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NA2742 Harold "Hal" Borns interviewed by Pauleena MacDougall and Adam Lee Cilli

Harold W. Borns Jr.
University of Maine

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Description: **2742 Harold "Hal" Borns,** interviewed by Pauleena MacDougall and Adam Lee Cilli, July 25, 2013, in his office in Sawyer Hall at the University of Maine, Orono. Borns talks about the beginnings of his career in geology; his interest in glaciers; his early years at UMaine; founding the Climate Change Institute; obtaining funding; the definition of "quaternary"; conducting research in Maine and Antarctica; and the reality of anthropogenic climate change.

Text: 12 pp. transcript
Recording: **mfc_na2742_audio001** 61 minutes
Photos: **P 12767 - P 12773, P14029 - P14033**

Related Collections & Accessions

Restrictions

Formats Included Document: Original= .docx, Master= .odt, Access= .pdf; Sound: Original= .mp3, Master= .wav, Access= .mp3; Photograph: Original= returned to owner, Master= .tif, Access= .jpg

Notes Borns also supplied 7 photos to be scanned and then returned.

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Narrator: Harold "Hal" Borns

Interviewer: Pauleena MacDougall

Transcriber: Adam Cilli

Date of interview: 25 June 2013

ABSTRACT: This interview took place in Harold Born's office, in Sawyer Hall. The interviewer, Pauleena MacDougal, was accompanied by her research assistant, Adam Cilli, who took notes during the interview but did not ask questions. In the beginning of the interview, Borns discussed how he became interested in geology, particularly glaciers. Later, he talked about his first years at the University of Maine, his experiences with various administrators and department heads, and how the Quaternary Institute was formed. In the final third of the interview, he described his own research experiences (in Antarctica and elsewhere), shared what he believed were his greatest contributions to geology and climate science, and offered his opinions on the so-called climate change debate.

Note: This is the transcriber's best effort to convert audio to text, the audio is the primary material.

MacDougall: This is Pauleena MacDougall. I'm in Hal Born's office on campus at the University of Maine, in the Climate Change Institute. It's June 25, 2013. I'm here with Hal Borns and Adam Cilli, who's a grad assistant, and we're going to be talking about the history of the Climate Change Institute which, when you began, was the Quaternary Institute.

Borns: Yeah.

MacDougall: So, I'd like to ask you a little bit about your own background, how you became interested in geology, and how you ended up starting out on this career in the beginning.

Borns: Oh, it's a fairly easy study. I came out of the military after World War II as an electronics technician. And I went to work for Bell Telephone for a while, putting up microwave towers around New England, doing the instrumentation in them. My father kept saying, "you better go to college, because someday someone's going to come along in the Bell company that doesn't know as much as you do, but because they got a degree they're going to get the job and you're not." Just as simple as that. And so I believed him, finally, and I had the GI Bill, so I went to Tufts as an undergraduate, mostly because my father was a graduate of that, he knew people, and it's a liberal arts school and that's what I wanted. But I started out in electrical engineering. And, after a while, most engineering schools make students take course that humanize them a little bit. There's probably a little less than that now, but I had an array of electives and I took geology. I thought "what in Heaven's name is this, and it's being taught by my father's old roommate in college." A guy named Bob Nichols. So that's what I did, I sat through, and the thing that turned me on was the sequence of rock events in the Grand Canyon, from the top to the bottom or the bottom to the top—and the fact that each layer was an entirely different environment. And we have, I remember them to this day, kigrab[?], cocaneno[?], suppi[?], and redwall. Redwall, I learned them backwards from what I normally would do but

the bottom was an ocean limestone overlain by riverine deposits, so you had to get out of the ocean, overlain by windblown sand, big sandstorm, dunes overlain by marine limestone. And so I was absolutely fascinated with that. That's what did it. I said, "That's the end of the engineering." And, as I found out, the engineering at Tufts at the time, I didn't really look into it, it was big power generation transmission systems, rather than the details of electronics, which you handled with a microscope sometimes, and little welding tools. Things like that, which I was used to doing; the innards of radios and things, which has all changed today, of course. But, so, that was it, and I just stayed with it. Then I got out of school, I didn't know what to do, and I tried different things; tried teaching for a while.

MacDougall: Where did you teach?

Borns: At a private school called Taber Academy at Marion, Mass. I tried working for the U.S. Geological Survey for one summer as a field assistant in Maryland, and finally I became a geological field assistant in Marine Geology at the University of Rhode Island. And I finally decided that I really wanted to do something in the field, so I applied to graduate school, to Boston University, and I continued to do that and do bedrock geology. And I slowly got more interested in surface geology and did that and then decided, "Where can I go to get the best education in surface geology?" Was Richard Foster Flynt at Yale University. So I wrote to him, said can I come spend a couple of years with you guys and he said sure, come along. So I went to Yale, and here I am. Took the job at Maine, and it was such a great place I just never wanted to leave. I still do. I think it's a wonderful school. And the best part of it is that it was so loosely controlled that you could do anything you damn well pleased to do, whereas the older, more set universities it would be almost impossible to build an institute like we did.

MacDougall: Yeah, so you found, sort of fertile ground for your creativity here. Glaciers. How did that come into the picture?

Borns: Glaciers? Well, here I was here in New England, never been in cold regions. In the military I was island hopping in the South Pacific and Iwo Jima and things like that. And I just started getting interested in, that map, for example [points to a geological map of Maine behind MacDougall]. That's when I got really interested. But it was finishing up the doctoral dissertation on bedrock geology in the Skowhegan region of Maine, right in the middle of the Appalachian Mountain system that I really started getting interested in the terraces of the Kennebec Valley and other things like that, which are glacial. I said, "That's what I want to do." Fascinated with glaciers.

MacDougall: So you came to the University when?

Borns: 1955.

MacDougall: 1955. And the department was a geology department?

Borns: No. Geology, believe it or not, was the first course ever taught at the University of Maine. It was taught over in one of the town office buildings in 1867 or so. Just cause the University was a committee when it was formed, and that's all it was. But anyway, it's been taught as geography; it's been taught as agronomy, mostly related to the agricultural fields. Well, eventually, it never was a department, and when I joined, geology as we know it today was taught in the civil engineering department. But not from an engineering point of view. All we

did was teach a course called geology for engineers. And we taught another one called geology for foresters. It wasn't engineering geology, it was geology for engineers. Well, most of our students actually were in the arts and science college. We were a department, a very small department, and it remained stable for four or five years. The positions were the same, subject-wise, but the people changed in and out of those positions for a while.

MacDougall: Where there other geologists here besides yourself?

Borns: Yes. The head man was Joseph Trephethyn. He was a structural geologist. We had an economic geologist, named Larry Wing. Mrs. Trephethyn was a paleontologist. And me, teaching glacial geology. And these were the courses that were taught for many years under Joe Trephethyn, who was the head. At that time it wasn't a democratic society. He could hire and fire people. And that's the way he wanted it. So the subjects stayed the same for many years, but people came and went, within the framework. Well, we finally became a separate department. By that time, the idea of a dictator-type department head, we went to a rotating chairmanship. And we voted to elect Phillip Osberg, who's around still, I mean he's in bad shape physically. Phil took over and, he had come over from Harvard and the University of Pennsylvania, and he knew what the world was about, and a really, really good geologist. He was interested in the structure of the Appalachian Mountain system. And he set the stage. What he said was we'd like to create a department that's known because it has a firm research field and a firm teaching field, and that's what we want to be known as. And the dean at the time was John Nolton, and he said that's fine, within the college of arts and sciences. And Phil said, let's break out teaching and research on a financial level. And so it's in writing: 70% this, 50% that, and so on. They couldn't do it because of the nature of the money and where the money came from. And they were frightened to do it, because the population might say, I thought we were teaching people to teach; we're not paying people to do research. They were afraid that if we looked like a non-teaching, the legislature wouldn't treat us very well.

MacDougall: That's interesting because Maine is a land grant institution, which has a research mission.

Borns: Yeah, but there's a difference. You know, I got the first NSF grant on this campus. It was 1965. It was 15,000 dollars to work on the terraces of the Kennebec River, and I got the award. NSF had just been formed. After Sputnik the United States said, well we gotta do something. And so they started to do non-mission-related research, like NSF does. NASA says, we're going to do research on X, Y, and Z. Write a proposal on it. That's mission-related research. This was anything you want type of research. So they put it in the Office of Naval Research, as a vehicle. That then evolved into the National Science Foundation. So, anyways, that's when I applied. I found an ad in the paper. So I did, and I got it, and I took it to the treasurer of the University, as I was directed by NSF, ask him for an account, and would transfer the money to the account. I went to the treasurer, a man named Prescot Voss, and he looked at me and said, "What can I do for you?" And I said, "I got this money from the National Science Foundation and I need an account to put it in." And he said, "You mean you asked the government to support your research?" And I said "yeah." He said, "That's tainted money. You shouldn't do this." And he refused to give me an account. He wouldn't give me an account.

MacDougall: That's incredible.

Borns: And so, I put in the bank; in the Merrill Trust, which doesn't exist anymore.

MacDougall: In your own pocket.

Borns: And, furthermore, NSF called me and said, "You forgot to put in overhead money." And so they said, "go over to the business office and tell them that, because there's some money that will come directly to the University." So, I did that. But that was the story of the first grant. So I went back. I was a little bit awed by administrators at that time. I shouldn't have been; I was 25 years old. And I've killed a few Japanese people in the meantime. I'm not very proud of that, but I shouldn't have been backward at least. So, I said, "Mr. Voss, you get money from the U.S. Department of Agriculture to support the experiment station, don't you?" "Yes." "And you get McIntire money to support forestry. Is that tainted money?" And he said, "Of course not. That's what this university does. We don't do your kind of research."

MacDougall: I'm amazed that you persevered through all of that.

Borns: Isn't that amazing? Absolutely amazing. That became a transition. The founding of the Institute. That was the end of the domination of agriculture here on campus.

MacDougall: Really, in the 70s?

Borns: There had to be, and President Libby knew it. 'Cause we were the first university funded research organization on campus, outside the department of agriculture. And he took a lot of heat for that, I found out. He saw the handwriting on the wall. And to this day, as far as I know, the Institute has brought in something like 38 million dollars.

MacDougall: 38 million. That's extraordinary.

Borns: Yeah. I added it up one day.

MacDougall: And there was no research-sponsored programs organization back in those days?

Borns: No, nothing. But, in the meantime, when we elected Phil Osberg the chairman, Joe Trephethyn was so incensed he left the University and went to Portland, which, the University of Southern Maine reported to us. He went down there and ended his career down there. But then, how're we going to make research time? The only way to do it is to combine the big beginning course that we had. Everyone taught beginning geology, 25 students at a time. So I was teaching two sections of beginning geology three days a week, and that took a lot of time. So we combined all of that and put it in Hauk auditorium. And I got the job of teaching it, and it was a total disaster. It was the first time this campus had ever had anything that big. I won't go into all the details, but immediately you can't use the slide projector; that's one problem. So where do you get the overheads being produced on a daily basis. Well, we had a place in education that did that, but they weren't geared up to this kind of pressure every day. So I tried experiments. And then, the other side of it, at that time all teachers had to take attendance. And at the end of the term, along with your grades you had to submit attendance. Well, we finally had a talk with the dean. We said, either we teach the course, or we take attendance; we can't do both. So what do we do? And that basically ended the business of taking attendance.

MacDougall: How many students did you have?

Borns: 600. I finally decided that if you ask a question in a group that big they wouldn't answer. So, I said I'm just going to pick out ten names randomly from a list, and leave the front row empty. So each day we would have a different set of students sitting up front and I would have a dialogue with them. And it didn't work. When I called the students they didn't come up. They knew I didn't know their names.

MacDougall: So, you had always had small classes before this?

Borns: Yeah, 25. And we'd repeat them. And that wasn't very good because, Joe Trephethyn was very relaxed and we never coordinated things so, this group, under him, was getting one thing, this group under me was getting something else. Phil Osberg taught physical, historical geology, and we never got out of the Precambrian. Anyways, that's the way it went. And then we decided, about the same time that we became a department, that was one of the things we had to do. We wanted to specialize in something so that we were competitive for research at the national level and for students. What are we going to specialize in? Well, Phil Osberg was a structural geologist. Well, we can't do that because Harvard's got that field sewed up, MIT does, Yale does. We all explored the fields, and my field, I went to Washington and went to the National Academy and asked them if this was a good time for quaternary studies. And they said yes, because its becoming apparent that we live in a climate dominated by quaternary climate history. And National Science Foundation takes its lead from what the National Academy says. So they said, yes, we're going to fund this. But they said, if you're going to do, you have to go at it from a multidisciplinary viewpoint. And I came back, that's what we decided to do; President Libby bought it, and off we went.

MacDougall: Now, how was quaternary defined at that time?

Borns: Quaternary? Well, you know the geological time scale. You got the whole Precambrian; the first two billion years of Earth history is there. But then, it becomes the Paleozoic, which starts at 500 million, Mesozoic that starts at 200 million, Cenozoic at 60 million, and we're a sub-division of that, which is basically the ice age. That's called the quaternary.

MacDougall: So, is it one million? Two million?

Borns: 2.5 million. And it's defined by the time when the big ice sheets reached the mid-latitudes.

MacDougall: So everything after that is quaternary, including the present?

Borns: Yeah.

MacDougall: I just wanted to get that on record, because people in the future listening to this might not agree with that.

Borns: These are just manmade lines, but they're lines you can measure… actually get out and stand on and measure. And that's why it's done that way. The earlier definition of quaternary was when the cold water moved down from the North to cool off the Atlantic, got into the Pennsylvania, and reached the toe of Italy at a place called Calabria. And at that point, you find warm water and cold water shells, and that line was the demarcation for the beginning of the quaternary.

MacDougall: How do you define cold water?

Borns: Well, there were arctic shells. There were a lot of different ways, and eventually radiometric dating systems came along, which allowed us to be put real dates on. So anyways, that's what we did. But we decided that we were not going to worry about quaternary as they would do it in Arizona or New Mexico, and we weren't going to do it as far as the marine world; we were going to do it in the northern ice world—and that was the specialty. And then I decided, and everybody agreed, we need two people in all fields. So there's an overlap and one can be away while the other's here. So, there are two people like me, George Denton and myself. There are two archeologists, there always have been. Two paleontologists, George and Ron Davis. And that's the way it was done, and we had a little step into the marine world. And we had a glaciologist, that's the other thing, just a single glaciologist.

MacDougall: So, you started out with about six people?

Borns: Yeah. They weren't all at once, which is a good thing. President Libby said, we're going to do this in concept, and every time we get money we'll give it to you. But don't expect everything at once, and it's a good thing, because each person that came aboard then integrated with us to find the next person. That's the way it went. We had a case here, we got the first EBSCOR grant on campus, in geology, and it was a dead failure. Hired about five people all at once, and after they were here they didn't talk to each other. They left, the whole thing collapsed.

MacDougall: Yeah. The collegiality wasn't there.

Borns: Yeah, it was a social thing. So, we did it the right way by accident.

MacDougall: I think it was more than an accident. I think that your vision and personality had a lot to do with it.

Borns: Well, yeah.

MacDougall: You were able to find people that were able to work well together.

Borns: They had to be compatible, yeah. We had a little friction here and there, between George Jacobson and Ron Davis; they didn't get along too well, but well enough. But that was the only friction that we really had. And it wasn't a serious one, at all. Then we had Rob Bonnicson, which caused a big commotion for a while. But, as long as you have the control to hire and fire, is what's important.

MacDougall: Now, when did you retire?

Borns: From the Institute?

MacDougall: Yeah.

Borns: I would say about 1988.

MacDougall: No?

Borns: As director. Then I went to Washington to run polar glaciation for the NSF. Oh, I actually retired in 2004. I would have retired a little earlier but, I had no intention of retiring but, there was a time when we'd look for someone new and then they'd can the whole search because they didn't have enough money. And I wanted to make absolute certainly sure that we don't lose the position. Of all positions to lose, you don't want to lose a glacial geologist, in an institute like this. And that could have happened quite easily, so I just waited until it was absolutely done before I actually retired.

MacDougall: So, how has your own research contributed to the institute's mission and goals?

Borns: Well, alright, I had an attitude that my job was teaching and research. There's no question about it. That's the way I was hired. By the way, when Joe Trephethyn learned that I got this grant from NSF, this was the department boss, he said, you shouldn't have done that. You shouldn't ask the government to fund your research. It's your job to do it, but you shouldn't ask the government. It was just the same attitude as… I said, well Joe, how're you going to do it, otherwise? He said, you do it on your own income. If you do it on your own income, you suffer a little bit, and so will your family, but you'll be a better person for it later. And you'll learn economy that way. But anyways, I told the group if I was going to be director I was going to continue doing research, because I realized that if you didn't, in an organization like this, you immediately lose contact with everybody. They're all doing their thing and talking to each other; you're standing on the sideline, doing nothing except paperwork. And you lose your respectability within a faculty if you don't do that. And you lose it in another way if you don't teach, because you can have a whole research organization that comes and goes and the teaching faculty doesn't know anything about it. So, you had to be a teaching-researching organization. My objective was to make it look like a department, but not be a department. And that's how you get the support of the faculty in general, when you need it. So, I told them I couldn't do all things for everybody at once. I'm going to do research; I'm going to be gone; some things may fall by the side of the road; I may assign you or you to follow through with the dean, or something like that. But not me, and you've got to put up with that.

MacDougall: So, I know you've done research in this state. Where else have you?

Borns: The other thing I felt for my whole career was that I'm part of the University of Maine and I should have a continuous program on doing research in Maine. And I've done that; I'm still doing it, although I'm presently working on Ireland, but I'm still working on Downeast Maine and other places. I've worked all over the state. But it's hard to raise money in Maine.

MacDougall: I know.

Borns: You gotta do it through NSF, but you gotta make it look exciting to NSF. And so that's been a little bit of a difficult thing to do. But then, I decided that I was going to do other things to. And so, being a Norwegian, I have a adventurous background I guess, gene in me. So I started to work in different parts of the world. But one of the places I wanted to work was Antarctica, because I wanted to see what one of these big glaciers does. And I also worked on the Yukon for a couple of summers on a valley glacier. Just to see what the valley glacier did. And out of it came some pretty good papers. That's how I got to know what a glacier was all about.

MacDougall: When did you go to Antarctica?

Borns: 1960.

MacDougall: Oh, that was early.

Borns: 28 or 29 times.

MacDougall: Who did you go with?

Borns: Tufts University. I got invited. The International Geophysical Year started in 1958. In went in the field, in the Antarctic, in 1959. And it continued until 1961. IGY continued for four years, and I was part of that.

MacDougall: Now, IGY stands for?

Borns: International Geophysical Year, in which the geophysical scientists of the world measure everything geophysical. And so, my former professor at Tufts said, Hal, how would you like to go with us as a field assistant? So I did, with three other people: George Denton was one of them.

MacDougall: Really?

Borns: He was a student at Tufts at that time. I had already had a Ph.D. And there were a couple more people there, from Tufts.

MacDougall: Tell me what that was like, going there for the first time?

Borns: Every day was an adventure. What do we do now, type. Bob Nichols had been there before, the previous year, and just did a little bit… the last science had been done by the Scott Expedition in 1912. And George Denton had been his field assistant. It was all very exciting. I learned how to camp, how to be a good expeditionist, how to man-haul sleds, and go places where no one had ever been and we didn't think anybody would ever come back again. 'Cause the idea was, when IGY was over, that's the end of it. But what came out of it was so spectacular that the program has continued as the U.S. Antarctic program since then. So, that was the beginning of it, and I didn't go back to the Antarctic for several years. And then I decided I've got to focus in and do more work down there.

MacDougall: What were some of the special challenges of working in an environment like that, in terms of doing your research?

Borns: The biggest challenge at that time was that it was a completely unknown area. Scientifically we knew hardly anything at all.

MacDougall: No maps.

Borns: But the field conditions were not known, except from the early expedition reports. So, the biggest problem was to learn how to live and do science at the same time. You could spend your whole damn day living, you know.

MacDougall: Did you have any special problems with equipment, or anything of that sort?

Borns: Oh yeah. They had problems. The support for us, for the sciences, was the Navy. It's not now; it's totally civilian. In fact, I was thinking about going down there and applying, just for the fun of it. But, at that time, the Navy helicopters that we needed were really apprehensive about flying too far from mother base. They wouldn't go into the dry valleys, 200 miles from McMurto. Very cautious about doing much.

MacDougall: How did you get around?

Borns: By foot.

MacDougall: You walked.

Borns: Yeah, we walked.

MacDougall: Snow shoes?

Borns: No. As a matter of fact, I was just looking at something [digs into a box behind his desk and then places several framed photos on his desk]

MacDougall: Gee, Hal. Would you let us scan some of those for the collection.

Borns: They're all dirty. I haven't looked at these for a long time. But this is 1960. 60-61. That's George Denton [points to photo of Denton]. And this is how we lived. We had two tents like this [points to tent in photograph] and that's it. And, no snow, it's called the dry valley area. The ice came down through the whole area, but as we moved into the predant[?] world the ice melted back and never came into the valley. So, there are big glaciated valleys, but the big inland ice sheet is way back up. You can see it [points to the ice sheet in the background of the photo]. But, you know, we're on our feet, and that's all.

MacDougall: So, would it be okay for us to scan these?

Borns: Sure. It's filthy.

MacDougall: Because I think this would be very interesting to have in the collection. And besides, and they may, as you know, fade.

Borns: So, almost all my work was in the glaciated valleys, 'cause that's where the record is. But then, in the last two or three years I worked there, we were working out on the ice sheet, on mountain tops sticking up through to get the former level of the ice sheet, like the ring around the bathtub. We worked in central and west Antarctica.

MacDougall: Let me ask you something about this. You were obviously aware of earlier explorations, not necessarily scientific. Did you think of yourself as an explorer?

Borns: No. Not really. Every once and it a while it crossed my mind that I'm the only person who's ever been here--you know, walking around these valleys—and probably no one else will ever be here. I got those kind of feelings. Today, people that go down there tell me, you guys went down there like a bunch of cowboys, compared to today. We're so tightly controlled on everything we do. It's just like living in a city. There's not that excitement of discovery any more.

MacDougall: Now, when you go to work at other countries, like Ireland or Norway, how do you develop relationships there, so that you can go and work there?

Borns: Well, what I been doing is, I am a Norwegian by definition, but that's not the reason. I pick projects that would give me a glacial record in fairly recent times, that has a climate history to it. So, the Undrias[?] has a wonderful record in Scandinavia. And then we started to look at things like the surface water temperatures in the North Atlantic throughout the deglacial period by working in Greenland, Iceland, Norway and Denmark. This project in Ireland is about an ice sheet that existed off the west coast that no one had ever seen before. And this is sort of a fun project, but it also contributes a mass of ice to the global sea level problems. And also it's a marine-based ice sheet.

MacDougall: Is it gone now?

Borns: Yeah, it's all gone. It flowed on to land and sat there for a while. That's how I discovered it. So, I worked with the geological survey of Ireland for a while, and they provided maps and stuff like that. And I'm still doing it.

MacDougall: So, what do you think has been the biggest contribution of the Climate Change Institute, or the Quaternary Institute?

Borns: Me? I don't know. Probably the work I did in west Antarctica, the last work I did. And also, I think, all the work in Maine. I think I made a big contribution to Maine, because when I came here, the last work was done in 1930—that map right there [points to geological map of Maine behind MacDougall]. That was all there was. There was no radiocarbon dates, nothing. And I just started in, saying to myself, where can I work in Maine that will give us the best, quickest, dirtiest view of the Ice Age history. I thought about it a long time and I decided the Kennebec Valley, because it was a sluiceway to meltwater. And whatever the ice sheet was doing, it had to drain water through that channel area of the Kennebec. So that was the first thing we ever did. Then I roped in Mindsy Stiver down at Yale, a radiocarbon guy, and we took on the marine submergence of the state. Because there had been earlier people saying, well, how long was water over the state? Was it twenty years? Thousand years? Was it up against the ice? And so we took it on to find out.

MacDougall: What did you find out?

Borns: We wrote a paper on it. The two of us defined the marine submergence of the state.

MacDougall: And how long was it submerged?

Borns: About a thousand.

MacDougall: But there must have been places that were above water.

Borns: It started over the coast at 13,000 radiocarbon years, went all the way inland, and drained back to the coast by 12,000. So, the marine clay at the coast is 13 at the bottom, 12 at the top. And of course, that reflects the interface of global sea level and land level changes. So anyways, those are the things I have been doing.

MacDougall: Thank you. I just have a couple more questions, then we'll finish up. There's a lot of debate in the political arena about climate change and so on. What's your perspective on all of that?

Borns: Well, yeah. That's a thing people think about all the time. I guess there're two ways to look at it. There's belief, and then there's scientific fact. And sometimes there's a mixture of those two things. I can believe there's a raging bull on the other side of that wall, and no one can prove that it isn't or is. You can't argue effectively with belief. You can argue with scientific stuff. And the way science works, as you know, you gather information, put it together, draw a conclusion, find a new piece of evidence, put it in there, draw a new conclusion. But the fact of the matter is, the Earth is warming. There's no question about it. It's so simple to see this, because if you look at the global atmospheric temperatures for as far back as we have records, into the 1600s, it's done nothing but get warming. The record is clear as a bell. How do you say it isn't happening? Every single glacier in the world, except one or two, is melting. How do you say, "No, it isn't"? And then the satellites going around the Earth say the global atmosphere is warming, and it has been ever since we have measurements. So, if you put it all together, you can't avoid the fact that it's getting warmer.

MacDougall: Have you been involved in any policy discussions?

Borns: No, I try to stay out of them. And the clear records of things that we have. Well, the CO, carbon dioxide cycles, the record is if the CO_2 increases, the temperature increases. That's a clear cut record. One of the questions that comes, of course, is, well, what role to humans… Well then you look at the CO_2 cycles, for example, they spike right around the time of the industrial revolution, and there isn't a level like that for the last 630,000 years.

MacDougall: And that's primarily from coal?

Borns: Yeah.

MacDougall: And does the CO_2 from the northern hemisphere also affect the southern hemisphere?

Borns: Yeah, it does. It must. It's global. Just like if you set off an atomic bomb in Bangor, you're gonna get it in South America. President George W. Bush, his people, said, well, it's just another cycle. Well, that did it. It generated an enormous amount of research that got the cycle back to 630,000 in the ice cores and the ocean cores, and there's no sign that the exacerbation in CO_2 level we are seeing today is anywhere to be found in that record. And now we've reached 400 parts per million, that's as high as it's been since 3 million years ago. We're in trouble. The follow through is that, at the time, sea level was 20 or 30 feet higher than it is today. And the temperature was 20 degrees centigrade hotter than today. So the temperature's going to go up; we just haven't caught up with it yet. Which is awfully scary.

MacDougall: That's certainly going to have a huge human impact in some parts of the world.

Borns: But, you know, the other side of this, the glacial cycles, these are driven by planetary positioning. But, you got 100,000 years of ice conditions, and ten to fifteen thousand years of interglacial like this. Where are we now? We are now 10,000 years in the present interglacial. We've gone through the warm part of it, that was 2-3 thousand years ago when the Indians lived

on the coast, and the oysters grew ubiquitously all over the Gulf of Maine, swordfish all over the place. And now we're getting colder. So, in spite of this global warming, we're on the way to the next glaciation. Beyond that, I don't know. There's been some suggestion that the present CO_2 rise is the trigger for the next glacial period. Because the global temperature is balanced by the great conveyer belt of water circling through the oceans of the world, which circulates warm water north to us and cold water south, and keeps everything balanced. But if you shut off the Gulf Stream, then the North would get extremely cold. And the South extremely warm. And that has happened; it's called the Unger Dries Period.

MacDougall: Well Hal, it's almost 3, and I know you have somewhere to go. Thank you very much.