Oral History of

Catherine Gwen Constable

Interview conducted by Laura Harkewicz

27 April 2007

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ABSTRACT:

Catherine Gwen Constable was interviewed in the Helen Raitt Room at the Scripps Institution of Oceanography Library in La Jolla, California on April 27, 2007. Constable was born in St. Andrews, Scotland on September 9, 1958. She received her B. S. from the University of Western Australia in 1979 and her M. S. from the Australian National University in 1982. She received a Ph.D. in Earth Sciences from Scripps Institution of Oceanography in 1987. Her dissertation title was: "Some Statistical Aspects of the Geomagnetic Field." She joined the Scripps and UCSD faculty as an assistant professor of geophysics in 1991 and became a full professor of geophysics in 1998. Her current research interests and projects relate to geomagnetism and paleomagnetism, applications of statistical techniques to geophysics data analysis and inverse theory, applications of satellite magnetometry, and ethics in the conduct of science. She is a member of the American Geophysical Union and the Royal Astronomical Society. The interview focused on Constable's experiences as a woman geophysicist at Scripps. We also talked about what it is like to be married to another scientist working at the Institution. We discussed her memories of graduate student life as well as her experiences as a researcher and professor at Scripps. The interview included her reflections on ethics in science and scientific responsibility.

INTERVIEW HISTORY: The interview took place at midday at the end of a spring work week in the Helen Raitt Room on the third floor of the Scripps Institution of Oceanography Library in La Jolla, California. We talked for approximately two hours with no interruptions.

Laura Harkewicz
Oral Historian, Scripps Institution of Oceanography, UC San Diego
May 29, 2007

Catherine Constable in her office, 1994.
Scripps Institution of Oceanography Archives, UC San Diego.

INTERVIEW WITH CATHERINE CONSTABLE: 27 APRIL 2007

Harkewicz: So, this is April 27, 2007. We are in the Helen Raitt room in the Scripps Institution of Oceanography library in La Jolla, California, and I am here with Dr. Catherine Constable. Good morning Dr. Constable.

Constable: Good morning, Laura.

Harkewicz: So, thank you for coming. And, hopefully we'll have a rousing discussion here today. First of all, I always have to ask people how you came to Scripps? How did you get to Scripps and into oceanography? How did you get involved in that?

Constable: Okay. Well, I came to Scripps initially as a graduate student in 1983, and I have to say that it wasn't my plan to come to Scripps. [Laugh] It was actually my plan to go and be a graduate student in Edmonton, in Alberta. But, I came here with my husband who came to a post doctoral position here and this was one of the places where we were both offered positions, him as a post doc and me as a graduate student. And, at the time we weren't quite sure whether this was what we wanted to do, but we came here and it worked out.

Harkewicz: All right. Well, that's great. [Laugh] So, I wanted to ask you too, I know you were born in Scotland. Correct me if I'm wrong, and you were raised in Australia. And, I wondered if you found the educational system to be any different here than it was in your previous experience?

Constable: Yes it is, really, in many ways somewhat different. I did my elementary school schooling in Scotland, and then I went to high school, and I did a bachelors degree and also a Masters degree in Australia. The differences at that time, and I think they're less pronounced now, but at that time the differences were that in Australia people tended to choose a specialization or at least a general area of specialization before they go to college for a bachelors degree. In the U.S., I think, looking at my children I see that it's very common for people to have no idea even whether they want to do liberal arts or science and they change their minds a number of times during the course of their undergraduate degrees. In Australia that's pretty unusual. I actually did change my mind, because I started out enrolling in a languages degree, and changed my mind there, and that was rather hard to do. [Laugh]

Harkewicz: So, you started out in languages and you ended up in science?

Constable: Yes. And I was lucky to be able to do it because I had sort of been preserving my options in high school, which not everybody was able to do but I did. I was able to do that. But really by the time I was in my first year as an undergraduate I was pretty much determined that it was going to be physical sciences of some kind that I would do, and that's a big difference. And then another big difference is

that it's quite common in Australia, as I did, to do a Master of Science degree entirely by research, without any coursework involved in graduate studies. It's very typical in Australia that people who do graduate degrees don't actually take any classes. And so, that's quite a different thing from what goes on here, at UCSD where it's quite common for people to do at least a year's coursework as part of their PhD programs.

Harkewicz: I guess that would follow, though, with what you had said about people sort of having a better idea of what they're going to do earlier in their life?

Constable: That's right. At the time I went to college in Australia there was no idea of having to do general education courses. So all of the courses that I did, once I decided I was going to major in physics, which is what my undergraduate major was, were all directed at the physical sciences. So, they were all math, and physics, and chemistry, and no sort of side issues there about getting a general education in history, or philosophy, or language.

Harkewicz: Boy, you have to be pretty directed, I guess. What happens if you decide, "Oops. I made a mistake"? [Laugh] Your whole life has already been going in that direction.

Constable: Well, I think it gets easier now, you know the system is becoming more flexible as time goes on. That was quite a while ago, after all. [Laugh]

Harkewicz: Okay. [Laugh] So, your husband is in geophysics also, correct? Is that . . . .

Constable: That's right, and he did his PhD at the Australian National University in Canberra, and I had done a masters degree there and we both were interested in coming to the U.S., and he actually wanted, had this opportunity to come to Scripps and work with Chip Cox,[1] who was in the Physical Oceanography Research Division at the time and was interested in, was actually doing pioneering measurements on electromagnetic studies in the ocean, so looking at the electrical conductivity of the earth's crust. And, my husband Steve[2] was interested in doing that. It was an opportunity to do something new that he hadn't done before. He thought that would be really neat, which was a difference from something that we would have done if we'd gone elsewhere where we would have done something rather similar to what we'd done before. And, to be honest I think it was, of course, a very reasonable and rational decision to come here and one that's been great for our careers.

Harkewicz: So, do you consider what you do oceanography?

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[1] Charles Shipley ("Chip") Cox (1922-) came to Scripps in 1954 as a research oceanography and served as Professor of Oceanography from 1960 until his retirement in 1991. He chaired the Ocean Research Division.
[2] Steven Constable (-) received a Ph.D. in Geophysics from Australian National University in 1983 and came to Scripps Institution of Oceanography as a Postdoctoral Research Oceanographer. He is now Professor in Residence, Institute of Geophysics and Planetary Physics, at Scripps.

Constable: No. [Laugh]

Harkewicz: Okay.

Constable: I don't go to sea at all. I consider what I do to be global geophysics, which means that I'm interested in the properties of the whole earth and how the whole earth has evolved over time. I would consider oceanography to be a small part of that. I mean, I would say marine geophysics would be a small part of that in the sense that it directly involves things that go on underneath the ocean. Now, some of what I do involves looking at collecting records from or looking at records that other people have collected from marine sediment cores. And, of course, it's hard to get away from plate tectonics in the ocean, and the kind of mitering geological plate tectonic history of the world. But, what I do is not dependent on there being an ocean out there, by and large.

Harkewicz: Well, do you think – this is kind of a tough question since this is your work anyways – but, do you think it's an appropriate use of Scripps, since it is an institution of oceanography, to do the kind of work that you do?

Constable: Oh, absolutely. I think it is. The reason, you know, if there was no earth underneath it there wouldn't be an ocean. [Laugh]

Harkewicz: Okay.

Constable: And, I think that without the global processes that go on we would be very hard-put to understand what goes on oceanographically. I suppose you could say that we have a very strong group here in global geophysics, as you probably know, and I think that one of the things that we've done has been to provide a very good idea of what the structure of the earth looks like and that provides a context for understanding how the earth has evolved over time. The oceans are a product of global Earth processes and if we can't understand those global Earth processes we'll never understand what goes on in the ocean, we'll never understand global change, climate change. There are these interactions between the formation of ocean crust. It's the simplest thing that you can think of. But then there's also, you know, recycling of various chemicals in the system and water. So there are these links between the ocean, the atmosphere, and the bit that's underneath us that we don't see directly and those are tremendously important in understanding what goes on.

Harkewicz: Okay. Earlier you said you're doing things that are different than you would have done if you had gone elsewhere. So I guess that would imply that your research went in different directions than it probably would have? So, can you talk about that a little bit maybe?

Constable: Yes. I came here having worked in Australia as what's called a paleomagnetist. So, what I did was to study the record of the Earth's magnetic field in lake sediments when I was in Australia. Of course, you know everybody starts out small and specialized. [Laugh] And, my specialty at that time was in looking at the record in very high sedimentation rate lake sediments, of the direction of the magnetic field during the past few thousand years. So, during the Holocene, the last ten thousand years, which was the topic for my thesis, my masters thesis. When I came here I actually initially applied to become a student in the geosciences research division. But, they wouldn't have me because I hadn't actually done any earth science classes, [Laugh] which was fair enough, you know. They were a geological group and they looked for geological qualifications. So, what happened was that, when I came here, because I had a background in physical sciences, even though I'd done something earth sciences for my masters degree, I ended up working at IGPP, the Institute for Geophysics and Planetary Physics. You may know that IGPP has a very strong background in theoretical sort of geophysics in Inverse Theory and modeling, and developing tools for interpreting geophysical data. And so, what I did for my PhD was to actually move in a much more theoretical direction. I worked on using, developing ways of interpreting data through Inverse Theory, and then also through using statistical methods to understand the rather spotty record of the geomagnetic field in the past in the sense that you get what's recorded in the rocks, and the rocks don't necessarily cooperate with what you want. It's not like taking an instrument out and measuring things continuously. You've sort of given it over to the rock as your magnetic recorder and that's not necessarily a very faithful recorder.

Harkewicz: Okay. So, you mentioned you don't go out to sea but do you do fieldwork at all?

Constable: I've done quite a lot of land-based fieldwork, collecting samples of – I've been involved at Scripps in a project that looks at what the magnetic field looks like averaged over very long time scales, so over million-year time scales. And, that's involved a fairly extensive amount of fieldwork in sampling lava flows that have erupted over the last five million years, with a view to getting a record, a global record, of what the magnetic field looks like from the magnetic record in those lava flows. So that has involved fieldwork all over the globe basically. And, some of that I've participated in. Some of that other people have worked on.

Harkewicz: So, you also mentioned using core samples. Are things from like the Deep Sea Drilling Project or are they from other places?

Constable: Yeah. Deep Sea Drilling Project is a big source of core samples and then there are also things like piston cores, which tend to be much shallower cores and they tend, of course, to be less disturbed than the Deep Sea Drilling Project cores, which are much longer samples. But, my primary focus from the field perspective has been on looking at records that come from lava flows where we take very, very short cores, which we take with a portable hand drill. Which,

they're sort of one-inch diameter cores and a few centimeters long, ten, fifteen centimeters long.

Harkewicz: Okay. So, you're talking about using actual materials, and then you were talking about statistical models. So, how much would you say like in an average workday is working with these objects, [Laugh] versus working with the models?

Constable: Most of what I do is working with models. I think it's really important to keep a connection between going in the field and working with the data from them and the modeling side of things. Because, one can be terribly deluded about what one can get out of the observations if one doesn't actually go out and look at the rocks in place and see, you know. [Laugh] There's a big difference between somebody giving you a direction of the magnetic field and saying, "This was the direction at this time," and then going out in the field and seeing the mess of the rock that was a lava flow that erupted and looks very lumpy and hard to tell whether it's actually still in the same place as when it erupted. And, of course, you have to figure out what the date was when that eruption occurred and that involves, typically radiometric dating and all sorts of complications associated with that. And, I think it's a really important thing for people to keep the links between the theoretical and the practical aspects of doing the geosciences.

Harkewicz: So, you find you have to change your models then after you see real life, so to speak?

Constable: I think, what it does do is it teaches you a greater appreciation for the uncertainties of the things that are being measured. So, when you go out and you take a rock sample and you bring it back and you treat it in the lab and you get a direction for the magnetic field or a measure of field strength you always have to assign an uncertainty to every observation. And, that's probably the hardest part about doing science, I think, is putting the uncertainty estimates on what you've measured and deciding what the limitations are. And, I think for theoreticians it's especially hard because they feel it ought to be possible to measure things better. [Laugh] But, in fact, the limitations about the assumptions that you make in making the measurements and the limitations of the recording medium, you know, can make a big difference to what you get as the final result.

Harkewicz: So, you don't consider yourself a theoretician then in that respect?

Constable: Oh, I think I do. I mean, I think I am a theoretician, yes. [Laugh]

Harkewicz: All right.

Constable: Most of my colleagues think that, I think.

Harkewicz: Okay. I want to ask you another question about the models, though, and I want to phrase this well. I talked to Richard Somerville[3] about climate. I know he's not really into climate modeling but we talked a little bit about climate models and, in Science Studies, we actually had a workshop about models last spring.

Constable: Oh yes, and actually I wanted to come to that and I couldn't. [Laugh] It clashed with something else. I thought that would be interesting to have come to.

Harkewicz: Well, you probably would have understood a lot of things much better than I did. But, what I wanted to ask, though, is how –I guess I'll just say this. I'm not sure this is the best way to say this. Do you see the model as being a model or do you see it as being a replacement for the real world?

Constable: Oh, I don't think it's a replacement for the real world. The model is full of flaws and I think this gets down to what I was trying to say about the importance to have the connection between the observations and the theory. People who are purely theoreticians in the sense that they, they describe things by, from first principles using physical laws, if you like. In my mind are doomed to failure if they don't take observations into account. Because, I think the greatest, most of the ways forward it seems to me for theoreticians have come because of the need to explain observations.

Harkewicz: Okay.

Constable: Now, of course, in modeling, there are different ways of thinking about modeling. The models that I typically deal with tend to be, I would say, sort of descriptions that bring data together and describe them in a global way. So, we'll have a collection of observations of the magnetic field at various places and times, and what we would like is to have a mathematical description, if you like, that would then say, "Supposing I don't have an observation here at this place in time can I make a prediction about it?" Now then, when you go and make a measurement there, of course, you've make a prediction there and what you use that prediction for is up to you. I mean, or what the particular scientific problem that you're interested in. But typically, I would say that what it does is it serves as a sort of basis for building hypotheses that you can then test. You can say, "Okay, I think that this is what I ought to see there and is that compatible with the data that I do have or the data from a similar latitude in the southern hemisphere?" In which case, you might worry about whether you have sort of hemispherical asymmetries in the magnetic field, for example. Now, I would contrast that with something that perhaps the climate modelists do but also is done in my field in people who try to build numerical simulations of how the magnetic field work, where they take the physics of what goes on in the core and then they try to build a self-

[3] Richard Chapin James Somerville (1941-) received his Ph.D. in meteorology from New York University in 1966 and has been professor of meteorology in the Climate Research Division (formerly called the Climate Research Group) at Scripps Institution of Oceanography, UCSD since 1979. His current research analyzes the role of clouds, cloud-radiation interaction, and cloud feedbacks in climate.

dynamical geodynamo simulation. So the process of generating magnetic field, we believe, comes from a self-sustaining dynamo in the Earth's core. And, there are people who try to build physical and numerical computer simulations of that. Those things, I don't believe, can replace the real world or even make predictions directly about the real world. They can make predictions that we ought to be able to compare with our observations based on sort of statistical descriptions, if you like. You can say that "On average I would expect the magnetic field to look like this." But if I ask you, using one of these things, to say, "What does the magnetic field look like at this time and place?" we're not yet at the stage of being able to do that. To do that we'd have to have a form of sort of data assimilation the way the climate people do, where they bring in, you know, weather measurement observations and then they make a weather forecast, which we then criticize. [Laugh]

Harkewicz: So, the predictions that you're making from the models, based on data and things, observations from other places, are you able to follow up with a direct observation or is this sometimes things that you're trying to . . . .

Constable: Well, they're not direct observations in the sense of present-day observations. What they are are really about building a picture of what the magnetic field looked like in the past.

Harkewicz: In the past? Okay.

Constable: And so, it, I mean it's a lot like trying to reconstruct some sort of historical scenario, except that we don't have writings or word of mouth kind of things. What we're doing is we're trying to read the record that's in the rocks. And, you know, in some cases you can go and you can find appropriate sediment records that you can actually sort of say, "Is this compatible with what I believe from my model?" And, if it's not then you have to think about revising the model. And that might lead us to say, "Well, okay, there are some things that are going on that really we don't understand in the way that we think about how the magnetic field works." And this is also where the numerical simulations that I was talking about tie in as well, because, in order for those things to be good they have to build in all the appropriate physics. The appropriate physics depends on what we know, which we get from the observations.

Harkewicz: Okay. Do you think there's anyone in particular at Scripps who may have influenced your research, especially when you were a graduate student?

Constable: Oh yeah. There were lots of people who influenced my research. When I came here initially I thought that I would work as a graduate student with Lisa Tauxe,[4] who is a paleomagnetist, and she actually came here the same week that I did, as a researcher. And, I thought that, "Well, she would be an interesting person to

[4] Lisa Tauxe (1956-) got her Ph.d. from Columbia University in 1983 and is now Professor of Geophysics, Scripps Institution of Oceanography, UCSD.

work with." And, in fact, I didn't work with her as a graduate student because her interests at the time were much more geological than mine were. I was more interested in the sort of the physical aspects of the magnetic field and I sort of viewed the collecting of records as being a, you know, a way to discover about the way the magnetic field evolved where she was more interested in the geological history and things like that at the time. So, when I was here at Scripps I worked with Bob Parker, who was my thesis advisor.[5] I also, in the early part when I first came here I worked with Alan Chave, and thought at the time that I might do something that was more related to electrical conductivity studies, but I sort of moved away from that fairly, fairly rapidly.[6] So, Bob had a huge influence on the way that I think, you know, because at the time he was writing his book on Inverse Theory, and he was teaching graduate classes in Inverse Theory and there was another, he had another graduate student at the same time, a guy called Philip Stark, who is now a professor of statistics at Berkeley.[7] And so, we had a very close collaboration as students in the sense that we were working on dissimilar things. He was working on seismology but we were using the same kind of tools to try and understand what was going on. And, you know, there were lots of other people who have had a lot of influence on me, people that I've collaborated with over the years and learned a lot from.

Harkewicz: So, you said that in Australia you went directly into research without taking coursework. Now, I guess you probably had to take coursework when you were working on your PhD here then?

Constable: Yes, it was a big shock, you know. [Laugh] I did a masters degree part-time at the Australian National University, and to do that I didn't have to do any coursework but I just had to figure out what I needed to know. And then, when I came here there were classes to take in the geophysics program, and my goal was to take as few as possible [Laughter] because it was really a big shock, you know. When you haven't been taking classes for four years, to come back and discover that somebody can give you homework and say, "You've got to do this by the next day."

Harkewicz: Yeah, I understand. [Laughter] Especially when you've been focused on your own research for a long time and then somebody's telling you to do something that you don't really want to. [Laugh]

Constable: Well, and you know the thing is that the time management skills are completely different. Because, I think that typically when you're in the workforce you're

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[5] Robert Ladislav Parker (1942-) received a Ph.D. in geophysics from Cambridge University and came to Scripps in the fall of 1967 as a postdoctoral fellow at the Institute of Geophysics and Planetary Physics (IGPP). In 1974 he became an Associate Professor of Geophysics. He served as Director of IGPP and Professor of Geophysics until his retirement.

[6] Name was misspelled in transcript as Chaff, and it has been changed to Chave, as seen here.

[7] Philip B. Stark (1960-) received a Ph.D. in earth Science from UCSD in 1986 and a postdoctoral fellow at Scripps Institution of Oceanography after completing his dissertation He went to the University of California Berkeley and became Professor of Statistics in 1988.

time scale for dealing with problems and producing results is much longer than it is when you're in the educational system as a student. Where there are some things that are long-term, but then there are also things where you go to class and somebody sort of says, "Okay, got to have this done in two days," and this is a quite different way of doing work than the way that you grow accustomed to doing research as a graduate student.

Harkewicz: Right. But, you survived, I guess? You made it through?

Constable: Oh yeah. I seem to have survived. [Laughter]

Harkewicz: So, when did you join the faculty here at Scripps?

Constable: I joined the faculty in 1991. I was a graduate student here and then I actually never left but I became first a postdoc here and then as a researcher on soft money.

Harkewicz: Okay. I've talked to some women who were, like Miriam Kastner, who was the first faculty person here. How many women would you say you ran into as other students or as other faculty people when you were here?

Constable: Well, an increasing number as time went on. [Laughter]

Harkewicz: I know, that was kind of badly worded. How many?

Constable: How many? Well, it is actually interesting that I think I'm something like, I can't remember the exact place, but I'm something like the fourth or fifth woman to graduate in IGPP. They have a list of, you know, all the people, all their graduates and the people who were working for PIs in IGPP and there are only a handful of people who were there, who had graduated before I did. But actually, my experience here was much more woman-friendly than in Australia. [Laugh]

Harkewicz: Well I wondered about that. Yeah.

Constable: Where, I mean as an undergraduate in physics, I was the only woman in my class. And, at the Australian National University there were, I think, two or three other women in the entire department who were doing PhDsthere. So . . . .

Harkewicz: Is that because of the kind of program you were in or is there some other biases just in the educational system in general in Australia?

Constable: Both, I think. I mean, in the sense that in physics, physics and engineering departments are absolutely the worst, I think, from the point of view of gender balance. Still are, in Australia and here. And, I think that in Australia the number of people who go to college, as a percentage of the population, is smaller than here. And so, the small sample statistics, you know, exposes you to programs

where sometimes there just aren't any, there's nobody like you. No, they were not very large classes. But, when I was in the graduate program here as a PhD student, you know, there were I think, about four or five women who were really, all doing things that were not very dissimilar from what I was doing. So, they were maybe twenty-five percent or thirty percent of the class at that time. And now, they're fifty.

Harkewicz: Okay, you mean just . . . .

Constable: Or close to fifty percent.

Harkewicz: Okay. You know, you mean as far as your research?

Constable: Yeah.

Harkewicz: But – okay.

Constable: As far as my research in that. So . . . .

Harkewicz: Okay. Did you notice any difference? Do you feel there was any difference, you were treated any differently as a woman, or just a smaller number of women as the men?

Constable: Here?

Harkewicz: Yeah.

Constable: I've always had very good treatment here and I don't feel like people have been prejudiced against me because of being a woman at all, or treated me differently.

Harkewicz: Okay. What about . . . .

Constable: This has been a very good environment, from that perspective.

Harkewicz: That's good. [Laughter] Did you notice, just in general, between your life in Australia and life here? I mean, not necessarily work related, just socially and stuff like that, can, were there differences in just the way people, obviously there probably was. Can you talk about that at all?

Constable: Oh, I think one of the reasons that I ended up in the U.S. is because the U.S. is a much larger system and at the time I was a student in Australia there were really very limited opportunities in academia, or in research at all. And so, at the time that I came here it was very much a sort of a, well if I wanted to go on doing research then it was a matter of going somewhere else in order to open up those opportunities. And, so that's a big difference. Australia had and probably still has a reputation for being a rather chauvinist culture.

Harkewicz: I've heard that but I wasn't sure if it was true or not. [Laughter]

Constable: Well, it certainly was true at the time that I was growing up there. I think it's less true now, though, I mean you still run into it. But then, you run into it here too, you know.

Harkewicz: It depends on where you go. Yeah.

Constable: It depends on where you go. I think one of the things here is that in a large, sort of, quite sophisticated university environment, like the University of California, people are very broadly exposed to a lot of cultures and whatever they think they don't necessarily express it because they know that it's not acceptable to do so.

Harkewicz: Okay. But that's not the case in Australia? [Laugh]

Constable: Well, it wasn't when I was growing up there, because at that time it was perfectly acceptable to express it. [Laughter]

Harkewicz: Okay. All right.

Constable: But, you know, it's almost twenty-five years since I've lived there and so what I'm saying now is not reflective of what goes on there now.

Harkewicz: Do you go back to visit?

Constable: Yeah, I do.

Harkewicz: Family still back there?

Constable: Yeah, I have family there.

Harkewicz: The people that you met, like in your graduate career, women and men, have you kept in touch with them, or are there still people, other people that stayed at Scripps?

Constable: There are other people who stayed at Scripps. A couple of my colleagues, Peter Shearer is a seismologist here.[8] The people that I worked with during my graduate career, many of them are still around. There are other people that I stay in contact with, people that I shared offices with. We talked about our research as graduate students, and yeah. So, there are a lot of ties, you know. In a place like Scripps you build professional relationships for life. You keep seeing these people at all the professional meetings and running the scientific establishment and professional societies. You go on seeing all these people forever. [Laughter]

[8] Peter Marston Shearer (1956-) got his Ph.D. in geophysics at UCSD in 1986 and returned to Scripps in 1988 after a postdoc at the University of Cambridge. He has been a Professor of Geophysics at IGPP since 1995.

Harkewicz: So, you don't want to make any enemies? [Laugh]

Constable: Well, you have to keep in mind that if you're going to make enemies you're not going to get rid of them, you know. You can't just put them to one side. [Laugh]

Harkewicz: I understand. Now, I talked to some of the older individuals from Scripps, like from the '50s. They were graduate students in the '50s and the '60s, and when Scripps was smaller there was a lot of socializing within certain groups. And, I wondered how that was for you by the time you had come here?

Constable: You know, when I was a graduate student here there was a pretty strong social group there. I have the impression and I don't know if this is correct, really, but I have the impression that we actually socialized across groups more than happens now. At that time I knew people who were in the geosciences group, who worked in the paleomagnetic lab. I still know those people like Jeff Gee,[9] who's now a professor in residence here, works in GRD. There were actually ties between physical oceanographers and the geophysicists that were perhaps stronger at that time. I took some classes in physical oceanography. So yeah, I think people are becoming more specialized now in some ways, in spite of our desire to move towards multidisciplinary and interdisciplinary programs. Those things are perhaps, [Laugh] I don't know how to say this, you know. It's that people are doing things at the edges of specific kinds of fields but they don't necessarily have the broader education that you get out of a smaller group, because the coverage is just less, if you see what I mean?

Harkewicz: Okay. So, as you're . . . .

Constable: I mean, I think Scripps has grown, and that means that you can't talk to everybody here.

Harkewicz: Right.

Constable: So, the tendency is to speak to the people whose words you understand.

Harkewicz: Okay. So, you tend to socialize with people that you can talk about work with?

Constable: Yeah, I think a lot of people do. Yeah. I mean my experience is that a very strong basis of my social life was at Scripps when I was a graduate student as a postdoc here. And, in fact, in many ways I've only kind of broadened out into the larger community as I've had children and that forces you to socialize with people who do other things because you meet your children's friends.

Harkewicz: People outside of Scripps, you mean?

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[9] Jeffrey Scott Gee (1962-) got his Ph.D. in geophysics from UCSD in 1991 and is Professor in Residence at Scripps Institution of Oceanography.

Constable: People outside of Scripps. And,as one sort of grows more senior in the university then you end up meeting people from the rest of the campus as well, of course.

Harkewicz: Okay. Do you live around here?

Constable: I live in University City, which is pretty . . . .

Harkewicz: Okay. Well that's pretty close. Yeah.

Constable: Pretty around here.

Harkewicz: Yeah. [Laugh] I wanted to ask you before I forgot, though, because you were talking about taking classes. Do you teach?

Constable: Yes. I do.

Harkewicz: And how is that being the one in charge then? [Laugh] Do you like teaching?

Constable: Yes, I do. I think it's very satisfying. I think it's satisfying from a number of perspectives. Firstly, if you're going to teach something you have to understand it, and you understand it in a way that's different from what you get from studying it as a researcher, because you have to explain it to people who don't understand it. [Laugh] They have a different approach to it. And, I think that's a great thing. So, you get a new understanding of how you look at things. I always find that that feeds into the way that I think about research. But, I think it's also very satisfying to see people learn things. And, you know, when you have people who are interested in what they're learning and all of a sudden they say, "Ah! I get it." You know, that's a great, great feeling.

Harkewicz: Uhm-hmm. Do you teach at the undergraduate level also?

Constable: I have done. I'm not doing that at the moment but I have in the past. There's an undergraduate Earth Sciences program at UCSD and I've taught geophysics in that program. And then I've taught various graduate classes over the years.

Harkewicz: How does that affect your research then, if you're teaching?

Constable: Well, you know, good teaching is very time consuming, but on the other hand I usually find that when I'm teaching I start thinking about things in new ways and that's good for research.

Harkewicz: Okay. [Laughter] So, not like your observations and your models things? You have to sort of go back and forth kind of thing?

Constable: I always think that whatever experiences you have you kind of inform what goes on. I mean, of course there are some conflicts between teaching and doing things like fieldwork, in the sense that, you know, you can't go away for months on end on fieldwork while you're trying to teach a class. Because it really doesn't work very well. But, I don't do that much fieldwork that that's really a problem for me.

Harkewicz: Okay. I wanted to ask you, you mentioned that you came here with your husband and he's still working here as well, correct?

Constable: That's right.

Harkewicz: And, I wondered what that was like? Because, with some of the older scientists that I spoke to there was a, Scripps had problems with couples working here at one time or another. I'm not really sure why but usually the women were the ones who suffered, but I wondered what it was like for you in your experience?

Constable: I think that I was quite lucky in the sense that I came at a time when it was becoming acceptable. When I came here initially there was some ambiguity about whether things like out-of-state tuition would be paid, initially, which probably wouldn't have occurred if I'd been, you know, applying on my own. I mean, it's like all two-body problems. Things get complicated. Things are complicated. But actually, I think, I've had a very good experience working here and I think, I have the impression that Scripps does this quite well now. If you look around the faculty here now there are a lot of my contemporaries who have spouses or significant others who are in the same organization, and for me that's always worked out. There was a very complicated period where we didn't know, after I graduated, where we were going to end up, but I think everybody has that. It's just a question of how it gets resolved. And in the end, we were able to resolve that. I had a faculty position and my husband had a research position and for a long time, for awhile that was a soft-money research position and now of course the institution provides some support for those people and he has subsequently become a professor in residence. So, I found that actually very good and I've also found that people are very sensible. In my experience people have been very sensible about things like potential conflicts of interest. And, we've always tried to be sensible about them too, to not get involved in things we shouldn't. [Laugh] You know, I mean things where – the university has rules about what you can do with your spouse and your children, or anybody else who works for the university.

Harkewicz: Nepotism and stuff like that?

Constable: Nepotism, and those kinds of things. And, if one follows those rules I think it's okay.

Harkewicz: Okay.

Constable: It works good.

Harkewicz: Did you ever have any difficulties – and you can answer this or not, -- you know your personal life with you both working here? Was it ever problematic for you or your husband?

Constable: No. I mean, we've occasionally collaborated on things but we don't do a lot of work together. We actually work in rather similar fields, and we occasionally have collaborated on projects, but mostly we haven't done that and I think that's probably been a good thing, you know. At some point it's good to just be able to put aside the work and sort of say, "Okay. Enough of that for today." [Laugh]

Harkewicz: And, you don't feel like either one of you have had to compromise your science at all because you're both here, or you're both . . . .

Constable: No. I don't think so. One of the reasons for that is because Scripps is such a large and successful organization. I mean, there was a period where my husband had some trouble with funding and I think that was not really a function of us both being here so much as a function of the fact that it was a kind of a cycle people were going through with NSF where they weren't interested in funding the particular kind of science that he was doing. He went and looked elsewhere for funding and after a kind of rocky bit he got out of that and was very successful doing other things.

Harkewicz: Okay. So, you mentioned funding. I was wondering where you typically do get your funding for your work?

Constable: I get my funding from the National Science Foundation, mostly from the Earth Sciences program there, in geophysics. There are various subdivisions of NSF that I get it from. And, I also get some funding from NASA. NASA runs satellites that monitor the current magnetic field. I don't think I said that my interest in magnetic field isn't just about the old magnetic field. It's also about, the magnetic field in general. [Laugh] And so, that's where NASA comes in, because they fly these satellites and I've been involved in interpreting those data.

Harkewicz: So, how much time do you think you spend like writing grants for funding?

Constable: Oh, it's very variable. It depends how many students I have and postdocs at the time, but typically I write probably three or four proposals a year, something like that.

Harkewicz: And, do you find that [Sigh]. . . .

Constable: Tedious? [Laugh]

Harkewicz: Well, tedious. I imagine it is, but I know that some of the older scientists, people that were used to ONR funding, you know, they're all bent out of shape about having to write grants and things like that.

Constable: Well, I didn't grow up with that. I'm just pleased there's someplace I can write proposals. [Laugh]

Harkewicz: Yeah. Okay.

Constable: But, no, I have to say, I think there are some aspects of it that, that can be a little annoying from time to time, that sometimes you think there's money available. You write a proposal and it turns out there's no money available and you think, "Well, why did I waste my time doing that?" And, from time to time, it's a source of stress trying to figure out how one's going to pay all the, you know, as a professor you end up supporting students, and postdocs, and technical people, and it can be a source of stress when you don't see where that money's going to come from. Because, tenured professors don't lose their jobs but the people who work for them can. . .

Harkewicz: Which influences your work then, or what you need?

Constable: Which – yeah. From the point of view of actually having to write proposals, in some ways that can be the most exciting piece because you get to say, "What am I going to do now?" and look at all the new, bring together new ideas for where you want to see science go. I mean, it's not always the case. But some aspects of proposal writing really can be quite fun, in my opinion.

Harkewicz: So, you are . . . .

Constable: But, don't tell the rest of the world that. [Laughter]

Harkewicz: Okay. You can write all the grants for the whole institution.

Constable: But, this is a reflection of the fact that the people who were working here in the '50s were getting ONR and DOE money, it was just a sort of a vat they poured money into as far as I can tell. And, for them it's a big shock, and there was no accountability there in terms of having to write reports. I think the thing that I find most tedious about the funding process is not the writing of the proposals but the writing of the reports and the, "What did you do with this money?" and "No, you can't spend this money on that." Those, those kinds of things, I think, are tedious.

Harkewicz: Okay. So, would you say that then most of your money is soft money then?

Constable: Well, I bring in twenty-five percent of my salary. The institution pays seventy-five percent of my salary. And then, if I want to have students or postdocs working with me then I have to raise the money to pay their salary.

Harkewicz: Okay. Is that pretty typical then for most institutions, that . . . .

Constable: It's, yeah. It's not atypical. I mean, researchers here, most of them have fifty percent of their salary supported by the director's office. They have a kind of parallel life to professors but they don't necessarily have to teach. It's, yeah, it's really quite typical. Some professors have a nine-month position and then they can raise extra money for summer salary if they want. I happen to have an eleven-month position that I get seventy-five percent of. So, it's just one of those complicated things. We shouldn't talk about this. Yeah. [Laughter]

Harkewicz: I'm sure there's probably all sorts of manipulations or something done, yeah.

Constable: Well, there are all kinds of perceived inequities in the system there but one shouldn't worry about them, I think. That's nitpicking, really.

Harkewicz: Okay. You were talking about practical and theoretical before. Do you have to argue some sort of practicality when you write grants for your research?

Constable: I have to convince somebody that they're going to learn something interesting.

Harkewicz: It doesn't have to have a practical application, like that necessarily?

Constable: Well, at NSF there are two criteria on which they evaluate things. There are broader implications and then there's intrinsic academic merit, or some intellectual merit, I think it's called. [Laugh] The intrinsic intellectual merit basically sort of says, "Define the scientific problem and why anybody would want to know this." And if one makes the problem so narrow that only two people in the world care about it it's not very likely to get funded, I would say. That's what the peer review system does to you. So, you have to somehow put the science into a sufficiently broad context that people can see what they'll get out of it. That is, unless, you belong to a group that has so many members that you'll get peer review from people who are, of course, interested. I mean, there are some areas where many, many people work in a given area because it's been a hot topic, for example. I mean, you could think of climate change, for example, as being something like that at the moment. So, if you could define anything related to climate change then you might say you've got intrinsic interest there. But then, there's also the question whether you've learned anything, whether you're going to learn anything that will move science forward as a result. And then the broader implications, "Who could you teach this to?" "Could you explain this to a school child and would it be interesting?" And, "How, would the general public care about what you're doing?" Now, in the magnetic field business people are always very interested in geomagnetic reversals, the fact that the magnetic field had the opposite polarity in the past. It's a little bit like astronomy in that sense. And, on the other hand one has to make a compelling case that one's

going to learn something new from the science, from the particular proposal in question.

Harkewicz: Have you ever found yourself doing something like what you were talking about a minute ago, maybe trying to appeal to a hot topic and make what you're doing fit sort of into that in order to ensure funding?

Constable: Not really, I don't think. [Laugh] I think that the work that I do is really not what I would call a hot topic. There are a lot of people at Scripps who do things that are very socially relevant. I would say climate change falls in that category. I would also say that to some extent earthquake studies and seismology of any kind can fall in that topic, and sometimes I think there are particular proposals, causal proposals where people are looking for things that are societally relevant, so they're working for hazard assessments and those kinds of things. It's hard to see how my work would fit into anything as useful as that. [Laughter]

Harkewicz: But it's still important, right?

Constable: Well, you know, I think it is. At some level you have to convince people that things are important and I think that studies of the magnetic field are important because without a magnetic field, we probably wouldn't have an atmosphere. So, it's a question of where you want to say the selling is coming in. I think the magnetic field is an important part of our planet. Other planets that don't have magnetic fields are a lot less hospitable. It's also a sort of key contributor to the way that the whole planet has evolved. So, in the sense that it's worth studying the evolution of the planet over its history, then it's worth studying the magnetic field and understanding how it interacts also with the piece of the magnetic field that comes from the solar wind and the external magnetic field.

Harkewicz: Okay. Can you tell me something about the work that you do with the Magnetics Information Consortium.

Constable: Oh. Well, that's really a sort of community service project, if you like, in the sense that what we're doing is we're trying to build an archive, a digital archive, of the kind of data that I typically collect, my colleagues in the paleomagnetic lab here at Scripps, Jeff Gee and Lisa Tauxe, collect, and anybody else worldwide so that people can have access to digital versions of the data without having to go directly to the people who collected it. So they can have it available on the web. This is is a reflection of the fact that typically when people write a research paper they'll publish a very small fraction of the information that they collected. Other people could benefit from having access to all of the measurements and information about the rocks that were collected for doing different kinds of, maybe doing similar kinds of studies and wanting to compare their data with the data that already exists, or for going back and using old data in new kinds of studies.

Harkewicz: So, somebody would collect massive amounts of data and put it all online then?

Constable: Yes. That's right. And the idea is that anybody in the world who's interested should then be able to have access to that online. So, a lot of the work that I do is very dependent on this kind of access to other people's data, because one of the things that I have sort of made my career on is compiling global data sets. So, taking data that other people have collected, where people have gone out, they've done a field study, they've collected rocks and they've studied what the magnetic field looked like over some time period at some place in the past. I actually spent a lot of my life gathering those things together so that one could make a global model of what the magnetic field is doing so you can sort of say, "This is what it, if you look at the magnetic field over this time interval globally this is what you would expect to see." And it's interesting from a point of view of synthesis. It tells you about how the magnetic field evolved over time. It's very hard to get those kinds of data collections together, you know. You write to people and they say, "Yes. Yes. I'll send it." [Laugh] And, it's not their top priority. And, it's also true that people grow tired of being asked for their data. If they have a very popular data set they send it to their friends [Laugh] and then somebody else asks for it and it's a lower priority, and they think, "Oh, you know, I'm tired of sending this." So, the idea is just to put all this data on the web so that anybody who wants to use it can have access to it. And, this is also, actually you mentioned the ethics issue earlier.

Harkewicz: I was going to ask you about that too. Okay.

Constable: This is also part of the, the thing about taking public funding to do science. If you take public funding to do science then as part of the obligation that you undertake when you accept that funding, you promise to disseminate the results. And in the past disseminating results, fifty years ago disseminating results meant you wrote a paper and you published a little table with half a dozen numbers in it. That was really all that one was able to do in the way of results dissemination. You'd have the ideas out there. You would have the numbers, and if you really wanted to know all of the individual measurements it was a huge project, those things together, because they were basically written down in people's lab books. But now, we're in the digital age. People are collecting huge amounts of data. And so in my opinion, and I think in many people's opinion the standard has changed, you know. When you are disseminating the results you should, in principle, be able to give people all of the observations, all of the data that you collected in your lab so that if the results don't agree you can understand what the sources of the discrepancies are. You can say, "Oh, okay. I understand now. This instrument was calibrated differently." Or, I used a different method here when I was trying to measure the strength of the field in the past. I used a different technique for establishing the field strength. So, rather than just publishing the result that says, you know, at this time, this place, the field strength was this. You can say, "This is how I made these observations. This is the composition of the rocks that I used," and then this allows people to go back and reanalyze the data,

maybe use them for a different purpose. Instead of doing a study of what the magnetic field was like in the past you might say, "Well, I'd like to know how accurately one can actually measure the magnetic field in the past using a particular kind of rock, for example." That would be very useful for technique development and those kinds of things. So, the Magnetics Information Consortium is sort of directed at those kinds of things, and it's also a means of trying to, it's a means of trying to make science go forward faster, really.

Harkewicz: Okay. But, there are two things I wanted to ask you about there, and I'm not sure which direction to go first. First of all, you said that sometimes people get tired of being asked for information the old way?

Constable: Yeah.

Harkewicz: Have you found people more apt to put it out there then?

Constable: Well, I wouldn't say that they're more apt to put it out there, in the sense of database in terms of the Magnetics Information Consortium. I would say we're still trying to get over the hurdle of getting people to be able to do this as part of the workflow in collecting data. So, the idea of this database is that, you know, one has to develop, first of all, ways in which one can archive the data, so you need to have a format, or a number of formats. And then, you have to give people tools to be able to take their standard way of working and turn it into the right format, and that's a significant hurdle that we're still in the process of overcoming.

Harkewicz: So, you're trying to sell this idea?

Constable: We're trying to sell this idea. We're still in the process of trying to sell this idea, even though we've been doing this for a number of years now. [Laugh]

Harkewicz: Well then the other question I had is in relation to the ethics, because I wanted to talk to you about that. I wondered about some of the, the information that I have read, the articles that you had noted on your webpage in regards to ethics, talking about credit. And, I wondered about how credit then is assigned if it's on this database online?

Constable: The way that this database works online is that usually the data would go in there as the paper is published. And the idea, then, is that associated with the data set there would a citation that one could give so that, so that when one does a search in the database one can say, "This is the search that I did, you know. I was looking for rocks this age and this kind of data, and only wanted lava flows or dikes or something like this." So, you can explain what search you did and then when you get the data, associated with the data there's a publication for the person who collected those data and you are expected to refer to that when you use those data in your own publication.

Harkewicz: Okay. All right. I wondered about that. I thought that might be problematic if, somehow . . . .

Constable: Well, I think some people see this as being problematic but I don't think that practically speaking it needs to be. It's no worse than people – I think it's just a different version of people reading things in the library and then not citing the publication they read them in, you know. There are forms of people not getting credit that have always happened. This is just a modern version of it. [Laugh]

Harkewicz: With a lot more data involved, I guess, too? Yeah.

Constable: With a lot more data involved. But that doesn't necessarily make the enormity of this crime, if it's a crime, any worse.

Harkewicz: Right. Okay. So, as I said to you before we started recording I was interested in this whole ethics and the conduct of science. On your homepage you noted that you and your husband were involved in this seminar series of "occasional informal discussions," as you said, "on ethics and the conduct of science." And, I wondered how you got interested in that and what these discussions are like, or the seminar is like?

Constable: The seminar is an informal group of students and faculty in the earth sciences at Scripps. Mostly geophysicists, maybe twenty percent of the people come from the geological sciences, and this series was sort of started because I read an article in *Physics Today* where they had surveyed young people about ethics in science and how they perceived they'd been treated during the course of a career.[10] I forget whether I talked to some students about this or what exactly. There had been some lunchtime conversation where people had been wondering about authorship assignments, and talking about how in doing their own personal research there had been this question of who was going to write what papers, and they'd been all sort of laid out, you know, and one person was going to do this, and that, and all the rest of it. And, then it seemed that there were some people who really didn't understand what it took to become an author on a paper, especially among our students. And I thought, "Well, you know, this is something we should be teaching them, because we're trying to train them to be professional scientists, and one of the things we ought to teach them is "What does it take to become an author?" And, when do you deserve to be first author and when should you be, you know, last author? First author in our field usually means that you've done the most, the largest part of the work, and put it all together and written the paper. But that other people would also be authors because they've made significant contributions. And then, there were also these various ethics scandals about the, the cloning research and those kinds of things. So, this was somewhat topical. And so, typically when we had those discussions

[10] Is this Kirby, Kate and Frances A. Houle, 2004. "Ethics and the Welfare of the Physics Profession," *Physics Today* 57, no. 11, 42-46?

we would focus them on a particular topic, like "When should you be an author?" "How much would you have to contribute to be an author?" Sometimes we'd get people to read a paper and then discuss the paper. In other cases, there's actually a handbook put out by the National Academy of Sciences on ethics and the conduct of research, and so we use some pieces from that as, as a focus for discussion.[11] And then the other things that we talked about were also things like conflicts of interest in dealing with industry, which more the area that my husband is interested in because he has a lot of support from industry for the research that he does. And he's occasionally done some consulting for industry and in doing that, he was very aware that there's a fine line that one has to tread between doing things that one would view as being within the mission of the university and teaching, and taking industry sponsorship and being able to be sure that one isn't actually doing research that's being directed by them rather than doing the kind of pure research that one wants to do within a university. I think it's actually quite interesting that within UCSD, there's a fair amount of support from the system about trying to make sure that you do only do things that are of direct benefit to you. For example, I think in the old days in NPL, and I don't know this for sure, but it seems to me there were people who actually took on defense work and they ended up doing research where they couldn't publish the results.

Harkewicz: Yeah. I've heard that.

Constable: And, that's also a concern, you know. If you work for the oil industry and you're finding potential large sources of oil, then they don't want their competitors necessarily to know about that. So, people who are developing research tools for industry to use want to be sure that the research aspect of those things can be published, that students who are involved actually have the kind of academic freedom that we've come to expect. So, there was sort of some issues of academic freedom as related to – and you have to, I think, also be careful that students sometimes feel, rightly or wrongly an inordinate amount of pressure from advisors to do exactly what they're told and they're not always, I think, well equipped to advance their own views and sort of say, "I don't want to do that." Of course, some of them are too well equipped. [Laughter]

Harkewicz: I understand.

Constable: So, these were the sort of topics that we talked about, how to make sure that you did what would be the ethical thing in various scientific scenarios.

Harkewicz: Okay. And it was . . . .

Constable: And it was intended to be a sort of educational thing for our graduate students.

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[11] Is this National Academy of Sciences, 1995. On Being a Scientist: Responsible Conduct in Research. Washington, D.C.: National Academy Press, 2d edition, 24 pages?

Harkewicz: Okay. I wanted to ask you about what you just said about the industry situation. Who would be in charge of that kind of situation? I mean, as the scientists are you saying "This is what I would or would not do?" and you may . . . .

Constable: You mean from the ethical perspective?

Harkewicz: Yeah. Because, I mean, if the industry's telling you to do something and if you want to take money from them, in a sense you, I mean . . . .

Constable: Well, you know, it kind of comes down to various issues of conflict of interest within the university. There are some rules about what one can and cannot do in regard to things like consulting. And, there are sometimes scientists whose careers become very heavily vested in associated industries. And, in those situations one needs to be clear about whose interest is at stake. When we deal with graduate students we have a role as educators and our primary goal is supposed to be to educate and train them, and we're supposed to train them to do research. We're not supposed to train them to make money for themselves or for us. So, it will occasionally happen and these are entirely hypothetical things I'm talking about. These are not things that have happened, but it will occasionally happen that there will be an opportunity where some company says, "Well, I really need somebody to go out and do the following survey for me," you know, or "Find the following mineral out there in the desert using, using your equipment." Right? And, said researcher might say, "Well, I don't have time to do that." And, the company may say, "Well, couldn't one of your students do it?" Right? It's not appropriate for a thesis advisor to say to a student, "Go and do this survey for X company using this equipment. You'll get paid to do it as a consultant," for example. Or even, "You won't get paid to do it. I'll get paid to do it." [Laugh Or, whatever. Those are inappropriate and unethical behaviors because they're not particularly advancing the student's training or education. Well, it's a special sort of education. [Laugh]

Harkewicz: Yeah.

Constable: But, you have to be careful about these things. So these are sort of ethical questions. And then there are other questions about, the other thing. So those are the sorts of things that one can run into, I think, with industry. People sometimes get, especially when there's consulting involved, people get focused on making extra money. And, those kinds of things shouldn't be allowed to overtake what's going on, you know. The university has quite generous rules about consulting. You can do those things. And, once you've stepped outside those rules, I think probably before you stepped outside those rules, you may already be in a position where you're not working for the benefit of the people that you should be working for.

Harkewicz: Okay.

Constable: And then the other thing we talked about, things like plagiarism. I mean, who gets credit for what, and when can you use somebody else's, when is your idea somebody else's idea? And, I don't know whether I should say this but part of the motivation also in this was about trying to make some of our students realize that, in fact, they were living off ideas that came largely from faculty and researchers. Because, I think there was a tendency among some of our students, who are now gone, to think that they had invented everything that they wrote down. [Laugh]

Harkewicz: I see. Okay.

Constable: You know, and these things happen. I mean, it's partly a writing-style thing. It can be a cultural thing, and it can also be a sort of feeling that "If I didn't invent this then am I worthwhile as a researcher?" So this was part of the educational goal, was to make people realize that, you didn't have to be a Nobel Prize winner in order to be a successful scientist. You could take work that had been ongoing, you could synthesize it, you could make a next step, and you could write down -- it was important to clarify what your contribution was.

Harkewicz: Right. I understand. But I wondered before though, when you said – what would you instruct your students then? You said, if their professor told them to go out and take these measurements and it was unethical to do it, would you tell them to go and tell their professor, "Well, that's unethical for me to do?"

Constable: I think the appropriate thing for the student is to say to the professor, "I'm not going to do that." And, if they have a problem then there are mechanisms within the department for going and saying, "I'm having a problem with what I'm being asked to do here." Because, we actually have an ombudsmen within the department, and then every curricular group has a faculty advisor, curricular group advisor, and the role of those people is basically to be, you know, a sort of warm, friendly body. Department cultures vary in this. In some departments, you have faculty and slaves. [Laughter]

Harkewicz: Yeah. I understand. [Laugh]

Constable: And in other departments you have a community culture. And sometimes you have a mix, and one of the things you want to do is to promote the community culture all round.

Harkewicz: Do you think you were able to reach out to some of those groups that were the faculty and slaves, or did you just get to only a small number of people?

Constable: Oh, well, it was kind of interesting. As always, you never get everybody to participate in this kind of thing. We had a fairly representative group, I think. There were probably a few people who would have benefited from coming who didn't, as always.

Harkewicz: So, was it a mix of students and faculty?

Constable: It was a mix of students and faculty. At the time we were running what we call our informal seminar, which had all sorts of things in it. Sometimes it would be students presenting their research. Sometimes we'd discuss topics. Sometimes you'd get a faculty member who sort of had an idea to put out there and wanted some comment on it. I think we've had maybe two, three, four of these things where we just sort of said, "Okay, we're going to have a discussion group this, this week." And, there were about, I think, half a dozen faculty that participated, a few postdocs.

Harkewicz: Well, I was really interested in this and I did read at least one of the *Physics Today* articles. If you don't want to keep talking about this we can, we don't have to but I guess I just wondered what some of your opinions or if you had run into some of the things that they had talked about in there? Specifically, you know, you mentioned the coauthors situation, or people withholding information from a manuscript until the final edits because they were afraid that somebody would steal their stuff? So, have you ever run into that?

Constable: I haven't personally run into that. I've met with people who have talked about the possibility of doing that. In fact, some, and I would say this is very much a matter of personality, when people do this kind of thing. That there are some people who are very, very competitive when it comes to doing science and for them it's important to be first, and sometimes they work in very competitive fields. And these cases, I think, in *Physics Today* were about the medical field, as I recall. I can't remember exactly.

Harkewicz: Yeah, I guess they were sort of generic, actually. They weren't . . . .

Constable: Yeah, they were, so there was some generic things. I'm of the opinion that that's not the way one wants to do science. It's not the way I personally want to do science. I would like to talk with my colleagues about how things work so that I can get the broadest information about how to solve a problem. Now, I can understand that if one works in an area, and I think when people are actually collecting data themselves, when you've measured something it's hard to see how anybody can really stop you from publishing that, if you know what I mean, because of a competitive edge. I mean, you might lose the first interpretation of that result. But I think the way that science functions now it's really very common that, in fact, there are ideas out there and everybody has them. Rarely you read a brand new, fantastic idea that's scientific, you know, that's come about because of the way that people are doing science. So I think that we'd move forward faster if people would talk to one another and understand the problems with their data. And, when you have these data sets that are irreconcilable with one another you hope that people will talk to each other about what they actually did in making the measurements. And you'll, then you can understand why they're different, rather than having these big public fights. You know sometimes,

in some fields you'll see these big public fights over observations and interpretation. I haven't actually had that experience personally, but I've talked to people who think that they ought not to talk to people about their science and I always viewed this as rather paranoid. [Laugh] I think there are people who try to do that. There are people who try to rush things into print so that they can be there ahead of other people. And I think, figure that in five year's time nobody will really care. But, that's a hard thing to tell a graduate student, because five years is a long time for a graduate student, when it's your first author, first publication.

Harkewicz: So, prior to this seminar that you had, you said there's the ombudsman. There wasn't any kind of system for teaching ethics to graduate students?

Constable: No, actually, it's very much been a sort of graduate student training, in many ways, is like an apprenticeship and so you get what your advisor offers. [Laughter]

Harkewicz: This is true. Okay.

Constable: And, that could be good or bad. Or, it could be good on some days and bad on others, you know, as far as all of us are concerned.

Harkewicz: So, there was no, no department of ethics at Scripps, or something like that?

Constable: No, actually,– I discovered, after we had this seminar, that Paul Dayton teaches a similar sort of class where they have a kind of discussion of various ethical principles. And, I think that's a more formal thing than what we did. You know, ours was just this occasional thing, and then we sort of put some stuff up on the website, and – I'm surprised by how many people pick up on it, actually, is the interesting thing. At the time we did it, we were thinking, "Well, we ought to do this because, from time to time we have students who just don't seem to understand the whole process," and obviously, you want it to work. And, every now and then in one's courses one gets a student who you assign a research paper and then you get something that had been cut and pasted off the web, these kinds of things. And you think, "Oh, time we . . . ." [Laugh]

Harkewicz: "Got to talk to this person."

Constable: "Got to talk to this person and maybe we should have a general, sort of, thing about this just to remind people." But, what surprised me is that in student recruitment a number of people have seen this thing, picked this thing up on my website, and sort of said, "Oh, that's interesting, you know. Will you offer a formal course in that?" And, I don't know that we're really competent to do that. I think we sort of see ourselves as just reasonable people who are trying to do that, trying to project a reasonable view out to our local group of students. And, I know that UCSD now, they have a new sort of emphasis on ethics that I think it

may, in part, come out of the bad publicity that's come out of all the various plagiarism things, and the fraud issues in *Nature* and *Science*.[12]

Harkewicz: Right. I don't know if this is a related question or not, now that I look at it, but it was something that I thought was interesting. I know that you also mentioned the National Academy of Sciences booklet on being a scientist?

Constable: Yes.

Harkewicz: And, in the booklet they describe science as "shared knowledge," and I wondered if that meant the same as "agreed-upon knowledge," because I know in Science Studies sometimes we talk about things like consensus in science. But, what happens if you have something that's different from the status quo?

Constable: Oh, I don't think shared knowledge is necessarily agreed-upon knowledge. I mean, that was not the way I interpreted it. I interpret shared knowledge as things you're willing to stand up and say, which is not the same as you agreeing with what I'm saying.

Harkewicz: Okay. But, it's not the same as . . . .

Constable: It's not the same as not saying it. Yeah. What I see the shared knowledge as, which I think is interesting about this National Academy booklet, is that it's very much about science as a community activity, which I think it is in a way. It grows more like a community activity every day, you know. There are lots of collaborative things, and this actually does bring in the reason that you need these sort of ethical things because it is a community activity. Everybody knows more or less the same things, or has access to the same things. So, you do have to be careful about giving people credit for what they've done and making sure that, you know, you say, "Well, I remember that he did this first," or "He was the first person I heard say that." You can get yourself into trouble when you say "He did this first," because then somebody else will come along and say, "No, he didn't. I did it." [Laugh]

Harkewicz: Yeah. Okay.

Constable: Which has happened to me more than once, when I've said that kind of thing. But I see the shared knowledge as the fact that a lot of the way that science advances now is through people going to professional meetings and listening to talks. And, of course stuff gets published. But, there's a lot of material that's still in hopper, if you like, of not quite having come out and been published, that's a kind of community knowledge. And that knowledge is enabling everybody to go forward faster than they would have, say, fifty years ago when they would have been relying on reading the published word, and getting things out into print also took much longer in that time.

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[12] Should we reference specific instances or papers here?

Harkewicz: So, that's what you mean by standing up and what they're willing to say?

Constable: Yes.

Harkewicz: It's not like some sort of insecurity that they're not going to say something because they're not sure that what they have to offer is going to be accepted, I guess?

Constable: Oh, well, you know, for some people that may be an issue. But, I would say that shared knowledge is something where you've done some work, you believe it's ready for public presentation. If you make that presentation there may be people in the room who quite strongly disagree with the point of view that you've presented, because of measurements they've made or because they're opinionated and pigheaded. Or, you know, for a whole variety of reasons. But, I think that the shared knowledge means that it's been disseminated publicly in some sense and that might not necessarily be by the printed word. It might be verbally.

Harkewicz: So then that brings up the whole thing of credit in that respect too, then?

Constable: Yes.

Harkewicz: Like you said, you had to make sure that you said, "I heard this in this location," or "This is the person said this."?

Constable: Well, people should do that and I think that people are less careful about doing that than perhaps they should be in some cases. It's quite easy to go to a meeting in this day and age and you hear an idea, you know. Somebody makes a presentation and you say, "Oh, I can use that." You know, maybe not in the sense of theft, but in the sense of, "Oh, if I use that in the context of the work that I'm doing right now then that would be great, you know. I can see that that would work here." And well, I think people have always been less careful in those contexts, because sometimes they don't even know where it came from. You know, and maybe I said that wrong in the sense it's not the aha moment when you say, "I can use that," so much as you hear something and then it all gets mulled over.

Harkewicz: Fits with what you're – yeah.

Constable: And fits with what you know and then it just become logical to go in a particular direction. And, I think this is where some of the more public cases of plagiarism have embarrassed some people who probably have no mean thoughts at all.

Harkewicz: Well, what about the whole idea, though, of going against the status quo? I mean I know that, at least with plate tectonics in the United States, it wasn't as readily accepted as it was in other parts of the world. And, I wondered what happens if,

especially graduate students, what happens if they have a idea that goes against what other people, the consensus?

Constable: I think having ideas is cheap. [Laugh] You have to show that they're right. What you mean is, do they have something to back it up? And, I think that there are people who are very, very conservative. I know people in my own field who still don't believe things that I thought were perfectly acceptable ten years ago. And sometimes they don't know them because they are conservative and don't like new ideas, and sometimes they don't know them because they're just not really keeping up with what's going on. And, it's hard to tell, you know. In the acceptance of plate tectonics in the U.S. I think there was an element of both in that area. So, I think this depends on the personality of the people. You know, there are some people for whom getting up and saying, "The current paradigm is totally wrong," is the scariest thing they would ever have to do and they're just not going to do it. And there are other people who thrive on that kind of controversy, who just feel as though they're not doing their job if they don't get up and do it. And, probably the people who go the furthest are the people who lie in the middle where they're willing to invest effort in showing that what they're doing is right. And at some point, they'll convince some significant fraction of the community. But, it doesn't mean that we're going to accept all the good ideas.

Harkewicz: But, do you think it matters who is doing the talking?

Constable: Oh, you mean whether it's a graduate student or a – well, probably.

Harkewicz: How do you feel about that though? [Laugh]

Constable: Well, you know, that's interesting. We'd like to think that it didn't matter, that you could make a compelling case, no matter what. The reality is that in most of the conferences that I go to as an earth scientist you get ten minutes, fifteen minutes, maybe even twenty minutes. It's not enough to put across a whole new concept. So, what you're counting on is that somebody's going to go back and read it. In fact I think, I have the impression that people read less than they used to, and they go and listen more. You know, they see the sound bites more. And, I think that does make it hard for graduate students to put it across. It's also true that, you know, in a conference structure where many presentations are done as posters, the exposure there is rather limited. So, yeah, of course the people who have reputations get to make more noise.

Harkewicz: And people go to see them talk, too.

Constable: And people go to see them talk, because they know whether they are going to give good talks or not. So, yes so I'm afraid it does. But, you hope that good science will prevail in the end, that somebody will pick it up and won't take credit for it themselves. [Laughter]

Harkewicz: Exactly. Well, you mentioned that, in the NAS booklet, they actually use the term "fellowship of peers." And, I wondered if you felt the fellowship outside of Scripps and inside of Scripps? Do you feel that it's a fellowship of peers?

Constable: Yes. Absolutely. The community that I work in is a community of sort of people who do paleomagnetic and geomagnetic work. It's a relatively small community, a few hundred people, and I think that when I go to scientific meetings there's definitely a feeling of presenting stuff and listening to people with respect, and learning things from one another. And so, yeah, I would say it's a fellowship of peers and it's a relatively friendly community. I guess that's not true of all the communities, you know. The geochemists have this reputation for being a very aggressive, cantankerous bunch.

Harkewicz: What about here at Scripps?

Constable: Oh, here at Scripps, you mean my community?

Harkewicz: Yeah.

Constable: Oh yeah.

Harkewicz: Or, I mean here and outside.

Constable: I think the community here is great. One of the nice things about Scripps is that it's such a large organization that if you have a scientific problem you can almost always find somebody here who will offer comment on it. [Laugh]

Harkewicz: Whether you wanted it or not, I suppose?

Constable: Well no. And usually it will be a potentially useful comment I would say. I mean, you know, it's not always useful because it just depends on, on what's going on. But, I think that's actually a tremendous benefit out of working in a large scientific organization is that the number of people you can interact with and their breadth of expertise is just, here it's just staggering.

Harkewicz: Uhm-hmm.

Constable: And we should use it. [Laugh]

Harkewicz: Yeah. I know they talked about, at least in the past, different groups getting together and discussing their work. Does that happen at all anymore?

Constable: At Scripps?

Harkewicz: Yeah.

Constable: In some areas it does. I think it depends. This informal seminar series I was talking about has been fairly successful in that regard in bringing together groups who work basically in the solid earth sciences. So, when it comes to the cross fertilization of fluid dynamics and earth sciences, then yeah, okay. It gets harder as a place gets bigger. But that's one of the things our new director's been trying to do. He's been trying to promote these Scripps science talks.

Harkewicz: What do you think of – well, I'm not going to say, "What do you think of him?" but he's a fellow Australian, does that – I guess that doesn't make any difference. There's a question in there, really.[13] [Laugh]

Constable: Yeah, I think, as an Australian it's interesting to see somebody come from Australia come and strengthen Scripps's ties with the scientific establishment in Australia. I think there's something to be gained on both sides there.

Harkewicz: Uhm-hmm.

Constable: Australia is a small scientific community, but there are some very good people working there, and there have been some good ideas that have come out of there. And so to strengthen the ties with that community is a good thing for us and for them, I think.

Harkewicz: Do you think it will open opportunities for people to exchange then?

Constable: Yeah. I think it probably will. I think in some science that's what's going on, some fellowship opportunities for students and things like that.

Harkewicz: Uhm-hmm. Another thing that they mentioned in that booklet was about the responsibilities of the scientist and I wondered if you would care to define what you think the responsibilities of scientists are? It can be within the profession, or in relation to society, however you want to answer that.

Constable: Well, okay. [Laugh] Within my profession there are two things that I see. First of all there's a responsibility to try and have a sufficiently broad focus that one does something that's, I guess, I would say scientifically interesting. I'm not sure if that's the right word, but something that fits into the larger scheme of things. So, I would say this is a sort of a broad impact issue. There's no point, in my mind, in focusing on something that's so narrow that nobody else is interested in it. One might do something that's very narrow but that's what one does for one's own personal pleasure rather than for one's profession, because it doesn't benefit

[13] A.D.J. ("Tony") Haymet (1956 -) was born in Sydney and got a Ph.D. in Chemistry from the University of Chicago in 1981 and a D.Sc. from the University of Sydney in 1997. He has held numerous positions both in the United States and Australia. He served as Chief of Marine and Atmospheric Research, then Director of Science and Policy, at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency, before becoming the tenth Director of the Scripps Institution of Oceanography in 2006.

the rest of the community. I think, as a scientist, one hopes that what one does will ultimately have some practical use but I don't think one should necessarily feel obligated to design all the projects that one works on so that one can see what the outcome will be. I think that there's a tradeoff between the, what some people call blue-sky science and applied science. You know, the blue-sky stuff is the stuff you just think about because it's interesting and fun to think about, and sometimes it's going to lead to great discoveries and at other times it's not. I think a fair number of us at Scripps do what we would call blue-sky science in the sense that we're thinking about things we find personally interesting and there is some broader audience for them but it's not immediately apparent that it's going to save the world. There are other people who do save-the-world kind of science and I wouldn't put myself in that category. The science that I do is not really socially relevant immediately.

Harkewicz: But let me . . . .

Constable: On the other . . . .

Harkewicz: Can I just interrupt you for just a minute, because I want to ask you – I know there are some people that are really adamant about the whole idea of not doing anything other than blue-sky science here. They feel like we shouldn't be doing anything that could be . . . .

Constable: That's socially relevant?

Harkewicz: Right. Well. [Laugh] I don't want to say that. Maybe more applied science. Socially relevant makes it really negative. But, I mean . . . .

Constable: I don't think there's anything wrong with doing applied science. I mean, I think that, at a high intellectual level, almost any kind of science is really interesting and may have huge payoffs. Almost anything that you spend a lot of time thinking about could prove to be really interesting and have a fair amount of breadth to it. And, I guess, some people would say that's about doing blue-sky science. Other people would say, you know, one ought not to do things that are applied. For example, there are people here who actually work on things that are relevant to the city of San Diego, the oil industry, geohazards. I think that what one hopes is that one can do the kind of science that will have sort of tentacles that reach into all kinds of areas, and that very often tends to be the case. If you only do blue-sky science you'd stop as soon as it became useful. [Laughter]

Harkewicz: Okay. Right.

Constable: I think we have the luxury of being able to do that kind of thing, and we ought to use it, to only do things that are very routine and crank-turning kinds of things is, of course, not a good idea. But I think there's a very broad range of things that has quite sophisticated intellectual content. So, I think the obligation is to do

something that's interesting and makes you think, in scientific terms. I think there's also an obligation in universities to disseminate that science, to contribute to the shared knowledge that we're talking about, and to educate the next generation to do it.

Harkewicz: So, it sounds to me, and maybe I'm misinterpreting what you're saying, but it sounds to me sort of like you think science, in itself, is sort of a higher calling, perhaps?

Constable: I don't know that I'd say it was a higher calling. [Laugh]

Harkewicz: Okay. Well, but good science is its own end, so to speak?

Constable: Yeah, I would say that. I think that there's absolutely nothing wrong with that point of view. You know, we live in a rich society and, and there are many people in our society that one could regard as not very useful. [Laughter] And, there are some societies where one couldn't afford the luxury of paying people to do science, or to think about problems that are not directed towards the improvement of society in general. And we don't happen to live in that kind of society. So, we have the luxury of being able to sponsor people to think about interesting problems and wait and see what happens as a result. Now, if those people don't share the results of their thought with us, I guess I would say they're not being terribly responsible. How they share that result, of course, can vary from person to person, you know. Some people like to get up and shout it out on TV. Other people like to blog it. Other people are only ever going to communicate by writing it down. And, I think all of those ought to be viable options.

Harkewicz: So, you described it as a luxury. But do you think that maybe it is a responsibility, to have people think about these problems, that it's a responsibility to think about it?

Constable: Oh, yeah I guess I do think that is the case. And, I don't think it's a good idea to run a society where we only ever care about the bottom line, because then we don't invest in, from an economic sense it doesn't make sense. I would take it as a luxury that we can afford and we ought to invest in. Maybe "luxury" is the wrong word. I think that if we live in a society where we always think about the bottom line next week we don't get the long-term investment, we don't get the developments that lead to the great breakthroughs. But, I don't know that I'd call science a higher calling.

Harkewicz: Okay. Well . . . . [Laugh]

Constable: I'd hesitate to give it a sort of, any, what do you want to call it, religious significance. [Laugh]

Harkewicz: Right. Sorry. It was a misphrase in there.

Constable: Yeah. Well. Whatever.

Harkewicz: So, where do you think you got these ideas of what science should be, and do you pass those ideas onto your students?

Constable: Well, I do try to pass onto my students--. I think these ideas basically come from the people that I worked with and the people that I respect. You know, I think that the people who are most focused on the sort of the personal prestige aspect of science, ultimately I look at them and I think, "Well, I don't respect it. I don't respect them as much as the people who are just sort of interested in the intellectual development for its own sake and where the result goes. There are people for whom there's a sort of a personal payoff in publishing and being a famous scientist. Of course, everybody has some piece of that in them. But, I think there's also a balance between doing work and producing something that is worth doing and will stand some test of time. One can always publish something that one's measured and a hasty interpretation of it, but I don't think that that's really a very responsible thing to be doing. I think I've been lucky to work with people who, by and large, care more about being right in the long run than about being first in the literature. [Laugh] And, that's something that I try to; it is something I try to pass on to my students, to say, you know, "What you want to do is to make a useful contribution, and you want to prove you can back it up. Because if you can't back it up then next thing you know it'll be a highly-cited paper for all the wrong reasons." [Laugh]

Harkewicz: Okay. That makes sense too. [Laugh] So, I've gotten us really serious here.

Constable: Yeah, very. I didn't know I was going to have such a serious discussion about the meaning of science.

Harkewicz: But, I wanted to ask you, about a comment that you made in this website about Women in Oceanography. And you said that, "Science was a career to be enjoyed."

Constable: Absolutely.

Harkewicz: So, I wondered if you could talk about some of the joys of scientific research?

Constable: Well, I think there are a substantial number of them. Firstly, you get paid to explore ideas that haven't necessarily been explored before. You get to interact with a lot of very intelligent people. Of course, some of them have egos, but then they're still interesting and intelligent people to talk with. And a nice life to spend your time talking with people who bounce interesting intellectual ideas off one another. All other things aside from what we've just been saying, I do think that in doing science, even blue-sky science, one does have the feeling that there's

the possibility of a useful payoff in the long run. You know, you're being paid to do something that's interesting and in the end it may turn out to be useful. Who knows what will turn up, what connections will be established. One of the things that I've found very pleasurable in the science that I've done has been in a project that I've been involved in over the past five years where I've spent a lot of time trying to write down a mathematical description of what the magnetic field looks like over the past ten thousand years, globally. So, the idea is you take a . . . .

Harkewicz: Small project? [Laugh]

Constable: Small project. So, you take as many observations as you can find, which is not as many as one would like, and then you say, "Okay, I want to make a mathematical model that will allow me to say, 'If I was here at this time then the magnetic field should have been this.'" Now, this was a first when we did it a few years ago. And, so we published this model and we put it up on a website and people went and looked at it and said, "It doesn't fit my data/" And, we said, "Well give us your data and we'll make a better model," sort of thing. The interesting thing about this is the number of people who've come and sort of said, "Oh, I'm glad you're doing that because I wanted to know that for some completely different reason." And so, it turns out that there are some historians who thought that they would like to use our model to figure out what the magnetic field declination, the deviation between magnetic north and true north was, in the middle of the Atlantic Ocean because they want to know the route that Columbus took when he was going from Europe to America. Apparently, it's a controversy as to which of the islands of the Azores he stopped at on his way over. So, this is really a lot of fun. Then we discovered that there are some people who worry about cosmic ray exposure of rocks and how that affects -- it's a mechanism whereby they can study erosion rates for rocks that are exposed on the surface because they get bombarded by cosmic rays which causes radioactive decay. And you can measure these. In order to do that they need to know what the magnetic field was in the past. So, it matters what it was doing locally, or regionally I should say. So, we sort of find there are people for whom there's a controversy about whether there's a solar impact on climate. In fact there's just global warming and how to reconstruct the climate in the past. You can do this looking at radiogenic nuclides. And, it turns out that in order to do that they also need to know the magnetic field. So, I think that one of the best things about science is that you start out with what you think is a localized problem and then you find before you know it you're talking to all sorts of different people, many of whom have expertise that's completely different from your own. And learning really a lot of interesting things. You know, you can do history, or you can do chemistry, or you can do climate studies. I didn't ever think that any of the things that I was going to do were really going to involve those kinds of things.

I think there's another pleasurable aspect, and that is that the scientific community is really a global community. That means that there are people from Australia, from Europe, from Asia, and I really enjoy this aspect of it because there's not a

kind of a fierce sense of patriotism there. [Laugh] There's not a sense of patriotic competition as there is in some other areas. And, I feel as a scientist, like a global citizen, not like a U.S. citizen or a – I mean, I, I have three citizenships. I'm Australian, British, and a U.S. citizen. But, I feel really that one of the advantages of doing science is that you don't have to have an affiliation to a particular culture or a particular patriotic sort of need to promote your country, that really there's a sort of an interest globally in advancing knowledge.

Harkewicz: So, you haven't seen nationalism?

Constable: Yeah, so it's really not a nationalistic activity. And I think, I mean that's one of the ways one would like to see the world evolve. [Laugh]

Harkewicz: Yeah. But, would you say, . . .

Constable: I wouldn't say that scientists are good at doing, no that's not meant to be a political statement.

Harkewicz: No. I don't know if you can answer this, because you can answer from your own experience, but do you think that that is a newer phenomena. I mean, you came into science in the eighties, do you think during the Cold War that same kind of thing – well, I, I'll ask you that.

Constable: I actually think that it's always been. People who are interested in the natural world have always been big travelers. I mean, if you look at some of the early successful scientists, people like Humboldt and those people who were the early explorers who had scientists on their ships. These were people who basically went out because they were curious about what was out there. And, the curiosity, I think, really overcame the sort of nationalistic tendencies. Yes, of course, the funding and those kinds of things probably came from the need for building of empires. But, one of the charming things, I think, about science is that it's very much curiosity driven. There are people who, who just sort of want to know new things. Of course there are ambitious people and people who want to be very, very successful, but I think one of the pleasures, I would say one of the pleasures of doing science is that there's all this new stuff that you can still go out and find out. And that there are other people who are interested in that too. One of the pleasures of doing fieldwork, actually, is that of going to other countries and other cultures, in some cases, and doing work there, going there not as a tourist but as somebody who participates in some sort of worthwhile activity. So that you sort of say, you go there and you have this feeling, "Well okay, I'm a commuter here too. I've got to go to work. I've got to go and get my rocks today." [Laugh]

Harkewicz: So, what kind of places have you gone and actually done that?

Constable: Well, for example, I've done some fieldwork in Costa Rica, also in Italy. I've done some fieldwork in – this is a different thing, of course, but in Antarctica, at

McMurdo, which is a U.S. base and that's definitely an alien culture. [Laugh] I mean, in the sense there's a huge amount of effort goes just into survival there. And, I don't mean that in a negative sense. So, those are different things from going to a place as a tourist, where you go in order to be entertained and to play. I hate to say "seriousness of purpose," because that sounds kind of pompous. But, there's a different way in which you interact with the environment there, and a different impression you carry away.

Harkewicz: Have you interacted with local people in those situations or is it mostly other scientists?

Constable: Quite often there are sort of logistical things that you have to sort out locally and those things can be quite interesting. Yeah. And then, this is true of doing fieldwork everywhere actually, that you always have to sort of explain why you're there and what it is that you hope you're going to learn, and why it is that you need to take away this rock sample and that particular one and not the one next door, you know. See, there's sort of little mini outreach efforts [Laugh] that you have to engage in.

Harkewicz: Okay. I see. So, I have a few questions that I ask everybody just to be general. The first one is, in your opinion what made Scripps succeed, or what has made Scripps succeed?

Constable: I think the thing that's made Scripps succeed has been that, in the past, the efforts of the people who founded it and directed it initially to bring onboard people they viewed as talented and to encourage them to do things that are worthwhile but not to tell them to do anything [Laugh] really. There are some exceptions to that, of course. But, by and large the, it seems to me that the direction that has been followed has been to say, "Okay, here are the resources. Why don't you come here and use them?" We were talking earlier about ONR funding and those kinds of things. I think those things have been enormously powerful in attracting more good people because there's been a fairly rich source of funding in the past that has allowed people to essentially do what they want without supervision, or accountability perhaps is the word. Or real detailed accountability. And, people have made good use of those resources. When I look at the earth sciences it's very clear that there was a time with the plate tectonic revolution where you'd succeed no matter what was happening. There are a lot of people who established their careers during that time who are now retiring or retired. And if you look at what they did for their careers, it's hard to imagine how you could really go wrong at that time, because there was just all this stuff to be done. Now, whether that will go on happening in the earth sciences is another matter. You know, there are different kinds of problems in there.

Harkewicz: Well, some people say we've trained too many people, that it's just gotten too big. Maybe not so much the earth sciences, but maybe oceanography in general, there's just too many people out there for the jobs that are available.

Constable: That depends if you think that the role of an institution like this is to train the next generation of scientists who are going to work at research institutions. We do train a lot of people, in colleges and at the graduate level now. I think perhaps this is happening already and it seems as though some of the people that have trained at Scripps have gone into government, science and government and social policy. Of the students who have worked with me only one, two, a couple have really ended up in research, academic kind of careers. Some of them have gone into industry where they do research. Others have gone off and done other things. But, I don't think it's a reasonable expectation to have, you know, two or three graduate students at any given time and expect that all of those people are going to find positions in academia. It's just not realistic.

Harkewicz: Actually, Richard Somerville said something similar too, and do you think that's, that's a new thing?

Constable: That people will go and find . . . .

Harkewicz: People will go into non science type positions?

Constable: I think they always have, actually. I suppose one thing that's interesting about Scripps is that there's a huge number of Scripps graduates who are populating academic positions around this country, and internationally. And, one of the interesting things about that is that you see people who have come out of our educational programs, which I think are very good, and they have then gone into small colleges, places which haven't traditionally trained graduate students who mostly do undergraduate teaching. And they've tried to maintain their own research programs. So, in a sense I suppose you could say that if we're not being successful in getting funding because of that then we've been victims of our own success. But, my impression is that Scripps is still competitive when it comes to having the ideas here and competing for funding, and those kinds of things. And, actually the beneficiaries have been these small colleges who have really excellent professors, teaching at undergraduate colleges.

Harkewicz: Okay. Then the other question I always like to ask everybody is, so you said what you thought made Scripps succeed, what do you think may have threatened its success?

Constable: I think that there are some risks in being as large as we are. I think when Scripps started out, it's my impression though of course I wasn't here, that the place was very successful because everybody could go and talk to the director and say, you know, "I want this, or I need that. What we should really do is this." And, there was some sort of communication and dialog. That kind of communication is very much more difficult now because we have hundreds of scientists working here. We have people who never meet the director let alone know he exists. We have people who don't know that we actually have a graduate department because

they just come here as postdocs and all they know is the immediate environment. So, I would say that's a threat in some sense and it's one that our new director is trying to address by making some changes in the structure. In the past we've had a very kind of flat administrative structure where there's essentially been the director, and anybody who wanted anything could sort of go and pound on his desk. [Laughter] And, that doesn't work for an organization this large. I think there are other threats that we see in the short term, and how long-term they'll be remains to be seen. You know, things like cycles of funding. And right now the way that places like NSF are funding things, there's a tendency to fund very large collaborative projects and those can be good for a place like Scripps in the sense that we are large enough to compete for them if people organize and put stuff together. On the other hand, they tend to be very much about infrastructure and observation, and they don't tend to be about something that Scripps has excelled at in the past, which is small grant science, where individual investigators write proposals for a graduate student and then lavish a lot of time and attention on that graduate student. I guess I would say that there's something of a threat in the sense that these large proposals mean that scientists turn into administrators. So, they spend a lot of time administering these large scale projects, and then they spend less time thinking about the science and the individual graduate students, postdocs.

Harkewicz: You may have answered this already but you talked a lot about teaching graduate students and what you see as the responsibility of a scientist. Historically Scripps has had this issue between research and teaching, like they're two separate entities. I guess I wonder how you, because you're sort of talking about both things and I wonder what you see Scripps' response, Scripps' responsibility being?

Constable: I think we have to do both. You know, in the past Scripps has been able to function almost exclusively as a graduate department. We were able to do that because we were here before the university was here. We had a special status with relatively generous research funding from the State of California at that time. Right now there's some considerable pressure from the state legislature to give less funding to Scripps on the research side of things, in part because there are other parts of the University of California at San Diego, other departments which have grown into large and successful research entities, which are in many ways not so different from us. And so, what I see is that we can certainly go on doing research but we can't claim a special status about not having to train the next generation of scientists. And, I don't think it helps us not to train people, because I think we want people to understand and be sympathetic to the research problems that we think are important, which are largely environmental, in terms of the sort of the social construct around us. I think it's really important that we train people who understand those things at the undergraduate level, which is something that Scripps has been relatively slow to adopt. I mean, we've had this undergraduate earth sciences program, but it has been I would say more as a feeder for the graduate program or for other people's graduate programs than as a sort of a way of educating the population at large.

Harkewicz: I see. Okay.

Constable: I think we moved into an era where it's very important for us to interact with the broader university population, to put our research and science into the context of what other people at UCSD do. And, I think that yes, we have a special status as an institution of oceanography, whatever that means. I take the broad view, being the solid-earth scientist myself. So, I think we have a special status there as a research organization because we have a fantastic organization here and lots of opportunities and resources to use. But, I think we also have an obligation to train all kinds of people and interact with not just the scientists on campus but also the policy people and those sorts of things.

Harkewicz: Right. That makes sense. Okay, then my final question is, what has Scripps meant to you?

Constable: Well, [Laugh] I guess it's the place where I've grown up into my professional life, really, more than anything. And it's been my social and professional interest for over twenty years. Don't think I could say anymore than that, [Laugh] you know.

Harkewicz: That sort of rounds, yeah.

Constable: It's made my life, really. It's been a very strong influence on my life.

Harkewicz: Okay. And, I was just curious. I said that was my last question, but I wondered, with you and your husband both scientists and you mentioned your children, are any of them interested in science?

Constable: Oh, they're doing their best to avoid it. [Laughter]

Harkewicz: It had to be one or the other, right?

Constable: Right. The jury's still out on my daughter, but my son is not going to be a scientist.

Harkewicz: He can be a spokesperson though, anyways, in whatever field he chooses, I suppose?

Constable: I think whatever he does it will be interesting, and that's what one hopes for with one's children. You know, I would hate for them to do what I do, I mean exactly, because I think that sets up a competition that one doesn't need.

Harkewicz: Right. Well, I have run out of questions. Is there anything that you feel like you wanted to add to, you know, have for posterity's sake that you haven't been able to share with us today?

Constable: No, I don't think so.

Harkewicz: Although, I did think of one thing when you were talking. You mentioned funding and I wondered what funds the Consortium that you were talking about?

Constable: Oh, the Magnetics Information? That's National Science Foundation funded. Well, we hope it's going to go on being a National Science Foundation funded project.

Harkewicz: Because, that did sound like it would be something that you would, you know, you talked about contributing to the community of science.

Constable: And actually I would say it's a project that we sort of came into not so much because we wanted to do it but because we thought it had to be done. [Laugh] And, so far that's been funded by the National Science Foundation. I was talking about these funding problems, and they're kind of undergoing a crisis of, "How on earth are we going to fund all this electronic database management kind of thing, cyber infrastructure sort of thing?" And really, in many ways, these kinds of databases are the next generation of libraries.

Harkewicz: Right. Yeah.

Constable: And, there's a bit of a strange situation right now where you can get funding from the National Science Foundation and it's subject to peer review. But, these kinds of projects are not exactly the kind of project you can turn on and then turn off again, which is sort of the way that other scientific projects work, you know. You justify it on the basis of science. So, it'll be interesting to see what happens with these things over the next decade or so, whether there'll actually be some sort of model where they evolve like libraries, for example, with a more direct funding. But then, you imagine that then there would be professionals who would do this kind of thing as opposed to sort of individual scientists on a kind of volunteer basis.

Harkewicz: Right. It seems like another incidence where technology is going faster than . . . .

Constable: Yeah, it really is.

Harkewicz: The support, and things like that?

Constable: That's right. And then, then there are whole problems about getting these various databases to talk to one another, so that you can search across them and find related kinds of information.

Harkewicz: Yeah.

Constable: So.

Harkewicz: Well, thank you very much for your time, and it was a pleasure talking to you.

Constable: You're welcome.

Harkewicz: And, I will stop here.