. There’s another one, too.” Soon we had spotted two native sailboats.

Our Captain suggested, “Let’s ask them to show us the pass through the reef.” Immediately, he proceeded directly towards the second sailboat, which appeared to be heading for Niuatobutabu.
As we drew closer we waved to the natives on the boat and they to us, but they didn’t stop. They motioned with their hands towards land. Larry turned to me. “Get the Tongan flag.”

I dashed down to the cabin to get this treasure, which he had presented me as a souvenir of Tonga. We had thought the ship would have no more use for the large, red flag which had been made for us in Fiji.

Up went the flag. Still the boat did not stop. The men were asking me for the Tongan words for “Stop. Help us.” Finally Larry called through a megaphone.

“This is the *Spencer F. Baird*, University of California research vessel. Will you tow our skiff in to the island?”

Would they understand us? The little boat paused. We came closer and as speedily as possible launched our rowboat. Into it went Bob Livingston, Willard Bascom, Dick Blumberg, Phil Jackson, and Bill Riedel, geologist from the *Horizon* who was visiting us for a few days. The rest of us kept our eyes on the native boat, in which sat men, women, and children, about twelve in all. Suddenly we saw Bob Livingston transfer to the native sailboat and our skiff return to the stern of the *Baird*. We were very curious.

“Now what?”

“They’ve got a sick baby,” our shipmates shouted to us. “Will you tow us closer to the island? We’re to go with them through the pass in the reef. We need a light, too.”

It was nearly supper hour. Time was not on the side of this venture. We handed them a light and towed them towards the encircling reef. At a 50-fathom depth, Larry stopped the ship and the little skiff started toward the shore, the men rowing vigorously.

We watched them pass on through the gap in the barrier reef, following the Tongan sailboat. Beyond the reef was
a white sandy beach, bordered by green palms. Farther up the shore a few thatched houses were barely visible. Watching the progress of our small, white rowboat through binoculars, we eventually saw it come to land beside the native sailboat.

We settled down to wait patiently until our explorers returned. As always, no hours were lost even now, for grab samples from the bottom were taken on the hydrographic winch. Brownie, who had been trolling off the stern, had caught a 35-pound wahoo and was busy cleaning it. Fresh fish to eat—good!

Later, after chow, as the sun was going down, Russ and I stood on the bridge with Larry and the others. We persuaded Brownie to get out his guitar, and as it was his birthday we sang in his honor, Tongan fashion.

After a time, the sun slowly sank on our starboard horizon. We watched night come, fascinated. Smoke rose from a fire in the palm forest and as dusk deepened, a light appeared. Soon five lights were twinkling on the shore . . . and then stars began to come out.

Russ said, “See Canopus over there, Helen. That’s the second brightest star in the heavens, only seen in the southern hemisphere.”

“What’s the brightest?”

“Sirius. We can’t see her now.”

Bob Haines quickly busied himself with his sextant and obtained a star fix.

As it grew very dark we wondered uneasily how the skiff would get through the dangerous reef in the night. We had turned on the big fantail light so that our ship would be easier to find. It was close to eight o’clock when I saw a light flash near the shore, and then flash again.

“I see them,” I called out. All on the bridge strained to
look toward shore. The light, blinking on and off rhythmically, gradually grew brighter. It was our rowboat coming toward us, its light appearing and disappearing among the swells.

As the little boat approached, all of us gathered on the stern to hear what had happened on the island. We saw Willard Bascom and Dick Blumberg, clad in grass skirts, and others with sisis, all bearing gifts, canoe paddles, shells, leis, and such. In the yellow light on the fantail they looked—they were—Polynesians.

Bill Riedel shouted happily with his soft Australian accent, “We got what we went for,” waving a bag of volcanic samples. As our friends climbed aboard, they looked exhilarated, happy.

The nongeologists aboard were interested in hearing Bob Livingston’s story about the baby and the village. Bob reported that he had found the sick baby wrapped in an old piece of tapa cloth and with open sores on its body.

“The baby could hardly open its eyes, its color was pasty, and it was obviously dehydrated,” he said.

“What was wrong?”

“The child was burning up with fever, rose spots on the abdomen suggestive of typhoid. Worse yet, the mother was very ill too, apparently also with typhoid fever. She was unable to supply sufficient milk. The grandmother was trying to care for the baby.”

“What did you do?” we asked.

“My job was to get some fluids into the child,” he continued. “They had a baby’s bottle, but the holes of the nipple on the bottle were too small. I fixed these, and we managed to get some water into the baby while we were heading for shore.”

We learned that Vaca, captain of the native vessel and
chief of Tafahi, could speak only a few words of English, but he told why their boat had not stopped sooner when we first hailed them. They were racing to get the sick child ashore.

“There is a small hospital on the other side of the island, four miles away,” said Bob. “When we got ashore we were met by a trained Suva medical practitioner, a man with a goatee. The baby and family were hurried off to the hospital. Vaca said his people had a hard life because of the poor soil on the extinct volcano and asked us for pants and shirts as natives did everywhere else in the South Pacific.”

Bob pointed to a large square reddish-brown volcanic sample on our fantail. It was a rock about a foot long and might weigh 40 pounds. “Here’s a rock from that barren island of Tafahi.”

Roger and the others examined the stone with interest. “How did you ever get that?” asked Roger.

“I saw the rock in the Tongan skiff. They used it for an anchor. ‘Can we have it?’ I asked Vaca. He said they needed it for an anchor. Then I explained about the expedition and promised him some cigarettes when our skiff came to land, and he agreed to give the rock to us.”

This expedition to one island was a success, with geologic samples from two islands for loot. Bill Riedel told us that on Niuatobutabu there had been thick vegetation profuse with coconuts. He said that news travels fast in Tonga without the benefit of radio or television, rather by the mysterious processes of gossip. Even on Niuatobutabu they had heard that Prince Tungi had given us a feast.

*Wednesday, January 7*

We’re coming into port today and our ship has an expectant air. The very tone and atmosphere changed over
night. There is a busy-ness and hum and urgency about that has to do with the mail and coming into land.

For the last two days letter paper has been in evidence and men’s faces have that partially withdrawn
look they possess when they are writing letters home. By sheer force they have managed to pull themselves
out of the present hourly cycle of ship’s life and are concentrating on home.

On the boat deck MacFall has been busy for days in the tiny, hot darkroom that has practically no
openings for ventilation, getting proofs of some pictures to send back to Scripps for publication. Whenever
these pictures are out on a shelf, a group of men can be seen huddled over them. But poor Mac—the
conditions under which he produced these prints were impossible. Many times after rough weather he
would come to his lab to find everything on the deck, the room in a horrible mess. The long hours it took
to chill waters and develop at desired temperatures in this heat were frustrating.

Not only should pictures go home but expedition reports. And at this port Roger was sending home a
discussion of the Tonga Trench.

This article was born with great travail, as I can witness. It began one hot day on the bridge. Roger says
that he nearly always writes by dictating.

“It doesn’t matter who is there to take my words. Anyone will do.”

“Let’s find a cool spot,” I said and got my pad and pencil. On the bridge I sat down on my pandanus
mat which served as a portable seat, and waited. The day was one of bright sunshine and the ocean was
very blue.

Roger’s method of sentence creation meant going into a mental retreat for so many minutes and then
coming up
with the sentence. He paced back and forth across the rolling deck. In the beginning it was tough going, and the first two pages took perhaps an hour. As he warmed up to the subject at times, his dictation would change, and he would suddenly be hurling words at me. This usually happened at the end of a session, just as someone on the bridge called us to chow. Knowing how long it had taken to get this flow of words, I hated to stop at that point.

But on that first day it was slow going. While waiting for sentences my mind could take a trip to Fiji and back while Roger thought of point two of the unsolved problems of the Tonga deep. It would be bad business to ever ask him questions about the subject, as his chain of thought must not be disturbed. Bob Livingston and I had suggested this project, and we had hoped for an article on the Trench. This was the first time Roger had tried to write while at sea.

Each day that we worked on the article, he’d begin in this manner.

“Let’s read over what we’ve written.” Of course there would be changes. And now on this last day, coming into Samoa, where it must be mailed, we were still changing it and I was hoping for a perfect copy for Thomas Manar in Publications back at Scripps—but no such luck. Now on this last day we were still working; we had reached the summary.

“Take this,” said Roger.

“The work of the Capricorn expedition has added considerably to our knowledge of the Tonga Trench and the island chain. We have found that the Trench is rough, rocky, narrow, V-shaped in cross-section, straight for long distances along its axis; that in its present form it is so young there has been little time for sediments to accumulate; that most probably it is still changing shape.
“West of the Trench there are parallel structures that must be closely related to it: the Tofua Trough, which has acted as a catchment basin for 7,000 feet of sediment, and beyond the Trough a long ridge capped by active or recently active volcanoes. This ridge itself is an upward fold in the earth’s crust, just as the Trench is a downward fold. Our investigation showed that the deeper parts of the Trench are very rough, almost like upside-down mountain summits. We think that much of the bottom on the western side of the Trench must be bare of sediments. Where sediments were obtained, these were always gray, unaltered volcanic sand and silt, which were probably ejected from the nearby active volcanoes.

“Beneath the Trench, the material of the earth is bent downward and crustal rocks are being forced into the earth’s interior. The Moho (the line of demarkation between the crust and the deeper mantle) is 12 miles below sea level under the Trench, while on the east flank it is only 7 miles. We were not able to find the Moho on the west in the Tofua trough.

“It seems evident from the narrow V-shaped profile, irregular rocky surface, thin veneer of sediments, frequency of earthquakes, and existence of large anomalies in the earth’s gravitational field, that active movements of the crust are taking place on a grand scale at the present time along the axis of the Trench. Every indication points to a squeezing-together and downward-bending of the earth’s crust. In the volcanic region on the west, the rocks below the surface have melted and forced their way upward through the crust, perhaps because of relief of pressure at great depth.

“Perhaps we may liken the Tongan area to a gigantic engine in which the Trench forms part of the boiler where energy is added at high pressure and the volcanoes represent
the condenser where heat is dissipated at low pressure. But what is the source of energy for the giant earth-moving machine that has so violently operated here?”

“Chow’s down,” someone shouted. Good! There are some men aboard this ship who take care of the inner man and not the sea bottom.
12. PAGO PAGO

Wednesday, January 7

What would I do when I came to Pago Pago? I could no longer push this question down into the subconscious. Roger had offered me passage to Samoa, but what happens now?

There are disadvantages to a one-way ticket to the South Seas. Should I go home from Samoa? I was just beginning to get the feel of this oceanographic ship. I didn’t want to leave. But Tutuila, the large island of American Samoa, was looming up on the horizon. What would I do when the ship came into port?

“There is no problem,” said Roger. “Come on to Tahiti. We’ve taught you to work. Why should we lose you now?”

I discussed this matter with Walter Munk, who was trying to decide if and when he should leave the expedition. His advice was forthright.

“Stay with the ship until Tahiti unless you have to leave at Samoa,” he said. “The men have adjusted to you. There’s no problem.”

I was happy to learn he thought the situation well in hand. But the mail in Samoa might bring me news that demanded a return home. None of us had heard from La
Jolla since long before Christmas. I couldn’t decide whether the very wet day which marked our entrance into the Pago Pago harbor was a good or a bad omen. We stood in the rain and looked at the rugged green volcanic islands on either side as we proceeded up the harbor.

It was here I had expected to stay for two weeks before meeting Russell. I had introductions to Samoan chiefs, trips planned to other islands.

Samoa, unlike Tonga and Fiji, had been subject to a number of foreign powers, and between 1860 and 1889 the island had been ruled by chiefs directed by American, British, and German Consuls. The treaty of Berlin in 1899 divided the Samoan Islands in two, Germany controlling Western Samoa, the United States controlling American Samoa. After the treaty of Versailles, the government of Western Samoa was given to New Zealand under a mandate from the League of Nations. At the present time New Zealand is the trustee of Western Samoa for the United Nations.

American Samoa comprises the seven islands lying east of the 171st meridian. It had a total land area of 76 square miles and a population of 18,602 in 1950. It has been administered successfully by the American Navy for over fifty years. Now this unincorporated, unorganized territory has just recently been turned over to the Department of the Interior.

Government bulletins issued by the Navy on the Government of Samoa told me of the job our Navy had done in colonial administration. Apparently we have been able to keep 99 percent of the land in the hands of the Samoans and part-Samoans. These people have a high standard of living for Polynesia: schools, a fine hospital and health
program, a government patterned after democratic lines. “Poverty as we know it does not exist,” I had read.

Most interesting to me was the fact that the Samoan customs and cultures have been preserved. The people live in villages as elsewhere in Polynesia. Each village is usually made up of from ten to forty households. Each household, which included a large number of “in-law” relatives, is headed by a person called a matai chosen by the family. He supervises all the affairs of the family, dividing the work and the proceeds among the family. These matais make up the village council, which is headed by a village chief.

The Samoan legislature has a House of Chiefs (or Fono), twelve holders of the highest-ranking titles in American Samoa. These men are empowered to advise the Governor and recommend legislation. The lower House of Representatives contains fifty-four members, fifty-two of whom are chosen from the important Samoan villages living under the matai system.

We had been told about these friendly, handsome people and their love of ceremony, and we were hoping to share in a real kava ceremony at a native village.

How long the ship will stay here is not definitely known; probably two days, just enough to refuel and exchange explosives and supplies between ships.

As the Baird tied up to the dock next to the Horizon, we saw only Winter Horton standing in the rain, looking as if he had been there for days, and our ship’s arrival a mere detail. He hardly greeted us except to say with enthusiasm “Samoa is wonderful!” and to hand over the mail. This was quickly distributed, and everyone disappeared to read letters, land or no land.

Of course I opened my daughter Martha’s letters first.
These were the first I had received as yet from my thirteen-year-old, and I was so happy to see the address in her carefully printed script. I hoped all was well at home.

It was a long, happy letter, describing Christmas with grandmother and the family. Apparently our hound, Ginger, was the only problem, but he’d always been a problem. The letter concluded:

“Well, don’t worry about anything here, as everything is all right and be sure to have a wonderful time. Your everloving daughter, Martha.”

Luck was with me. I could go on with Russ to Tahiti. I quickly scrawled a few more sentences to the letter I had ready to post to Martha here in port.

How very different it was to be aboard the ship arriving in port rather than waiting on the dock. It took real effort to pull myself out of the shipboard routine, dress like a lady, collect Russ’s and my bag of dirty linen, letters to mail, and prepare to see this island.

Roger waylaid me before I left the ship. “Will you help me with this,” he said, as he thrust a message into my hand. It read:

DR. ROGER REVELLE CORDIALLY INVITE YOURSELF THE TWO CAPTAINS AND SEVENTEEN OTHERS WHOM YOU SELECT TO COCKTAILS AT GOVERNMENT HOUSE AT FIVE THIRTY THIS DATE STOP COULD YOU PLEASE SUPPLY US WITH YOUR LIST OF NAMES FOR THIS PARTY

GOVERNOR

This was just an hour away! Oh me!

Thursday, January 8

In a Samoan fāla (grass house) I learned what traders our oceanographers have become as I stopped at the
market and saw Willard Bascom, Walter Munk, and Dick Blumberg squatting on mats, having a happy
time bargaining for beads, baskets, and other treasures. I watched Willard open up his white sack, pull out
a La Jollan abalone shell and see what he could trade for it.

“Go away,” they said. “You’ll ruin our business with money.” They well knew that I had run out of
goods with which to barter. I went on to the Samoan Craft Industries, a shop run by Samoans, a producer’s
cooperative. Here I could buy a pandanus mat (9 by 12 rug) for 11 cents a square foot, a tapa cloth for $4,
table mats, wooden gongs and bowls. The Horizon personnel, having arrived here first, had bought nearly
all the kava bowls in stock, so it became a challenge to the ingenuity of the Baird people who wanted kava
bowls.

When I arrived back at the ship with my purchases (the Samoans had brought me back in a jeep, as I
had bought such ungainly gifts) the busy men aboard examined my tikis, tapas, and said “Are there any
more? Will you get me some too?” So back I went in the rain to buy more treasures.

On this day the scientific personnel, stripped to their waists, had worked in the pouring rain in a bucket
brigade lifting 17,000 pounds of TNT in heavy ammunition boxes from one ship’s hold to the other, a
difficult operation. The Horizon needed this TNT for explosions on future seismic runs. Quantities of this
commodity had been carried on both ships. All explosives would now be carried on the Horizon, and it
had been difficult to find a place in the South Pacific where this transfer could be made.

Late in the afternoon John Coole, a friendly anthropologist of the island, loaded up his jeep and took a
group of us to visit the village of Fagitua on the waterfront. Here
we were taken to a guest fala, a circular building with a dome-shaped, palm-thatched roof, built up on a platform of rocks covered by pandanus mats. No nails were used in this house. The beams were tied together with afa, cord made from coconut fiber.

We were all seated on mats by the “talking chief,” the official in the Samoan hierarchy who does the speaking for the high chief. Roger as head of the expedition was treated as our high chief and in this capacity could say nothing (a new experience for Roger). Mr. Coole acted as his talking chief and conversed in Samoan. The amazingly handsome talking chief of this village called in High Chief Leiato, who met us all and then sat in his position in the circle as high chief opposite Roger. Leiato had just been appointed district governor and was, I believe, the second-highest chief in the Samoan hierarchy.

I suddenly realized we were about to participate in the renowned Samoan kava ceremony. Most of us had tasted the drink in either Fiji or Tonga. It is said that it will temporarily paralyze the legs if taken in excess. As no one has tested out this theory on our ship, we cannot give the answer.

The intricacies of the long, delightful kava ceremony (ava in Samoan) will never be forgotten by those of us present—the preparation of the kava by the lovely village tupou (virgin), the speech that preceded the serving of each guest, the graceful motions with which the drink was offered, and our attempts to quaff it properly, uttering the correct Samoan toast, “Manuia.”

While young men prepared a special coconut pudding for us, we went for a walk in the village, which was the cleanest I have ever seen and teeming with flowers. After the refreshment, served in coconut shells, we took leave of
this village, inviting Chief Leiato to come aboard the ship the next day.

We said tofa (goodby) to those at the village and I thought how many words in Samoan were like the Tongan. Hello, good morning, and good afternoon, are talofa; the ofa syllable is reminiscent of the ofa (love) in Tonga.

The Samoan word for “wonderful” is one I’d love to make part of our vocabulary—’ola. Watching a siva dance, we shout in praise “’ola, ’ola!” I had been so amused the night before when a group of our men were entertained by some young Samoan nurses at the hospital. The young nurses, all dressed similarly in their green sarong-type dresses, had pulled Russell, Roger, Bob Dill, and others out on the floor, made the men take off their shoes, and had tried to teach them the Samoan siva dance. Amidst much hilarity and many shouts of “’ola, ’ola” the evening had come to a sudden ending as the nurses were led off to a session of prayers.

Another expressive word in this part of the world in all their speech and songs is aue (pronounced “ah way”) which means “alas!”

Aue! I’d like to stay here. Why do we have to leave tomorrow?
13. THE LONG SHOT

Sunday, January 11

IT IS six o’clock in the morning. We have left Samoa behind and I am on watch by myself on this ship that never sleeps. My partner, Bob Dill, is eating breakfast. I plan to have coffee with Russ when my watch is over. I have been only half concentrating on what I write. The ship has been rolling from side to side, and I have to stop every ten minutes and punch the button on “Sir Ronald,” the magnetometer recorder. I’ve also been jotting down fathometer readings, 0600 ................. 2710. There’s a place for comments, but I’ve no comments today.

We are embarked on another leg of our journey and making entries in a new little green log book, entitled “Samoa to Tahiti.” We are taking a southeast course, and on a chart in the navigation room I saw that we would bypass the Cook Islands and might reach Tahiti in about seven days, allowing three days to stop for the seismic points of King, Love, and Mike, which are planned for this leg.

The bottom has gone down steadily from 1,230 feet at Pago Pago to a depth of 16,200 feet. It has been a flat bottom for a very long time. At last we are now crossing the
deep, flat ocean basin that Roger had told me was pimpled with volcanic seamounts, below and above the sea surface.

“Perhaps the islands we will see are all chains of volcanoes that rise directly from the sea floor, and are not peaks on a broad arch or swell,” he had said.

I have never seen the bottom so flat before. This will make Russell happy. He can get much better reflections in such an area.

At this moment we are changing course slightly to reach Point King by eight o’clock. The bridge calls:

“Bridge to Lab.”

“Lab, ay,” I answer.

“Stand by for course change. At 0617 change course to 160° true.” I record this change in the log book and on a chalk board in the lab. Soon the hydrophones will go out, cores go down, and the temperature probe be put overside. (At least, the plan for the day I’d posted at midnight said we were to do this.)

This watch is part of the regular routine of the ship whenever we are under way. Two of us stand this watch for four hours once in every twenty-four hours. The watch rotates each day. This morning I came on watch at four o’clock and I’ll be off at eight o’clock. My watch for the previous day would have been from midnight to four o’clock.

The men don’t look forward to these watches between stations. When the ship is under way, they would like to be working on their equipment, studying their records or reading. But the watch breaks into their time and doesn’t let them do any of these things—at least, not very well. There is just enough detail to almost keep one from doing anything else on lab watch.

Sometimes I’m asked to pinch-hit for one of the men.
Men who have been coring hour after hour or working on a seismic run that lasts for, say, fourteen hours at a stretch, need a rest. I am an expendable, not being on these hardworking teams, and so can be put on watch night or day when they need a relief.

Awakening the next watch has been one operation I’ve been spared, being a woman. Contrariwise, anyone of my shipmates enters our cabin and awakens either Russ or me for our watches. These rotating watches wreak havoc on one’s sleeping habits, and it has seemed many times that I was going to bed as Russ was climbing out.

While on watch we make measurements, or at least check on the instruments that are making the measurements. It has taken a while to train me to stand watch. I realize the scientists haven’t yet full confidence in my ability to take care of the magnetometer recorder or to read the echo sounder on time or correctly, for nearly every watch one or the other of them is constantly asking me “Did you punch Sir Ronald?” Perhaps time and performance may give them more trust.

My partner, Bob Dill, is back from breakfast, and we have to take a BT. One is taken every two hours when the ship is underway.

“Give the bridge a call,” says Bob. I have never done this part of the operation before. Gingerly I pick up the phone of the intercom system between the lab and the bridge.


“Roger,” comes over the intercom. And then I call the engine room.

“Can we have power on the BT winch, please?”
“Okay,” says the engineer on watch below.

Bob Dill has meanwhile taken a glass slide from the case. We go to the BT winch on the port side of the fantail and proceed to insert the glass slide in the BT, a two-foot-long tube thermometer. Then Bob expertly lowers the tube into the sea and allows the winch to unroll the cable. The instrument sinks into the water behind the moving ship until about 1,000 feet of wire are paid out. Then we begin to wind it in.

My job is to help guide the wire so it will wind smoothly onto the drum. To get a BT back aboard safely is not easy, and I am glad to have my watch partner assume full responsibility for this operation. Sometimes the line snaps as it is jerked toward the ship, and a BT is lost. The trick of bringing a BT aboard is to get the BT out of the water and onto the ship without bouncing it against the side. Knowing which way and how much a BT will swing as it breaks the water is like guessing the bounce of a football. And then there is always the possibility on this rolling fantail, which is occasionally swept by waves, that a man might lose his balance and go overboard while trying to land a BT. That is why there are always two of us to take BT’s.

Bob Dill lands the tube safely and examines the glass slide. The slide resembles a black-and-white glass-covered negative from a 35-mm. camera. There is a barely discernible line across the surface. If the record were imperfect we would have to do the job over again. Today we are successful, so back to the lab to label and file the slide in its box and then record on a form at least ten different notations (mostly about the weather) on the operation.

I nearly forget to punch “Sir Ronald”; I make it on the
nose at 0700 ship’s time. It makes a record very slowly on an eight-inch-wide strip of paper that is wound from one spool to another, very much as a film is rolled in a camera. I haven’t learned much about it yet, except that it is an instrument for continuously recording the magnetic field of the earth. Every so often the needle goes completely off the paper and then must be laboriously returned to its course. (I can’t do this.) This recorder is connected by a line and red cable to the “maggie,” the actual measuring instrument which is being towed approximately 400 feet behind the ship. I am told that it must be towed this far behind us so that the magnetic field generated by our ship doesn’t interfere with the measurements of the natural field of the earth.

One of the more thankless operations on the ship consists of slowing the *Baird* to 30 turns in order to stream a magnetometer. At this time three or four men hoist the heavy, torpedolike instrument overside off the stern of the ship. This is simple compared to retrieving it, an arduous task in which the ship is stopped, and the scientists tug and heave until at last the heavy gear is aboard.

I see by the clock it will soon be time for this operation. I walk to the fantail and know again that the weather is the best ever and the sea most smooth. This is what I had expected the great South Seas to be. Here comes Bob Livingston into the lab to relieve us, and here are Russ and Dick and Alan opening the bins which store the hydrophones and floats.

I’m off watch now. I can go back to the ward room for a cup of coffee and then to the day’s work of keeping the log of the ship, making my bed, and the eternal effort of trying to keep clean aboard ship, getting a pail and washing out a pair of shorts and a shirt for the next day.
No, I slept after that watch. It doesn’t much matter whether it is night or day, the temperature changes very little. But this afternoon, things were happening. We were on station, and as usual the winch was rattling noisily, this time with the temperature probe on its way to the bottom. Russell’s group was receiving shots from Horizon every ten minutes. The Horizon passed us before noon and was now striking out further east at a regular clip, dropping shots according to schedule. And here was some news from her:

“Nan Peter Love Fifteen William from Nan Peter Love Fifteen Uncle.”

“Go ahead, please,” said the Baird.

“William, this is Uncle.” And Bill Menard told us of a seamount they had found, 33 miles east of the Baird’s present position. This seamount was causing Russ all sorts of trouble, but those geologists on our sister ship seemed very happy over this discovery.

“This one may be a flat-top,” said Bill. So far we had not found any guyots (flat-top seamounts) in this part of the Pacific. The Horizon had to continue her long straight run eastward and couldn’t stop to survey the seamount.

“Can you take a couple of runs over this one when you reach the area?” asked Bill.

“We’ll take a look at it,” promised Roger. When we would do this we did not know. All the instruments had to be brought aboard and a deep-water cast was scheduled for seven o’clock that night. So we wouldn’t be off-station until long after dark. But this wouldn’t matter. There is only night in the deep-sea world, anyway, and most of our instruments can operate twenty-four hours around the clock. Only the seismic crew was supposed to stop work when the sun went down, because of the danger of handling explosives after dark.
For about three hours the seismologists continued to be annoyed at the seamount, which was interfering with the reception of their shots until the Horizon was no longer over this volcano.

Later the shots began coming in very well. The reception was exceptionally good, as the Horizon was back over the flat area of the deep Pacific basin. She was further away from the Baird than on any previous run.

“Would you like to try a little longer run than usual tonight?” I heard Russ ask Will North on the Horizon. “How about a really distant shot, 100 miles away?”

A consultation was held, and it was decided that this time the Horizon would put over a charge when the ship was 100 miles distant. This would not be until after dark.

“What size charge?” asked Will.

“What have you got there ready to go?”

“That’s fine,” answered Russ. He was pleased, for this would be the opportunity to get a more accurate measurement from the Moho, the discontinuity that signified the sound waves had reached the deepest layer of rock. This deepest rock of the earth was only discernible when the two ships were far apart.

“Is this a chance to tell me how the sound waves travel through the layers of the earth?” I asked Russ. He began to explain to me, speaking slowly.

“First the shot explodes about 200 feet beneath the surface of the water at the point where it is released on the Horizon; in this case, 100 miles away. Some of the energy travels down through the water, the sediments, the crust, to the mantle of the earth, through this and back up to the listening hydrophones, which are 200 feet below the surface of our ship. It’s like this:” He began drawing me a
How the seismic waves were transmitted from the Horizon to the Baird and what they revealed.
“The sound is refracted through these layers of the earth.”

“You mean, the wave is bent?”

“Yes. Sound travels at different speeds through different materials. In general, the heavier the material, the greater the speed of sound. Sound travels about four to five times as fast through water as through air, and about five times as fast through the dense rock of the mantle as through water. This is why, when our ships are far apart, the wave that arrives first is the one from the deepest layer, the earth’s mantle, even though it has traveled the longest distance. We don’t always get this wave. Many times we get a wave through the crust, as we did on that run in the Tofua Trough. This wave through the crust we also get when our two ships are close together. It goes down and back like a big V, and it is slower than the wave through the deeper area of the earth. Sometimes this crust wave also shows up on the same record as the wave through the mantle.”

I was beginning to understand a little. We recognize these various layers by the speed of sound. Studies have been made of the speed of sound of many materials on the continents, so we can make a guess as to the rock under the ocean, although the velocity cannot actually identify the rock and give it a name. Still, we can correlate geologic layers and label them by their velocities.

This mantle of the earth no one has ever seen. We do know the mantle layer has a speed of sound of 8.2 km per second, is very dense, and has the rigidity of steel. Some scientists believe pieces of this mantle have been thrown out in volcanic eruptions, and still others suggest that the mantle could be like stony meteorite.

So these thousands of miles of profiles Russ and others have been running over the ocean are beginning to give us real clues as to the nature of the earth beneath.
But now the *Horizon* was back on the air. It was a few minutes past eight o’clock. After identification we heard Willard North say, “We’ll fire a shot in thirty seconds.” Those of us in the lab gathered about Russ’s oscillograph. Then came Will’s voice:

“Fifteen seconds . . .”

“Ten seconds . . .”

“Five seconds . . .”

“The fuse is lit,” Will announced as dramatically as always.

“Mark!” Now Dick Von Herzen turned the little button on the oscillograph. Would it begin to move? We watched excitedly. Suddenly the little pen began to oscillate gently.

“We got it!” shouted Russ triumphantly. “That’s the wave.” In about two minutes came a second wave and Russ said, “There’s the water wave.” He turned off the recording instrument, tore off the paper, and answered the *Horizon*, which was calling, “Uncle this is William.”


After telling Will of the successful reception, Russ intently examined the record. He pointed out to me the large gyrations of the water wave. I thought of the picture he had drawn for me which showed this slower water wave which is not reflected or bent as are the others. This water wave goes straight from the explosion through the water to our listening hydrophone and tells us that the *Horizon* is 102 nautical miles away, for we know that

\[
\text{Distance} = \text{Speed} \times \text{Time}.
\]

Russ was very happy. This was the most distant shot so far recorded on any of his seismic stations. I knew that such measurements, in which the waves penetrated
the mantle rock of the earth, were greatly desired by oceanic seismologists. This method of seismic-refraction prospecting is itself relatively new and has only been carried on extensively at sea since 1949. The English geophysicists in their prospecting used one ship and sono (sound) buoys and usually got reflections through the earth’s crust. Maurice Ewing, Director of the Lamont Geological Observatory, has made a great number of seismic studies, using two ships in the Atlantic and elsewhere.

I gather that from the results of all this work we have a body of data which is now being studied and that it will be some time before its full significance is understood.

“We have now only a rough picture,” said Russ. “We think the sediment thickness seems to be about two or three times greater in the Atlantic than in the Pacific. However, it is clear that the average sediment thickness is much less than the 3 km which has been geochemically estimated as the total sediment to have been delivered to the deep sea from our continents. Why is this so? This is one of the unsolved contradictions.”

Another discovery from this method of earth-probing by seismologists is the fact that the earth’s deep mantle is much closer to the surface under the oceans than under the continents. “We believe,” says Russ, “that the mantle is found on the average 40,000 feet below the sea level, whereas on the continents it is found at 100,000 feet.”

In five more years what will they learn?

*Sunday, January 11*

One of the men I work for on this ship is a character. I can hear my friends saying, “They’re all characters, if you ask me.”

And my answer is, “Of course, but what lovely characters!”
—especially Willard Bascom. He has characteristics that are uniquely his.

Willard is a doer: Every problem has a solution. His lithe, six-foot browned body co-ordinates and acts always with lightning speed. He can sing and play a guitar, quote beautiful poetry, and has great romance and love of beauty in his soul; but we on the ship have little opportunity to see this side of Willard. He is busy most of the time, often taciturn and withdrawn.

Willard calls himself an oceanographic engineer. He can do a great many things far better than can others. He is quick, clever, and inevitably makes others feel inferior by comparison.

If a thing has to be done, you do it!

“This lab is a mess. Look at this fantail. If those jokers don’t stow away their shells pretty soon, I’m going to heave them into the sea,” he said. And heave he would. Willard wants the fantail free of impediments, the lab more functional. What is in the way gets tossed out.

How can any one man do so many things well? Willard had been in charge of one of the major projects of the expedition, one that was completed before I boarded the ship. In spite of the great pressure when preparing for the expedition, he had managed to design a house before leaving and had left his competent, pretty wife to have it completely built before he returned home.

Now on this ship he has been made Senior Scientist and as such is one of my bosses. He is not only an oceanographic engineer and diver, he is also a writer. Willard can sit down and write with great speed in a clear, lucid style, describing complicated machinery tangles for my ship’s log. He is my friend and very good to me, the incompetent log-keeper, struggling to learn.
I find that in addition to his other duties he is also managing to write a book while on the trip. He has to choose between working in a crowded hot, dark, three-tier bunk room or on a noisy, rolling, windy deck.

I have already learned of his abilities in ports. Each Polynesian kingdom is one to which he might return. He is usually involved in some scheme, whether it is finding a new crop for Tungi and Tonga or raising a sunken ship from a harbor. He will wander off into the countryside, meet the natives everywhere, and come home with gifts of many kinds. Once he brought back a large conch shell which the Tongans in a certain village near Nukualofa had used to call their players to a game of cricket.

He is a kind, sensitive, loving man. He has a fearlessness possessed by none other on the trip, a willingness to try anything that works, to risk his life. As the crazy instruments swing aboard precariously on the fantail, Willard will handle the situation—perhaps too dangerously to suit all aboard. When the aqualung divers went down to find the one sunken ship in the harbor of Vava’u, it was swarming with stinging jellyfish and dozens of aggressive-looking barracuda, and, prudently, our divers came back up quickly. Not Willard. He went down to the sunken ship to explore it.

Equally interesting is my other boss—R.R.R. I’ve known Roger since college days. He was a brain then and still is. I don’t envy him his job on this expedition. He rarely leaves the ship in ports, he is so busy entertaining visitors. We are a traveling circus without the animals, and in the ports belong to the people, a scientific expedition small boys and men must see.

Roger is practically the only man aboard without sandals. His feet are so big that his wife, Ellen, couldn’t find any
sandals to fit his size fifteen. He should have tried in Suva, where the Fijian police are more his size.

I remember how we smiled at the picture he made wading through the reefs at Serua, shoes and all, moving those huge, long legs in and out of the water, encumbered by gear he was carrying for the divers. The men had said, “Look at Roger,” and laughed at this big awkward man, their leader whom they liked and respected.

He has no easy job on ship coping with this group of individualists. Co-ordinating the work of a great number of scientists, each bent on accomplishing his particular purpose, is no holiday. No one else on board would have tackled the job. As usual, everything that goes wrong is laid at Roger’s feet—“that so-and-so.”

Outwardly at least, this bothers Roger not at all. Every twenty-four hours he meets the problems of the day, and calmly. The men on the Horizon will hatch a special plan that will take them to an area of the ocean on a survey in direct conflict with Russell’s plan for a seismic run the next day. At the same moment the geologists will feel that they should stop right here and take a core.

“If we stop here, we can’t reach Point How by morning. No use shooting unless we start early,” argues Russ.

And, from another quarter:

“The bridge wants to know where is the next point to be; the bridge wants to know now.”

And so it goes.

Despite these conflicts, Roger rarely loses his temper, and the men on the Baird stand in the lab listening with smiles on their faces as Roger in his deep voice argues with the Horizon scientists point by point until a compromise is reached.
One word is always on Roger’s tongue: “Why?”
“We want to pull in the hydrophones now,” says Russ.
“Why?” asks Roger.
As he wants to understand the reasoning behind every action, he also spends hours puzzling over the various mysteries of the results the men are getting at sea. He has a colossal memory and a great imagination. These lead to his advancing stimulating theses on many of the riddles of the Pacific. Long hours are devoted to argument and discussion, which start at any time of the day or night. He is curious about an infinite variety of subjects.
But Roger has absolutely no sense of time. His mind lives in the present, is completely intent on solving the problem at hand. He rarely gets to meals unless someone suggests he eat, so great is his concentration and interest in the subject of the moment. His drive and excitement in working and accomplishing the maximum at sea keep him always alert, and on many occasions he will be up all night.
“Alan has been busy all day, is needed at five tomorrow and has the midnight watch,” someone will remark.
“I’ll take it for him,” says Roger.
In moments of crisis on the fantail Roger will pace back and forth nervously, unable to relax a minute until the gear is safely aboard and no one is hurt.
“Everyone off the fantail when the winch is rolling,” is his order—except Roger himself.
He has the lucky combination of a rugged, horse-trading business sense, a tremendous imagination and intelligence, a love of people, and a lot of stubbornness.
Today’s adventure came to us as a complete surprise. It was not part of any plan. (I have never liked a planned existence anyway.)

Early this morning Bob Haines pointed out that our ship’s course would lead us quite close to Palmerston Atoll, a solitary necklace of islands that lie between Samoa and Tahiti and are part of the Cook Islands under the administration of the New Zealand government. The only available detailed chart is based on a survey of 1774, presumably made by Captain Cook during his second voyage when he also named the island for Lord Palmerston. An inspection of the chart showed us no obvious passes into the lagoon.

Not being able to resist the temptation of studying this atoll from the sea, we changed our course.

We looked in the Pacific Islands Handbook to find what it could tell us about this small speck in the ocean. Here was another island with a story! The Handbook said:

“Palmerston is a small atoll (one square mile) 270 miles northwest of Rarotonga, and is occupied by about one hundred
descendants of William Masters. He was an English sailor who selected there wives from among the natives of the Northern Cooks, and hid himself away on this isolated island about the middle of the last century. The community, light of colour, contented and hospitable, speak a queer kind of English.”

To know this and no more was tantalizing. We were not going to land there. Would we have the opportunity to see and talk to some of the people?

As our ship slowed to 30 turns we looked out upon a group of tiny green islands surrounding a large lagoon where the water was a much lighter green color. We could see the reefs clearly on the closest island, jutting buttresses of the outer edge of the reef over which the waves broke, and then the shallow, dead-coral flat extending to a very white beach. Watching the waves pound on the ragged edges of the reef, which made a continuous ring about the atoll, I wondered how a boat could ever land on these islands.

Pointing to another island in the atoll, our Captain said, “According to the chart, that island is inhabited.”

We proceeded toward it. Someone soon shouted,

“I see a boat. I see two boats!”

“They’re coming toward us!”

We were maneuvering at slow speed, for even though the depth was several hundred fathoms, we were very close to the reef. The nearest sounding on the hydrographic office chart was 60 miles away. A few hundred yards from the inhabited island we hove to. The two boats came closer. They were well-built open dories with gaff-rigged canvas sails, each manned by eight or ten men and boys.

We all lined the rail and studied our visitors. They looked like the other Polynesians we had seen, were dressed in tattered shirts and shorts, and wore all sorts of hats.
The islanders lowered their sails, waved to us and then came abreast our fantail. In a minute they were swarming over the ship. Their faces revealed their mixed European and Cook Island ancestry and just as the *Handbook* had said, they all spoke a kind of English.

They had brought aboard some objects to barter—wooden spears, large Tridacna shells, belts and hats, which they wished to trade for clothes.

We soon met Mr. Ben Masters, the present chief of Palmerston. He was a gray-haired, rather short, stocky man, dressed in an untattered shirt and dark trunks. On his head he wore a visor-type cap. We wished to make a recording of what this chief could tell us about his island. Bob Livingston had quickly rigged the tape recorder and was ready. I grabbed the page of questions we had noted down a few minutes earlier and Roger began the interview.

“How many of you live on the island?” Roger asked.

“Seventy-eight now . . . Some went away . . . to other islands to work,” Ben answered.

“How long have you all lived there?”

We heard a garbled account of the history—how the first William Masters had gone out to Palmerston to manage the island for a trader named Brander.

“Brander went away, never came back,” said Ben, and we learned that this first Masters stayed on with three wives and was given a lease by the British.

“Now the New Zealand government man at Rarotonga wants money from us. We didn’t pay last year. We don’t see why we have to pay . . .” He launched into a story of troubles.

“What do you grow on your island?” asked Roger.

“Copra, arrowroot. There is no water. We have to catch the rain and keep it. Sometimes a schooner comes to the
island,” Ben Masters said. “Maybe two times a year.” We heard that Palmerston had been badly hurt by hurricanes.

“The storm in 1934 washed everything away—houses, copra sheds. Nothing left. We climb to coconut trees on the hill.” (This hill was al of 20 feet above sea level.) “Two of us were drowned.”

“How did you stay alive afterwards?” asked Roger.

“Nothing to eat but fish. A ship came. Brought us food,” he answered. We learned that after the hurricane, some of the people went to other Cook islands.

Listening to this troubled Polynesian trying to tell us the story of his people I longed to stop and visit the island itself, to see their homes and learn more of their history.

“Would your men sing for us?” we asked.

“Yes.” I quickly collected my ukulele and Brownie’s guitar and joined the rest on the fantail to listen to the songs. They sang in their Cook Island native tongue, not in English. At the second song Joe and Bob began to dance, a hula long to be remembered by everyone aboard. At the end of each song and dance, one of the Masters men translated the songs into English.

After three songs, we bade them goodbye and they climbed into their boats, still covetously eyeing our rope and ship’s gear.

It was frustrating to taste the beginnings of such a story, to see this island and be unable to land. What were the women like? We gazed sadly at the small islet receding in the distance as our ship proceeded on its serious business, which was to make a detailed survey of the bottom leading up to the atoll, using our echo-sounder and magnetometer.

Previous to the Baird’s departure I had put aboard for Russ and others a notebook filled with articles, culled from
a huge pile of magazines. But water flooding in the hold had destroyed the notebook before Russ ever saw it, and now I could find no mention of Palmerston in the magazines and books on the ship. I was sure I had read about this island.

It was only later when we reached Tahiti and I found an anthropologist that we gained more information. He showed me what Edwin H. Bryan of the Bishop Museum had written about these eight small islets. William Masters had gone to Palmerston in 1862, married a woman from Penrhyn Island and left three lines of descendants through his wife, her sister, and a third Penrhyn native. At first they intermarried, but now they have married people from other islands and are a "strong, healthy population."

The first Masters (sometimes spelled Marsters) had insisted that all the children at Palmerston should speak English and not the native tongue of his three wives.

Through the years these people have met with misfortune after misfortune from hurricanes. When their homes were washed away and their belongings swept into the lagoon in 1923, some migrated to other islands. Some of the Masters who went to Suwarrow atoll, north of Palmerston, had gone with wives and some without. Trouble had developed, and three men were strung up on coconut trees to die. Consequently, the three Masters families who later went to Suwarrow took their wives and children.

The first William Masters died in 1899, and the eldest son of his legal wife succeeded him. This second William Masters lived to be eighty-four, leaving his son Ben to be chief of the island in 1946. Ben Masters, whom we met, was not as colorful or photogenic as his father, the patriarch, a staunch old man with a long white beard. This William Masters had married several times, wrote traveler William
Albert Robinson, and in 1931 had a very young wife, a daughter considerably older than the wife, and a
grand-daughter older than either the wife or daughter.

I wish I had asked Ben about his wives.

But we’re oceanographers. Back to the oceans, the deep sea and the sediments. This is what my ship’s
log tells for January 12:

“As seen from the sea, Palmerston is a typical atoll, with a broad reef, capped by several low islands,
ringing a shallow lagoon…. Its small size made Palmerston attractive to us as an area for reconnaissance
survey, and we decided to run a series of sounding and magnetic lines around it. Our first approach was
from the northwest. In this direction the atoll begins to rise from the general level of the sea floor at
about 2,800 fathoms, nearly 50 miles from the reef. It begins to slope very sharply upward from 2,000
fathoms, 9 miles from the reef…. Following our usual practice we steamed slowly in as close as we
dared approach, then turned on course perpendicular to the reef, proceeded outward at standard speed
to get a more accurate picture of the slope. We held this course until 500 fathoms was reached, then
turned parallel to the general trend of the western side of the atoll across the major concave indentation
of the reef. Our objective was to test Fairbridge’s hypothesis that such concavities are due to large-scale
landsliding. During the course of the afternoon three sounding lines at increasing depths were made across
this possible landslide area.

“The magnetometer was not yet repaired, and we took advantage of the opportunity to lie to in shallow
water near the inhabited island of the atoll…. We then proceeded down the slope off the inhabited island,
and at 1608 at a depth of approximately 1,000 fathoms the magnetometer was streamed. The second of
the three lines mentioned above was run across the possible landslide area parallel to the western edge of
the atoll. We then continued on a box survey around the atoll, crossing
Bathymetric and magnetic contours of the area surrounding Palmerston Atoll. Bathymetric measurements are depth contours. Magnetic measurements show the distortion of the earth's magnetic field produced by the magnetic core of the atoll.
the northern summit at 250 fathoms, approximately half a mile from the reef edge. Because of approaching
darkness, the remainder of the survey was conducted in somewhat deeper water farther off shore. . . . At
1956 we resumed course toward Point Love . . .

“It is hoped that comparisons of the slope found off Palmerston with those found in the Marshall Islands,
together with the results of the magnetic survey, will furnish some evidence concerning the depth of
calcareous material overlying the presumably volcanic core of this great structure. It was evident even
from inspection of the preliminary navigational plot that the exposed portions of the encircling reef are
both longer and wider by several miles than is indicated on the chart.”

*Tuesday, January 13*

I’d like to write about love today. I know this isn’t my job on ship. We are studying the ocean and the
world beneath the ocean. But I’m a woman, and women are concerned with love.

These men can’t expect me to think about seamounts, undersea volcanoes, long cores of ooze,
exclusively.

Today is Tuesday, January 13, and we are stopped on Point Love, 17° 30’ S. and 160° 59’ W. I’m sure
this particular spot in the Pacific has never been called Point Love before, but in our alphabet H-I-J-K-L
becomes How-Item-Jig-King-Love.

Even the heavens and the sea have conspired to make this a joyous spot for the ship. My mind wanders
from the description of the core obtained here, the core of manganese iron nodules, crystals of phillipsite,
fish teeth and apparently weathered glass—to Love.

On this ship, for instance, we all feel the wonderful regard our most popular shipmate, Bob Livingston,
has for us all. It isn’t because he’s a good doctor or a good diver that he’s
liked by everyone aboard. In our little world of the ship, here is a man who truly cares about each of us, what we are thinking and feeling. There isn’t one of us who would hesitate to talk to Bob whether it’s an ego out of joint or an ankle. Bob has found the secret. He’s an outgoing, loving person.

Another man who thinks about love is our Frenchman, Henri, who is interested in the subject of men, women, and love. He is curious about the subtle relationships of men and women in Tonga as well as in La Jolla. He talks to the crew and scientists on these subjects and often stimulates discussions that last late into the night.

Whether Henri is trying to explain to us the problem of the bachelor male on an island or how one should drink wine, he is always amusing. With his delightful accent, inquiring mind, and co-operation in helping on arduous tasks, he is a great favorite.

The crew love to hear Henri’s accent over the intercom from the lab when he says “I want to take a Beeceee Teee.”

Henri told me he wanted to be an oceanographer because he loved the sea and liked to be on ships, and it would enable him to leave France and travel.

“I was educated to be an engineer, but when I was through with my studies and had to take a job as an engineer, I discovered I wasn’t made for this kind of work,” he said. So he went to Paris and began to study oceanography, attending lecture classes and working aboard ships. To continue his studies he went to Sweden as a student in the Oceana-grafiska Institutet at Göteborg and then worked as a chemist there for the two following years.

“Sweden is a real paradise for the western European,” says Henri, his eyes sparkling. “I had such a time I shall probably never have in my life now.”
He described his pleasant working conditions at the laboratory under Hans Pettersson. “We were like a family working together. It was absolutely wonderful. Once they are used to you, your way of thinking, your way of living, your way of speaking, it is very interesting. People couldn’t have been nicer than they were.” However, Henri thought the food in Swedish restaurants practically impossible. This remark caused an argument with Gustaf, our Swedish geologist whose beautiful wife, Jenny, had gone home to Sweden to have their second child.

“No, Henri, that is not so!”

“Their basic food is boiled potatoes and smashed meat. It is the most terrible food,” Henri said. “But the main factors of pleasantness of Sweden were the women.”

Women and the ocean are obviously factors in Henri’s life. “The sea is exactly like a woman, always changing,” he says.

On this ship of men I learned a little of what different concepts men have about women. Man-woman relationships in Sweden, in France, in Polynesia, all came up for discussion.

American women were on the carpet. American women are crazy about things—new cars, new dresses, new hairdo’s. A man’s worth is what he can give his woman in goods, not in love, companionship, and emotional security, said some. American men are so busy trying to make money that they have no time for anything else.

“They are too busy to make love,” says Henri. But then, no Frenchman ever wants to think that American husbands can be good lovers.

A woman always wants something—a new television set, a better refrigerator—just gimmicks, not the real stuff of which happiness is made. Polynesia brought home to me
how closely wedded we’ve become to the world of possessions and how happy those brown women were without all these trimmings. The laughter, music, rhythm, and warmth of love are part of life also, which brown women with flowers over their ears can give.

“American women are the most spoiled women in the world,” says Henri.

Are they?
This was to be another busy, noisy day. When I heard the ship stop this morning, I groaned. This meant, instead of relaxation, the beginning of many operations. We were stopped all day yesterday on Point Love, and last night some of the men worked the whole night through as Walter supervised a jog log maneuver with the Horizon, making simultaneous measurements of the surface currents from the two ships at varying distances apart.

Also, we recently completed a survey of a seamount. We called it Disappointment Seamount, because it didn’t have a flat top. This was the Seamount that Horizon found on Point King. They thought it might prove to be a guyot. According to my log, it turned out to have a sharp and narrow summit and marked irregularity near the base; perhaps there had been submarine landsliding or “slumping.” (Who but geologists would describe earth movements in such a picturesque fashion?)

Today we’re on one more of the twenty-six stations Russ plans to occupy. I’m even learning the pattern of these stops. When our ship slows to 30 turns and our listening ears, the hydrophones, are streamed behind, I know that someone will soon be sampling the bottom. Sure enough, early today
a combined water-cast and corer went down off the heavy winch. The bottom here is flat, beautifully flat—2,665 fathoms, 15,990 feet deep. Perhaps nothing has disturbed the sediments in this place for millions of years. But they’re going to be stirred up now!

Afterwards, if we are fortunate enough to obtain a core, we are going to put overside the temperature probe.

Art Maxwell, the always-pleasant young oceanographer, was preparing the temperature probe for its long trip to the bottom. This is Art and Roger’s baby. It is a 13-foot-long, yellow, rusty instrument that contains thermo-sensitive elements that are pushed down into the bottom of the ocean to record temperature.

“This is a fairly delicate instrument, and it has to be able to withstand great pressure,” Art told me. “It contains all the equipment necessary to measure and record temperature differences in the sediment at the bottom.”

“I remember the summer Teddy Bullard was here from England and you first began to work on this,” I said.

“That was in 1949. So far, we have very few measurements, six on the Mid-Pacific expedition in 1950 and a few made by Dr. Bullard since his return to England.”

“How well does it work?”

“All right, but I worry about it every time I see it leave the deck,” said Art. “It’s not like a piston corer. This instrument has batteries and a fair amount of electronic circuitry; it must be completely automatic, yet rugged enough to take the rough handling it gets going over the stern and being jammed into the bottom.”

Looking at this instrument on the deck, one would not realize its complexity. Most of the probe is a long, hollow steel spear, 10 feet long and about 1 1/2 inches in outside diameter. The temperature measuring instruments are hidden
at each end of the spear. When it is plunged into the bottom they get records of the temperature at approximately 2 and 8 feet below the sea floor.

At the upper end of the spear is a watertight chamber. Art removed its protecting yellow metal cover and I looked at the complicated maze of wires within. I am told that in here is a “battery-powered, self-balancing, null-type potentiometric recorder,” whatever that is.

And now, today, this instrument was attached to the long cable, and was hanging overside. When the tip of the probe reached the bottom it would continue to sink because of its weight. I saw Art give the signal to the winch operator to send his precious instrument down the 15,990 feet to the bottom.

Once it pushed itself into the bottom it was allowed to stay for 30 minutes for equilibrium conditions to return, because there is a sudden increase in temperature due to friction when the probe pushes its way through the bottom sediments.

“What are you trying to find out?”

“What we’re really interested in is the rate at which heat is escaping from the bottom, but we can’t measure heat flow directly, so we measure independently the temperature gradient beneath the ocean floor and the thermal conductivity of the bottom sediments; the product of these quantities gives us the heat flow.”

“One thing at a time! These are two measurements you need,” I said.

“If we can measure the temperature at 10 feet below the ocean bottom, and then at 2 feet below, we can get the temperature gradient, the gradient being the change in temperature per foot of depth.”

“How much of a difference is there?”
“Just a few tenths of a degree difference between 2 and 10 feet—the temperature at 10 feet is always warmer because the center of the earth is hot and heat flows out from the center of the earth.”

“Yes. Now the other measurement—the thermal conductivity of the sediment.”

“We have to know how well the sediments at the bottom conduct the heat. Suppose you put two pans of water on the stove to boil, one of which has an asbestos pad under it. The pan without the asbestos will come to a boil faster. This is because metal conducts heat better than asbestos. It has a higher thermal conductivity. The rest I’m afraid you’ll have to take on faith—that is, if we know the temperature gradient and the thermal conductivity we can calculate the heat flow.”

“You know I’m always willing to take things on faith,” I said.

“Well,” said Art smiling, “we need both of these measurements, and since the thermal conductivity of the sediments seems to vary considerably from place to place, we have to measure it every time we measure the temperature gradient. The temperature gradient we get with the probe; the thermal conductivity is done in a lab from a core sample. Then we calculate the amount of heat flowing from the earth to the ocean.”

I was beginning to get the picture, even if it wasn’t too clear. I knew that today, fortunately, we have a core. I had recorded in my log that it was chocolate-brown, clay, with a manganese nodule on top. Now we hoped Art and Roger could also get a temperature-probe record from Point Mike.

“What have you learned so far about this heat flow?” I asked.
“We’re perplexed,” said Art. “When we first started making these measurements on the Mid-Pacific expedition, we were surprised to find that the amount of heat flowing from the ocean floor is about the same as that under the land. Maybe this doesn’t seem surprising to you, but based on all we knew about the earth in 1950 before we made our first measurements, it was predicted that the heat flow would be three times more on the continents than under the ocean. This calculation was based on the fact that the rocks under the continents are different from the rocks under the ocean…”

“The andesite line,” I broke in, suddenly recognizing a familiar train of thought.

“Under the continents they thought that about four-fifths of the heat flow could be accounted for by the radioactivity within the earth’s crust, the rest being supplied by the cooling of the earth, but Russ’s seismic results show that the highly radioactive granitic layer, rich in thorium and uranium, which is supposed to underlie the continents, is absent from the deep oceans. Instead we have the basaltic rocks known to have a much lower radioactive content. Thus there should be less heat flowing out from under the ocean than from under the continents. But we’ve found that there isn’t. The heat flow is the same.”

Art took a deep breath, and I did too.

“So to go back to your first question of what are we trying to find out: Ever since we made our first measurements, we and others have been hoping to make this bit of information fit in with what we already know. As of now, it doesn’t. It just sits there as an experimental fact, explanation unknown.

“What we hope is that by making more measurements at different places in the ocean, we’ll learn enough to tell
us where we went astray in our reasoning when we thought the heat flow through the oceans would be one-third of what it seems to be.”

But today at 3:51 P.M. we were concerned only with getting another measurement. Half an hour earlier, Art had heard the signal that the probe had struck bottom, and by now it had rested in the bottom for thirty minutes.

The winch operators were given the signal to haul in the wire. At five minutes after six that night Art called out “Sight,” and then “Surface.” Soon the huge dangling instrument was hauled aboard, and we could go down on the fantail.

“See the mud on the tube, Helen,” said Roger, hopefully. “It shows all the way to the weights at the top. Now we’re sure it has penetrated satisfactorily.” We watched Art open up his probe and take out the paper record. Not until this moment would he know whether or not his instrument had behaved properly below. Sometimes the long tube was bent when it returned to the ship, but this was not fatal. Roger and Art quickly scanned the record, a piece of paper similar to an echo-sounding record.

“Success,” they said, as they went to the lab for further scrutiny of the results.

And I suddenly realized that my log today showed every measurement successful. Of course, it didn’t come right out and say this at all. It described the bottles that took samples at 1, 3, 5, 25, 75 meters above the bottom. “There was no evidence of pretripping,” says my log.

About the probe it says modestly, “The probe came aboard at 1805 with a good record,” and then I have some completely unreadable figures, totals indicating the heat flow: $1.3 \times 10^{-6}$ cal/cm² sec.

Russ’s final comment, dictated tonight, concerning his
very successful seismic results, says, “The total length of profile was approximately 100 miles. The calm sea and negligible drift combined to produce an unusually low noise level, and a considerably longer profile would have been possible.”

Thursday, January 15

This is another tropic sea today, just unbelievably flat, calm, and enticing. The sun beats down, few clouds are observable, no islands on the horizon. It makes me think of the Rime of the Ancient Mariner.

“As idle as a painted ship
Upon a painted ocean.”

Except that we are not idle. In spite of a 48-hour stretch of work, day and night, we seem a happy relaxed ship. I enjoy the fantail these nights—the men, clad only in short trunks, sitting cross-legged, happily sanding down their recently acquired kava bowls, polishing coconut shells and looking up from their work and out at the sunset saying nothing, but on their faces is an inscrutable look of joy and peace.

Today I feel I am a happy, lucky woman, beloved by the gods. For now there is no past, no future—just present. I want to record these days when we’ve become “Happy Polynesians, All.” But I have so much to learn on this ship. I am still in the debit column, but hope to change this status. I prop my nine-pound typewriter (which has already fallen and been damaged) over the icebox, push away the conglomerate mess, and start on the log. I wish the neat and efficient Scripps secretaries could see me now, squatting on a rolling box, stool, or anything I can find, dressed in shorts, shirt, and dirty sandals. No matter how well I could have typed, the action of the ship defeats me. I’ve tried placing
the machine parallel to the roll and then perpendicular to it, but the carriage takes itself completely out of control every so often and goes rocking across the page at any moment. Skipped spaces and letters are common occurrences.

Until this trip Scripps oceanographic ships had never had a woman typist aboard. This is something new. To show the type of log I’m taught to keep, I feel I should insert a sample page. And why not yesterday’s log, where so many operations were successful?

Each day begins at midnight.

Walter Munk completed his current measurements with the GEK, which he had been overseeing these last days. When not busy running this instrument he had arranged to do some fixed-nitrogen sampling on the top bridge deck. These air samples were taken in the evening hours. But I should let the log tell the story:

“At 0816 the first shot was fired on the seismic run with the Horizon being approximately 50 miles away at 16° 52.8’ S, 159° 08.2’ W. Baird position at 0900 was 17° 29’ S, 158° 37’ W.

“At 0830 a combined bottom water cast and 150 lb. gravity corer with 1” band went overside on the heavy winch. This struck bottom at 1033, depth 2665 fm with 5130 meters wire paid out when the ball breaker was heard . . . ”

But that’s enough. It goes on like this for pages. I used to think of a log romantically. Surely a log should have color, humor, excitement—a record for all time of what actually occurred on the Spencer F. Baird. But no, it is a record of
all measurements and operations of each 24 hours, a rough description of the ocean bottom over which
we are traveling.
I don’t say, for example, “Today is so hot that every bit of clothing seems superfluous. I envy the men
who appear today with only their trunks on. The perspiration pours down Kenny’s face as he bakes bread
in the galley. We wonder how he can keep up his high standard of meals in spite of the weather and the
sea? But what wonderful odors waft through the ship when he bakes bread.” No, I can’t say that in the
official Capricorn log.
I mop my face every few minutes in the lab. In this equatorial climate my body never feels fresh and
clean as I remember a body can feel after a shower at home—but back to work.
“At 1305 the temperature probe was put overside . . .”
Henri comes over to my typewriter. “Helen, could I disturb you?”
“Of course. I’m glad for the interruption.”
“I want to get into the ice chest.” We remove the typewriter, then the working board. Henri opens the
chest, which houses film, chemical solutions which must be chilled—and beer.
“You are working too hard,” says Henri. “It is not good for women to work as you do.”
“Everyone works on this ship.”
But then I notice the men, one by one, going overside for a dip, and for the first time, I’m tempted to
try, I, who only swim at home where I can touch bottom. Here the bottom is over 16,000 feet down.
There is a rope overside as a means of getting on and off the ship. I dash up to change to my bathing
suit. Russ stops me in the lab. His face is wet with perspiration.
“You aren’t a good enough swimmer, Helen.”
“Please. Just once. Bob Livingston has promised to watch out for me.”

In the water I soon discover swimming far out in the ocean is not like swimming near shore. There are huge swells that wash up against the ship and the job isn’t to stay afloat—this is easy—but how to get out of the sea and back on the ship. I’ve always been afraid of the water.

I might as well try now. I allow a huge swell to push me close to the ship. A quick grab for the rope before being bashed against the hull. I get a toe hold on the side and clamber upward. Russ’s hand reaches out. So help me—I’m aboard!
16. TAHITI

Saturday, January 17

The Baird and Horizon went full speed towards Tahiti on Friday. Hearts aboard were high in anticipation. We knew that the Horizon would beat us into port, for this had happened previously. Our arrival was to be at sunset. We had carried our plates of food to the fantail so as not to miss a minute of the scenery. We were passing renowned Moorea, that majestic island with its huge crags and pinnacles, its volcanic craters.

Then our ship came closer to Tahiti itself, with its steep 8,000-foot peaks, green mountain slopes and coral reefs. The pilot conducted us by Motu Iti, a palm-covered little island within the reef which was once the resort of Queen Pomare. Now we could see Papeete—the red roofs, the scarlet flamboyant trees, and the white ships moored to the quay.

We dropped anchor close to the Horizon and learned that we were both “dirty” ships—had, in fact, come from the land of the rhinoceros beetle—and could go to the dock only during the daylight hours. These beetles fly only by night, and then only over distances of 400 yards at most, it is said. So we had to leave the quay an hour before sunset, anchoring at least 500 yards from shore, and not return to the docks until an hour after sunrise.
No business could be conducted on this important evening, so as quickly as possible all hands donned shore clothes and took off in the launch to find out the truth about Tahiti.

Here we met happy, laughing people who expect you to laugh with them, beautiful women with their intermixtures of blood—French, Tahitian, Chinese. This was Polynesia, conquered not by missionaries, but rather by love of life.

The French writer, A. R. Serstevens, in his long and beautifully written book *Tahiti et sa Couronne* has paid homage to what cannot be denied, the physical beauty of the Tahitians that “has survived racial intermixture, syphilis, alcoholism, new kinds of food, security, boredom, all that the whites have brought them. It is astonishing that they have resisted so many factors of dissolution and that one can still meet ideal specimens not only in distant isles but even in Tahiti.”

Panoramic impressions highlight Papeete’s carnival spirit: a wreath of sweet-smelling flowers for the head as one arrives, happy glances and greetings thrown out by the pretty Tahitian girls who stroll by in twos or threes under the red flamboyant trees, the girls dressed in gaily printed cottons and with their long, dark hair falling over their shoulders, and always wearing sweet-scented flowers. At a night spot where Tahitians were dancing, the native orchestra would play Tahitian tunes and body movement would sweep through the room—a pulsing, joyous, throbbing rhythm as they all began to dance, every glance inviting one to share in the fun.

We walked along the quay at midnight, by the fascinating array of adventurous, small white boats at anchor . . . the little red-and-green carts selling ice cream, watermelon, and soda pop by the light of the kerosene lamps. Suddenly we were surprised to see one long row of bodies sound asleep on mats on the sidewalk. These Tahitians were already in from
the country for the market in the morning. Only a mat was needed for a bed.

This was all in contrast to daytime Tahiti. On Saturday morning the shops were open from seven to eleven. In the bright sunshine many men and girls were about on foot and on shiny bicycles. What fun Russ and I had as we started out to explore the town for ourselves.

Meanwhile Kenny, our cook, was hunting up fresh food and supplies for the long trip home. When we arrived back at our ship we’d begun to look like a copra schooner, with huge bunches of green bananas on the deck, baskets of limes, papayas, and much more. We lacked only the live pigs and chickens.

Roger made his official call on the Governor accompanied by our own Frenchman, Monsieur Henri Rotschi. The Governor was in conference and was busy, couldn’t see them then, but made a surprise return call later in the morning.

Interesting people began to arrive at the ship—adventurers, people that made Papeete a port of stories. Mrs. James Norman Hall, widow of the writer, came to whisk away her friend and our doctor, Bob Livingston.

The Wentworths on their 84-foot flush-deck schooner the Arthur Rogers, out from England, had been in Tahiti for some months and were planning to go on across the South Seas. They were not moored to the quay but were anchored out in the harbor. Walter Munk, who had corresponded with Skipper Wentworth, swam out with Winter Horton to pay them his respects. When they arrived dripping wet, they did not find the Wentworths aboard. In the engine room they met a young girl, dressed in a pair of overalls, with a greasy T-shirt, steel-rimmed glasses, with her hair pulled back in a knot. She gave them a big smile.

“Hello. I’m Micky. Who are you?”
They introduced themselves and learned that Micky was a nineteen-year-old American girl and the engineer of this ship. She had gotten her start on shrimp boats in Louisiana. This acquaintance ripened.

Winter had a philosophy about cultivating friendships with the opposite sex: “Look beneath the surface. Don’t fall for the obvious,” were some of his suggestions. Here was a situation dear to young Winter’s heart. “We must bring out the feminine qualities,” he thought, after having a cup of tea, and he invited her aboard the Horizon.

When Micky came to visit the Horizon with Winter she soon disappeared for the whole day. Obviously Winter was neglecting the feminine. Where was Micky?

She was found deep down in the ship’s engine room, discussing a diesel engine with the engineers on the Horizon. The diesel which ran the generator unit on the Horizon was like Micky’s diesel on the Arthur Rogers.

On our first day in Papeete John and Purea Reasin, who had been notified of our ship’s arrival by Harold Coolidge in Washington, D.C., abducted Roger, Russ, and me off to their home in the country.

Purea Reasin was a beautiful French Tahitian woman, daughter of one of the chiefs of an older Tahiti, and has been photographed by many visitors to these islands. Their home in Paiea was set far back from the road across a spacious green lawn and consisted of four small buildings, some palmthatched, others wood; all overlooked the reefs. Purea, owner of much land by right of her high lineage, supervised buildings and farming. John Reasin, her American husband, said that it was his personal responsibility to educate their two children.

We were taken out to explore the reefs. Roger was hoping to make some experiments on the solution basins on the reefs.
on the following Sunday morning, so we went out to make a preliminary investigation.

These reefs were magnificent. Through my face plate I could see branching organ-pipe coral, little brilliantly colored fish, and pink algae with occasional spots of white sand.

John Reasin said, “See those huge blackish-purple spiny sea urchins? Be sure you don’t step on them.”

I had stupidly not worn anything on my feet. I thought I could swim better without tennis shoes. In trying to get out to a spot on the reef where Russ was calling, “Come and see this!” I forgot and put my foot down, stepping directly on a sea urchin and its mass of spines. I yelped with pain, turned and swam towards shore, the others following. Pulling myself up on the beach, I lay face downwards. They applied the only remedy—which was to break off the thirty or so purple spines in the bottom of my foot, leaving the tiny barbed ends inside. John Reasin rushed for the turpentine which he applied immediately—Tahitian treatment.

Diver Hans Hass has best described these spines as “four inches long, very thin, brittle as glass, and poisonous, each one stinging on its own account.”

“There is nothing you can do,” said John Reasin. “In six weeks’ time the spines will be absorbed into your system. But you must keep off your feet for a few days. You don’t want to be laid up for weeks with a poisoned foot.”

The thought of not being able to get about during my few days in Tahiti was more than I could bear. The tears—not so much from pain but from anger at my stupidity—flowed freely, I’m afraid.

Spines or no spines, I would not stay off my feet in Tahiti. I’d take the chance. Back at the ship, Bob Livingston examined my foot with curiosity. I was to be a guinea pig, I could plainly see, and he had me soak my foot in hot water. It only
soaked a few moments, for we were off in the launch to the home of the French Governor, Monsieur Petibon, for cocktails. I was so proud of Russ’s French at this event. Then on to Quinn’s, a famous local bistro, where we planned a rendezvous later with Bob Livingston and Mrs. James Norman Hall. Bob Haines, our handsome bachelor, said “Let’s eat at the Hotel Les Tropiques. I want to see if this is the place for a honeymoon.”

“We’ll all see,” we said, and found a topless touring car to take us out of town to the hotel, with its palm-thatched roofs and many palm-thatched cottages. Here on the lanai, close to the reef, we had a leisurely supper. Lala Hall and Bob joined us later, and then back we all went to Quinn’s, where Saturday night was in full swing.

It was now past midnight and we had made our rendezvous for five in the morning to attend the Sunday market and go to John and Purea Reasin’s. Why go to bed? Lala Hall collected some of us in her red car and started toward Venus Point. However, this Sunday was election day, the one election day in five years, and by law all night spots were closed.

“Come to my house,” said Lala. And we did. Lala Hall radiated that warm hospitality for which she is famous. Blonde, effervescent, the mother of two grown-ups who did not live in Tahiti (her married daughter was in Hawaii and her son Conrad in Hollywood), she put us instantly at ease in this home at Arue where her husband had written his South Sea novels.

Lala (her name was Sarah), a French Tahitian with a Scotch seafaring father and grandfather, had married “Jeemie” (as she called him) when she was fifteen years old, I believe, and he was thirty-eight. She was still in love with the memory of this wonderful man. She showed us his library, the desk where he had worked.
Bob Livingston had first met the Halls in Santa Barbara during World War II, when he had been in the Navy and had been a week-end guest at their home there. He had told us about the Halls on shipboard.

“Sarah is lithe and lively and exotic to all men,” he had said. “She has eloquence in French, Tahitian, English, cooking, the hula, and God knows what other arts.

“As for her husband: Jimmy was not a big man, nor very striking in appearance; yet one looked at him. He was alert, yet relaxed, and there burned such a fire of humor in him that it smoked from his eyes all the time, glowed through his teeth when he smiled, and radiated like a blast furnace when he laughed.”

We walked out into the starry night of Arue and saw the Tahitian guest house on the water’s edge where Lala’s guest was staying. In the silence of the night we could hear the quiet lapping of the water on the shore.

It was time to go. We said we would call a taxi. No! No! Lala’s Tahitian house boy would drive us back to the dock. He must go to the early Sunday morning market. “I must have my fresh fish and chicken,” said Lala.

Sunday, January 18

It was Sunday morning, and we had slept two hours when we were wakened by two of our companions who had managed to stay up all night.

“Come, you louts. We’re going ashore.”

It was now five-thirty in the morning. Russ, Walter, Henri, Roger, Rhodes, Winter, and I were loving every moment of the open-air market. Here were crabs, clams, and strings of brilliantly colored fish hung in patterned arrangements; fruits piled high in native woven baskets—limes, melons, mangoes, passion fruit. Hundreds of towns-people,
completely wide awake at this early hour, were bustling about.

We found a large car to take us to the Reasin’s home and were off for an early morning ride.

Perhaps Purea was surprised that we had really meant to explore the reefs so early. At least she didn’t show it; she and John were ready for us. We started out to the barrier reef in several outrigger canoes. Rhodes Fairbridge, our geologist, was an expert on coral reefs and with Henri and Roger was making experiments on the acidity of the water on the reefs. My ambition was to find some live coral to take home. This was not easy, I soon discovered. Living coral is strong, much like rock, and clings tenaciously to the hard sea bottom on which it grows. Finally, with Russ’s help, I was able to pry loose a few pieces.

When we started back with the corals and water samples in the canoe, bad luck was with me again. Not spines this time; inadvertently, I don’t know how—only a slight movement does it—I tipped over the canoe, and into the sea we went, Roger, sample bottles, coral, and I.

The others had elected to swim back the quarter mile across the reef and viewed our plight with humor. Fortunately we did not lose the water samples.

The rest of the day is one of those days like a dream—a delicious Tahitian breakfast served by Purea and her Tahitian girls in the little thatched-roof dining room set apart from the rest of the house, a siesta on the beach, all of us rolled out on mats sound asleep, and then a ride farther around the island to Teva.

On our drive back to town we stopped to call on an anthropologist, Mr. Donald Marshall, whose bibliography I had studied at the Bishop Museum in Honolulu and who lived next door to the Reasins.
“I have four houses here. My wife has gone back to the States. Won’t you visit me?” he said to us, especially to Rhodes, who was leaving the ship to fly back to his University of Western Australia. After hearing of our adventures at Palmerston Island, Mr. Marshall said he would come to the ship to hear our recordings and would bring a package of some shoes which we could take on to another anthropologist in Nuku Hiva in the Marquesas, our next port of call, if we didn’t mind delivering packages.

As we rode back our American host joked us about the difficulties we would have in leaving port.

“Some ships plan to leave Tahiti in the morning and blow and blow for their crews all day. Sailors are left behind, but not if the French officials can help it.”

Roger then told him that he had already turned down five applications from people who wished to work their passage back to the States, one of them a woman.

Finally back at the ship, I barely had time to soak my sore foot for a moment, change into dinner clothes, and then off again in the launch to meet our next host.

This time we went to Lewis Hirshon’s romantic home at Venus Point. Here was another American married to a beautiful part-Tahitian woman who had planned for us a gourmet’s feast. She was also an accomplished singer and dancer, we learned after dinner.

When Mr. Hirshon discovered that I was interested in pearl divers, he promised to arrange an interview with a pearl diver for the following morning. Late that night we were driven back to town, and we took our launch out to our ship, well lighted in the harbor. I could hardly keep an eye open or speak a word. I was tired, happy, and my foot still hurt.
Monday, January 19

I didn’t want to leave Tahiti, but I wasn’t sure I had the courage to stay on there alone. I am now expected to go on with the Baird to San Diego. Anyway, the expedition planners, many months ago, had laid down the policy that no one was to disembark at Tahiti and fly home. Moreover, I don’t think Russ would be content to leave me here. True, there will be a French ship coming into port on February second which would have taken me to Panama. From there I could have gone up the west coast through Central America and home as planned.

But I’ve become part of the Spencer F. Baird. I’m used to jeans and hard bunks, and with my sore foot I haven’t the courage or energy to get off our ship and go it alone any more. I can’t imagine getting my clothes organized for travel on a big ship or airplane. I’ve been too many days roughing it. I hope I am not imposing on the expedition on this last long trek. Water will be short, and only salt-water showers will be allowed part of the time. But they say they’ve trained me and expect my services. So that’s that.

On this last busy day of hurry and bustle we interviewed Hare Viriamu, a Tuamotuan pearl diver, a fine-looking, sturdily built Polynesian, forty-three years old, who had been diving since he was sixteen.

To make life more complicated, a storm of uncertain force has arrived. It is hurricane season, and we are bound for an area of hundreds of small islands. Surely the ship wouldn’t put to sea in a storm!

By noon a 60-knot wind gust had blown off the roof of the local restaurant, “The Yacht Club.” This event was suitably observed by our meteorological party, who, as Walter remarked,
“in their usual prognostic frame of mind had chosen to lunch there.”

The wind increased in the afternoon and the rain made all loading a slippery and hazardous occupation.
I asked “Why should we go to sea in the face of a gale?” I pictured us buffeted by the waves, foundering on some reef, as I had read of ships doing.

“We can’t get any work done here in the harbor,” answered Roger. “If we leave, maybe we can run out the storm. We’ve only thirty-one days left and . . .”

“Yes, yes . . . work!”

Right at that moment the Horizon out in the harbor began blowing her whistles. They had an impatient note, as if Captain Ferris wanted to leave, storm or no storm.

I looked at a few of the men making quick, wet, and romantic farewells to their recently found friends before taking the launch in the pouring rain to board their ship out in the harbor. The geologists from both ships had been in the Baird’s lab plotting courses. Bob Fisher and Bill Menard reluctantly left Roger, Russ, Gustaf, and others to go back to the Horizon. There was never enough time to talk, to plan, to core, to survey, to do anything they seemed to need to do.

No more civilization for thirty-one days, so I had many last-minute errands. I dreaded the thought of no more ports where one could disembark. What would happen to the dispositions of those aboard? If it became obvious that a woman shouldn’t be on this ship, I couldn’t escape now.

Our departure was set for the moment the icebox was repaired, but it was difficult for me to believe that we would be leaving Papeete. I was ashore talking to Lewis Hirshon on the quay when we heard the Baird’s whistle.

“They’re blowing for you,” he said.

“What?”
I grabbed my camera and ran towards the ship, remembering the difficulties some ships had when trying to leave this port. When I arrived, everyone else was aboard.

“Well, Helen, are you coming with us?”

Amid many accusations I climbed up the wet and slippery plank to go on with the ship. Farewell, Tahiti!
What a storm! Yesterday afternoon the pilot boat conducted us out through the pass in the reefs as the rain poured down. We headed straight into this northeast wind and sea, taking green water over the bow. We could proceed against it at a speed of only seven knots.

The combination of the storm, the three days in port, and little sleep put the majority of the personnel in their bunks. During the heavy rolls last night, one bunk came right out of its sockets, and bunk and crewman landed on the man and bunk below. In our cabin everything was on the deck by morning.

I stumbled down to my assigned watch at midnight and was greeted by partner Dill. He had noted in the log book “Heavy seas and thirty days to go until we get to San Diego.” The ship was practically deserted except for those on watch.

I couldn’t remember when last I’d slept or eaten, and this, combined with the lurching of the storm-tossed ship, left me feeling utterly miserable. During the night the wind increased. I clung to my stool in the lab and waited my watch out. There was very little to do but feel badly, for in such weather no one was allowed to take a BT and the magnetometer was not being towed. We were even having trouble...
getting echo soundings, and these we recorded feebly in our new little log book entitled “Tahiti to Marquesas.”

The rain came down in regular squalls and pounded noisily on the portholes. The ship’s motion was especially uncomfortable, for in addition to the northeast seas, there appeared to be a heavy swell from the south.

The rain was hardest and the sea was highest at two o’clock in the morning. Only the conviction, “Never go to bed if you feel badly at sea,” kept me going through that night. Don Heller stalked into the lab with a raincoat and rainhat on, looking like some wet apparition.

“I can only see the wave crests from the wheel house,” he told us. He was on his way to the fantail to examine the gear, which had been lashed as tightly as possible to its moorings before we had put to sea.

“We’ve already lost one of Russ’s hydrophone buoys from the boatdeck,” he added.

“That’s not going to please your old man,” said Bob to me as he prepared to follow Don out on the wet stern.

I couldn’t see how the fantail was fit for man, beast, or gear on this stormy night as the huge waves broke high over the rail. This little tug takes about as much water over its low fantail as it does over the bow. The Baird rolled and pitched heavily. Anything that could roll did roll.

Bob Dill was back in the lab looking for tools. He told me that our 50-gallon drum containing fish specimens in formaldehyde which had been secured under the skiff, port side aft, had come adrift and was washed over to the starboard side of the fantail. I was not surprised.

As he left to rejoin Don on the stern I was most uneasy. They might be swept overboard.

There was the disaster of the 200-foot oceanographic schooner Vema, off Bermuda.
In a storm where the ship faced high winds and mountainous seas, four men were swept overboard by one huge wave as they were engaged in trying to fasten down four big oil drums that were threatening to break in the after deckhouse, endangering the ship.

Professor Maurice Ewing, oceanographer and Director of Lamont Geological Observatory of Columbia University, was not only swept overboard but injured as he was bashed by the huge drum before floundering in waves high as a house. His brother John and the first and second mates had also been sent into the stormy sea by the same wave. Nor were all of them saved.

The second mate, Charles Wilkie, lost his life. Only the quick action of the navigator and the Captain of the ship saved the other three from drowning in this disaster.

Now, tonight, I had no feeling of security for my friends working on our wet, rolling stern. How could a man be picked up at night in this sea if knocked overboard?

When Don and Bob returned to the lab thoroughly soaked I was greatly relieved. But Don immediately returned to his post on the bridge.

“How long will this storm last?” I asked Bob, a silly question only a woman would ask.

He shrugged his shoulders. “But Helen, will you look at this.” He had the Pacific Islands Handbook in front of him. “The Tuamotu Archipelago is called the Danger Archipelago. Listen to this:

‘The reefs and islands are so low, and so many, that the area has become, in 150 years a vast graveyard of shipwrecks, and records of wrecks which have long since disappeared and are everywhere.

‘This is where we are headed!’"
Midnight, Tuesday, January 20

It is now midnight and the storm has abated somewhat. We are in the midst of the “Dangerous Islands,” going through a seven-mile pass. The small atoll of Niue is abeam not far away, and we can’t even see it. Our echo sounder tells us we are in not-very-deep water, 600 to 700 fathoms, and we have crossed a seamount less than 500 fathoms from the surface.

I am reminded of the skippers of the little copra schooners who find their way from atoll to atoll by a sixth sense, listening for the waves breaking to warn them of reefs.
18. AN ATOLL RICH IN MYSTERY

Wednesday, January 21

How could I be so lucky? Always before I’ve stood on the deck and watched the men pull away in the boat as they went out to investigate a tempting little island. But today I was to be on the shore party landing on the atoll of Takaroa. We had only been given two hours’ notice. Because of the storm, no definite plans had been made about the work program in this area of the Tuamotu Archipelago. But when the weather improved slightly, the magnetometer was streamed, and it was decided to do a bathymetric and magnetic survey of an atoll in the afternoon.

Before coming to the South Pacific, I had agreed to find out what we can learn about the hazards of the sea to the underwater swimmer in the Pacific. Scientists, skin divers, UDT’s (Underwater Demolition Teams) are all curious about the hazards below.

Doctors, engineers, researchers in our country and elsewhere have been hard at work on the problem of perfecting underwater apparatus and techniques for the men who are to go below. We are grateful to Cousteau and the French for the design of aqualungs we have aboard.
Bob Livingston and other men I had met at Scripps Institution were concerned with safeguarding the many people who would soon be using such equipment. A nationally important research committee interested in these problems was also concerned with the hazards about which we know little, remedies for injuries suffered that are well understood by the native whose ancestors have been diving in these waters for hundreds of years.

At the Bishop Museum I had read a description of an immense sea star, 2 feet in diameter and having sixteen arms, which crawls over the sea floor on countless numbers of tubular feet. If one stepped upon this spiny creature, his blood stream would be immediately filled with poison. But the natives had a remedy. The diver injured in this way should turn the sea star on its back with a stick at once, and apply the wound to its mouth. The powerful pumping action will suck out the spines and poison, too, and quick recovery follows.

We hoped the natives would tell us of other such remedies. My report was to include what we could find out from interviewing native divers in the South Pacific. Dr. Hugh Bradner, physicist, diver, and friend from the University of California had given me a set of questions to ask the divers we would meet in the area.

I had been given ample time in Suva to arrange with Rob Wright, Fijian government photographer and expert diver, for a whole day of diving with Fijians at the island of Serua. Twenty of us had visited that little island and swum over brilliant coral reefs. Our divers had carefully watched the methods used by the agile Fijian Tony and his friends as they impaled numerous brightly colored, exotic fish on their pronged spears.

Again, at a diving rendezvous near an island in Tonga,
our divers had observed the Tongans, who went to greater depths than did the Fijians.

At the Bishop Museum I hunted for all references on pearl diving. A British publication furnished me with a list of the pearl-diving islands in the Tuamotu Archipelago. I copied down these names: Hikueru, Takume, Takaroa, Tatakoto, Makema, Manihi, Arutuia, Raroia, Kaukura, Marakau, Hao, Apataki.

My work in Tahiti interviewing a pearl diver there had really convinced us that these Polynesians have a diving record worth observing. Could it be true these men went to depths of 120 feet many times a day?

What diving equipment did they use? Did they dive by regular surface dives or did they sink feet first until they were below the surface? Did they pinch their nostrils to blow and clear their ear passages? Did they do this both before and during the dive? What dangerous fish are there besides morays and sharks? We wanted answers to these questions and many more.

Takaroa was one of the pearl-diving atolls, and the news I was to go ashore there was too good to be true. Also, the geologists aboard our ship were interested in atolls for a number of reasons. All islands are clues to the nature of the sea bottom below, and these islands vary greatly in this eastern Pacific region. Some islands are young, some middle-aged, and some old. On this leg of our trip from Tahiti through the Marquesas we would observe an atoll, an island suffering the tribulations of old age, geologically speaking. On the other hand, we would also have a chance to explore the younger Marquesas Islands with their interesting problems to solve.

Here in the Pacific these atoll islands do not come straight up from the deep Pacific-ocean sea basin as at Tahiti, but are rather pimples on a broad arch or swell of uplifted land. We
were curious as to what our echo sounder would show in our survey of a single atoll group. These could be compared with atolls in the Marshall Island and Palmerston. Our chart told us there were eleven islands in this one atoll. (The Baird counted twenty.)

On our shore party were Henri and Gustaf to speak French, and the divers Willard Bascom and Bob Livingston. I wondered what requests for pills the natives might make of Bob at this island. He had said that nearly always the Polynesians tell him about aches and pains and ask for pills. Others of our party included Mac (our photographer-diver), Bob Haines, and Louis, who were assigned to man the launch and make a survey of the lagoon.

Armed with pencil, pad, bathing suit, and gifts, I awaited instructions at the rail.

“Jump in,” called out Bob Livingston, already in the launch with his aqualungs, flippers, and recording machine. Overside I went.

“Come back tonight when you sight us beyond the reefs,” said Roger.

“So long, it’s been good to know you,” we sang out and waved goodbye as our small boat left the ship. Our eyes were now turned shoreward as we looked for the pass through the reef into the lagoon and at the tiny palm-covered low-lying island.

To me this atoll is best described as a necklace of small green islands surrounded by light green water and a jagged reef against which the surf pounds. I could see the one pass now, dead ahead, which would allow us entrance into the quiet, deep blue lagoonlike lake inside. But most of all, an atoll is low and flat.

Our launch came closer to the barrier reefs, the jagged ridges surrounding the little circle of islands. These meet and turn back the rough waves, thus protecting the white shore
inside from being washed away. The pink algae growing on the outer reef has given the name to this so-called ridge—lithothamnion.

Inside the barrier reefs on the ocean side of the islets, we could see the white beach, made up of broken coral and shell. This was again the noisy side of the islands, where the surf pounded loudly and the wind whistled through the palm trees. No houses or people were visible.

We had nearly reached the pass when we were met by an outrigger canoe in which sat a policeman and a French civilian from the village. We took them aboard, towing the outrigger behind us. Henri and the Frenchman conversed volubly, but I did not know what was being said. As we found our way through the pass, this narrow, dark-blue surging water with waves on either side, we came to a calm lagoon, and now could see on our left a row of houses and villagers, men, women, and children, all running to the quay to meet us.

The little village ahead seemed hardly real; it was more like a stage set—blue water foreground, white earth and green palms with accents of red, pink, and yellow.

The green of the islands consisted of a coarse grass, tangled pandanus trees, coconut palms and beach shrubs, all growing on a soil made from cemented coral, rubble, shells, and rock, not like our good earth.

In a few moments I found myself in the midst of a group of Tuamotuans, being introduced to the chief, Paniori, and then to Taumata Mapuhi.

I was in luck again! Taumata, a man in his forties, heavyset, dark, spoke English rather than French (he’d been educated in New Zealand) and was a diver.

Suddenly hearing an American voice, I looked around, surprised. I saw a young, short fair-haired missionary.
“Where did you come from?” I asked.
“San Francisco,” he answered. He said he was a Mormon and introduced me to a second Mormon, short, heavy-set and much older. Two Mormons on this tiny island of three hundred people. These Mormons were cared for by a family on the island. We were in a village where smoking, drinking of alcoholic beverages, and even coffee were forbidden.

I left the Mormons to visit Taumata, who had invited us to his house overlooking the quay. Our job was to find out about pearl-diving techniques. At his small frame house we met Taumata’s wife, Vahinerii, a pleasant, quiet woman, and were given seats in the parlor and cool fruit juice to drink.

Taumata and Vahinerii have a family of seven girls and three boys, some of whom we met. Most prominently displayed on the table in the parlor was a picture of one daughter, a beautiful girl by any standards.

“She is in Tahiti,” said Taumata.
I remembered the stories of how these island girls go to Papeete and live for months, sometimes years, especially pretty young girls. Some never return and others come back when weary of Papeete life. In these atolls there are small islands now practically deserted, with only a ghost village inhabited by one or two families.

This was not the afternoon we should have chosen to visit this little island. A woman, the best singer in the village, wife of one of the diver, had recently been taken sick.
“First she had a pain here,” said Taumata pointing to the side of his abdomen.
“What did you do?” I asked.
“No doctor—not like popaa land. We call on our wireless but no help. No copra schooner comes now to take her to hospital in Papeete.”

“Was it painful?”
“Yes, eight days. Last two days, swelling. Then she died. Very sad.” We learned that the funeral would be held today at four o’clock.

“You come with me to the funeral,” said Taumata.

This explained why the villagers were dressed in their Sunday best, the men in clean white ducks and white shirts, the women in fresh cottons, all heads sleek and well-combed. Our diving research would obviously have to be adjusted to the funeral.

In the midst of our conversation on diving Taumata put on a white linen coat and said,

“We go now.” I followed along, secretly chagrined to be the only woman in this village going to a funeral in jeans. Perhaps I could stay inconspicuously in the background. The rest of our exploring party were scattered in many directions, carrying out their commissions.

Standing in the hot sun, waiting with the quiet villagers and listening to the wailing within, I felt my legs and arms bombarded with gnats. Unable to control my reflexes, I found myself constantly swatting the flies and gnats with a ferocity I can never remember before in my life. These pests would be a great deterrent to the romance of atoll life for me, I fear.

Presently a native priest (also a diver, I’m told) dressed in a red surplice came marching with two acolytes down the village path and into the house. There is one priest for the fifty or so Catholics on the island. After a time they reappeared, followed by pall bearers (most of them divers) who carried the coffin, using a diving rope with which to hold it. The family followed close behind the coffin and we then all walked sadly down the village path to the Catholic church, where a very short service was held.

I did not go inside. The priest again led the pall bearers
carrying the coffin to the grave in the small cemetery. The villagers and I followed, but this time I hesitated in the rear and stood at a distance from the grave. More chants were intoned, and soon the priest departed.

Suddenly there came a downpour of rain. Most of the mourners hurried to the shelter of the large and imposing nearby Mormon church. The rain was over in about five minutes, and the ceremony continued with some singing. Then cement was mixed to put on top of the coffin, which had been lowered into the ground. Was this because hurricanes have been destructive to graveyards? I don’t know.

Back at the Mapuhi home, I decided on a swim, as the others had not yet returned from exploring the reefs. One of the five daughters, the fourteen-year-old, agreed to go in the water with me.

I was taken to the next room to change into my bathing suit and saw the large impressive double bed made up quite fancily. I wondered if they actually slept on this bed or on mats on the floor, as I had heard. Looking through large wide open windows I smiled at other Mapuhi daughters who were watching this papaa vahine undress. My swimming companion put on a sarong with a European brassière as a top and led me to a shallow spot beside the quay.

I put on my face plate. I have never seen such an exciting underwater scene as this, because the bottom dropped off immediately into a blue-green sea canyon. It was as though I were in an aquarium of tropical fish.

After my swim I presented Vahinerii with a gift of new materials for a pareu (sarong). She took me inside her little storehouse, where I saw many pieces of cloth on the shelves, and I realized she had all the cottons she needed. She in turn gave me an embroidered blue pillowcase.

The rest of our party had returned, and the villagers had
gathered together to sing for us. Ahu, a pretty young girl with long black braids, jumped on a shiny bicycle and rode off to get a guitar for Tomohai to play. As they sang the songs composed by this young diver, Tomohia, we made recordings.

Listening to these natives singing, I somehow sensed in them an apathy—no lust for living on this tiny island. They seemed to lead a comparatively placid, uninspired existence.

Malinowski says “Now once you make life unattractive to a man, whether savage or civilized, you cut the tap root of his vitality. The rapid dying out of native races is . . . due more to wanton interference with their pleasures and normal occupations . . . than to any other cause.”

Compared to the vitality of a Samoan cricket game, the noise and fun of a Tongan village, the gaiety of Papeete, I sensed a death of man’s spirit here. But perhaps this was because I was visiting the village on the day of a funeral.

Our ship had been sighted. The village sang us their traditional farewell and accompanied us to the docks as we made a romantic but somewhat hasty retreat from our little Tuamotuan village.

*Thursday, January 22*

I want to get it down immediately before I lose it, before we all forget. Roger wants reports in the log from all of us who went ashore at Takaroa. The ship is again stopping on another seismic station, Point Nan, and the big corer is going overside. But I’m trying to remember what we learned about pearl diving yesterday.

In spite of the funeral and the short time ashore we managed to accomplish our purpose. Both Willard Bascom and Bob Livingston had gone below with the divers. Many villagers and Mac and I had stood by to watch three
divers in bright-colored pareus go under the water with Willard, who was wearing flippers, face mask, and aqualung. Their red and blue cotton suits combined with Willard’s brilliant yellow tanks made a striking picture as they all dove deep down into the clear blue-green water of the lagoon. The pearl divers were soon out of sight. Willard followed them down with his aqualungs and saw the great depths to which these men could go. Their claim to 120 feet deep was a fact.

When they had come back up to the surface, we watched them swimming toward the quay. The crowd began to laugh. An unconscious race was on between the divers and Willard, who was unaware of what was happening. There were shrieks, calls, telling the Takaroans to hurry, as Willard beat all to land.

Perhaps I can swim faster,” said Willard, “because of these flippers. Try them.” He took off his long green rubber feet and handed the pair to one of the divers. At other dives in Polynesia, the natives had not seemed interested in flippers. These men tried out the gear and were convinced that they wanted flippers and they wanted them now.

Would we sell them our flippers? If I had had a pair I would willingly have left them behind on this coral atoll, as would any of us, but we had not brought along extra flippers.

These divers had gear too, but not like ours. We saw their diving rope which had a 16-pound weight on the end. When out in a boat diving for pearls, they grab this rope with their feet and go down feet first as quickly as possible, while holding their nose on the descent. Leaving the rope, they speedily collected the shell with a gloved hand, then placed this in the basket, which was suspended on the second rope about four feet from the bottom. Sometimes they were able
to collect three shells, sometimes twelve, before their breath was gone and they quickly ascended the basket rope to the surface. Each diver wore metal-rimmed goggles and took several deep breaths before going down. They are able to stay down on the average of two and a half minutes (their estimate) with a maximum of three minutes.

At the height of the three-month diving season, Taumata and Henri had told me, some five hundred more people came to live on the island, directly across the lagoon from the village, and the scene was a busy one, with many small boats—men and women at work, diving for shell.

These Tuamotuans were the tools of the shrewd Chinese traders who brought them here. The traders bought the pearl shell which the divers brought up from the lagoon floor, and then set up concessions in which the divers and their families could quickly spend all the money they had received. Often at the end of the diving season the diver was in debt to the clever merchant. Plants to make ice cream were set up, movies shown every night, and many objects of civilization of little use to a man on an atoll lured these simple people into spending.

“But do you get many pearls?” we had asked Taumata.

“No, not now. Not like the old days,” he had answered. And we learned that only two or three pearls of a fourth-rate quality had been found at Takaroa last season. The average haul of shells a day would be 150 shells or 50 kilograms. Each shell was examined for a pearl, but these were rarely found. A diver could earn between $35 and $50 a day, I believe.

Taumata told of a trip he had made in 1947 when he traveled 700 miles to a shell bed in Marutea, one of the Gambier Islands.

“I saw my first large shells. I found two pearls.” Taumata
smiled proudly as he had told us of this exploit, and we learned that one of his pearls had been the second-
largest pearl found that season.

“We go out in the lagoons at eight o’clock. We dive until three-thirty or four o’clock in the afternoon. Five days a week,” he said.

“What do you eat?” I asked.

“Not much when in the boat. Canned beef and bread for lunch. We eat well when our diving is done
for the day.”

He stated that the divers went down from sixty or seventy to a hundred times a day and that the average
depth was 15 fathoms. A fathom is assumed to be equal to their bras, which is the distance across
Taumata’s outstretched arms.

“What is the deepest you go?”

“Twenty-two bras.” This would mean 132 feet, certainly a record few of our skin divers make. Women
can go 30 to 40 feet and a boy of ten can easily dive 12 or 18 feet down, we learned.

“Do your ears ever hurt?”

“At first, yes.”

We discovered that when the season began it took several days before the pain was all gone from the
body and the head sinus areas. On these first nights the women rubbed their men until the ears cleared
and the pain had departed. After this, a diver only felt pain when he had a cold and tried to dive with this
disability.

The average age at which they start to dive is around eighteen or twenty years and the average stop at
sixty, while some go on diving until they are seventy years old.

“Some divers get kind of crazy when they get old,” he stated. “Those that go down a hundred times a
day, all the time. Sixty to seventy dives a day is better. If a man dives too much, he feels drunk afterward,
but not under water.”
If they feel that way when diving, they stop, or otherwise they might not be able to get up to the surface.

Taumata did not describe any tragic accidents to divers in the lagoon of Takaroa. He did not believe that sharks bother divers, as only small sharks enter the lagoon, and the men do not dive at sea. A diver is not in danger unless he spears a shark and wounds him. These divers consider the barracuda the most dangerous animal of the sea. If a barracuda is spotted, a shout of warning is given above, and all divers immediately surface.

However the Takaroans did tell us of sharks as large as 24 feet in the open sea. And I remembered Viriamu’s story of how three men were fishing five meters apart outside the reef and the middle man’s hand was bitten by a shark.

Did these divers have physical equipment unlike ours? Had their long years of diving, this occupation which was almost hereditary, become a factor? We were curious as to how they went to such depths. Did they die young, suffer ill effects? I discussed these problems with Willard Bascom and our diver doctor, Bob Livingston.

The depths at which they did useful work were far beyond those conceived as being practical in the United States, and what is more, they could do it as often as fifty times a day.

“Do you think they have any natural physical advantage?” I asked Willard.

“No. They were both thin and padded, short or tall. They did not have any unusual chest development. But their divers appeared to be thirty-five years old or more.”

“Perhaps the poorer divers were weeded out,” I said. I thought of the accounts of mishaps to divers in this part
of the Pacific and realized that they frequently happened to the greenhorn. Willard continued: “The fact that they live on a small island and are dependent on food from the sea and on diving for their major income obviously keeps them in continual practice. I’m doubtful if there is any hereditary advantage or that the abilities of the best of them would survive a few years away from the water. Also the lagoon floor is 20 fathoms deep—they have to dive that deeply to recover the shell.”

Their diving techniques are quite a factor in their success. Their working at depth seems to be dependent on a preliminary breathing exercise in which air is inspired and expired in deep breaths for perhaps two or three minutes; then with a last, great inhalation the diver seals his lips, holds his nose and descends, creating pressure by blowing into his middle ears in descent. Going down with the weight line makes the diver’s descent rapid.

On the bottom, at 20 fathoms, the diver has considerable negative buoyancy because of the reduction of volume of the voids in his chest, stomach, bowels, etc., but he still has ample oxygen (and low drag). As he rises, the air-filled spaces expand and he has less gravity forces to work against until at five or seven fathoms below the surface he becomes neutrally buoyant, and from there on to the surface he is aided in his ascent by his buoyancy. I also learned that such dives are made possible by the use of very small, eye-fitting goggles which have a minimum air space to be subjected to compression.

These divers seemed to me to be of excellent physique and were fine-appearing Polynesians. They lead temperate lives and take good care of their bodies, I’m sure. They are careful to do no heavy work or undertake other heavy
physical exertion, but save themselves for their diving, and if they are the least bit under the weather or ill, they do not dive at that time.

This visit to an atoll has me distracted. We’ve talked about Takaroa incessantly once back aboard, and I’ve studied the literature in the ship’s library.

These gentle people have a background of exciting stories which I failed to discover while there.

For instance Taumata, as we stood in front of his father’s imposing tombstone, never told me that here was a Tuamotuan who had stood head and shoulders above all. Taumata had pointed and said proudly, “My father.”

But the elder Mapuhi had been famous throughout all French Polynesia, for he of all the Tuamotuans had become a great trader, had not allowed the orientals or popaa adventurers to outwit him. This Mapuhi was said to have been familiar with the reefs of all the Tuamotus and could skipper his ship through the most dangerous passes with uncanny judgment. Earlier visitors to Takaroa describe him as a mammoth man, very dark from hours of diving in these warm waters.

In thinking about this atoll I also began to wonder how life had first come to these islands, such a highly inhospitable environment? I tried to imagine the very beginning of the atoll, a flat exposed reef-rock probably covered by rock debris and sand and shells, nearly at sea level.

“Chemically it was very saline, calcareous, basic, low in iron, high in magnesium and nitrogen, with a little organic matter but no humus,” ecologist Fosberg wrote.

As the rains came and storm waves attacked the coral, broken material was piled up on the seaward side and sand came on the lagoon shore. Then came weathering of
rock by solution and physical abrasion, and there was soil.

Life in its simpler forms appeared. There never developed the normal complex flora and fauna found elsewhere in our world. With the sea so close, much life could not tolerate the salinity of the water, and there was an original deficiency of iron. Many plants need iron.

But most destructive to the growth and evolution of a complex flora and fauna were the hurricanes and typhoons which would completely destroy all living things. The land surface had no chance to grow old. It was so frequently destroyed by typhoons.

Then man came to the atoll, to this young, dangerous, thoroughly inhospitable environment. Man brought with him rats, flies, lizards, and new plants, breadfruit coconuts, and plants of the type of taro. On some atolls he brought also pigs and dogs.

These new visitors obviously changed the picture, and many inhabitants barely surviving in the rugged atoll environment were now destroyed, and some others were given increased chances to live.

Coconut trees took over the soil that had been used by other plants. The birds were killed by rats, dogs, and hogs, and therefore there was less phosphate and nitrogen added to the soil of the islet, and this made the soil even poorer. In addition to this meager soil, deficient in minerals, there was always the problem of water. Sometimes the islands were subject to long droughts.

"Yet atoll people had, left to themselves, evolved a mode of life well fitted to this environment," said Fosberg. "... though rigorous and simple, it was so far as we may know, a happy and satisfactory existence. These people had come to terms with their environment and made the necessary adaptations for life in it."
Then came another era in the life of this atoll with the arrival of Europeans. Human diseases and disease-carrying insects were introduced. In most areas, the native populations began to decrease rapidly. The rats, most aggressive and adaptable, became a great destructive pest.

As Rachel Carson writes:

“In all the world of living things, it is doubtful whether there is a more delicately balanced relationship than that of island life to its environment. This environment is a remarkably uniform one. In the midst of a great ocean, ruled by currents and winds that rarely shift their course, climate changes little…. The harsh struggle for existence that is the normal lot of continental life is softened on the islands. When the gentle pattern of life is abruptly changed, the island creatures have little ability to make the adjustments necessary for survival.”

*Friday, January 23*

There is nothing like a coral atoll in the world of man’s experience. These tiny green islets that partially or completely encircle a lake-like lagoon have piqued man’s curiosity since he first saw them. For more than a hundred years, explorers and scientists have examined these curious island phenomena and tried to reach some conclusion about how they came to be.

Only in certain warm tropical waters are these islands found. Atolls are made from depositions and growth of countless coral polyps, tiny living organisms, reaching out their animal tentacles, spreading and building steadily the bases of these islets on their volcanic foundations.

I always thought of coral as a plant; the coral beds could be called the gardens of the sea. But coral is really a plantlike animal related to the jellyfish and sea anemones. These plantlike animals, multicolored and beautiful, form on death
the solid structure of which reefs and coral islands are built.

But what conditions must this coral polyp have to begin life? Apparently these lime-forming animals, which reproduce by budding in plantlike fashion, must have clear and shallow warm water, preferably with a temperature above 68°. They do not like depths over 150 feet, but thrive best near the surface. Nor can they stand exposure to the air for more than a few hours at a time. They demand circulating fresh sea water.

The tiny larvae which develop from fertilized eggs swim about feebly from one day to three weeks at the mercy of the currents until they attach themselves to a rock or any clean hard surface.

Then the little polyps begin to grow, putting out tentacles like plants, needing food, oxygen, and light. They are carnivorous and feed upon animal plankton carried by the ocean currents. They get their food through the center of a coral cup or oval lips, as it were, mostly during the hours of darkness when the plankton rises to the surface.

Corals, like all living organisms, encounter destructive processes—enemies that threaten their very existence. These are wind, storm, and ocean waves, hurricanes or typhoons that can break up whole sections of reef and roll them into the lagoon. A tropic downpour may dilute the salt water and kill the coral, as does the sediment washed down upon them.

But these corals survive, and in their myriad shapes, from the yellow-green brain coral and the stony coral to the branching staghorn, corals continue to delight man whenever he finds them. Live coral is found in many brilliant colors, yellow, blue-green, purple, brown, and many more.

Roger has written one of the best descriptions of coral reefs. He says:
Comparative profiles of two volcanic islands, a seamount, and a coral atoll. A fathom is 6 feet and a nautical mile is 6080 feet.
“Of all earth’s phenomena, coral reefs seem best calculated to excite a sense of wonder, and of all the forms of coral reefs, the atolls have appeared to men of science to be the richest in mystery and most strange. Rising alone from the empty sea, these ancient structures, growing now slowly, now fast, toppling when the sea retreats and flung up in haste when the sea level rises, are like a Gothic cathedral, ever building yet never finished, infinite in detail yet simple and massive in plan. Tiny plants and animals are their builders. Their architects are the giant ocean and the restless wind.”

But what is the explanation for an island born from the work of tiny living carnivorous organisms? Why do atolls occur where they do?

Out in the vast reaches of the Pacific Ocean we do not usually find sedimentary mountains in small island formations. But we do find a world of volcanic peaks, islands in various stages of development, formed with black lava rock thrown up out of the sea, peaks flat-topped and close to the surface called guyots, and islands barely below the surface such as the Falcon Island our divers investigated.

And all these volcanic seamounts are of different heights, as our echo sounder has shown. Nowhere has nature suddenly sent up mountains just 120 to 180 feet below sea level, just so high and no higher. Where on land do we find a range of mountain peaks all equal in height?

Then what happened? Roger says Darwin thought “that reefs start to grow around the shores of a land mass which is initially above the sea but which is subsiding relative to sea level. The living reef grows upward as fast as the foundation subsides, and the area between the reef and the shore is kept nearly filled with calcareous debris. Eventually
Three stages in the formation of an atoll according to Darwin.

A. Fringing coral reef around the base of a volcanic island.

B. As the island sinks or the sea level rises, the fringing reef grows upward, becoming a barrier reef.

C. The volcanic island has disappeared below the surface of the sea, and the barrier reef has grown upward becoming an atoll.
the rocky foundation may be completely submerged and an atoll is born.”

Darwin himself wrote, “As mountain after mountain, and island after island, slowly sank beneath the water, fresh bases would be successively afforded for the growth of corals…. I venture to defy any one to explain in any other manner how it is possible that numerous islands should be distributed throughout vast areas, all the islands being low, all being built of corals, absolutely requiring a foundation within a limited depth from the surface.”

The South Sea writer Frisbie said it so beautifully: “Think of the untold billions of creatures that have lived and died for ages to build up a coral atoll. And think of the untold billions of creatures that are laboring even now ….” On an atoll that grows slowly upward at precisely the same rate that the sea bottom subsides. “Here is land becoming rather than one become, a land functioning in Time rather than in Space.”
19. NUKUHIVA, LAND OF TYPEE

Saturday, January 24

Our last stop before the long voyage home was to be Nukuhiva, one of the Marquesas Islands. Our five-hour delay due to trouble on the big winch yesterday has allowed that “happy ship,” the Horizon, once more to precede us into port.

These Marquesas Islands have had a most romantic and tragic history. Says our Pacific Islands Handbook:

“The Group was a happy hunting-ground for whalers, traders, slavers (black birders), and all the white scum of the South Seas. The native men were taught all vices from alcoholism to opium smoking; the women were debauched. European diseases, against which these island folk had bred no immunity, went through the villages like wildfire; in epidemic after epidemic, the natives died in masses. It is the most tragic and sordid history of the South Pacific.”

These islands lie about 740 miles northeast of Tahiti, have a total land area of 590 square miles, and could support a large population. There may have been 100,000 people there in 1800; now there are nearer 3,000.
We were all on deck after supper as the ship came close to Nukuhiva. We looked through the binoculars at the island, 14 miles long and 10 wide, with high mountain peaks rising right out of the sea.

The steep red-brown, rugged sea cliffs that fronted the ocean did not resemble in color and vegetation those of other islands visited, but reminded some of us of the coast of Mexico.

We proceeded through passes of brown and black volcanic rocks into horseshoe-shaped Taiohae bay and came to anchor. In a short time rowboats and outriggers brought French officials, a Marquesan ship captain, and natives who came aboard the *Baird*.

We prepared to go ashore and make an official call on the French administrator and his wife, Monsieur and Madame Reboul. Russ and I accepted the invitation of the Marquesan ship captain to go ashore in his small boat, and we jumped into his lurching rowboat. When we reached shore, I was startled to be picked up and carried through the water by the Marquesan captain. Setting me down, he told us that his small interisland boat at anchor in the harbor was unable to sail because his engineer was sick. “We will have our doctor see your engineer,” we said, and thanked him for the pleasant ride to land.

Then five of us found our way over the hill under a flaming array of red flamboyant trees and through a gate to the imposing residence (at least imposing for the Marquesas) of the Rebouls. We were warmly welcomed by the amazingly large and handsome young administrator and his wife.

During our conversation Madame Reboul suggested a horseback ride for the morrow for Bob Livingston and me, since the two ships planned to conduct a seismic survey.
of the shelf along the island and we would not be needed aboard.

“You could follow the trail to the top of the ridge, the one Melville described in Typee, and then see the Taipi valley,” she said. Taipi is pronounced as Melville spelled it many years ago.

This prospect seemed most inviting, so she told us how to find trader Bob McKittrick, who would arrange for some horses to rent.

We spoke of our desire to see some ancient dances such as Gustaf had witnessed when he had been here five years previously with the Albatross Expedition.

“The natives could be persuaded with some francs,” Monsieur Reboul said.

“I’ll get no work done around here,” lamented Madame Reboul. “If they dance, they will be busy all day preparing for the event.”

Leaving our host and hostess, we started on a walk along the bay and began to meet friends from the Horizon who had found trader McKittrick. We saw that a dance in a little square outdoor pavilion on the beach was beginning with a Marquesan man at the guitar and many voices to assist him.

Whenever a Marquesan appeared, grunted at me in a strange manner and with no smile on his face, expected me to dance with him I did. It was quite an evening and ended only when the owner of the Coleman lantern wished to go home and so disappeared with the light. Back to our ship we went.

_Sunday, January 25_

At 0730 there was a call in the ward room where last-minute breakfasts and cups of coffee were being consumed.
“All ashore that’s going ashore.”

We loaded up the skiff with what gear we would need for a day on Nukuhiva. I took a bathing suit and cap, a brandy bottle filled with water, part of a bar of chocolate, a towel, tennis shoes, and jeans.

Of the six in our skiff, three of us, Bob, Dick Blumberg, and I, had planned to take the Typee trail, while Walter, Henri and Ronald were going exploring in another direction on foot. Before setting out, Bob went first to call on the sick Marquesan engineer. An advanced case of tuberculosis, was Bob’s diagnosis, and he gave instructions and suggestions for treatment. Then, leaving some of our possessions at a little house, we followed the path around the semicircular bay to call on Bob McKittrick, for forty years the trader in the village. He was friendly: Nothing, however, could be done about horses until the natives came home from church service, he explained.

While waiting, we admired the lovely woodcarvings for which the Marquesans are famous and regretted that the Horizon personnel had purchased all available paddles, bowls, and tikis (carved statues of ancient island gods) the day before.

There are not many woodcarvers left in the Marquesas—perhaps five—and these carve on inspiration only. Of what use is money in a land where the food grows on trees, there is no cold, no lack of houses, beer and wine are rationed anyway, and lovemaking is as simple as eating? We knew that Willard and Gustaf from our ship were visiting the one woodcarver of Nukuhiva and we wished them success.

Mr. McKittrick’s native wife, a tiny woman with gray hair, must have seen the desire in my eyes as I fondled a wooden object, because she brought out a beautiful small
fruit bowl from the back room and asked me with gestures if I wished to buy it.

"Of course," was my answer and she asked her Scotch husband in her native tongue to set the price.

Soon the villagers came down the road from the church, dressed in their Sunday clothers, the women picturesque in their white, Panama-type straw hats tipped at all angles. As they went by, many spoke to us in their soft, shy way. After a time the Marquesans produced three horses of sorts and small wooden saddles.

Bob Livingston was given a bony creature that looked barely large enough to hold him, Dick, a slightly larger animal, and I was told to mount "Little Mother," as I called her, because her colt was close behind and, indeed, followed us on our trip over the ridge and back, stopping to get milk from the mare whenever we paused for rest.

Off we started through the village up the path towards the high volcanic ridge behind it. The mountains we were ascending make a large craterlike amphitheater around Taiohae Bay. The highest point on this range was Anapii to our left, over 3,000 feet high. The peaks on Tutuila and Viti Levu had been nearly inaccessible because of their dense tropic vegetation. Now to look up at these green slopes above the trees and to feel we could attain the ridge seemed a fascinating possibility.

Riding by each little home up the trail, I greeted the villagers with my only phrase of Marquesan, "Kaoha nui." Kaoha means hello, goodbye, and thank you, a most useful word. Behind, Bob greeted each one with "Bob Jour." We passed by ancient paepaes, stone platforms or house foundations some 6 feet high and 30 feet square and built without use of mortar or cement. They were the relics of a former people.
We soon left the little village far behind and began our climb up through a lush green canyon. I noted the pattern made by the leaves of the large breadfruit trees, and the tall banana clusters hanging green from the limbs of the trees. As I rode, the tropic greens brushed my legs and I could reach out and pick flowers or wild limes from the branches as we went by. Always in this sweet-smelling valley we could hear the sound of the stream in the distance.

Suddenly Dick called. “Look out!” And I saw Bob’s horse stumble on the trail and roll over. No one was hurt, and we went on. Now, on the lookout for ripe bananas, we stopped by some very yellow fruit and also had a sip of fresh coconut milk from a green coconut.

As we climbed higher the vegetation changed and now there were no more coconut trees, and no fruit trees. We reached a dry area as our trail made switchback ascents upwards. When we got closer to the summit we were above the bushes and trees, and found ourselves passing through ferns and grass.

It began to rain and I, thinking of the water shortage aboard our ship on our long 25-day voyage home, said, “Lucky we, a fresh-water shower.” It was. We were drenched thoroughly. More of a problem were the trails, which became reddish-colored streams. The soft, clay-filled paths, not easy for our horses to traverse in dry weather, became so slippery in the rain that the horses frequently stumbled. Soon we were walking and leading our horses up the rain-swept trails. Just as we reached the ridge, with its panoramic view of the Taiohae Bay, the rain stopped and the sun peeked through the clouds. Out at sea we saw one of our ships, and looking down on the village, we noticed the many red roofs which had not been visible from below.
The water of the blue-green bay was so clear that from this height we could even see the dark volcanic ridges extending out into the bay beneath the sea. But what was on the other side of the ridge? We crossed over.

I thought of Melville and how he and Toby had arrived at approximately this same point in 1842. They had expected to find another deep semicircular canyon such as the one they had ascended. They had jumped ship, and needed food on which to survive the ten days while hiding out until their ship departed.

Looking out over the rolling, grass-covered hills on the other side they must have been as surprised as we. Not a sign of food. Being pursued, they could not turn back, as we could.

Perhaps it is the magic of Melville’s beautiful prose which haunts all this scenery and makes this trip memorable. My mind is filled with recollections of Melville’s description of the beautiful maids of Nukuhiwa swimming out to the ship, with white tapa cloth held high out of water, drying themselves, anointing themselves, and then swarming gaily over the ship with their long dark black tresses, and then Melville’s miraculous escape over these self-same mountains to the arms of Fayaway in the Typee valley below.

There was surely more to see of Taipi if we could go farther. We knew that some of our companions from the Horizon had been landed there today and were walking up the valley in search of ancient stone tikis. We started down the ridge toward the Typee valley.

We found we were hungry and so decided to unbridle our horses and allow them to graze while we ate. Dick, looking in his knapsack, discovered that the lunch that he had brought from the boat for us all had been left behind. We
had my piece of chocolate bar and one quart of water. These had to suffice.

We had promised to be back at three-thirty, and so could not go too far into the Taipi valley. We climbed a fern-covered ridge behind us and there found a superlative view.

We looked over the next range towards the ocean on the far side of the island, then down into the head of a wild valley, into which cascaded a long, straight waterfall. Following with our eyes this deep V-shaped green chasm with no signs of trail or human beings, we saw it meet the long, narrow Taipi valley in which we could barely discern one grass hut. Then, turning to the east, we observed how the ocean came into the valley and made the bay.

On our return journey, the sun had somewhat dried out our trail and made it easier for our horses to pick their way down the rocky, steplike path to the village. Mentally I explored the possibilities of returning and really visiting this island. One would need a boat to get to the inlets and bays from which to start out on foot. I can think of no better adventure, no more spectacular jaunts, no greater feeling of a world remote. I had not minded the little wooden Marquesan saddle and had loved every moment of the ride. If I’d be stiff and sore tomorrow, what of it?

The only handicap to hiking or riding in the Marquesas is the *nou nou* fly. On ship I had read about this little pest, a species of the sandfly—very small, but with a big, nasty bite.

Douglas and Johnson in *The South Seas of Today* said in describing their encounter with the creatures: “Their first settling is imperceptible, owing to their small size, but glancing at hands or arms the traveller soon finds them covered with a swarm engaged in sucking blood so vigorously
that the little black insects swell visibly and turn a dull purplish colour from the distension of their abdomen with the blood of their victim. On brushing them away one sees quite a large spot of blood resulting from their ministrations, and although at the time no irritation is felt, the bites later on give considerable trouble and may even cause slight fever …”

No mosquito-repellent seemed to affect these flies, so perhaps one should think twice before suggesting camping out in the Marquesas.

Towards midafternoon we arrived back at our village, thinking hungrily of the lunch we had left behind, only to discover that the ants had found it first! Returning our horses to their native owners, we picked up our gear, Bob’s aqualung and box, and started off to the administrator’s for a swim.

I was badly streaked with mud from our climb and was happy I had brought along a clean pair of jeans and shoes. Our swim at the Rebouls was punctuated with rain, and, still with no food, we were offered a delightful drink following our swim.

Back at McKittrick’s, we saw our meteorologists from the Horizon taking time-lapse pictures of clouds. They had been at this all day.

Late in the afternoon our two ships appeared in the harbor, and soon Russ met me ashore. He was eager to see all he could of the island. I was hungry. He solved this problem by buying a loaf of bread, a tin of cheese, and a jug of wine from Mrs. McKittrick, and we were off.

We explored one of the streams and then decided to follow the long crescent beach beyond the village. Here we ate under a full moon, which lit up a white beach, blue-black ocean, and black volcanic rocks.
The ancient dances had been scheduled for tonight. We had paid the natives about forty dollars for the performance. We were all very curious about what we would see, so we made our way back to the landing place, escorted by many little Marquesan boys and some girls, and I went to the ship to change to a dress in honor of the occasion.

Back at the dance we found that the one guitar player of the night before had drunk too much wine; and as long as he couldn’t play, no one else could use his guitar. Resourceful Bob Dill took command. He tore back to the ship for Brownie’s guitar and my ukulele, which by now had only three strings, but was still in excellent condition by Polynesian standards. It had been played by many brown hands during the past two months.

The administrator and his family and the two French civilian officials and their wives arrived. We five white women were given seats of honor on a board to watch the festivities. The village and the personnel of our two ships gathered in a great circle around the fun.

Then began the strange set of dances. The first was called the pig dance, which is a fertility dance connected with the pig (puaka), which symbolizes human flesh.

Gustaf explained it to me. “After the eating of human flesh was forbidden, the sacrifice was transferred to the puaka.”

Six women seated themselves in the center, flanked on each side by a line of six men. Amidst a weird beating of hands and snorting grunts from the dancers, they began the pig dance, with many gesticulations. At a certain moment six men dancers straddled six other men, snorting rhythmically, and moved their arms in a formalized pattern back and forth, back and forth. The leader called out each successive movement of the dance, and they
did snatches of this dance with seven variations, each one short.

Gustaf said, “When I saw it danced five years ago, it was considerably more complicated and elaborate. Apparently they seem to be forgetting their ritual, or are changing it.”

Then came the flying-fish dance. Here the motion of the arm was similar to that of a crawl stroke in swimming. “The flying fish is diving up. The flying fish is diving down,” they sang in Marquesan.

In the sandpiper dance the group formed a circle about one woman who began the movements. More women joined in the center as the ecstasy of the dance became intense.

In the dim light of the one Coleman lantern no movies could be taken, but our men were snapping photoflood pictures and Bob Livingston in the background was recording all the songs.

The dancers finally wearied and the exhibition ended. We moved to a small pavilion close by and began to dance as we had the night before.

The administrator and his family, the French officials and their wives all joined in the fun. It grew late, but I was loath to go back to the ship, for this would be my last land for twenty-five days. Suddenly the Coleman lantern disappeared, we said farewell to our hosts, and returned to the ship.

So the day ended.
“Russell, what were you doing on the ship at Nukuhiva while I was up on the ridge?” I asked.
“Making a reverse seismic refraction profile of a shelf running along the south side of Nukuhiva about one to two miles from shore.” This was a typical answer from my husband, short and to the point. It is like pulling teeth to extract information from this friendly guy anyway, but with patience it can be done. He likes to state facts in the shortest possible manner.
“I think, I believe, it seems likely,” usually prefaces Russ’s conclusions on any matter. He had gone into the world of geophysics with a doctor’s degree in physics, and this previous training had given him a definite slant towards all geological problems.
He was interested in facts, data that could be proved to be true. It was a shock to me to find that this man, whom I thought I knew a little, had facets to his character I had never suspected. He was not a stickler for detail about his possessions around home, yet his work aboard ship showed great efficiency and attention to detail. I’d known he was conscientious, kind, and possessed of a sense of humor everyone loves, but I’d not been prepared for this anxious,
tense man on the days when his seismic runs were on the schedule, nor for the careful, precise man in the lab.

“So many things can go wrong,” he would say. Pessimist that he was, he probably lived each day of the seismic survey with the belief that his hydrophones or oscilloscope would foul up completely. They never did, and all minor damages were always instantly repaired, but from the time of the first shot to the last, he was tense, abstracted. He hated to ever stop while there was yet a record to take.

How different from the relaxed man I knew, who came home with a smile and saw the humorous side to most situations. Always considerate of others, bending over backwards rather than offend another, Russ was placed in a difficult position by reason of my being aboard.

But back to Nukuhiva. Why had he run a seismic survey on the shelf of this island? “I’ve done seismic studies on atolls in the Marshall Islands and elsewhere,” he continued. “Our results have indicated that buried beneath the calcareous material is a volcanic core.”

“Yes. An atoll is an old buried island under a deep blanket of coral,” I recited. “But Nukuhiva isn’t an atoll.”

“No, perhaps only an atoll in its youth,” said Russ. “But it gives us the chance to do a seismic survey of known volcanic material, so we can compare the velocities with those we find where we suspect there is volcanic rock.”

“And the results?”

“Four kilometers per second—the same velocity. This gives good circumstantial evidence that the layer of rock deep beneath the coral of the atolls is volcanic.”

“Where else have you done this?”

“I’ve had this opportunity twice before, in Hawaii and off the coast of Mexico.”

He was also investigating the thickness of the sediments at Nukuhiva and the topography of the shelf. I knew that
in the Marshall Island atolls he reported that we could expect to find the volcanic rock 4,000 feet below. And now we have more than circumstantial evidence of this fact. For even I could remember the excitement of the day just a few months ago when news came to Scripps that the deep hole they were drilling in the Marshall Islands had finally broken through the solidified coral and hit the volcanic rock at 4,610 feet.

Harry Ladd, the geologist who had explored Falcon Island years ago, had been instrumental in getting a deep hole drilled in an atoll island, Elugelab Island on Eniwetok. It was the deepest hole ever drilled to date in an atoll, 4,630 feet deep.

I can understand that if coral, which can only grow near the surface, is found thousands of feet beneath a coral atoll, then this coral must have been at the surface at some time, and the atoll has subsided.

It is interesting that Darwin proposed the theory and in 1881 wrote Alexander Agassiz, one of the first American oceanographers, saying, "I wish some doubly rich millionaire would take it into his head to have borings made in some of the Pacific and Indian atolls, and bring home cores for slicing from a depth of 400 to 600 feet."

Agassiz disagreed with Darwin’s theory, however. He called Darwin an armchair scientist, who had seen only one or two atolls. He said:

"As for Darwin, he only sailed through and never stopped at all.” This crusty, energetic explorer Agassiz went about in his ship scoffing at Darwin and his theory of atoll formation. He studied atoll after atoll and wrote: “It is really absurd that Darwin and Dana should have written such a lot of nonsense, all evolved from their own brains or reading what others have said or done.”

Neither Agassiz nor Darwin is alive today to hear how
geologists in the United States had drilled a hole at Eniwetok, not 600 feet as Darwin suggested, but 4,630 feet deep. Here reef coral skeletons were found deep down in the atoll, proving for all time that Darwin’s theory of subsidence is true, at least for the Marshall Island atolls.

One more piece of the puzzle has been fitted together, but now comes the question: how does the earth subside?

Roger tells me about finding great numbers of flat-topped guyots in the central Pacific, all under the sea, seamounts which must have at one time been above the surface and have been planed off by surface waves. These must have subsided or perhaps the sea level changed in respect to the seamounts. He said:

“On our Mid-Pacific Expedition, shallow-water reef coral and molluscs were dredged up from the flat-topped peaks, now at depths of 5,000 to 6,000 feet. Ed Hamilton has shown that these fossils are cretaceous, that is, they lived about a hundred million years ago during the age of dinosaurs.

“On some seamounts, where the environment was more favorable for coral growth, coral built upward at the same rate as the seamounts subsided, and these became coral atolls. On others, the coral either could not get started or failed to keep up with the subsidence, and these became flat-topped seamounts.”

This question interests all. There must have been a change in the conditions of the sea in this large Pacific basin. Did the land subside or the ocean rise or both?

Tuesday, January 27

“Mud! Mud! Mud! Mud! Calcareous sediments—God bless ’em.” So I scrawled in my notebook, in which I’ve been taking dictation on the “Study of Coral Reefs.”
It seems that “this absence of large coral reefs in the Marquesas has puzzled geologists and biologists for more than one hundred years.” Why are large coral reefs absent in an area that appears superficially to be favorable to their existence? The living reef corals are present here only in small fringing reefs around the margins of some of the small bays which indent the islands. Yet the water temperature is above 78 degrees even in the coldest months of the year, and warm enough for coral growth.

Roger reached into the pocket of his shorts, rust-stained and grease-smudged after a day on the fantail, and extracted a cigarette. His reaching for a cigarette was involuntary, and apparently his mind was still pondering the words he was dictating.

“Dana suggested that it might be due to rapid subsidence. Agassiz’s explanation is that there are apparently no great platforms of erosion around the islands on which reefs grow…. Others think that sometimes the water gets too cold for corals to live.

“Our soundings around Ua Huka, Hiva Oa, and off Nukuhiva show that neither Dana’s hypothesis of rapid subsidence nor Agassiz’s supposed absence of a broad shelf can be invoked. The island shelf around these islands is everywhere more than a mile wide, in places more than two miles. The seismic velocities show a thin layer of sediment but it is a semi-consolidated sediment, which could mean that there might have been a coral reef about this island when the ocean was lower.

“Then why isn’t the coral growing on the Marquesas now? More facts are needed to solve this puzzle, which two days in this area cannot give.

“Perhaps the amount of debris washed out from shore may have been so great that reef corals could not establish
themselves on the shifting floor of sediments in transit across the shelf, and could not live in the relatively turbid waters from which fine-grained particles were continually settling. With the rise in sea level at the close of the ice age the shelf became too deep for reef coral growth except right at the shore, where continuing marine erosion of the highest cliffs prevented their establishing themselves. Also we cannot rule out the possibility of sudden chilling of water by upwelling, brought about by changes in the trade winds.”

I scrawled on as the words came, but tonight somehow the sky was too beautiful, a brilliant red. We were sitting on the rusty bucket seat where a few hours earlier Ted Folsom had been letting down Nansen bottles. We were interrupted by a call.

“Someone on the Horizon wants Revelle.” Roger left to go to the lab and talk to our other ship. When he returned his chain of thought was broken.

“Let’s take a vacation,” he said.

“All right. Let’s write about Polynesia,” I suggested. After leaving the Marquesas we had been involved in many deep discussion on matters pertaining to the South Seas. Now that we could no longer visit another island our thoughts were dwelling more on the ones that we had seen.

“I’d like to do that,” he said. He stood up and began pacing back and forth on the deck. Light spray from the ship’s wash splashed across my bare legs. It felt cool and pleasant.

Roger was deep in thought, his eyes looking out at the sea yet seeing nothing. How could any man pull out of his mind the long and well-composed sentences that somehow came forth? He turned towards me.

“All right. Let’s begin. Notes on Polynesia.”

“Most Americans have a dream of escape with which
they solace life’s more difficult moments. This dream in a sense is part of our racial inheritance because it began at least two hundred years ago when far-wandering sailors returned from voyages to the islands of the Great South Sea.

“Perhaps our Anglo-Saxon ancestors ignored as Latin extravagance the tales told by the Spaniards and Portuguese who first visited these islands. But when such stolid Englishmen as Captain James Cook and his shipmates, including the eminent fellow of the Royal Society, Sir Joshua Banks, returned with glowing descriptions of an earthly paradise, where men lived like lilies of the field toiling not nor spinning and women were both lovely and loving—they captured the imagination of our eighteenth-century ancestors. The dream was nourished by the tales of Yankee whalers, by Herman Melville with his wonderful stories of the Marquesas, by the Frenchman Pierre Loti with his romances of Tahiti. With these came the true stories; the history of the Bounty Mutineers, who risked and lost their lives for a few months of paradise, the happy story of Robert Louis Stevenson’s life in Samoa, the somber last years of Gauguin which produced such glowing and mystical paintings. All these deepened the dream.

“The very existence of Polynesia, so far away and yet on the same earth, has profoundly influenced us all. Because of it we have known that life does not need to be complex and hurried, that economic man is not necessarily all men, that men can live happily in simplicity and beauty and innocence. Perhaps the tales of the South Pacific have done as much as any single thing to destroy our fathers’ belief in man’s original sin, sin that can be redeemed only through mortification of the flesh and spirit.

“It is our common human experience that anticipation is
better than reality; those things we look forward to the most turn dustiest in the mouth when actually tasted.

“Not so Polynesia!
“’To a temporary visitor these seem in very truth to be islands of the blest—overflowing with beauty that appeals to every sense, inhabited by happy people in harmony with themselves and their environment, so far removed from the perpetual crises of our western world that the visitor ceases to believe these crises exist, and even loses his consciousness of time itself.”

Our dictation was again interrupted.

“Revelle, Bridge wants to know the next station.”

Why do we write about coral reefs?

Thursday, January 29

Another seismic station with everything going up and down that can. But my log for today had an entry not in the other logs:

“The seismic run was interrupted from 1243 to 1318 while a shorted hydrophone was taken in. At 1236 to 1238 the hydrophone was attacked by a shark. At 1238 the hydrophones were observed to be very noisy and the middle hydrophone was found to be shorted to ground in the cable. Shortly hereafter a large shark was seen cruising back and forth near the hydrophone spread. On pulling the middle hydrophone aboard, large gashes were found in the cable at the position where the six-pound sash weights are tied. They are at a depth of 200 feet. The sharks were observed a few minutes afterwards. Sharks were sighted later, and crew members fished for them somewhat unsuccessfully during the afternoon. Bob Livingston swam out to observe the other hydrophones.”
Saturday, January 31

It is midnight and we have come upon another seamount. I suggested the name Midnight Seamount. I read much later in the International Hydrographic Review that geographical names should be given wherever possible for the major features and only where there is no suitable geographical name should a personal or ship’s name be used for a feature. It also suggested that to encourage ships’ captains, personal or ships’ names could be given to a few of the deepest soundings.

And to think I flippantly treated these new seamounts to such titles as Disappointment and Midnight. Anyway my log says: “Midnight Seamount proved to be located on the edge of a 200-fathom escarpment rising from 2,100 fathoms to 1,900 fathoms, which probably marks the boundary of the Albatross Plateau.”

For five days we have been heading east by south over an empty blue sea hunting for the Albatross Plateau, a large, comparatively shallow area which some scientists believe may be more of a continental structure than oceanic.

Sunday, February 1

Today I have the impulse to hide from one and all, but this isn’t easy. One can’t disappear on a boat. I’m just a different breed, a different kind, and very much in the minority, and it isn’t all it’s cracked up to be. I can sympathize with Spencer, who never sees another dog. I never see another woman. I’m one of a kind in a world that belongs to men, and I’m not a man.

Perhaps my position would be comparable to that of one brown Polynesian in a world of whites. Our ship’s complement could not have been nicer to me. I on my part have
tried to carry out my function on the ship, to type what they want typed, record the mud they want recorded, and listen if they wish to talk. I have tried to stay only in the parts of the ship where I had jobs to do and to stay out of the way of the crew whenever possible.

But in spite of it all, it is lonely, in a way none of them understands, this loneliness for one’s own kind. There are so many funny little intimate things that one woman could say to another.

And the rivalries, the animosities that exist between the sexes. I have to take full brunt, full burden for all my sex on this score. I have no one with whom to share the onus:

“Women, those stupid creatures. We can’t live with them. We can’t live without them.”

There are times at sea when a woman is much in the way, when men want to talk man and when they don’t wish the responsibility for this extra, weaker human aboard in the moments of danger and crisis. I’m an intruder in their world, and occasionally I feel I want to hide.

Perhaps I can’t make this clear. I listened to the partly bored European women exiled for a number of years on these islands:

“Don’t tell me you are the only woman on board the ship with all those men. You lucky person.” Of course they meant it. And I said that I liked these men with whom I traveled.

“But they make me work like a man,” I would always remind them. “Our life is rugged at sea, and we don’t spend many days in ports where I can be a lady.”

Yes, I know I am lucky. I hate to have the men on the ship remind me of this, however, for they can’t understand, and I don’t try to make them understand, what Spencer and I have in common, the dog and the woman on the ship. When Spencer isn’t wanted, they can lock him up.
21. SIGHT! SURFACE!

Monday, February 2

Some men go fishing, but oceanographers go coring. Scientists look at the bottom of the ocean on their echo sounder as fishermen peer into the sea, wondering “Shall we drop a line here?”

The fisherman decides from his knowledge of the sea below, the sky above, and Lady Luck where he will find his school of fish today. The oceanographer looks at charts and at thousands and thousands of miles of ocean, which to him is an unmapped landscape, and chooses the spot where the mud is to give him hundreds of thousands of years of geologic history.

And as a catch of fish means success to the fisherman, so on this geological and geophysical expedition big cores and a lot of them make a successful venture.

We are now headed towards an area of the ocean which may prove to be a happy hunting ground of sediments. Bad luck can’t sail with us forever, corewise, as it did back in the Tonga Trench. The men hauled in long cores in the Fiji basin before I came aboard, but until two days ago I had never seen a piston core filled with thousands of years’ deposit of mud.
And now today we tried once again, when our 28-foot core barrel went below. Perhaps this time the ocean would generously share her secrets with these insatiably curious mortals.

We are stopped on Point Sugar, which, like most of our other stations, was a long-discussed compromise. Many hours had been spent over the chart and many messages exchanged with the Horizon as to the selection of the location: 14° 17' S and 119° 8' W, a spot I would describe as well on our way to “No Man’s Land.” No oceanographer would call it this, but we’re headed toward a great expanse of open ocean, the largest in the world. Perhaps nothing has disturbed the sediments here, ever.

At 0600, an early hour, the coring crew sent overside a large gravity core on the hydrographic winch. This gave us a sampling of the bottom, 11,160 feet below. When brought aboard, the core was fouled up. Evidently the whole assembly had been on the bottom and perhaps dragged. Anyway, we had no sample.

The corer was sent over a second time and 106 centimeters of yellowish-brown foraminiferal ooze was brought aboard. It looked like mud to me. The geologists were hopeful that this was another day to try for a long core.

A gravity core is relatively light and small. The barrel is about six feet long, and it carries between 40 and 150 pounds of weight with which to force itself into the bottom. Most important, these lightweight corers can be used from our relatively high-speed hydrographic winch. In 12,000 feet of water we can get the coring tube to the bottom and back in about 45 minutes to an hour.

Our piston corers (or Kullenberg corers, after their Swedish inventor), on the other hand, have barrels of 28 feet and longer, and carry upwards of 800 pounds of
weight. This is an operation of a different magnitude. The equipment is heavy, big, and in rough weather, on a rolling ship, it can be dangerous as well. This heavy equipment can be handled only from our big, new, and oh-so-temperamental dredging winch. Our big winch can handle loads of about 40,000 pounds, but it reels in the wire very slowly. In 12,000 feet it will take three to four hours for the coring tube to reach the bottom and return.

The routine aboard the *Baird* has been to first try a gravity core. Depending upon its results and the time available, we secondly lower a piston core.

Today Russ and his seismic crew were busy receiving shots on their hydrophones from the *Horizon*, over 50 miles away. The rest of us were gathered near the fantail to watch the big core go overside. The coring crew—Art Maxwell, Phil Jackson wearing his usual bath towel, and Dick Blumberg—were on the stern ready for orders. Everyone’s safety in this operation depended on that young man Bob Dill, who calls the moves.

The engineering crew with Buddy and Obie at the winch controls stood waiting for the day’s operations, and down in the after hold where the big drum houses the cable, all was ready to release the wire over the stern. An engineer was on watch there. The corer was laid out on the deck with the nose at the stern—28 feet of 2½-inch diameter orange-colored pipe. At the forward end of the core barrel is a release mechanism and an arm extending at right angles out from the barrel. From the arm dangles another smaller coring tube, a 6-foot Phleger corer. It is this coring tube that hits the bottom first, trips the release mechanism, and allows the long barrel and weights to come sliding by the wire-held piston and down deep into the sediments.

When everything was rigged, Bob Dill signaled to Obie,
holding up his right hand and moving his forefinger round and round, indicating “Take her up.” The whole coring apparatus slid over the stern with the retaining lines preventing it from swinging too wildly as it hung from the A-frame. So far so good. Now the doughnutlike weights had to be added. They help to drive the coring tube into the ocean floor.

The weights were added one by one until 845 pounds had been piled on. The safety catch on the tripping arm was removed, and the whole heavy apparatus was lowered beneath the surface.

But all was not in readiness for the long trip to the bottom yet. The sheave over which the cable passes was lowered from the top of the A-frame to a safer position near deck level by the cargo winch on the boat deck. Then the responsibility for lowering the core was turned over to Buddy, winch operator.

“It’s all yours,” said Bob Dill, and we heard the horrible grinding of gears and rattling of wire as the cable began to unwind slowly at first and then faster at the rate of 100 feet a minute. We went about our business now, supposedly unconcerned, yet with a secret ear to the clatter of the winch.

While the huge drum was noisily releasing the cable, all members of the expedition were ordered off the after deck. If anything should snap, someone could be badly injured or even killed. As the core went down, the number of meters of wire let out was being recorded at the winch-control box. The oceanographers know the depth from their echo sounder. After two hours or so it was near the bottom, and we heard the question “Did the ball breaker break?” We noticed one of the coring crew standing on the boat deck, his ear glued to a loudspeaker. He was waiting
for a signal deep down in the ocean which told him the corer had struck bottom, over several miles below.

This ball breaker is a tricky device, fashioned by John Isaacs and Art Maxwell at Scripps. It is simply a pointed steel plunger and a small (about two-and-a-half-inch diameter) glass ball. When the ball breaker hits bottom, the plunger is released and the glass ball broken. The resulting noise of the “implosion” is picked up at the surface on the echo-sounder hydrophone and heard audibly over a loudspeaker. Like much other oceanographic equipment, it doesn’t always work.

Today our fathometer read 1,900 fathoms. When the winch control box showed that 3,591 meters of wire were payed out, we heard Art Maxwell shout, “There she goes.” The gears stopped grinding for the moment. The core had hit bottom.

Here the fisherman is different from the oceanographer. His big moment comes, he has hooked his fish, feels the great tug and starts reeling in the line. His catch is on the hook! Not so the oceanographer. He gives the signal to pull in the core and must wait through two and a half hours of anxious moments while the big winch steadily pulls the core back up, not knowing what will be the result when it comes overside. Will it be empty, mangled, its nose bent, as when we tried to core in the hard volcanic bottom of the Tonga Trench, or will it come up loaded with thousands of years of geologic history?

Obie and Buddy from the control box kept Bob Dill informed of the progress of the core as it was hauled upward. When it neared the surface, Bob stood on the stern platform, peering anxiously below.

“All right!” Bob called out when the instrument had nearly reached the surface. Then the shout, “Surface!” All were
assembled to watch the core crew bring the corer over the stern. Anxiety was on all faces, expressions of doubt and concern. One man crossed his fingers, two others made a bet.

The engineering crew were somehow all assembled at the winch control on the boat deck and were looking down with questioning smiles to see if the men below had made a catch.

When the topmost gear was a few meters out of water, we heard Dill’s order, “Raise the topping lift.”

The sheave was hoisted aloft. Then the ball breaker and Phleger corer, a six-foot yellow-colored cylindrical tube attached to the trigger mechanism, were removed from the cable. The Phleger core was handed to Gustaf. We watched his hurried motions as he replaced the core nose and core catcher at the end of the yellow tube with a rubber stopper. But we couldn’t see inside. Mud or water? Which was it? Probably both. The long inner plastic tube was ready to be pulled out of its protecting case. Henri pulled and tugged the plastic tube upward as Gus held the core barrel. First we see water in the upper section and then mud, good brown mud. All were smiling. At least this small core penetrated bottom. There was hope for the long core.

But now the long orange pipe must be brought aboard and laid on the wooden horses ready for it. The winch pulled the weight stand up clear of the water and close to the deck. It was lashed to the A-frame uprights and the heavy weights taken off, just as one would lift weights from off a steel baby scale, but these weigh 65 pounds apiece.

The winch lifted the corer to a convenient height, a rope was tied to the weight stand, and the core was pulled dizzily onto the deck.

At this point we gathered on the fantail to see the results.
The core nose and core catcher were taken off the big pipe. The geologists immediately examined the mud, felt it fondly, tasted it, and smelled it. They next peered into the steel core barrel, tapped it, trying to estimate how full it was. The opposite end was opened.

“Helen, run and get the bucket,” they said. And I put the bucket down to catch what water might run out of the barrel. If it is only water that runs out, it’s a sad day. No core. Every eye was on the water. We saw this time only a trickle. Lucky ship. We had a core at last, a long, long core, too. The good news was bandied about. It was 28 feet long.

“What does this represent in geologic time?” I asked.

“Perhaps 500,000 years,” said Roger. We were joyful.

“We’re running in luck,” thought the engineering crew. “Sheer luck.”

We hadn’t been lucky just three days previously. After that long afternoon of trouble I had been too discouraged to even write in this log that night. It had been on Point Queen, a day that started like other seismic station days, but with a different ending.

This time the Kullenberg corer had gone overside as today with a 15-foot barrel rigged for a 6-foot free fall. Just after lunch we had heard the clanking noise cease, and the wire stopped moving on its way up. What had happened?

Trouble again. Great coils of heavy steel cable were hopelessly bent into nasty kinks. The men had attempted to increase the speed of hauling in, and in this effort the storage-drum hydraulic system failed. About 20 meters of slack developed between the winding drum and the storage drum. Result—bad kinks! And we had 13,000 feet of wire out. This could not be sacrificed, cut off, and left in the
A come-along, a clamp used to hold the wire from being pulled overside, was immediately rigged aft of the winding drums, and the slack taken up. It was decided to splice the cable while the wire was overside. I knew our cable had been spliced in port, and once before on shipboard. But I was most curious to see how this difficult job would be accomplished, how the heavy, thick cable could be cut in two and then wound back together so that it was one smooth wire again, and all on a rolling ship with 2 1/2 miles of cable stretched down into the sea.

A second come-along was rigged just forward of the A-frame sheave. Then about 200 feet of wire was paid out on the deck. The cable was cut and the kinked middle section was removed, thrown into the sea, and the long, 120-foot splice begun.

My only knowledge of splicing was gained from a study of knot books and instruction from a sailmaker, so I was fascinated by this operation and wished to help. All the scientific crew were put in teams to help Brownie, the one man aboard with the know-how.

The six outer strands were untwisted from each end, a distance of sixty feet. The ends of the inner strands, or core, were butted together. Then one strand was unlaid a further distance of sixty feet and the corresponding strand from the other part of the cable was wound in its groove and "tucked in" between the remaining strands with a steel marlinspike. A strand was unlaid from the other part and replaced in the same manner with a strand from the first part. This process was repeated until three strands from each side had been wound on and tucked in, making six tucks in all. Each tuck had to be smooth, with no jagged
wires sticking out to cut a sailor’s hand or catch on a sheave. Making a proper tuck is a most difficult process with stiff wire such as our cable.

It was interesting to see our doctor’s nimble fingers following Brownie’s directions. In fact, I learned about the manual dexterity or lack of it in a number of our scientific staff on this one job. A theoretical oceanographer could not unwind wire with much skill. Roger and Walter were not very skillful compared to Bob and Willard.

It was dark before the operation was completed. It had taken only six hours. The come-alongs were removed, and the core brought on deck by midnight. It was a good long core.

I thought of my watch partner Bob Dill, the man responsible for this difficult and dangerous phase of the work; he had been at it steadily since five-thirty that morning. He must be tired. And I thought of Bob’s energy on land.

If one asked the natives of the islands visited by our two ships what they remember about Capricorn, it would not be the fact that a great number of our men were over six feet tall or that they were always asking questions.

It would be the little man with the red hat, Bob Dill. Why should they remember him? Because he could dance as none of us could. He would throw himself into the frenzy of a Samoan siva, a Tahitian or Marquesan hula with all the spirit and gusto of the natives themselves. Invariably they were convulsed with laughter as they watched him dance. He made records of their music, he talked and danced with them in every port, and they loved him always.

Yet this same young man who looked like a boy (many natives asked me his age) had a cool nerve and sure mechanical skill. When dangerous operations were in progress, he was entrusted with the safety of all.
WE ARE out in the deep Pacific, hunting for the Albatross Plateau below the sea. Day after day we continue on our eastward course, watching our echo-sounder records with a wary eye, looking for a rise in the ocean bottom.

Roger and Walter are working on a shipboard scientific report of the expedition. They say, “One of the subcontinental areas lies west of Tonga. The Fiji Islands are a bump on its surface. We are now heading towards the Albatross Plateau.

“The islands on these subcontinental areas contain large amounts of a rock called andesite. In the deep central Pacific basin, on the contrary, the island rocks are nearly entirely basalt.”

The islands in the Eastern Pacific are very sparse, and therefore the delineation of the andesite line in the east is much less definite. There are andesitic rocks on Easter Island, but the rocks are basaltic on Pitcairn Island. Within the vast region between these islands there is nothing similar to the Tonga Trench which would help to indicate the position of the andesite line. However, it appears reasonable that if a continental-type structure lies beneath the sea
floor anywhere within this region, it would be the Albatross Plateau. This is a broad, ill-defined, uplifted region 1,600 to 1,800 fathoms deep, lying north of Easter Island. Some oceanographers call it the Easter Island Rise.

Day after day we were now going towards this “broad, ill-defined, uplifted region.”

On February 1 we found Midnight Seamount with a summit at 1,600 fathoms, located on the edge of a 200-fathom scarp rising from 2,100 fathoms to 1,900 fathoms. This scarp might mark the boundary of the plateau. On February 2 came Point Sugar. By February 4 we were on Point Tare, and a bathymetric chart made by Bob Dill suggested that we were up on the Albatross Plateau if there were one, and had been since February 1.

Now tonight, February 5, just at midnight, we came across another seamount which is to be named for me, Helen Seamount. They began the survey of this seamount which I will never see. Its summit is 796 fathoms below the surface, far out on that great, unknown, ill-defined region at 14° 57’ S and 113° 09’ W.
23. ALONE ON THIS DESERT OF OCEAN

Friday, February 6

We are lost in a great ocean, not lost geographically, for there are always the charts and the star fixes, but lost figuratively speaking, we have been so many days in the South Seas. To commemorate this night I've sent out a drift bottle, a small little brown bottle with a message inside asking the finder to write me. I doubt if it will ever be discovered, so isolated from land, ships, and man are we.

The mood of our ship tonight, whether many of us realize it or not, is best expressed by Roger and Bob Livingston in their radio message home. They say:

"We will soon cross the track of Kon-tiki, the raft of Heyerdahl. As far as we know, Horizon and Baird are alone on this great desert of ocean, and we have somewhat the feeling of travelers on a space ship in which the beginning has been almost forgotten, and the end is hard to believe in."

"I don't care whether I ever get home," is the subconscious theme that comes to me. I am not unique in this feeling; others share it, though they may not admit it. I
would not even pose the question. But why should I, a woman dominated by emotions and ties of home and my children, be so lost?

Is it the isolation of our ships, 2,000 miles west of Peru and more than a thousand miles east of the Marquesas? Our nearest land is Easter Island, far to the South.

Or is it the subtle effect of nearly three months in Polynesia? All of us talk constantly about the islands, the people we met, what we find in books. Replaying our recordings of the songs we have heard in the islands brings recollections of the simple, loving, freely-giving people we have met. The music reminds us of the strong fragrance of flowers, the clean, rhythmic bodies of the women, and the magic of the island night. We all possess a happy-go-lucky feeling of living for the moment, with no past and no future. I do not want to leave this world in which only the present is real.

And yet I, of those aboard, can still remember the emotions of the wives waiting at home for the ship’s return. I can’t forget how agonizing the last two or three weeks become to those on shore, the feverish activity that seems important at the time to get everything ready for his return, the new plants in the garden, new paint on the walls, a car Simonized, all the little things wives think to do when husbands are away—a new dress to wear he arrives.

I can remember rising at five-thirty every morning (an unheard-of act for me) on the last week before Russ’s arrival from Mid-Pacific Expedition, and painting the garage in the early morning. The last week is always the longest and the hardest. A woman alone in a house without a man is wasted. One reason for her existence has flown out the door.
But this time I won’t be waiting at the dock. I have learned what it would have been best for me never to know—how completely we lose for a time those that go adventuring—for *I* am lost.
24. EXTRUDER EXTRAORDINARY

Saturday, February 7

Just when I think I’ve seen everything that can happen on our oceanographic ship, I find something new being tried. Bob Livingston came to me, thrust a paper in my hand and said:

“Will you take records of this experiment for me?”

And I discovered that he was going to be a human hydrophone, going to go down with his aqualung and listen for the explosion from the Horizon which Russ was recording in the lab.

This was all fine, but at this point the ship was more or less a three-ring circus. The crew on the deck were putting over the big corer, the gang in the lab were recording explosions every three minutes, some of us were rushing about getting ready a transfer of supplies and men to the Horizon when she came alongside us at noon.

Bob looked about to find one diver or swimmer to go down with him and got Willie Sawday, the mess boy and an excellent swimmer.

I had the record sheet and stood with watch in hand. A
long rope was thrown into the water. We conferred on signals. Willie was to stay on the surface with his face mask and observe Bob under water. After each shot Bob planned to put his hands over his head to signal that he was all right. If for any reason he didn’t signal, Willie was to dive down and bring him up immediately.

Bob was interested in learning the effect of explosives in the water on the human body and had chosen this moment when the explosions were close to the ship.

The shots and announcements came over the radio. Standing on deck I listened.

“‘The fuse is lit,’” I shouted overside to Bob in the water. Down he dove. Meanwhile I could hear: “Fifteen seconds, ten seconds, five seconds. Mark!” And then 45 seconds later in the lab we’d hear the explosion. I signaled at the deck and Willie watched Bob through his face mask. In five minutes he surfaced.

“I got that one,” he said, and then dictated notes to me rapidly.

We repeated this every three minutes, with the *Horizon* coming closer and closer. Soon Bob reported hearing not only the shot but also the bottom echo. Then the *Horizon* was nearly upon us and still shooting. We were wondering how the close shot would affect our diver. He surfaced and said:

“That time I felt it in the chest.” Fortunately the shooting stopped at that point.

*Sunday, February 8*

It is two o’clock in the morning, and Bob Dill and I are on watch, responsible for the lab and writing into the sounding log every ten minutes. I have just finished a long and
busy evening as core extruder. Not every woman can be an extruder. I am quite proud of my function on this ship, “extruder extraordinary.”

It all happened one day when they were shorthanded. The coring crew had been busy since five in the morning; at five o’clock in the afternoon they were slightly weary. Also we had been running in luck, getting long 28-foot cores for a number of days in a row. Now tonight we had another. The thousands of years of mud were all in the pipe but must be recorded and preserved for study. This was no simple process. It took us another eight hours or more before the job could be called finished.

The ocean bottom was proving to be all these geologists had hoped for. We were in an area where the sediment collects very slowly on the bottom of the sea. Mostly it is made up of skeletons, or remains of those plankton that grow hard shells. We find meteoric dust, sharks’ teeth, and material floated down by past glaciers. Also there is material such as iron oxide, which is precipitated out of the sea water.

But we are so far from land and the outflow of rivers that here the material accumulates very slowly. This is why Gus likes the Mid-Pacific. In some parts of the central Pacific the sediment is laid down at about one inch in 5,000 years.

Thus we are able to get a past history of our world by carefully studying the sediments at the bottom of the ocean, noting particularly the changes with depth. If we can identify the fossils, we can tell about how long ago any given layer of sediment was laid down. Then by noting the changes in the core from layer to layer, we can identify times and areas of past active volcanism, extent of past glaciers, and changes in climatic conditions.
We’ve been fortunate to take long cores, temperature records as well, in this area of the Albatross Plateau. But I’ve discovered that it is foolish to ask these men what they’re finding out about this little-known desert of ocean. Some years after we get home, I may learn a little about what they found out here.

But now tonight I was made core-extruder, and I’ve learned how Gustaf preserves his cores for study. The core is in the long, orange-colored pipe, laid out on deck.

“Let’s extrude,” says Gustaf. He collects thirteen aluminum trays from their shelves and lays out a sheet of acetate on each. These trays are designed to hold 70 cm of core (about 2 1/3 feet). We take the first tray and go out to the pipe reposing on the wooden horses across the center of the fantail. We hold the tray in front of the open pipe at one end, while Roger and Henri begin to operate the crank at the other end. Slowly a long cylinder of wet mud is pushed onto the tray.

Gustaf hands me a piece of wire and says “Will you cut this when I say ‘when’?” The mud is still being pushed onto the tray. It is cracking in some places but holds its circular shape beautifully.

“Stop!” calls Gustaf when 70 cm have been pushed through—“When.” I cut off the core with the wire. “Wait one,” he calls to Roger and Henri, and we carry the aluminum tray with its cylinder of wet mud into the lab. I now become wrapper and record-taker as well. When I saw the first long core come aboard, I wondered how they would ever record those million years of history. I know now. I can do it in my sleep.

We stand beside the wooden board on the icebox. Gustaf has the metal tray with the core on it in front of him and all his tools beside him. I take his notebook, open it to
pages especially ruled for this purpose, and await his dictation.

“No. 1 Cap 43 BP 70 cm,” he says. I write this down. Meanwhile he quietly and tenderly scrapes the core with a knife and gazes at it in his loving, curious Swedish fashion. In his eyes he is seeing the oldest sediments of the sequence.

“Brownish-gray calcareous ooze,” he dictates. “Then from 47 cm to 58 cm write somewhat darker.” I do this on the sheet in front of me. “A fracture at 17 and an oblique fracture...”
at 64.” I make the lines indicating these fractures at the proper places. “Sample removed at 69 cm.” Gustaf cuts away 1 cm and places this in a sealed bottle which I label. This is for immediate examination.

All this concluded, we wrap the core in acetate after putting plastic discs on the ends, then label it with a grease pen 1 Cap 43 BP ← Up and move it to a position of prominence on the chart table.

A new fresh piece of acetate goes on the next tray, and we go out to the long barrel and ask the extruding team to extrude some more. They crank, Gustaf holds the tray, I cut, we record, and wrap. This goes on for hours until the entire 850 centimeters of mud have been studied, recorded, and wrapped.

But we are still not finished. The thirteen core sections must be rewrapped and relabeled again in brown wrapping paper and put inside waxed cardboard mailing tubes which are also labeled. These mailing tubes must then be taken to the galley and dropped in a bath of hot liquid wax and sealed tightly, rewrapped a final time, labeled again and stored carefully to go back to Scripps Institution for study. They do not wish the cores to dry out, but wish to preserve them in a moist state.

The waxing process, which takes place late at night in the galley, is the most tedious part of the job. Gustaf, with his infinite patience and attention to detail, fills the tops of the tubes with paper, pours a small amount of hot wax into the end, allows it to seal, pours more, and then finally inverts the tube and repeats the process. It is quite different from putting paraffin on a jar at home in a kitchen. Here our problem is to seal this long tube, of which neither end is closed and there are about two inches on each end to be filled. Imagine the difficulties of working on rolling ship
and seeing the hot wax slop over as the ship heels to one side.

Finally the whole tube is immersed in the hot wax bath, in a long rectangular container on the galley stove. But we mustn’t spill any wax in Kenny’s clean galley. The first rule of a ship is to keep the cook happy!

One sweltering night when Gustaf was out of commission from a hand burn, some others of us, not as experienced, attempted to wax the cores, using his technique. By the end of the evening we had wax on the galley floor, on the walls, on the stove, all over our hands, and, incidentally, in my hair. I had leaned over a tube at the wrong moment and the wax landed on my head as well as in the tube.

I hear they have better methods of core preservation on Scripps expeditions now.

This hard, tedious work was all part of learning about the world beneath the ocean. I came to have great respect for this quiet, kind, courteous Gustaf. The ship called him Gus, but the name did not fit him at all, and he confessed that he had never been called by this nickname in Sweden.

He was a young Scandinavian, tall (over six foot), blond, with blue eyes and a friendly smile. We asked him many times about the Swedish Deep Sea Expedition on the Albatross, which had circumnavigated the globe. He had published his Ph.D dissertation on the “Sediment Cores from the East Equatorial Pacific.” Now he had come to Scripps Institution of Oceanography to continue his studies of the Pacific sediments.

“Why are these sediments more interesting to you than sediments from other oceans?” I asked.

“Because of the large size of the open part of this ocean, which gives more clean-cut oceanic conditions than any-where else.” I thought of the size of this great Pacific Ocean,
larger than all the area of the land, and how we were certainly far from land, surrounded completely by ocean. Gustaf should be happy.

As we worked the long hours of the night, I began to ask Gustaf what was the significance of these cores. This is what he told me:

“In our cores taken in the area between the Marshall Islands and Tonga, the sediments were very much influenced by recent volcanism, the islands, and the peculiar topography of the bottom. We found volcanic glass and crystal fragments that had been ejected from submarine volcanoes in some of these cores, and also crystals growing from the decaying volcanic matter.”

“Like the phillipsite you showed me under the microscope?”

“Yes. And the cores raised between Samoa and the Easter Island Rise (Albatross Plateau) show this to be a region of very low rate of deposition, very well suited for the study of minerals forming and growing on the sea floor. Remember how we described many of these cores there as chocolate brown in color?”

“And now—” (His face lit up. I saw Gustaf had arrived at his favorite part of the world; he called it the East Pacific Eupelagic area. We had left the Albatross Plateau and were in another part of this desert of ocean.)

“In words of one syllable, what do the cores here tell us, Gustaf?”

“Many facts, after sufficient study. For instance they give us our past oceanic ‘climate.’ We know that once the ocean was warmer at a time when mammals were evolving on the earth. The deep-sea water has gotten cold recently. Twenty million years ago it was 54° F., not 34° as it is now.

“Then these cores tell us of the fertility of the sea, when in the past there have been many little animals and when
not so many. In these cores are the calcareous or siliceous skeletons of small animals and plants that live as plankton on the surface layers of the sea, chiefly diatoms, calcareous algae, foraminifera and radiolaria.

The fossils in the cores tell us about the changes in oceanic circulation and we know something about the surface water during the various advances and retreats in the glacial age of the Pleistocene.

“When was this last retreat of the ice?” I asked.

“About twenty thousand years ago.”

And then I learned that these deep-sea sediments are unique in one respect. When we see fine particles of clay, iron hydroxide, or other minerals which make up the sediment, we know they have reached their grave, their final resting place. They are rarely, if ever, uplifted to form sedimentary rocks on land.

One of the questions posed on this expedition to which we are trying to find an answer is, “What is the total mass of sediment deposition on the floor of the deep sea during the two or three billion years of geologic time?”

Complicated business this, which geologists and oceanographers all over the world are studying. New techniques of dating open up new vista in geologic history when applied to these cores. The results will not be immediately known, but come only after years of study by a number of people in laboratories.

These cores are the historical treasures to the geologists as ancient artifacts are to the archeologist. I’ll treat them with proper respect!

Monday, February 9

It has suddenly turned quite hot. We are heading straight for the Equator, and the cold, fresh air of the last two days seems gone forever. I woke up this morning not quite aware
of this change in climate and groaned, thinking, “All my sea-going clothes are dirty. What will I put on?”

The recent core-wrapping which I’d been doing was definitely taking its toll of my clothes in dirt and stains. Zippers break anyway. Two pair of clam-digger slacks had been cut off because they’d become so dirty.

After taking a salt-water shower, combing my hair, which by now was beginning to look like those heads in Fiji, and surveying my rapidly diminishing supply of face powder, which would disappear any day now, I put on a bandana top and skit and thought perhaps I’d try a pair of shoes and look like a woman.

How long has it been since I’ve had shoes on, anyway? My beach sandals, which are my standard gear, look like something that has been in a village dump in the rain for several years. But my broken little toe (yes, I’d been clumsy again) will not fit into a pair of shoes, so back into the sandals. Fortunately the purple spines have nearly disappeared in my other foot.

The straps have been coming off my sandals and are cut away regularly, so now they have only the big-toe thongs and a strap across the foot. All else is gone. I’m hoping they’ll hold together until the end. One doesn’t go barefoot on shipboard. Most of the men on the ship wear sandals of many types, the most popular being the Japanese split-toe variety. When the water sloshes across the deck, it is more comfortable to be in sandals than tennis shoes that slide too easily.

Little did I know how much modern woman has come to depend on certain standard equipment until I found myself on this last leg of the journey. There is a ship’s store only for men on the Spencer F. Baird. We are efficiently supplied with drugs, books, good American food, but how I
cling to my bathing suit, sandals, and such feminine gear as I have, and hope to high heavens these will survive.

Now to my chores. Russ brought in the clean sheets before he went on watch. The sheets were a welcome sight; I knew it was Monday, the only day Kenny issues this commodity to us all. They will stay clean a day or so and then we will endure them for a week, until we are given more. I have put a lava lava over my sheets for a spread to protect them during the day, hoping to keep them from getting so dirty, but even this does not help too much.

To wash my clothes I got a bucket from the head, filled it with salt water, added the dirty clothes and the detergent that Kenny has been nice enough to give me, and I scrubbed and scrubbed and scrubbed, and then for the rinsing in fresh water, one only. We can’t waste water. I hung the wash on the rope strung on the bow. Two other busy souls had their pants and shirts out before me.

Then to the lab, thinking I can get in a morning’s work, but now I discovered the heat. . . . All my determination to work was gone, and I thought I’d try it in the cabin, so picked up my pad and pencil and went to our cabin. The inevitable happened. I felt sleepy. It is so easy to fall asleep. Russ awakened me for a huge hot lunch and I was off to sleep again, an interlude awake and then sleep like a person drugged. I’m wondering what would happen if I didn’t leave instructions to waken me. Knowing that I have a four-hour watch beginning at midnight and won’t go to bed until after three o’clock tomorrow morning doesn’t help to keep me out of my bunk.

Oh, me—I feel sleepy again. I can’t write any more now. It must be the tropics. . . . I’m sure I’m not the kind of woman who would like to go to rot in the tropics. It’s too hot. . . .
25. OPERATION “CONCUSSION”

Wednesday, February 11

We had been up all the night before, taking a core. This busy day didn’t find me or the others at the peak of our usual efficiency, which at sea is still only 50 percent efficient anyway. However, the day was bright and beautiful, the weather not hot, although we were now on the Equator.

The hydrophones were out and shots coming in at regular intervals, the probe was down and the winch gears were grinding noisily. A “Gus core,” wider than the usual core, was being taken on the hydrographic winch, and then the divers dreamed up “Operation Concussion” for late afternoon. These men must have suddenly realized that stops for diving were nearly at an end and so decided to get in one more diving day.

Bob Livingston, Bob Dill, Walter Munk, and Willard Bascom with Don Heller, oarsman, set off in the skiff to a predetermined distance from our ship. They had a stadimeter and a ball of twine wound out with which to measure the distance.

Russ’s job on the fantail was to set off ½ -pound charges of TNT at a fixed depth of 100 feet (plus or minus 10). The divers, two at a time, planned to be 20 feet under water.
and feel the effect of these charges. They arranged to come closer at each charge.

All aboard were interested in this experiment and appeared on the stern or on the bridge, curious and observing. It was not reassuring to realize that we were 2,000 miles from the nearest land. If anything did happen, we couldn’t have been further from help. But Bob Livingston maintained that at the distances assumed, they would be safe.

Bob believed that the experiments would improve our understanding of head injuries. He told me:

“One of the theories of cerebral concussion is that it relates to a sharp pressure wave followed by a negative rebound which is of a very short duration but powerful, enough to cause cavitation in the nervous system and thereby bring about a brief period of unconsciousness, loss of reflexes, etc.”

So they were being guinea pigs to learn more about the mechanism of concussions.

As the Horizon, now nearly fifty miles away, was firing her regular charges which we were recording in the lab, we could not set off our TNT at the time a sound wave was being received from the other ship.

The whole problem of carrying and using explosives on our ships was a ticklish one. Now, after three months, we had fired over 35,000 pounds of TNT. As I watched Russ prepare the small charge to throw overboard here on the Equator as far as any ship could get from help, I thought of the stories of accidents we had heard concerning explosives on ships.

Once the fuse is lit, the explosion occurs in a minute or less. If a sudden roll disturbs the man with the TNT, anything can happen. One can’t yell “Run,” as on land if
the charge isn’t thrown overboard at the exact second intended. No—the fuse goes off on the ship, and the
ship with it.

An accident had recently occurred on a west-coast vessel, not an oceanographic ship. For some reason,
the man didn’t get the charge overside. It slipped, rolled on the deck towards a fellow worker who could
not get out of the way. The gunner grabbed the explosive. In trying to get it overside he saved his
companion, but lost his own arm as the charge went off.

Both our ships’ captains are concerned with the safety rules governing these explosives. Scripps’ and
Russ’s record of no accidents over long years is reassuring. One safety precaution of this expedition, and
a good one, was that no TNT should be handled at night.

Today we had just a short time before darkness, and must work quickly. Bob Livingston had arranged
a set of signals for this experiment. The skiff had a white flag with a red center, “Fox,” which mean “fire
when ready,” and a flag “Charley,” of red, white, and blue stripes, which meant “Cease firing.” We were
watching the divers through the glasses from the bridge and the fantail. Phil Jackson, one of the diving
crew, was alerted for this job.

Suddenly we saw them put up their white flag, “Fox.” Russ yelled to the bridge through the intercom
system on the fantail, “Raise the prep.”

First mate Bob Haines raised “Peter,” a blue flag with a white square. It waved gaily at the yardarm and
thus told the divers that a shot would be fired in two minutes. This gave them time to get under the surface
so that their ears could adjust to the pressure of the water.

With stopwatch in one hand and fuse in the other, Russ
watched the seconds pass, and then in a loud and happy tone shouted, “The fuse is lit.”

“It’s in the water,” he said, as he hurled it into the ocean off the port side. At that moment on the bridge, down came our blue flag “Peter,” and the men in the skiff and all aboard knew that the shot was in the water and would soon explode. I waited tensely for the explosion and could imagine the excited anticipation of the men underwater. I had never been on a ship before when the explosion occurred close by. The Horizon had done all the firing on this expedition.

“You’ll know when it goes off,” one of the crew said to me with a knowing smile. But it seemed a long time that I waited for the sound. Suddenly I felt a tremendous shock, as if our whole ship’s hull had struck a huge rock, and simultaneously a loud bang. I screamed involuntarily in surprise and then looked out towards our swimmers. After a few seconds, Phil, who was watching them through the glasses, said,

“They’ve surfaced.” They were safe! We wondered what they had felt. Their skiff moved closer, and the process was repeated.

At the second shot, Gustaf, who had been up all night sealing cores, rushed from his cabin. He was much disturbed. His precious three-inch-wide core was coming up on the hydro winch, and he desperately wanted to get a core from this station on the Equator.

“Will my core be able to stand this?” he asked anxiously. “Won’t it be all shaken up?” We all laughed, and Roger assured him that his core was still deep enough in the ocean and could withstand the effect of the shots.

The swimmers moved in, and as the sun came closer to
the horizon, more shots were fired. Life aboard the Horizon must have been quite a different one from that on the Baird. Their ship was shaken over 100 times at each station by these terrific reverberations, and not just one day, but many many days. Bang. Bang! Bang! Finally the divers were within talking distance of our ship. Surely they would stop now. No, they continued to hoist a flag asking for more shots. We had fired ten times. The sun had set over the horizon, and our friends were too uncomfortably close. At last we saw their “Cease Fire” flag hoisted. Operation Concussion was concluded.

The skiff soon unloaded the cold and badly-stung divers on the port side. The sea tonight had been full of jellyfish. The records they took told us what they had experienced. At the longer distances they heard double-sharp bangs, but with only a very slight feeling of pressure, and by the fifth shot they had a “startle reaction” or involuntary reflex jerk in response to the explosion. This became stronger as they came closer. When they were the nearest to us, Bob said,

“We got quite a loud, flat-sounding double snap, the double effect due presumably to the shock wave followed by the first bubble pulse. Several seconds later we could plainly hear the bottom echo. Aside from the sound of the explosion and a sense of jarring, our own ‘startle’ response was about the only noticeable effect. There were no sensations of pain or distress.”

Suddenly everyone’s attention was called from the divers. An emergency had occurred on the hydro winch, for the wire had tangled badly just 150 meters above the core.

The night lights on the fantail were now turned on and gave the scene that mysterious glow. A group assembled to try to get the core aboard, with the huge tangles of cable
constantly coming up. There was much heaving of block and tackle. The men were sweating, pulling hard on ropes to get this heavy core hoisted overside without the aid of the power winch—no small task. Dick Blumberg, Ted Folsom, Brownie, Bob Dill, Phil Jackson, Art Maxwell, Willard, and Roger were worrying, tugging and pulling on the thick rope with all their brute strength. Their bodies glistened in the bright glow of the high floodlights, as they sweated, pulled and strained.

Nerves were taut, and except for short orders called out by Roger there was complete silence until the cumbersome swinging instrument was safely aboard.

The climax came when Gustaf sang out that in spite of the tangled snarls of cable he had a core. He was exuberant! Later in the evening he brought us one at a time to his microscope and showed us exciting evidences of the glacial age in the layers of mud from this core on the Equator.

Also on this memorable day while the divers were unloading and the core was being pulled in hand over hand, I was allowed to help bring in Russ’s hydrophones. In the sea, flying fish skimmed over the surface and schools of squid swam beside the ship. The sea seemed more alive with animal life than on any other night.

Up came the new moon in the east over a relatively calm black ocean. Now for the first time in many months I can see the Big Dipper again. I had a wonderful view of her last night. We’ve been seeing the Southern Cross but now to see the Big Dipper is to greet an old friend.

I hear the sound of engines, and we are under way at standard speed. The crew is happy, as the ship is off to the next station. The scientists are completely weary but relieved to have averted one more crisis, and they relax over beer and coffee and talk.
On the fantail on this black night of such beauty I nearly trip over the tangled wire cable which was cut off and will soon be tossed in the sea. I take one final look at our little ship plowing its way through the black night and say goodbye to the Equator.

“Helen, come in, you know the rules. No one alone at night on the fantail.”

“Yes, I’m coming.”

Sunday, February 15

This afternoon Russell pointed out a beautiful deep scattering layer on the fathometer record. It was slowly rising about 50 fathoms an hour. This deep scattering layer has been a phenomenon of interest to me ever since its existence had been announced. I had learned that in the ocean there was a whole layer of tiny organisms, reflecting sound, that rose to the surface at night, stayed there for a time and then regularly descended down into the deeper water.

Russell, with Ralph Christensen and the late Dr. Eyring, had come across this layer by accident when engaged in under-water sound research during the war. Previous to that time, man had not known of the existence of such a phenomenon, but now it has been seen in many areas throughout our oceans.

Originally called ECR layer for its discoverers, it is now everywhere referred to as the deep scattering layer. Physicists had no sooner told of its existence than biologists began to try to ascertain the nature of the organisms reflecting the sound. The answers hadn’t come quickly or easily. Martin Johnson says that it appears to be planktonic organisms or larger forms feeding on the plankton, following it up and down on its migratory course. Why this layer rises at night has puzzled the scientists.
I looked at the echo sounder and saw the scattering layer now returning back down to the depths from which it had first appeared. This was happening in broad afternoon light, not at night, as is usually the case. A faint wavy black line above the bottom echo records was the only indication of this large layer in the ocean.

About this time our ship stopped in a rough sea and I saw our longest corer being put overside. We have been very fortunate during the last four weeks, and have eight full-length piston cores and 43 gravity cores to take home for study, all secured between 15° S and 15° N—that is, if we are lucky today. This will give the geologist information over an 1800-mile section across the east Pacific equatorial region. These men are much happier beings when they are getting cores, I’ve discovered.

I smile when I think what strange phenomena made my friends aboard happy—mud, man-made earthquakes, magnetic anomalies, seamounts, time to explore the watery world of fish and sharks.

In our lab, these last days have such an urgency. Each man is working on his charts and records preparatory to landing. The shipboard report, which has been a great challenge, is coming along with greater speed. Walter had been persuaded to assume the responsibility for collecting and writing up the material for the preliminary summary of the results of Capricorn, which Roger wished to get off the press as soon as we reached home. The two had been in conference daily on this undertaking.

“Have you finished typing the article on sediments?” Walter would ask me; or—“Can I see your log for such and such a day?” or—“I need the Vava’u chart. Where is it?”

Not only have the coring crew been hitting the bull’s-eye, but the temperature probe has been bringing back
records of the heat flow from this almost completely unknown area of the Pacific.

Stations Uncle, Victor, William, and X-Ray have all been occupied with success and all equipment working. By now nearly 40,000 pounds of explosives have been fired on over more than 2,000 shots, and many many miles of seismic profiles of the South Pacific recorded.

I’m doubtful if we’ll ever get to Point Zebra, the end of our alphabet, as the weather is getting near to impossible for such work, I hear, but we nearly made it. If we had happened to occupy a twenty-seventh station, I wonder what these men would have named it.

Everyone is busy racing for the finish line. We’re fast approaching this, and life aboard feels its impact. Roger, poor man, has just learned over the radio that he has to step off the ship and give a speech at U.C.L.A. on “Exploring the Deep Pacific.”

Today, Walter is making one of his regular visits to the Horizon, where he talks with the scientists there. Bill Menard, geologist, who has been visiting us aboard the Baird, discussing results with Roger, is returning to his ship with Walter.

I can only learn by reading drafts of the shipboard report some of the work being done on our sister ship, and by talking to the scientists who come aboard us on short visits.

Much of the work was the same as ours. Their echo sounder was continuously tracing the bottom just as ours. Both ships took bathythermographs, made Nansen bottle casts and took gravity cores; however, only the Baird took the long piston cores. On the other hand, only the Horizon made dredge hauls. I can still remember the excitement on our ship when Harrison Stewart told about trying to dredge in the seamount in the Tongan Trench.
The *Horizon* didn’t have Sir Ronald, the magnetometer, nor did it make any temperature probe measurements. Instead of measuring the temperature gradients in the bottom muds, meteorologists aboard the *Horizon* measured the temperature gradients in the atmosphere by radiosondes (small instruments attached to meteorological balloons that radio back temperature, pressure, and humidity data as the balloon rises through the atmosphere). On the *Horizon* they towed a “kytoon” (a sort of miniature barrage balloon) at a height of 1,000 feet from which they suspended instruments for continuously recording temperature.

I’m sure I would have enjoyed seeing biologist Martin Johnson bring aboard his deep-water trawls with the various bizarre types of life to be found at those abyssal depths. He was most interested in observing the increase in the abundance of plankton on crossing the equatorial current systems. The regular plankton net brought him many samples for his 200 biological collections from both the eastern and the western crossing. It was curious to find such a dearth of plankton on that beautiful calm ocean we crossed from Samoa to Tahiti.

On the *Horizon*, Martin also maintained a bird watch. If I had been on the *Horizon*, I too could have been a bird watcher. But I’m a core extruder on the *Baird*. It’s all wonderful!

*Monday, February 16*

Today might have been called “Operation Shark.” We are on Point Yoke, 1,139 miles from San Diego, and everyone believed it to be the last stop if we were to reach home by Feb. 20 or Feb. 21 as planned.

It was again a three-ring circus. The winch was letting down its last big core, and the temperature probe had to
take its last trip to the bottom and back. The Horizon was dropping off bigger and bigger charges of TNT on their last day of shooting.

“William, this is Uncle.”

“Uncle, this is William. Over.”

We heard Willard North’s voice. “This is a 450-pounder, Russ coming up. It’s the 2030 shot of the expedition. We’re nearly through!”

“Roger, over.”

Meanwhile, down the side on the hydro winch went a Nansen bottle cast. A Gus core had already been recovered earlier. As if there was not enough happening, the divers decided to go down in this rough and sunny ocean and take some pictures. It was to be their last diving day.

They wanted more pictures of underwater swimmers.

“Also, I want to photograph the under surface of waves,” said Bob Livingston. “The part of a wave that attracts your attention is the crest. The trough of a wave appears less dramatic from the surface; but under water, it’s the trough of the wave that seems to come billowing along toward you.”

It was certainly rough enough for this. The air had definitely turned cooler, about 75°F. and a wind of force 5 was recorded in the bridge log today. Larry tells me we are headed straight into a storm. It is really rough, and getting colder.

I sat on the deck and watched Willard Bascom, Walter Munk, and Bob Livingston prepare to go overside with their aqualungs. These lungs had been filled previously with compressed air on the Horizon. First the men knelt and tested their equipment, opened the valve of the bottle to be sure the air could get through, sucked the tube to see if it was all working correctly. Then I watched Bob put on his long rubber flippers and the mask on his forehead. Next came
the yellow aqualung cylinders, which had to be strapped on his back like a knapsack. The breathing tube went over his head from the back, and he adjusted his belt, which contained a number of lead weights. Bob then fastened the straps to harness himself to the lung. It has a special clasp that allows the diver to slip it off quickly if need be.

Standing near the rail, I saw Bob put the mouthpiece in his mouth, suck on it to be sure all is working. He then held onto his face plate with one hand and his aqualungs at the back with the other and jumped in, feet first. He didn’t want to have the lungs kick up and knock his head. He then came to the surface and readjusted the mouthpiece and prepared his face plate (saliva was put on this to keep it from fogging) before submerging.

Hanging overside from the ship was a rope ladder and a rope tied securely to the ship. As soon as all three divers were in the water, a camera was handed down, and the divers went below under the ship. Always in previous dives they had gone down in pairs, as a safety precaution. Today they were a trio. All we could see were bubbles coming to the surface.

They had been lost to sight for some minutes when we heard Ted Folsom, who was standing in the bucket putting Nansen bottles overside shout: “Big shark over here!”

We called to the divers, but of course could not attract their attention. At the moment all three were under the water. Then came the call.

“Shark’s started down under the ship.” We all moved quickly to the port side. Get those men out of the water! One of the men on the rail grabbed a gaff to use on the shark if needed. But we knew we were helpless. Mac, camera in hand, was trying to focus on the shark.

Apparently the divers had also seen the shark down
below. Walter now came to the surface, swam to the ship’s ladder, and slowly began to hand up his lungs and equipment to the men aboard. The shark was also coming to the surface. He was fully six or eight feet long, a fast, sleek gray animal.

Hurry! Hurry! We watched Walter’s slow movements impatiently. Walter didn’t believe in showing fright or speed or fear in the face of this creature. But there were two more men below, and only one could come aboard at a time. If we had only been able to lower the skiff, they could have climbed out more easily, but the sea was too rough.

The shark obviously had no fear of us, and was definitely not giving us the great-circle route of inspection.

Now Bob and Willard arrived at the surface. We saw the shark at the stern, swimming two feet from the hull of the ship, and right towards the divers. A free-swimming shark had not come quite this close to the ship before. The men had, of course, encountered these beasts often, but we hadn’t been at the scene. Also a diver was mightily more vulnerable at the surface, where ship’s refuse might whet the shark’s appetite.

We gasped. The shark had sideswiped Willard across the chest and then swum on toward the bow. No man could out-swim this huge creature, who glided effortlessly through the water. I thought of its powerful jaws and row on row of sharp teeth.

Willard calmly began to lift off his cumbersome equipment and secured it to the rope overside. He was at last free to swim about with greater ease.

But the shark had turned around and headed directly towards Bob Livingston, who was trying to get free of his lungs and preparing to come up the rope ladder after Walter.

We saw there was nothing Bob could do to defend him-self
if at this moment the shark chose to take an arm or leg I’m sure Bob was frightened and must have wished for a lung or some object to hold in his hands in front of him with which to ward off an attack. But he was struggling to get free of his gear.

“For God’s sake, get aboard!” MacFall’s movie camera was clicking. We were all lined up on the port side, horrified.

The shark brushed by Bob and by Willard again, and then went toward the stern of the boat. Our two divers now finally climbed up the rope ladder. Hands reached out to hurry them aboard.

Capricorn’s last dive. No casualties! Thank God!
Monday night, February 16

This is the last station, the last core, the work of the expedition is nearly over . . . in a few hours we will be running for home with the Horizon ahead of us. We waved goodbye to her today and do not expect to see her out here again. Except in ports, she’s been the only ship we’ve seen on our journey. For some strange reason I had tears in my eyes as I watched her disappear off to starboard.

Perhaps because it is the end, I feel the usual sad feelings at the end of a lovely experience.

Gone are all the warm days and nights. Sweaters appear on the men. I have none. We are beginning to lose our tans. As we go north, the ocean is rougher each day, and we’re heading into a storm.

I can already feel the joys, conflicts, and drives of my world at home encircling me. I am not sure that I will be able to adjust immediately to our busy town with cars going faster and faster, people rushing about. I’ll think of the leisurely village streets, full of bicycles, and the nights when we sang and danced and no one was ever cold.

I’ll be unable to look at women dressed in the height
of fashion teetering about on their heels, clickety-clack, clickety-clack in big department stores with glazed eyes and unsmiling faces, without comparing them with the poised, happy barefoot women of Tonga.

Things will have little importance. I’ve visited in homes where there were mats, papayas, good food, and music, and I felt no need for more.

I’ll probably go about abstracted for a time. I can hear my friends saying: “Helen, forget it. You’re lost. La Jolla is a wonderful place.” And each one will ask:

“Do you want to go back to the South Seas to live?”

“No.” I will say. “I wasn’t born a Polynesian and I have a good life here. But I do want to go back for a while and live in a village, for instance, Vava’u. We are so close to a world which may soon be gone—this peaceful, happy, loving world of these Tongans. I would like to see it again for a time, before it is lost forever.”

I thought of the many amusing discussions that had taken place in the ward room when I had asked the men on the ship “What part of the Pacific do you want to go back to?”

It was never, “Do you want to go back?” Looking at most of the faces as we sailed out of these ports, I knew they wanted to return. I can still see Bob Livingston as he stood in the high crow’s nest, throwing his lei upon the waters with a great, sad, dramatic gesture as we sailed away from Pago Pago.

“What’s your choice?” I said.

“Why ask?” was the retort. “You know.”

When they said that, the answer was obvious. Tahiti. I can well understand this preference. And there was Roger, who invariably answered “Fiji, the geologist’s paradise of islands.” Those faraway Marquesas. They received a vote from
such hardy souls as my Russ, and as Walter, who had looked at Invisible Bay with deep desire in his eyes.

Then Tonga had its converts. Russ and I longed to go back to Tonga. Only there did I live in a village and feel the life of the people and see the still-strong remnants of a proud Polynesia that had received the least impact from our western civilization.

In Vava’u there would be a boat from the outside world once a month, no electricity, no telephones, a small hospital, kerosene refrigerators, an adequate diet, peace and beauty unsurpassed, and boats. I would like to go back to Vava’u and live on the water where there is a breeze and paddle my outrigger in the bay and hunt for fish and corals. Perhaps in a year I could learn to speak with the Tongans, sing their old songs and plait pandanus mats.

And Russell could study earthquakes. He wouldn’t have to make his own in Tonga for they have them nearly every day. It is an exciting world to a geophysicist.

But I’ve always believed that one can never return. Here is our ship, rolling, pitching, and speeding toward home. I know too well that this interlude is nearly at an end. Russ has hauled in his hydrophones on this last station. We climbed to the bridge. We watched the sunset together. I know that this voyage can never repeat itself. As W. H. Hudson wrote: “The beautiful has vanished and returns not.”

Tuesday, February 17

We were standing in the radio shack waiting for a radio telephone rendezvous with home. For several days I had been pestering Buckey, asking him. “Do you think we can get a call through to home today? Are we far enough north yet?”
And tonight he and John Colton were making every effort to reach La Jolla. We were in the area where our operators could hear tuna fishermen talking to their wives, and radio hams talking to ships.

“Hello, dearie. How are you. Over” we could hear.

“When will you be coming home? Over.”

But I was completely unprepared to hear voices from La Jolla that I had not heard in nearly three months come booming forth from our loudspeaker in the radio shack, which had for nights and days been broadcasting ship-to-ship communications such as “The fuse is lit.”

Tonight we heard Ellen Revelle’s voice, clear and sweet, talking to Roger and then to me. I knew that if anything had gone wrong at home the news would have been kept from me on this last leg. I was greatly relieved to hear Ellen say that all my family were well.

Then came the Revelle children’s voices—Mary Ellen, Carolyn, and Billy. To hear these out on this ocean where we had been so completely cut off from all the world for such a long time was uncanny.

“Here’s Martha, over,” said Ellen. Then came my daughter’s voice. The shock was more than I had bargained for or anticipated. I was called back to my world at home sharply and irrevocably.

“Hello, Mother. Hello, Daddy. This is Martha. Over.”

I couldn’t speak. Tears were streaming down my face. I quickly motioned to Russell to talk, and turned my back on them all.
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The two oceanographic research vessels of the Scripps Institute of Oceanography Expedition Capricorn. At top, the *Spencer F. Baird* at sea, and below, the *Horizon* at anchor in Papeete Harbor, Tahiti. The large “A” frames are clearly visible on the stern of each craft.
Lowering the core barrel over the stern preparatory to taking a sample core of the bottom sediments.

Putting over the temperature probe which records temperatures at various depths of the bottom sediments.

The fantail of Baird. A very bent coring tube lies across two horses, while assorted equipment litters the deck—coring apparatus, temperature probe (being sat upon), under-water camera, etc.
Engineer Buddy King stands behind the drum holding the Baird's 40,000-foot tapered steel cable.

Gustaf Arrhenius and Roger Revelle examine the gravity core which has been detached before the long 28-foot core barrel is brought aboard.
Streaming the hydrophones in preparation for a seismic run.

Russell Raitt examines the seismic records made by the hydrophones.
The recording instrument of the echo sounder is showing an irregular bottom. The line running upwards shows core barrel coming aboard.

The author typing the log in the lab. The rack in background contains Nasen bottles used for taking water samples at various depths.
Walter Munk equipped with aqualung and flippers examines a coral formation.

Takaroan pearl divers Fereti and Tehaere with diving goggles around their necks confer with Capricorn diver Willard Bascom while village chief Paniora stands by holding weighted diving line.
The almost perfect cone of the uninhabited volcanic island of Kao. Tofua island is behind.

Marquesans at the village of Taiohae about to perform the ancient dance of the loving pigs.