

Tapes from Art Raff

Arthur D. Raff

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49

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49-50

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Mason plotted and contoured data at four inch per degree scale. I had to plot and contour at a scale of 14 inches per degree of longitude and then photograph down to four inch per degree for publication. All worked well

50-51

To speed up reduction of data for publication, I employed a red-headed lady, and when she left, I employed Norman Head's wife. Brilliant mind. Employed a professional draftsman to put all in ink for photographing and publication. Determining the earth's smooth field and subtracting it from total field data to make an anomaly only map which was published. Al Focke looked at our map and said anomalies not real and not to publish. I knew he was dead wrong and published. Years later mentioned to Focke the success of our publications. He was embarrassed and said, good. He died soon afterwards

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Preface Page and Introductory Page

An introduction by Art Raff to the following typed transcription and accompanying audio tapes:

I started this on 28 March 1996 with a completely unplanned narrative of reminiscences about my days of working for the Marine Physical Laboratory. I told of events just as they happened to come to mind, and thus the sequence is in no way chronological. Betty Shor typed a transcript from this first tape. When I read the transcript I was embarrassed by the unprofessional quality of my audio tape. I took the liberty quite some time later to severely edit the transcript and add more events of interest, but left it in its original nonchronological sequence. So now in July 1996 I am making an audio to accompany the edited and enlarged transcript by reading the transcript to an audio tape recorder. I have compiled an index to help an interested person years from now to locate some event. This index will accompany the final transcript and audio tape.

Tapes from Art Raff

Today is the 28th of March 1996. My name is Arthur D. Raff, more commonly known as Art Raff, or just Art, and behind my back at MPL, no doubt some other names which I never heard very likely occurred. When I joined the Marine Physical Laboratory it had been going for a few months, and the personnel aboard there at the time as I remember it were Dr. Carl Eckart, Dr. Russell Raitt, and Dr. Leonard Liebermann. Then there was Eckart's secretary, Frances Sparks, and Chris Baldwin and Gloria Slack and Gwin Roy, who I remember as usually going around sucking on a piece of hard candy. I wondered how she ever had any teeth left. Then there was Mr. Grimley and Stan Lai and Earl Squier and a machinist, Archie Dunlap. And there was a German lady; I do not remember her name. Her job there was to translate documents in German into English.

[Editorial note by Betty Shor and Art Raff:

When Art Raff started making the taped reminiscings, he was speaking casually and had no documents to work from. He asks that the following names listed here be made available to readers of this transcript along with some comments. As of late 1996 an accurate list of the original personnel does not exist. Several people attempted to make a reasonably accurate list with the few documents now available.

Marine Physical Laboratory became a funded organization on 1 July 1946. The director was Dr. Carl Eckart. There was Dr. Leonard Liebermann, Dr. Russell Raitt, and a Dr. Robert Young who was finishing up some work carried over from U.C.D.W.R. while starting to do research for the Navy Electronics Laboratory. There was a Dr. Charles Mongan who was searching for documents in Europe.

Then there were Frances Sparks, Gloria Slack, Archie Dunlap, Finn Outler, and Chris Baldwin, who was at first paid by U.C.D.W.R. moneys and then fully M.P.L. funds. There was a Will Rayton whose duties, funding, and duration of time at M.P.L is not clear.

In the few months following 1 July 1946 the following people came aboard: There were Vic Anderson and Dan Andrews who were graduate students attending classes at U.C.L.A. in anticipation of later obtaining doctorates. There were Dan Gibson, Earl Squier, Bill Grimley, Francis Byrnes, Stan Lai, and Gwin Roy.]

I came aboard at MPL in February 1947, and it was just a matter of dumb luck that I happened to make a career here. In fact, before I came here I was not even aware that there were any such activities down here on Point Loma as MPL or Navy Electronics Lab or whatever. After getting out of the army I just rested up for a while, and I waited for delivery of a new car, and when my new Chevy came through I went out looking for some career type of work. I had gone down to some of the aircraft factories in the L.A. area, and they were interested in me but did not say that they would hire me tomorrow or anything like that. So I went on over to UCLA to see what was going on there, and I was talking to somebody there in the physics lab, I think, or the department and they introduced me to Carl Eckart, who just happened to be there on some business. We talked a minute and he said to me, "We have an activity starting up down at San Diego, and I'll give you the address. Why not come on down and talk to us?" So I said, "Fine, I will." And a few days later I did drive to San Diego and found out on Point Loma the Marine Physical Laboratory — no, at that time it was not exactly on Pt. Loma. It was over there where the Navy Sonar School was and the Navy Antisubmarine Warfare School is nowadays. I was introduced to Dr. Russell Raitt, we talked a while and he said, "Well, I think we could use you here," and he gave me a starting date which was maybe a week later, and we agreed on a monthly salary of \$220 a month which sounds terribly small now. In fact it turned out that was a little too small, and I had to ask for a raise about six months or a year later because I could not pay all my very small bills on \$220 a month.

When I actually started work for Russ Raitt he gave me an office upstairs in the building. It was right above the cafeteria that we had there then, and as I remember it my first work was to analyze some records from a fathometer that he had been using. And I'll tell you this was some fathometer. Instead of the records being on anything that we're aware of now — sort of a continuous profile record — they were individual echo returns on a continuously running photographic negative strip. The 35-mm negative strip ran fast enough to resolve the actual motion of a very small particle in the water — not an envelope curve. The fast-moving negative recorded the outgoing ping and the ping echo coming back from the seafloor. By measuring the distance from the outgoing ping to the echo return, one could determine the ocean depth at that point. By noticing the shape or signature or the envelope of the returning echo, one could tell something of the seafloor character — smooth sediment, rocky, or whatever. It all was an evolving science —

the relationship of the outgoing signal to the characteristic of the echo as determined by the character and/or morphology of the seafloor. They were quite laborious to read, and my first job as I remember it was to start going through those things and catch up to date. Now these had been obtained on this very very special fathometer — one of its kind and just about a first — that was aboard the ship that we called the *Stranger*. This *Stranger* had quite a history.

I will go back now to its origins; let me see if I get my story straight. This ship that was named the *Stranger* when I was using it had been built before World War II by a quite well-to-do gentleman. He was a rancher from Wyoming. He knew almost nothing about yachts or boating, but he had, besides other activities, a yen to sail around the world in his own ship, and he wanted to design and supervise the building of his own ship. He had the notion that people had been building boats of the wrong design all these years and that he had some sort of a special gift to design one that would do a much better job of sailing and all that. So he designed this ship which we called the *Stranger*; it had a different name to start with. It was a double ender, and I would just guess about 130 feet long. It was made entirely of wood; frames, planking and all that, except of course the nuts and bolts. He designed it with a cross-section along the middle that one would call a V-bottom — very definite V shape. He considered that to be the ideal shape; it goes through the water with more efficiency and so on. So he had his builders construct this thing and finally it was ready to launch. It was launched out into the bay and sat there; it looked fine, new coat of paint and everything. The first thing they did was to bring a dinghy alongside — that's a very small rowboat — and tried to bring the dinghy aboard. So they put a davit over. It had a block and tackle and a line going over to some sort of pulling device. They attached a hook to the dinghy and started to pull the dinghy up. Instead of the dinghy coming up to the davit, the davit block came down to the dinghy, and after the ship had leaned over a ways they decided they'd better stop, and they let the line slacken back, and the ship finally came straight up like it should be. They gave up bringing a dinghy aboard that day. They were very chagrined about this and they got in some sort of a huddle and decided that the way to remedy that situation would be to add more lead to that already in the bottom of the ship. The Spanish put ballast stone down in the bottoms of their galleons, and he put a lot of lead down there. The builders also modified the V-bottom by some rounding out with more wood planking. Well, that made it vertically stable, and they were able to bring a dinghy aboard without tipping over to the side. Things looked much

better, and he would be able to sail around the world, or whatever he planned to do. I don't know for sure if he ever did sail around the world or not in that ship; he may have decided that discretion would be the better part of valor, and just not do that, and sail locally instead. I'm not sure about that part of the story. Anyway, World War II came along and the Navy either purchased the *Stranger* from him or he gave it to them for their use in research. The Navy wanted to use it for their research effort in anti-submarine warfare by studying how sound travels in the water and at what distances they could detect submarines by listening to them, and that sort of a thing. So they proceeded to do just that. I think it was called UCDWR at that time — University of California Division of War Research. Well, UCDWR took it to sea; first they installed this very strange fathometer that I was telling about so they could do this sort of work. They had listening hydrophones and other various paraphernalia that would be necessary for the scientific endeavor. This very strange fathometer had as a source of sound a very large magnetostriction device. When that was given a pulse of current it would ring, and when an echo came back off the bottom this magnetostriction device would pick it up again. It was not ideal as to the shape of the pulse but it did work.

They took the fathometer to sea and made a lot of measurements with it that I have described. They also got into some other work, listening to echoes off the bottom that seemed to be a false bottom and that turned out to be what was described as the deep scattering layer which was essentially discovered by Eyring and Raitt and Christensen, all working there at that time.

With this V-bottom shape and all that lead in the bottom, it apparently was safe to use, but it gave a sickening ride. It rolled terribly and I remember Raitt telling that one time it was rolling very severely and one of the crew members — probably somebody from the engine room — was down in the galley, and when it rolled a long ways over one time he simply walked up the side to the ceiling and turned around and walked back down to the deck or floor. His greasy shoes left prints up the side and back down, and the maintenance people aboard were rather proud of that picture. So when painting and cleaning up, they did not cover over those footprints, and they were there for a long time for people to look at.

The scientists at UCDWR and the Navy people finally decided that this was no way to continue using the ship and they would remedy the situation. Their solution, I think, was to add even more wooden planking along the sides to give the ship's cross-section a conventional

appearance like almost all the ships we have today — diesel-powered ships. When they had added enough planking to give it the proper shape, it was so thick in places that the portholes were essentially tubes. As I remember it, in some places one could barely at arm's length reach into the porthole out to the side of the ship — that's how much planking was added. People used to joke that there was so much wood in that ship that it was unsinkable; it would just float by virtue of its very very thick hull. As I remember it, when the *Stranger* was lying to, it rolled very little, and that was very definitely a redeeming virtue. But when it was under way it rolled considerably, due to something people never did quite understand. Under way the *Stranger* would lay over on one side for about 15-20 seconds, and then it would lay over on the other side for about 15-20 seconds — back and forth, back and forth in such a manner. And when running along on one side it would start to turn, and the turn was always in a direction that would tend to make it come up straight, and it would go over on the other side, a sort of positive feedback to rolling. Really, positive feedback is not the correct term, which would indicate the amplitude of roll would keep increasing as long as this was going on. I do not know of any correct term, correct for this strange kind of roll. One simply has to describe it as I have done here. Scripps did use the *Stranger* for two long cruises, 1956 and 1961, after it was given, free, to the institution in 1955. I lost track of the *Stranger's* final years; it could have been sold to a civilian who used it for long cruises or just local cruises. Anyway, I never saw it again. I heard someone mention that the *Stranger* was finally sold for scrap and that the scrap company bought it not for the machinery in it especially but for the value of the ballast lead it contained. If not true, this is an example of how some of the great lies of history were made.

Before I proceed further with the stories on these tapes, this is a good place to explain some of what is said on the tapes. First, for identification of these tapes, this section is side A of the first tape. I should mention that what I say here about MPL is not hard history with well documented accurate accounts of events, satisfying the requirements of who, what, when, where, and why as they apply to the events. Rather, what I am saying about MPL is reminiscences about things of human interest, funny events, exciting events, people, accidents, failures, funny things about some of our ships, criticisms, advice, and so forth. Also what I say here likely will not be entirely accurate, because people's memories play tricks on them when it comes to reminiscing about

events. Furthermore, I should have made these tapes ten years ago, when my voice was strong and not the quavering efforts of an old man.

Now back to the original staff at MPL. I did not mention Finn Outler. My recollection is that he came aboard about a year later; I'm not real sure about that, but that's the way I recollect it. Now Finn was raised in Georgia, as I remember it, and Finn was the first casualty of World War II. This happened on the *Panay*, an American river boat that sailed on the Yangtse River, if I remember my geography correctly. I think the boat was named for the Philippine island of Panay. The Japanese were very nervous and unhappy about an American ship operating on the Yangtse River, and they one time surprisingly dropped a few bombs on it. Now Finn happened to be standing somehow between two bulkheads — I don't know exactly the details — and one bulkhead was smashed up against the other and crushed Finn in between the two. Naturally, the crew got their crowbars out and whatever, and pried things apart so they could get Outler out of there. He was very badly hurt. His chest was crushed, lots of ribs broken, and this plagued him the rest of his life. I think that he could not get a good deep breath. I remember there at MPL that he was very careful of the health of his upper body; he wore extra warm clothing over his chest all the time to make it more comfortable and to ward off any kind of congestion or possible pneumonia or whatever, and he was very limited on what he could do in any one day. He told me once, "Art, I'm good for just so many steps a day, and when I've taken those I'm through." I noticed that he measured his activities out carefully so he got through the day without having to take all his steps there at the lab. Yet he made a good showing and got a lot of work done. As I said, I think Finn was from Georgia and a farm boy on a large farm. He used to say what a tough character his dad was in making things go correctly, and Finn was somewhat the same way. When he was young, he was strong as an ox. He used to tell me of some of the things he did — the feats of strength, his endurance, and all that. And I think he felt very badly that he did not have that any more after his injuries aboard the *Panay*. Anyway, the *Panay* did him in for the rest of his life. At the time of the bombing of the ship I think he was a warrant officer in the Navy, of some particular specialty or grade; I'm not just sure how this business of warrant officers works. I've seen so many kinds of warrant officers, both in the Army and in the Navy. Generally speaking, Finn was demanding of competent work. You could see his exacting military training, and yet he was fair and reasonable. One time Finn was watching Stan Lai prepare and assemble some gear

for work on a local reservoir or in nearby coastal waters. Finn jokingly quipped to Stan that his gear and efforts reminded him of the disorganization and employee conduct in a Hong Kong noodle factory. Stan got a good-humored bang out of that comment and would with laughter tell his friends about it.

Since I was doing a lot of talking about the strange ship that we used, the *Stranger*, I'll just dub in here about another unusual ship that we had use of. Its name was *Saluda*, and it had quite a history. Now back on the east coast there was a very well-to-do young woman, and she had a boyfriend, and she wanted to impress him with what a good catch she would be or whatever. So she found an architectural firm that would design and build a sailing craft to her general specifications; that is, to the amenities it would have. She obviously knew nothing about marine architecture and recognized that, and she paid this company plenty to design this craft for her. She wanted it to be what I would call a gold-plated seagoing sailing craft. As I remember, it was about 60 or 70 feet long; I think it was yawl-rigged and had very nice lines, and the appointments in it were simply out of this world. It had a marble fireplace, in which one could actually burn logs safely, and in the bathroom (I'll call it) it had a very nice lavatory with gold-plated plumbing — faucets, spigots, whatever and it had a good flush toilet. I don't know if it had a shower or not, but it had a bathtub that was really gold-plated. I don't know what the tub was made of; it must have been some kind of a metal. Now that was really something. The furniture in this *Saluda* was all the most beautiful, expensive kind of woodwork you could imagine. It was a dark wood, as I remember it, and the flooring, the walls, and the decking above, all were of the very best materials and construction.

There was another feature about the *Saluda* which was rather unusual and interesting, and that was the dining table. It was on gimbals, a very nicely made table, and would very nicely seat four people, two and three on each side if really needed, and the length of the table was longways of the ship, fore and aft. To make use of the gimbals it had weights below. Thus, if the ship was at sea and rolling, the table would stay level all the time. The ship would roll back and forth, but the table would stay level. If the ship was not rolling much, as in a reach or for whatever reason just leaning over constantly, the table would stay level and not move up and down but just stay in that position. Russ Raitt never did quite get used to that table. When we would be in a reach and the table was tipped down 20 degrees with the edge around just above the knees or maybe up close

to one's chin, he would forget himself and lean on the table with his elbows, with the full weight of his shoulders on there, and of course that would tip the table towards him, and he was lucky if he did not get his soup in his lap. He made all sort of stammering excuses, and he was very embarrassed, and we'd all sort of chuckle and say, "Oh, that's OK, Russ; everybody does this sort of a thing." If we were in a very distinct roll, back and forth 30 degrees, first the side of the table next to the person eating would be down around their knees, and then it would swing up about chin level, and it was just next to impossible to get a piece of steak or a spoonful of soup as it went by one's mouth level. So depending on how far it was rolling and what we were eating, we had to get hold of our food and eat it when it was at an extreme position. I usually preferred to get something when it was down around my knees; that way I could very easily reach down and get a nice spoonful of soup or piece of steak or some potatoes or maybe put some gravy over things. I had to do that quickly because in just moments here it would come back up again. But that was all part of the game, and fun, and one learned to get used to it and eat that way.

Now when the ship was in port, one did not need this gimbal mechanism because the ship would be sitting straight up and down, and it would be a nuisance to have it on the gimbals; people would want to lean on the table or put a big heavy tureen or such over on one edge. So there was a pin available for one to put into a slot there, and that held the table so it did not operate on its gimbals, and people could lean on it all they wanted to and do as they pleased and eat just normally like one would at any table. If we were in some foreign bay and there was no wave action to make the *Saluda* roll at all, we would put the pin in there so it was more handy and comfortable to eat.

You may be wondering why or how we happened to acquire this ship or have it at our disposal for use. When the war came along the Navy was either offered this free or they were asked to buy it, I don't know the details here, but anyway, the high brass out here in San Diego wanted the *Saluda* and so it was acquired. Their reason for wanting to have it here was for them to use for parties or fishing or competitive sailing or whatever — a very high class little toy for their fun. But they could not say that in spending considerable Navy money, so the reported reason for acquiring this ship, the *Saluda*, was that it would be very good for certain types of research work. It would be able to do work at sea without any propulsion engine running, which makes it nice for any kind of acoustic listening and that sort of a thing. And that is exactly what we used it for. Yet the high brass still got to have their fun with it now and then — sailing on a "gold-plated" ship.

When it was acquired by the Navy they simply had to take out some of these beautiful appointments. The fireplace was simply closed over so it could not be used, and the gold-plated fittings in the head or bathroom were removed. That gold-plated bathtub came out, for sure. I can't remember if we had a shower; we had some sort of salt-water shower, very likely. I'm sure originally it carried enough water so the people could have fresh-water baths. While its beauty was not destroyed, it was made more functional, and it still was a wonderful ship to sail in racing or for parties and those sort of things. I'll discontinue talking here about the *Saluda* until later when I tell specifically about some of the times we used it, and the things that happened.

Since I got to talking about ships, the *Stranger* and then the *Saluda*, I'll just continue telling about some of the interesting ships that Scripps has had and that MPL used. One was the old *E. W. Scripps*. Those of you who have read Betty Shor's book about the history of Scripps know something about the *E. W.* It was purchased very early and given to Scripps in the early days for oceanographic use, and they did make good use of it. As time went on, the ship showed its age, but they kept it in shape so that it could be used. I remember one joke made, that it was held together by its worms holding hands to keep it together so they would have a home, and if the ship were ever placed in a poison basin it would kill the worms, and the whole thing would fall apart. Nothing like a good joke about one of our old ships. The old *E. W.* had been converted considerably to make it useful for oceanographic work. It was not taken far away from shore because the insurance required that there was very much of a limit as to how far out we would go. We did not make much use of the shortened sail; once in a while the sail was put up to cut down on the roll or to give a slight boost as the ship was sailing along. We mainly depended for power on a small diesel engine that was very reliable. The speed was nothing to brag about, something like 6 or 8 knots in a good sea, but it was dependable. The automatic steering on this ship was something that bothered me quite a bit. It could be steered by hand, of course, but the person on the bridge usually preferred to have it on automatic pilot so they could turn their attention away from fighting that wheel all the time. In steering a sailing ship or a ship under power, one has to wrestle with the wheel a lot, and it takes some muscle and constant attention and observing the compass. Now this automatic power steering was a rather ancient setup. It had no neutral position. It was always under full steering power, either turning the rudder to the left or to the right; it just never stopped and rested for a while. And so at night when I was trying to sleep,

especially if I were near the aft, I would hear that motor going all the time, first running to the left, then to the right, then to the left. It became quite annoying, and I often wished I could cause it to malfunction so that somebody had to stay up there and wrestle with the wheel instead of depending on that power guidance system.

Russ Raitt and I did quite a bit of work aboard this old *E. W.* We did some acoustic study profiles of the bottom of the ocean, and then we did some seismic shooting, as I remember it. I remember one time when we went out we had a Navy officer aboard who was learning some of the tricks of the trade in oceanography. If I remember correctly, his name was Commander Sherry. I heard years later that he became an admiral. He was a fairly high-ranking officer, but he was dressed in civvies when working with us. We had a lot of work to do, and I had no more than gotten to sea than I came down with the flu or something like that. I tell you, I was one sick person, and I just could not stay out there to help as I should have. This Navy officer was quite disgusted with me. As bad luck would have it, I got over the flu about the time we were finished, and I think this officer had a very low opinion of me from then on. I'll tell you, one can get really knocked down with the flu. Between this officer and Russ they got the work done.

In spite of the sentimental attachment people at Scripps had for this ship, it finally came time to dispose of it. It was a liability, and it was very limited as to how far it could go out. So it was sold, I think, for a very low price to someone who wanted to acquire it and extensively replank most of it and make use of it again. I don't know just how much use was made of it, if they took any long trips or not. I do know that when the moving picture, "Around the World in 80 Days," was made, this was the ship that was used for the person who was going around the world in 80 days. The *E. W.* was made to appear as steam-powered. On the last leg of his run to Europe he ran out of fuel. He ordered that they start breaking up the furniture and feeding it to the firebox for the boilers. The movie showed them first breaking up the furniture and then breaking up the deckhouse. The old ship was getting pretty well down to just the deck and some freeboard below, but they did make it into Europe and completed their trip around the world. I don't know if they did it in 80 days or not; I don't remember that much about the story, even though I did see the picture. I figured that would be the end of the *E. W. Scripps*, but it was not. Somebody bought it and went to all the trouble to restore as a sailing ship, and use it again at sea for long cruises and Pacific island trade. It put into Tahiti once, and while there a party aboard got wild. There was

some kind of an accident that caused the *E. W.* to sink right there in the small harbor they have at Papeete, Tahiti. It was very definitely a menace. So the local people got a tugboat to latch onto that thing — I think the mast was sticking out of the water — got good lines to it in several places so they would not pull it apart and dragged it out to deep water and cut the lines. That sadly was the end of the *E. W.* When we were there the local people told us about all this. I imagined in my mind the old *E. W.* sitting out there a mile or so from Papeete, decaying away down in the water.

It seemed that Scripps was forever being given various vessels that the owners wanted to get rid of — I don't know if for tax write-off purposes or if they were really interested in helping Scripps out, or what. But over the years we acquired quite a number of ships, and many of them were a liability and a nuisance, and Scripps had to get rid of them eventually. One of them was a small power boat. I think it was about 40 feet long and carried several crew members. I wanted to run a magnetometer profile line; that is, measure the magnetics in profile to the west of San Diego and slightly south to fill in the gap there in some of our previous surveying and to check into something that I thought was interesting there. I was told that I could use this particular ship. I put all my gear aboard and we started west. I had planned to go out several hundred miles, but we were only about 100 miles from shore when the power steering went out. It had a very ancient power steering system, and it had no direct linkage from the wheel to the rudder. It had to steer through this system. When one turned the wheel it made electrical contacts with two relays down below, and power was sent to a motor which made the rudder turn as requested by the wheel above, either left or right. Somehow those large relays that were down below handling a lot of power to a large motor stopped closing because whatever activated them burned out or failed. Anyway, we had no steering. Well, there was almost consternation aboard wondering whether we would have to radio in for a tow to take us back to port or somehow get back on our own. After looking it over carefully for quite some time, it was decided that one of the crewmen, preferably an engineer, could stay below there, and the bridge would call down on a rigged-up telephone of some sort for him to hold these relays down with a broomstick — either the left rudder relay or the right rudder relay, as instructed by the bridge. I think there was a fair amount of voltage to the relays, and he would only be safe if he used a broomstick to push them down. As stated, on orders from the bridge he could hold down the one for left rudder or for right rudder. I think we did that for a few miles, and it appeared to work just fine. I wanted to continue our line on out and

gather my data, but I was overruled. The skipper said they would do well just to get back to San Diego with this very odd way of steering. We headed back to San Diego with this broomstick method of steering and made it without a hitch. That's the last time I used this vessel, and I think it was just about the last time it made a trip. Scripps, I think, decided it had better be disposed of somehow without hurting the feelings of the person who had given it to Scripps.

I will now tell some interesting things about a very odd vessel that Scripps had and I think still has, called FLIP. For obvious reasons it was named FLIP. This vessel was the pride and joy of Fred Spiess, and I'm going to perhaps hurt his feelings a little bit now in telling about this strange ship. As I remember, Fred with some other people designed it, and on a shoestring pretty much it was built. In its early stages naturally they had not thought of everything that could go wrong or happen or would be uncomfortable. It was finally delivered to San Diego and equipped to be used. I looked it over. FLIP was so unconventional that it stretches the word ship to include FLIP: FLIP had no propulsion of its own — not even a sail. It was shaped like a spar buoy with a head on it. Its principal function was to float vertically as a spar buoy to provide a working platform or space that responded minimally to the vertical component of wave motion, especially the usual swell that comes along. The head contained sleeping quarters, a toilet or head, a shower, a galley with a table, and scientific working space or platform.

To minimize its response to vertical wave motion, the diameter of the spar buoy narrowed to about half from well below the waterline to the head which had a lower diameter greater than the lower hull diameter.

I had looked at a pre-construction model of FLIP which was on display for study in Building 106 of MPL. The change of diameter from the neck to the working space head was abrupt — a 90° change of hull surface. I pointed out to Fred Spiess that if a very high swell ever reached that abrupt change of diameter, the water slap would cause a momentary stress that would likely snap off the head. He looked rather disgusted at me, saying that he was not worried about that and no problem there. I had a pretty good feeling for what the sea can do, having played with boats of all sorts since I was a small boy. I knew what a momentary stress can be given when water slaps a flat surface. Later on, once when it was at sea, there was a very high swell and one of them or two of them did slap this thing like I had predicted that it might. It began to tear loose, and with desperate effort and blowing of some ballast and some emergency welding the people at

sea got this failure strong enough so they dared flip it down to horizontal and come back into port. This problem was remedied by changing the shape to a flare so there would not be a water or wave slap causing high momentary stress. Also some struts were added there to give added strength from neck to head. I did not tell Fred exactly to his face, but I said to myself and a couple of other people, "Well, I told you so." Anyway, that problem was corrected, and the ship was made safe from that standpoint.

Due to the fact that it did flip and due to the system of ventilation, there were several peculiarities about FLIP. For one thing the galley had to be able to swing on a gimbal-like mechanism when the ship flipped so that as the ship changed from horizontal to vertical or vice versa, the deck or floor of the galley would stay level, and the dishes and food and everything would not come crashing down. To keep the galley from swinging some and from tipping a little if several people stepped in or out of the galley, a large steel pin was inserted into a special hole. Now when the ship would flip from one position to the other, it was the cook's business or responsibility to remove this large steel pin so that as the ship flipped the galley could smoothly keep its horizontal position and swing along as the ship flipped, and there would be no problem with any of the dishes, pans, or a meal that was cooking in there. When the ship flipped, it was required absolutely that everybody come up on top and be able to accommodate themselves as the ship flipped over. One time everybody was on top, and the ship began to slowly come over to the other position, and suddenly everybody could hear something like a truckload of dishes being dumped out on the steel deck. Everybody said, "Oh, no!" They looked at the cook, and the poor guy turned beet red and did not know how to explain himself. There was nothing to do but to reverse the flipping process and come back to the position that it had and go down there and see what had happened. Well, obviously, the cook had forgotten to remove this large steel pin, and all the dishes were down on the deck. We were about to have a meal; the food was all down, and it was one god-awful mess that had to be cleaned up sufficiently well so that all aboard could attempt to flip again. Right then and there, there was a new rule made. It was: When the ship had all its personnel up on top, ready to take the flipping, that the cook had to hand this steel pin to one of the responsible people there, the skipper or first mate if there was one, or an engineer. This person would declare that he had the pin, and he might hand it back to the cook, and we could continue flipping. That way there would be absolute assurance that the pin was not left in the galley when

we flipped and repeat this terrible experience. As I remember, the time that it did dump everything on the deck a number of people cleaned up the mess the best they could, broken dishes and all. The meal was ruined. The cook served some cold cuts and that was it for that meal. Next time around for a meal he had control of things, and we all got some good food.

There was another feature about this early FLIP that I absolutely hated. In setting up the ventilations and air-ducting and the blowing system for the FLIP to get air down to the engine room and any place else down there, they had inadvertently created a system in which, when we were in the vertical position the air pressure between the outside of the head — bathroom you might want to call it — and inside the bathroom or head was quite different. The air pressure on the outside was considerably greater than that on the inside. It was enough to suck the water out of the lavatory trap and to cause a blast of air out of the toilet that would blow little bits of water and whatever else was in the toilet all the way up to the ceiling. Now this toilet for obvious reasons, which I'll show now, had no regular seat, and people were expected simply to sit on the cold toilet bowl. I was instructed that when using this I would have to sit there with my legs close together so they would act as a seal over the top. One had to flush the toilet with the top sealed over, and after flushing leap off fast to avoid the water that would spray up. That might work for the fat-legged person, but I was skinny and could not close that all off. Anyway, I did try using it once. Well, with my not being able to cover the toilet bowl all the way over with my skinny frame, dirty water spray kept blowing between my legs. When I did press the flush lever a lot of dirty water started blowing up between my legs. I leaped off, and the whole mess blew to the ceiling. I decided no more of that for me. I would hark back to some of the techniques, bathroom techniques, used by Columbus on the *Niña*, the *Pinta*, and the *Santa Maria*. I simply found a bucket and lined it with newspaper, and that worked just fine. I left this miserable toilet to people who were fat enough to use it. Furthermore, I had to save face by getting some scrub rags and cleaning the material off the ceiling and make the head rather presentable again for use and not a stinking mess. No doubt these annoyances have been corrected by now, and people can go to the bathroom with relative confidence that the plumbing will work properly. No doubt Fred Spiess will be annoyed with my saying this and piqued that I would say it, but looking back these many years later, I think it was very funny and now worth telling about.

I'm going to tell something about Stan Lai that by these many years later is rather funny, but at the time it was not the least bit funny. At noon at Building 106 several of us would often gather in one office and enjoy our sack lunches along with some gossip and talk about our work and whatever. Stan Lai was sitting at his desk eating away on his lunch and sitting right on the edge of his swivelchair. It was a wooden chair, castered, and had rather high arm rests, and he was sitting right on the edge of the chair. Suddenly, the caster part below scooted back away from him, and he went down with his chin resting on the desk and the back of his head caught by the top edge of the chair back. He could not get his arms up past the big arm rests, and there he was hanging by his head, and his butt several inches from the floor. A couple of us immediately recognized his problem. We dashed over there and lifted him by his arms, allowing the chair to be removed. We let him down, and he was able to get up. I'm quite sure that if he had been eating alone there when this happened, he could have not extricated himself from this predicament, and he would have hung himself. Somebody later would have come in and found him quite dead. Luckily for him several of us were there to help him out.

Since I was talking about Stan Lai, on a lighter note I'm going to tell a little joke about him. I mentioned at the start of this story that of the original people at MPL when it started up, one was Frances Sparks, Dr. Eckart's secretary. Frances was tall and, to say the least, she was really quite skinny. One day she had just been talking to several of us, and when she left, Stan said, "I'll take care of this for canary-legs." We guys sort of chuckled, and then later on the rest of us would often refer to Frances Sparks as "bird legs" or "canary legs." We made sure we never let her hear that, because she was a really very nice sensitive gal. Her nickname around the lab was "Sparky."

I remember one time at sea when it came time for the mates — people on the bridge — to shoot the stars for a fix or position; it was a nice clear evening. One of the men spotted a very nice bright star and started to train his sextant on it. He was having trouble keeping the elevation. After about 15 seconds, we heard him let out some very vile swearing about that star. The others looked at him and sized up the situation. He had seen a satellite. It was just about the brightness of a star, good and bright, and he was trying to use that for his readings to get a fix for the evening. That was good for a lot of laughs and kidding for a while, and he was somewhat embarrassed. I never heard of anybody else trying to get a fix on a satellite until nowadays when satellites are used all

the time for very sophisticated computer equipment to obtain the most accurate sea positions obtainable.

If any of you were working for Scripps or MPL at the same time that George Hohnhaus was working at sea for Scripps, as a sort of a muscle man aboard ship, I'm sure you will remember him. George Hohnhaus was the kind of a person that one does not easily forget. He was a character in his own right. He was powerfully built — big, thickset, lots of muscles, big hands; and he believed in doing things by muscle power when working over the side or the stern of a ship instead of using cute little devices such as winches and hoists and what not. I remember that I would be trying to do something with the magnetometer or whatever, and he'd look at me rather disdainfully and say, "Here, let me show you how to do that," and he'd grab something that weighed several hundred pounds, pick it up, and set it over there or put it over the side. He was also known for being just about the most foul-mouthed person we ever had at sea. I'll tell you, when he was the least bit frustrated over anything he could swear to curl a mule skinner's ears. Of course, word of that got back to people at Scripps, including the wives of the people who went to sea. Some of the ladies decided that they would like to take a short trip out from the bay, for a couple of days at the most, and hear some real swearing. It would be a thrill. So it was arranged that several ladies could go out for the day, and, boy, were they disappointed. He clammed up; he never uttered a word except very politely. They never heard one swear word. That kept him quiet most of the time. The ladies were all very disappointed. No performance.

Another person who worked for Scripps and was a character in his own right, was Fred Dixon. Dixon was not a full-time employee of MPL, but did help with our work at sea on several expeditions. I do not know who paid Dixon's salary. MPL may have been charged for his services when on a trip that was mostly MPL activity.

On several trips we had one or more Japanese scientists aboard. Fred showed very little respect for the feelings of Japanese aboard. When he got a little teed off at one now and then he would call him a dirty Jap. I have seen the hair raise on the back of the neck of some of the Japanese scientists, but they were in no position to do anything about it. Anyway, we were on one trip near Japan and waters to the north of Japan, and Fred was insulting the Japanese right and left. They decided to get even with him for all the insults and pulled a little joke on him.

In Japan business name cards are a very important part in doing any business, meeting people, clients, and whatever. One always hands the other person his name card, business card, with two hands and makes the little bow that they do, and it is accepted. Of course, all is written in Japanese on the card. Dixon, being somewhat of an egotistical person, said to several of the Japanese scientists that he would like to have some name cards for his own use. The several Japanese scientists present said, "Why, sure, we'll be glad to do something like this for you. We will have some made for you, and you can hand them to your Japanese contacts." Here was their big chance to get even. On the cards, 50 or a hundred of them, they had something in Japanese printed on the cards. Fred obviously could not read a word of it. Several of the scientists as a group handed the box of cards to Fred, telling him to present cards to whomever he wished. Well, I would have loved to have seen the expression on the faces of Japanese to whom he presented cards. The cards read, "I am a prick." I'll bet the recipients had trouble keeping their composure. So far as I know, Dixon never caught on to what the cards said. In fact, Fred Dixon gave me one of the cards. I should have kept it, but I just tossed it away later on, like a dummy.

[For another story about Fred Dixon, listen to the events recorded at the end of cassette number six or see pages 82 and 83.]

I told about two Scripps employees whom I described as characters, George Hohnhaus and Fred Dixon. Another person who was actually an MPL employee was Willard North. He was in a very different class than Hohnhaus and Dixon.

Russ Raitt employed Willard some time in the middle of 1952 to help him do some studies of Eniwetok Island where it was planned to detonate a fusion bomb as a test of the techniques, blast power, and consequences of a fusion bomb. Willard accompanied Russ to Kwajalein from where they went to the actual island of Eniwetok and its surroundings.

I went to Kwajalein shortly before the detonation, mainly to bring back to Scripps all of Raitt's data concerning the fusion bomb test. Raitt planned to continue on with the Capricorn Expedition and would not be back in San Diego for some months. Kwajalein was almost crowded with Americans performing their various roles in preparation for the detonation and subsequent work. As part of keeping up morale the American management allowed an Indian entrepreneurial trader and merchant to bring a lot of East Asian handcrafted jewelry to Kwajalein and set up a store for selling this stuff to the American personnel. The jewelry was beautifully made and dirt cheap

compared to prices in the U.S. I bought about a dozen pieces for Carolyn and our daughter, Suzanne. Willard bought many times more than I did.

As a safe sure way to bring Raitt's data back to Scripps, I used the Kwajalein carpenter and cabinet shop and some help from the cabinet maker to construct a wooden "suitcase" with a strong handle. It was about 36" by 24" by 8" and all put together with screws. One side was designed to easily be removed by spinning out the screws. That would allow access for packing in the data and removing it as desired. I planned to take this "suitcase" along on the plane to Travis, keep in my hotel room overnight in San Francisco, and then take it along as checked personal baggage to San Diego. Loaded with data it weighed close to a hundred pounds and was very hard for me to carry.

The jewelry I had bought, I packed in my personal traveling suitcase with an itemized list, expecting to declare it when entering the U.S. and pay some import duty on it. I did that as planned — no problem. Of course, the customs agent wanted to look in the big wooden suitcase. I told him what was in it and opened up the side. Out fell Willard North's bags of jewelry. The agent looked at me. I said I could guess good and well what that was and how a Willard North had taken advantage of the situation to sneak his jewelry in the suitcase after I had packed it with data and him expecting that customs would take my word for what was in the wooden suitcase and not open it. I told the agent to confiscate Willard's jewelry, and that would be just tough for Willard. The agent thought a minute and said that he knew of the dozens of people coming back from Kwajalein and to close the case back up and he would forget it. He certainly was a lot nicer guy than I would have been.

So I proceeded as planned with the hotel in San Francisco overnight and the flight to San Diego. Upon arriving in San Diego I waited for my checked baggage. My personal suitcase was there, but the wooden suitcase was nowhere to be found. I told the manager of the airline office about the wooden suitcase — its contents and why and the very high scientific value of the data. He immediately telephoned the San Francisco and Los Angeles offices, and they could not find it. So I said I would be willing to wait till the next morning when I would come back to the manager for the wooden suitcase. I added that if it were not there, I would report the loss to the F.B.I., and all hell would break loose, with the airline investigated, especially their employees who could steal it and sell it to a foreign agent, Russian, that is! When I returned the next morning, I was promptly

and courteously taken into the manager's office. He greeted me with a handshake and said, "Here is your heavy wooden suitcase." He apologized for the line causing me so much trouble and had an employee take the suitcase out to my car. My guess is that the F.B.I. had spotted this suitcase in the San Francisco airport and used their authority to take it for investigation before letting it go on to San Diego. When I opened the suitcase, nothing appeared to be out of place. There was no damage or loss whatever. Willard got his jewelry after I chewed him out for that trick. And Russ Raitt got all his data in perfect condition.

One day after Russ Raitt had returned to his routine work in his office, he, accompanied with Willard North, came into my work area in building 106. In his halting stammering way Russ said to me that Willard was replacing me as his principal assistant and that I would fully instruct Willard in my duties and use of the seismic equipment at sea. I had invented and developed and improved and found the best techniques for using the equipment at sea. Russ said that I would become Willard's assistant, working directly for Willard. I was dumbfounded, to say the least. I listened, but said nothing. The next day I typed up and handed in my resignation to the personnel office and a copy to Russ Raitt. The personnel office told me that I would have to answer a number of questions they had and write in detail why I was quitting. So I complied. I finally severed all my relations with Scripps. I then used my time to complete the construction of my house on Point Loma. I am still living in this house.

I later found out what had caused Russ Raitt to put Willard North in charge of me. It was typical Willard North as I learned in succeeding years. Willard did have an impressive career before he came to Scripps. He was a well paid crew chief in exploring for oil and gas for a leading oil company. He had to know how to place explosives as to size and depth to obtain maximum results. He was in charge of a lot of equipment and men. When he was shooting in the swampy areas of Louisiana and Texas his crew was having great difficulty getting around to do their shooting with all the equipment that they had to have along. He drew up plans for a "swamp buggy" and got company permission to build one at the company's expense. It was simply a big platform above two huge floating drums that would turn as floating wheels powered by a gasoline engine up on the platform. It worked great, and more were constructed. Other prospecting companies copied the idea. Improvements were constantly made. Today the swamp buggy is a very sophisticated thing, low slung and running on wide caterpillar tractor type tracks.

Later in his career as a crew chief there was an explosion accident in which several men were killed. Willard was getting old and wanted to retire and live in San Diego. So he moved out here, bought a comfortable home, and settled down to his interests. He soon became restless and so obtained employment by Russ Raitt to go to Kwajalein and Eniwetok. After the bomb detonation Willard had a good chance to observe my work for Raitt and hatched up the scheme to become my supervisor. From his experience in working for oil companies he knew how to wine and dine for favors.

Willard and his wife invited Russ and Helen to his house for dinner. Mrs. North prepared a sumptuous meal and the ideal setting. Mrs. North made it a point to become very friendly with Helen and described Willard's impressive work history and suggested that Willard could do a lot for Russ as Russ's principal assistant. After a delightful evening of a fine dinner and pleasant conversation the Raitts went home, and Helen pressed Russ to make Willard North his main assistant and so forth. Russ succumbed to Helen's urging; I have been told what happened. Dr. Liebermann told me several years later that Raitt said he made a big mistake when he made Willard his principal assistant and sure missed me working as his assistant. In view of the fact that Raitt never seemed to appreciate my work for him and the relationship may have become stale with time, perhaps it all was best for me that I stopped being his assistant.

That afternoon following Raitt's demotion of me and when I was supposed to be teaching Willard how to do my job, Willard unblushingly and unembarrassed told me why he wanted his new job with Russ. He would use his time the way he wanted to. I would be doing the hands-on work. When a trip to an interesting and exotic place would come along, he would make the trip. When there was no trip he wanted to make, he could loaf around the lab while I was doing the hands-on work, and he could learn all the latest techniques and could discuss with me what improvements might be made and also do some reading of data records, something he had done in his former work for the oil companies. He said the setup was a nice "plushy" job for him. This all made me determined to resign the next day. I "kept my cool" in listening to Willard.

While I was working full time at building my house, Willard came around once or twice to see how I was doing. This sounds odd, but Willard was the kind of person who could take unfair advantage of a person and then visit later with that person with no apparent embarrassment.

Later when I was working in building 106 for Ron Mason, Willard would drop by for a chat about old times and what he had done to people and his construction of several apartment buildings on the south shore of Mission Bay.

Willard was by nature ambitious and hard working. When he retired to live in San Diego he could not settle down to loafing. He was always alert to make a fast and easy dollar. One activity to use up his energy was promoting and helping his son, Lowell, with competitive star boat racing. Star boats are a class of sailing vessels about twenty feet long. The class has a well organized committee that makes its rules and schedules the racing events, mostly on the west coast and east coast. Lowell and his dad built their own boats and did very well in the races. Lowell was a world winner several times. Several times when the races were held on the east coast, Willard and Lowell built a special trailer towed by the family car, to haul the boat and all the equipment there and back. They drove the car hard, putting a lot of wear and tear on the engine. For one east coast race they built a boat to within about an eighth of an inch of the rules specification limits. It was a sensational winner and made Lowell famous among the sailing community. Lowell made use of this by setting up a business in San Diego called "North Sails."

Willard decided to buy another family car and sell the one that hauled boats to the east coast. No used car dealer would touch that car for the money Willard wanted to get out of it, although the body and upholstery looked fairly nice. So Willard and his wife hatched up a scheme. The odometer was turned back.

They hid away from the front part of the house anything of Willard's that would reveal that a man lived there. They ran an ad in the paper reading something like this: "Elderly widow lady wishes to sell the very low mileage family car. Mint condition." There was a phone number but no address. Only Mrs. North answered the phone during the days of the ad. She discouraged callers that sounded real sharp. She wanted only women to actually see the car and at night. Mrs. North finally made a night appointment with an older widow lady. When the lady arrived to look at the car, Mrs. North told the lady that only Mrs. North had driven the car and only in San Diego. The prospective buyer accompanied by Mrs. North drove the car for several blocks in the neighborhood. The engine must have been well tuned up because it sounded O.K. Finally the lady wrote a check for the car and drove it home. The Norths never heard from the buyer again.

While telling about this car sale, Willard slapped his sides and laughed. He was real proud of getting a good price for the old car — the method be damned.

Willard was fairly smart, had an interesting history, and was a good conversationalist.

Some years ago while shopping in a grocery store I happened to meet him. He was there alone. He was showing his age. He wanted to make an appointment to come visit me and talk over old times. I never did get around to phoning him to come over. Not long after seeing him in the store I heard that he had died.

One time just a few miles off the coast here, we got a real thrill and a lot of excitement for a while. I forget just what our project was, but we had borrowed or somehow were using the NEL ship 855 or 857. It was lying to or moving slowly out there doing some work. The Navy at the same time was doing some target practice. I don't know if there had been a foul-up in scheduling or communications or what. In those days the Navy with a very long line would tow a light barge with a huge canvas on it, and that would serve as a target for cruisers and destroyers to do target practice. They were doing so on that particular day. They could not see these targets. Locating the targets had to be by radar. They got mixed up and mistook the NEL ship for the target. So all at once there was a salvo; I think three splashes out there in the water, and people on our deck thought, "Hm, what goes on here?" In a short time there were three more splashes closer. It was obvious that we were a target, and they were getting their ranges and closing in on us. The skipper immediately became very alarmed and told everybody to get up on deck or take emergency measures or whatever. The black cook came up on deck just as we were straddled, and his eyes bugged out when he saw what was going on. He took some kind of cover. By that time the skipper had got on the radio to whatever communications are set up for this sort of a thing and got orders to the cruiser, I think it was, to stop shelling; that they had a ship instead of the target they were supposed to be shelling. The shelling stopped. All this time while the shelling was going on, our skipper was taking evasive action to get away from the position that the cruiser thought was the target. Well, we lucked out that time. Our NEL ship was not sunk, and everybody came home unscathed and undamaged.

Some of you may remember Ronald G. Mason. He was an Englishman. He lived in London and he taught and did research at Imperial College of London. Anyway, he was over here because of his interest in magnetics on the surface of the earth and other magnetic phenomena

that had to do with the earth. Roger Revelle had invited him to come over here. The arrangement was that he work part time here, and he could take some trips. Then he would go back to London and satisfy both universities as to what he was doing. One time he was on a rather long trip at sea. It was very likely on the *Baird* or the *Horizon*. At breakfast time people would order from the cook what they wanted for breakfast. One might want a couple eggs over easy or fried potatoes or whatever. It was pretty much a short-order breakfast situation. Mason would usually order a couple of boiled eggs. He would eat one of them, and he would take the other one with him as he left the galley. People would notice that. What he was doing with his spare eggs was to set them up on a beam above his bunk over his head where they could not easily be seen. He had something attached to the beam so the eggs would not roll out. He was accumulating many boiled eggs up there. Goodness knows what he was going to do with them. By snooping, people found out where he was putting the eggs. My guess is that he planned to save the eggs up, thinking they would keep until he got back to Scripps and he would have one of them every noon as part of his lunch when he was working up his data. You may think that extremely odd, but if you knew Mason, he was a most frugal person; he made every penny count. He found peanut brittle at some store in La Jolla that he could buy for more calories per dollar than just about anything else. This store specialized in very large pieces of peanut brittle about six or eight inches across with lots of peanuts in them. He would buy a lot of that and at noon munch on peanut brittle while he was doing his work. He was a very hard worker. He not only saved his own money, and ate very sparingly the very cheap things; he was the same way with the laboratory research money. I remember when he found how much I was being paid at that time, he said, "Art, you should volunteer for a cut in your salary, and that would leave more money to buy equipment and whatever and to gather our data and do that sort of thing." He was very serious about that. I replied, "Well, I'll think about it." I did not think long; I just thought nuts to you.

Many of you know of Dr. Richard von Herzen, who did oceanographic work and other things. In his early days, when he was a young fellow, he worked out here at Scripps. On two different cruises he was my assistant in whatever we were doing. He liked to swim. One time when we were down around the equator out there in the Pacific it was a quiet day. We were lying to for whatever work we were doing, and the sea was absolutely glassy. I was out on the fantail, trying to stay cool and observing what was going on. Dick came out—we called him Dick in

those days — with some swim fins, and said, "I'm going to have a little swim." Knowing him, that was not unusual. I went over to the side where he was going to jump off; he was on the right hand side of the ship. I looked over the side just as he was about to step up on the railing and dive in with his fins. I looked down in the water and I said, "Hold it a minute. Look down here before you jump in." He looked down, and there was the largest tiger shark that he or I had ever ever seen. That thing appeared to us to be well over 20 feet long. Before narrating this story this week, to make sure this was a tiger shark and not something else, I telephoned the aquarium-museum to Bob Burhans who is the curator and knows a lot about sharks. I described the shark to him. I described its shape, flatness, and the stripes that run sideways and all that sort of thing. He said, "That's obviously a tiger shark. Yes, you were looking at a tiger shark." When I told him how long we estimated it to be he said, "That's a mighty long shark." He checked into a couple of books there and the limits were about 18 feet on record for a tiger shark, and usually not more than 15 feet. He asked if I were sure it was that long? I replied that I have a garage that's about 20 feet long, and that thing was longer than my garage. The shark's body was very close to a right angle with the ship's side. Our estimates of its length could have been influenced by the excitement we were experiencing. This shark, when Dick was ready to jump, was about three feet below the surface with its head toward the ship, motionless. As we watched, it let itself very very slowly settle down, apparently by gravitational forces, and when it was down low enough to swim under the ship it very slowly went under the ship, and we did not see it again. I don't know if it left the ship or not. Bob Burhans says that tiger sharks will often follow a ship for days just waiting around for any garbage that's going to be thrown over. When Dick saw that tiger shark down there, he said, "No, thanks," and I don't think he ever again attempted to do any swimming in the ocean — cold water, warm water, anything else. If Dick had jumped, he would have hit the water just in front of the shark's nose, and the shark waiting for garbage to splash would have seized Dick immediately! He learned his lesson, thank goodness.

At this point I think it's time to stop telling these cute little jokes about things and people and go back to some of the serious research that was done by MPL. So I'll take up with what Russ Raitt was doing, and how I was helping him. Using the more modern fathometers on better ships we had done a number of depth profiles, and one thing he was interested in continuing was to see if he could correlate the scattering of the return echoes and the type of bottom it was. Well,

that correlation was not very much. While doing this he noticed that in some places there was the regular bottom echo and under that was something giving a second reflection and sometimes a third below that, and that jogged his interest.

Maurice Ewing of Columbia University had run a reflection profile across much of the Atlantic, using near-surface explosions and a receiving hydrophone to listen to the echo off the bottom. To greatly improve the signal-to-noise ratio, Ewing would allow the hydrophone to sink away freely just as the echo was due to return. The return showed the first bottom which would be usually sediment and then something below that which would give a second reflection and sometimes a third reflection and a fourth. That was really quite interesting. It showed that there was structure down there, horizontal structure, and it could be studied. Learning of Ewing's observations, Raitt was interested in doing the same sort of thing out here, but he had no equipment. He did not like the way Maurice Ewing was doing it, having to give complete slack on the hydrophone every time an explosion's echo was due back. He wanted to try something that would be much easier. He really did not relish the idea of crossing thousands of miles of ocean constantly throwing explosives in the water and then paying out this hydrophone to keep it quiet from water noise. So he had me rig up something, and we went out to sea not very far from San Diego and tried our luck. Well, the noise was just horrendously high. Anything that we towed in the way of a hydrophone had a towing noise that was so loud that it masked out the return echoes. It was a case of very high noise-to-signal ratio. He was discouraged. He said, "Well, Art, it looks like we're not going to be able to do this sort of a thing under way." He went to his office to do some thinking about the things he could do, and I said, "Russ, let me try to see what I can do with this problem." He said, "Go ahead. You're on your own." At that time we were in Building 106 over at the waterfront at NEL. We had available to us two or three Navy picket boats; I forget the exact designation for them. They were about 30 feet long, diesel-powered, and good near-shore work boats. Each had a Navy crew that consisted of the man for the wheel and an engineer, and sometimes a line handler. Those boats were getting very little use, and NEL was glad for anybody to use them that could, to substantiate their being kept there including the expense. I got permission to use them. I devised two schemes to tow along side by side so I could test one against the other. I loaded my gear on one boat and went out a few miles. I started recording while we proceeded along very slowly, say at 3 or 4 knots. The noise was high on both schemes

but more on one than the other. I was beginning to have a handle on this. I came back in and tried an improved scheme on the one having the most noise. I took these two schemes out to test in the same way, using the first one that was less noisy and substituting in its place my next try at a quiet towed receiving hydrophone. In some cases my hopefully improved scheme was better, and in some it was not. I began to get some real improvements.

I remember one day we were just barely moving ahead, and a signal began to come in that was very low frequency; I would say something about 2 or 3 cycles per second. It kept increasing. It was on both hydrophones. So it was not noise, for sure, and it ran along there for about a minute, and then it began to die away slowly. I showed this to Russ and several other people and said, "There's something interesting going on out there; this is a real signal and not noise at all." But nobody seemed to be interested; so I did not pursue that further. I never noticed that again while working out there. I have no idea to this day what was the source of that sound or signal.

I reasoned that perhaps I needed something to keep the ocean water at the surface from yanking the line to the hydrophone up and down and creating noise, and then something down there where the hydrophone was — say, something streamlined or whatever — that would not generate noise from water flowing over it. After tries of various things I decided to try a spar buoy. It was formed by Archie Dunlap in his shop, and the welding was done up at the NEL shops. The buoy was about 5 or 6 inches in diameter and about 5 feet long. The idea was for the hydrophone's electric cable to extend aft about a hundred feet to the lower end of the spar buoy and from there down to a weight and then about 20 feet to a neutrally buoyant streamlined hydrophone. The electric cable from the weight to the hydrophone was made buoyant by a little float taped to it every 2 or 3 feet. To make the hydrophone neutrally buoyant it was attached to a 5-foot-long, 2-inch piece of aluminum pipe. The front end was round and the tail end was tapered for a streamlined shape, and the hydrophone was clamped to that with clamps that would make the least amount of drag and all. This was all worked out by trial and error. That device had a surprisingly low noise-to-signal ratio if it was towed at less than one knot. But the slow speed defeated the original purpose — to steam at 4 or 5 knots for reflection shooting profiles. I agreed with Russ that long reflection profiles were not practical. By 1970 and at present time with the latest state of the art equipment, reflection profiles obtained at 10 knots are common.

So Raitt's interest in refraction shooting with my listening techniques was chosen as the work for the years to come to learn about the structure of the oceanic crust. The dividends were very good. Refraction shooting requires a shooting ship or boat and a listening ship. There is no point in describing here the techniques of refraction shooting. That is all in the literature. In using this listening gear and techniques, we were always making improvements. We would sometimes use two and maybe three listening hydrophones at different distances from the ship. It helped to have the long cables out to the spar buoys floated by taping five-foot-long floats to the cables and spaced twenty or thirty feet apart. There were many more little improvements always being made — too numerous to be mentioned here.

Russ depended on me to invent and develop the physical aspects of his gear and equipment. I was of the inventive sort and had a talent for this and was quite successful. In telling and reporting of our work and accomplishments, Russ and I each saw things from our own perspective. Raitt was the senior person, the Ph.D., in charge, and I let him take full credit without complaint in his reports about his work. Looking back, Raitt could have improved morale and motivation by briefly giving credit here and there in his formal publications. I think he was just rather absent-minded about these things. I will tell about some things of human interest that happened while doing this work.

I remember at one time we were out in the central Pacific. Russ wanted to get a really really long line because the longer the lines were the farther down we could study the structures. He wanted to go all the way down to the Mohorovicic discontinuity. We decided to really use up a lot of explosives on that one. We carried a load of explosives that could have blown the ship sky high. We had to be very careful with our load of explosives. Anyway, he had the shooting ship go to a great great distance. He had the people on the shooting ship make up a charge of four or five hundred pounds — an immense charge for us. We had a recorder for listening to that. It was a rather cranky old thing. It used a paper photographic tape that was 6 inches wide as I remember and thus could carry a lot of channels. We had an electronic stack setup; it would filter and transmit to the recorder the various frequencies so we could get a good handle on analyzing the transmitted sound. There was one channel that let through the low frequencies clear down to about one per second. It came time for this huge charge to be set off and everything was going fine. We had not set up our communication well between Russ and myself while both of us were standing

by the recorder. He had in mind that he was to turn on the recorder at the proper time, and I had in my little mind that I would turn on the recorder. There we were, both standing by the recorder. It came time to flip it on, and Raitt flipped the toggle switch, and my mind set was so strong that I reached over and flipped the switch again, which turned off the recorder. Russ yelled that I had turned it off, and with desperate fumbling turned the recorder back on. Russ was just a second or so too late. We had missed the arriving signal by one to three excursions of the recorder pen. I was mortified, and I said, "Russ, this is very important. Have the shooting ship turn around, go back a ways and drop another 400-pound charge." He said, "No, we don't have the explosives and time, so let's just continue." He was the boss. We let the shooting ship continue, and we went down to smaller and smaller charges. Otherwise we got a good profile there, out to both directions. I'll never forget about having goofed and lost that signal from the 400-pound charge. I'll tell you that it is critical when there are two people operating an instrument, to make sure who does what, and not get two people trying to do the same thing with one cancelling out what the other does.

In some of our early seismic work we needed a qualified expert to handle our explosives. Russ and I definitely were not experienced at all, handling fuses, electrical explosions, or whatever. We requested from the Navy a qualified expert to do and supervise our explosive detonations. The Navy assigned to us a chief gunner's mate. He was old and about to retire, and we thought that he would know a lot about it, having done this all his life. We found out differently after he started working for us and handling our explosives. One of the first jobs he did for us was when we were slowly moving our small steel-sided ship along, and he was to make up 5-pound charges and heave them out as far as he could from the side of the ship. He made up the first one, put a fuse on it, and heaved it out. He made up another one, heaved it out. Apparently his arm was feeling the effect of throwing, so he did not throw it quite as far. He did another one and did not throw it quite as far away, did another one, did not throw it quite as far away. I thought he was blowing the ship up. He'd got the last charge just a ways over the side. He had loosened the steel plates enough for leaking to start. In port they had to be welded back in place. So he was instructed, "For Pete's sakes, throw those things a long ways out. If you can't, have somebody else do it."

Another time we were working near an island, Guadalupe, I think. The gunner's mate and I were to set off charges in shallow water near shore, and Raitt to record the refracted signal starting at the maximum distance and then at distances closer and closer, having to stop and pay out the listening gear at each location — a one-ship refraction operation. For the maximum distance shot we were instructed to make up a 200-pound charge; we had good radio communications between our shooting boat, a powered life boat, and Russ on the ship. Being in the lee of the island we had calm water. All charges were to be electrically detonated. I helped the gunner's mate assemble and bind with much heavy marlin the 200-pound charge. An electric detonator with about ten-foot wires was included. A light manila line was attached to the big charge for lowering it to the 20- or 30-foot bottom, and I provided the mate a long, two-conductor shooting wire. I turned away to work with the radio and arrange gear while the mate was electrically connecting the two 10-foot detonator wires to the two shooting line wires. The heavy charge was just over the side as he made his connections. He finally said he had it connected. I looked at his connection with lots of friction tape around it, and we lowered the charge to the bottom, and then while paying out rope and electric line slowly moved a couple of hundred feet away. I radioed Raitt that we were ready to detonate. He said to fire! I pressed the button and nothing happened. I told Russ to hold while we went back to the charge and find what was wrong. When over the charge, the mate and I pulled it to the surface with the manila line, and I opened the mate's electrical connection. He had twisted all four bare wires together which made a dead short in the connection. I thought, "Jeepers, creepers, what does he know?" I got scared about working with him on such potentially dangerous gear. I said, "Look, let me show you how to do that. Now you've got to connect one detonator wire to one detonator line wire and one detonator wire to the other detonator line wire to have a complete circuit. The current has to go down one and come back on the other. You can't have all four twisted together making a dead short." We repeated the operation of lowering the charge and moving a safe distance away. I radioed Russ that we were ready to detonate, and he said "Fire." There was a proper terrific explosion. It turned out that the old guy, the gunner's mate, knew nothing about handling ammunition; how he ever got his stripes and qualifications as a gunner's mate I have no idea.

I will continue here with a few more amusing stories about this gunner's mate. He should have been retired. I think he was staying as long as he could to get the most he could out of the

Navy. He had married a very young wife not too many years before; I think that was his first wife, and he had several children. His problem was to feed and clothe them. He grabbed on to all food that he could to take home to help out with his grocery bill. One time we were on a relatively small ship and had been doing some seismic work for Dr. Raitt, close into shore, not far from San Diego. We were lying to, waiting for something. He was looking over the railing on the port side, and he saw a school of fish come by. He yelled out, "Look at those fish!" He yelled so loud that he spit out his false teeth. He made a swing to grab his false teeth, did not quite catch them, but he went overboard. We reached down and pulled him up on the deck. He had no teeth, and he was wet. The sight of fish had excited his mind because there was some food going by. I think they were large mackerel. He went on home that night, sans his teeth. That meant he had to go to a Navy dentist and get some more dentures made, which he promptly did, and he was soon back to help us.

Later on, Raitt and I with help by this gunner's mate were using fuse detonated explosives aboard the *E. W. Scripps* a few miles off shore from the Mission Bay area. When it came time to come home for the day the skipper sailed through the kelp beds near the Point Loma lighthouse. Suddenly right in the kelp bed we heard a muffled explosion in our wake. We looked back and saw a plume of spray rising from a charge that was five or ten feet deep. The mate without telling us had tossed in about a five-pound charge. This gunner's mate yelled, "Stop!" So the skipper immediately stopped, and the gunner's mate said, "Let's get all those fish!" Sure enough, there were fish floating up everywhere. I did not realize those kelp beds contained so many fish. There were sheepshead coming up. There were kelpfish, mackerel-type fish, and half a dozen other species. Well, there were all those fish, and they were going to go to waste because those fish were dead or dying. So, the crew put over a dinghy and they started rowing to where the fish were. The way they picked up the fish was that one person leaned over the bow of the dinghy as the other person rowed. He'd pick up the best fish and throw them over his back, and they'd land in the dinghy. After a while the dinghy was down to where it had almost no freeboard left. It came back to the *E. W. Scripps*, and the fish were fast and furiously thrown aboard. They went back for another load. I'll tell you, two dinghy loads of fish loaded down to the gunwales were a lot of fish. We threw the fish on the deck, hauled the dinghy back up on deck, and proceeded to go on in to port and tie up where the pier was at 106. It happened that the *E. W.* had a lot of

gunny sacks, potato sacks, aboard. Everybody who wanted some fish started filling potato sacks. Russ Raitt had a family to feed, so he filled a gunny sack clear full. Those gunny sacks hold a hundred pounds of potatoes; they held a whole lot more than a hundred pounds of fish. When it came time to lift it; no way! He could not even get it off the deck. So he had to find a couple more potato sacks and distribute his fish. The gunner's mate grabbed enough potato sacks to provide fish for his family for a long long time. I took two or three of the nicest sheephead. Several other people took a lot of fish. I think everybody was satisfied they got all the fish they could use. As stated, we proceeded on in to the dock, and people took their fish ashore. I was a little worried and so was Russ about what might happen if anybody saw us killing and taking the fish. Sure enough, the next day we got a call from some officials that have to do with protecting the fish in the kelp beds and bombing. Somebody ashore about where the lighthouse is up at the top had seen us come by there. They saw the explosion. They saw the fish come up. They saw us picking the fish up, and this was all reported. We were reprimanded, very definitely, but being on government business and all, it was sort of smoothed over. Nobody had to go to jail or pay any fines. It was not our fault except for that silly gunner's mate. He never told us he was going to do that; he just figured that if he dropped a charge we'd go back, and he'd get some fish, which is exactly what happened — plus a bonus for the rest of us.

We'd had enough of that gunner's mate. He was nothing but trouble. He did little anyway, and he was dangerous. He knew nothing. So the Navy withdrew his services from us, and I never saw him again. Thank goodness. I have no idea how long he stayed with the Navy before he retired, but no doubt to the very last day to get all he could out of the Navy.

In telling about the almost useless chief gunner's mate that was assigned to Russ Raitt and myself for our seismic refraction shooting, I related how he set off an explosive charge in the kelp bed near the Point Loma lighthouse and the big harvest of fish killed by the explosion.

In doing any kind of explosions in the ocean all sea life near the explosion is killed. In the open seas there are not many creatures nearby to be killed and noticed, but near shore one explosion may kill hundreds to thousands of mostly fish. Russ and I did a fair amount of seismic shooting near shore, and it hurt my sense of responsibility toward nature and life to kill so many fish and sometimes ducks, seagulls, and perhaps a seal. I used to think that we might arrange to

have a local fisherman be on location with his nets to gather in all the fish and market the fish for either human consumption or commercial animal food.

One time working near Benitos Island, I think it was, the first explosion brought up only half a dozen small fish. I was happy to see that I was not killing a lot of fish. The second charge brought up two of the largest barracuda I had ever seen — about six feet long. Barracuda are good eating. So I pulled them into the boat. The big barracuda had been attracted by the small amount of fish food. The next explosion brought up another one or two, and I pulled them in for use in the ship's galley. The following three or four charges yielded about six more big barracuda, and I saved them. On this trip Russ and I were using the Navy's 857 or 855, and there were a lot of people aboard to eat fish. That afternoon about four o'clock the barracuda were taken aboard. For supper the cook used only two barracuda to make all the fish steak we could eat, with some left over. The steaks were big and delicious. People thanked me for the great fish dinner. That was enough fish steak for the time, and the remaining barracuda were frozen for later use. I do not remember any more fish being served on that trip. Perhaps we returned to San Diego from that seismic location.

I had better get on with stories and accounts that have to do with Russ Raitt's seismic work. As you well know, the use of ships is very expensive; that's the most expensive part of doing research in the oceans. Russ was forever thinking up ways to get by with just one ship instead of two. One time he decided that he would put me in a lifeboat and I would detonate the charges. He gave me a lifeboat with a lot of explosives. I knew how to handle them by then. He steamed away in the main ship. We had radio communications, and he was to let me know when he wanted a charge dropped, how large, and everything. None of them were really big charges, because I could not put a heavy charge in the water. He steamed away over the horizon out of sight. He was going to stop each time and listen when I set off a charge. That would work just like it did with two ships, except the explosions would come from a very small ship, the lifeboat, and he would have to stop and listen with the larger craft every time. I forget just how far north or south it was, but it was not cold, and it was a dead calm. I got to thinking, if our radio communications broke down, boy, would that be one lonely place out there. That's the only time in my life I have known what it would be like to be lost at sea in a lifeboat. Nobody would know where I was, and nothing to eat. I had a sandwich or two with me and a very little water that day.

I tell you, that gave me an eerie lonely feeling. Luckily, the communications did not fail, and after working there for a long time, a good share of the day, Russ's ship showed up over the horizon. There were a few more charges to drop, and then the lifeboat was pulled aboard. I decided right there, that was the last of doing it that way. There were too many things that could go wrong. For one, as you well know, at sea a storm or a squall or wind can come up suddenly, and a lifeboat like that is no match for a choppy sea; the lifeboat could be turned over, and that would be the end of Art Raff, unless I had a very good life vest, no sharks, and Russ would be able to find me somehow.

Another time at sea Russ was using a lot of sash weights; Chris Baldwin obtained them for him from a local foundry. They did not want to sell her sash weights. They said sash weights were antiques; nobody built windows that way any more. She said she was aware of that, and they were not going to be used for windows; she wanted them for weights. A sash weight is a cast-iron cheap sort of thing about an inch and a quarter in diameter. They come in several lengths to give several weights, just enough for two of them to balance a sash window. There is a sash cord that runs from the window up over a built-in pulley and back down to the sash weight, and that's used for making windows easy to slide up and down. Anyway, he wanted these sash weights to make his charges sink faster and to have a better control of things. Aboard there were several tons of sash weights. Russ and assistants were making up charges with weights and dropping them over the side; everything was working just fine. Crewmen were observing what was happening and noticed that once in a while a shark would be damaged, blown up or whatever when the charges went off. They got the idea that while we were lying to, they'd have a little fun. They tied quarter-pound charges with fuses to some weights. They threw some food in the water, and in no time at all there were a lot of sharks going into a feeding frenzy. They threw a fused charge in the water, and some shark immediately would swallow it. I don't think they even used weighted charges all the time. They just threw a quarter-pounder with a short fuse on it in the water, and some shark would grab for it and swallow it, and it would almost immediately go off and blow the shark's stomach out. Then, they threw some sash weights in to see what the sharks would do, and a shark would grab at a sash weight and swallow it, and it would fall right out the bottom of the shark's stomach. Apparently those creatures have very little sense of pain, especially if they are in a feeding frenzy, because they would do that repeatedly; swallow a sash weight, and

it would drop out the bottom of their stomach. Crewmen then decided to try something else. There were sharks around that still did not have their guts blown out. They would just toss to a shark a sash weight, and the silly shark would grab and swallow it; no problem. So then they'd throw another sash weight to the same shark, and it would swallow that one, and keep on repeating that until the poor shark was beginning to tread water, so to speak, to stay up at the surface. Finally, when the shark could not manage to stay at the surface any more, it would slowly sink down. I do not think the sharks were able to regurgitate those sash weights, and no doubt sank all the way to the bottom of the ocean. A new experience for a shark. I have no idea how long a shark stayed conscious or alive as it went on down. Crewmen sank several sharks using up a lot of our sash weights. We had to call a halt to that fun; we needed the sash weights for the regular scientific work and not for sinking sharks.

Another time Russ Raitt wanted to take the *Saluda* down to the area of Guadalupe Island and do some work there. This being a sailing ship, it would take a long time to get down there. We were going to have either the 857 or 855 with us. It was decided that they would give us a tow, and that would speed things up a lot. So when we got out of the harbor a good long line was attached from the Navy ship back to the *Saluda*. It was made secure somewhere around the bow. The skipper of the *Saluda* expected that he would be able to direct the speed of the Navy ship. His sailboat was also Navy. The skipper was a warrant officer with lots of sailboat experience, and he knew how to handle the *Saluda* very well. We said we were ready, and the Navy ship started ahead. Things were going just fine, and then the Navy captain increased his speed a little without our asking for it, and then increased his speed a little bit more. If you've had experience with the shapes of sailboats, sailing ships of the type the *Saluda* was, you know that when they go fast they do not plane, but the stern goes down in the water, and the bow comes way up. That's exactly what the *Saluda* did, and as the skipper of the towing ship kept increasing speed, our bow kept coming up farther and farther. Finally we were essentially riding on the stern with the bow high in the air. The skipper of the *Saluda* got on the radio and tried to call the skipper that was towing us, and the guy — I don't know — must have turned his radio off or something or was not listening, and increased the speed a little bit more, and the tow line began to pull the bow off of the *Saluda*. Several structures began to come loose and our skipper on the *Saluda* was frantic. I can't remember if it was a line that could be cut with an axe or a steel line that could not be cut with an

axe. In any case, if it were some kind of a steel line, it would be very dangerous to get out there and saw that in two. A person might be there just as the bow was pulled off the *Saluda*. Finally, our skipper got through to the towing skipper and got them stopped. Boy, was he mad. Being a junior officer to the skipper of the towing ship, he couldn't express too much anger, but he was certainly able to show his feelings without saying anything directly. Well, there we were. We had a damaged bow, but it was not completely pulled out. The towing skipper learned his lesson. We attached a line again, back to some stronger parts of the ship. The instructions were that communications were to be maintained at all times and that the command for speed and direction and all would come from the *Saluda*. We made it on down to Guadalupe Island. That's a long island, very high and rather rocky. It had goats and cats and mice and the Guadalupe cedar which were becoming extinct at that time because the goats would eat all the seedlings that came up — too bad to lose those majestic cedars that were growing there. I have not been there for a long time, and it's very likely that the last one has died of age and fallen over, and that's the end of the unique cedars. When we got to the Guadalupe area we did refraction shooting with the powered ship dropping charges and the *Saluda* listening. The crewmen lashed some structural pieces to the bowsprit to make it possible to safely use any of the sails for our making way as necessary. I cannot remember for sure whether we returned to San Diego under sail power or with the Navy ship towing us. I think it was by only sail power. I certainly regret not having kept a personal work diary during my career. When we finally got back to San Diego the Navy sent the *Saluda* over to wherever they send ships to have expert carpentry done on wooden ships, and it was fully repaired — new hardware, new wood, and beefed up some to make it stronger. It came back over to the NEL waterfront area by building 106 and was in service again.

Another time we wanted to go down to Guadalupe Island and do some work with the *Saluda*. The plan that time was to go there under our own sail power. It took quite a while to get down there, but we did some useful work on the way as I remember. We had to put up with all this business of beating and tacking and everything else with the huge sails. Finally we got to Guadalupe Island. We put into a something that one could just barely call a harbor at the south end. We carefully worked our way in there and put an anchor down from the bow and one at the stern. There wasn't room to allow the ship to swing around 360 degrees on the end of a bow

anchor, so we had to be tied down to the bottom both fore and aft. Luckily no big storms came along, and that worked out just fine.

Raitt wanted to have some pictures of what we did, not human-interest pictures, but technical pictures of how we were handling the lines and that sort of thing. I checked out a good 35-mm camera with color film from the NEL photo lab and took it along to do the things that he wanted recorded on color film. I did that. Since I had a camera and a lot of film I took pictures of Russ on deck fiddling with the gear and handling hydrophones and following the cable from one section to another. He was not aware that I was taking his pictures. Several other times unbeknown to him when he was working I'd take pictures of him. I have always felt such shots make the best kind of photos of people; that is, when they are not aware they are being photographed, and they're working casually, paying no attention to the camera. When we got back to San Diego I had all this stuff developed at NEL. They gave us the master copies in color. I handed them to Russ, and he went through them with a little machine we had to enlarge them so one could see them easily. He saw these pictures of himself, and he was really flattered. He said, "Boy, I didn't realize I took such good pictures. I want a copy of all those. I think we're going to have to get you a camera and have you take all sorts of pictures for us on all our trips." Well, that never happened, but anyway, Russ was impressed with my ability as a photographer, both for official things and casual pictures. I did obtain a set of color transparencies for Raitt's personal use.

As I mentioned earlier, the *Saluda* had a warrant officer as the skipper. Directly under his command was a chief bo's'n mate. He also was well experienced with sail and a capable chief for handling the sails and all deck operations. He was a big, well built, athletic type man. He also was a no-nonsense driver of the deck hands. Among the deck hands, he had the nickname of Captain Bligh, borrowed from the story *Mutiny on the Bounty*. This nickname was not used to his face, but most likely he was aware of this reference to him. In spite of all this, the personnel assigned to the *Saluda* considered it good duty. Where else does a navy man get to live on and operate a large plush sailing yacht that has little sea duty?

I remember another time when the *Saluda* was coming to tie up, the first mate was handling the ship, I think, and he lost control of the engine. He was coming in using the small engine for docking, and he did not get it stopped in time, and he rammed the *Saluda* right into the pier. The

piece that extends forward out there, called the bowsprit, was high enough to be just over the top of the pier, and the *Saluda* rode up on the pier and then slid back away. That again severely damaged the bow area, and the *Saluda* had to be sent over for expert carpentry work and everything restored and made a little stronger than before. So the bow area of the *Saluda* kept getting stronger. That was the last accident it had. I do not know what the fate of the *Saluda* was. I've lost track of it completely.

I will tell about the time an experienced smart Navy skipper saved me from serious injury or drowning. Again Raitt wanted to do refraction shooting with only one ship, this time to the east of Guadalupe Island. The ship was the 855 or 857. The Navy ship was to be the listening sound-recording vessel and would have to stop at each listening station, stream the hydrophone, and notify me to fire the charge. The sea was fairly calm. The deck hands of the Navy ship readied a powered lifeboat, helped me load it with my radio communications equipment, some sandwiches and water, explosives for the day, and fuses to provide time for me to lift a charge over the side of the boat and pull away a safe distance. The skipper provided an experienced lifeboat man to operate the engine and safely handle the boat in both shallow and deep water. The deck crew lowered us to the water. I was to drop the charges in water about twenty feet deep where they would explode on the bottom. I noted rocks and trees in several directions that I could line up so as to drop the charges in the same place. Everything was going fine until about noon when suddenly a very strong wind came from the north.

Almost immediately there was chop about two feet high. I quickly secured the gear as best I could. The boatman pointed the boat into the chop to minimize water coming into the boat and at the same time worked the boat away from the beach out into deep water where there was less chop. I had radioed the skipper and Russ to come rescue us from the worsening situation. Out in deeper water high steep waves were developing. By the time the ship arrived the boatman by keeping the boat pointed into the steep waves was just barely keeping us afloat. The Navy ship arrived for rescue. There was no chance that in such rough seas we could attach the pulley block hooks fore and aft to our boat.

With the bullhorn the skipper told us to hang on and ready the slings to quickly attach to the pulley hooks. With full power he circled us twice at the smallest radius possible. That knocked down the waves to a slick. He stopped the ship downwind of us and yelled for us to hook up

quickly while the surface was slick. We did so and were hoisted up to deck level and tied fast to the rail or whatever was there to lash to. We were safe and a little wet. With the ship moving ahead slowly for least roll, we unloaded and got the gear inside. The deck crew brought the boat over onto its rests and made it fast. No more shooting that day.

I say again, it is very dangerous to put one or several people in a small boat to work either near a rocky coast or in open deep water while the mother ship sails out of sight.

One time when a ship of ours, either the *Baird* or *Horizon*, was in Honolulu, one of the crew who liked to drink — he was Portuguese; he talked with an accent — went ashore and imbibed entirely too much alcohol and came back to the ship very late, probably past midnight, in a drunken stupor. He was going up the gangplank to come aboard, and he fell off. He fell down in the water. He either did not know how to swim or was too drunk to swim, and the poor guy simply drowned. Some time the next forenoon somebody saw a body down there, and he was fished out. That was the sad end of this particular crewman. I can't remember what was done with his body, whether he was embalmed and sent back to the states or what.

When the U.S. was getting ready to test the fusion bomb, Russ Raitt was asked to run a line, I think mostly reflection shooting to see what was there in the way of the geology so they would know more about the effects from the bomb blast. Russ was provided a Navy ship of which the officers had little experience working with scientists. The skipper of the Navy ship was told that Russ would tell him where to go, how fast, and when to stop. There may also have been some refraction shooting with the charges set off in shallow water near shore. So they proceeded from very near shore to the north farther away from shore. As you remember, Russ was sort of a stammering type and he would tell the skipper in his stammering way that he wanted to stop and do something, and then change his mind, and after two or three times of that the Navy skipper decided Russ was some kind of a bumbling fool and did not know what he was doing. So the Navy skipper simply fulfilled his minimum requirements by steaming on north as far as he was supposed to go, and paid no attention to Russ. Russ just watched the ship go out farther, turn around, and come back. Poor Russ got off with his gear. Russ had obtained some useful information before the skipper would listen to him any more.

Some of you no doubt remember Max Silverman who died some years ago. One time when I was aboard, I think it was the *Baird*, we were well out in the Pacific in tropical waters. I

forget what island we were near, but anyway, Roger Revelle was aboard, and Max and I were aboard along with other science personnel. Max was a very good cartoonist; he seemed to be rather sensitive and ashamed of the fact that he liked to do cartoon work. He preferred to be thought of as a scientist or a ship designer. But in my mind Max was a better cartoonist than he was of the other things. He should have made a career as a cartoonist. The type of cartoons he did were not the fast type that are just slung off having smooth lines. His were very meticulous. They would show all the joints. If it were a hand, there would be all the knuckles in the hand and fingernails. Facial features were in bold rugged detail. It was very easy to recognize the person that he would be drawing and of course what they were doing. One time he drew a picture of Roger Revelle doing something aboard. It was excellent. I wanted it to hang up on the bulletin board. He said, "No, I don't dare do that. That's Roger. I'm not going to take any chances on that." I said, "Give it to me," but he wouldn't do that either. I should have swiped it before he tossed it over the side. Then he did some cartoons of some of the ship's personnel and some of the rest of us. He never drew me as I know of; he perhaps drew me and hid it from me. These cartoons were excellent. I've seen him do this once or twice at other places, and again they were always excellent cartoons. It's too bad in a way that he was sensitive about doing his cartoons; he should have done a lot of them and saved them and published them and maybe done that for a living instead of what he did do.

Another incident that had to do with the fusion bomb: When it went off I was aboard the *Baird*. Our ship was to be a long ways away, and I was to do some listening perhaps for something acoustic coming through the water. Mainly we were just to be a long ways away in a safe place. We had the time at which it was to be detonated, and we all sat there waiting to hear the blast, but when it finally arrived at our distance the only thing we could detect was just one sort of a slow breathing of air pushing in through the portholes and then back out. Our other ship, the *Horizon*, was much closer. The meteorologists figured out just which way the winds were going to go at various elevations and that ship was told to proceed, I think, to the south where it would be clear of the fallout. Dan Gibson was one of the people aboard. Anyway, when the fusion bomb detonated, the winds changed at the time it detonated. The very dangerous radioactive material went down toward our other ship, and it rained down heavily on them. The ship was terribly contaminated. Of course they radioed in what had happened, and they proceeded away

from that area of falling radioactive material. When they got to where there was clean water they hosed the ship down thoroughly and scrubbed time and again while hosing. Everybody's clothing that was badly contaminated, instead of being laundered, was bundled up with weights and thrown overboard. Finally when the detectors that were put aboard to measure radiation showed it down to the level where it satisfied the people in charge of that sort of thing, the *Horizon* was returned to the planned cruise operation. I think they kept track of the personnel for a while to see if any ill effects resulted. As far as I know, there was no damage to any of the people who got the fallout on them.

The latter part of 1952, as I remember it, Russ Raitt and I had a disagreement about hiring practices, and I thought that I got the short end of the stick. So I simply handed in my resignation. I've never particularly held that against Raitt. I think that he fell for the line of a slick operator and regretted it later. Anyway, I completely severed my relation with Scripps, and I used that year to build the house I'm living in right now. I had built part of it with comp time before that. I had rough finished the garage, the driveway, and foundation. Then when I resigned from Scripps I went at it full tilt. I had fun designing it and then constructing it; strictly an Art Raff job. After the house was finished just in time for my son, Charlie, born December of 1953, I needed employment again because I'd pretty well used up my savings. So I went out to Scripps to look around and see what might be happening there and what they might be able to use me for.

I will now give the background involved in my employment. R. G. Mason — I'll just call him Mason from now on — was at the Imperial College of London where he was an instructor and did some research work. He was acquainted with the work that P.M.S. Blackett had done with astatic magnetometers. Mason was interested in that. Maurice Ewing of Columbia University had towed a magnetometer of his design across much of the Atlantic from west to east and recorded a profile of the magnetic intensity at the surface. Some rather interesting and startling things had shown up. Of course, if they went over a seamount, that showed very nicely on the profile record, but a lot of the time there were anomalous changes of magnetic intensity with no seamount there. That rather stumped people. Maurice Ewing did nothing about it at that time. But Mason found out about this and was very interested and considered that to be a new type of research that he should get into. He was contacted by Roger Revelle about the possibility of doing that. Revelle wanted Scripps to broaden its field of activities and go into new lines of research. So he suggested

that Mason come over here. They made some sort of an arrangement whereby Mason would do magnetic work with Scripps funding. Revelle wanted Mason to come over full time, but Mason did not want to do that. He felt more at ease and more at home if he stayed with his teaching commitments at the Imperial College of London. So they struck a compromise in which Mason would spend about half his time at the Imperial College of London, meeting his teaching requirements and the other half over here doing research in magnetics. His idea was to use a towed magnetometer although that was not the only instrument that he planned to use. Roger had told Mason of my need for a job, and Mason called me for an appointment to discuss employment. I talked to Ronald Mason, and he decided that, considering all the experience I had here, and that he was impressed with what I had done for Russ Raitt, he would make use of me. So I was employed. As stated [later], R. J. Smith had built from schematics provided by Van Allen the electronics for a fluxgate magnetometer.

I'd better give some detail about how these instruments came about. During World War II there was a terrible submarine menace, and the Navy had commissioned several people to develop something with which they could hunt submarines. Vic Vacquier had done some work for Gulf Oil to adapt the fluxgate principle for use in prospecting for oil. With Vacquier working for Gulf Oil the fluxgate was to be made into a submarine hunting device. A Navy plane with the detector suspended well below the plane on an electric cable would go back and forth over the ocean looking for an anomalous signal which would indicate that there was a submarine down there. It was Navy policy at that time to always have two sources of any type of instrumentation, and for use they picked the one made by Gulf. The other was a back-up to meet the requirements of having two sources for instrumentation. They had Western Electric, as I remember it, build the back-up magnetometer to detect submarines. A number of those were built and simply put on the shelf to meet the requirements. After the war was over the Western Electric instruments were declared surplus, and they were available for free to any scientist who could make good use of them.

There was a group on the east coast headed by Van Allen that decided to build one or two for geophysical magnetic work. He changed the wiring in the submarine detector enough so it could be used for a fluxgate magnetometer to do this geophysical work. He worked out the basic principles of the conversion and drew the schematics and specifications. Anyway, Mason got hold

of all these instructions by Van Allen on how to convert the Western Electric equipment to fluxgate geophysical work. That's what he was having R. J. Smith do to the electronics, and I was to build the fluxgate part and all the supporting components and over-the-side hardware. Then Mason immediately went back to Imperial College of London, England to do some teaching commitments that he had there.

My first job was to take the electronics part that R. J. Smith had built from some schematics and some hardware provided to Mason and build a magnetometer for Ronald Mason's use. Magnetism was something that I had never given a second thought to up to that time, and it hit me cold. I read one book Mason had given me, something about fluxgates and the earth's magnetic field and the gamma, the geophysicist's unit of magnetic field intensity. I wasn't doing very well, and Mason was not there to coach me at all. So things rather slid along until Mason came back. Using some materials that Van Allen gave us and some materials I purchased and with the specifications by Van Allen, I went down to Archie Dunlap's machine shop. Archie was a very competent machinist with many years of experience in shop techniques and the physics of treatment of materials. We carefully went over all the specifications and discussed what he would have to do to achieve our goals and build the fluxgate and all associated hardware.

This is not the place to tell how to build a fluxgate magnetometer, so I will only touch on interesting high points. Using a special kind of glass, Archie had to make a spool about 3/8 inch wide at the flanges and 1-1/2 inches long with a hole in the center to take the heat-treated magnetic foil Van Allen gave us. Archie made the glass spool, using grinding techniques. Then the spool had to be wound with very fine insulated copper wire, neat as the thread on a spool of sewing thread. Rolling the foil and inserting it in the spool hole with no damage to the foil was quite a feat. Mason had ordered from the cabinet shop a control box of wood about 20 by 20 by 20 inches. It was to contain a very sensitive expensive galvanometer, a light beam and mirror method of reading the galvanometer, six very accurate detent decade rotary resistors, and a standard volt cell which could not tolerate any current drawn. The purpose of the control box was to measure the value of the earth's magnetic field in terms of the current in the glass spool winding that exactly canceled the earth's magnetic field.

The fluxgate and associated hardware and electric motors had to be towed 500 feet astern of the ship to minimize the magnetic field produced by the steel ship. This required some sort of a

streamlined watertight case which we always referred to as the fish. Mason reasoned that the shape of the old bathythermograph would have been well tested and ideal for the shape of our fish, bathythermograph shape scaled up to fish size. The fish, to contain the fluxgate, the gimbals, and the little electric motors that were about three feet away from the gimbals, had to be about 12 plus inches in diameter and five feet long, and with the round nose and tail making for a total length of about eight feet. The watertight case was about an inch thick and made of a very special plastic. It had to withstand a water depth of about a hundred feet in case it accidentally sank a ways while being handled over the side. There was an inch and a half thick plastic cap on each end machined to fit with "O" rings for a watertight seal. We had a local builder of fiberglass and plastic boats construct the round nose and finned tail with instructions to use no metal, especially iron. When the pieces were delivered to us I could see an iron paper staple in one place. I had to have it all X-rayed to find all the staples and then dig them out and patch up the holes. For any later fish, I did my own glass and plastic work. The fish had to have enough pitch and roll stability to not exceed the rate at which the electric motors could turn the gimbals to keep the fluxgate aligned with the magnetic field. This was accomplished with a lead weighted keel. The 500-foot-plus towing cable had to also have electric conductors. Vector of Texas custom built this. It was a 1-1/4 inch steam hose, one piece, about 510 feet long. Inside was a stainless steel multistrand wire, tested to 2000 pounds stress. Also in the hose were about nine electric conductors with some shielded. The fish was held by a heavy brass harness with two clamps around the fish body and a hinged piece reaching up to the stress terminating piece about four feet above the hinge. A heavy, hard to handle kludge.

Russ Raitt and George Shor had worked up a refraction shooting trip off southern Mexico, and Mason wanted to take along his newly constructed magnetometer for both testing it out and obtaining some magnetic data. He was to arrive in San Diego just in time to help load gear on the ship and with me sail south to Raitt's working area. This was a two-ship refraction shooting operation with my ship the shooter. Russ Raitt and George Shor were in charge of the seismic work, and they both were on the listening ship on the way south and most of the time in the working area. I knew a lot more about seismic work than magnetics and consequently helped the seismic people while neglecting the magnetic work, instruments and all. That was really unfair to Mason in view of the fact that he was my employer, and Mason's funds paid my salary. If Mason

felt that way about my work interest and attention, he never said so, but I suspect that he felt short changed by me.

When Mason and I were well clear of the harbor we streamed the fish astern for towing and recording the magnetics. I knew a lot more than Mason did about handling gear over the side and towing things, so I supervised all this with Mason helping. We hooked up all the components and turned on the switches for operation. There was no signal! I really knew nothing about the magnetometer's electronics, and Mason knew a little. We had a complete set of schematics aboard, and Mason started meticulously checking the circuitry wiring. He found nothing obviously or grossly wrong. He kept working away almost day and night. I stayed close by to help as best I could. Mason was getting very discouraged, thinking he would be taking a long trip with no returns for his time and effort.

Finally he found one place where R. J. Smith had made an incorrect circuit connection. Mason changed the connection to that shown on the schematics. He turned on the power switches, and lo and behold he got a good magnetic signal. He let out a shout of joy! I too was quite happy because that got me off the hook, so to speak. We proceeded on south to the seismic work area getting a good magnetic intensity profile all the way. Mason and I took turns standing watch over the components and tending the recorder, an old Esterline-Angus.

When I first met Mason, in a casual conversation he had told me of the wonders of an English beer called Guinness. I saw some Guinness beer in a store, and even though expensive, I decided to buy one and take it along on the trip and enjoy it some warm evening. Such an evening came along when we were well south headed for the work area. I chilled the beer well in the refrigerator and then took it back to where I was standing watch on the magnetometer. I had just taken a few sips when Mason sauntered in. When he saw the Guinness beer his eyes lit up. He did not expect me to share it with him, but he started to tell me in great detail how to enjoy Guinness beer. First it must be drunk at room temperature; I happen to like beer well chilled, so continued to sip. He wouldn't stop talking about beer. I found it hard to enjoy the beer with him sitting three or four feet away telling me how fast to drink it, at what temperature, and obviously wishing he had a beer. If I had had another beer and at tropical room temperature, I would have given it to him to watch him drink while I enjoyed mine. Well, I finally finished the beer — good

to the last drop. I then wished I had taken along a six-pack to improve a few more tropical evenings — and only one free warm beer for Mason.

We finally arrived at the seismic work area, and the magnetic gear was secured. Raitt and Shor pushed hard to accomplish the maximum in the scheduled, allotted time. On my ship it turned into a madhouse of work, work, work. To coordinate the explosive charge detonation times with the seismic signal arrivals at the other ship, we had the ship's radioman tune in to the master clock, one-second interval ticking broadcast in the Washington, D.C. area. I recorded these ticks, with precise time of day noted, on a Brush strip chart recorder, along with the detonation signal coming from the charges we dropped. Raitt and Shor were doing something similar on the listening ship. Then, too, we had to keep the usual radio communication between the ships going, and the radioman had to make his daily reports to Scripps. This all kept the radioman so busy from dawn till dusk that he barely had time to eat a sandwich at mealtimes. We were running the poor guy ragged! One evening about a half hour after dusk when shooting stopped I had to record some Washington, D.C. exact time and ticking to tie the work on both ships together. I called the radioman to furnish me with this ticking, and he said he had just turned in for the night and was too tired. I told him it was a must, and imperative that he give me these time tick signals. He complained to the ship's captain, and the captain came down to where I was working and interceded for the radioman. I told the captain it was a must and promised to not do this again after the radioman turned in for the night. He ordered the radioman to get up and give me the time tick signals. Boy, was I unpopular!

There were a lot of empty rough wooden ammo boxes left over from Raitt's shooting. I used a number of them for our small supplies and parts and magnetic profile records. I cleaned fully two dozen of the ammo boxes, made them stronger, and stored them away for use at my home. Some of them I knocked out the bottom of one and attached it atop another with its lid removed, to make double depth boxes. I made a few double depth boxes for our magnetic project use.

Finally the allotted time for seismic work was used up. We secured all the seismic gear. We brought out the magnetic gear, hooked it together, streamed out the fish tow, and turned on the electronics. We got a good magnetic signal and proceeded on north to San Diego. We had considerable experience by then with all the equipment components and so had a well run, happy

trip north. Mason plotted the magnetic intensity profiles and wondered about what they meant or revealed.

With the first way we towed the fish, the harness holding the fish was quite a heavy kludge, as mentioned earlier. As time went on I learned from experience and kept improving the ways I attached the towing electric cable to the fish. By the time I discontinued using the fluxgate the attachment consisted of a long tapered rubber snout. A finned tail with a lead weight at the end of the lower fin to prevent rolling was used.

Up to 1953 ocean magnetic surveys had been nothing more than long magnetic intensity profiles. Maurice Ewing of Columbia University ran one across most of the north Atlantic, and Mason borrowing Ewing's magnetometer in 1952 ran one from Samoa east and then up to San Diego. Seamounts caused intensity anomalies, and then there were many anomalies with no apparent seamount — a puzzle to everybody.

I told of Maurice Ewing of Columbia University towing a magnetometer across the Atlantic. It was a fluxgate similar to those I made. He towed it about 500 feet aft of the ship. The towing line consisted of a steam hose with the necessary electrical conductors inside and a multistrand metal wire to take the towing stress. Out at the fish where the hose entered the front end of the fish he did not devise a watertight entry. To keep water from slowly filling the fish he connected a tank of dry nitrogen to the hose where it entered the ship's laboratory. The valve on the tank of gas was set to slowly feed gas into the hose. The gas traveled through the hose to the fish where it simply entered the fish and built up enough pressure to leak out of the non-watertight fitting fast enough to keep the seawater from coming in. Thus the fish trailed little nitrogen bubbles constantly. This was all done before I built my first magnetometer for Scripps. From what I knew of Maurice Ewing it was a typical Ewing way to keep seawater out of the fish. People used to joke, no doubt with exaggeration, that when Maurice Ewing went to sea to gather data he would at the last minute fill boxes and bushel baskets with his laboratory junk, a box full of assorted radio vacuum tubes, a lot of glue, and a lot of string and tape. Then he built his working equipment as needed at sea.

For his magnetic intensity profile from Samoa to the east in 1952, Ronald Mason borrowed Ewing's magnetometer. So Mason had to put up with Ewing's dry nitrogen bottle feeding gas into the hose and the nitrogen gas pushing back any seawater that tried to enter the fish. I think that

Mason ran out of nitrogen and rigged up an air pump to force air to do the same thing the nitrogen had done. Mason possibly used the ship's air pressure system. Anyway, he got by.

When I built an entire fluxgate magnetometer assembly for Mason's use on Scripps ships I made it a point to get away from Ewing's dry nitrogen in pressure bottles. It was easy to devise a watertight entry of the hose into the nose of the fish. It worked well.

The Navy had their atomic submarines which ran quite deep, and the Navy feared that a deep running sub might hit an uncharted seamount of which there were many. So the Navy made a deal with the U.S. Coast and Geodetic Survey to do a survey of the ocean from the west coast out to about 300 miles and from about Guadalupe Island to Queen Charlotte Island off British Columbia. To do the survey the Navy loaned to the Coast Survey the *Pioneer*, a 310-foot submarine tender capable of cruising at 17 knots for a month. It was a very comfortable ship. The survey was to have lines running east and west, five miles apart. If there was suspicion that a seamount was fully between the lines, that area had a line in between — known as splitting the lines. Every seamount was to have a detailed survey to determine how close the peak came to the surface. For navigational purposes a state of the art navigation method was installed on the ship. The method was called electronic position indicator, EPI. It used precisely located shore stations manned by operators and service personnel. EPI gave ship positions out to 400 miles with an accuracy of plus or minus 150 feet. The ship used the best available fathometer. The ship would run three weeks at sea and put into port for eight or ten days for rest, refueling, supplies, and repairs. The ship operated first out of San Diego, then San Francisco, Portland, and finally Seattle.

Roger Revelle heard of this operation being organized and realized the value of having a recording magnetometer aboard. He alerted Mason, and Mason jumped at the chance to survey an area, something that might solve the questions of anomalies noticed when running the long lines of Ewing's and his own. He obtained permission to tow the magnetometer on a non-interference basis. Mason was too late to get a magnetometer aboard for the first three weeks of survey near Guadalupe. But he was able to put a magnetometer aboard for the next two trips. The Coast Survey allowed this because their leading officers were quite open minded about any survey work, especially something new like magnetic surveys. Mason considered that he only had time available for two months before returning to England. The data of two consecutive trips would likely

answer his questions. While towing the magnetometer for 24 hours a day, he had enough time aboard to plot up the magnetic intensity data and contour it. The emerging picture was startling — north and south banding. I think he had Max Silverman aboard with him to stand watches on the magnetometer. I cannot remember just why I stayed ashore — perhaps to service and build equipment. When I looked at the contoured map from Mason's first three weeks at sea, I became very interested and thought this kind of survey would yield much of value to the scientific community. Mason said that he did not have the time from Imperial College to continue on north with the *Pioneer*, especially all the way to Queen Charlotte Island. I said that I considered the magnetic data valuable enough for me working alone on the ship to obtain data on north. Mason said that suited him, and I could do so. I ordered more equipment and supplies. I knew from experience that I would need spare fish and electric towing cables. I was more than busy.

The ship's captain had assigned the most aft cabin on the main deck for us to use for the control and recording equipment. This cabin was very handy because it was next to the fantail from where the fish was towed. In order to be able to handle the magnetometer operation all by myself I set up one bunk so I could get some sleep on the job. I devised an alarm to sound when the recorder was about to go off scale. It all worked out fine. I did have a good private cabin up forward in the ship's officers' area. I will say that sleeping by the recorder with its alarm bell interrupted my sleep far too much; I was rather dopy most of the time. Then there was the matter of meals in the wardroom; I would excuse myself several times during a meal to check on the recorder.

During the months that I was spending so much time on the *Pioneer* Al Focke was director of MPL. One day when I happened to be back in San Diego at MPL, Al Focke called me into his office and said, "Raff, you're just gone all the time. You're not getting anything done." I did not quite know what he meant. Perhaps he meant that I was not in building 106 soldering wires together and lifting heavy equipment. Well, anyway, I ignored him and continued as I had been doing. That's one time I ignored the director and got away with it.

On several trips I took along another person to stand regular watches for the benefit of my health. Once it was Alan Jones. Another time it was Max Silverman.

When winter came along the seas were often very stormy, and the sea conditions interfered with the Coast Survey's need to obtain high quality information about seamounts, their prime

objective. They discontinued operations for about three months, putting into San Francisco. This time in port allowed for extensive maintenance of the ship and all its special equipment, a good rest for both ship personnel and shore-based Coast Survey personnel, a good chance for me to rest and build a reserve of equipment and turn over a lot of raw data for Mason to work on.

I felt that it was asking too much of me and my family to stay so much with the ship for all the trips required to complete the survey all the way to Queen Charlotte Island. I got permission from Mason and Revelle to employ two people to make the rest of the trips; two people aboard on all trips would allow for regular watch standing without undue fatigue. There was a Don Lindberg, an MPL technician who was getting a divorce and needed to be away from San Diego; I employed him. I made a trip to U.C. at Berkeley and talked to the head of the engineering department asking if they had a student who needed employment for a couple of semesters. They did. It was a Gregory J. Nicholas. He was very sharp and planning on a career in electronics and snapped at the chance to work for me. He was just what I needed to keep the complicated magnetometer operating. When the ship departed San Francisco for its first trip out on the second season of surveying, I accompanied the two new employees to teach them how to operate the equipment. Then it was no more trips to sea for me, although I almost always met the ship each time it put into a port. That way I kept tabs on the work and would bring back to San Diego the new raw data. Also I would take to the ship ordinary supplies, replacement equipment, and newly improved equipment. Al Focke criticized me for running up so many miles on Scripps motor pool pickup trucks to meet the ship each time it came into port. I ignored the criticism, and he did not make an issue of it.

It ended up that Nicholas in a way double crossed me. Just as the ship was about to depart on its last trip out, Nicholas jumped ship. Unbeknown to me, he had been negotiating with Bell Telephone in Oakland and San Francisco to become a career employee with them. He had given up on further schooling at Berkeley to instead make a career with Bell. Lindberg sailed out alone with the ship and at sea sent me a message about Nicholas not being aboard.

I did not know of it, but Lindberg had not bothered to really learn all the ins and outs about the magnetometer during his time aboard but instead had depended on Nicholas to really keep it operating. With luck, Lindberg kept the mag operating most of the time — only a minor loss of data. I was furious at Nicholas. I made it a point to meet the ship and Lindberg when the *Pioneer*

put into Seattle. The Coast Survey had decided to take the ship to San Francisco and prepare for similar work around the Hawaiian Islands on instructions from the Navy. So the Coast Survey decided that on the way to San Francisco they would continuously take depth data and firm up a few places where they considered the data to be weak or insufficient. This would take up about a month. I instructed Lindberg to accompany the ship and collect magnetic data. I met the ship in San Francisco and offloaded all the gear into a rented truck. I took the opportunity to contact Bell Telephone and go visit Nicholas and chew him out at his place of work in Oakland. I told Bell what Nicholas had done, and the supervisor rolled his eyes in surprise but made no comment to me. When I first heard from Lindberg that Nicholas had jumped ship I immediately drove over to Scripps and talked to the person who was in charge of payroll. I stopped any and all moneys going to Nicholas — salary, overtime, or whatever. We took our good time paying Nicholas any money owed to him.

When Lindberg and I had fully loaded all the magnetometer gear and records on to the truck I paid my respects to the ship's captain and executive officer and thanked them for their wonderful cooperation and the opportunity for Scripps to obtain all the magnetic data. Lindberg and I headed out for San Diego late in the day planning to drive straight through to San Diego. Soon after sunset it began to pour down rain, in sheets, so to speak. Luckily we had a covered truck. The rain let up soon after midnight, and we had good driving conditions on to San Diego.

While the *Pioneer* was completing the Coast Survey's project all the way to Queen Charlotte Island Mason at both Imperial College and a small basement room he had at Scripps was plotting up the magnetic data and contouring it on maps. He used the Mercator projection that had a scale of four inches between the one degree, 60 nautical miles at the equator, meridians, the same scale as the standard navigational plotting sheets used by almost all American navigators when working on the bridges of their ships. This was certainly true of all the Scripps captains and navigators.

Putting all the magnetic data on maps of such small scale required a person that was very near sighted and had a very steady hand. Mason had both. He would work with his eyes only several inches from the paper. Anyway, he did accurate and beautiful work. He made the magnetic maps all the way north to the Mendocino scarp, and I did the maps from there on north to Queen Charlotte Island.

I certainly could not make the magnetic maps at that four inch per degree scale and did not even attempt to, even using a magnifying glass. I figured that it would be very easy when photographing my maps for publication to photoreduce them to the scale or size which the publisher desired. I chose a scale of fourteen inches per degree of longitude. The only problem with that scale was that my map would be more than a dozen feet from top to bottom. I solved that problem by cutting out rectangular pieces of paper for each degree of longitude with a two-inch border all around the edge. On this rectangular sheet of paper I drew a heavy black line to indicate the longitude and latitude parallel lines. When contouring I would hold two sheets together so that I could carry the contour lines smoothly from one rectangular degree to the next. When the whole map area was contoured I had a photographic facility photograph each rectangular degree down to four inches per degree of longitude and glue the individual photo-prints to a large sheet of cardboard. That was my working master map for showing to people. I photographed my cardboard backed map at the same scale for sending copies to publishers or other interested people. If a publisher wanted something at a smaller scale than I submitted, the publisher merely photoreduced my submitted map down to the desired scale. The scheme all worked very well.

Using the EPI navigational information furnished to me by the Coast Survey I plotted all the magnetic intensity values on the large rectangular sheets. To get all the contouring finished in a reasonable time for publication, I needed help. I employed the wife of a person who worked for Scripps at La Jolla. I forget her name; she was a redhead. After a couple of months her husband took a job in Florida, so I had to find another helper. This time it was Norman Head's wife. She was absolutely brilliant and hard working. She could soon outperform me, although when it came to interpreting geology and magnetic theory, I would help her. We did the contouring in pencil allowing for erasing as necessary. To put the contouring in ink for photographing to a smaller scale I employed a draftsman experienced in ink work. He overlaid our final pencil contouring with semitransparent mylar and inked on the mylar. He did good work, but had an ego much larger than his drawing capabilities. I had to handle him with kid gloves, so to speak.

Finally the contouring of the total measured magnetic field intensity was completed, and his inked contour work was sent to the photographic facility for photoreduction as told of earlier. Now came the job of removing the earth's theoretical smooth field leaving the anomaly only. I observed, as had Mason earlier, that the theoretical field of a dipolar earth did not describe very

large areas such as the extent of the *Pioneer* survey. Therefore, I had to determine the local smooth field of the surveyed area. Mason used one method for his map, and I used another for my northern map. I looked at each rectangular degree of the total measured field and noticed the value where there was no anomalously high or low value, an eyeball value. I wrote that number in the center of the rectangle. Having done this for the whole area of my map, I contoured those numbers with contours that were gentle or smooth curves. That was then my working smooth field. Using the trick fast method of subtracting the smooth field that I mentioned earlier I made a map showing only the magnetic anomalies. This was what was published. Where my map joined Mason's I moved my anomaly contours a little one way or another to make a smooth transition. Some scientists who were observing our work objected to obtaining a smooth field as we did; they said we should use smooth fields published in the literature. I had looked at these, and they were terrible — based on very sparse data that were sloppy measurements to begin with. Time, with more knowledge about the earth, has justified our choice of a smooth field.

When my maps were about ready for publication Al Focke asked to look them over. After studying them for some time he came into my office where I was working on some maps and said, "You and Mason should not publish these. The things you call magnetic anomalies are only artifacts of your instruments and not magnetic features at the surface of the ocean." I was dumbfounded. I knew my equipment well and knew that there was no possible way that equipment could erroneously create long north-south bands; that would require that the equipment had intelligence and wanted to make a fool of me. Focke should have, with a little thinking, realized the same thing. I did not argue with him. He was very serious in making these statements — not "pulling my leg." I figured that a scientist with a doctorate making such statements should be ignored. I went ahead with publication not even telling Mason what Al Focke had said.

Many years later I met Al Focke at a social event at Scripps. I mentioned to him that our publications of the *Pioneer* magnetic contour charts had been very well received by the scientific community and had started a whole new line of geophysical and geological thinking. He was embarrassed and red-faced and mumbled something about his being glad for our success. Al Focke died a few years later, but anyway, I think our work was finally vindicated in his mind.

Mason was the type of scientist who believed in doing very good accurate work and no hurry to publish as there is around Scripps. That is what got him scooped by the article in

Research Reviews. Mason and I finally got the material ready for publishing the entire *Pioneer* survey results in an American journal. We submitted the two articles with maps to the *Bulletin of the Geological Society of America*. [The one on the southern half was "Magnetic Survey off the West Coast of North America, 32 Degrees North Latitude to 42 Degrees North Latitude," by R. G. Mason and Arthur D. Raff (volume 72, number 8, pages 1259-1266, August 1961). The one on the northern half was "Magnetic Survey off the West Coast of North America, 40 Degrees North Latitude to 52 Degrees North Latitude" (volume 72, number 8, pages 1267-1270, August 1961)]. Each had a large anomaly only map accompanying it. The editors must have considered the maps quite valuable to the readers because they included the large maps as fold-outs. As soon as the articles came out in the August 1961 number of the *Bulletin* there was a big demand for reprints. We were about the most referenced authors in the literature for the following two or three years.

While we were using our fluxgate magnetometer the people at Varian Associates in Palo Alto were developing their proton precession magnetometer. They had in mind producing this to sell to geophysical prospecting companies to tow from an airplane and working only over land or at most shallow coastal waters. I repeatedly would take our fluxgate to Varian for calibration. They were happy to perform this calibration service for us because it was good advertising for the precession magnetometer.

Having used Varian's precession magnetometer many times I decided to adapt it to towing 500 feet astern of a ship as a replacement for our heavy fish and fluxgate magnetometer. Vic Vacquier fully agreed that such a change should be made. Because the precession mag would operate with great accuracy while rapidly pitching or tumbling, it only needed a small case with no stability fins or weighted keel. I built a watertight plastic case about seven inches in diameter and thirty inches long. This smaller fish was towed by an electric cable about five-eighths of an inch diameter and containing electric wires and a covering weave of non-magnetic stainless steel wires. The steel wires were covered by a tight fitting rubber jacket to protect all from seawater. The nose had a tapered rubber snout similar to the tapered snout on the fluxgate case and for the same reasons. [When a fish is being towed there is an ever so slight bending of the steel stress wire — back and forth, back and forth. This bending occurs right where the wire with other members of the towing cable enter into the case and are tightly clamped there. That localized constant bending causes metal fatigue, and the steel breaks after about two days of towing.]

After the experience of having almost lost a larger fluxgate fish to metal fatigue, I figured out what was happening and invented a way to distribute the constant bending over several feet of length. That consisted of a rubber snout clamped tightly to the front end of the fish and of necessary diameter there and tapering down to the diameter of the towing cable several feet away. With that device and solution, I never again had a wire break from metal fatigue. Some towing cables had fully a year of towing time altogether and showed no metal fatigue. Without a tapered rubber snout the steel stress member of the cable would break after about two days of towing.

One time I was towing one of these proton precession magnetometers as we approached Honolulu, Hawaii. When we were sailing along just east of Waikiki beach sharks attacked the fish. I was not aware of the attacking sharks at the immediate time, but when I pulled the fish aboard just before entering the harbor at Honolulu, I grabbed the fish to heave it aboard and felt something cutting the palms of my hands. I looked at the fish case and saw dozens of sharks' teeth sticking out all over the case. The teeth had broken sharp ragged edges. I treated my hands and then examined the case. None of the teeth had penetrated the case but were firmly embedded. Using a sharp edged steel tool I scraped them all off down to where there were no cutting edges to cut bare hands. I continued to use that fish for years. I never again had that happen to a towed magnetometer fish.

[New subjects]

In doing refraction shooting there always seemed to be plenty of intensity with the water wave and with the higher frequencies coming through that were refracted, but the very low refracted frequencies from the deepest layer in the ocean were weak. This frequency was down around 3, 4, 5, maybe 10 cycles per second, and we always needed more intensity. So I started thinking about ways in which we could get more intensity to this low frequency at the expense of the higher frequencies. I did this on my own initiative with Russ just letting me do it. I thought that maybe if an explosive charge were set off in a bell of some sort, say two feet in diameter and three or four feet vertical, and this bell was filled with air and held down by weights to the optimum distance below the surface, say about twenty feet, and an explosive charge were set off in the air space, that it might generate a lot more of the very low frequencies which we needed.

I decided to try that down by the NEL pier. I got a great big trash can and attached to the open end a wire bail and a lot of sash weights. I'll tell you it takes a lot of sash weights to pull

down a big barrel full of air. I rigged up an electrically detonated charge of about a quarter pound. After assembling all this I carefully lowered it with a cherry-picker of some sort to a depth where the bell was about four feet below the surface. I looked around to see if all was clear of people and pressed the detonation button. There was quite a thump, and the pier shook. I had listening hydrophones with recorders some distance to the south. When the charge went off the bail broke and the heavy load of sash weights fell to the bottom. The breaking of the bail did not affect the strength or character of the sound pulse. I had to borrow a grappling hook and fish around for the bundle of sash weights. I luckily snagged on to the bundle of weights and pulled them up with the cherry-picker.

The water displacement of the pulse was moderately large and had a sharp spike at the beginning and a lesser spike at the end. I estimated how big the pulse would be in the open sea with a larger charge detonated at about twenty feet deep. It was not all too impressive. I figured that handling a large charge from a ship in the open ocean would be too difficult and dangerous. So I gave up on that scheme, and Russ agreed with me.

At one time Russ told me that he would like to find out how much sound was transmitted straight up in the air from a charge that was set off, say, 25 feet below the surface and vice versa how much sound from a charge set off in the air is transmitted down into the water. I did not know what he had in mind that he was going to do, but anyway, he asked me if I would find an answer to that. That meant setting off some explosions up in the air and having a listening hydrophone below. So I thought of various ways I might do this. I decided that if I had a charge with a fuse on it and tied to a weather balloon, it would lift this charge up several hundred feet above the ocean surface, and when it went off the sound would come down through the air to my listening hydrophone below in the water. So I got some weather balloons and some explosives and a lot of fuse that would give the delay times that we needed. I again used one of the picket boats from NEL. I waited for a calm day. The sailors were astounded when they saw me putting all this aboard. Anyway, we got it aboard and we proceeded on out just beyond the mouth of the harbor and about a thousand feet to the west. With the help of a sailor I filled a weather balloon with hydrogen from a metal pressure bottle. With about three feet of string I hung a one-pound charge below the balloon and attached a fuse of estimated length to let the balloon rise about a hundred feet before detonation. We held the balloon over the side, lit the fuse, and let go. The

charge settled down to the water! I should have had sense enough to test on deck before lighting the fuse, if the balloon could lift the charge, but I did not. There it was in the water, and the fuse going. Well, I never saw a skipper of a small boat get things started so fast in all my life. He rushed to the wheelhouse, hit the starter button of the diesel engine, threw it in gear and revved it up, no warming at all, and pulled away from there. He got it out at a safe distance, and all we could do was just wait to see it explode. When the charge exploded a beautiful orange-red ball of burning hydrogen rose up about thirty feet. The burned rubber balloon made a little smoke, and there was a dirty spot on the water. I turned to the skipper saying, "Thank goodness you got away from there. Let's try again. We know what to expect now." So we rigged up another one-pound charge and a lot longer fuse. Weather balloons are made to swell a lot before bursting. I could keep adding hydrogen till I got the lifting force I wanted. We added more and more hydrogen till we were satisfied that the balloon definitely lifted the charge. I lit the fuse and let go. It slowly rose straight up — no wind at all. It rose up to about two hundred feet and suddenly moved south. There was a wind current up there unbeknown to us. I was not very happy about that. I wanted it to explode right over our boat where I had the listening hydrophones in the water. Well, we looked south, and there was a large Navy carrier steaming slowly into port. The balloon rose higher and getting closer to being over the carrier, and when it was right over the carrier; Kerbang! A huge orange flame from the hydrogen curled up. Well, we all stood there wondering who was going to get in trouble now. I'll bet the guys out there on the carrier deck got a surprise when they looked up and saw that ball of orange flame rising in the air and then dissipating. We never heard a thing from that. Apparently, they were not worried or had no idea where it came from. I've tried to remember if we tried another one. I think I did one more, and knowing about the upper wind current and how high it had to be when it went off I set it to a rather short fuse, filled it up with the same amount of hydrogen, and let go. It went straight up, and since it was a short fuse, kerbang, right over our picket boat. I did pick up some sound. I can't remember how much, but anyway there was some sound transmitted down to the hydrophone.

Well, after thinking it over I decided that using weather balloons, fuses and all, was not the way to go. One had poor control, never knew what the wind currents were above, and the situation could be very dangerous if we were using it off something like the *Baird* or maybe the 857 Navy ship. I just cancelled that idea out.

So then I got the idea that maybe a kite would be good. If we had a kite with a two-electric wire line in place of string, that could be used for the string to go up to the kite, then this electric cord could go on down the tail and have a charge there. All one would have to do is launch that from any of our ships after getting up speed so there was plenty of wind and let the kite rise higher and higher by paying out more and more of the electric cord. When the kite was just as high as we wanted the ship could move around and go right over the listening hydrophones that would be out from another ship. When the charge on the tail was right over these hydrophones press the button for electric current, and the explosive would go off. We could make kites as large as we wanted and really lift a big charge.

I decided to make the first try of a kite on land instead of on a ship. I got permission from the Navy to try a kite about where the sewage treatment plant is now. I built a three-stick kite with the two long sticks crossing like an "X" and a shorter stick crossing the "X" at its center. The finished kite was a full five feet tall and nearly four feet wide and symmetrical about the center. I covered it with a plastic sheeting that contained fibers to make it both waterproof for possible dunking at sea and very strong. The tail was nearly forty feet long. Willard North, who was my assistant at that time, helped me build the kite and all its accessories. I chose a one-pound charge for the test. When it was all ready to test I checked the hillside for a good breeze from the west, alerted NEL guards, and we took it all in a pickup truck to the test site. I had Willard hold the kite with the tail and charge laid down toward me, yelled for Willard to hold it up high, and I ran down the gently sloping hill. The kite and charge rose up to a good height and stayed there when I stopped running. Willard came down to where I was holding the electric wire "string," touched the two ends of the two-conductor wire to a battery, and kerbang! The explosion blew off about three feet of tail. We congratulated ourselves on a good test and took our gear back to the lab. I put my feet up on my desk, leaned back in my chair, and thought it all over.

It was obvious that such a kite and tail would be difficult to launch from a ship. I thought over the various kinds of kites that required no tail — box kites, cross plane kites, etc. I remembered reading about kites that the Weather Bureau used before they had weather balloons to take their instruments to high altitude. A kite can lift only so much string. To reach the very high altitudes they had to use a series of kites; each lifting only its moderate length of string. Each kite was shaped like a box kite except that its cross section was a triangle instead of a square. When

flying, a point of the triangle was down and had its string attached there. There was a cross stick on top, one-third of the way back and long enough to form a wing on each side. The whole kite configuration was very stable and had a lot of lift. One of these could be easily launched from the stern or top deck of a ship. The charge would be hung on its electric wire from the tail end of the kite and with the charge about forty feet below the kite. When the kite was launched someone would pay out the tail wire to prevent tangles and let go of the charge immediately when the tail wire became taut. I was about to build one of these weather bureau kites when Raitt said he was not going to do more about transmission of sound from air to water or vice versa. He never explained to me why he had an interest in this and why he lost interest. Russ was not very talkative about many aspects of our work. Anyway, that line of development was finished. While we were testing the first kite on the hill Willard North said that was the best job he ever had — flying kites and exploding things in the air and getting paid for it all, to boot. I, too, had a lot of fun. All my life I loved to fly kites, dozens of them.

If I had it to do over again, I would have built a weather bureau kite of about eight feet height and flown it from one or more Scripps ships to demonstrate what such a kite can do. Then likely other people would have made use of the idea of kites flown from ships. I did make a four-foot weather bureau kite at home out of my own materials. It performed fully as well as expected. My kids and I had fun flying it for many years.

As to the big kite that Willard and I used on the hillside I could think of no more use for it at MPL. Furthermore, when people would see it at MPL it was the butt of jokes at my expense. So rather than break it up and throw it in the dumpster I brought it home for the kids and me to fly. One evening there was a good breeze, and my kids and I put it up out in the street to fly. A neighbor kid, Tommie, asked to fly it. A kid had to lean back to hold the big kite. After tiring of flying it Tommie just forced the stick with ball of twine on it to the pavement and let go. He expected it to sit there — no sense of physics! Well, you know what happened. It immediately started going up the street, the ball of twine and stick bouncing along. It landed on the top of the house of an old lady who lived farther up the street. We all went running up there, and it was on her house with the tail part down the side over a tree. I knocked on the door and said, "Our kite landed on top of your house. May I come in and get it? I think I can just pull it off by the tail." She glared at us and said, "Nobody's coming in here to get a kite out of my yard." So that was the

end of our fun with a big kite. I don't know what happened to it; it probably just rotted up there on top of her roof. Anyway, kites — some fun and some explosives.

I mentioned that the *Pioneer* put into San Francisco for the winter to get ready for a similar, fine grid survey around the Hawaiian Islands. The Navy wanted to accurately know the bottom topography, especially seamounts, from near shore to about three hundred miles in all directions. I felt that if I towed the magnetometer as I did for the survey near the mainland, I likely would discover something as interesting as the north-south lineations off the mainland. I spent part of my time that winter preparing for the Hawaiian survey. The Coast Survey management said they would be glad to have me come along on the same basis and using the same space as for the survey off the mainland.

The Coast Survey planned to sail for Pearl Harbor early in the year, 1957. A few days before the sailing date I loaded all the gear in a rented van and took it to San Francisco. Actually the ship was tied up at a government pier on the west side of the bay in the South San Francisco area.

When I arrived at the ship there were the usual greetings and pleasantries. With the usual great effort all the gear was lugged aboard and made ready for the trip. We cast off in the forenoon. Since the ship was to be based at Pearl Harbor for over a year there were a lot of tearful goodbyes between crew personnel and wives and families and some girlfriends.

I towed the mag from San Francisco to the islands and recorded an interesting magnetic profile that later proved to be of value. Most all of the wives and families of the officers decided to live in Honolulu during the ship's stay in the islands, and they flew ahead by commercial air to find housing, in readiness for the arrival of their husbands. When the ship first arrived at Honolulu we tied up at the pier where the tourist ships dock. The officers' wives had arranged for and orchestrated quite a show and welcome for us. The city's tourist welcoming band was playing, and there was some colorful throwing of paper ribbons. As soon as the gangplank was down the families, leis in hand, came aboard. There was the customary bussing of the women. The executive officer's teen-age daughter tossed a lei over my head and around my neck and extended her cheek for a big kiss. Refreshments were served, and we all had a high old time for the next couple of hours. Then it was back to business.

The ship for the first six months or so did not tie up at the Navy's Pearl Harbor. The military security at Pearl Harbor was a nuisance, and the Coast Survey people much preferred to work at a commercial pier, although the Navy later insisted the ship berth at Pearl Harbor, probably cheaper for the Navy who was paying the bills of the *Pioneer*. For those first six months or so, the ship tied up just across from the busy commercial docks where we had the big reception and band. Next to Kukahi Street there was a large paved, little used area with a good long dock along it. I think it was city owned and leased by the government. We tied up there. There was plenty of parking for all our vehicles. It was only about a one-block walk across this paved area to Nimitz Highway which gave good access to all parts of Honolulu.

There was a teaching and research geologist at the University campus in Berkeley. He was a Dr. someone; for the life of me I cannot recall his name. His name may have been Runnuls. Aboard the ship everybody called him and referred to him by the nickname, Squeaky. The nickname, Squeaky, was obvious because he had a high pitched, very squeaky voice. He did not particularly like being called Squeaky, but tolerated it.

With information coming from both R. L. Fisher and Bill Menard, Tom Chase had a theory about the geological and sedimentary history of the area off the southern part of Costa Rica and Panama and out to Cocos Island and beyond to the Galápagos Islands. The teaching geologist, Squeaky, at Berkeley had a similar theory and had somehow corresponded with Tom Chase about this theory. With funding from M.P.L., surprisingly and really not intended, I later found out from Dr. Spiess, Chase obtained ship time on the *Baird*.

Tom Chase and Squeaky wanted to obtain numerous sediment cores and dredge hauls on the Cocos Ridge. Chase called me saying they were a little short of help, and if I would like to come along on the expedition named Criss-Cross, in 1963, I could tow my magnetometer on a noninterference basis. That would mean towing the mag between all their work stations. I figured I would acquire valuable magnetic information of a considerable area not yet studied magnetically, so said that I would be glad to come along. In February 1963, I towed the mag south to the survey area, and when arriving at the work area the scientific work proceeded as planned.

Tom Chase always liked to digress from the scheduled work for a little adventure, and he could say that he and Squeaky wanted to look at the geology of Cocos Island. So when we were

near Cocos Island, a very small and tall tropical island, we put into the north side cove which happens to be the lee side most of the time. There was a considerable shelf area there with water about three to ten feet deep.

Cocos Island has a reputation of being a place where a particular, successful pirate stored his considerable loot. People interested in such things generally believed the pirate buried his treasures just off the north side beach in the three to ten feet deep water, most likely in water that was about three feet deep, which would put the treasure about twenty feet from the beach.

The first treasure hunter who had substantial financial backing, using whatever logic such people use, thought that he could pick out the exact spot where the treasure was buried in the sandy bottom. With quite a bit of help he constructed a circular iron cofferdam about 12 or 15 feet in diameter and about twenty feet tall. He lowered the cofferdam by, from the inside, digging the sand out from under the edge. As it lowered, the sand and rock in the center was likely lifted by bucket and rope up and thrown out over the side.

On the first try no treasure was found. Using his intuitive logic he decided the treasure was about thirty feet away, and he put down another cofferdam. Still no treasure. I do not remember whether there was a third cofferdam or not. Anyway, he went broke. The rusting cofferdams were still there but filled with sand, no doubt from storms blowing from the north.

Using the ship's dinghy, Chase and Squeaky went ashore carrying their geologist rock picks as hammers and a bag to hold samples. They found a path of sorts that led steeply up the side of the island. They soon met a man who was dressed for the climate and introduced himself as from the New York City Museum of Natural History. I do not remember his name. He was a Ph.D. He had received a grant of funds for a study of the island's bird life, any other animals, and the plant life on it that pertained to animals, especially birds. He expected to find that birds had adapted to the island's environment if they were sufficiently isolated from the mainland. Costa Rica claimed ownership of Cocos Island and required that anyone staying for a time on the island take plenty of food supplies and be accompanied by a Costa Rican army officer. A Costa Rican with a side arm was assigned to accompany the scientist. The scientist hired a boat to take him with plenty of supplies and the officer to the island, with instructions to return for them a set time later. I think it was about three months.

While Squeaky and Chase were up on the island, I with various crew members looked over the rusting cofferdams and talked about buried treasure. Squeaky and Chase hiked around collecting rock samples and were accompanied some of the time by the naturalist from New York. The New Yorker had an alarming story to tell them:

The officer, living in the isolated environment, had become demented. Also their food supply had suffered spoilage to some of the items. They had no radio communications with the mainland. The officer blamed his troubles on the scientist and threatened to shoot the scientist if the scientist did not get him back to the mainland. The officer slept apart from the naturalist and kept the gun under him so the scientist could not get ahold of it at night.

Late in the afternoon, Squeaky and Chase having completed their geologic study and sampling, took the scientist and officer to the ship where the scientist and our two Americans explained the situation to the ship's captain. The scientist requested that we take the officer back with us to the mainland. The captain said absolutely no, but he would radio Costa Rican army headquarters, explain the situation, and recommend they send out a boat to pick up the demented officer and at the same time send out another officer to comply with the rules and also send along some food supplies to replace the spoiled items — all this at the scientist's expense. Our cook fed the two guests a good meal. The good food, the social aspects of the activities aboard the ship, and the promise to the officer that Costa Rican army relief would soon be coming, made the officer happy and likely a lot less dangerous to the scientist. We put them ashore and said goodbye. Discussing the situation among ourselves that evening, we were not at all sure the Costa Ricans would act on our request to come to the island and correct the problems. That is the way things go in that part of the world.

When we had finished all the work of Chase and Squeaky the ship put into Costa Rica in early April before returning to San Diego. I took the train up to San Jose to look over the city and thought I had better find out if the demented army officer had ever gotten back and if not, tell the army headquarters of the urgency to do something. I walked into army headquarters and asked to talk to the officer in command there. I started to tell him about the dangerous situation on Cocos Island with an officer losing his mind, and he interrupted me saying the lieutenant is right here and then stepped into another room and called him to come out to see me. The lieutenant immediately came to the desk and greeted me with a handshake. I was in an embarrassing situation and so said

I was glad to see him and just dropped in to say hello. After another sentence or two I said I had a lot to do that day and must hurry on my way. I was sure glad to get out of there without making a worse fool of myself.

Now to get back to more about our visit to Cocos Island: That forenoon while our ship was anchored near the island a very nice, larger than average, sailing yacht approached the island and anchored about a block away from our ship. Several of us rowed the dinghy over to the yacht to say hello and satisfy our curiosity about a nice sailing yacht coming to the island. Aboard the yacht was a nice looking woman in her late twenties, a middle aged man, and a tiger cub with a nasty disposition toward strangers. The man was an American engineer who had heard of the story of Cocos Island, a pirate, the buried treasure, and the history of the earlier unsuccessful treasure hunters. He believed that he could find the treasure where others had failed. He had obtained permission from the Costa Rican government to look for the treasure with the government of course getting their percentage. The girlfriend was a capable sailing partner with a lot of experience with this yacht, and the tiger was the girlfriend's pet.

I was quite curious about what method the engineer was going to use to locate the treasure and then retrieve the treasure. I was fully aware that a treasure hunter was not about to divulge this information. In just the pleasant talk I got the feeling that he had invented a detector that would sense gold at distance up to perhaps twenty or thirty feet. I hoped it could differentiate between gold and iron because the area was quite contaminated with iron nuts and bolts and just plain junk. We told the newcomers about the unhappy situation on the island. Since leaving Cocos Island I have never heard a word about this engineer treasure seeker. My guess is that he used up a small fortune there with no return.

I should have realized the potential literary value of the whole Cocos Island story of that day and made extensive notes to use in a magazine article to sell to a publication that uses such stories. I later heard that one of our crew members wrote such a story of that day and sold it to an adventure magazine.

When Tom Chase's work took him near the Galápagos Islands, he again happily digressed from the survey and decided to spend most of a day looking over one of the uninhabited northern islands. The ship anchored near the southwest shore of the island, and a number of times our powered dinghy took people to the rocky shore where they could jump over to dry land. The

dinghy kept going back and forth most of the day. The landscape was covered with desert-like brush. The soil was very dry. The center of the island had considerable elevation. Several people hiked up to the top where a large eagle was perched. I found most interesting the hundreds of iguanas both submerged in the water and perched up on the rocks. They showed little fear of us. This island was uninhabited by people. It was actually illegal for us to have gone ashore here, as stated by Ecuador, the country owning the islands. Late in the afternoon we all boarded ship and departed the islands.

Here is an amusing little story about Navy security of the waterfront area of the old NEL on Point Loma. In driving a car south on Rosecrans toward the NEL waterfront area one first came to an opened gate that was guarded by uniformed marines. A sign in the middle of the road at the opened gate said "Stop for Inspection." Ordinarily one would stop, and a marine would look for the NEL decal on the car and then approach the driver's side and look for a lapel identifying card. If all looked OK, the marine would wave the driver on in. The Marine Physical Laboratory was about a city block on in at building 106. MPL had temporarily employed a young fellow to work at 106. He was working for us for two reasons: One was that his very wealthy father who lived in another state wanted his son to gain some experience of what it was like to live and work in the ordinary competitive world to make a living. The other reason was that the young fellow wanted to work in the MPL setting to learn about choosing a career possibly outside his dad's well established business.

The parents had decided to take a trip to California and at the same time see how their son was doing at MPL. The parents were traveling by chauffeured limousine. One morning the son asked his dad to have the chauffeured limousine pick him up and take him to work at MPL. When the limousine began to slow down approaching the marine-guarded gate the marines all snapped to attention and saluted as the limousine was waved on through. The chauffeur took the young fellow on in to building 106 and departed for where the parents were staying. This young fellow howled with laughter and thought he had really put one over on the marine guards whom most of us disliked.

As a result of seismic studies of the sea floor and the magnetic intensity profiles made by Mason, myself, and others there was generated an interest in the Mohorovicic discontinuity of the oceanic crust. There were a number of theories about its origin and what the material there might be. Geophysicists became sufficiently curious of the Moho that a national effort was made to drill down to the Moho and obtain a sample. It was expected that when a first sample was obtained, enough questions would arise to make it worthwhile to obtain samples from a number of sites scattered over the oceans.

Roger Revelle asked me to do a survey to the east of Guadalupe Island and choose an exact spot where the drilling ship would drill in an attempt to obtain a sample of the material of the Moho discontinuity, and with luck, additional samples farther below the Moho. I would make the decision based on magnetic intensity profiles, depth profiles using the fathometer, and perhaps a sediment core or two. I was given use of either the *Baird* or the *Horizon*. A graduate student by the name of Dale C. Krause was to help me with the gear and standing watch over the instruments. Newbegin was the skipper. We had a skeleton crew for the ship — not enough for round-the-clock surveying. So we would anchor nights near Guadalupe Island. I ran most of the survey lines east and west. We had one storm which cut into our survey time. Newbegin was sick with the flu or something similar most of the time.

I had a curiosity about what was causing the many positive magnetic anomalies I had seen when there was no topographic expression correlating with the anomalies. So I decided to take advantage of the opportunity and choose a drilling spot at the top of a magnetic anomaly that had a north-south trend or lineation. After telling about a position-holding technique used for the drilling ship I will get back to what was found when the drilling was done.

The name of the drilling ship was CUSS I. The capital letters, CUSS, did not refer to the vulgar word, cuss, used to refer to a person or animal that is annoying or worse, which would have been quite appropriate in referring to the ship, but rather to four oil companies, Continental, Union, Shell, and Superior, that formed a joint venture to build a special drilling ship for prospecting and geological studies of the continental shelves. Their joint effort was motivated by the prospect of making money in the long run. When the joint effort had no more urgent need for the ship it was sold for what they could get out of it to the government funded company that was to try for the Mohorovicic discontinuity. The Roman numeral, I, indicated that this ship was the first

of a possible series of drilling ships. So far as I know, CUSS I was the beginning and end of the series.

To keep from breaking the drilling stem that ran from the ship down to the bit, the position of the ship had to be held to within a few feet. That was to be accomplished by having three buoys around the ship, and the ship could know its distance from each buoy in turn by reflecting pulses of sound off of each particular buoy in turn.

Now that meant that each buoy had to keep its position to within a few feet. The people in charge of CUSS I decided to use streamlined taut-wire buoys submerged twenty or thirty feet. Placing such buoys is no mean feat in itself.

The company that was in charge of CUSS I contracted with a development engineering firm on the east coast to design and build and place the taut-wire buoys. The buoys were beautifully made of a stainless steel. They were streamlined for all directions by being shaped like two saucers placed together, clam shell like. Each buoy was about fifteen or twenty feet in diameter and four or five feet thick at the center. Each buoy was to be held underwater by a sufficiently heavy weight sitting on the ocean floor and a wire running from the weight up to the buoy. The tension on the wire was so great that it would stretch about ten feet, and they had to compensate for this stretching in deciding how long to make the wire to submerge the buoy the desired depth, about twenty feet. Each buoy was filled with air under sufficient pressure to prevent it from collapsing from the water pressure at its depth.

Revelle asked me to accompany the buoy placing operation and possibly give them some advice on handling the gear, and, of course, tell them where the drilling ship would be located. When it came to advice from me the east coast people did not want any. They felt fully expert and competent. About half way through the placing of the first buoy they ran into unanticipated difficulty and turned to me for some advice. That placement of the taut-wire buoys was technically the most difficult over-the-side operation I have ever seen. It required brains, experience, and a lot of luck. Finally with great relief all the buoys were in place and ready for CUSS I to take its position in the center of the three-buoy approximate triangle. I did not stay there to observe the drilling but returned to San Diego.

As I remember it, when drilling got started down through the sediment the first rock encountered was basalt. CUSS I had no way of changing drill bits when the first bit became dull

from use, and unfortunately the bits of that day were not capable of drilling through much basalt before becoming too dull to cut through more basalt. After drilling through some basalt the bit became too dull to proceed farther down. So that was the end of trying to drill to the Moho at that time. The allotted money was almost all used up. Earlier seismic refraction shooting had indicated that in this area there was very little basalt-like material above the Moho discontinuity, and that is why the area east of Guadalupe Island was chosen for the CUSS I attempt to sample the Moho. The basalt that CUSS I encountered was much harder to drill than anticipated from the seismic work in the oceans.

The sediment and rock samples from drilling were rigorously analyzed and measured for remnant magnetism. The body of basalt encountered by the drill was negatively magnetized (field direction opposite to what the earth's field is now).

Roger Revelle was most unhappy that CUSS I had not obtained a sample of the Moho discontinuity. When he looked at the positive magnetic anomaly where I chose to drill he interpreted the anomaly as being caused by the basalt body that was drilled. He let me know that I exercised poor judgement in choosing a drilling site at a positive magnetic anomaly because the positive anomaly obviously showed the presence of a thin basalt body such as was encountered, even though negatively magnetized, and had the drilling bit not have had to use up so much penetration capability the Moho may have been reached. I did not try to explain to him that the negatively magnetized body was a minor lava flow that occurred at some time when the earth's magnetic field was opposite to the present field direction. Actually, all the minor basalt body did was to slightly lessen the magnitude of the main positive anomaly. And actually the basalt above the Moho was essentially continuous in all directions as seismic refraction shooting indicated, and the large positive and negative magnetic anomalies were caused by alternately positively and negatively magnetized basalt caused by Earth's field reversals as the basalt was formed by seafloor spreading and then cooled in the environment of the earth's magnetic field of the time. That is something nobody knew of at that time. I showed poor judgement in my dealing with Revelle and others when I chose a drilling place over a positive magnetic anomaly because if anything went wrong, Revelle and others would blame me saying I chose a site over a discrete body of basalt that caused trouble. I should have picked a site where the sediment floor was flat and there was neither a positive nor negative magnetic anomaly. Then if the drill could not go down to the Moho, people

would have said the bit was not up to the job. To this day I do not know for sure if the drill bit could have reached the Moho in that area if it had not used up some of its drilling capability in a rather small flow of basalt. I am fairly sure that the minor body of basalt was from a small lava flow that happened when the earth's magnetic field was opposite to the present field.

Looking back now on the CUSS I attempt, in my undiplomatic nature and way, I should have made an appointment to see Revelle and when the door was closed, said, "Roger, I am going to give you a short lecture about magnetics." Then I should have done just that. Overall, Roger was a great oceanographer, but he did not know everything.

The CUSS I attempt to obtain a sample of the Moho was not a complete loss. It yielded a lot of information about the difficulties of deep sea drilling and what kinds of technology would have to be developed and perfected, such as same hole re-entry with new bits replacing the worn out bits and that much better, fast cutting long life bits would have to be invented and developed.

The attempt by the Marine Physical Laboratory to use the LaCoste Romberg gravity meter was a rather sorry, unrewarded, unhappy experience.

The original LaCoste Romberg gravity meters were developed to measure gravity on land, one reading or measurement at a time. In oil and other mineral prospecting they were successful instruments and much used by geophysical prospecting companies. These companies expressed an interest in obtaining similar gravity measurements over ocean coastal areas of continental shelves and relatively shallow basins in the Gulf of Mexico. So a team consisting of Professor Romberg and his former student, by that time Dr. LaCoste, attempted to fill that need and market. Actually, by that time Professor Romberg was too old to help much with the adaptation, and Dr. LaCoste did most of the adaptation.

The sea-going gravity meter was basically a dry-land instrument with all sorts of suspensions, dampers, electronic compensations, and electronic filters to mitigate the very high accelerations, both vertical and horizontal, experienced at sea on a surface ship. For exploration one needs to know the acceleration or force of Earth's gravity to about one millionth. The vertical accelerations at sea can be up to one half that of Earth. This may be thought of as a noise to signal ratio, a very large number. In ordinary electronic work this is an intolerable and unmanageable amount.

LaCoste finally developed a sea-going gravity meter that prospecting companies could make use of under highly controlled conditions. The measurements were made under way so that one actually had a gravity profile to study. When I used a gravimeter on Scripps ships it was on a non-interference basis, definitely not catering to the needs of the gravimeter.

I felt that Fred Spiess for some reason wanted to get me out of the sea-surface underway magnetism effort. Perhaps he had noticed that I had taken over the magnetometer and made it yield a lot of data which was well received by the scientific community, and that I could do the same for the sea-going gravity meter. To get ahead of the story, I could not do as well with the gravimeter. The gravimeter was a whole different ball of wax, so to speak: The towed magnetometer did not require that the ship cater much to the needs of the magnetometer but not so for the gravimeter. That difference made impossible a similar success for our gravity meter. Furthermore, Spiess was quite inaccessible for discussions of how I was doing with the gravimeter and why. At the end of our effort with our gravity meter I felt quite badly that I had disappointed Dr. Spiess, especially considering the great amount of money I had spent in learning to use it and all the travel to Austin, Texas and the many motel bills.

Gravity measurements and values had been something of special interest to Spiess for some years. He had used submarines to obtain some of these measurements, but the Navy could not see funding such measurements in submarines on a continuing basis. That left him with only Scripps ships on a share-the-ride basis. Spiess obtained the instrument we had from Louis Slichter of UCLA. I took a Scripps van up to UCLA and hauled the meter down to MPL, building 106. Then with a rented van I took it to the LaCoste Romberg shops and laboratory at Austin, Texas where it was overhauled, putting it into good condition and at the same time training me to use it.

One time Spiess had me try taking some gravity measurements aboard FLIP just off the San Diego coast. The meter was to sit on a platform well down below the sea surface. An earlier trip aboard FLIP had shown that there was too much horizontal acceleration when the meter was mounted in the upper working space of FLIP. What was happening was that the upper part of FLIP had a reed vibration due to the flexibility of its neck. The frequency was about two cycles per second as I remember it and of considerable amplitude. Our gravimeter was not designed to work under such conditions. On the second trip the meter was to be hand lowered by rope to the above-mentioned platform. I instructed the chief engineer about the delivery of the meter and how

he with his helpers should lower the meter down to the platform. I went down ahead to the platform and was to call up orders about what to do. I told them to start lowering. About half way down the meter started swinging sideways and was about to hit the walls of the well. I yelled up to hold till I could get up to the meter and steady it. The chief engineer got impatient with my close supervision of him and kept lowering on down. As I anticipated, the meter bumped the wall of the well. That bump damaged the sensing element of the meter as I found out when trying to get a reading down on the platform. End of that effort on FLIP. I did not try another trip with the gravimeter on FLIP. I always had trouble convincing people of the very fragile nature of our gravity meter.

Almost every time the gravimeter was damaged by a bump it had to be taken back to Austin, Texas for LaCoste's shop repair, and this happened all too often. I tried using the meter on numerous Scripps cruises. One time it was near the Siberian coast where the storms and very high seas were almost constant. No good measurements to speak of.

As mentioned about people not appreciating the delicacy of the meter, a big problem came about when the meter was being taken unused from one port to another, and I was not aboard. I would carefully pack it and store it with well posted instructions that it was not to be moved. Then some oceanographer wanting some more valuable deck space would move it to another location and damage it in so doing. I would then come aboard and find that the meter was damaged beyond repair at sea, and it was back to Austin, Texas. No end of trouble!

Considering that Scripps was getting little useful data from the meter and that John Rose of the University of Hawaii expressed a need to acquire it, Spiess transferred it to the University of Hawaii and Dr. John Rose. Rose had a ship with which he could fully cater to the meter's special needs. He got some very good data which revealed a very large anomalous area near Borneo, as I remember it. I went back to doing some magnetics and other things.

Up to and beyond the time MPL was using a LaCoste Romberg gravimeter, the sea surface meters had to operate under favorable prescribed conditions — moderate seas and often only one or two headings of the ship. LaCoste was fully aware of these limitations and wished to market meters that could do good gravity work under almost all sea and course conditions.

At the Austin, Texas facilities Dr. LaCoste built an elaborate sea conditions simulator. A sea-going instrument would be mounted on the simulator and then heaved up and down about

fifteen feet maximum and ten feet side to side. First one thing and then another would be devised and added to the meter and then tried on the simulator. Finally LaCoste had a sea-going gravity meter that he believed could operate well in severe sea conditions, and he wanted to try it out. He contacted me about possibly trying the gravimeter on one of Scripps' ships. It so happened that Dr. Mel Peterson of Scripps had some postgraduate students who needed some experience at sea doing oceanographic and marine geophysical work. Also Peterson wanted some depth information in an area north and west of San Francisco. I told Peterson of LaCoste's need to test a meter, and he happily said he would have the gravimeter aboard to learn even more of his area of interest and at the same time enlarge the experience of his students.

So I telephoned Dr. LaCoste and acted as the middle man between LaCoste and Peterson in arranging this trip. Two of LaCoste's experts with the meter were to bring the meter to San Diego via rented van. They would install the meter on Peterson's ship. I would accompany them aboard the ship to show them how to use a Scripps ship and also make use of the chance to observe how well LaCoste's new gravity meter could cope or perform at sea. I planned to only go as far as San Francisco. Peterson with his students would board the ship at San Francisco.

LaCoste's two experts and the meter showed up at San Diego as scheduled. I watched them install their meter on the ship. Early the next afternoon, I think it was, we headed north to San Francisco. About dark a severe sea state developed. The ship heaved and rolled excessively. The lead expert got terribly sea sick and could not function at all; with much throwing up he just tried to stay alive. The second expert and I were able to carry on. In the heavy seas the gravimeter was incapable of measuring gravity. Perhaps in sea conditions half or a third as bad the meter would have yielded data. As we approached San Francisco and entered the Golden Gate the sea conditions quieted, the meter yielded data, and the expert who was about to die of sea sickness recovered and had some breakfast and took charge of the meter again. He told me that no way was he going to sea again to operate the gravimeter for Peterson and students for a couple of weeks. He also told me that he now knew how well their new meter could cope with sea conditions. In my mind, he did not really know this because he had not operated his new meter under a number of sea states. But he was the boss of the meter try, and I did not argue with him. When we tied up at San Francisco he rented a van, and the two men removed the gravimeter from the ship and made it secure in the van for the trip back to Austin, Texas.

When they had finished loading the meter in the van it was getting late in the day, and we all decided to take a hotel, the same hotel, in San Francisco for a good night's rest before heading our various ways. We were all very tired from the almost constant work of the previous two days. After a good night's rest we all met early in the morning and went down for breakfast on the ground floor of the hotel. We chitchatted; I said that it was too bad they did not get to test their gravimeter as they had wished, but they seemed to express no regrets. I would not recommend them as oceanographers. They headed for Austin, Texas, and I took a plane to San Diego. I think they took me to the airport on their way to Texas. It is quite a hassle for a person without personal transportation to get from down town San Francisco to the airport.

I immediately notified Mel Peterson of the unhappy experience with the gravimeter. Then he was unhappy but could do nothing to correct the situation. After he had returned from his survey with his students he told me that on their survey the seas were mostly calm, even slick some days. They did have a day or two of moderately rougher seas. I think that had the LaCoste people gone on as originally planned, everybody would have benefited — the LaCoste Romberg development shop and Mel Peterson.

Not long after my trip to San Francisco with his people Dr. Lucien LaCoste wrote me a letter asking me to come work for him in Austin, Texas. At that time I was unhappy with my employment with Scripps, and I think LaCoste had heard of this, perhaps from his two men who came to San Diego. I did not want to move my whole family to Texas, and then, too, I had a lot invested in my retirement plan here at the University of California, PERS. I did not want to jeopardize or subtract from that in any way. I doubted that any amount of benefits I would have received from LaCoste Romberg would compensate for the loss of benefits from PERS. So I declined and thanked him and told him why I declined his kind and generous offer. What LaCoste really wanted was an experienced sea-worthy oceanographer to help with his development of seagoing gravimeters. He was in business to make money.

LaCoste was a nice person. I liked him very much. I think he took a liking to me. We had visited often. He once invited me to his home for dinner. He was a big well built man. He loved to play tennis. Financially he was well to do. He belonged to several clubs there in Austin. He was timid or bashful. I really don't know why, but he had somewhat of an inferiority complex. Again, there was no reason for that because he had done very good work and was capable in

inventing and managing a company. I once complimented him saying that I had always respected someone who could regularly meet a payroll, and he had done that quite well.

When I was working out of Hawaii on the *Pioneer* I often needed some strong-back type of help in handling the heavy fluxgate magnetometer. I asked Roger Revelle if it were possible for Scripps to furnish to me a hundred dollars in cash for me to hire a strong person now and then when needed. I could pay them in cash with none of the clumsy practices and accounting as when hiring people by the book, which would not do at all for hiring a person now and then as needed for an hour or two. Roger thought a minute, and then wrote me a personal check for a hundred dollars saying to turn it into cash to hire help as needed.

Well, it turned out that the ship's executive officer told the civilian crew members to help me when I had some heavy lifting to do while in port. At sea these sailors had always helped me under direct supervision or orders from the crew or deck chief.

When my work on the *Pioneer* came to a close I endorsed the check back to Revelle. I do not know if this messed up his checking account or what, but he appeared rather disgusted or peeved when I handed the check to him and explained why.

It seemed that Roger and I thought differently about a number of things that had to do with research. We seemed to use different logic. I must say that Roger was good hearted. And too, how many directors would use their personal money to keep a line of research going?

An interesting note about the history of a World War II submarine tender named *Pioneer*:

It was about 310 feet long, narrow beam, and had enough power to cruise at 17 knots for a month. Quite some time after the war, 1952, the *Pioneer* was loaned to the U.S. Coast and Geodetic Survey to make very accurate depth charts of the area off the U.S. west coast out to about 300 miles and similar depth charts around the Hawaiian Islands out to a 300-mile radius and then some other areas of interest to the Navy.

I neither saw nor heard any more of the *Pioneer* until I was reading my copy of TIME magazine for April 14, 1975. When I got to page eleven there was a photo of the *Pioneer*. I recognized it immediately. The decks were crowded with people. According to the caption the crowd of people on the decks is South Vietnamese marines. The ship is docking at Cam Ranh Bay

after the trip from Danang. My guess is that these marines are getting the hell out of the country before capture by the North Vietnamese army. Most of these marines are now likely living in the United States.

I have not seen or heard anything more about the *Pioneer* since reading that article in TIME. I wonder where it is now, probably was cut up for scrap and made into Japanese cars. You may now be driving around in part of the old *Pioneer*.

I am going to add something here that is not at all MPL history but is advice and recommendation to Scripps.

A problem we ran into in putting together information for this 50th [anniversary of MPL] was that while ships' logs are available and tell rather precisely what a ship did, such as when and where a ship put into port and departed and the fixes at sea and such, we had to depend on people's memories for additional information. There is not much recorded information to fill this gap between information from the ship's bridge and people's memories except what is available from the formal publications of Scripps research scientists.

What is needed is an historian aboard all Scripps cruises. Now this need not be an extra person, but a designated individual aboard every cruise. This person would be given very exact written instructions as to what to record about a cruise. This record would not compete with the ship's log made by the officers of the bridge.

Every day this appointed historian would make brief entries about sea conditions, stops at sea for work of data gathering, any unusual problems, accidents, fights, unusual passing ships, islands passed, at least one fix per day, exchange of personnel between ships at sea, and any other event that might be of interest to people fifty years later. It should be impressed on the historian to not wait several days to a week before making the entries, thus depending on his or her memory. People's memories are just not that good. This history would include every time a ship put into port and tell what for, people departing the expedition, new people joining the expedition, any particular problems in port both material and with personnel, supplies taken on, data records sent back to San Diego, etc.

The notations should answer the questions of Who, What, When, Where, and Why when not obvious about any of the questions. It should not be wordy, but terse and brief; the historian's time on average per day should not exceed ten minutes.

These "diaries" of expeditions and cruises should be kept in strong, well made books, not loose-leaf. It would be better if they were hard back. The pages should be approximately 8-1/2 x 11 inches in size and with lines to make the writing neater. Writing should be in ink. Errors may be crossed out. The writers should sign their work or at least initial it. Each book should show the expedition or cruise name and date, on the cover. If it is a two or more ship operation, each ship should have its historian. Any one book should not cover more than one cruise. When just a few pages are needed to finish a cruise several sheets of typing paper could be taped into the back (ending) of the "diary" book. For one-day cruises to several-day cruises special books of a few pages could be used.

When the books are returned to Scripps the books should be given to the Scripps archivist for keeping in a readily accessible place. People using the books years later should be required to study the books in the archives building and never but never take the books away to another building or to the person's home. The archivist should only allow responsible people with a "need to know" use the books — not kids doing a "for school" requirement or essay or assignment.

In addition to the aforementioned histories of events on Scripps ships or expeditions and cruises there should be histories kept on the equipment used on the Scripps ships. These special ships' histories should tell of all equipment installed on and removed from the ships, special work problems about the ships, solutions to these problems, and problems with shipboard equipment and the solutions. All entries should be addressed to and answer the questions of Who, What, When, Where, and Why as they apply to the entries.

These histories should start now and also go back as far as people's memories allow. When a ship is removed from Scripps use the history would be handled by the archivist in the same way as for the cruise histories.

The director of Scripps Institution and the director of Marine Facilities should both make sure that such ship histories are kept.

Now that Scripps administers and manages the new ship, *Roger Revelle*, here is a chance to keep a history as described above for the entire life of an oceanographic vessel. I highly recommend this.

Since narrating the first reminiscing, several other events have come to mind that may be of interest to people. So here is some more reminiscing.

Earlier I told of an attempt to put more useful sound into the water when doing seismic refraction shooting by setting off a charge in a large air-filled bell.

For this second idea and attempt one should note that when a charge is detonated in the water, sound is sent in all directions with much of it not going to the receiving hydrophones some distance away. I thought of the possibility of having a number of charges in an array which would direct more of the sound toward the receiving ship. I tried a simple array of about six charges in a line crossways to the direct line to the receiving ship. Assembling six charges with electric detonation and then controlling their positions in the water proved to be just about impossible and certainly impractical.

One time Russ and I were doing an experiment concerning seismic refraction work. It involved having a small ship with a hydrophone over the side in the water, and sound picked up by this hydrophone transmitted by radio to a large ship some miles away. I was aboard the larger ship listening for this sound, and Bill Whitney was aboard the smaller ship which had a wooden planked deck. Whitney was to generate a pulse of sound by stomping his foot on the deck. We had good voice radio communication between us.

I instructed Whitney to stomp on the deck. I had trouble with the radio receiver and recorder for this pulse of sound generated by his foot stomp. So I called for him to stomp again harder — still a problem. I called for him to do a series of hard stomps. Then I called Bill for another series of hard stomps. By the time I got my radio receiver and recorder working correctly poor Bill had about flattened his arches!

Another time Raitt and I were doing seismic refraction shooting off Catalina Island to its east. It was another of the one-ship operations with the ship having the seismic receiving and

recording gear with Russ aboard the ship. I was aboard a powered life boat with a Navy sailor operating the engine and tiller. We were several miles north of Avalon in shallow water. I was to drop to the bottom a number of charges as called for by Russ Raitt.

When the first charge was detonated there was the usual sprinkler effect on the surface followed by a plume of water ten or fifteen feet high. Soon after the charge had detonated I noticed nearly a dozen beautiful gold-colored garibaldi fish come to the surface belly up. The sailor and I put the garibaldi in the boat just in case they might be good eating.

On Raitt's instruction I detonated another charge in exactly the same place and then another and another till Russ had finished his day's work. Each detonation brought up several more garibaldi even though the detonations were in exactly the same place. By the time we stopped shooting we had two or three dozen garibaldi in the boat. The ship came back for us, and our boat and fish were hauled up and aboard. I do not remember if the garibaldi were good eating or not, but I was informed by several people that garibaldi are a very protected species and that there is a large fine for killing garibaldi. Several people up the hill from the shore had seen what we were doing and reported this to the law enforcement people. Being Navy and Scripps we somehow escaped heavy fines, but were severely reprimanded.

Russ Raitt was interested in the crustal structure of the area between the channel islands and the mainland as far south as San Clemente Island. Earlier he had done refraction shooting in the southern part of this area with the *E. W. Scripps* and another vessel or two. Then there was the work east of Catalina Island where I killed so many garibaldi.

This time Raitt was going to acquire information to the east of the northern channel islands. For the charges he obtained a number of Navy antisubmarine depth charges, the kind that are rolled off the stern end of a fast moving destroyer. They appeared to be the same size as a 55-gallon oil drum. Russ and I knew nothing about properly handling and detonating such charges. Russ arranged to have a Navy commissioned officer, who was an expert in the use of depth charges, accompany us on the trip and do all the handling and detonation of the charges.

When I supervised the loading of the depth charges to our ship at the NEL pier, I handled them with the greatest of tender care. Then later on location when I saw the Navy officer removing an iron band from one end of the first charge to be used he was whaling away at it with a claw

hammer, and on a blow now and then sparks would fly from the steel to steel contact. I was horrified! I asked him if that was not taking an awful chance. He answered that there was no way a person could detonate the charge by hammering on it. He needed my assistance, and there was little safety to me if I went to the other end of our small ship. Since I am here to talk about it he apparently knew what he was doing with the depth charge.

The charge was to rest on the bottom about a hundred feet deep as I remember it and be electrically detonated by means of a long wire that we paid out as the ship moved away to a safe distance. Raitt on the receiving, listening and recording ship called for a detonation. The Navy officer touched the wires to a battery, and wham!

The sea surface was glassy calm that day. When the charge went off there was the usual fast expanding ring on the surface with its sprinkler effect, then the loud thump on our ship's hull, and then a hundred or so foot plume of water above the charge — quite a sight. Soon about a dozen of the largest sea bass I ever saw came to the surface belly up. While we were preparing the next charge the cook gathered up the large sea bass. When our cook prepared the sea bass he found the flesh had some small worms. I cannot remember if he cooked and served any of the fish or not.

We completed the day's seismic work, the depth charges were all used as Raitt called for detonations, and we headed for San Diego. I should note every subsequent detonation had brought up several more sea bass and a lot of various small fish. The sea gulls in the area ate till they could barely take off from the water — a day of feasting.

On one of our trips to a work area about thirty miles west of San Diego we used the *Paolina-T* and either the Navy's 855 or 857. While working, one of the main propeller shaft bearings of the *Paolina-T* severely overheated. The engineer managed to keep us working by pouring cold water over the bearing when the shaft was turning. Upon completion of our work it was decided to have the NEL Navy ship tow us back to the entrance to San Diego bay. The tow was uneventful, and when we were near the entrance to the bay we came on in and docked by pouring cold water over the failed bearing.

Another time we were using the *Paolina-T* one or two hundred miles west of San Diego. This ship had only enough bunks for the crew as a purse seiner, and when two or three scientists were aboard some people had to sleep on the deck or use the hot bunk system. Also the bunk area was over the engine room as I remember it, and so, hot and noisy. I took along an army cot. There was a cotton-filled bed mattress aboard for people who had to sleep on the floor.

When we had finished our several days of long hard hours of work I was exhausted. We headed to San Diego after the evening meal, and I immediately set up my cot in the huge fish hold, put the old cotton bed mattress on the cot, loosened my clothing, and lay down. There was only the low rumble of the propeller shaft, and there was plenty of fresh cool air. The next morning early, when the *Paolina-T* was docking I woke up from one of my soundest nights of heavenly sleep, fully refreshed and rested and hungry for breakfast.

Russ Raitt scheduled us for some seismic refraction work to the east of San Benito Island, I think it was. It was another one of the money-saving one-ship operations. As usual I was in a powered lifeboat with the radio communications gear and sufficient explosives. The water depth off the east shore of the island increases slowly with distance. So to have the correct water depth for electrically detonated charges my position was about a half mile from shore, and I was to detonate every charge in the same place.

I detonated the first charge as called for by Russ. About a half dozen assorted sized fish floated to the surface belly up. I put the larger fish in the boat. I set off another charge as called for. The dead fish had attracted several large barracuda, and they were killed by the explosion. Because barracuda are very good eating, I put them in the boat. Each subsequent explosion killed some more fish and a barracuda or two.

After shooting for quite a while I saw a rowboat approaching me with two men wearing official looking caps. They came alongside. They were Mexican coast guard people. I knew enough Spanish to say good day to them, and they returned the greeting. Then in an authoritative way they began to question me about what I was doing in their territorial waters. I understood just enough Spanish to get the gist of what they were saying, but I could not answer them at all.

The ship Raitt was working on was one of NEL's Navy ships, the 855 or 857. I remembered that one sailor aboard spoke both good English and Spanish. So I called Russ on the

radio and quickly described the situation and asked him to have the skipper send the man down to where Russ had the radio and have this man translate for us by radio. Russ did so and the two Mexicans talked by radio to the translator.

I think Russ made up a story telling the two Mexican coast guard men that we were doing scientific work and had permission from Mexico City to do the explosions in the island's territorial waters. The two Mexicans were quite impressed with all this going on and told me to go ahead with my work. I offered them some fish. They took two of the largest and a barracuda and waved goodbye as they rowed away to the beach.

While the conversation was going on back and forth by radio, the ship's captain came on the radio and told me in English to tell the two Mexicans to vamoose. Well, he was miles away on a substantial Navy ship, but I was in Mexican waters facing two Mexican officials, one of whom had a side arm. So I said nothing about vamoosing and continued the negotiations which all worked out well.

Late in the day I was picked up by the Navy ship and glad to be away from there. To my knowledge we never heard anything from the Mexican government.

The following story is about something that, I only, know about. I did the construction and tests without saying a word to any of the people at MPL or Scripps because I thought that people would criticize me for wasting my time or would think the idea silly and make fun of me.

A number of times when a Scripps ship was near an uninhabited island some of the people aboard would want to go ashore either for some scientific reason and/or just some adventure. In going through the surf their rowboat would often swamp and too often turn over. I have been dunked several times. Overturning in the surf can be dangerous as well as uncomfortable. I would put my camera in a watertight bag that would float and then have the only camera ashore that was workable. Helicopters were unavailable to us. I thought there must be some relatively cheap and small device for going ashore through the surf and getting there without getting soaked and expensive equipment ruined.

I thought that perhaps a very special catamaran might do the trick. The two hulls or floats need be nothing more than long cylinders with one end pointed. Each float would be about twenty feet long and two feet in diameter. It would be made of a light foam plastic covered with fiberglass

and plastic laminate built up to about one-eighth or three-sixteenth inch thick. The floats would be about twenty feet apart. About ten feet above the floats would be a passenger and equipment platform about fifteen feet long and five feet wide. The floats would be connected to the platform by cantilever struts that have considerable flexibility so they would be fail safe.

Power to propel the craft from the ship to the beach, and then back to the ship, is a problem. Hand rowing or paddling from the high platform could not be done. Fixed propellers on each float would be damaged in the very shallow water at the beach. A solution could be two outboard motors mounted on the aft end of the passenger platform and with a propeller shaft to each propeller close to the side of each float. The propeller shafts could be angled down as necessary to the propellers by means of universal joints. Some sort of a lever would have to be in place so that by a fast hand pull on the lever, that propeller would be swung or lifted up enough to clear any rocks, cobblestones, and the beach sand. I have done this when using an ordinary outboard motor on my boat and going over some rocks or logs in the water.

When this craft is coming in through the surf an about thirty-inch diameter sea anchor which looks like a shallow parachute would be dropped in the water to keep the craft from planing in like a surfboard. When planing one loses control of a boat. I have had this happen a couple of times with my boat when I landed on a beach along San Diego. When using a sea anchor drag the drag of the anchor is immediately stopped when desired by a pull on a dumping line to the back side of the sea anchor.

This seems to be getting rather complicated, but could be done after a little practice.

Launching the craft off the beach and through the surf would require the same technique used by thousands of fishermen, wearing shorts and rubber shoes, hand push the craft off the beach into water deep enough for the propeller to be used.

For storage aboard the ship it would require wing nuts and bolts separating the floats from the struts and the struts from the passenger platform.

Really, all I did in secret from MPL, aside from thinking about the problem and solution, was to build a little model with aluminum pipe floats about two feet long, two feet apart, and a 3/4 inch thick wood platform. I took the model to a sand beach along the San Diego ship channel where motor boats were making a small surf on the beach. I had a string attached to the model so as not to lose it. While I was playing with the model in the small surf a man strolled along and

watched. I could tell that he thought I was some demented character playing with a funny looking little boat in the water. He did not seem to want to get involved in talking to me. If he had asked some questions, I would have explained what I was doing.

Because of all the anticipated difficulties with such a full-sized craft and the expense I did not push for Scripps funding and all.

Looking at this scheme from the perspective of twenty or so years later I feel that it was an impractical solution to a need. All said, it is better for people wishing to go through the surf to get on land, to simply use a small rowboat, some floating water-tight bags for cameras, and plan on getting very wet. Thick clothing and rubber shoes could protect people from abrasions from rocks and also protect from poisonous marine life.

It was in tropical Pacific waters that one of our two sea-going tugs converted to use for oceanography was working, with all male people aboard. Roger Revelle was aboard. As the noon meal was being served Roger came in to eat. There was tall Roger sitting down, bare footed and stark naked as a jaybird. To say the least there were a lot of raised eyebrows. The meal continued with the usual small talk. When two or three more people came in to eat, each did a double take of surprise.

When the meal was over and the tables cleared, the captain called Roger aside and told him that it was an unwritten rule aboard his ship that all people eating at the tables wear shoes, either long or short pants, and at least a T-shirt and that Roger would have to comply. He did comply.

People, usually the scientists, would work, go around the decks, and lounge completely naked. Crew members were required to wear clothing when on duty and generally did so on their time off.

Roger well knew that his eating naked at the tables would cause plenty of gossip, especially when the personnel aboard returned to San Diego. He just did not care. That was typical of Roger Revelle.

Dick von Herzen obtained the *Baird* in 1961 for a long expedition from San Diego to Lima, Peru and on to Papeete, Tahiti, then back to San Diego. The expedition was named Risepac.

Aboard were von Herzen, Seiya Uyeda, Chris Harrison (the student from England who married Russ Raitt's daughter), Fred Dixon, and myself.

We spent several days at Papeete. The local authorities had been helpful and Dick decided that he would help relations between oceanographic people and the local government if he put on an evening cocktail and snacks party for the main government officials. He reserved a large dining type room for the party.

That day Fred Dixon purchased a very light grey suit, white shirt, tie, and white shoes, also a nice straw Panama hat, I think. That afternoon he walked around town tipping his hat to important looking people. He happened to meet a middle-aged couple, tourists from the U.S. He introduced himself to them as the chief scientist of Risepac oceanographic expedition and invited them to the cocktail party he was giving. Seiya Uyeda, the Japanese lady anthropologist, and I, arrived a little early. We took a table for four and began to munch a little on the snacks. I enjoyed asking the lady some questions about Japanese prehistory, migrations, etc.

The American tourist couple arrived and took a table next to ours. Fred Dixon arrived and was walking around the place in his splended suit — the dignified American scientist. Other guests were coming in by now. The American couple introduced themselves to us and said that the chief scientist, Fred Dixon, had invited them to his cocktail party. Uyeda laughed and said, "Chief scientist?" The gentleman said, "What do you mean?" I explained that Dixon was a technician on the expedition and was known for playing "grandee" occasionally. I pointed to von Herzen across the room, in an open collar shirt, talking to the governor. The tourist was embarrassed and said he was tricked and was leaving the party. I implored him to stay, saying there was plenty of food and drinks, so enjoy the evening as our guests. He replied that he was really angry, embarrassed, and he and wife were definitely leaving. I said something like, sorry, and bid them good evening.

Fred had been liberally partaking of the drinks and by that time could not care less when I confronted him with what he had done.

It seems I was forever apologizing and making excuses for Fred Dixon — the Hakodate hotel, aboard the *Argo*, Tahiti, and such.

Incidentally, it was on this trip between Peru and Tahiti that Fred called Seiya Uyeda a dirty Jap!

Ship engine rooms of all diesel and gasoline powered ships have been noisy places. The Navy has always contended that suffering such noise is just part of the job even though many a sailor has suffered permanent hearing impairment. Scripps had two small ships in which the engine room noise was unusually severe — a large harbor tug of unusual design and the *Ellen B. Scripps*.

When Scripps acquired the tugboat Marine Facilities needed a good shakedown to test and evaluate it. As happened with several other newly acquired small ships, I was told that I could have its use for some of my survey work. With two or three other ships on which I combined shakedown with my survey work the ships got a good shakedown and evaluation, but my survey plans were cut short because the ships broke down in one way or another.

I decided to use the tugboat to get a couple of magnetic intensity profile lines to the west-southwest out from San Diego for several hundred miles. On the small fantail deck I set up the towing cable and the "fish" for launching. Inside the small bare room, which was over the engine room, I set up the electronic gear and recorder. I took along an army cot on which I could get some "catnaps" and planned to be the only person attending the magnetometer.

I had done this on numerous occasions. I had a small electrical contact device which would ring a bell when the recorder pen went off scale. This would awaken me, and I would turn a control box knob to put the pen back on scale. The noise coming through the deck plates was a little annoying but tolerable. After launching the fluxgate fish the first evening, things went just fine for me.

The next day the engineer who was spending most of his time in the engine room except when someone from the bridge would relieve him for a time for meals, a little relaxation on deck, and such, told me that the noise was driving him crazy and giving him a headache and that when he left the engine room he was partially deaf. He doubted that he could continue for the shakedown days.

I thought over his problem for an hour or two and realized that considering that he could not understand a word of any orders from the bridge he should put cotton in his ears and cover them with some padding to shut out most of the intense noise. He had been getting orders from the bridge by means of electric light signals, as I remember it. He covered his ears as I had

suggested, and that relieved him from the loud engine noise but was no longterm solution. He needed to be able to talk back and forth with the bridge by phone.

After some more mulling over the problem I told him that when he got back to Marine Facilities he should forcefully tell them of this ship's noise problem and request that they obtain for him and any other engineers assigned to this ship, special head gear for protection and communication with the bridge.

I told the engineer that a long-term solution to the intense noise problem would be some earphones such as are used by some people who, for listening to hi-fi music where there is ordinary noise, buy special headset phones consisting of earphones embedded in thick soft foam rubber. The foam pads cover the ears and the sides of the head. There is an opening through the center of each pad allowing for sound to pass from the phones to the ear canals.

Scripps did obtain such a set of headphones for him. He told me later that while wearing these earphones he could hear and understand voice from the bridge and reply by means of a phone piece held very close to his mouth. I think that Marine Facilities also obtained for him a specially designed helmet with earphones inside. The problem of intense noise in the engine room was solved.

I got my magnetic survey lines out from San Diego and back and considered this a successful trip for me.

While telling about an engine room noise problem and solution, I might as well tell about another small ship on which I tried to combine survey work and shakedown. Again we headed out from San Diego to the west-southwest, and I think I wanted to run a line to near a Hawaiian port, turn up to the port for fuel and water and food, and run a return magnetic intensity profile line back to San Diego.

We were out about two hundred miles when diesel fuel began to come out of the tank fueling receptacle which was flush with the forward deck. Diesel combined with salt water that splashed up on deck made something as slick as ice when people walked on deck. We thought that perhaps the tanks had been filled with very cold diesel, and the warm conditions at sea expanded the diesel fuel enough to expand and overflow the tank, much as many of us have seen gasoline overflowing a car tank on a warm day. But the diesel fuel kept coming up out on on deck. Some

deck crew people were hosing it off the deck to make things safer, and rags were placed at doors for people to wipe the diesel off their shoes when going inside.

It became obvious that there was more to the problem than cold fuel expanding. A careful check of all the plumbing found that a constantly running saltwater pump feeding water in a pipe was feeding a small stream of water into the fuel tank. This was corrected and the up-pouring of fuel to the deck stopped. We had lost a considerable amount of fuel. Marine Facilities was told of the problem by radio. Since all agreed that we might not have enough remaining fuel to reach Hawaii we turned back to San Diego and made it back without incident.

For a time during the years when I was assisting Russ Raitt with seismic refraction shooting, and we still used the motor sailing ship, *E. W. Scripps*, the Navy sent several commissioned officers to UCLA to obtain doctorate degrees. Because the activities and business of the Navy is closely allied with and uses the findings of oceanography in general two or three of the officers came down to the Marine Physical Laboratory for several months.

One was a Commander Sherry, a dignified looking man, blond and blue eyes. He had an unusually interesting story about his service in the Navy. During World War II he was an officer aboard a submarine operating in waters near Japan. A Japanese naval ship detected his sub and gave it the depth charge treatment. His sub's external propulsion machinery was damaged beyond use, but they could still safely submerge and surface. They submerged, lying on the ocean floor in the not too deep water. The officers spent a lot of time discussing whether to remain submerged and eventually die from lack of air, or surface and radio the Japanese to rescue them and of course, make them prisoners of war. They finally decided to surface, radio for rescue, put out their rubber rafts, put their sub into rapid permanent sinking, and get into the life rafts and wait.

A Japanese naval vessel soon found them and took them all aboard, confining them as prisoners of war. Almost immediately aboard and then for some days on the Japanese mainland they were interrogated intensely. They gave the Japanese little more information than name, rank, and serial number. They were placed together in a Japanese prison and required to work in a prison factory making equipment for the Japanese military. Life was not too bad.

The officers had fun, in a way, constructing the equipment in ways that passed inspection but would soon fail when put to use.

Sherry told us that one day there was suddenly much excitement among the Japanese guards. When the prisoners of war asked what all the excitement was about the guards said, "Big boom, big boom!" Work in the factory about stopped. The food and treatment of the prisoners improved. Things happened and proceeded on to final repatriation of the Americans.

These naval officers at MPL were all commanders. They very seldom showed up in uniform. At MPL they wore casual clothing as did the rest of us around MPL. When at sea they wore heavy work clothes as needed as did the rest of us. They were interested in learning about "hands-on" oceanography. Commander Sherry seemed to be especially interested in underwater sound which naturally accompanied the seismic refraction shooting. Sherry is the officer I told about in an earlier account as having accompanied Raitt and me on the *E. W. Scripps*, and how I immediately came down with the flu, and Raitt and Sherry had to do all the work.

Another one of these Naval officers was a man by the name of Commander Wilkinson as I remember it. He had a severe speech impediment which made it almost impossible to communicate verbally. I could not understand why the Navy would take on, train, and keep in service an officer with such a handicap. When he tried to talk to someone his facial muscles would contort; sometimes he would lose a little saliva and finally get out one or two words. He should have kept a writing pad and written out what he wanted to say. I avoided talking to him.

Many years later I was a guest of the Navy on their oceanographic ship, *Silas Bent*, working out of Yokosuka, Japan. For one of the trips Washington sent out a commander to look over and evaluate the work being done. I happened to mention to him my earlier acquaintance with Sherry and Wilkinson. He knew them both well. They had both made admiral. I mentioned Wilkinson's severe speech impediment. He said Admiral Wilkinson still had the severe speech impediment. I asked this officer how Wilkinson managed to communicate in performing his duties, and why the Navy kept him on duty as an admiral. He replied that communicating with Wilkinson was still the same unhappy problem, and that he avoided talking to him. As to the Navy's keeping Wilkinson on duty as an admiral this officer did not have a ready answer. I surmise that perhaps Admiral Wilkinson was a brilliant planner or organizer or evaluator.

Jokingly, I wonder if such a person could ever become president of the United States.

MPL had its lighter moments in the front office. When our front office was located in building 106 of the NEL waterfront area a visitor came in one day. He happened to be introduced to Finn Outler and then to Fred Fisher. The visitor jokingly said that the names Finn and Fisher had an association with oceanography and the seas it studies. So a secretary, likely Chris Baldwin, pulled out a roster of the MPL personnel, and the visitor noted that we had a George Shor — the sea shore, a Jackie Fish, and an Arnie Force — the numbered wind forces associated with sea state. There may have been one or two more names with ocean association. I cannot remember.

Unless I happen to recall another event of interest to people this is the end of my reminiscing.

Art Raff

Note by Betty Shor (December 1996): The preceding material began on audio tapes that Art Raff prepared at his home in April-May 1996. I transcribed it from the tapes and returned to him a copy of the typed material. He went through that and revised it into a smoother manuscript, which is the above copy. He also put his revised version onto tapes.