

National Park Service (NPS) History Collection

NPS Paleontology Program Records (HFCA 2465)
Vincent Santucci's NPS Oral History Project, 2016-2024



Jacob Lowenstern
February 11, 2022

Interview conducted by Vincent Santucci
Transcribed by Teresa Bergen
Edited by Molly Williams

This digital transcript contains updated pagination, formatting, and editing for accessibility and compliance with Section 508 of the Rehabilitation Act. Interview content has not been altered with the exception of omitted PII as present.

The release form for this interview is on file at the NPS History Collection.

NPS History Collection
Harpers Ferry Center
P.O. Box 50
Harpers Ferry, WV 25425
HFC_Archivist@nps.gov

Transcript

[START OF INTERVIEW]

Vincent Santucci: 00:00:02 There we go. All right, if you're ready, I'll go ahead and begin.

Jacob Lowenstern: 00:00:07 Okay.

Vincent Santucci: 00:00:09 Today is Friday, February 11th, 2022. My name is Vincent Santucci, the senior paleontologist for the National Park Service Paleontology Program. Today we are interviewing Dr. Jacob Lowenstern, research geologist with the US Geological Survey's Cascades Volcano Observatory in Vancouver, Washington. During today's telephone interview, we hope to capture the history of Jake's career with specific reference to his work involving National Park Service areas. So welcome. Thank you.

Jacob Lowenstern: 00:00:42 Thanks very much.

Vincent Santucci: 00:00:43 Okay. I'm going to start off with a series of very easy questions. So can you pronounce and spell your name for us?

Jacob Lowenstern: 00:00:51 Yeah, my name is Jacob Lowenstern, and I usually go by Jake.

Vincent Santucci: 00:01:00 Excellent. And can you spell your last name for us?

Jacob Lowenstern: 00:01:04 L-O-W-E-N-S-T-E-R-N.

Vincent Santucci: 00:01:09 Great, and can you tell us your current position, title, and location within the US Geological Survey?

Jacob Lowenstern: 00:01:18 Yeah, I'm a research geologist, but specifically, my duty right now is as the director of the Volcano Disaster Assistance Program. So that's the international arm of the Volcano Hazards Program, and I do it out of the Cascades Volcano Observatory in Vancouver, Washington.

Vincent Santucci: 00:01:41 Okay, great. And so you specifically deal with volcanic hazards, but I'm assuming you have a general volcanology background as well?

Jacob Lowenstern: 00:01:48 That's correct. I was trained as a geologist and a geochemist, focused on petrology, and so the origin of

volcanic rocks and their evolution and the gases that come off of volcanoes.

- Vincent Santucci: 00:02:05 Outstanding. Well, very good. Well, a few more, very easy questions. When and where were you born and where did you grow up?
- Jacob Lowenstern: 00:02:15 I was born in Washington, DC. I grew up nearby in Falls Church, Virginia, where I lived until I went off to college.
- Vincent Santucci: 00:02:25 Excellent. And then growing up as a boy in high school, before you went to college, were there any sort of outdoor nature, geology, or other activities that you engaged that sort of influenced your interest in going into the career field you have done?
- Jacob Lowenstern: 00:02:45 Yeah, absolutely. Trips west with my parents in middle school, definitely triggered a major interest in the outdoors. A long hike to Grandview Point in Grand Canyon and trips to Yellowstone and Yosemite as well were major influences on me. And then in Falls Church, I hiked most weekends in Shenandoah National Park, partly through the Wander Birds Hiking Club in the DC area, and Shenandoah National Park was a really important place for me growing up.
- Vincent Santucci: 00:03:34 Outstanding. That's the perfect childhood. So when you were applying for college or university, did you have a particular field of study in mind and did you select a school based on that?
- Jacob Lowenstern: 00:03:51 I knew I wanted to go into natural sciences. I didn't know whether geology, or forestry perhaps, would be more fitting for me, but I had a feeling that I wanted to go into natural sciences and I went to Dartmouth College and immediately enjoyed the geology classes that I took and kept moving in that direction.
- Vincent Santucci: 00:04:20 So your undergraduate degree was in geology or earth science?
- Jacob Lowenstern: 00:04:25 Correct.
- Vincent Santucci: 00:04:25 Okay, great. Did you begin to formulate an affinity for volcanology during your undergraduate degree or did that come later?

- Jacob Lowenstern: 00:04:38 Yeah, Dartmouth had a real history working in volcanoes. In particular, there was a guy named Dick Stoiber who spent a lot of his career working in Central America, and he led a trip for students down there my junior year. And that experience, plus the classes that I took at Dartmouth, definitely got me fascinated with the general field of the igneous petrology; how volcanic rocks form, how volcanoes are related to igneous rocks below the surface of the earth, granites and gabbros and other rocks like that. So I definitely got interested in volcanoes as a result of studies at Dartmouth. I did a senior thesis, not in a national park, but in the national forest along the Oregon/California border, something called the Colestin Formation, a legacy in volcanic rocks. And then after Dartmouth, I got an opportunity through a connection that Stoiber had to do a Fulbright Fellowship on Mount Etna in Sicily.
- Vincent Santucci: 00:05:57 Oh wow. That's fantastic. Yeah, tell us a little bit about that. That sounds interesting.
- Jacob Lowenstern: 00:06:06 Well, I got hooked up with a professor at the University of Catania named Renato Cristofolini, and he had a project in mind for mapping out some lava flows from an early part of Mount Etna's history, around 10,000 years ago. And I got assigned to go map out those units and collect rocks and make thin sections and collect and set everything up for getting chemistry at the lavas. So I learned a lot about doing field work and living in Italy in a place where I was still learning the language and it was an exciting year in every way.
- Vincent Santucci: 00:07:01 What a great experience. So I'm interested because I'm Sicilian on my father's side, so excellent.
- Jacob Lowenstern: 00:07:07 Oh nice. (says something in Italian)
- Vincent Santucci: 00:07:11 Yeah, so that'll be the one thing I will remember about you the most, probably. That's very cool. So then did you begin to think about graduate school and what were some of the considerations in terms of where you wind up going?
- Jacob Lowenstern: 00:07:28 Yeah, I had started the process before I left for Italy and basically, my applications were ready to submit while I was gone. I think I gave them to my mother to mail and then I had to do some final decision-making while I was in Italy of different possible places to go to graduate school. And

then, yeah, I went the following fall after I got back, so right away.

- Vincent Santucci: 00:08:02 And so where did you go? And did you do a separate master's and PhD or did you do them together?
- Jacob Lowenstern: 00:08:08 I went to Stanford. I was entered into the PhD program, but while I was there I ended up doing both a master's and a PhD because they were sort of unrelated projects and that's how Stanford preferred to do it.
- Vincent Santucci: 00:08:25 So Stanford and Sicily. That's amazing. The campus at Stanford is just so incredible. My daughter went there for some courses and fell in love with it. But yeah, congratulations on that. And so what year did you defend your dissertation and receive your PhD?
- Jacob Lowenstern: 00:08:47 I finished up at Stanford in 1992.
- Vincent Santucci: 00:08:53 Okay. And then the focus of your dissertation if you could just briefly share.
- Jacob Lowenstern: 00:08:59 Volatile metals and gases in two volcanic areas: Valley of Ten Thousand Smokes in Alaska, and Pantelleria, Italy.
- Vincent Santucci: 00:09:11 Very good. Excellent.
- Jacob Lowenstern: 00:09:13 Have you been to Pantelleria before?
- Vincent Santucci: 00:09:15 I have not.
- Jacob Lowenstern: 00:09:17 That's a interesting place.
- Vincent Santucci: 00:09:19 But I've been to The Valley of Ten Thousand Smokes. So can you tell us a little bit about that? I assume that you had an important field component for that work, right?
- Jacob Lowenstern: 00:09:28 Yeah. So that, in the summer of 1988, I went to VTTS with a fellow graduate student, guy named Peter Wallman, and his advisor, Dave Pollard, and Dave stayed about a week and a half to two weeks with us, and then he left and went back, and Peter and I stayed for another five weeks. I think we were seven weeks in total staying almost entirely at the Baked Mountain Hut, which no longer exists, but is way up at the head of the valley near Novarupta. And so we kept our food down at Three Forks in the cabin down there, and every 10 days or so when we ran out of food, we would go

back to that larger cabin, grab more of our stash, and head back up into the hut where we were staying.

00:10:39 And then I assisted Peter on his PhD dissertation research, which was to understand the structural geology of the eruption and the way that the vent formed, and also issues related to how the valley itself formed and the cracking of the pyroclastic flow deposits. And then I collected materials, ash deposits from the rhyolite, dacite, and the andesite components of the 1912 eruption so that I could do a study on the gases dissolved in the glasses, in the melt inclusions they're called.

Vincent Santucci: 00:11:29 Very cool.

Jacob Lowenstern: 00:11:30 Yeah, that probably that took one of the weeks of the time I was there and the rest of the time I was collecting or I was helping Peter.

Vincent Santucci: 00:11:40 Excellent. And just for the sake of somebody listening to this a hundred years from now, that Novarupta is very significant for a lot of reasons. It's within Katmai National Park, and it's an area where there's lots of bears. Did you have any encounters with wildlife?

Jacob Lowenstern: 00:11:59 We saw bears on our way in and out a couple times, but not any really close calls. And of course then we stayed, at the end of our trip, we spent a couple nights at Brooks Camp and saw the bears in their classic location on Brooks Falls. It was a real interesting experience just getting there, in that you fly to Anchorage and then to King Salmon, and then you take a float plane to Brooks Camp and then you get on a bus and travel for 30 miles and then you get off at the end of the bus and you have a 10-mile hike into where you're staying. So it's a long process getting to the Baked Mountain hut and/or camping up at the head of The Valley of Ten Thousand Smokes.

Vincent Santucci: 00:12:44 Excellent. And in one sentence, what is the significance of the Novarupta?

Jacob Lowenstern: 00:12:53 Novarupta is the vent area for the largest volcanic eruption of the 20th century, on earth.

Vincent Santucci: 00:13:03 Not too shabby of a dissertation project for sure.

Jacob Lowenstern: 00:13:07 It was a really big eruption and it's a classic field area. All sorts of studies were done in the decade after the eruption

occurred, mostly by the National Geographic Society. There's classic references and then we're still continuing to understand aspects of the eruption even today.

- Vincent Santucci: 00:13:31 And then just a short statement, what is significant about The Valley of Ten Thousand Smokes?
- Jacob Lowenstern: 00:13:38 Right. So the eruption was out of Novarupta, and the eruption was very explosive and it produced on the order of 10 cubic kilometers or two and a half cubic miles of debris that was streamed out over the countryside and it filled up an entire river valley with extremely hot ash, and pumice formed in place, these very hard deposits that are still not entirely revegetated. And so The Valley of Ten Thousand Smokes was steaming for decades after the eruption, which is why it was called -- get why it was given that name and was really an important learning experience for geologists to understand the kinds of deposits that can form during really large volcanic eruptions.
- 00:14:45 The eruption also created a caldera at the summit of Mount Katmai, so that implies that magma had to move underneath the ground from Mount Katmai to Novarupta where it actually vented. And so that was also a real head scratcher and still is for those people trying to understand how these eruptions take place where there is a huge subsidence of the ground in an area, I believe 10 kilometers distant from the actual egress area of the magma.
- Vincent Santucci: 00:15:25 Oh, thanks very much. Good stuff for sure. I guess final question about your dissertation, did you find the National Park Service staff at all helpful to you in your efforts? Did they interact with you much?
- Jacob Lowenstern: 00:15:45 At that time, I don't think I really met anybody from the National Park Service on that trip. It's (laughs) there might have been somebody walking through once or twice. And I did not do the logistics for the trip, so I do not really know much about getting our permissions in line or any other aspects of the work.
- Vincent Santucci: 00:16:10 Sure. Very good. So you finished your dissertation, and so where did you go from there?
- Jacob Lowenstern: 00:16:25 I was a postdoc at the Geological Survey of Japan, working in the Mineral Resources Department there, and doing research related to my dissertation and extending into the

field of geothermal energy and geothermal systems. And that lasted for a year. And then I got another postdoc at the USGS in Menlo Park, California that started in 1993.

Vincent Santucci: 00:17:07 Okay. And then—Go ahead.

Jacob Lowenstern: 00:17:08 Sorry. And then that project was on a volcanic area related to mineral deposits in Utah.

Vincent Santucci: 00:17:15 Okay, very good. So in my short lifetime, I've seen quite a bit of reorganization in the US Geological Survey, so names of branches or divisions within the survey have changed over time. Would you say that is the case among the volcanic components and entities within USGS?

Jacob Lowenstern: 00:17:46 Yes. When I was hired, I joined a group that had just changed names from Igneous and Geothermal Processes to Volcanic and Geothermal Processes. Later on, that became the Volcano Hazards team. And right now we are called the Volcano Science Center, but more or less it's the same group of people and the same locations.

Vincent Santucci: 00:18:15 Okay. So we're at the point of we can do one of two things. We can talk about your career and the positions that you've held or we can talk about the experiences that you had throughout your career involving national parks. Do you have a preference on which route to go?

Jacob Lowenstern: 00:18:37 I have no preference.

Vincent Santucci: 00:18:39 Okay. So starting to work for the US Geological Survey, I assume that was a permanent position?

Jacob Lowenstern: 00:18:49 It was after about a year. I was a postdoc for a year working on this project in Utah, and then I was hired on about a year later to work on both geothermal and volcanic topics.

Vincent Santucci: 00:19:05 Okay, all right, very good.

Jacob Lowenstern: 00:19:08 In Menlo Park.

Vincent Santucci: 00:19:10 So moving forward then, in your career at Menlo Park, did you have opportunities to work in any capacity, research or otherwise, in national park areas?

Jacob Lowenstern: 00:19:29 The main one early would've been Lava Beds National Monument, and a little bit of casual work in Lassen Volcanic National Park. I worked up at the Medicine Lake

Highlands, which is mostly Forest Service land, and I did some work in the Clear Lake area, which is mostly private land. And then I did some international work in Eritrea and various small projects in different locations. In 2002, I was asked to take over coordination of the Yellowstone Volcano Observatory, and at that time I started working at Yellowstone.

Vincent Santucci: 00:20:24 Okay. So that's one we want to talk a lot about. So let's not shortchange Lava Beds. Just quickly, what was your work at Lava Beds?

Jacob Lowenstern: 00:20:37 Well, I was really supporting some of the work that was done by Julie Donnelly-Nolan, who mapped the entire Medicine Lake Highlands as part of her career accomplishments. So she mapped all of the volcanic rocks on a really large area that extends from Tulle Lake all the way down to Fall River Mills. So it's a 70-mile-long stretch, I think, that is mostly one volcanic edifice. And I did a couple different projects in relationship to that work. I worked on Medicine Lake itself, which is at the summit, and is in mostly the Modoc National Forest. And tried to understand more about the history of the lake, the history of the ash deposits that ended up in the lake. We did the bathymetry of the lake and it involved work extending into Lava Beds National Monument, but I wasn't working specifically in Lava Beds.

Vincent Santucci: 00:21:52 Okay, very good. And then sort of the same question for Lassen Volcanic National Park.

Jacob Lowenstern: 00:22:00 I worked closely with a woman named Kathy Janik, and I was her supervisor doing geothermal gas work. So we would collect gases all over California and other locations nearby to try and understand more about the gases and the thermal fluids that were coming out of the ground. And Lassen was one of the areas that we would typically go. And Kathy in particular, she wrote some papers that I helped with, and helped review, on Lassen and the history of Lassen, and its geothermal features. And we did the same at Clear Lake and some other areas in California in the Long Valley area.

Vincent Santucci: 00:22:58 Very good. So let's see. So did you bring up Yellowstone because chronologically that was probably a logical discussion, or are there other national park projects that you were involved in before Yellowstone?

Jacob Lowenstern: 00:23:18 Not really. Yellowstone really is the first substantial involvement I had with a place associated with my work in the USGS. So a lot of my work prior to that was more conceptual in understanding geological processes that didn't require a detailed knowledge of any particular area, but they involved samples that I could acquire and look at and study. And so examples include various projects that I did overseas and this work that I did in Utah, and a lot of work at Medicine Lake. But I didn't really have a assigned field area until I started working at Yellowstone and I did that work for 15 years.

Vincent Santucci: 00:24:13 And so that started in 2002, did you say?

Jacob Lowenstern: 00:24:13 That's right.

Vincent Santucci: 00:24:13 Okay. So how did you come about getting this position? Is it something you helped to plan in advance or how did you wind up in probably one of the coolest positions on the planet?

Jacob Lowenstern: 00:24:35 It's a good question. It's interesting; we did not have a formal Yellowstone project, or we certainly didn't have a Yellowstone Volcano Observatory for many years, even though we had been at—USGS has had a major role working in Yellowstone since its early exploration. There was a lot of work done at Yellowstone in the sixties and seventies. In particular, Bob Christiansen, who's the geologist who remapped all of the volcanic rocks in the context of understanding about explosive volcanic eruptions similar to The Valley of Ten Thousand Smokes. And so actually what we learned at The Valley of Ten Thousand Smokes as a field was part of what allowed us to recognize what had happened at Yellowstone. So the USGS did that work with Bob Christiansen, and lead in, at the same time, we were funded to do geothermal exploration and geothermal drilling in Yellowstone National Park in the late 1960s.

00:25:58 And that was spearheaded by a man named Don White. And he had colleagues, Patrick Muffler, Alfred Trusdale and Bob Fournier, who also worked close with him on those projects. So we had this strong research program that really kept going into the early eighties, but after that time it really slowed down. Partly because those guys moved on in their career and partly because the USGS started to focus more and more on volcanic hazards and Yellowstone

wasn't really deemed as being as relevant to both the volcanic hazards in the country and also the geothermal activity that might end up being used for energy utilization, since Yellowstone is off limits. And so we didn't work so much in Yellowstone, but we ended up still providing funds to the University of Utah starting in the 1980s to run the seismic network.

00:27:14 Well, USGS went through all sorts of challenges in the nineties, it got reorganized, it had reduction in force. We ended up being regionalized and all of our volcano observatories were over on the West Coast and in Alaska and Hawaii. And I think at that point in time they realized that if we wanted to be uniform in our treatment of the volcanoes in the US, we needed to include Yellowstone as well. And so through this regionalization process, the Volcano Hazards Program got more serious about Yellowstone and decided to create the Yellowstone Volcano Observatory. And that happened in 2001, so it was probably -- they probably worked on it for several years. There was Marianne Guffanti, was an important player in that for the USGS and Bob Christiansen was brought on as the scientist in charge to work together with Bob Smith at the University of Utah and the National Park, Yellowstone, that would be the third member of the Volcano Observatory.

00:28:25 But Christiansen was close to retirement and he planned to retire, I believe, in 2002 or somewhere short thereafter. And so our management was looking for somebody who was interested in explosive rhyolitic eruptions and geothermal systems. And I was the logical candidate being one of the few hires in the team, and therefore one of the few sort of younger middle-aged scientists who had the right scientific background to be able to fit in easily into that role. So I think that's why I was approached and I was delighted to do it. I guess I need to back up here because I left out one major part of Yellowstone in my life. Can I do that?

Vincent Santucci: 00:29:34 Oh, please. Thank you.

Jacob Lowenstern: 00:29:37 So yeah, backtracking, I went to Yellowstone when I was in eighth grade with my parents, and then again in ninth grade. I went back there on a program called Wilderness Ventures where we backpacked all across the country, I think when I was 16. And there was a trip that I did in the

Snake River area backpacking for about a week, and that was my first back country experience at Yellowstone when I was 16. And I have to admit, I think there was a little bit of illegal swimming at the time, but that's kind of what happens on those trips, at least back then they did. And then my sister actually worked there around that time during the summers, and so I decided to work there after my senior year of high school. And I didn't get in at the beginning, but I got a letter in early June saying that they would take me if I showed up on July 2nd. And so I took a bus across the country and got off in Livingston and caught the TWA services shuttle up to the park, and I became an employee at Lake Lodge in housekeeping.

00:31:08 I did that for the rest of the summer, and every days off that I had, I would summit another peak in the area. And so I got to know Yellowstone very well during that time and it became a major place of importance to me. But as a USGS employee, I got to go there in 1994 when Bob Fournier—it might've been '95—Bob Fournier, as he was getting ready to retire, he wanted to show people all of the exciting stuff that he was able to see and work on during his career. So he brought a group of about six of us out to spend about a week going to and back from Yellowstone and seeing a lot of the key sites. And at that time, I thought it was extremely unlikely that I'd ever get the opportunity to work in Yellowstone since we didn't really have a program there anymore. But then seven years later we did, and I was in charge of it.

Vincent Santucci: 00:32:17 Outstanding. And so where were you duty stationed? Where was the Yellowstone Volcano Observatory based out of?

Jacob Lowenstern: 00:32:28 Yeah, so it's a virtual concept and I never stopped working in Menlo Park. So it was the Utah folks worked out of Salt Lake City and the Park Service collaborators worked out of the Yellowstone Center for Resources in Mammoth. And then we had various USGS people involved from working out of Menlo Park and Vancouver as well.

Vincent Santucci: 00:33:04 I'm sure it may have evolved over time, but in the 2002 time period, how would you characterize the mission of the Yellowstone Volcano Observatory?

Jacob Lowenstern: 00:33:19 Well, it was one to maintain monitoring systems for geodesy and seismology, and any other monitoring that we

wanted to or thought we needed to develop. It was to do research to understand the system more thoroughly, and it was to provide communications and outreach so that the public would understand what happens at Yellowstone and why it's a place of importance, globally, as a volcano. And that purpose hasn't really changed. The Volcano Observatory has changed in how it is fulfilled and who is working with it, but those basic ideas are still what drives the Volcano Observatory, and it still remains a virtual observatory in that there is no real staff assigned to live and work in Yellowstone full-time.

Vincent Santucci: 00:34:28 And I guess what I'm most curious about is your relationship with the National Park Service, how close that was, were there key individuals that were your points of contact that you had—

Jacob Lowenstern: 00:34:42 Absolutely.

Vincent Santucci: 00:34:43 Okay. Yeah, if you could share some of that, that would be great.

Jacob Lowenstern: 00:34:49 Yeah. So, the Observatory was a three-way partnership at that time, and we worked with YCR [Yellowstone Center for Resources]. So there was a geologist, a park geologist, who at that time there had been turnover and there was a new guy named Henry Heasler. And so he was the geologist and most of my interactions were with him. However, his boss was a guy named Tom Oliff, and Tom definitely was critical in terms of a lot of the decisions that got made in terms of what we did as an observatory and what we had permission to do. And then his boss in turn was the head of YCR, John Varley. John retired after a couple of years, and Tom took that place. And so Tom is a real important park service representative for YVO [Yellowstone Volcano Observatory] working with the superintendent and his group. And Tom was critical in some of the proposals that we put forward. I think that John Varley and Tom both recommended that we put together a monitoring plan, which we did and finished around 2006. And we also at that time were working on hazard assessment, and the Park Service folks were involved in that.

00:36:39 Then of course, anytime you're doing a research project in Yellowstone, you're working with the research coordination team, getting permits. Christie Hendricks was in charge of

that most of the time that I was working at Yellowstone. And so they're very diligent about making sure there are no problems in terms of environmental damage by the research. They want to make sure that you're doing everything in a safe manner, and they usually want to see what you're doing and travel in the field a little bit with you as well. So certainly worked very carefully with a whole suite of different people at YCR. And I also had the opportunity during that time to meet people outside of YCR, Nancy Ward doing the maintenance, and the superintendent, Suzanne Lewis, was the first superintendent while I was there. And occasionally got an opportunity to speak to their group to tell them what was going on.

00:37:53 We had a lot of geological activity during my time working there, including a couple of really large earthquake swarms. And so during those times, I often had an opportunity to talk to the leadership of the National Park and tell them what we were doing and give them briefings. And I also had the opportunity to help with some of the training for the interpretive staff of the park and the staff at Xanterra as well, who had their own group of naturalists and got training usually from the geology staff, Hank Heasler and Cheryl Jaworski. And so I would assist them every year or two with discussions of Yellowstone and its volcanic past and present.

Vincent Santucci: 00:38:51 So since you were based out of Menlo Park, how frequently did you travel to Yellowstone?

Jacob Lowenstern: 00:38:59 I would say probably three times a year. I was probably there maybe a month a year, most years, if you added up all the time. My Fall trip usually lasted at least two weeks. I usually spent at least a week there in the springtime, and then had various other trips for different purposes that could occur at any time of year. I certainly went there numerous times in the winter and every season when the roads were closed. Hank and I led trips for the Yellowstone Association Institute a couple times where we led courses for people paying the Yellowstone Association, and so I was able to do that while still a USGS employee. And that was a great experience also to be able to be in the park in the winter and to just get a better perspective on all of the different aspects of how Yellowstone is run and the relationship between Xanterra and the other concessioners and the National Park as well.

Vincent Santucci: 00:40:20 Yeah, that sounds like an extremely valuable thing for the Park Service to have that sort of professional relationship going on. Did you have a team of individuals that worked with you as part of the Yellowstone Volcano Observatory?

Jacob Lowenstern: 00:40:39 Yeah, in USGS, there were probably about 10 different people who did research in Yellowstone. And my job was mostly to know what they were doing, to try to facilitate their work as much as I could, and then to make sure that their work was well represented to the park as well so that people were aware of what the USGS was doing. As YVO, we had annual or biannual meetings and so we would meet up for one purpose or another every other year with folks from Utah and Yellowstone and the USGS. And when we enlarged the Volcano Observatory, then those became even more important and they involved new partners. So that's something that happened starting around 2009, 2010, somewhere in there.

Vincent Santucci: 00:41:44 I assume you probably didn't know Rick Hutchinson, who worked as a geologist, who died tragically in the nineties at Yellowstone. You probably heard his name though.

Jacob Lowenstern: 00:41:56 Yeah, well, I met him on that trip with Fournier in 1995.

Vincent Santucci: 00:42:01 Oh, okay. All right.

Jacob Lowenstern: 00:42:02 Yeah, so I definitely met Rick, and I saw him at least a couple other times over the years, but then yeah, he was not there by the time I started working there for YVO. He was gone before YVO started.

Vincent Santucci: 00:42:23 Yeah, interesting. Hey, just a piece of information. So John Varley and Tom Oliff interviewed the position that Hank Heasler received, and they were two finalists, Hank Heasler and Vince Santucci.

Jacob Lowenstern: 00:42:42 Oh, wow.

Vincent Santucci: 00:42:42 I think they hired the better person for sure. But anyways, it's just—

Jacob Lowenstern: 00:42:49 Well, he had many good qualities. He left while I was doing the job, so that was a whole other controversy. But we don't need to talk about that.

Vincent Santucci: 00:43:03 Sure. And so there may not be a relationship, but I just thought I would ask the question, the fires of 1988, by

virtue of opening up a lot of the areas because of the burning of the trees, did that influence ability to do any sort of remote sensing at Yellowstone having that opportunity to have a greater window on the surface?

- Jacob Lowenstern: 00:43:31 I'm sure it did, and I know it did in terms of geologic mapping, but I think by the time I was around, in 2002 and later, the real improvement in geological reconnaissance would've been mostly over.
- Vincent Santucci: 00:43:49 Okay. Yeah. And so a lot of the reports that I read are tied to J.D. Love and his work and mapping in Yellowstone, but I think that Christiansen named and described 16 units. There are stratotypes or type sections or type areas that were defined by Christiansen during his tenure.
- Jacob Lowenstern: 00:44:19 Yeah, well, he basically closely mapped all of the young volcanic units, and then lumped everything that was older. So he made huge strides in our understanding of what happened starting in the latest Pliocene and early Pleistocene. And then of course, at that time, there were also mapping all of the surficial deposits, separate geology teams from the USGS. And a lot of this work was funded by NASA at the time because they were having their lunar program and they were interested in extraterrestrial volcanic analogs or basically terrestrial analogs for what they might find out in space. And so they provided us the money for a lot of that mapping and even some of the geothermal drilling.
- Vincent Santucci: 00:45:21 Oh, very interesting. Did you get pulled in at all to the discussions regarding the bioprospecting from the geothermal areas in Yellowstone?
- Jacob Lowenstern: 00:45:34 I pretty much tried to avoid any of those discussions as best that I could. It was very controversial topic when I first started in and yeah, I mean, Yellowstone in the natural sciences, especially at that time, was really popular for two reasons. And one of them was this whole brand new field of biogeochemistry of hot springs and extremophiles, and then also understanding the nature of the mantle and hotspots in the earth. So on a global scale. And so there are people interested in what's happening a hundred miles beneath Yellowstone, and there were people really, really interested in the biology of these hot acid features. And I pretty much told myself when I started Yellowstone that I was going to not take part in either of those two fields and

my focus was on what's happening in the upper crust, the volcanic processes, and the inorganic geothermal processes that are most relevant to volcanic hazard.

Vincent Santucci: 00:47:02 Okay, very good. I understand that. During the tenure that you were working specifically with the Yellowstone Volcano Observatory, would you say that there's one event or one time period that was of greatest interest or excitement regarding activity that was going on that you were monitoring at Yellowstone?

Jacob Lowenstern: 00:47:31 There's a lot. I'll touch on a few briefly, and we can do some in longer as needed. The day that I started at YVO or the day after, there was a big earthquake in Alaska on the Denali Fault that was, I think a magnitude 7, 8, or something like that. And it caused surface waves that were directionally sent down towards North America and they joggled the geothermal system in Yellowstone and caused about 500 earthquakes the next day. And that was— Nobody knew what was going on, and that was a big deal. So that was a good introduction for me as to just how active Yellowstone can be and how—what an interesting—how working on real time events can be very exciting.

00:48:52 Another really important geological event was the earthquake swarm at the northern part of Yellowstone Lake during the period, basically between Christmas and New Years of 2008. There were a lot of felt earthquakes, and there was some discussions with the park. There was a little incident command set up, and there was some discussion about whether the people who lived at Lake ought to be moved. There were fears that maybe some of the hot waters underneath the lake could become unstable and could create steam explosions as a result of the earthquakes. And it was really one of the first, I think, internet explosions related to Yellowstone. Yellowstone was already well known because of some documentaries that came out around 2000 by the BBC. And of course, we had a movie that was co-produced by Discovery and BBC called Supervolcano that was about Yellowstone and featured the Yellowstone Volcano Observatory. And that was in 2005.

00:50:21 So there was already a pretty large community of science enthusiasts globally who were really interested in Yellowstone and were in their way convinced that it was going to have another caldera-forming eruption. So by that time, late 2008, there was a lot of data online. We had been

progressing more and more, not just at YVO but throughout the US, and making sure that of our seismic data and other sorts of data were available online to the public, but that meant that the public now could make their own decisions on what they thought was happening. And so it was the first time for me where not only was I doing communications about Yellowstone and trying to help people understand its importance, but also now having to explain the data in real time and try to convince people that it wasn't all about to start with a new volcanic eruption.

00:51:37 And so that was very busy at that time. There was a lot of information that we had to put out for the public on our website, and a lot of interviews that were done with the press, and the park service was very, very involved. And so we had a lot of conversations with, I think, Al Nash was in charge of communications for the park at that time, so a lot of back and forth between our group and the park service as well. And then another swarm happened about a year later on the Madison Plateau. Bigger swarm, more earthquakes, lasted longer, but it wasn't quite as big of a deal to the public. Partly, I think, because something about lakes and things happening under lakes make it all scarier and more impressive to the public.

Vincent Santucci: 00:52:48 Interesting. Thank you.

Jacob Lowenstern: 00:52:50 So all of that was going on, and at the same time, we have ARRA. So the American—and I am not sure I can remember—Restoration and Rehabilitation Act, it was passed right after Obama came in in early 2009. And so by mid-2009, we had to start planning for how we were going to spend money at Yellowstone with the funds from that project. And there were, I think 14.5 million dollars for volcano monitoring all throughout the US, and about a million of it was targeted for Yellowstone. And so in that case, we had to work again closely with the park to come up with a strategy of how we could spend that money most fruitfully and come up with some exciting new ways that we could monitor Yellowstone.

00:54:07 And that was on top of (laughs) a separate thing that happened a couple years earlier, which was EarthScope Program that provided new monies that allowed for additional GPS or ground deflation and some seismic experiments and instrumentation on the landscape throughout the United States. But it would definitely also

come to Yellowstone and so our monitoring plan put together with the advice of Tom Oliff and John Varley got used in guiding how we, and Yellowstone, would react to the EarthScope Program as well as ARRA. And it allowed us basically to fulfill a lot of what we thought we wanted in that initial 2006 monitoring plan for the Yellowstone Volcano Observatory.

- Vincent Santucci: 00:55:21 Very good. So when did you leave your position at the Yellowstone Volcano Observatory? What year?
- Jacob Lowenstern: 00:55:33 Not until 2017.
- Vincent Santucci: 00:55:36 Okay. So you had a long tenure there.
- Jacob Lowenstern: 00:55:39 Yeah, I mean, we haven't even gotten to redoing the observatory, (laughs) growing the observatory, and then my research, long-term research at Yellowstone, which is also probably something worth talking about. But yeah, both of those things are major activities that happen during my tenure as well.
- Vincent Santucci: 00:56:05 Okay. Yeah, I mean, I'll let you have free rein to cover things that you feel are important. I do have a couple more questions regarding Yellowstone, but I think that I'd prefer you to lead the discussion because you know where the story should go.
- Jacob Lowenstern: 00:56:24 Well, you never know what people are going to be interested in, so I can just talk about what I'm going to talk about. But, around the time when ARRA was happening and we were having those projects, and Yellowstone is in the news a lot as a result of these documentaries and the greater interest that people were starting to have, some of the state geological surveys grew more interested in having a role in the Yellowstone Volcano Observatory. And that made sense because they're the states who are working in and around Yellowstone and their people are interested in what's happening in Yellowstone. And also this group, UNAVCO, which was responsible for all of the EarthScope instrumentation, had a big role in guiding the monitoring within Yellowstone National Park. So we decided to grow the observatory by adding in the three state geological surveys, UNAVCO, and the University of Wyoming. So that's five new partners beyond the three original partners.

00:57:54 And that was not easy because not everybody really was equally interested in allowing that to happen. There was some pushback from the park, there was some pushback from the University of Utah. But overall, there were a lot of reasons why it was a good idea, and eventually we were able to convince everybody that it was worth doing. And so that took place, I think around 2012, where we officially grew the observatory to eight partners. And at that time, we began to have monthly teleconferences, and we made sure that we had our meetings every couple of years, and we tried some new things like running an exercise for a Yellowstone eruption to seeing how well the observatory could respond and work through the incident command system. And we just tried a whole lot of new projects that allowed us to thrive as a larger institution.

Vincent Santucci: 00:59:37 Very good.

Jacob Lowenstern: 00:59:40 Yeah. And then I thought I'd just say that personally, most of the work that I did at Yellowstone for research was looking at the geothermal fluids and the waters, the gases, and trying to understand how they vary geographically. One thing that's kind of amazing is though, even though there was a lot of collection of waters over the years, and a lot of that data did get published, there was almost no published gas data when we started working at Yellowstone in 2002. And that's partly because when the USGS did a lot of their work in the sixties and seventies and the eighties, they were still developing the techniques. And it turned out that not all of the data were really high quality.

01:00:37 And so it took a while before everything was -- all the kinks were fixed and the procedures were right for really going at it and collecting a lot of data. So we did that and we would have annual field campaigns, mostly in the Fall, exploring different parts of the park and collecting data and publishing it all in various different USGS reports as well as journal articles. And I think we really were able to publish a lot of new information and have a key role in developing more understanding of how this magma system that impinges on Yellowstone is manifested through geothermal activity. And that work started in relation with Hank Heasler was key in getting our work started and collaborating with us. He was great in that role and really valued his partnership. And then we had a group of five or six of us in the USGS who contributed to that work.

- Vincent Santucci: 01:02:10 And given all of your administrative responsibilities, you were able to find time to continue to do the research?
- Jacob Lowenstern: 01:02:18 Yeah, I mean, so the work at Yellowstone Volcano Observatory did have some significant managerial aspects to it, and I've described a lot of those because they were important that we put out these monitoring plans and hazard assessments and do exercises, but I didn't have a whole lot of supervisory responsibilities like a lot of the jobs in the other parts of the USGS for the volcano observatories. So where I work, at the Cascades Volcano Observatory, the scientist in charge has 50 or 60 people directly underneath him. And so there's a lot of bureaucracy and management as part of that job, and that's not the case at Yellowstone.
- 01:03:12 So I'd say that most years I had over 50% of my time free to pursue research, and not all the research was at Yellowstone. I still continued to do some lab work in Menlo Park, but I did also have a lot of time to dedicate to understanding geothermal fluids at Yellowstone. And so that was great, and that kept me excited because ultimately that's why I became a geologist was to be able to study the earth and to make contributions and to write about it for other scientists. And so although I've always valued being able to write for the public as well and to directly work on projects related to volcanic risk and hazard, I also enjoy being able to be a researcher on topics that are more pure and fundamental to understanding the earth.
- Vincent Santucci: 01:04:20 Excellent. Very good. So, let's see. So 2002 to 2017, I wanted to throw out a couple of questions. Did you know Lindsay McClelland from the Park Service?
- Jacob Lowenstern: 01:04:39 Yeah, I definitely knew the name way back and because I think he came to two of our program council meetings for the Volcano Hazards Program, and visited us for some meetings. And then I think when I went back, I did a little bit of work meeting people on Capitol Hill one year. It would've been in the early 2000s, mostly for me to talk a little bit about Yellowstone. It was when we were trying to grow our National Volcano Early Warning System project, which has now been authorized, but it wasn't authorized at that time. So Lindsay was there to work with us at that time. So I met him a variety of times over the years, but not so much in Yellowstone or directly related to the work in Yellowstone.

Vincent Santucci: 01:05:34 Okay. In 2009, there's a Geologic Society of America special publication on geologic monitoring, and you're a co-author as well as Lindsay in a volcanic monitoring chapter. I guess James Smith was the lead author on that one. Any thoughts about the geologic monitoring manual? Is it something you feel was a useful investment of time?

Jacob Lowenstern: 01:06:08 Sure. It wasn't a major investment of time for me, and so certainly it was a nice thing to be a part of. And I think Hank Heasler also contributed to that volume.

Vincent Santucci: 01:06:30 And I have sort of a personal question. So here we are in 2022, it's the 150th anniversary of Yellowstone, it's sesquicentennial. We are involved in a paleontological resource inventory this year at the park. And so of course, we love the Absarokas volcanic super group, and all of the petrified trees that it preserves. And so I assume that you've been able to see some of these scattered throughout the northern part of the park.

Jacob Lowenstern: 01:07:06 Mm-hmm.

Vincent Santucci: 01:07:07 Have you hiked Specimen Ridge?

Jacob Lowenstern: 01:07:11 Yeah.

Vincent Santucci: 01:07:12 I just sent you an email with a painting that actually just arrived at my home today that I commissioned. Do you have access to your email?

Jacob Lowenstern: 01:07:24 I do. I'm opening it up. Yeah. Very nice.

Vincent Santucci: 01:07:31 Yeah, there's this legend, this mountain man lore, that's tied to Jim Bridger and his discussion of petrified birds are singing in petrified trees, some petrified songs, and you probably have heard that, and so many people aren't aware of that, even at the park. And I thought, well, this is a way to get that story out, to have an interpretive painting done of probably one of the more famous locations where the petrified wood is exposed. Had you ever taken the time, I know it's outside of your real area of interest in research, but have you ever looked at some of the research regarding the work of Erling Dorf and his identification of 27 successive layers of petrified trees at Yellowstone that are part of that volcanic-clastic sequence?

Jacob Lowenstern: 01:08:28 Well, I didn't remember that name, but I definitely have from time to time in needing to do interpretive talks at

Yellowstone, and as part of just writing papers, wanted to have a better understanding of the history of the Absaroka volcanics. And so I have looked at some of those older papers to understand a little bit more about what they did and what they found, and what kind of materials are inter-layered with the volcanics. So yeah, that's one of the exciting things about working at Yellowstone is there's a rich history of intensive work and done over many decades that provides fun and interesting reading.

- Vincent Santucci: 01:09:23 Yes, absolutely. So one final question as it relates to Yellowstone. So of course it's important for a lot of reasons to us in the National Park Service, being the first national park, giving birth to an idea and a concept that's spread around the world, and Yellowstone is a World Heritage site as well. Any personal perspectives? If I ask you the question, in 25 words or less, what is significant about Yellowstone? What would your answer be to a group of undergraduate students you're lecturing to?
- Jacob Lowenstern: 01:10:09 Well, it is perhaps the most outstanding example of the interaction between biology, hydrology, and magnetic heat that we can find on the surface of the earth.
- Vincent Santucci: 01:10:50 Very good. Thank you.
- Jacob Lowenstern: 01:10:51 Did I make it under 25 words in my—
- Vincent Santucci: 01:10:54 Yeah, that was good. Thank you. Yeah, I love those kind of quotes to get out of people because, of course, your experience as a young boy going to Yellowstone and then coming back and working there, it's nice to hear those kinds of perspectives, so thank you.
- Jacob Lowenstern: 01:11:13 Yeah. And I think even as a kid, I sensed that, just it's how unusual—Once you get working at Yellowstone, you almost expect to see little puffs of smoke when you come around the bend, but that's not the way it is most places.
- Vincent Santucci: 01:11:32 So I was in Yellowstone in September, and I was driving from Mammoth down to Norris, and I saw this huge cloud coming from the Norris Geyser Basin thinking, "Wow, there's a lot of humidity down there." And the closer I got, the more I began to realize that has to be a big eruptive event, and no, it's not going to be Steamboat. And lo and behold, it was. We were there on the day that Steamboat erupted, and it was so impressive. You could hear it before

you got to it. And I mean, what a wonderful experience. We ran to get as close as we could to see it and just showered. Had you seen—

- Jacob Lowenstern: 01:12:24 It's erupted hundreds of times since 2018, and I think it erupted five times in the 15 years I was at Yellowstone, so I didn't have very good luck with Steamboat.
- Vincent Santucci: 01:12:41 So why in the world did you decide to move on from Yellowstone?
- Jacob Lowenstern: 01:12:51 Well, I think I wanted to keep working and doing science at Yellowstone, but I figured I had done everything that I was going to do as a manager of the Volcano Observatory and that it was time for somebody else to take over. I was a little tired of the social media aspect of Yellowstone and constantly trying to rebuff amateur volcanologists and their prognostications about imminent eruptions. And I'd spent a lot of time working to get the observatory into a situation where all of the neighboring states and the different partners were in a better situation for a longer term observatory. And I did that, and it was time for somebody else to take over.
- 01:14:01 So I was ready to stop doing that. I guess I probably could have finagled a way to keep working there as a scientist but not be running the observatory, but it's actually a lot easier for somebody taking over if it's a clean break. I also got asked to do this other job, which seemed like an exciting opportunity for me in my career. And so that required a move from Menlo Park to Vancouver. I actually live in Portland, Oregon, but across the river from Vancouver. So it allowed me to continue doing international work and to work with USAID and to focus more on how to improve volcano observatories internationally. So yeah, I decided that I would switch to this other job and let somebody else take over at Yellowstone. And my supervisor was content for all that to happen, and made it happen. And so I moved up in early 2018 to the Vancouver area.
- Vincent Santucci: 01:15:24 Excellent. I had one other question that's tied to Yellowstone, the term supervolcano. Is that something that sort of emerged through the media or was that an acceptable scientific term that existed prior to that?
- Jacob Lowenstern: 01:15:44 No, it never existed until it got created more or less by these documentaries. But scientists pretty quickly accepted

it, in that it made sense to call something over a certain size a super eruption. The concept of super eruption is straightforward, in that it's what we call a VEI-8 in the volcanic exclusivity index. And so it's a thousand cubic kilometers of material vented, explosively in one overall eruption. So people were content with that. But then, basically, you had to say that, well, a supervolcano is what creates a super eruption, but I don't think any geologists are really happy with the term, but we live with it because people seem to like it. But the problem with it is the day before you have an eruption like that, if you've never had one before, you're not called a supervolcano, but then the day after, all of a sudden, now you're a supervolcano. So what changed? Well, you had the eruption, but I mean, it was already in the state where it could create an event like that.

- Vincent Santucci: 01:17:15 Interesting. Yeah, I saw the same sort of thing occur with Hurricane Sandy, that overnight it became Super Storm Sandy just because of the magnitude of it. So maybe it's just a human nature thing.
- Jacob Lowenstern: 01:17:35 Where do you live, by the way? I can't remember if you were in Denver. You're in DC.
- Vincent Santucci: 01:17:37 Yeah, so I live in Gettysburg, Pennsylvania, so I keep away from the epicenter of Washington DC, just in case of nuclear holocaust. No, we enjoy living in Gettysburg, and I grew up in Pennsylvania, so we feel at home here.
- Jacob Lowenstern: 01:17:55 Where in Pennsylvania?
- Vincent Santucci: 01:17:57 In Gettysburg, Pennsylvania.
- Jacob Lowenstern: 01:17:58 In Gettysburg. You grew up there?
- Vincent Santucci: 01:18:00 Well, I grew up in Pittsburgh, but we spent a lot of time in Gettysburg.
- Jacob Lowenstern: 01:18:05 Okay.
- Vincent Santucci: 01:18:06 Excellent. So then you moved on to this new position, and I assume you had broad involvement then with lots of national parks as it relates to their volcanic resources?
- Jacob Lowenstern: 01:18:23 Well, internationally, so they're different countries.
- Vincent Santucci: 01:18:29 Okay. I see.

Jacob Lowenstern: 01:18:29 So different bureaucracies, and we're not the ones dealing with them. So yeah, I only work now on outside the US.

Vincent Santucci: 01:18:36 Okay. Did you work at all with Tom Casadevall?

Jacob Lowenstern: 01:18:44 Sure. Tom was around from the time of my initial hiring, and he later became the Deputy Director of the USGS. He might've even been Acting Director for a while. He's been a colleague and mentor for many, many years.

Vincent Santucci: 01:19:06 Yeah, he's a real friend to us in the park service. He's focused on promoting geologic heritage in the last decade or so, and he's making some good things happen.

Jacob Lowenstern: 01:19:19 Good. He's got so much energy.

Vincent Santucci: 01:19:20 He does.

Jacob Lowenstern: 01:19:24 He's great at whatever he chooses to do.

Vincent Santucci: 01:19:26 Sure. And then just a couple of general questions. So since you had done some work at Alaska early on, did you ever get to Aniakchak Caldera?

Jacob Lowenstern: 01:19:38 I've never been there.

Vincent Santucci: 01:19:39 Yeah, I visited. It's just such an amazing place.

Jacob Lowenstern: 01:19:43 Yeah, I bet.

Vincent Santucci: 01:19:44 The largest caldera on the Aleutian chain. How about other national parks? So for example, Valles Caldera is now a unit of the National Park Service, that gets referenced as a supervolcano by some.

Jacob Lowenstern: 01:19:59 Yep. Yeah, it's not active in that—It's actually erupted since Yellowstone. So I think that the youngest volcanic unit there is like 40,000 years, which is younger than the youngest—Well, actually now they've redated stuff outside Yellowstone, so actually we're down to 25,000 years in the Henrys Fork area. But anyway, it's not nearly as seismically active as Yellowstone is in terms of deformation. So we don't see it as likely to erupt, but it's a fantastic example of a caldera and beautiful country, and has a real rich volcanic story to tell us.

Vincent Santucci: 01:20:45 Definitely.

- Jacob Lowenstern: 01:20:47 I mean, I've been to a lot of national parks. Just on those trips with my parents, I've gone a ton. I love Pinnacles, which is I guess now a National Park. I've spent a lot of time hiking there, and I've been to all the Mount Rainier and Crater Lake and Glacier and Big Bend and Great Smoky Mountains and Acadia, and certainly Lassen, Joshua Tree, Death Valley. I've been to a lot of them, not to all of them. And I think going back to my childhood again, just the experience that I had in all those parks and Shenandoah's history of being a gift to the federal government from the state of Virginia got me interested in the whole concept of public land and sharing land and how do we treat our land. And that was something I got interested in at a young age. And of course, the story of why Virginia could give Shenandoah Park away is the story of the Chestnut tree and its demise and the loss of an entire culture of people living on the mountain.
- Vincent Santucci: 01:22:24 Definitely. So what's next for you in your career? Do you have a bucket list of things you want to try to do?
- Jacob Lowenstern: 01:22:34 That's a good question. I never really done it that way, and I usually just take things as they come without pre-planning too much. I'm 58, and I could probably do this job that I'm doing until I retire, but I don't really want to be more of a manager than I already am. So I don't think I'm going to apply for my boss's job anytime soon. So yeah, I'm content with the stuff that I'm doing, and I may end up, like many of my colleagues, being a volunteer once I retire so that I can continue to do research.
- Vincent Santucci: 01:23:20 Very good. Anything that you wanted to share that I haven't asked in our questioning?
- Jacob Lowenstern: 01:23:32 I don't know. I think we've hit a lot of highlights. No, I don't really think so.
- Vincent Santucci: 01:23:41 Yeah, very good interview. I really enjoyed it. Thank you.
- Jacob Lowenstern: 01:23:46 Thank you.
- Vincent Santucci: 01:23:47 I do want to say that on behalf of the National Park Service, really indebted to the work that you've contributed to make parks a better place for people that work there, and for visitors that come to them.
- Jacob Lowenstern: 01:24:03 Thank you. Obviously it's been, I don't know, a treat, I'm not coming up with the right word. I've been very fortunate

to be able to work in Yellowstone and in similar places and to be able to take these national treasures and learn more about our earth as a result of their preservation.

Vincent Santucci: 01:24:37

Well, very good. So what we can do is we can end it here. I'll turn the audio off.

[END OF INTERVIEW]