Antarctic Deep Freeze Oral History Project
Interview with Charles R. Bentley, PhD
conducted on December 2, 1998, by Dian O. Belanger

DOB: Today is December 2nd, 1998. This is Dian Belanger. I'm speaking with Dr. Charles Bentley about his experiences during the International Geophysical Year in Antarctica.

Good morning, Dr. Bentley, and thanks for talking with me.

CB: Good morning.

DOB: Start by telling me something about your background. I'd be interested in where you grew up and where you went to school and how you decided to devote your professional life to ice.

CB: I was born and grew up in Rochester, New York, where I went to a small private school that was just a quarter of a mile away from the house.

Then I went away for a year at Philips Exeter Academy in New Hampshire. I went to Yale for my undergraduate work and then Columbia for my graduate work in geophysics. I was a physics major at Yale.

When I was nearing the end of my senior year at Yale, I didn't really know what I wanted to do. I was interested in law school because we had lawyers in the family. In fact I took the law school aptitude test and did well and got into a couple of law schools: Yale and Harvard Law Schools.

Then I also took a battery of vocational aptitude tests, and they showed that I was not vocationally suited—or temperamentally suited—for the law but that I should do physics and outdoor work. That was what came up strong.

So the interviewer looked up physics plus outdoor work in a little handbook he had, and he found physics plus outdoor work equals geophysics, which neither he nor I ever heard of. This is 1950. It was not nearly as well known then as it is now. So I thought that sounded pretty neat.

DOB: Where did the outdoor interest come from?

CB: I'd always been interested in the outdoors. I liked to be outdoors, and it showed up on the vocational aptitude test. Actually the only thing besides the geophysicist that came up strong, positive for me would be an airline pilot, but my eyes aren't good enough. Besides, I wasn't interested.

So it happened that my aunt knew somebody in Standard Oil Company in New Jersey, as it was called then; now Exxon, soon to be Exxon Mobil. So she

put me in touch with him, and then I went to see if I could—because geophysical exploration, of course, is largely done by oil companies looking for oil.

So I went and talked to him to see if I could get a summer job to see what it was like, and they didn't have anything. But he, in turn, was a friend of Professor Ewing at Columbia who was pioneering oceanographic work and geophysical work in the Atlantic in those days. So I sent a message to Ewing and asked if they would have any space available on the summer cruise—this was in the mid-spring—and he said no, they didn't have anything. So I was pretty much resigned to going to law school.

But then in June, I got a message from Ewing saying, "We now have an opening on a research ship for the summer. Can you be here in a week?" And I said, "You bet."

So I started out on a research cruise out of Woods Hole on the *Atlantis* in the summer of 1950, and I was enthralled by it. It was so exciting to be discovering new things out in the ocean—or I mean just to be along while the people who knew what they were doing were discovering new things.

So Ewing was encouraging, and he got me into Columbia Graduate School even though it was already late in the summer when we got back from the cruise.

So I went to graduate school in geophysics. And then for the first few years, I was doing oceanographic seismic work primarily with Ewing and his crew. But after a few years I didn't have a good Ph.D. thesis topic.

Well at the time, Frank Press was an assistant professor at Columbia. He was also a member of the panel on glaciology, or whatever it was called, part of the IGY program responsible for looking for people to go to the Antarctic and participate in the glaciological program. And in particular, Frank Press' responsibility was for geophysicists to do the seismic sounding and other geophysical work on these over-snow traverses.

And Frank, being a conservative sort, decided that the first place to start looking for people will be to walk across the hall and see if any of his own graduate students, or the Columbia graduate students, wanted to go. So he walked in one day and said, "Does anybody want to go to the Antarctic?" And I thought that sounded like a wonderful idea, so I volunteered. That was about 1953 or '54.

The upshot of that was that I went to Greenland in 1954 and 1955, learning how to do the seismic work. I didn't have anybody to teach me how to do it so I was developing my own techniques largely following work that had been done by the French in Greenland in the '40s from the literature only, and also by the Norwegian-British-Swedish expedition in Antarctica in 1949 to '52.

DOB: So you went to Greenland only to learn to—

CB: Yes, to learn what to do in the Antarctic. But it was an interesting project and the work I did there then became my Ph.D. dissertation.

DOB: Which was?

CB: Which was on seismic refraction measurements on the Greenland ice sheet, or some such name.

DOB: And in layman's language, what were you trying to learn?

CB: Trying to learn the structure and characteristics of the ice sheet at Site 2—which is a spot about two hundred miles inland from the west coast, east of Thule Air Force Base—and also the structure of the upper crust of the earth underneath the ice.

And then we did some other more local experiments, like seeing how waves propagate around crevasses, how seismic waves—how they're distorted by crevasses, and some measurements by an ice cliff to see what kind of a slope there was to the bed going back away from the ice cliffs.

It was all great fun. So it served two purposes: it gave me my thesis and it gave me my experience and training for going south.

Most of the people left for the Antarctic for the first IGY expedition—the scientists—this was Deep Freeze II. There wasn't much science that went on in Deep Freeze I. But the science crews went down in Deep Freeze II, leaving in about October of 1956 from Davisville, Rhode Island, on a ship. But I hadn't defended my Ph.D. thesis yet, so I defended it later shortly after the departure of the ship from Davisville. I got permission from Bert Crary to do this—or from somebody at IGY headquarters—and then I flew down to Panama and picked up the ship as it went through the Panama Canal, and then rode it on down to New Zealand.

On that first trip down to the Antarctic, the Sno-Cats that we were going to use on traverse were right on board on the deck of the ship. So not only were we able to work on them and get them ready, put in benches and things to make the seismic work easier, the geophysical work, the glaciological work—those traverse parties had two glaciologists, two geophysicists, and one mechanic in the early days, and we were all on board the ship, all five of us. So we were able to work in the Sno-Cats. We were also able to sleep in the Sno-Cats because it was much more pleasant up on deck going through the tropics than it was below deck where it was hot and stuffy and awful. So we were really lucky that way.

Then we got to New Zealand where—the only time this has happened—we had a schedule delay. We knew that we were free for two weeks. So we had two weeks free, and we could travel all over the South Island of New Zealand long before places like Queenstown were all built up into tourists traps. I still remember that. That was just magnificent. Beautiful, beautiful country.

Then we went back and checked in and found out that we had another week. The third week we went to the North Island and took a look around the thermal areas and the volcanos. *We* being the two glaciologists and two geophysicists; not the mechanic who was older and not interested in that sort of thing.

DOB: What ship were you on?

CB: The *Robert F. Merrell*. It was a cargo ship. The captain was not too experienced in ice. At times he treated this thin-hulled cargo ship as if it were an icebreaker, and he went charging into the ice. He's lucky he didn't sink the ship.

DOB: Did you have an icebreaker—

CB: Yes, when we needed it. I have some pictures of the caravan. It's not what it's called, but . . . .

DOB: Let me just ask you what you found as the salient differences between the northern and the southern polar regions, if any.

CB: Well, I never spent a winter in Greenland. I was only there during the summer, although Greenland for me was a lot colder because we didn't get issued proper equipment. For example, out in the middle of Greenland where it was often down into the teens or colder, all we had were these gloves. They didn't issue us any mittens, so my hands were cold the whole time in Greenland. It was a bit hit or miss.

It wasn't the environmental characteristics that were different. Site 2, or the center of the Greenland ice sheet, looks just like a place away from the mountains in the Antarctic looks. I mean, an ice sheet looks just like an ice sheet.

But we had to work at night—of course it was light, but during the off-hours so we could share the vehicles, the Weasels, that we were using at Site 2 with the people who wanted to use them during the day, who had priority. It was a lot more back of the envelope, slapdash.

By the time we got to the Antarctic, things were really pretty well organized, up to a point.

[Interruption]

CB: Things were well organized when we went down to the Antarctic, up to a point. We had marvelous clothing issued. In those days the clothing was mostly Army clothing, but at least we had warm boots and warm mittens and had all the proper clothing.

The thing that wasn't so well organized was the cargo system. When we got to Little America, we had dozens of boxes of scientific gear and other types of gear that we needed to get together, and the cargo was all taken off the ship for the whole Little America operation, not just ours. Hundreds and hundreds of boxes, and they were nominally put in some kind of order, but that was only nominal so these boxes were just scattered all over everyplace. And then on top of that we had a snowfall, so they all got buried in the snow.

So one of our biggest jobs when we got to Little America, preparing to go on the first traverse from Little America out to Byrd Station, was to find our boxes. That took a couple of weeks.

And then they had been treated very roughly and quite a lot of the sensitive equipment was damaged. In some cases we had to glue a mirror back together because we didn't have a spare one, and glue the little pieces of silver glass back to make a mirror out of it.

I don't know. We didn't have that kind of a problem in Greenland, but in Greenland we went out from Thule, or Tuto—Tuto was a camp right next to the edge of the ice cap. Tuto means Thule takeoff. T-u-t-o. It stands for Thule takeoff. It was a little Army camp that was there simply because it was the edge of the ice sheet and that's where tractor trains were put together to carry all the cargo out to the sites in the interior of the ice sheet.

They drove at two miles an hour, twenty-four hours a day. It took us five days, I guess, to get from Tuto out to Site 2 which was only two hundred miles away.

I later learned that the tractor train that took us out there was under the charge of Bob Rutford. Do you know who he is? He's now president of SCAR.

DOB: Yes, and he was at the symposium.

CB: Yes. In fact he talked about it. He showed some pictures of that tractor train.

So going back to the Antarctic, we did eventually get all our stuff together and had equipment that was almost as good as new.

DOB: Did you find it all?

CB: Yes . . . well, no, I don't think we found everything, but we found everything we really needed.

So about the 1st of February, we left Little America to drive out to Byrd Station. Going down on the ship, they were still trying—when we were on the ship, we heard reports that they still hadn't been able to get out to Byrd Station. They had such a terrible time getting through the crevasse zone at the boundary between the Ross Ice Shelf and the inland ice where it rests on rock.

DOB: Why was Byrd Station chosen?

CB: Because it was supposed to be the center of a high-pressure area as well as—an atmospheric high-pressure area, a semi-permanent high pressure, quite different from the overall meteorological conditions on the Ross Ice Shelf. And it was in the center of West Antarctica, and it was a long way from anywhere that anybody had ever been before.

It turned out it wasn't a high-pressure area at all, but it also turned out to be an interesting spot. Anyplace is an interesting place to put a station.

DOB: How did you end up at that station?

CB: I was assigned to it. I didn't know one station from another at the time the personnel arrangements were being made.

In the month between the time we were crossing the Pacific—or six weeks or so—and the time we actually got to McMurdo around Christmastime, they had succeeded in getting the trail through what then became Fashion Lane. Have you heard of Fashion Lane?

DOB: Tell us.

CB: Fashion Lane was a seven-mile stretch on the Little America-to-Byrd trail going through the crevasse zone, and they eventually found the crevasses and bulldozed them full of snow. And then to mark the trail through all these crevasses and make sure that nobody went off—it was only bulldozed full along the trail, there were still crevasses off on the sides—they had to put a lot of trail flags up. So there were all these colored flags all through the seven-mile stretch, and that's how it got to be known at Fashion Lane.

DOB: Were the colors significant?

CB: Yes, but I don't know what they meant. There was a color code. Nowadays black means a crevasse and red and green are used for trail markers just as they are at sea. I don't remember what the system was then; maybe it was the same. Since there had been these D-8 Caterpillars with twenty-ton sleds driving through there, it was pretty obvious where the trail was, so we just followed along where the trail had been.

DOB: When I looked at the roster of people at Byrd Station, I counted six people including yourself who were affiliated with the Arctic Institute of North America.

CB: Yes.

DOB: And I have two questions about that. Did you all know each other? Did you come together?

CB: No, we didn't know each other. We didn't work for the Arctic Institute of North America until we went to the Antarctic.

DOB: And so the obvious question is, so how—tell me about this organization and why is the Arctic Institute interested in the Antarctic?

CB: The Arctic Institute, I think, was also responsible for the clothing issue, but they were an agent of the National Science Foundation. So NSF gave its money to the Arctic Institute, and the Arctic Institute paid the traverse scientists, not the station scientists, and I think they were responsible for providing the clothing and providing some of the food supplies and things like that.

I don't remember exactly what else the Arctic Institute did besides sign my paycheck. But none of us, either before or after as far as I can remember, worked back home for the Arctic Institute.

DOB: There were a lot of you at Byrd Station who had had previous polar experience. What kind of a difference did that make?

CB: Well, a lot meaning maybe four . . . four people, five people.

DOB: But Byrd Station was small.

CB: I don't think even—George Toney never wintered over before, did he?

DOB: He'd been in Greenland and in the north.

CB: Wintering?

DOB: I don't remember whether it was—

CB: I can't remember whether he wintered before, but of course none of the rest of us had. I'd had two summers in Greenland, the glaciologist, Vern Anderson and—Mario Giovinetto was the most experienced. He'd been to the Antarctic with the Argentines—he's an Argentinean native—and he'd been to the Argentine stations a couple of times, I think, back before IGY, even though he was young. He was only twenty-three or something like that when he went with us, so he was a real youngster when he went with the Argentine expeditions. So he had the most experience.

Vern Anderson was the chief glaciologist, but his only experience in training was with the training program in Greenland that was run under the direction of Henri Bader of what was then SIPRE, now CRREL. It was run in Greenland. Mario was there, too, but as I say he'd had that previous experience down south.

Ned Ostenso, who was my assistant, had been with me in Greenland the second time I went up but not the first time, so he'd had some experience. He'd also had experience in Alaska, but of course there are no ice sheets in Alaska.

DOB: So you got to Byrd then on the traverse?

CB: We got to Byrd at the end of February. It took us a month to drive out doing our first seismic measurements. In the course of that first trip from Little America to Byrd Station, we found that the bed of the ice sheet, unlike what everybody expected which was that it would be mountainous underneath the ice, but in fact the bed lay a thousand or fifteen hundred meters below sea level. That was a very startling result.

In other words, if we took all the ice away, there'd be open ocean. It wouldn't be land at all. That's true of all of central West Antarctica.

DOB: And nobody knew that before.

CB: No. Since there are mountains all through Marie Byrd Land and then the Horlick Mountains down south, everything that anybody had seen was all mountains, and nobody suspected that there was this great lowland lying in between the mountains.

So we were quite startled when we found that, and it took quite a lot of experimentation before I actually came to believe my own results.

DOB: I want to get back to that. That's really interesting.

When you arrived at Byrd Station, tell me about it. I want to talk for a little while about life and work at Byrd Station, and I'm assuming that when you got there, the station was built, although barely—

CB: Barely, and not completely built. We got there in time to help finish building the station.

There are two things that stand out in my mind. One was that the outbuildings for the seismograph and the magnetometer had not yet been built. The seismograph—it was fairly routine. As I remember, it was put in a trench and the building was put in the trench. I don't remember the details, but it went about the way it was supposed to.

But the thing that's much more memorable is that the magnetometer was supposed to go in a hut, a pre-fabricated building made out of special panels that had no steel nails in them. They were all supposed to be made out of copper, non-magnetic nails. And they had special markings on them—"M", the building, the code number, and then an "M" at the end to indicate non-magnetic.

Well, it turned out that all these panels for the magnetometer building at Byrd Station did not have copper nails in them. They all had magnetic nails in them—steel nails. And what we found out later was that somebody building a building at Little America had taken all the special non-magnetic panels and just used them for some routine use at Little America, and then they'd taken a bunch of other panels that were the same nominally, written an "M" on, and then shipped them out to Byrd.

So we had all these magnetic panels, which would've interfered drastically with the operation of the magnetometer.

So our first construction job, then, was to take all these panels apart, take every nail out—fortunately, the magnetics guy had a supply of copper nails for repair work that he might need, I guess. So we had to take all these pre-fabricated panels apart, pull all the nails out, and then build them back up again with copper nails.

DOB: How long did that take?

CB: Oh, it only took a few days, I guess. So then we were able to make the magnetics building.

And then the other thing that was memorable was the aurora tower. Now the framework for the aurora tower was . . . the pieces were there, but they weren't ready to go together. I can't remember what the details were.

But the aurora observer, Dan Hale, had to design the pieces for the aurora tower—how to take these beams, how to fit them together—and the holes had to be drilled so that this whole tower could be bolted together and then one of these pre-fabricated buildings would go up on top of the tower.

This was getting pretty late in the season. By the time he'd finished with his planning and gotten all the beams ready—the girders ready—it was May, and temperatures were down to fifty below.

I remember working out one day and putting—this was very exposed, up above the surface, trying to put this tower up at fifty below in twenty knot winds. God knows what the wind chill is at that.

George Toney was out there. George Toney didn't want to wear a face mask. Most of us—when it gets that cold, I think we were wearing face masks. He didn't want to do it. So we were watching, and his face would get white from frostbite, and so he'd have to go inside and thaw his face out. And then he'd come out again and work for a little while more without a face mask, and he'd freeze up again and go back in and thaw himself out. Of course we were *all* going in quite often to thaw ourselves out because that's cold.

And then it turned out that poor old Dan Hale, who had no experiences—he was not an engineer, he was a textbook physicist, had just gotten his degree—and one of the things he didn't think of was to make a little allowance for small errors. So he had designed these holes to be just barely large enough for the bolts to go through. Well then of course the holes on different girders didn't exactly line up, so we couldn't put the damn thing together. We had to take it all down again, redrill the holes so they'd be bigger so there'd be some slop, so it was near the end of May as I remember before we finally got the aurora tower put together.

DOB: Which would be dark.

CB: Oh yes, dark all the time.

But then as a reward for helping to put the aurora tower together, we got an opportunity to stand aurora watches which is fun. Everybody had a couple of hours—see, the aurora observer couldn't be up twenty-four hours a day watching the aurora, but the aurora were potentially there twenty-four hours a day during the winter when it was dark all the time. So we got to spend two-hour stints up in

the aurora tower watching. Often it was cloudy, but on any night that it wasn't cloudy, there'd be some kind of aurora.

DOB: What did you see?

CB: Well, the most common is just a quiet yellow-green arc, but often there'd be much more dramatic things going on, changing rapidly across the sky.

DOB: In different colors?

CB: In different colors, yes. Red is the most uncommon, as I remember. There's a very deep red that shows up occasionally.

DOB: Did the people get along at Byrd, and I'm particularly interested in the interface between the Navy people and the scientists and the—

CB: Most of the people on both sides got along pretty well. There were some that were a little bit less easy to get along with. I don't know whether I should tell any stories about individual people.

There is one good story about—I don't remember exactly who the individuals were that were involved, but one of the weather observers who had to go out and make weather obs—somebody had to go out to the shelter, which had to be away from the station so there wouldn't be any disturbance from the station. Every six hours they're supposed to make the weather observations.

One of them had abominable snowmen on his mind—Yetis. He believed that they existed in the Himalayas, and he wondered whether there would be any in the Antarctic.

So one of his friends in the Weather Bureau got a couple big pieces of wood and cut them out in the size of Yeti footprints. And they went out, when nobody knew about it, and made Yeti footprints around the weather station.

So this one observer was completely convinced that there was a Yeti around there somewhere, and for the rest of the winter he wouldn't go out to read the weather instruments without taking his revolver along. Believe it or not, in those days we were allowed to have firearms in the Antarctic. It's unimaginable.

DOB: Did many people have them?

CB: I don't think he was the only one who had a pistol with him. It's hard to imagine it nowadays. So he went out armed so he could defend himself against the Yeti.

DOB: But you didn't find cultural differences and expectations between the Navy people and the civilians generally?

CB: No, things worked pretty well.

DOB: What do you attribute that to?

CB: George Toney. And Brian Dalton, the OIC. Brian Dalton was a doctor who was an Irishman, and I think he'd gone through medical school supported by the Navy. I've forgotten how he got into the Navy as an Irishman. He was in the United States, and I guess in those days, if you were of the right age, you were subject to the draft—I can't remember exactly what it was—even if you were an alien.

So however it happened, he got his degree and a few days later he was shipped down to the Antarctic to take charge of Byrd Station. He had no polar experience, no command experience. But he was a bright, sensible guy.

And George Toney was even brighter, more sensible dynamic guy. So yes, I think the main credit for the success we had goes to George in particular, and the two of them in general, because they agreed that everybody had to participate in everything.

It wasn't a case where all the dog work had to be done by the Navy people, and the scientists sat around on their duffs and were waited on by the Navy. We did share in the KP, or the mess cooking they call it in the Navy. We shoveled snow for our own showers just like everybody else, and that's fair enough. Even though from the official naval standpoint we were all officers, and all the Navy men were enlisted men except for Brian Dalton, nobody paid any attention to that. We were just a group of people working together.

Of course they did most of the work. They had the skills to do the plumbing and the electrical work and keep the stoves going and drive the tractors and all that kind of stuff. But I mean the really menial work that can get pretty annoying if you feel that somebody else is lording it over you, that we all shared.

That's in striking contrast to some of the stories I've heard about Ellsworth Station, which you probably have heard. Since I wasn't there, I don't have anything more to say about that, although I would be interested to hear what you—some of your oral reports on what went on there.

But it's with that in mind that I emphasize that it was done the way it ought to be done. Somebody went back out afterwards and said it was a hardship station. Well, hardship meant that our pool table didn't get out there, our ping-pong table

didn't get out there, we were low on brandy and hard liquor, the beer froze. But that's not hardship. We had plenty to eat, we had good food, we had a warm place to live, we didn't have to work very hard.

DOB: Some people apparently have said that there were serious shortages including food.

CB: No, there wasn't any shortage of food. Maybe there were shortages of some kind of food. I mean, we didn't have fresh fruit and vegetables all the time, but they didn't have those anywhere else. Well, there are different perceptions, different people, different perceptions. Depends on what you want for food, I guess.

DOB: You seem to have been legendary as a baseball fan.

CB: Really? I didn't know that.

DOB: Well, I read in the scientific leader's report on Byrd Station where there were a number of press releases sent back home from there and commented that you kept everybody informed about the major leagues and who was doing what.

CB: Interesting.

DOB: You didn't know that.

CB: No, I don't remember that. When I grew up, I was a fan of the Rochester Red Wings, and then the great manager of the Rochester Red Wings, Billy Southworth, went to the parent team which was the St. Louis Cardinals, so I was a Cardinals fan, and then he moved to Boston, so then I became a fan of the Boston, I think they were Bees in those days, before they became Braves. Yes, I guess—I remember in graduate school I was a strong Braves fan.

DOB: Could you listen to radio?

CB: No, radio connections were poor. Well, yes, you could listen to—we had little radios that we were going to use on traverse. You could pick up a few short-wave stations, Voice of America and Voice of the Andes. I don't remember specifically that we heard these at Byrd Station. We heard them after we got out on the trail.

There's a religious station in the Andes that is very powerful, and I remember one time we were out on the trail—this is a bit of an aside—but there was a radio blackout. You couldn't hear anything. Everything was dead except this one station, which came booming in with all the word from God.

We figured that they had some special dispensation, this religious radio station. They weren't affected by the blackout. God gave them a break and didn't affect them by the blackout so His word could be transmitted around the world when everybody else was deadened.

DOB: Tell me about the blackout. What does that mean?

CB: What happens in a blackout is that the ionosphere is disturbed and does not provide the reflections for the radio waves that allow them to travel long distances. Long-distance radio wave transmission is not direct, it bounces off the ionosphere. The lower parts of the ionosphere interfere with radio transmission—absorb it or bounce it back too soon. In nighttime, the lower ionosphere goes away, and the higher ionosphere then provides excellent long-distance transmission which is why short-wave is so much better at night than it is in the daytime.

But during a radio blackout, there is a magnetic storm from the sun that interferes with the upper levels of the ionosphere and prevents this kind of radio transmission. So then you can't talk to anybody, and we couldn't talk to our home base as well as not being able to listen to Voice of America or the BBC or WWV. WWV is a station that just broadcasts time signals. But that was useful, so a lot of the time we just had this steady tone on the radio, punctuated by clicks every one second. It's rather a boring program.

DOB: Is that the one that comes out of Boulder?

CB: That's one of the places. There are broadcasting stations around the world.

DOB: Tell me about your scientific work while you were on station. I assume you were getting ready for the traverse the following summer, but what did you do all year?

CB: We didn't do much scientific work until after March. For the month of March—I'm not sure just how this fitted in with helping to build the magnetic station, but maybe it was after we were done with that. Anyway, we had a month or so while it was still warm enough to do some seismic work out in the vicinity of Byrd Station, and the glaciologists were also out working setting up stakes and measuring snow accumulation and that sort of thing.

But then when it got too cold and too dark, we had to move inside. Then we had all the data from our trip from Little America out to Byrd to work on, and that took several months. There's a lot of detail to that besides just the measurement of the ice thickness.

Then we spent a couple of months preparing things for the traverse. Later on in the winter we were preparing equipment. We spent a lot of time trying to get the gyrocompasses to work in the Sno-Cat. We had gyrocompasses because it was sort of automatic that you can't use a magnetic compass at the Pole—you're too close to the Pole. Well, we had a terrible time with the gyrocompasses. They weren't properly damped and we didn't have the right fluid to provide the proper damping.

We did actually start out on the traverse trying to use the gyrocompass, but it didn't work. And finally it dawned on us that there really was no reason not to use the magnetic compass because if you consider where the South Magnetic Pole is, way over on the other side of Antarctica, and where we were at Byrd Station, we were actually farther from the magnetic pole than we are from the North Magnetic Pole right here in Wisconsin. So a magnetic compass works better at Byrd Station than it does in Wisconsin, and it was silly not to use it.

They weren't supplied to us, but somehow we wound up with one of these vehicle compasses. It was actually a tank compass, something that was designed for use in a tank. And we used that, and then we forgot about the gyrocompasses which were the latest in technology, but they didn't work.

DOB: Sometimes simpler is better.

CB: A magnetic compass is much simpler and very reliable—and then the other thing, of course, we navigated by was just the sun. Keep track of a shadow. Bert Crary used a sun compass a lot on the Ross Ice Shelf traverse.

DOB: Well, speaking about tools and equipment, what other kinds of things did you have? How would those technologies compare with what you've done in more recent years?

CB: What we had was seismic equipment—we had a lot of explosives, we had seismic cables and geophones, and a lot of electronic recording equipment. One thing that's different with seismic work now is that things are recorded digitally, and it's all nice and clean. But in those days, the recordings were on photographic film with an oscillograph that had a roll of the unexposed paper in it, and one had to stick one's arm into a light-proof sleeve and then, when the shot was fired, we ran the film through it. Ran off about a couple of feet—

[End Side A, Tape 1]

[Begin Side B, Tape 1]

CB: So the paper then came out of a slot underneath the oscillograph into this developing box, and one stuck one's arm out like this and caught the paper laid back and forth like this. And then you had to gather it up in your arm, turn it around, and then underneath there were three tanks: one with developer, one with stopbath, and one with hypo for developing the film. Just like developing ordinary film.

So you had to run it through each one of these in turn with—well you could use two hands. There was a way to stick your second hand in, run it through these baths, and then it was okay to take it out. And later on you had to wash it and hang it up to dry.

This worked fine except that for months it was this constant exposure to these chemicals. It wasn't so bad when they were warm, but they tended to cool off, and then they go slow and the seismologists' hands were a mess. They were all brown from the developer, and then they were all chapped from the hypo, which accelerated the chapping.

DOB: What did you do about that?

CB: Used some kind of hand lotion—Noxzema. I think Noxzema was the favorite. I used a lot of Noxzema.

Yes, so that was one difference. The gravity meters were our supplementary way of measuring ice thickness as well as measuring the earth's gravity field, which is interesting in its own right. They have changed essentially not at all, except in very recent years. Now there are some new model gravimeters for that kind of work, for portable work. But the ones we used in the early '90s—the last time I was down there, they were still using the same type of meters that we used back in IGY, essentially.

The biggest difference that came along later was the development of radar as a way of measuring ice thickness. Radio waves travel through the ice—radio waves of a certain frequency, say ten to a couple hundred megahertz—travel through the ice very easily, and so nowadays ice thickness is measured using flying aircraft. They just send out a radar pulse and time the echo, just as though they're flying over the ocean or something.

That technique was developed—the very beginnings of it were investigated during IGY. There was a man named Amory ("Bud") Waite who was a Byrd veteran who was at Little America in Deep Freeze II testing transmission of radio waves laterally through the snow. I think it was in 1959 he got the first radar sounding through the ice—not at Little America but around at Wilkes Station.

Meanwhile, about the same time, the British accidentally discovered this penetrating character of the radar waves. They had an ionospheric station on the ice shelf.

An ionospheric sounder sends a radio signal up—it sweeps through frequency—it sends a radio signal up and gets the reflection back from various levels of the ionosphere. But they found some very odd interference patterns on the signal that came back. And what they eventually realized was that they were getting a combination of the signal that had gone straight up to the ionosphere and come down, and one that had gone down through the ice, bounced off the ocean underneath, and then gone up and come down. And as they changed the frequency, the phase relationship changed so they would get this odd interference pattern.

They realized from that that these radio waves were sounding the ice, so they developed a radio-echo—they always called it radio-echo sounding. We generally call it radar—it's the same thing. They developed that in England about the same time that Bud Waite was developing the system in the United States.

DOB: But you didn't use that.

CB: We didn't use that in IGY, no. It wasn't really even known then. We started using the radar—Bud Waite lent us his radar system, and we were using it in 1963, I think was the first time, on Roosevelt Island. In 1964, we got the first radar sounding on the inland ice at South Pole Station.

DOB: So radar was around, but nobody had thought to put that application to it.

CB: Right. The analogy I like comes from oceanography where, in the old days, the way you measured the depth of the ocean was with a lead line. You put a weight on the end of a rope and lowered it over the side.

And then they developed the sonic echo sounder, and that was orders of magnitude faster and more accurate.

To make one seismic sounding at one spot takes a couple of hours by the time you lay out all the spread, drill the hole, shoot the shot, and gather everything all back up again—well, maybe an hour. To make one sounding using radar takes thirty microseconds.

The only reason the analogy isn't better is because the seismic method is just as accurate as the radar method. But you can't run a continuous line—you can't fly along and do seismic work.

So that was the biggest change.

DOB: Did the results of your work, just in general, compare with the goals you had set? Did you meet the goals that you were working on?

CB: Oh yes. Our goal was to map the ice sheet: map its thickness, map the snow accumulation rate on the surface. Those were the primary objectives. Yes, we succeeded with that.

When I first went down, I didn't go for two years. That wasn't my idea. Our first full season's work—after the first winter at Byrd Station—was the Sentinel traverse, that sort of trapezoidal traverse that runs north from Byrd Station and over to the Sentinel Mountains, that was so interesting and so exciting that all this huge thickness of ice up to over four thousand meters—I think the deepest was four thousand two hundred and fifty meters or something like that. So that there's a spot in the bed that's twenty-five hundred meters below sea level, right in the middle of what's supposed to be land, or continent.

That was all so exciting that when the end of the first season came around, I figured—oh, another thing I should point out is that IGY was viewed as a one-and-a-half-year program—well, for the Antarctic, a two-year program. It wasn't viewed as something that was going to continue through the rest of recorded history. So I didn't know that I was ever going to have an opportunity to go back, so near the end of the first year, I decided I was not ready to give up without going *south* from Byrd Station to see what was there.

So I volunteered to spend another winter so I would be able to continue the traverse work down the other way and sort of complete the picture, at least from the standpoint of a center at Byrd Station.

DOB: Well, that was my question. What possessed you to do this a second time?

CB: That was it. It was excitement about the work, plus a feeling that I wasn't going to have another chance. It was now or never. That turned out to be untrue, of course. I've been going down irregularly ever since. It's been my main life's work.

DOB: Did you leave the ice at all during those two years?

CB: No.

DOB: No R&R?

CB: No. There wasn't any way to get in and out. Well, there obviously was a way to get in and out or everybody would've been there for two years. But it was difficult enough and expensive enough so that nobody had R&R, nobody had leave during that time, at least not from Byrd Station. I think they did from McMurdo but not from Byrd.

DOB: Were you glad you did it?

CB: Oh, absolutely, yes. My gosh. I still look back on the excitement. And you know, it wasn't just the scientific work, it was also the excitement of being out in an area that nobody had ever been before.

And there were specific things that showed up within the details on the seismic soundings, which I don't need to go into, but they were details about internal structures in the ice that were exciting to a seismologist and one who has since come to call himself a glaciologist.

I didn't think of myself as a glaciologist when I went to the Antarctic. I was just a geophysicist. But somewhere along the line I started thinking of myself as a glaciologist.

An example of the excitement was driving eastward over towards the Sentinel Mountains. At the time, all we had on our maps was Mt. Ulmer, which had been seen by Lincoln Ellsworth when he flew across West Antarctica back in '36, I think it was.

DOB: Spell that . . . Ulmer.

CB: U-l-m-e-r. And that's a small mountain and not very striking. It was on our maps but there was nothing else over there on our maps. Well, I guess the Sentinel Mountain name I think was there, and I guess there were a few other little peaks around Mt. Ulmer.

But as we drove eastward across the ice cap, gradually coming up above the horizon we saw this huge, spectacular mountain ridge that we didn't know was there. Of course it was there when Lincoln Ellsworth—he would've seen it but it must've all been under the clouds, so all he saw was this little peak at the north end and a few surrounding peaks. But the main mountain range had not been seen.

So we saw this, and we started seeing it maybe a hundred miles away, or probably more than a hundred miles away. We were only going twenty-four miles a day, or maybe thirty miles a day, so every day it would get a little bit higher. A week, ten days went by as we approached this, and finally we got

close enough so that we actually were able to walk over to one of the outlying nunataks. Then we surveyed in some peaks.

We actually got away with naming one group for ourselves. That's a no-no normally. I don't know why the Board of Geographic Names ever even allowed that, but within the Sentinel Mountains there's a Traverse Group, and in the Traverse Group are peaks. There's a Bentley and an Anderson and an Ostenso and a Giovinetto. [And also Long Gables, named after Bill and Jack Long, new members of the traverse party that season. (Bill replaced Mario, and Jack replaced Tony Morency.)]

DOB: There are lots of names from the '50s on features down there.

CB: One of the reasons they allowed it may have been because eventually there were so many features to name that they were running short on names to attach to them. The rumor is that there is even some geographic feature down there that's named after an oiler, one of the guys who worked in the engine room on an oil tanker who never even went ashore, let alone spend any time in the Antarctic. That's probably not quite true.

DOB: That's exciting. How old were you?

CB: I turned twenty-seven just before Christmas in 1956, so I was twenty-six when I left the United States and I was twenty-seven when I left Little America for Byrd Station.

DOB: So you didn't have a family at that time?

CB: Not my own family, so to speak. I had a mother, two sisters, and a brother, and uncles and aunts and cousins, but no children, no wife.

DOB: Would that have made a difference?

CB: Yes, that would've made a difference. I have not wintered over again at all, but I certainly haven't wintered over again since I've been married.

DOB: You have or have not ever wintered over?

CB: I have not ever wintered over again since IGY, since my two years. That was enough. The main reason, though, really was that before long, it wasn't necessary to winter over. The reason we had to winter over was to be there at the beginning of the field season.

Many expeditions still have to send their people down for a year because, if you go by ship, you can't get in until late in the summer because of sea ice conditions. So people who want to be there to have a full summer field season have to go in the fall before, spend the winter so they can get off at a decent time in the spring, and have several months to do their summer's field work. And that's the way it was with the U.S. in the IGY days. But before very long they were flying people in and out and you can fly in in October and November, as everybody does now, have a full field season, and then fly home.

So there's no need to winter over anymore. If you have experiments to do during the winter, of course that's different. But for those of us who work outdoors and do summer-type work, there's no need to winter over.

DOB: What was different about being at the station the second time around, if anything?

CB: Well, even the nominal hardships were gone. We did have a pool table, we did have ping-pong tables, we had unfrozen beer, there was liquor besides Old Methusalem. Did George mention Old Methusalem?

DOB: Everybody mentions Old Methusalem.

CB: The world's worst bourbon. I don't think anybody ever heard of it except—I don't know where the Navy got that stuff, but any port in the storm. It tasted pretty good when you didn't have anything else.

But at any rate, it was much easier going. We didn't have to build anything, we didn't have to build an aurora tower, we didn't have to reconstruct a magnetics building.

And another reason that things ran particularly smoothly was that there was a Navy chief there. Chiefs are what really make the Navy go. Officers don't really run men. What the sergeants do in the Army, the chiefs do in the Navy. The higher non-commissioned officers are the ones who really keep the troops in line and work with them because they're of them but still with some charge over them.

So there was a chief and he was a wonderful guy, and he got along marvelously with all the other enlisted men and the officer in charge. I think his name was Norfleet Carney. The officer was also much more attuned to Navy life. I can't think of his name . . . Ruseski?

DOB: R-u-s-e-s-k-i. Peter Ruseski.

CB: Yes, yes. He was from Bridgeport, I think, as I remember. And he was a hard-nosed guy who was more a military type than Brian Dalton was. The main division of labor, the way of running a station was just the same, but the combination of the—I do give a lot of credit to having a chief. To have the only guy trying to run a bunch of Navy enlisted men a foreign doctor who's never spent any time in the Navy before is not ideal. It was just asking for trouble. So the second winter they did it much more sensibly, and it showed. I didn't feel we had a bad time the first winter anyway. I certainly didn't.

DOB: My reading of the reports from the various stations suggest that people at Byrd did well. To what extent do you think that is attributed to leadership?

CB: Oh, a lot. I think it's attributed a lot to leadership. I think it was a good bunch of people we had on both sides, sandcrabs and Navy guys alike. But frictions arise, and it's the job of leadership to keep them from getting out of hand. So sure, I give them a lot of credit for that.

DOB: Do you want to say anything in particular about some of these people? I know you have a few already—this may be repetitious—but my list includes George Toney. What would you say about him?

CB: I have the greatest admiration for George Toney. Every once in a while I give a somewhat tongue-in-cheek talk about experiences in the Antarctic, and I show George cleaning the latrine and doing things like that, and I refer to him as the one who liked to lead by doing. That's only partly a joke because that was his leadership style.

As I said, anytime anybody was out building the aurora tower, he was out there working on it. Anytime there was anything to be done, his first idea was to do it himself, and if he couldn't do it himself then he'd try and get somebody to help him.

I remember he used to do the same thing when he was the NSF rep at McMurdo. If there was cargo to be moved, he wouldn't call somebody to come over and get in the forklift and move the cargo around, he'd go do it himself. He'd hop into the seat of the forklift and start moving the cargo around.

And he's very even-tempered, good sense of humor, everything you need to keep things under control.

DOB: Brian Dalton?

CB: As I say, he was a fish out of water. I liked him, he was a very nice guy, and I think he did as well as somebody under his circumstances could be expected to. But the Navy made a big mistake in taking somebody who had no experience,

no time in the Navy, wasn't even an American, and putting him in charge. I don't know what they had in their heads. It could easily have been a lot worse. As I keep saying, I didn't have a bad time. But it could've gone better, as it did the next season because they had a proper type of command system.

DOB: Steven Barnes?

CB: Oh, I haven't thought about him much. He was probably the most popular guy at Byrd Station because he ran the ham radio.

That reminds me of a story that I was going to tell you earlier. That first year it took a long time to get ham communications back to the United States. Steve and others, Virgil Barden, worked long and hard trying to get a good antenna system. I don't know just why it was so difficult, but it was. And it wasn't until the middle of the winter that we finally got ham communications back to the United States. And there still weren't many hours of the day when you could do it so we had to set up a schedule—and the communications weren't good every night. So the idea was to at least give everybody a chance to talk home once before the winter was over.

One of the Navy guys had a girlfriend back home that he'd been boasting about during the winter, and when it came his time, this is whom he wanted to talk to back home. When it came his turn, he got on the ham radio and they talked to Jules, the ham in New Jersey who all the IGY people probably remember. You know the way it works, you give the telephone number and then the ham makes a collect call and then patches in the radio after the connection is made.

So Jules called up this girl and said, "I have a collect call for you from John Doe in the Antarctic. Will you accept the charges?" And she said, "How much are they?" And he said, "Fifteen cents," and she said, "No." And that was one unhappy guy. He was already unhappy. He was kind of an unhappy sort before this happened, and after this happened he was distinctly more unhappy. I think he was the most unhappy of the people who wintered over at Byrd Station.

DOB: So his rejection would've been fairly public as well.

CB: Yes, of course.

DOB: The Steven Barnes I'm thinking of was the scientific leader during the following year?

CB: Oh, I'm mixed up. Steve Barnes was the ham operator the second year, and then he was the—oh, he *was* the chief. Oh yes. He was the scientific leader.

DOB: At least he wrote the report of the second year.

CB: Yes indeed he was. It's funny that I'd forgotten that. I guess that's what happens when you have something that runs so smoothly you don't even remember.

Yes, I'm remembering that wrong. Virgil Barden was the ionosphere guy the first winter. He's the one who got the ham system going. Then Steve Barnes who was, indeed, the scientific leader was also an expert ham, and he had a really smooth-running ham radio system so that there were very good ham communications all through the second winter. Another reason perhaps that it was such a smooth time.

Yes, he was very easy going, and things went so well that I don't think he really had any major difficulties to face.

It was all the difference in the world between stepping in in the second year of a running operation where things are already pretty smooth, and all the things we faced in the first winter when the station was only half built. There were major problems associated with just getting it ready to go and last through the winter.

DOB: You mentioned Crary, A. P. Crary. Was he on the ice when you were there?

CB: Yes, he was at Little America. He also spent two years, the same two years that I did.

DOB: Did you have interactions with him?

CB: Occasionally we talked on the radio.

DOB: He was in charge, wasn't he?

CB: Yes. And most interaction would be by radio message. We didn't do a lot of talking on the radio in those days. It was mostly by message traffic.

DOB: Was there anybody, leader or otherwise, that you met on the ice that you were just particularly glad to have there, either from admiration and respect or friendship?

CB: Bert Crary, yes. He was sort of the demigod of polar geophysics. I'd heard about him when I was just a new graduate student at Columbia. I heard about this fantastic guy, Bert Crary, who was up in the Arctic and doing all these wonderful things. Actually one of my roommates when I was at graduate school, Jack Oliver, who's now a retired professor at Cornell, had been in the Arctic for a season with Crary. I probably heard quite a bit from him. And then he was the boss, and he had all the previous experience of doing—he was a very good

geophysicist. Oh, I'd heard his name before because he had worked with my professor, Maurice Ewing, back in the '30s, some of the early geophysical work on the east coast of the United States.

One of the things that most people are surprised—you know I am the A. P. Crary professor in geophysics. That's not just coincidence. That came about because I was awarded a chair here, and the way it works on a lot of them is that the recipient can name the chair for whomever he or she pleases, so I chose Crary. The downside of that is the name goes away when I go away. I'm now A. P. Crary professor emeritus, so I can keep the name alive as long as I'm alive.

But one of the things that surprises people who know about Crary and know about me is that I never worked with him directly. I never spent any time in the same field camp. It was always only at long distance. And then of course he was the chief scientist at NSF for years in polar programs. So he was funding me and supporting me for a lot of work that I did in the Antarctic.

I turned the tables on him in 1960. I convinced him that the planned traverse from McMurdo up Skelton Glacier and then to South Pole couldn't be done unless he went down and led it. He was the head at NSF and he had already decided he was through going to the Antarctic, but since he had run that traverse in IGY up Skelton Glacier and out westward onto the Victoria Land Plateau, he knew Skelton Glacier and I didn't think—it's a terribly difficult place to drive vehicles up and down, particularly these extra big ones. The ones that I mentioned that are now left out in Queen Maud Land after three traverses from South Pole? Well they got to the South Pole because Bert Crary drove them there in 1960-61.

So he reluctantly went down and ran that traverse, and successfully got the vehicles up Skelton Glacier and to the South Pole.

DOB: That must've been difficult to do.

CB: Yes.

DOB: How do you get Sno-Cats up—

CB: Carefully. You can drive around crevasses as long as you know where they are. If they're not too wide you can cross them, and you want to make sure you can cross perpendicular rather than at a shallow angle where you just put one side of the vehicle or sled in. But the crevasses don't show very well on Skelton Glacier—they're pretty well covered up. And also it changes from time to time.

Now when Sir Edmund Hillary went up Skelton Glacier to meet Sir Vivian Fuchs [neither was "sir" at the time] coming across from the other side of the continent—the Commonwealth Transantarctic Expedition—it was either he, I think, or Trevor Hatherton, another Kiwi who was with him, a geophysicist, who said there was just a great bloody highway to the Polar Plateau. They had lighter vehicles. Then Crary's IGY traverse did not find it an unobstructed bloody highway to the Polar Plateau. They had a lot of trouble. Actually I think they had less trouble with the big vehicles because of the previous experience. They had a better idea where to go, how to avoid the crevasses, where to find them, look for them.

DOB: Let's talk about the traverses, your traverses in particular. I remember that at the American Polar Society's symposium, you were introduced as Mr. Antarctica for—

CB: Dick Cameron is very kind.

DOB: —all that work, and it was in the material from there that you actually had led six of them. Is that right? Six traverses?

CB: One, two, three, four, five, yes, that's about right.

DOB: Three of them during IGY.

CB: Yes, three during IGY and then one immediately thereafter in '60-61.

DOB: So how many seasons have you spent on the ice altogether?

CB: I believe it's fifteen, sixteen—no, eighteen. It think it's eighteen.

DOB: All over the continent?

CB: Yes . . . well, I spent many seasons in West Antarctica in the inland ice, five seasons on the Ross Ice Shelf, a couple of seasons on Roosevelt Island in the Ross Ice Shelf, a couple of seasons at Dome C, which is around in Wilkes Land, eastern East Antarctica, three seasons up on the South Polar Plateau. I've never been over on the Filchner Ronne Ice Shelf or the Antarctic Peninsula, and there's a big gap between Dome C and the Pole of Inaccessibility that I've never seen.

DOB: But you've seen a lot.

CB: Yes.

DOB: In terms of beauty, where would you go to show someone—

CB: Antarctic Peninsula, even though I haven't been there. I couldn't really show them, but that is surely the most spectacular part of the continent because it's all mountains and glaciers and water and sea ice. Everything is there all at once.

DOB: Who determined the routes of the traverses that you were on and why did you go where you went?

CB: They were laid out in general plan by IGY planning people. And then . . . I'm trying to remember. We had always planned to go over to Mt. Ulmer, which turned out to be the Sentinel Mountains range. As we headed north—I can't remember why we headed north rather than heading straight out that way. I think maybe it was because it was affected by a discovery that the bed was so far below sea level, and so we wanted to go north to see how far one could go before you got into the subglacial mountains instead of the subglacial, huge valley. As we went north, we saw several mountains that were not mapped. We wound up heading for Mt. Takahe which was a spectacular volcano about thirty miles across.

We named it Mt. Takahe. Takahe was the name of an R4D. Our first resupply flight on traverse was flown in Takahe—I've forgotten the name of the pilot. It wasn't Gus Shinn, it was . . . Gus Shinn did come out and see us later. He was one of the people who was made an honorary member of the American Polar Society. I can't remember the name of the pilot, but the airplane was called the *Takahe*.

Takahe was a wingless bird that was thought to be extinct that had just been rediscovered in New Zealand within the last year or two before the IGY expedition. So the Navy guys had picked up on that and called the plane the *Takahe*, so we named the mountain after the resupply plane rather than after the bird directly . . . although we named our Sno-Cat after a bird.

When we were traveling around New Zealand before going down to the Antarctic when we had those three weeks, we came across a picture of a bird called a Gallirallus australis hectori, and we thought that was a wonderful name, and that's what the seismic Sno-Cat was called: Gallirallus Australis Hectori.

DOB: Shall I ask you to spell that for our transcriber?

CB: Yes. G-a-l-l-i-r-a-l-l-u-s. You know, what I probably should do is dig out the slide that has the name to make sure I'm spelling it right. G-a-l-l-i-r-a-l-l-u-s a-u-s-t-r-a-l-i-s h-e-c-t-o-r-i. And when we talked back and forth between Sno-Cats, we did not use the full moniker. We went by Hectori.

The other two Sno-Cats were named Carole for Vern Anderson's girlfriend, now wife, and Buttons for the daughter of the mechanic. So they were very conventional naming after female members of the family. Ned Ostenso and I, the geophysicists, were less conventional.

DOB: So the role of air support must have been pretty important.

CB: Yes, it was. It was tremendously important. There was no way we could've done this. We couldn't pull enough fuel—primarily it was gasoline that we needed. It was nice to get some food supplies and mail and things like that, but it was gasoline that was absolutely essential. And we could not pull with our Sno-Cats enough gasoline to go around the whole traverse. We had to be resupplied every couple of weeks.

The first resupply was particularly memorable because resupplying the traverses, at least our traverse, hadn't really sunk in with the support people, and we sat out there waiting and waiting and waiting for somebody to come out and resupply us after we'd sent in notice.

We were down to our last few tens of gallons of gasoline. The weather was nice, but we had to decide whether to conserve the gasoline so we could just run the heaters to stay warm or whether we were going to use it to do some more seismic work. And we said, "They're going to come find us." So we used up most of our gasoline doing a long-range seismic experiment.

And then of course they did come before we were totally out of gasoline. The pilots and the crew were enthralled once they found us out there to fly out in the middle of nowhere and see these little vehicles, to come down and resupply them. They thought that was the greatest thing.

So from then on, anytime we wanted to be resupplied, we'd just send in a radio message and they'd be out instantly. They loved coming out to find us. They were a little surprised sometimes, though. They thought that when they came out—they'd have a professional navigator on the plane—they'd come out and tell us where we were, they found out that we knew a lot better than they did for the simple reason that when you stay on one spot on unmoving earth for twenty-four hours, you can get a lot of solar observations that give you very accurate position, much better than what you can get with a sextant looking out the bubble of the top of a flying aircraft.

DOB: It seems like it should be pretty tricky though to land an aircraft on the ice.

CB: Oh no, it's not tricky. I'm not a pilot, but you've got hundreds of miles in all directions of flat snow surface and skis on the bottom of the plane, and all you have to do is lower the plane until it lands, if the weather conditions are good.

DOB: No crevasses.

CB: No crevasses. I always used to think that—I used to tell people in the early days that we never had any crevasse problems because the only crevasses we had to encounter were the ones in Fashion Lane, and they were all filled full for us. The route was flagged through.

Once we got inland, I used to believe that the crevasses were only along the margins of the ice sheet where it joins the floating ice or went around mountains or something like that.

So we just drove around everywhere. Gave up worrying about crevasses except for when we were right next to the mountains. And we got away with it, but we were actually living in a fool's paradise because now we know that there are these huge ice streams all over the place that have thousands of crevasses. They're characterized by crevasses—the fast-moving ice—and we didn't know they were there. We didn't deliberately avoid them, we just luckily avoided them.

There are lots and lots of crevasses in the interior that aren't obviously associated with mountains or with margins between the inland ice and the ice shelf. But we didn't know that, so we had no crevasse problems.

DOB: Where did the planes come from? Little America?

CB: In those days they just came from Byrd Station. I think there was a plane that was based at Byrd Station, but they could easily shuttle back and forth between—I don't remember really. Maybe they came from Little America and stopped at Byrd. I don't know, I wasn't there. We were hundreds of miles away.

DOB: Did the planes ever get delayed—well they must've—by weather?

CB: I told you about the first delay which was because nobody had quite absorbed that this was something that needed to be done. But after that, yes, weather delays, but that was all . . . and not a lot of weather delays.

DOB: How about weather for you on the ground? How often would it get so that you just couldn't work or couldn't travel?

CB: Not very often. No more than on the average a couple days a month. It seemed like we had specific storms every—

[End Side B, Tape 1]

[Begin Side A, Tape 2]

CB: —a real blizzard. High winds and—so there was a lot of snow blowing around and we really couldn't do much of anything.

DOB: What did you do?

CB: Sat inside the Sno-Cats. We lived in our Sno-Cats—we didn't have tents. I think we may have had some tents along but we never used them. We might have had emergency tents. But we lived in the Sno-Cats. And then we also had a wanigan that we built for cooking in. So we just waited it out.

We could take a substantial wind and still travel along. We could actually travel in worse weather than we could do the seismic work in because the winds caused a lot of noise that interfere with the seismic work. The seismic detector is a sound detector, in essence. It detects the sound that travels through the ice, so if you've got a lot of snow blowing along the surface and bouncing, it makes a lot of noise.

Or driving. Since we weren't trying to follow a marked trail, we could drive along following the compass. As long as the tracks didn't fill in with drifting snow between the time that the first Sno-Cat went by and then the other two—one of them traveled three miles ahead of the other two so we could make interval readings with our altimeters to get height differences. The altimeters measure air pressure, and the main thing that changes air pressure is changing weather. But it's also sensitive to changes in height. So in order to tell the difference between what was changes in the weather, which would happen more or less all over at the same time, at least over a three-mile stretch—pressure changes that come from that and pressure changes that come from one being higher than the other, we had to travel separated.

DOB: And again there were only half a dozen of you on this—

CB: Yes, on both the Sentinel and the Horlick traverse, there were six people. We got a new mechanic. The one who went with us from Little America out to Byrd then left, and we had a new one who came in for the Sentinel traverse and stayed through the Horlick traverse. Jack Long was his name.

DOB: So two seismologists and—

CB: Two seismologists, two glaciologists, a mechanic, and then we picked up an extra guy just to—one of the weather people decided he'd be interested in going along, so we had six people.

DOB: So that meant all of you had to do—well, in terms of the science, did you all do your own thing or was this a team effort?

CB: The geophysicists and the glaciologists had quite different tasks. We were doing the seismic work and the gravity work, reading instruments, laying out these long cables for the seismic work and that kind of thing. The glaciologists' main job was digging a two-meter pit—

DOB: You didn't have to help do that?

CB: We didn't have to help with that. We didn't have to do any digging. We had to drill holes to put the seismic charge down in, so we had a little physical effort. Actually, muscling those cables out and particularly picking them up again was—they've got an eighty-pound reel hanging on your chest, and it bends you forward. It's light to begin with, but as you wind the three-thousand feet of multiconductor cable up onto this reel, eventually it really starts hurting you in the back.

DOB: Tell me again what you were trying to learn. What were you out there to do?

CB: We were out there to learn as much as we could about the configuration and the nature of the West Antarctic ice sheet—how thick it was, how fast the snow's accumulating on the surface, something about its internal structure which is related to its potential for movement.

We didn't have any good way of measuring ice movement in those days. We didn't actually measure the movement of the ice.

DOB: Do they do that now?

CB: Oh yes. You can do it now using GPS, that's one way. Another way of doing it is with satellite radar interferometry. Really high-tech stuff . . . and extremely accurate. You can detect movements of a few centimeters from a satellite. It's amazing.

DOB: All right. So how did you do this? I read about taking seismic stations and—

CB: Okay. Seismic sounding involves exploding a small charge of TNT or some explosive, which is a sound source, and the sound travels down through the ice, which transmits sound very nicely—a sound wave is the same thing as a seismic

wave, seismic compressional wave—so it travels very nicely down to the bottom of the ice, reflects off the bed, and comes back. It's an echo sounding thing.

It really is quite similar to what an echo sounder does in the ocean except you have to set off an explosive charge to get enough energy into the snow. You don't have a nice—water provides a good coupling to some kind of a transducer that goes on the bottom of a ship. There's no good way of doing that that anybody has discovered for the snow surface, so we have to set off an explosive charge.
And then to pick up the echo, we sent out a string of twelve geophones each in two different directions. Sometimes they're strung out in lines, and sometimes they're strung out at right angles to each other.

DOB: What's a geophone?

CB: A geophone is a motion detector. It's a very sensitive device that picks up the movement of the surface.

DOB: Like a speaker in a radio?

CB: Well yes, except instead of—a speaker or a microphone is sensitive to pressure variations. This is the same idea except instead of being sensitive to pressure variations, it's sensitive to actual motion vibrations. And when the sound comes back up, it vibrates the surface, so that's what the geophones detect.

Now in principle, we would just take one geophone. The sound goes down, comes back up, and you see it on one geophone. But in fact, there are other signals that come in, other paths that the sound can take, and if you have just one geophone you wouldn't be able to tell which was the return that's coming from the bed, if any.

So in order to be able to tell what's coming up from directly below and what might be coming from the side or going straight through the ice or something like that, that's why you have to put out these strings because if the sound is coming straight up, then it's going to hit all these geophones at the same time. And I say straight up because, even if you set this out over a hundred meters, if the sound is going down three thousand meters and then coming back up, it's essentially coming straight up.

So the bottom echoes then are recorded on all these geophones at essentially the same time. Not exactly the same time—

[Interruption]

CB: What was I saying?

DOB: You were talking about—

CB: Oh yes. And then I mentioned that we sometimes had them perpendicular to each other. That's because if the bed, instead of being perfectly flat, is sloping a little bit, then it'll take a little bit longer for the sound to come back to the geophone down where the ice is a little bit thicker. And so with the spread that's laid out in an L shape, it can actually get the dip, the tilt of the bed, which is secondary but still useful information.

Because I told you it took a couple of hours to do a seismic station, we couldn't do that very often. Every time we stopped for the night we did a seismic sounding. But that was, depending on the traverse, twenty-four, thirty nautical miles apart, and we wanted intermediate measurements of ice thickness, so we used gravity for that.

The gravity meter measures the strengths of the earth's gravity field, which varies from place to place because the variations of gravity are caused by variations in mass. Gravity is a result of mass. So if you have dense rocks near the gravity meter, you have a higher gravitational attraction than you do if there's less dense rocks, like ice. So there being a big density contrast between ice and the rocks underneath, gravity is sensitive to variations in ice thickness.

It also measures all kinds of other things all the way down to the deep interior of the earth, so it's not an absolute measurement. But it's effective if you have periodic seismic stations and then—we used to do gravity measurements about every three miles to interpolate between the others. So that was the ice thickness measurement.

On each traverse, we did maybe three seismic long refraction profiles, which is a process in which one sets off explosives—large charges up to fifty or a hundred pounds or two hundred and fifty pounds—and measures off to long distances. You get seismic waves that travel down through the ice and through the layers of the earth underneath the ice and come back up at the other end. You get information about what's underneath the ice that way. That took a lot of explosives and took several days to do, so we didn't do those very often.

We also regularly did little experiments to study the wave speed and the variation of the seismic wave speed in the uppermost part of the ice, which is related to how the density changes with depth in the upper part of the ice which is of glaciological interest.

DOB: In terms of what you learned, you mentioned earlier that there were some surprises under there. How much had you postulated, you or anyone, before IGY or was this really virgin territory?

CB: It was really pretty virgin territory out there. As I mentioned, because of the extensive mountain ranges that were known in West Antarctica, both south and north of Byrd Station, it was generally presumed that this was a whole mountainous area and that there would be rough relatively high land underneath the ice sheet in central West Antarctica—around Byrd Station, too.

As we went off the Ross Ice Shelf, where, of course, the bed is below sea level because it's a floating ice shelf, we sort of expected as we went inland that the bed would come up, but it didn't. It went down.

I said we had to do some special experiments to reach the point where I could believe what we were actually seeing. The point of that was the sound from an explosion, not only does it go down to the bottom and bounce back up, but when it comes up to the surface it bounces again off the upper surface, and it can go up and down several times.

What we were worried about was that we were seeing not the single echo, but we were seeing the double echo, which would mean that we would over-estimate the ice thickness by a factor of two, and that the first echo would be lost in a lot of other sounds that come close after the shot from the energy that travels directly out through the ice from the shot.

And so the best way to determine that that was not in fact the case was to be able to actually record both the first echo and the second echo.

Now if we were right and the ice was really thick, then that's what they would be—the first echo and the second echo at twice the time. But if we were wrong, and the ice was only half that thick, then what we were calling the first echo would really be the second echo, what I'm calling the second echo would really then be the fourth echo, and in between there would have to be the third echo.

In other words, if we could record the primary echo and the first multiple, they call it, and there was nothing in between, now out in a part of the seismic record that is very quiet, there's not a lot of disturbing noises, if we could see this one and this one and there's nothing in between, then we knew that we weren't misinterpreting the echo.

And that we succeeded in doing before we got to Byrd Station. It was about two hundred miles from Byrd, I think, we finally got the definitive double echo that let us know for sure that we weren't kidding ourselves.

But the gravity was showing the same things. We did have some other reason to believe that it was really deep.

So we never did find any high mountainous land until we got . . . well, when we went by the Whitmore Mountains, which are a little mountain range which by then were already known—their nunataks would stick up through the ice.

DOB: How much has been added to that knowledge base since? Has it been more—

CB: It depends on where one is. In some places, particularly over to the east of Byrd Station where the ice is really thick, the one limitation in radar sounding is that the radio waves do get absorbed by the ice, and the absorption is strongly temperature dependent.

So if the ice is relatively warm—warm ice sounds like an oxymoron—but if the ice is relatively warm and very thick, as it is in central West Antarctica, then you can have extensive regions where radar sounding doesn't work.

And both because of that and because there are regions where radar flights haven't even been tried, except on a very reconnaissance basis, a lot of the information between Byrd Station and the Sentinels and north from there still comes from the IGY days or that '60-61 traverse.

In fact, I'm working on a paper now that I'll be presenting at the American Geophysical Union meeting next week which was—it's really the work of my graduate student, Mark Stenolen, who got a Ph.D. here just last spring. He's now working for a company that won't give him any time off to do any geophysics. So I'm going to present our joint paper—he's the first author—at the AGU meeting.

But the thing that's interesting is that what he was doing was this really modern, high-tech SAR [synthetic-aperture radar] interferometry which, as I mentioned, you can measure displacements of the ice a few centimeters. The highest tech, most modern form of geophysical studies of the ice sheet.

But the only soundings in that area—we wanted to give the ice thickness map—come from the IGY info from '57-58 and '60-61. So the maps that I produced for this talk are a combination of the newest and the oldest.

DOB: It must be something very satisfying about that.

CB: Yes, there is something satisfying about that.

DOB: Well, what else would you like to tell me about traverses and that work that you did? I want to move on to another subject, but I don't want to leave this if I've neglected to have you tell me something that I should know.

CB: Well, I do think of one other thing that was fun. When we drove out to Byrd Station first from Little America, we were on a marked trail so all we had to do was be able to see the next flag and that told us where to go.

Sometime early in the winter we were—following that at Byrd Station we realized that when we went out the next year, we weren't going to have any flags to follow and that we were going to have to learn how to navigate. Now no member of the traverse party had any navigational experience. I can't say that this was totally unanticipated because we did have navigational books and all of the right nautical almanacs and whatnot, so we knew we were going to have to learn how to navigate.

So I had a book by Bowditch, a famous old navigational handbook that I studied during the winter, and then we used to go out and practice to see if we could find out where Byrd Station was shooting the stars.

That wasn't easy because the big problem with that was that the weather normally was either relatively warm, say only ten below, and cloudy or it was clear and maybe fifty or sixty below. And to shoot the stars, you use a theodolite with these little knobs and windows that you have to peer into. Trying to do that when it was really cold was not only hard on the fingers—even with anti-contact gloves the fingers got cold very fast—it was also hard on the instrument because the instrument was so cold that it warped. And instead of moving on its gimbals and—well, instead of moving easily, it froze up and so we got very poor results. We even tried doing it from inside shooting through the aurora tower which was a plastic dome. That didn't work. There was too much distortion in the plastic dome.

So we never did do a very good job of finding Byrd Station, but we did learn how to do it. And of course after the difficulties of trying to do the navigational shooting during the winter, it was just a breeze to do it in the summertime. I did most of the navigation and—Ned and I did it together. I really enjoyed that. That was fun.

DOB: And you got where you thought you'd go?

CB: Yes, it was fun. You do a sun-shot, which is a measure of the elevation of the sun above the horizon. That gives you one line on a plotting chart, so you know that your position is somewhere along that line. And then you have to wait for a few hours, and then the sun's in a different position. And then you see how high

it is again and that gives you another line, and where they cross is where you are.

We normally like to have three so that you have a little triangle in the middle—they don't cross exactly in the same spot because no measurement is perfect—and then that would give you an idea of what the uncertainty is in where you were and a check to make sure that the first two lines were correct.

So that was kind of fun to do the sun-shooting, and then each night we could plot up our position and see if we really were where we thought we were.

DOB: And you stayed fairly close, I assume.

CB: Yes, that's because the magnetic compass works so well.

DOB: Anything else?

CB: I don't think of anything.

DOB: I'd like to talk a little bit about the rest of the world. There were a lot of other countries involved on the ice during IGY.

CB: There were a dozen.

DOB: And there was a lot going on in the geopolitics of the world particularly at that time. And indeed, IGY came to be in the depths of the cold war. Do you think that's relevant, and if so, how?

CB: Yes, I think it's relevant because I think the international cooperative venture in Antarctica served as a model for many years, particularly during all the cold war years, that it was possible for different countries with different political viewpoints to get together.

Of course one has to realize that the reason that one could cooperate and work in the Antarctic was that there was no real political importance to the Antarctic in contrast, say, to the situation in the Arctic. During the cold war, it would never have been possible to develop the kind of openness that was characteristic of the work in the Antarctic because the Arctic Ocean is right in the middle of the cold war. You've got the Soviet Union on one side and right across the Arctic is Canada, over the other way is Europe. It's the Mediterranean of the cold war, so to speak.

So the reason that it could work in the Antarctic was that there wasn't that same kind of strategic importance to the Antarctic. Nobody was going to be firing

intercontinental missiles across the Antarctic, whereas potentially they were going to be fired across the Arctic Ocean.

So people could cooperate; they could openly transfer data of the sort that could be of strategic importance elsewhere in the world.

And of course the conditions were so extreme. It was the sort of place where people who work in the Antarctic feel they have a lot in common with other people who work in the Antarctic, whereas somebody who works on a farm in the Midwest probably doesn't feel anything particularly in common with somebody who works on a farm in Siberia.

DOB: Did you have contact with scientific counterparts, for example, from other countries while you were there?

CB: Not much while we were there. We did have some foreign scientists who worked with us. The Horlick traverse had a Chinese seismologist, but he was a graduate student at a U.S. university, so that's a little different. We also had a Lebanese geologist who was with us, but he didn't come straight from Lebanon. And besides, Lebanon was not a SCAR country—not one of the Antarctic cooperating countries.
I did meet a couple of the Soviet exchange scientists. The U.S. and the Soviet Union did exchange scientists going back right to the beginning of IGY. Mort Rubin and Gordon Cartwright were at Mirnyy, I think, in the IGY years. I've forgotten which order.

And then there also were Soviets at the American station. There was a meteorologist at Little America . . . what's his name? Ostapenko, I think his name was. And there was a glaciologist named Sven Yevteev whom I did know and have seen since. He was at McMurdo but I think—that wasn't IGY. I think that was—it was just at the end. I think he was there over 1960. And I think that there was a Russian during the second IGY year, too, but I can't remember specifically.

But the cooperation was mainly between the Antarctic expeditions and at meetings after we came back, off-season, so to speak. Antarctic meetings always are very interesting because there are people from all these different countries that would be there.

DOB: How did their results and methods compare with yours?

CB: They were doing the same kind of thing. Most of the countries did not have the extensive traversing capabilities that we had, but the Russians did. And the Australians and the French did it on a somewhat lesser scale. The British ran the

Commonwealth Transantarctic Expedition, which was just as long range. It wasn't scientifically as successful.

DOB: When did you get involved in the international aspects of the Antarctic program?

CB: Somewhere in the middle '60s, I think, in terms of having my first position as a member of a SCAR body—Scientific Committee on Antarctic Research. I was appointed as a member of the working group on solid earth geophysics. I don't remember exactly when, but I think it was about—I could look it up if you like. It's just here in the next room. I could look it up. About 1963, '64 maybe.

And then I was associated with that group for quite a while and also with the working group on glaciology. And then I became the alternate delegate, which means second. It's not like an alternate, it's not a substitute in case the first guy can't go. It didn't start that way.

In the earliest days it was just one delegate from each country. But then they wanted to increase the size of the delegates body so they could have a little more variety in the officers, so they established a system with two delegates from each country. And one was called the delegate and the other called the alternate delegate, but they were equivalent for all intents and purposes. They both could be officers, for example.

So I became the alternate delegate which I was then up until a year ago last summer.

DOB: And what do they do?

CB: They talk about cooperative ventures in all the different scientific disciplines in which research is being carried on in the Antarctic. So I talked about the working group in solid earth geophysics. That was particularly concerned in the earlier days with coordinating the seismograph and magnetic station measurements—not the over-snow, the traversing kind of stuff so much, that was more in the province of the glaciology working group—but the station seismographs and the station magnetographs.

And then the glaciology working group was concerned with anything that had to do with ice. And there was a meteorological working group that has come and gone, or gone and come I should say. There was one, then there wasn't, then there was. There was an oceanography working group for a while, upper atmosphere physics, studied the ionosphere.

And those are working scientists primarily in the working groups, so they are the ones who are actually active in the science in the Antarctic, and they talk about—it's partly information exchange and then they also discuss types of research that

could be advanced by having cooperative programs between the different expeditions.

DOB: And then what happens with that information?

CB: Then that information is all passed along to the delegates who make recommendations to the national committees who are in the various countries who are the ones who are actually organizing the programs. So the SCAR delegates could make a recommendation to national committees saying, "Here's a summary of the sorts of things that we think would make a good climate change program, and we recommend that national committees work on these different projects."

So it's a way, both in that formal mechanism and more informally through all the contacts that people make, of coordinating the work between countries partly so it isn't duplicative, partly so it—because the total is more than the sum of the parts.

DOB: Were you on the U.S. national committee for Antarctic research?

CB: Yes. That's also known as the Polar Research Board. Yes, I was on it for a long time, then I was chair—well, a lot of the time I was on it it was ex officio because the SCAR delegates are both ex officio members of the national committee. But then in the early '80s, I served a tour of chairman. Then I was vice president of SCAR in the late '80s, I guess it was, early '90s, and I was convener of a group of specialists.

SCAR also has what are known as groups of specialists. Groups of specialists are scientists who are selected not as national representatives, like the working groups have representatives, one each from each of the countries, but groups of specialists are selected for professional expertise to study focused scientific problems. There can be more than one from one country; there doesn't have to be somebody representing every country on SCAR. Some members aren't even members of SCAR countries at all.

So while I was still vice president, the SCAR developed a Group of Specialists on Global Change in the Antarctic, and I was made convener of that.

DOB: Tell me what they do.

CB: That group of specialists was charged with developing a program of effectively instituting global change-related research in the Antarctic of all kinds—it's cross-disciplinary—and also to improve the interaction between SCAR and the

Antarctic scientists and all—the IGBP, the other big international global change programs.

[Interruption]

DOB: We were talking about global change.

CB: Oh yes. So the other side of the coin was to improve coordination between what was going on in the Antarctic and the International Geosphere Biosphere Project, IGBP, and the World Climate Research Program, WCRP, and all their subprograms. Because one thing that anybody who thought about it would know is that no matter what hat or what rubric the research in the Antarctic was going to be done under, whether it was called a WCRP project or IGBP project or SCAR project, it was exactly the same people who were going to do it because there's only one set of Antarctic operating organizations for each—one for each country.

So what it's called and what the international political status of a program is is not really very important. The important thing is to see that the critical research related to global change problems is undertaken.

DOB: Are we talking about global warming particularly?

CB: Yes, particularly global warming but global warming is just one aspect. Actual warming of the climate is just one aspect of change. It's going to change other aspects of the weather besides just the temperature, and it has potential for changing sea level quite a lot, and it's changing ozone protection so it has biological effects. There are a lot of ramifications that cross the different sciences.

DOB: And the ice sheet, is it shrinking?

CB: It doesn't appear to be either growing or shrinking very much right now. We know that it has shrunk in the last ten thousand years, which is fairly fast on a geological time scale, but it doesn't amount to a hill of beans on a human time scale. But yes, one of the aspects is how is the ice sheet going to change and what will that do to sea level.

DOB: Are we worried?

CB: It depends on who we are. I'm not. I think there's only a very remote chance that the amount of ice in the Antarctic will decrease rapidly enough to have any—I won't say to have a noticeable effect, but to have a dramatic effect on sea level.

Right now sea level is rising at about two millimeters per year, and maybe accelerated outflow from Antarctica could make that go up to three millimeters per year. But that's not going to keep anybody awake at night. And the idea that it could go up to ten times that rate is very poorly supported. Very, very unlikely that that will happen.

DOB: That's reassuring isn't it? Did you have any input in the formulating or the working on the Antarctic Treaty?

CB: No. That was all going on while I was at Byrd Station.

DOB: How about the protocols that have been added to it since?

CB: No. Only very slightly as a member of SCAR. SCAR has commented a little bit here and there, but it hasn't even been a major part of my work with SCAR, and SCAR's contribution is quite minor to that. So essentially no, I haven't.

I did testify in front of Congress a couple of times in support of the Antarctic protocol, pointing out that it was a good idea—

DOB: Which Antarctic protocol?

CB: The environmental protection one. Pointing out that it was a good idea and the scientists were quite willing to put up with a little inconvenience for the sake of protecting the place. Inconvenience meaning that we have to collect all our garbage and take it back when we go.

DOB: I'll come back to that. The Antarctic Treaty, of course, as you know, set aside the continent for peaceful purposes and, in particular, scientific research. Do you think that it's possible to continue that indefinitely?

CB: Yes, I do. I think it's not only possible, I think it's likely. I don't see anything on the—I mean, there's always a potential threat of mineral resource development in the Antarctic. And if one says—I mean, it's not going to go on forever. Humans aren't going to go on forever after all. Forever is too long.

But the environmental protocol covers the next fifty years—well, it's not quite fifty any more, I guess, but . . . . And although there are escape clauses, I don't really see any tendency towards anybody being anything other than satisfied with a protected Antarctic. It seems to me it's becoming a more and more accepted idea rather than the other way around.

DOB: Even if there were—

CB: Now with low oil prices now—maybe if oil prices went up to a hundred dollars a barrel instead of eleven dollars a barrel and it looked like it was starting to get scarce, then perhaps there would be a strong pressure to go and drill for oil in the Ross Sea, for example, or places that are known to have potential reserves. But that's far into the future, and it's all very hypothetical, and I'm not sure it would happen even under those circumstances.

DOB: That's very encouraging. What do you think about the growing tourism in Antarctica?

CB: I think tourism should be encouraged, and I think tourists are an asset, by and large.

DOB: In what way are they an asset?

CB: They're an asset because the more people know about the Antarctic and have been there and have seen it, the more people recognize the value of the place, both to preserve it and to study it and recognize that it does have a real role.

It is part of the earth, and it's just as important and in some ways more important than other parts. Not for humans directly, of course, but from the physical aspect it's a very important part of the earth's system. And the more people go there, the more people know that, and so more likely it is that the taxpayers will continue to support Antarctic research.

Besides that, it's aesthetically a valuable place, and I think it's good for people to have a chance to see anyplace as wonderful as the Antarctic. And 99 percent of the tourists are—particularly from the U.S., I think, and the western countries—are just as concerned about protecting the environment as other people are. It's not that the tourists are a bunch of messy slobs and leave all their litter around, and the scientists are all good guys who clean up everything. There are good guys and bad guys in both groups.

The problem, I think, is getting the less well-regulated and more fly-by-night tourist operators to maintain the same standards that everybody else does, and that's a big problem.

And the other thing I think is a big problem is just the numbers, particularly at a place like Palmer Station, as you probably heard, where they're—

[End Side A, Tape 2]

[Begin Side B, Tape 2]

CB: —ten, I don't know that I'd take that number literally, but . . . . Yes, so the numbers are potentially large, and so it isn't possible to give tourists free run of the scientific stations, or the scientific work would just be totally disrupted.

DOB: But you're not too worried about tourists encroaching on the environment.

CB: No, I think it's a matter of continued efforts to develop good controls and make sure that all the operators are careful. I'm not sure just how that should be done. I don't mean that it's not a serious concern, but . . . . I suppose in a sense it's harder to regulate than the behavior of the scientists from SCAR countries because their specific national organizations are charged with the scientific exploration, but I don't see it as a fundamentally different problem.

There is another aspect of that and that's the poorly—this isn't so much tourists—but the poorly equipped and poorly planned adventure explorations. People who go down to—and then they get into trouble, and one of the national operators has to rescue people because they can't just be left to die, which is what they deserve.

DOB: There's quite a bit of that, isn't there?

CB: Yes, there's quite a bit of that and that bothers me a lot more than the tourists. But again, it's a free country, it's a free world. There's not much one can do about it except try and find some way of forcing these people to be a little more sensible.

There are idiots who go climb mountains without proper preparation and get killed all the time, too. What can we do about it? Well in that case, nobody goes to their rescue. No, that's not quite right. They do go to their rescue, but it's sudden death on a mountain rather than slow death if you get lost and if you run out of supplies in the Antarctic.

DOB: Well, if we're back on the issue of human encroachment and pollution and all of that, in the '50s how much did you worry about the environment?

CB: None. When I first went down, when we were still based on the ship in McMurdo Sound, we were a long way from McMurdo Station because there was a lot of sea ice. But we walked across the sea ice to one of Scott's huts—this isn't exactly environment, but it's at a different level, so to speak—there was no protection of Scott's hut as a historic monument.

I actually have a little tin of pony nails that I picked up around I think it was Cape Evans, that I picked up and I brought home. And I ate some gooseberry jam out of one of the tins that was left strewn around.

And people routinely killed penguins and brought them home to be stuffed.

DOB: Routinely?

CB: Well, no. Perhaps that's going a little too far, but I mean there was no ban on it. So in those days, I guess partly because environmental psyche hadn't yet developed in human beings very much—that was barely after people had finally learned that you shouldn't throw all your garbage out the window of your car. In the '40s, all the highways were littered in the United States, so this wasn't very long past that.

So it was a young idea generally, and in the Antarctic it was so big and we were so small, so few, that I don't think anybody had any idea of the importance of protection.

In our freezer here at the University of Wisconsin in the Geophysical and Polar Research Center, a penguin appeared in the early 1960s. A frozen whole penguin, and nobody would claim it. I'd never known for sure just where it came from. I have my suspicions, but I don't know where it came from.

But what I think happened was that it might've been a penguin that was killed and collected by somebody who was down there before penguin killing was banned, and brought it home and stuck it in the freezer here. It was somebody here at the University of Wisconsin. And in the meantime that became—either he did it when it was illegal or it became illegal in the meantime—but for some reason he then was too embarrassed to claim the penguin.

So we had this penguin in our freezer along with our ice cores for a good twenty years, I guess, and finally talked the Science Museum of Minnesota in St. Paul into taking it off our hands when they had an Antarctic exhibit that they put together. So we finally got rid of the penguin.

I never did anything like that. I don't like killing animals whether it's illegal or not.

DOB: When you were there, were you ever truly scared for your life?
CB: No. I can't remember ever being.

DOB: Was that attributed to—

CB: There wasn't anything scary that happened.

DOB: Would that suggest that you were just careful enough to avoid scary situations?

CB: I told you we lived in a fool's paradise. We weren't being careful, we were just being lucky. I had this idea that all the crevasses were outside us, so to speak, and as long as we went back and forth in this interior of West Antarctica—and it's partly true. There are vast areas in the interior where there aren't any crevasses—there isn't anything to worry about.

If you got bad weather and a storm, you can just wait till it's over. It's not very scary. Now if it had gotten strong enough so it could blow a Sno-Cat away, then that might've gotten a little scary. But hurricane force winds? No, you didn't have anything like that.

And I never had a close call flying. Nothing scary ever happened.

DOB: To you.

CB: To me.

DOB: That's good to know. What's the one best thing that you remember from those early years. If somebody asked you at a cocktail party saying, "Oh, just tell me, what was amazing?" what would you share?

CB: I think the quiet evenings when we were on traverse when all the Sno-Cats were shut down and we've had a good bellyful of dinner, so we're warm and the day's work was done. And just to walk out around the countryside—of course the sun was still out brightly shining, and it seems to me, in my biased look back, that it tended to always to be calm and sunny in the evening.

It was a time when you had time to realize that one was in the Antarctic and just to enjoy the scenery. And there *is* scenery in the Antarctic, even when you're not in sight of mountains. You can see some marvelous colors in the snow. Little snow crystals act like prisms, and sometimes the whole surface just sparkles. You move your head and you see changing colors and changing brightnesses in these little pinhead-type spots all over the ice. That's quite a sight.

So that was often on view in the relaxed evenings when we listened to the silence.

DOB: I've asked a number of people if they were artists what they would paint as the essence of the Antarctic experience. Is this what you're describing?

CB: Maybe it is what I'm describing. I'm not an artist. I don't think of it from that standpoint.

Oh, I know one thing. This isn't really particularly of artistic interest, but one thing that is of visual interest—a couple of things I can mention. One is there were a lot of atmospheric optical phenomenon. These rings around the horizon and color spots, sundogs and halos and inverted halos—quite a catalog of optical phenomena from the ice crystals at various points in the atmosphere.

And then the other thing that was neat sometimes was the mirages that come from the temperature structure, again in the evening when the wind is still and you get a strong temperature inversion.

I remember one time walking no more than five hundred meters away from the Sno-Cats, and then I looked back and I could see at one Sno-Cat, I could see the Sno-Cat and then I could see another one upside down on top of it. And then there was a third one right side up on top of the upside-down one, so there were three—this sandwich of Sno-Cats all due to the miraging effect. It's essentially the same thing. It's the refraction in a very strongly stratified air column that causes mirages.

DOB: Can you take a picture of a mirage?

CB: Sure. It's the real thing.

DOB: And you'd get that—

CB: Yes, because it's not an optical illusion. The thing is that the image that's transmitted by reflected light through the atmosphere is following more than one path. There's more than one way it can get from the Sno-Cat to your eye. I didn't have a camera with me, but sure, you could take a picture of that. I have seen pictures of mirages of various kinds.

I never did see the green flash, though. Did anybody tell you about the green flash?

DOB: Tell me about the green flash.

CB: Green flash is a sudden and brief quite striking green that occurs on or around the sun. I can't describe it very accurately because I've never seen it. It's very rare in lower latitudes and lasts very briefly but—particularly around the South Pole where the sun goes down so slowly, I guess the green flash can last for quite some time. Maybe even a minute or so as part of the sunset. It's a sunset phenomenon. But I've never seen it.

DOB: Well, Paul Siple wrote, and I'm quoting from him: "The Antarctic generally wields a profound effect on personality and character, and few men are the same after a

stay there." Do you think you were changed by your experience on the ice, and if so, how?

CB: I'm sure I was changed by my experience on the ice. I can't say how because I don't know what I would've been like if I hadn't been there. I don't have any specific sense of character change or anything like that. Maybe that's because I really felt quite at home there. Maybe I was changed less than some people because my psyche was already well attuned to the Antarctic in the first place. I never minded being alone, I like being outside, I like the cold weather, I like exploring, and I like doing science. And those are all the things that characterize being in the Antarctic. So maybe it didn't change me very much.

DOB: Did it intensify you?

CB: Well it certainly stimulated my interest to the point that I spent my whole life working on Antarctic things. I suppose in that sense it changed me. Obviously if I hadn't gone to the Antarctic I wouldn't have spent my life doing Antarctic research, but you can say that about most any discipline that one goes into.

I think people—one thing that occurs to me is that for people who aren't familiar with the Antarctic, they don't realize how little a sense of it being hugely different from other places there is.

I think of the Antarctic and sure, it's different. It's got an ice sheet there, but in the middle of the winter I go out on Lake Mendota in front of my house and it's got lake ice there, so what's the big deal? I mean, that's the way the Antarctic is, that's the way Lake Mendota is.

And when you're properly equipped and got something to do and don't have to worry about safety, it's field work. It's a different type of environment, but it's earth science field work that people do in lots of places. It's not as different as it seems at first blush.

DOB: Just colder.

CB: It's colder, yes, it's whiter. Well, it's no whiter than Lake Mendota in the wintertime. I mean, that's all white, too, if it's snowed on top of the ice. It's white just because of the snow, and it would be white anyway if it only had a meter of ice instead of four thousand meters of ice. It wouldn't look any different.

I'm not—I like the place. I'm not putting down the Antarctic by what I'm saying, I'm just saying—maybe it's because of my familiarity with it that it just doesn't seem all that—

DOB: Not quite as exotic as it is in—

CB: No. A place you've been to eighteen times and spent several years of your life doesn't seem very exotic anymore.

DOB: Well, what haven't I asked you that I really should have?

CB: I don't think of anything. It seemed to me that covered things pretty well.

DOB: Thank you so very much. I really enjoyed the morning and learned a lot.

CB: Thank you for talking to me. You can tell that it's not a subject that I'm reluctant to talk about.

DOB: And I'm glad of that. Thanks.

[End of interview]