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Dewey Livingston: Well now, so Bill, let's shift into your mapping experiences and I understand you had quite a project in support here as far as mapping Cordell Bank.

Bill Kruse: It actually turned out to be the beginning of my next career, which I'm in the middle of now, which is a remote sensing mapping computer career. And it came about based on some of the things we talked about earlier where we didn't really know what was there. The charts were vague at best. Depth sounder profiles were local and not particularly accurate in their location and position and we wanted something else but we hadn't figured out what to do. Of course, you can design things but you might be a decade doing that.

Apparently, there was a national need to know what the coastal areas were in what's called the exclusive economic zone and I had something to do with some world treaties that were happening at the time. But President Reagan signed that effort into being, I think in 1983, somewhere around there, and that led to NOAA actually officially doing a long-range large-scale mapping of the coastal zone out to 200 miles. So it started with the GLORIA side scan off the shore of the deeper waters and USGS handled that and I think that was in '83 or '84.

And then we heard that NOAA was going to use a SeaBeam or multi-beam sonar along the Pacific coast. And Bob had some connections with people at NOAA because he had already at that point in time suggested, "What do we do to see if this can become a sanctuary? I think it's important." Not everybody listened to him but at least he was able to get feedback and information on what was going on.

Somewhere in that process, Bob wrote a letter and got us the opportunity to go on board the ship that was gonna come and map Cordell Bank. They mapped Cordell Bank 'cause basically Bob asked them to. It wasn't on the official plan. And what was most spectacular about it is Bob and I actually got to go out on the ship and participate on the survey and I actually got to run the sonar equipment because they were one man short. Of course, it was the midnight to 4:00 a.m. shift. You get that shift when you're the low man on the totem pole. But it gave me insights into the problems, into the data quality, and when to look where there's bad data.

‘Cause I actually was on shift one time when we had equipment failure and we had to stop the ship and get it back up and wake some people up and do that. So being able to touch and feel and understand what was going on is different than just reading it in a book and intellectually. And we could watch the bank being mapped on the pen plotter as we were going and that was incredible. We were able to see things where we had been and we could see the depths. This wasn’t a nice picture, this was a contour chart with depth soundings all over the place and we could see that as we went.

So this lasted for ten days and we had requested that we get a copy of the data. The trouble is, the data was in a format specific to the software that was on the computer on the ship and the post processing back on the East Coast, I guess Reston, Virginia, I think, is where the NOAA mapping office is. A little vague on that, right, Reston, Virginia.

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So Bob says, “Well, what are we gonna do?” And I said, “Well, why don’t we ask for the software?” little did I know. And they said yes, after some cajoling. So we got copies of the source code of the mapping software that NOAA uses to translate this stuff from the ship to what they make the contour charts with or at least feed to the contour plotting system. And I looked at it and I said, “Oh, my gosh. They’re throwing away 98, 99 percent of all the soundings and just picking the shallowest one because that’s important for charting. You want to know where the shallowest point is for the chart.”

And then they’re throwing away a few more in that area saying we have contours every 10 or 20 meters. We don’t need all those points to draw those contours, so those are thrown away, too. So maybe 1, maybe 2 percent of the data was actually being used and the rest was being left on the cutting room floor, so to speak. But the data was all there on the source tapes and the program to process every single sounding was there. All you had to do was change a few lines of code to export it.

So it was more work than it may have sounded because the software was for a computer I didn’t have, so it had to be imported to another computer system, another computer compiler, and then it took about a month to debug it and get it working so I could get the same results as we got on the

ship. And we made sure we had sample results processed on the ship so we could compare them and get the exact same numbers.

The only problem was, and this was completely independent of what we were doing, is there was a conflict between NOAA and the Navy and Congress, apparently, about how this data could be used. The Navy wanted it classified, Congress wanted to map the exclusive economic zone, and NOAA wanted to have it and figured it should be shared with every agency and organization that needed to use it for minerals and strategic planning and stuff like that. But somehow, we got in early in the process, made the request, and were granted the request for the data before this officially was all written up and agreed to.

The trouble was when we went to leave the ship, they told us we can't take the data. I had the tapes in my hand in the box, but, "No, you can't take them. They are going to be classified." So I went home and for a month, we didn't know whether we could get the data after all this preparatory work. Somewhere in the system some rational person spoke up and said, "Everybody's gonna get the data eventually. This is a place that's in the process of being nominated for a national marine sanctuary. It's a small, postage stamp location. Yes, it's important. Yes, it might be sensitive but maybe we should just go ahead and let the data be used."

And I'm not sure they really expected us to use it in the way we were, even though the people within NOAA, I'd been communicating with the guy that was in charge of the software there. So we finally got the tapes and then, of course, it was, wow. I'm getting out of sequence here, but after we had processed the data, I got a phone call from a guy from Lockheed who said, "I'd like to come and speak with you."

And he did and Bob was there and we showed him – he said, "I'd like to hear what you're doing with Cordell Bank." And I suspect some of this was already triggered by the hole publicity back a couple of years earlier. They knew who we were and what we were doing and were kind of interested in how far we were gonna go with it. I think some people thought perhaps we had gone a little too far at that point, so there was tension in the government, in the defense industry, and we weren't sure where it was coming from but we were in the middle of it and didn't know quite what would happen.

So to make that section of the story shorter, we did get the data, we did get to keep it, and we did get to put it in the public domain, and at the time, that was pretty special, apparently. And I just went back last night to read some of the articles in *Science News* about this and it talks about some of the details that I'd forgotten how special Cordell Bank was. Apparently, there was only two locations in the whole exclusive economic zone where they declassified the data so it could be used and I don't actually remember what the other one was.

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So one of the challenges at that point in time in the computer software is we didn't have graphics cards. We didn't have Photoshop. We didn't have GIS systems. We didn't have the software to handle the results of this point data, sounding data. So I'm eternally optimistic that things can be fixed and things can be done and so I made a reasonable attempt limited by my own capabilities at the time to write software to grid and render the imagery and that's what we ended up using for the 1986 trip out to Cordell Bank to find things.

Of course, we didn't have navigation that well and actually the survey itself wasn't GPS referenced like 2005 or the Reef Crest trip a couple of weeks ago. They had ranging transmitters, a mini ranger navigation system where there were antennas on shore that the ship would ping off of and measure the time delay and position the ship relative to these antennas sitting over USGS markers for reference on shore. So it was supposed to be accurate to within several meters and, embarrassingly so, we're still having trouble aligning the data from those days with the data from the GPS survey, but I think that must be something stupid I did rather than the original navigation.

So we actually were able to create from all of the soundings a digital elevation model or digital surface model of the bottom and do some shaded relief rendering of it, which at the time, was pretty unusual. It was a 20-megahertz, 16-bit computer that did all the work and each picture took 30 minutes to render. And so it was the sort of thing you could start things up in the morning and go to work at your job.

The other challenge, and this is a really excruciatingly technical issue, but the data format on the tapes that came from the ship was 800 bits per inch computer tape and that was already obsolete in the rest of the world, so I had to actually go to a surplus auction at the Lawrence Livermore Lab to

buy a tape drive that I could interface with the computer just to be able to read the tapes on the computer.

So we jumped through a lot of hoops, which was challenging and interesting and frustrating at the time, but the end result is we had the only and the best map of Cordell Bank that had ever been made at the time. And for 20 years, that remained the only map of that quality. So it was a pretty technically interesting and personally satisfying effort and NOAA was actually kind enough to provide a small research grant to produce some of the imagery in the end, which to a large extent, up until recently, has been the imagery used for presentation purposes. So we pushed the envelope and we got more than we had hoped for in the end.

Tom Santilena: Did you ever find out why they were so reluctant to give you the information? I mean what was so sensitive about some plots on a – ?

Bill Kruse: It had to do with, I think, submarine warfare and people knowing where they were in submarines. This was before GPS, so you used inertial navigation for navigating the submarines and one way to correct for drift was monitoring contours on the bottom or bottom topography with the sonar and you could correlate this with the actual position if you knew what the bottom topography was accurately. So this was the most accurate bottom topography that as far as I know had ever been imaged. It was four-meter resolution, pings four-meter resolution sonar pings, and there were other multi-beam systems but they were all being used in deeper water, so they were lower resolution in the deeper water.

There may have been other places where this sonar had been used but this was the first time it had been used in this way. Of course now, with the right sized check you can go out and buy one of these and put it on your skiff, but in those days, it took a 220-foot vessel and a crew of, I think, 60 to put this out to sea.

The other thing that happened when we were out there is, as has been discussed perhaps in other places, the weather in April is really nasty in Cordell Bank. Generally, there's a north wind and a current and the weather was so rough that half of the crew on the 200-foot NOAA ship, *Davidson*, was seasick and this is the crew of the ship. Fortunately, I wasn't and got to eat well and sit with the captain and work with the equipment and work with the technicians who created the data.