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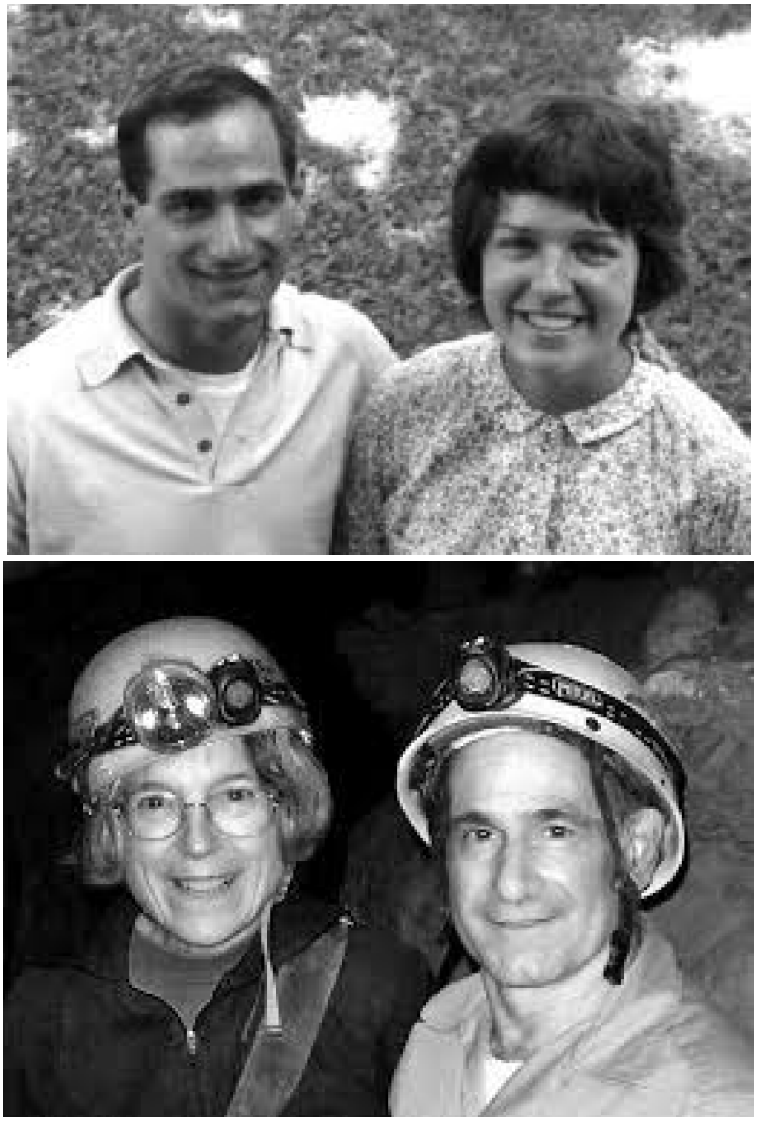
National Park Service Paleontology Program

Oral History Interview – Art and Peg Palmer

Natural Resource Report NPS/PALEONTOLOGY PROGRAM/OHI—2020/004



ON THE COVER
Art and Peg Palmer, retired cavers and geologists.

National Park Service Paleontology Program

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Natural Resource Report NPS/PALEONTOLOGY PROGRAM/NRR—2020/004

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The National Park Service, Paleontology Program publishes a range of reports, plans, oral histories and other documents that address a range of paleontological resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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Transcript

[START OF INTERVIEW]

Vincent Santucci (VS): Yes, hi. Is this Art?

Art Palmer (AP): It sure is.

Peggy Palmer (PP): And this is Peggy.

VS: Hi Peggy, how are you?

PP: Good.

AP: We're both hanging in there.

VS: Really appreciate your time, and I'm very excited to chat with you and the more I dig into your life and your career on the internet, the more interesting stuff I'm finding.

AP: Oh gosh. (laughs)

VS: This may require 10 hours of interviews I think.

AP: (laughs) Well, we're here.

VS: Well, sure appreciate it. I've done quite a few oral history interviews before, and I really enjoy them, and one of the projects I was involved in, I was interviewing WW2 military intelligence officers that interrogated top German military prisoners and—

AP: Oh boy.

VS: Yeah and they had signed secrecy agreements so they've never talked about what they were involved in, and so it was great discovery. But we didn't know what to ask, because—

AP: Yeah.

VS: —most of this information was classified. They were given permission by the Pentagon to interview with us, so it was great fun.

AP: Oh I bet.

PP: Golly.

AP: Well, I hope we can supply some information that's not classified.

VS: I hope you can provide both types of information. So yeah, thanks again for your time. So I've never interviewed two individuals before, so I guess it's going to present a little bit of logistical decision making.

PP: Oh that's ok, you can interview Art, because he was the mastermind.

AP: Oh right?

PP: He's the spokesman. So that works.

VS: You certainly are an exceptional team, so I think that I'd like to talk with both of you. So when it's appropriate, certainly we can go back and forth, and I'd leave that up to you to decide who would respond and in what order.

AP: That sounds fine. I'll assume that I'm gonna be answering the question,

PP: Yeah.

AP: Because I'm kind of used to talking whereas Peg's not much of a talker.

VS: Sure.

AP: But I used to teach and a teacher can blather on forever. But sometimes I'll ask Peg, and Peg you can just sort of butt in.

PP: I probably won't remember what happens when.

AP: Yeah.

VS: Sounds good, so just a couple of other things going forward, pretend like I don't know anything about the response to the question I'm asking, that way you feel free to provide as much detail and background as you'd like

AP: Got it.

VS: Particularly for those that may want to review these in the future, these interviews. It might be very helpful to have contextual information when appropriate.

AP: Yeah ok, I'll make sure that we start, not from the end of your question, but sort of back off a little bit and add some background information.

VS: Sure. And the other thing is that I try to, but it's difficult at times, and it'll be difficult given how much you've been involved in projects for such a long time, is that I'll try to proceed chronologically when we're able to, but certainly we don't have to absolutely stick to that.

AP: Sure.

VS: Ok. So I begin just with a short introduction. And so, are you ready?

AP: All set.

VS: Great, thank you.

VS: So today is Thursday, April 23rd 2020, and my name is Vince Santucci. I'm the Senior Paleontologist with the National Park Service Geologic Resources Division. Today I'm interviewing Dr. Arthur Palmer and Margaret Peg Palmer, retired geologists, about their cave and karst research, and experiences in National Park Service areas. So thank you very much to both of you for your time.

AP: Well, thank you for asking us.

VS: Sure, and thanks for your service to the National Park Service, that's for sure.

AP: Oh, it was our pleasure, and we got more out of it than they did, I think.

VS: Good to hear. So the first question is a very basic, general question, and this would go to both of you, is that, if you are willing to disclose it, when and where were you born,

5:00

VS: Where did you grow up, prior to going on to your college education?

AP: I'll start with that. I was born in Massachusetts, so I'm getting a little long in the tooth here. And Peg, you were born in—

PP: Oh, in Ohio, had really no previous physical experience with life.

VS: And during your time growing up, was there any early experiences you had that drove you sort of towards an interest in geology?

AP: Well, for my sake, or from my angle, I was always interested in fossils, and—

PP: Dinosaurs.

AP: —Yeah dinosaurs, especially, I think all kids are excited about them, and we had some books at home that covered the topic. I was really keen on reading about the fossils, and sketching them and so forth. When I found my first fossil, when we were in New York State for a little while across the border out of metamorphic rock the nice sedimentary ones, I went wild, I found a brachiopod shell, and so forth. I was really ecstatic.

VS: Do you remember how old you were, approximately?

AP: Heh, well let's see, I was about 14.

VS: Ok, great.

PP: Art, describe you and your brother going caving.

AP: Uh, yeah, well actually, my brother, who was a good 7 years younger than I am, was on the same page very much, so he and I did a lot of work together in caving, early caving. And so that was a big help to self-encouragement there.

VS: Great. Was this an older or younger sibling?

AP: He's 7 years younger.

VS: Ok. So you were the one that took charge, the leader of these expeditions?

AP: Kind of, yes, I was definitely in charge, but he was not far behind.

VS: Great.

AP: We were kind of like peas in a pod.

PP: Art, explain Clay Perry.

AP: Oh yeah, another thing is that, being from Pittsfield, Mass, that's the home of Clay Perry, who was one of the earliest cave explorers, in fact, he had written a couple of books about the subject, and I had taken them out of the library. And he worked at the newspaper in town, and I went up and talked to him a little bit, kind of trembling in my tracks there, because he was a famous character and I was just a little kid. And he was very courteous and told me where to go and so forth and we became good friends. He was unfortunately getting on in years, and passed on about 4 years after I met him. But he and his group invented the word 'spelunker', 'spelunking', as a hobby. I didn't know where that came from, but it comes from the Latin word "spelunca" for "cave". And so, that was, so they called themselves 'Spelunkers'. Most people think that's kind of a silly word, so they don't use it much anymore.

VS: Uh huh. Very good. And so, go ahead.

PP: Oh Art, so explain how you got into a grotto.

AP: A grotto, that's the word/name for, a group of members in the National Speleological Society, which is the head caving organization in the U.S. and so instead of having separate chapters, which in fact, most people call them, they call them Grottos. You've got the national organization, and a whole bunch of grottos spread around over the country. I was in the Berkshire Hills Grotto, which is the western part of Massachusetts.

PP: Explain people you met.

AP: Oh ok, there were lots of friends, in fact, being a cave explorer automatically makes you a friend of everybody else that is crazy enough to do that,

10:00

AP: And so I met a lot of people, and went on, and they're still friends today. Most of them have passed on, unfortunately.

VS: Ok, very good. So, although I'm particularly interested in any observations that you have had over your career related to paleontology, I think your contributions to cave and karst geology are just phenomenal. So I would say that paleontology in this interview, will be the only time I've ever talked about fossils in a secondary perspective, and

AP: Yeah

VS: I welcome the opportunity to chat with you about your career as Geologist and your avocation as cavers as well. So why don't we begin with your education then, at the college level, where you did your undergraduate and graduate work.

AP: Ok, let's see, I graduated from high school and assumed I would go to college, but a few days before the applications were due, I applied to a few colleges in the western Mass area, University of Massachusetts and so forth, let's see, Amherst College, Williams College, they were very close. I think their proximity to me was what got me interested in them, turned out to be pretty good schools. I ended up with a really good scholarship at Williams, so I chose that. A wise choice because they let me do a senior thesis on caves. Seniors were able to do a special project, or a thesis, something like that, and I said ok, thesis sounds good to me, and I would do it on cave origins, specifically on a cave I helped discover in New York State, Skull Cave, a horrible place. I had a bunch of friends from college and we went caving, so to speak, and I

ended up doing a thesis on the geology and origin of that particular cave. It was pretty well received. And let's see,

VS: The name Skull Cave, certainly makes me think there may have been a fossil in there. Was it a modern skull? Or?

AP: Actually it was a misnomer because the actual true Skull Cave was next door, but it had been filled in, so the name sort of wandered over to the open cave, then it referred to the skull of a cow, that's all.

VS: Ok.

AP: So nothing particularly exciting. In fact, we never did find a skull in there.

VS: Ok, and then going on with your education?

AP: Well I graduated from college, and I thought that I didn't really know what I wanted to do. I was a geology major, which was encouraging, and I liked it a lot, but I wasn't quite sure what I wanted to do with my life. And so I took a year off and worked for General Electric in Pittsfield, and while I was midway in that course, I got a letter from my advisor at Williams saying, "Hey Art, there's a fellowship available in hydrogeology at Indiana University, why don't you apply for it?" And so I said, "ok", it sounded interesting, caves have a lot to do with hydrology, and so anyway, I applied for the fellowship, and got it, and was very happy there, because I was able to become a hydrogeologist and geophysicist and geochemist, those are the 3 topics that I ended up teaching. Not even straight geology, but they all involve some geology, and so I did that and graduated, finished with my work anyway, about 1967, that's when I left Indiana, and came to New York State, where I've been ever since. A small college, it's part of the state university of New York, with its 70 campuses and so forth, so every part of the university is small,

15:00

AP: But this one was good because it's up in the hills and close to a caving area. More importantly, the faculty were very gracious and gregarious and so forth, they were great people. So I stuck around and enjoyed it for my entire teaching career. I've been retired for about 10 years, more than that. And yeah, about 13 years. You can see I have a lot of practice talking, I have to remember how to do it. But anyway, that's a thumbnail sketch of my career.

VS: Perfect. And then Peg, you are a geologist as well, what was your education?

PP: Oh, let's see.

AP: Indiana.

PP: Yeah, Indiana University, yeah, and got an undergraduate degree there, and met Art, and we got married and moved to New York. And I got a master's degree in hydrology in New York. And that's it.

VS: Very good. And you've worked as a consulting geologist?

PP: Yes, sporadically.

VS: Ok.

AP: Just, pretty much on demand, she never went out beating the bushes for jobs.

VS: I see. Very good. So, I guess the next question is, when did you start venturing into National Park caves, and what was your first project in a National Park Service cave?

AP: Well, I think it all started with one of the books I'd gotten out of the library, "The Caves Beyond", which covered the story of an expedition to Mammoth Cave. Actually it wasn't Mammoth Cave at the time, it was just "Floyd Collins Crystal Cave", which was not part of any other system at that time. And a group of cavers from the National Speleological Society got together and had a weeklong expedition in this cave and tried to push it to the limits and map it all. Of course it fell flat because they spent a lot of time moving food and equipment and sleeping gear and so forth, in and out of the cave, but so they had little time left for exploring and doing anything creative. But they did write the book. I read that book, it was in our local library and I was enthralled with it. And I finally got a chance to meet the author, and I didn't let on that I thought he was a god or something like that, but I was just so thrilled. By that time, I started growing up, everybody puts his boots on in the same manner and so forth. Roger Brucker, I haven't heard from him since yesterday.

PP: Art, explain Blue Spring, and how you got invited.

AP: Yeah, the thing is, the exploration in Mammoth Cave was very much an invitational thing at that time. You can't just saunter in and say, "I'm a caver, let me in". And so what I did was, when I was in Indiana, I had to do a thesis, dissertation, I chose a karst area of course, a limestone area with plenty of caves and underground water and such. And I and my group, actually the group was a local group of people, mostly in high school, and we were exploring a cave called Blue Spring Cave, which at one point became the third longest cave in the world, except it's just because people didn't know much about long caves at that time. And so it really did reach a very high level. There was an international, not international, a NATIONAL caving group that had a meeting in Bloomington, Indiana, where I lived in 1965 and I was asked to give a talk on cave mapping. I gave the talk on cave mapping, there was some older folks in the audience, who said, after I was done, kind of clustered around me and said, "would you like to see a cave?" and I realized that they were from the Cave Research Foundation, which is doing the work at Mammoth Cave.

20:00

AP: I said, "Sure, would YOU like to see a cave?"

VS: (laughs)

AP: So we bundled up and got couple of my buddies together and everything, and we had a trip into Blue Spring Cave, which involved about a half mile long boat trip, in a rowboat. And going into one entrance, you climb and so forth for about a couple of hours, and you come to this river with a boat sitting there, waiting for us. And we piled in, took the boat to the other entrance, and by that time they realized yes, ok, we were pretty big cavers. I say we, but Peg, you weren't there,

PP: I wasn't, yeah.

AP: But the other people in the group were already cavers and they were busy with other projects. So they said, "gee, you know it'd be good if you could come down to Flint Ridge",

which is part of the Mammoth Cave System, "and help us with the Crystal Cave project". Actually the one that I'd already fallen in love with from the library book. And so I was just so gung-ho, went down there and not more than a couple of month later, and ran around and did very well there, cuz I was pretty well experienced, as they were. And they said, "ok great, you're welcome to join us" and it just blossomed from there.

PP: Explain, Art, that you were involved with surveying for several years, and then decided there was more to life than surveying.

AP: Oh you mean, in the cave.

PP: Yeah.

AP: We'd been doing a whole lot of just plain old cave surveying, you discover a passage, you survey it, draw it up, and that's it. But there's a lot more to it and we were trying to figure out what the control would be, what the origin would be. Why does the cave form in the way it does? Where do the passages go and why? And so forth. And eventually that cave linked up with other caves in Flint Ridge and then the Flint Ridge system was connected with Mammoth Cave. So all of this is part of the Mammoth Cave system. And I was made, I should say, we were made caretakers of the Crystal Cave project, because we knew so much about it, and by that time we'd mapped most of the cave, remapped a lot of it.

PP: (Unintelligible)

AP: And the thing is we realized that the Cave Research Foundation neglecting to take any vertical measurements, because using a Brunton Compass is very difficult in any circumstance, but especially going caving, so they'd been measuring everything horizontally. You get the distance and the direction, and that's it. And that was fine as far as it went because it told you where you were going, but not how deep. And it being a very three dimensional cave, it was kind of critical to know how deep we were going and how things would correlate with each other. And so that meant we'd better learn something about the stratigraphy. And so we mapped not just the vertical positions of the passages, but also the strata as well. And the cave goes down through, let's see, 500 feet of strata, I guess.

PP: Yeah.

AP: Well not quite, 300 feet. Yeah, got the strat column here in front of me. But anyway, we mapped a lot of strata in the cave, which I'd already been familiar with from Indiana, because some of the names were even the same names, even though we'd gone across the border into Kentucky. And so I was able to map strata that I was already quite familiar with. The fossils helped a little bit. And being able to measure things vertically was very important, and so we introduced hand leveling, which is a big Indiana thing, where we go through and we not just measure the direction and distance between stations, but also the vertical distance.

25:00

AP: And so that gave us a stratigraphic column. I don't know, did I send that to you?

VS: No.

PP: We sent a bundle of things to the park service, we could send you a copy.

VS: Oh that would be greatly appreciated.

AP: In fact, we've got a pile of old guidebooks to Mammoth Cave. We first of all, figured out the stratigraphy, and we sent in a little report that described it, and how to identify the various beds and so forth and they said, "gee, you know, would you like to write a book on this?" and I said, "well, sure". I'd graduated by that time, we had plenty of time, so to speak, and I'd came in 1981, and it's still not quite in print, it's popularity dropped off a little bit with time because it was so old. But most of the ideas in it were valid. And I'll send one of those to you, along with a strat column.

VS: Thank you very much.

PP: Oh convince him to explain Garland Dever (unintelligible).

AP: Oh gosh, yeah, you're a paleontologist. So we invited Garland Dever from the Kentucky Geological Survey to stop by, to see what was going on in the cave. We wanted to make sure we were doing it right, that we had the strata figured out and so forth, and named properly.

PP: He was a well-known stratigrapher.

AP: Yeah and he was actually doing some current work there around Mammoth Cave. He turned out to be a delightful person. And we became friends and even on that single trip we became friends. We were chatting about things that we knew about that we knew would be a help to the other people. He showed us lots of things. We were down in Mammoth Cave, in Mammoth Dome area, if you're familiar with that, maybe not,

VS: Yes, uh huh.

AP: But it's a very famous place. He looked around a little bit and he saw a Syringopora fossil, it's a coral fossil, he said, "oh it's a syringopora, I use that as a tracer for mapping on the surface. I said, "Oh that's great", I knew the name, and I also knew there was a syringopora also about 30 feet higher. He said "yeah, I use that for tracking on the surface, I have this trouble trying to follow the fossils around/through the woods, against the woods, with a lot of nastiness, trying to find out where you are stratigraphically" and I said, "yeah you've got this other syringopora 30 feet higher up in the passage we just came through" and there's this silence. Then he says, "after all these years, the rocks have turned against me!"

VS: (laughs)

AP: We just laughed and laughed!

PP: He didn't know that their span was that great.

AP: He didn't know about the upper part at all, cuz he just thought there was just one. So if you're using a fossil as a tracer, and you've got two horizons where they occur, and especially in a place where it's difficult to find outcrops at all, it did help him. So that was the main fossil excitement in our surveying. He passed away not too long ago, very sad to see that.

VS: Thank you. So what I was trying to develop, was a strategy, that I came up with, that involved 3 questions for each cave that you worked in.

AP: Sure.

VS: We can talk for days probably on each of these caves, but I thought I would come up with 3 questions consistently to ask you regarding each cave. So the first one is, that if you were speaking to a group of undergraduate geology students, and you wanted to concisely characterize the significance of the geology of Mammoth Cave, how would you present that to them?

30:00

PP: The Pleistocene.

AP: Yeah, right now we're kind of concerned with the Pleistocene glacial history, there's a lot of glacial information trapped in the cave, even though they never overlapped. But that's getting ahead of the story. I would say that the thing about going into Mammoth Cave or any other cave, is that you're seeing a world of geology, it's all around you, and you're seeing things that are just simply not visible on the surface. Or if they are, you see just a little glimpse. But in the cave you can follow these beds and go across them, up and down, and so forth, and you're in a different world. You're able to see things that other people don't see. It requires a lot of effort too, so it helps to be in good shape, make an adventure out of it. And those things together, the adventure, and the geology, and the science, and the things that you can learn about geology from going caving, they're all very significant, they all wrap together into one package.

PP: Hydrology of Mammoth is simple

AP: Yeah, the hydrology of Mammoth Cave is fairly simple, water goes through the limestone, and it pops out at the lower end. But, for that reason, it was a great cave to start with in terms of mapping and stratigraphy, because it was all right there. What you see in say, the Flint Ridge part, is the same as in Mammoth and you can go across into the next ridge into Mammoth Cave or if you want to, you can crawl underneath the valley between the two, and connect them. And you find that the strata are just a little bit different in Mammoth Cave, thinner in the upper parts and thicker in the lower parts. In other words, the Girkin Formation is thinner at Mammoth Cave and the Ste. Genevieve is thicker, but you end up with about the same thickness, overall.

PP: For undergrads what you could say that the cave is a better reflection of the underground hydrology, geology, everything.

AP: Yes, that's good, I got off the track there a little bit. The hydrology is one very important aspect, because water flow through the ground is fairly well understood by those who study it. In other words, Darcy's Law and all that sort of thing. Since (Mammoth's?) topic that I was teaching, it showed up here and there, and I had to point out that where you end up with non-uniform material, in other words, highly stratified and different rock types and so forth, you have to take Darcy's Law and twist it a little bit, make sure that you're not forcing the ground water to do things you think it should whereas it won't. In fact, in Mammoth Cave, for example, you'll have water running down a hillside, and it drops into a sinkhole, drops down vertically, maybe a few feet, maybe 100 feet. And eventually it gets trapped by resistant beds, or more likely, lack of fissures, and you have the water following mainly along the bedding plane partings. So you'll have bedding control, and that's where it was so handy to know the strata, stratigraphy. When water drops down from the surface, it tends to get trapped on the strata, the resistant/less permeable strata, and goes down the dip of the beds. Rather than starting at the surface and going straight down all the way to the water table, it will get trapped on these beds, which in Mammoth Cave are dipping at a nose-bleedingly steep dip of point-four degrees. (laughs) And yet it still

works, the water goes down and goes across, following the strata, down the dip. And then it might find a vertical joint and drop down again and eventually reaches the water table. And then, if it's in a particularly favorable bed, the water will not continue following that favorable bed down below the water table, because below the water table things would tend to tighten up a little bit because you're farther below the surface and the pressure is greater.

35:00

AP: What will tend to happen is, that the water goes along the strike of the beds. So you have a great tendency for water to go down the dip of the strata, and then hit the water table, and then make a rather sharp 90 degree bend along the strike of the beds. Well the strike goes in both directions, but the direction the water would tend to go, of course, is the one that leads to the spring outlet. The water table is sloping in that direction. So you have a very marked pattern of down-dip, and then strike-oriented flow. And since the beds are dipping only about half a degree at most, there's a lot of relief along the bedding plane partings. So what we consider to be down the dip and along the strike, will actually be a kind of sinuous path, it's going down the dip finding the steepest available path. And then once at the water table, following along the water table as much as possible, and again you've got various structural controls and so forth, diverting the water in various directions but overall along the strike. So that's probably the most important thing that we've learned about caves and groundwater.

PP: We cannot [see?] that to date, things that had occurred in the past

AP: Yes, various levels of cave development, all relate to various periods when the water table sort of stopped dropping, and had paused at a certain level, and the thing is, that correlates with glaciations farther north. Glaciation in Ohio and Indiana, it never got down as far as Mammoth Cave, which is down in the middle of Kentucky, probably 200 km south of the glacial extent. So by going into Mammoth Cave, we have these various levels which were controlled somehow by some kind of hydrologic, or geological phenomena. And the glaciers seem to provide that cadence so to speak, what would control whether the water was going in one direction versus another, but also in the same direction we end up with the cave telling us a lot about how the glaciers worked. There's been a lot of work done, or a lot of publications on glaciation and what's controlling it in North America recently, and a lot of the questions that people have had, can be answered to some extent by the cave work.

VS: Very interesting. So let's see, the 2 other questions for Mammoth Cave, and then maybe we might want to jump to another cave, is let's see, is there a particular moment or experience that you had at Mammoth Cave, which was figuratively a WOW moment? One of your most memorable times at Mammoth Cave, either involved in research or in spelunking, or whatever it was, is there something that stands out as exceptional for you?

AP: What do you think, Peg?

PP: It was gradual, it took a lot of thought.

AP: It was a lot like building a brick wall, you put in one brick and then another and so forth, and it all added up. Being able to do the stratigraphic column, and tracing it from one cave to the other was really quite exciting. But the most exciting parts, of course, are the exploration, and we were pretty good at that too. Whenever there was a big deal going on, or there's a big connection or something in the works, we were asked to be part of the exploration team, the mapping. And

I'd say that the big deal was when we were trying to find the connection between the Flint Ridge cave and Mammoth Cave.

40:00

AP: That turned out to be one of the goals of the very first trip that I was invited on, and so we had to go into the Flint Ridge cave, walk for about 3 miles, then crawl for about 2 miles, and ended up underneath the valley between Flint Ridge and Mammoth Cave Ridge. We kept going in this horrible crawlway, it was all gloopy mud and so forth, and pretty soon the mud dried out as we continued, and it became a dry passage. I noticed that that probably represents going underneath the valley, where it was very wet, going underneath and from there progressing underneath the sandstone and limestone caprock over the cave. Blah, I'm losing my track here, anyway, we'd gone underneath the valley and we were ready to start walking and pushing on into Mammoth Cave when we got to this place where the passage filled completely with breakdown. No go. That was very exciting, it was the first time people had been through from Flint Ridge cave into Mammoth Cave, or at least into the ridge. And we ended up doing some other connection trips like that. We were on the team that discovered the connection between Mammoth Cave and the cave that's way off to the east.

PP: Proctor?

AP: Proctor we were already in.

PP: Fisher? Anyway, to the east.

AP: Yeah, to the east, (both laugh) so that was a pretty exciting time, because we had made a connection that led to a whole different system that was already being explored. So we had connected 2 major caves. It was another big deal, but not very important in terms of geology or anything.

VS: Well that's very exciting, that must have been some great times for you. I have one final question regarding Mammoth Cave. You already talked a little bit about some fossils at Mammoth Cave, are there any other encounters with fossils at Mammoth Cave that you'd be able to share?

AP: Well, unfortunately, not really, the stratigraphy is pretty well understood and so are the fossils. The fossils are a little bit hard to find, they tend to get lost in the weathered walls and so forth, but if you take time to go through you can see quite a few places where there are fossil beds. In other words, it's not fossils top to bottom, but you see lots of fossils clustered at certain beds, I'm trying to get the column out here so I can take a look. There are some beds that are just totally rich in some fossils, and they would be the ones that tell you, "oh, we're in the Joppa member of the Ste. Genevieve limestone" and that sort of thing. So I guess that's about it, that's what we've done.

VS: So there's a number of place names in the cave, like Fossil Ave, does that bring anything to mind?

AP: Yeah, there are lots of fossils in it (laughs)

VS: Ok (laughs).

AP: In fact, just recently there was a report on a fossil shark, was it, that was discovered?

VS: Yes.

AP: We know exactly where that is, in terms of stratigraphy, it would be in the, about halfway down through the Joppa member in the Ste. Genevieve. We had mapped fossils in that particular area, but we hadn't gone far enough to be able to see the shark fossil although I think we had seen some before without recognizing what they were.

VS: So, just to let you know, based on one field trip and collecting at Mammoth Cave, in the Ste. Genevieve, over 20 different shark taxa have been identified.

45:00

AP: Geez!

VS: Yeah, and it's a brand new fauna, because there's really no descriptions of fossil sharks from the Ste. Genevieve from other localities, and so this is really a rich area. We're gonna share a lot more information with you as we go through that, but there's at least 2 new species never previously described that are coming out of Mammoth Cave.

PP: Cool.

AP: So you say there are 20 different shark species?

VS: Yes.

AP: Wow, that's amazing.

PP: How many sharks can there be? (laughs)

AP: We had known that there was something funny going on, because we could see these things that looked like, maybe chert strands and things like that, not chert nodules but elongate things that look bone-like, and we didn't have any idea that they were vertebrate fossils down there. To us everything was—

PP: Rock.

AP: Yeah, and brachiopods and so forth, but we did notice things that suggested bones or something of that sort. We thought possibly they were just chert stringers.

PP: Yeah.

AP: And we didn't want to poke around with them, we didn't want to break anything.

PP: We would never have known.

AP: We aren't qualified to do that sort of thing, it's not encouraged in the National Park to do that sort of thing, unless you've got special project.

VS: Well when I follow up, I'm gonna send you some photos of what we're finding, and we'll wanna talk to you specifically about that stratigraphic range, because this is going to be very important to publish this,

AP: Oh yeah.

VS: So we'd certainly like to work with you on that.

AP: Yeah, that's fine. We're quite familiar with that area. In fact, it's pretty easy to get to, I believe it's off Cleveland Ave, which is walking all that way, and then you head off toward the northwest just a little bit, and drop down a little bit. You're still in the Joppa. But again, I don't believe we had ever spotted—

PP: No.

AP: —vertebrate fossils in the Joppa—

PP: —yeah.

AP: That we could identify.

VS: Always something new (laughs).

PP: Yeah.

AP: Yeah, if I'd known, I would have been looking,

PP: That's good!

VS: Yeah.

AP: So excited.

VS: Absolutely.

SP: But I'm excited for the folks that found it,

VS: Yeah, thank you.

AP: The good thing is that it was found. Were you part of the party?

VS: Yes, uh, I wasn't part of the field team, but I supervised the young paleontologist that I sent there to do the collecting.

AP: Oh that's great, that must have been exciting.

PP: Yeah, for everybody.

VS: Absolutely.

VS: So, for the sake of time, we've gone about 45 minutes, I don't want to impose on you too much, are you willing to go on a little longer?

AP: Oh sure, yeah.

VS: Perfect, thank you.

AP: We're doing fine, I'm taking a lot more time to answer your questions than I should, maybe I can trim down my speech a little bit.

VS: And if it works out that, if we don't get to everything we want to talk about today, if you're willing to chat again, that would be fantastic.

AP: Sure.

VS: Well let's shift to Carlsbad Caverns, a very different cave—

AP: Oh boy, yeah.

VS: It seems like you started about 1970 at Carlsbad. What drew you to Carlsbad?

AP: Yeah. Well the fact that it was there (laughs) and we had a friend that was/who lived not too far away from us here in New York, and he was running a trip down to Carlsbad. He was a paleontologist and so forth. He was quite interested in showing us around the cave. We had dropped by Carlsbad ourselves, just as visitors, but we ended up being in a small group of people that were allowed to go into the cave after dark, just go through the Big Room with all the lights out and everything, and we were able to see a lot of things that we hadn't seen in Mammoth Cave. Carlsbad is just such a clean cave, in terms of there being no mud and so forth, and rocks that are so well exposed. So we were mainly interested in the cave origin though, rather than the fossils. The cave origin at Carlsbad is quite different.

50:00

PP: Unique.

AP: Yeah well.

PP: Not well known at that time.

AP: Unique in terms of Park Service caves.

AP: So with hydrogen sulfide rising up from below and oxidizing at the water table, so it was quite a different cave, in terms of cave origin.

PP: The whole origin was being thought out, at the time. Carol Hill would be the one to interview.

AP: Yeah, there's been a lot done, other than what we've done. We've done some work that other people haven't done. So we were able to contribute a fair amount to the geology in that park.

VS: And you were involved in some of the early exploration of Lechuguilla, is that correct?

AP: We never really did much exploration—

PP: We [unclear] it.

AP: Yeah, by the time we got there, it was just like flies to honey, everybody was eager to go in there and explore and map. We realized, well you know we've got plenty of other projects to do, mainly at Mammoth and at Wind Cave, and so we thought what we would do at Lechuguilla was to go through and do a vertical survey, much like what we had done at Mammoth Cave, but also to try to correlate the different rock units and so forth, and give a vertical profile that would show how the changes in the cave had been affected by the strata. So that was our contribution to that.

VS: Ok.

AP: And also the geochemistry. We got into the geochemistry a bit—

PP: Oh the pool.

AP: Yeah, the pool geochemistry and so forth.

PP: [unclear]

AP: A lot of our chemical work was done in Lechuguilla and Carlsbad.

VS: Good. So if we ask you the question, I think you addressed it already a bit, but if we ask you to tell your undergraduate geology students what is significant about the geology of Carlsbad Caverns, what would you say?

AP: The fact that it's there in the first place is just amazing. It's up to 12 million years old, which is quite a lot older than Mammoth Cave.

PP: Art, it's the relationship to the oil basin, right?

AP: Yeah, and you have petroleum basins around the area, where a bunch of hydrogen sulfide, trapped in the water, and wherever the hydrogen sulfide is able to find an escape route, it'll go up to the water table and it oxidizes, and then it becomes extremely acidic. But the trouble is, with the limestone, it's able to neutralize all that acidity, so by the time the water gets up to the cave, it's not able to dissolve very much, but it still has lots of hydrogen sulfide in it. So the water comes up into the cave, and the hydrogen sulfide is very volatile and it'll escape into the cave air. And what it does then, is get trapped by droplets of moisture coming in from above. And so these droplets and films of water, drive toward the surface, become tremendously acidic; the acidity in these things gets down below zero in some places, and you end up with negative pH's. Most people don't even think that's possible, but it is, we've actually measured that in a cave in Mexico, kind of a modern analog of Carlsbad. Carlsbad isn't actively enlarging today, but the processes that form it are observable in certain caves that are very dangerous to go in to. Hydrogen sulfide, for example, is toxic, highly toxic, so you need a gas mask. And so you go in there with gas masks on and find that, if you take a pH meter, hold it to one of the drops that's hanging from a stalactite, for example, maybe from a/more likely from a strand of—

PP: Mucus from biologic—

AP: Yeah, biological filaments and so forth, you'll find that the meter gives you an error message, it's below its ability to read the pH.

55:00

PP: But this isn't in a National Park, it's an analog.

AP: But that's what it would have been like in Carlsbad, and Lechuguilla. So the cave formed kind of like this. Everybody sees Carlsbad as kind of being an example of a phreatic cave, obviously formed deep beneath the surface, below the water table. You have these huge rooms, and so forth, and none of this nice, wiggly passageways like in Mammoth Cave, but instead, giant rooms sort of like big bubbles underground. And you think this must have formed below the water table, but in fact, most of the enlargement of the cave is above the water table, not far above the water table, but definitely above it, where the hydrogen sulfide can escape from the water, and mix with fresh water coming in from the surface, and produce the cave by etching it away along the perimeter of the area where the wate–the air, is escaping into the cave.

VS: So is there a particular memory or moment or discovery that would be your WOW memory for Carlsbad Caverns?

AP: Well, for Carlsbad, let me see, a wow moment. I guess, yes, going into the cave in the first place was "WOW". And going into Lechuguilla Cave was also a "WOW".

PP: And getting out alive. (laughs)

VS: (laughs)

AP: Right (laughs), yeah, well our longest trip in Lechuguilla was, what, 36 hours? We had to sleep in there, and it was – getting back to the surface was just like entering a whole new world. Starting to imagine the color blue, for example, cuz everything is grey down underground. So that was probably the biggest thing, was just the length and technical difficulty of the trips, and we enjoyed it a whole lot.

VS: Is there any—

AP: We did a lot of—sorry.

VS: Go ahead.

AP: No, no, that's alright, I shouldn't mention this, but we did a lot of work in there, just the two of us, because at that time there was a limit on people going into the cave. I asked the person in charge, how many people, what's the minimum number of people you can have going on a trip, and he said "two", and I counted, Peg, me, that's two. So he knew all about this, and he was very eager to have us go down and do the mapping. So we just did it on our own, and we were safer that way, because there's nothing more dangerous in a cave than having somebody along that you are worried about whether they are gonna make it or not. So we've done a lot of work on our own, and it's really quite safe.

VS: Very good.

AP: But that's not to be repeated.

VS: Ok. (laughs) Thank you.

VS: Is there anything that stands out for Carlsbad or Lechuguilla in regards to fossils?

PP: Oh the thing Mike found, the brachiopod, with some beautiful etching of fossils, leaving the inner guts of the brachiopod, I forgot what you call it.

AP: Spiralia.

PP: Yeah, ok.

AP: There was a brachiopod, I don't remember the genus name, but it was one of those spirifers. And it had been etched in such a way that the spiralia had been preserved intact and were just sort of hanging there kind of like a ribcage.

PP: And there were other examples of fossils in there that are very well etched.

AP: Yeah, the thing is that they are preserved so well—

PP: It's etched in the air.

AP: Yeah, it's as though you were, if you had a dinosaur fossil, for example, embedded in the rock and you spend your whole lifetime digging away with a toothpick and so forth, and these were just as though you had done that already, preserving all the really hard parts, and taking away everything that you're not interested in.

1:00:00

VS: That's very interesting, it's like almost a natural fossil preparation that's occurring.

AP: Yeah, exactly.

VS: Yeah, that's a very good observation. So, you're aware that that area in the Guadalupe Mountains is just an extraordinarily rich area for caves, Guadalupe Mountains National Park has quite a few caves. We have lots of—

AP: Yeah.

VS: —Pleistocene vertebrate fossils from many of the caves in the—

AP: Oh yeah, that's right.

VS: —Guadalupe and Carlsbad region. Upper and Lower Sloth Cave, and other caves.

AP: Yeah.

VS: Any general comments about the regional cave and karst?

AP: Just that it's a classic example of a carbonate bank along the shoreline of the former inland sea.

PP: Well the back-reef caves.

AP: You've got the back-reef, fore-reef, and then the reef rocks themselves. It's all just laid out in such a perfect order. You can spend a day just walking up and down and seeing a whole geological structure.

PP: The petroleum people have periodic field trips and they always wind up going through Carlsbad to look at the rocks.

AP: Yeah, they go into the cave, and the funny thing is, as our friend from New York said, they have these field trips, and they go on the surface, and they'll be poking around on these little outcrops and so forth, and then, grubbing around in the dirt and everything, then they'll say, "Ok, time to go into the cave, let's just have some fun". And so he kind of lamented the fact that so many people who are geologists, go into the cave and think that the cave is the feature that, the only feature that you can look at, but the cave exposes all of these things like the fossils, the different strata, facies changes and so forth, that you can't see on the surface without some difficulty. But you can see it all right there in the cave.

VS: Well said. Well, before we venture off to the Black Hills, which I think is going to be a good discussion, did you want to mention anything about your time at Grand Canyon, and the cave systems that are there?

AP: Yeah, just briefly, because that's all I can say, tell you about the time we lost the raft, for example, and other things (laughs) but that's another story. It is wonderful, but it is very difficult

to get to the caves, it requires a lot of climbing and so forth. Fortunately, we had some very good climbers on the trip, they could go up vertical walls with no trouble at all, and then they'd hang the rope down and the rest of us follow. So it was a really great team effort, with a group of geologists and cave explorers and climbers. There were 2 trips and it ended up to be about 6 weeks total.

PP: But it's so difficult, the logistics, that we only saw a few caves.

AP: Yeah, and the whole purpose was to find—

PP: Folia.

AP: —particular kinds of cave deposits, which would indicate water table conditions, and one set of features would be called folia, as the name implies, they're like leaves of paper exposed in the walls. We found quite a few of those and we were able to date some of them. I say we, meaning Victor Polyak who was really in charge of the whole thing. So quite an exciting time. But in terms of caves, the caves we saw were pretty run of the mill, they were interesting, but there were never any tremendously big ones.

PP: We could only stand about a half an hour.

AP: That was about all we could—

PP: That's about all the time we had.

AP: That was about all the cave was. (laughs) A half hour long cave was a pretty big one in the Grand Canyon. There's some long ones, but, in fact, they found some huge caves in the western part of the canyon. You have to repel down on a rope several hundred feet and swing into the entrances,

1:05:00

AP: And they have gone how far? 80 miles or something in one of these systems?

PP: Yeah. They're mazes.

AP: Yeah, they're big maze caves. That's just in the western part of the canyon, there's some in the main part of the park, and they're not nearly so big. We're not involved in that exploration, we know the people involved in it, but we're just busy elsewhere.

VS: Ok. Moving from the Grand Canyon to Great Basin National Park and Lehman Cave, your experiences there?

AP: Ah, not much. Great Basin, we were there, let's see—

PP: We were shown some of the caves by—the guy in Utah.

AP: Dale Green from Utah. We had no real purpose, other than to be shown around. So when we went to, say, Leeman Cave, it was kind of a tourist trip, except that we were able to spot some things that were important in terms of cave origin, and pass those on to friends who are now working on the cave, trying to figure it out, its origin and history and so forth. Out west in the California caves, in the—

PP: Marble Mountains, Kings Canyon.

AP: Kings Canyon, yeah, that was probably, briefly. There were some pretty big caves, there was Crystal Sequoia cave, which is quite an interesting cave because of the types of deposits in that, lots of cave formations that are not the typical stalactite/stalagmite business, but lots of strange things with shelves of calcite sticking out and that sort of thing, lots of crystals. And that was mainly invitational, from people who were working at the cave, and so we were just supporting what they were interested in. We were able to supply a little bit of information, but we learned a lot from them too.

VS: Did you interact with Joel Despain at Sequoia Kings Canyon?

PP/AP: Yeah, oh yes.

VS: Ok.

AP: Yup, yup. Yeah, in fact, Joel, we've done a lot of caving with him. Joel helped us on a trip in Crystal Cave in—

PP: Kentucky.

AP: —Kentucky.

VS: Let's shift briefly over to Hawaii Volcanoes National Park. It sounds like you were able to visit some of the lava caves?

AP: Oh yeah, we did. We did some good mapping there and—

PP: Lucky we were shown around, and we don't know anything about Basalt.

AP: We were there just sort of invitational trip. Somebody said, "hey you wanna go to Hawaii?" Sure, why not? It was, what January? Nice time to go. We were in the National Park, Hawaii Volcanoes National Park, and we were having a little picnic there, towards sundown. And all of a sudden the sort of rumbled a bit, and we realized something was happening, and a lava flow came out about two or three hundred feet down below where we were sitting. It just kind of came oozing up out of the ground. By the time we got down off the mountain, it had spread out so it was about a hundred feet wide and extending on down into the valley. But moving very slowly, it's not gonna overcome your—

PP: [unclear]

AP: —to run away. But that was a pretty exciting time to see the whole thing working in front of you, in places where you could see a cauldron of bubbling lava down below, and you could stick a stick down in, kind of stir it up a little bit.

PP: Which would become a cave.

AP: Yeah. We weren't really into that sort of thing too much, we stood our distance. But we were with a very competent person who was probably the expert on lava caves in Hawaii, Fred Stone, but he passed away just last year.

1:10:00

VS: Well, are you up for venturing into the Black Hills for discussion?

AP: Well that's the one that we need to discuss the most I think.

VS: Yeah. I don't want to take advantage of your time, but, if you're willing to venture.

AP: Not at all.

VS: Well ok, Let's go to the Black Hills, and it's your choice, do you want to talk about Jewel Cave or Wind Cave first?

AP: I actually do them both at the same time because they're—

PP: [unclear]

AP: Everything from one cave illuminates what goes on in the other cave.

VS: Ok.

AP: Our first trip was just passing through, and we stopped by and saw Jewel Cave. We took the tour, and we kind of made an opinion about it, that—

PP: Was totally wrong.

AP: Actually it turned out to be right more than we realized. "Gee, you know, this looks like something that would be formed by water dripping down in from the surface, mixing with water down below". And then after a while I thought, boy that's a stupid comment, I hope nobody remembers that. Now it seems to be pretty close to the truth. But there are lots of alternative explanations. In fact, Peg and I don't always see eye to eye on this entirely. But we won't worry about the discrepancies in what we think. Anyway, we were there at Jewel Cave and we thought, the people who explored the cave live right nearby us, real famous cavers, Herb and Jan Conn. And they had heard of us, and of course we had heard of them, and we thought we would stop by and see them. So we chatted for a while, a very pleasant couple, and we said, "Thanks a lot for inviting us over, very fun speaking with you" and so we said we've got to get going, and went out to our car, and Herb and Jan followed us out and they said, "Do you wanna go see the cave?" And we spent the whole next day mapping with them in the cave, had a great time, and became fast friends. Wasn't 'til decades later that Jan said, "you know the reason why we invited you, is we realized when you left–", we were the first people to visit them that didn't ask if they could go into the cave with them. Because everybody that sees them says, "gee this is our way to get into Jewel Cave", and we didn't do that, because actually we had other things to worry about. But it was our first trip, and we really liked it. But it wasn't until about 10 years later that we were invited to go to Wind Cave by one of the people working there, because he knew our interest in caves in general. He said come on over to Wind Cave, and when we stopped by and we spent 3 weeks there, wasn't it, Peg?

PP: Yeah.

AP: Being free during the summers has its advantages. So anyway, we went there and at the end of our trip, they said, "would you like to give a show on what you've learned?" So we gave a show. At the end of it, they said, "wow, that was so different from everything else that we're heard" The explanation of features, and things like that. They said, "would you like to write a guidebook to the cave?" A popular guide, you know just like Wind Cave National Park visitor's guide, or something like that. So we became quite close to people there, did a lot of work in Wind, then later on, jogged over to Jewel, and they wanted us to do the same thing, write a guidebook. So we still are very close with those teams too. The thing about, let's just say, Wind

Cave in general, you go into the cave and you're used to seeing Mammoth Cave or Carlsbad Caverns and so forth, but you go into here, and it's just totally different, a totally different experience, because the passages don't seem to do anything that you expect them to. A very complex cave, up and down, left and right, holes going off in all directions. It's just like a big sponge.

PP: And the boxwork.

AP: Yeah, and then strange features like boxwork and—

PP: And the big breccia type [unclear].

1:15:00

AP: Yeah, we're so used to kind of, not dumbing it down but speaking in terms of lay language. It's good to be speaking to a geologist who knows what things like breccia are. And so the caves are just spectacular, geological museums almost and their origin is just so cryptic because they're totally – almost totally, inert, I'd say.

PP: Yeah, they're removed from the present.

AP: So we've worked there quite a bit. And we've had the person who we went to Grand Canyon with he came with us one time, and he is pretty good with dating calcite and so forth. We got some samples, he dated them at 105 million years for a particularly important deposit, that's kind of midway through the whole history, and gave us a chance to figure out how old the cave must be, because the caves are not that old, but these features do show up in the cave because the cave intersected them.

PP: We've learned a lot since we started there.

AP: Yeah, we've learned so much, and we've enjoyed the whole history of—

PP: The Park Service has always been incredibly supportive.

AP: Yeah, they seem to be more excited about what we do than we think they should.

VS: (laughs) Boy, it's really nice listening to you describe it. I can tell there's a lot of passion there about the Black Hills and Wind Cave, with both of you.

PP: That's because it's so hard to figure out.

AP: Yeah we just spent a huge amount of time in there. In fact, the Park Service invited us, the regional office of the Park Service invited us to/asked us if we would help to figure out what would happen to the lake in Wind Cave if the demand for ground water increased to the point where the water table was dropped, because their cave is not far north of Hot Springs, South Dakota. It's growing toward the north, up toward the National Park, and if that got highly populated to the southeast of the cave, and everybody's pumping water like crazy, what would happen is the lakes would probably dry up in the cave. So this got into the computer modeling of ground water, which the USGS office in Rapid City was doing, and that was fine with me, because I was very familiar with that approach doing the computer modeling and so forth. So it fit right in with my other life, which is teaching hydrology.

VS: So if we were speaking to a group of undergraduates, what is significant about the geology of Wind and Jewel Cave?

AP: Their correlation with what was going on around them. For example, they are located within the Black Hills, which is an uplift, of course, of early—

PP: [unclear]

AP: Yeah, early Tertiary—

PP: It's Laramide.

AP: Yeah, well, Laramide orogeny. In fact, it was kind of late in the Black Hills, Laramide started in the west and it worked its way eastward, and didn't get to the Black Hills until toward the end of the Cretaceous. And so there's all these things going on, first of all, caves formed because there was sort of a paleokarst zone in that area, a lot of debate there, but there must have been, because it can be traced all through the whole western part of the continent.

PP: And evaporate solution.

AP: Lots of evaporites in there and evaporites can be dissolved and you end up with a lot of hydrogen sulfide released from some of these things. Water coming in from above, seeping down through sandstone above, water coming up from below a little bit

1:20:00

AP: not artesian particularly, but a lot of support for that from other geologists that it's, the caves were simply hypogenic as they say, where the cave was formed by water rising from below. That doesn't really fit very well, even though we were coauthors of their paper, that doesn't really work. But it's one of the things that has to be mentioned, because it does happen in the area, especially at the lower end of the cave, where there's water going down along the strata in a confined aquifer, and it goes back up again in the springs around the Black Hills perimeter. So you'll have large springs coming up where the water has gone through the caves, gone deep underground, and then back up again to the surface.

PP: And a lot of faulting with bedrock alteration.

AP: Yeah in fact, the bedrock alteration is to us the most exciting thing about the whole thing because it reports on geologic and chemical processes that have been so far removed from today. Oh I should mention that the Badlands National Park, outside the Black Hills, is right in line with Wind Cave, and Wind Cave is forming about the same time as the beds were being deposited in the Badlands. So there's a relationship between those. Piecing these things together has been kind of fun. And the last shot was made by a couple of USGS people that had been working with us on this whole project. The USGS had been invited also by the National Park Service to join us as sort of a team. So it's the USGS people that came up with the last bit of information, possibly the water table fluctuations in Wind Cave, which we had mapped so carefully by taking samples of calcite and having them dated by the USGS, there's a very good record of rises and falls in the water table. And they thought that the glaciers coming down from the north didn't really reach the Black Hills at all, but they did end up in, where, Peg? The Williston basin, covering Willison—oh, it was off to the northeast.

PP: Yeah, yeah. Northeast.

AP: I figure that even though the ice didn't get to the caves themselves, or to the Black Hills at all, that pressure on the confined aquifers of the Williston would be transferred to the south and cause the water table to rise throughout the eastern part of the Black Hills. And I find nothing wrong with that idea, it's definitely an idea, definitely something to consider. So there you get the glaciation with rising up out of the murk to complicate things.

VS: Thank you. So, we'll ask you the wild question, was there a moment or an experience that stands out for the Black Hill caves?

AP: I'm sorry I lost—my phone is beginning to fade.

PP: Oh come on in here, Art.

AP: Yeah, transferring over.

PP: Wow moment in Wind and Jewel.

AP: Yeah, Wow moment in Wind and Jewel. For us, you mean?

VS: Yes, uh huh.

AP: Wow moment. Yeah, wow moment was when we first went into Wind Cave. We were being led by one of the rangers, and we went down the staircase into the entrance, and we thought, WOW, we've never seen anything like this before, it's just like being an expert in say—

PP: [unclear, far in the background]

AP: Well, yeah, all sorts of analogies like going to, say, Bulgaria, and you expect to hear everybody speaking Bulgarian, but instead they're speaking French.

1:25:00

VS: (laughs)

AP: It just didn't seem to fit, just strange looking at this cave, you expect to see passages like at Mammoth Cave or big, huge rooms like in Carlsbad, and here it was just like being in a sponge. In Wind Cave. And all sorts of strange features in the walls, and everything, that was a wow moment for sure, just the first glimpse of that cave.

VS: That's great. By chance, any encounters with fossils in any of the caves in the Black Hills?

PP: Oh yeah, root casts.

AP: Anything about fossils, yeah plenty of root casts. And let's see, there are quite a few brachiopods exposed in certain beds. They show up on the tour route quite nicely, going to, what's it called, the, well it's a big room, and if you go in you can see in the ceiling there's a bed that's just loaded with brachiopod fossils.

PP: [unclear in background]

AP: Yeah. Ok, Leptothrix. Iron fixing bacteria are preserved as fossils in—[to Peg] you think which, Lechuguilla?

PP: [unclear in background]

AP: Oh in the Black Hills.

PP: Yes.

AP: Yeah, the Black Hills, in fact, yeah. There are—

PP: (in background) The crown jewel [unclear].

AP: Yeah, there are lots of formations that, it's a little bit hard to tell if they are speleothems, cave formations, or they're some kind of bacterial growth, turns out that they're coated with quartz crystals and so forth, quartz and calcite. So if you can imagine, say, a sponge fossil, or maybe a bryozoan fossil, branching coral fossils, things like that, not just as parts of the rock but as cave formations, that had grown and acquired crystals and so forth. Not, they themselves aren't cave formations, but they had altered so that they are part of the cave with things that continue off, on to the wall. So for example you've got quartz crystals growing on these branching fossils that continue on down along the wall, so it's as though the fossils were part of the rock, part of the cave formation process. So Wind Cave is a good place to see, if you want to see everything going on at once, millions of years of history, and features that blend in with other features and so forth, and it's like seeing the whole cosmos being revealed in front of you. If you wanna see it, you go into Wind Cave. Or Jewel.

VS: Thank you. Just a couple of quick names I wanted to bounce off you, to see if you have any thoughts. So I'm sure you've interacted with Ron Kerbo?

AP: Very much, yes, he unfortunately died last year—oh no, no, no, wait, it wasn't Ron, no. Sorry! No, we know Ron quite well.

PP: Yes.

AP: Yeah, it was a person we used to go caving with at Carlsbad that died just last year, and Ron and I came up to write his obituary.

VS: I see.

AP: So, Ron is a fine person. With an amazing, amazing [deckcrowd?]

PP: (In background) Always interesting.

AP: He was a roughneck, with the, he so called it, the oil patch. Part of a high school education, he never got his diploma. I think he finally did, we were all decking him on that. But the thing is that he was the brightest guy, he'd come up with all these great ideas, he was a poet, a philosopher, just a wonderful person. I say he was, he still is, but his wife died recently and he's been very lonely since. So he's sort of looking into the void, so to speak.

1:30:00

VS: Yeah, Ron's a great person, I really admire Ron.

AP: Oh gosh, yes, he really made Carlsbad a pleasant place to go to. We could go there, and we'd be able to do just about anything because he trusted us.

PP: And he could cope with things.

AP: Yeah, he was so good about interfacing with all the crazy people going there, especially with the Lechuguilla thing going on. Once he was really in charge of that whole thing and making sure that people did it safely. And he came down hard on some people for not following the basic, common sense rules. A very tough job, and he did it so well. Yeah he, the Park Service really lucked out, choosing him.

PP: He encouraged us [unclear]

AP: Yeah, he encouraged scientists, he, himself wasn't a scientist, but he spoke about the people who would show up at the cave with their flowing robes, you know how they would say, "Well I have a PhD, in something or other", so they would go in and expect special attention. And he was just so happy to see people who were just simply interested in the cave, whether they were professors or not. He could speak with professors, or roughnecks from the oil patch, visitors just off the streets, all sorts of people.

PP: [unclear in background]

AP: Yeah, helped foreign visitors. He was in charge of running one of the presidents of the USA, down through the cave, and I guess that's Ronald Reagan. And so they chose Ron to do it. And of course Ron did a fabulous job.

VS: It's nice to hear these things about Ron.

AP: I can't say too many good things about him. (laughs) What a wonderful person, and his family.

VS: Yeah, thanks for sharing that. Have you interacted at all with George Veni?

AP: Oh yes, we've known George quite a long time. George took our course at Mammoth Cave, we used to teach a cave geology course at Mammoth Cave at the request of Western Kentucky University. George took one of our earlier courses back around 1983 or 4, something like that. Then he got his PhD from Penn State, went on and became quite a figure in karst. In fact he's in charge of the NCKRI, National Cave and Karst Research Institute. We correspond quite frequently.

VS: Yeah, he's been great to work with as well. The name Victor Polyak is new to me, you had mentioned you had worked with him at Grand Canyon?

AP: Yeah, well Victor is kind of a shy, retiring type, very bright. Yeah he came from Lubbock, Texas, and he used to work for—oil companies I guess, or mining companies, and—

PP: (In background) He's a good [unclear].

AP: Yeah, and he has a really good geologic background. So he was hired by University of New Mexico, and—what Peg?

PP: The dating.

AP: Oh yeah, became an expert on dating things. So everybody wants to know how old things are, so you get these people who find some kind of a mineral, Victor, he'll date it for them. Not everything is datable, the caves of course, are the problem, because a cave is a lack of something, not a deposit, so you have to find a deposit in the cave, then you've gotta figure out how the

deposit formed, and when it formed, was it there before the cave formed, or after the cave, and so forth. Often it's been altered, so it's not the same thing that it used to be. Victor does all of that sort of thing. We've worked very closely together, which, him and his wife.

VS: One other thing about dating; we had a bit of email communication back and forth about Vick Schmidt, and can you share with me, your recollections of Vick, and his work at Mammoth Cave?

1:35:00

AP: That's funny, because actually he did that work at Mammoth Cave while we were also working there, but we didn't overlap. He was doing his work in Mammoth itself, while we were over at Flint Ridge, at that time. He didn't stay there very long, he would go collect some things, then go do the paleomag work. He was a fine person, and it was a shame that he died so early. I was also familiar with the technique of finding the remnant paleomagnetism, and had done a little bit of it in Indiana. But his dates were good, he was able to come up with some pretty convincing dates. There was one problem, in that some of the most important times were when the cave was not accumulating sediment, and so his dating is fine, except that the sequence was off a little bit, he missed the latest reversal, for example, just simply because nothing was being deposited at that time. So his dates tend to be off by a bit. Some of them are a little bit too old, others are not old enough, but he was getting it down as best he could. Trouble is, he had one crack at it, and he had a chance to show that the cave was, in fact, quite old, but he wasn't able to make a perfect correlation between the beds and the beds of sediment and the age of the cave, and he was going to be doing that, but by that time, but I guess he died in the '90s; 1993 or something like that?

VS: Yes, uh huh.

AP: Yeah, and just about that time, the technique for dating caves like Mammoth Cave came through, where you measure the aluminum-beryllium ratios in clastic sediment that's carried down into the caves. And Mammoth is perfect for that. So we teamed up with the guy who was planning to do that, he gave a talk at a convention. He said, "well we can date caves this way" and when his talk was over, there was this big scramble to get to him, to talk about the opportunities and I asked, "Would you be interested in Mammoth?", he says, "Yeah", he was going to get in touch with us. And so, that worked out very well, we worked with Darryl Granger on that. That's one of the biggest advances in cave science, the idea of using clastic sediments as a way of finding cave age. That's when sediments carried in by cave streams, which were the same things that formed the passages. You can have some misleading things that show up, but in general that's really the hot topic for today. That's where you can start correlating with glaciations and things like that.

VS: Very good. And just a quick question, you worked at Mammoth Cave quite a long time, are there people that work for the National Park Service that you felt really were worthwhile supporters of your efforts?

AP: Oh yes, most definitely.

PP: (In background) Oh almost everybody.

AP: Yeah, almost everybody was really behind it.

PP: [unclear in background]

AP: Oh yeah, that's true for Wind Cave and Jewel Cave, in fact, Carlsbad. When you are working there as a scientist, the best thing to do is become part of a mapping team, isn't it, that sort of thing, because you get to know all the people personally and be part of the family, so to speak.

PP: And the guides.

AP: Yeah and the guides were really enthusiastic at Mammoth, Wind, and so forth, but at Mammoth, we interfaced with the staff quite a bit and have done so for many decades.

1:40:00

AP: And, so just about everybody who's been really interested in the cave, we've known. It's kind of odd that we didn't interface with Vick at that time, because we were kind of busy with other things. He probably stayed at some other place, yeah but he wasn't into the caving aspects very much, he hadn't really started as a caver. But we ended up knowing him quite well toward the end.

VS: There's a lot of turnover in staff in National Parks, and I think it's a testament to your longevity and the many relationships that you develop with Park Service staff that is certainly worth recognizing.

AP: Well, yeah, we feel as though staff in the parks is really part of the excitement. Just knowing them we've become very fond of many of them. Yeah, and the fact is, they really want to know the answers, not just so that they can spew them for the public or anything like that, but just because they themselves are interested in what the answers are. They're always coming up with questions. In fact, as we stand here, we're in the process of putting together a report on Mammoth Cave and how it relates to the glaciation to the north. And this is something that we've been working on for the last few years, because there have been a lot of work on glacial history too, and being able to merge the two, from two different aspects entirely, the map/the cave versus the glaciers, and the record that they preserve. Some of the people that worked at Mammoth Cave we've known for many decades, we've worked closely with them, in fact some of them helped us with the Black Hills, and Carlsbad. What Peggy?

PP: Rick.

AP: Yeah, Rick Olson, for example, do you know him?

VS: Yes, I do.

AP: Yeah, Rick's helped us at Lechuguilla and Mammoth. A lot at Mammoth, and Wind, and Jewel. Rick used to work at Jewel Cave. We meshed quite well on that.

PP: [unclear in background]

AP: Rick Toomey, in fact, just about all the long timers at Mammoth, we know. They've all been very gracious.

VS: So we're down to the last two questions—

AP: Oh good. (laughs)

VS: (laughs) You've been very patient, thank you.

AP: Oh no, that's fine, we're happy to, in fact, I apologize for sounding like a – somebody who died about 20 years ago. (laughs)

VS: Not at all. (laughs)

AP: Trying to think of simple words and so forth.

VS: Not at all, you're doing great. So, here it comes, if you were talking to a classroom of undergraduates in geology what would you tell them, in terms of the value of fossils as they are associated with caves? Do they have any value or meaning to research regarding caves?

AP: Yeah, in fact, it's kind of an interactive thing, because the caves will provide access to a lot of information about fossils, just simply because the caves are there, they protect things so well. If you have a delicate fossil that's exposed in the walls of a canyon, for example, that fossil is not going to last very long. But in a cave, especially something like say Wind Cave, the fossil will be preserved indefinitely. So it works very well that way. And back in the other direction, the- there was another direction I had in mind (laughs), the fossil—

PP: (In background) Recent bones.

AP: Yeah, recent bones, and fossils preserved. Well yeah, Pleistocene. Caves are really super for a place to see fossils. They are preserved but they haven't been underground long enough to be-

PP: (In background) Oh, the Mammoth Site.

AP: The Mammoth Site.

PP: (In background) But that's not a National Park.

AP: No it's not a National Park, but the Mammoth Site—

1:45:00

AP: —it's just south of Wind Cave, yeah, water was rising up around the Black Hills, as I was mentioning before, and it formed kind of a mud pot of quicksand conditions. Quicksand is where water will be rising up slowly through sand, and the upward hydrostatic pressure balances the weight of the sand, so if you step on the sand, then down you go. And that's what happened to the mammoths, so they got trapped in this place, it was just kind of a natural trap for mammoths and deer and all sorts of things.

PP: (in background) Mastodons.

AP: Mastodons.

PP: (in background) Like 50, I think.

AP: I think, or a hundred of them, were trapped in there. It's a huge pit being excavated there. It's just completely filled with mammoths and mastodons and so forth, yeah, and ancient animals of various types. So the relationship between Wind Cave, Jewel Cave, and The Mammoth Site, is very tight, geologically. They seem to be quite different in origin and character, but putting them all together, they all are part of the same hydrologic system. So The Mammoth Site doesn't have anything to do with the Park Service, but it certainly is part of the scene.

VS: Well over the last couple of days when I was doing some background research on your work, I just, I was overwhelmed with the discovery of how much work that you have contributed to the understanding of caves in National Parks, and on behalf of all the geologists that I work with in the National Park Service, I wanted to thank you for your many, many years of work, and contributing science and understanding, things that we can now help to share with the public, so that they can better appreciate and understand the origin and many of the details related to these precious caves and national parks.

AP: Well that's really nice. It works both ways. Peg is just saying the same thing. It's been a tremendous pleasure and a tremendous honor for us to do that. And we've had such a great experience with the park service, and with all the people working for the park service. And so it's been a major part of our life, our lives. We have been the main beneficiaries, and any honor, and so forth, that we've been given, it's all thanks to the caves, and the people who work there.

VS: That's very nice of you to say. I would say that you clearly are part of the National Park Service family, and—

AP: (laughs) I guess so!

VS: (laughs) It's been a real honor to talk with you. I've learned a great deal through just listening to you, and I'd like to continue to correspond with you if that would be ok, and I have a few things—

AP: That'd be fine.

VS: —I'd like to send to you if I could get your mailing address through email. Ron Kerbo and myself published a big publication on an inventory of paleontological resources associated with National Park Service caves and I don't know if you have a copy—

AP: Great

VS: —but I'll send you a copy of that.

AP: Oh that'd be swell. You want our mailing address?

VS: You can just email it to me, that would be fine.

AP: Yeah, let's get – email the address to him and yeah.

VS: Any final thoughts from either of you?

AP: Well, yeah, we're just so happy to be in contact with you, because we feel as though we owe a lot to the Park Service. And we've always just had such a wonderful experience with them. And we don't often get to branch out very much from our entrenched path that goes from here to Mammoth and back again, then over to the Black Hills and back again. We don't get out a whole lot, and it's nice to be able to communicate with people that are interested in the same thing.

1:50:00

VS: So one of my to-do's after this is I'm gonna call Ron Kerbo and tell him about this wonderful conversation I just had with you folks.

AP: Oh yeah, (laughs) yeah we miss him greatly, yeah if you can , (laughs), yeah there's some things I wish I could think of, to have you tell him, funny things that, he's just such a great guy in terms of jokes. But anyway, he's been one of the finest people we've met in our caving experience, and he's helped us a tremendous amount. Much more than we helped him. So, yeah, if you're gonna be, just say hi to him for us.

VS: I'll do that (laughs), I'll tell him there's a lot of other nice things they've said too, it'll be in the transcript.

AP: Yeah, well Ron has the honor of having named us, Art-N-Peg, A-R-T-N-P-E-G, all one word, ARTNPEG, it's like one person.

VS: (laughs)

AP: And he jokes about that, "yeah well ARTNPEG are here". And it just sort of says it all in one simple word.

VS: That's nice.

AP: So yeah, it shows that he understands (laughs). So—

VS: Final—

AP: —feel free—oh yeah.

VS: Just a final thought is that, one of the great things about this is that, the young students that come along in the future, you can read the scientific publications, but the history of the research and the science and the people behind it are really incredibly interesting and important. And information that's easily lost, so having the—

AP: You're right.

VS: And having the privilege and opportunity to have an oral history interview that we can record and hear your excitement when you talk about discoveries in parks, they'll be worth their weight in gold to young people, for generations to come. So I just wanted to thank you both again, for both the work you've done, and allowing me to talk with you about your career working with the National Park Service.

AP: Well that's great, we both very much appreciate that and I'm sorry that we couldn't be more eloquent on the phone.

VS: You were great.

AP: Ron Kerbo would be—

VS: (laughs)

AP: He's like a poet. But, I mean, he's got the high school education and I don't.

VS: (laughs) Very good.

AP: I've spent my whole life speaking in front of groups of people and now that I've been retired, I don't talk much at all so I appreciate Peg being in the background here to fill in my words when I can't think of them.

VS: (laughs) Very good. Well you two are obviously a good team, and it's been a real privilege and thank you, I look forward to future correspondence.

AP: Great, yeah, if you're ever in Oneonta, New York, number one, you're lost, and number two, drop by.

VS: (laughs) Sounds great. Well thanks to both of you, and I look forward to our next time we talk.

AP: Fine, and I'll send our mailing address, or Peg can, by email, so that it's written down in black and, whatever the other color is.

VS: (laughs) Perfect, thanks again.

AP: Great, nice talking to you, Vince.

VS: Likewise. Have a great day.

AP: Best wishes.

VS: Same to you, thank you, bye-bye.

AP: Bye.

[END OF INTERVIEW]

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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