PUBLIC HEARING
STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

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1220 S. Saint Francis Drive
Santa Fe, New Mexico

TRANSCRIPT OF PROCEEDINGS
February 24, 2025
VOLUME II

HEARD BEFORE:
HEARING OFFICER RIPLEY HARWOOD

COMMISSION MEMBERS:
GERASIMOS ROZATOS, Chair
BAYLEN LAMKIN, Member
WILLIAM AMPOMAH, Member

COUNSEL TO THE COMMISSION:
DANIEL RUBIN

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I N D E X

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(On the record at 9:16 a.m.)

TRANSCRIPT OF PROCEEDINGS

CHAIR ROZATOS: Okay. Good morning to everyone. Happy Monday. This is the continuation of the OCC hearing that we started up on Thursday. Today is Monday, the 24th of February.

As I've stated before, my name is Gerasimos Rozatos. I am the acting director for the Oil Conservation Division. I'm also the acting chair for the Oil Conservation Commission.

With me, we have the other commissioners, so can we do a roll call real quickly.

COMMISSIONER AMPOMAH: I'm Dr. William Ampomah, a professor and professional engineer at New Mexico Tech, designee of the Energy secretary. Thank you.

COMMISSIONER LAMKIN: My name is Baylen Lamkin, a petroleum engineer, designee of the commissioner of public lands.

CHAIR ROZATOS: Excellent. So I would like to bring this meeting back in order for today and for the rest of the week. We will be continuing our hearing for consolidated case by Goodnight Midstream and Empire New Mexico. It's Case Numbers 24123, 23614 through 17, 23775, 24018 through 24020, and

24025. It's an evidentiary hearing that is going to be heard in front of the Commission.

Are all parties present? I will start from the right of the room and then work my way over to Mr. Rankin.

MR. RANKIN: Good morning, Commissioner Rozatos, Commissioners. Adam Rankin appearing on behalf of Goodnight Midstream and these cases.

CHAIR ROZATOS: Excellent. Thank you.

MR. PADILLA: Members of the Commission, Ernest L. Padilla on behalf Empire New Mexico.

CHAIR ROZATOS: Bring your mic down, Mr. Padilla, so we'll pick it up. Thank you.

MR. PADILLA: Members of the Commission, Ernest L. Padilla for Empire New Mexico.

CHAIR ROZATOS: Thank you.

MS. HARDY: Good morning, Members of the Commission. Dana Hardy on behalf of Empire New Mexico, LLC.

CHAIR ROZATOS: Thank you, Ms. Hardy.

MS. SHAHEEN: Good morning, Commissioners, everyone, Sharon Shaheen, also on behalf of Empire New Mexico.

CHAIR ROZATOS: Thank you, Ms. Shaheen.

MR. WEHMEYER: Corey Wehmeyer, Santoyo

Wehmeyer, PC, here on behalf of Empire.

CHAIR ROZATOS: Thank you, Mr. Wehmeyer.

MR. BECK: Matt Beck on behalf of Rice Operating Company and Permian Line Service, LLC.

CHAIR ROZATOS: Thank you, Mr. Beck.

MR. MOANDER: Thank you, Mr. Beck.

Chris Moander on behalf of the New Mexico Oil Conservation Division.

CHAIR ROZATOS: Excellent. And on our platform.

MR. SUAZO: Good morning, Commissioners. Miguel Suazo with Beatty & Wozniak, appearing on behalf of Pilot Water.

CHAIR ROZATOS: Excellent. Thank you, Mr. Suazo. Anybody else on the platform?

Excellent. Before we start, I know there were some issues that came up on Friday, so I will transfer it over to Dan.

MR. RUBIN: Good morning, folks. Just two quick preliminary matters, I believe, before we get started.

The first is, Mr. Harwood, there was an e-mail I sent out to the parties on Friday, documenting the waiver of any notice issues. So unless any of the parties now have something else to state about that position, I would ask that that be included in the record. You had that e-mail on Friday.

HEARING OFFICER HARWOOD: Yes, sir.

MR. RUBIN: Second issue, there was a motion to reconsider filed by the Oil Conservation Division. We had sua sponte, as they say, which means without motion from the parties, struck this, the supplemental rebuttal, the statement by the OCD as it appeared to be beyond the deadline. However, there is a motion now to reconsider that ruling.

I will say that, as per Mr. Moander, there is no objection from the parties to the motion to reconsider this filing. And I have reviewed the filing. And unless the Commission has any questions for me or wishes to go into closed session, I would recommend that the motion to -- hold on, we have a little blackout. Okay. -- that the motion to reconsider filed by OCD be granted.

Before I ask for a motion on that, do any of the parties object to the motion to reconsider?

MR. RANKIN: No. Speaking for Goodnight Midstream.

MS. HARDY: No, on behalf of Empire.

MR. RUBIN: Mr. Beck?

MR. BECK: No objection.

MR. RUBIN: Mr. Suazo?

MR. SUAZO: No objections from Pilot.

MR. RUBIN: So if I could have a motion to grant OCD's motion to reconsider the striking of its supplemental rebuttal testimony and exhibits.

COMMISSIONER AMPOMAH: Mr. Chair, I move that we approve the motion by OCD.

CHAIR ROZATOS: I second it.

MR. RUBIN: All in favor, say aye.

ALL MEMBERS: Aye.

MR. RUBIN: Any opposed? Okay. Motion passes.

(Motion approved.)

MR. RUBIN: I will now turn it back over to Mr. Harwood. That's all I have.

HEARING OFFICER HARWOOD: Okay. Good morning, everybody. So my understanding is that Empire goes first. Is there anything preliminary from Empire before we move straight into your witnesses?

MS. HARDY: No, Mr. Examiner. Thank you.

HEARING OFFICER HARWOOD: All right. Let's see. I'm looking at my notes, and I'm not sure if you'll be calling them in this order, but my notes show that you mentioned Jack Wheeler first. Is that your first witness?

MS. HARDY: Mr. Examiner, we've shifted around our witness order to accommodate schedules.

HEARING OFFICER HARWOOD: Sure.

MS. HARDY: And our first witness is actually Dr. Robert Lindsay.

HEARING OFFICER HARWOOD: Is he here in person?

MS. HARDY: He is here in person.

HEARING OFFICER HARWOOD: I'm not sure what the protocol is. Do we usually have witnesses up here on the witness stand?

CHAIR ROZATOS: So, yes.

Mr. Lindsay, if you'll come, please, have a seat right here on the witness stand. And if you'll also, please, once you do come to the witness stand, press the microphone button. It's the little person with the two marks right in front of them. You can turn the microphone on, please. There you go.

HEARING OFFICER HARWOOD: Ms. Hardy.

MS. HARDY: Thank you.

ROBERT FORREST LINDSAY,

having first been duly sworn, testified as follows:

DIRECT EXAMINATION

BY MS. HARDY:

Q. Good morning, Dr. Lindsay.

A. Good morning.

Q. Could you please state your full name for the record.

A. It's Robert Forrest Lindsay.

Q. By whom are you employed, and in what capacity?

A. I'm a consulting geologist, so I'm self-employed.

Q. Have you previously testified before the Commission?

A. No.

Q. Have you provided a summary of your education, training and experience with your direct testimony?

A. Yes.

Q. And can you please provide a brief summary of your experience that is specific to the Eunice Monument South Unit, which we will refer to as the EMSU.

A. Okay. I first started working on -- at EMSU in November 1988 and worked on it continuously into the early 1990s, and then worked on it sporadically through the remainder of the 1990s into 2002, when I retired from Chevron, and then used the data from Eunice Monument to write a Ph.D. between 2004 and 2014.

Q. And did you obtain your Ph.D.?

A. Yes, I did.

Q. In what subject?

A. In geology.

MS. HARDY: And, Commissioners, Hearing Examiner, based on Dr. Lindsay's qualifications as set out in his direct testimony and here today, I would request that he be qualified as an expert in petroleum geology.

HEARING OFFICER HARWOOD: Any objection, Mr. Rankin?

MR. RANKIN: No objection.

HEARING OFFICER HARWOOD: He'll be so recognized.

BY MS. HARDY:

Q. Dr. Lindsay, have you provided direct and rebuttal testimony and exhibits in this case?

A. Yes.

Q. Do you affirm today, under oath, that your testimony is true and correct?

A. Yes.

MS. HARDY: Commissioners, I request that Dr. Lindsay's direct and rebuttal testimony and exhibits, which are Exhibit B, B-1 through B-34 and Exhibit J and J-1 through J-12 and Appendix 1 be admitted into the record.

HEARING OFFICER HARWOOD: Any objection, Mr. Rankin?

MR. RANKIN: No objection.

HEARING OFFICER HARWOOD: They'll be so admitted.

MS. HARDY: Thank you.

(Admitted: Empire New Mexico Exhibits B, B-1 through B-34, J, J-1 through J-12 and Appendix 1.)

BY MS. HARDY:

Q. And, Dr. Lindsay, I'm going to share my screen here so we can talk about some of the highlights of your testimony. Can you see that?

A. Yes.

Q. Okay. Dr. Lindsay, what does this slide that's up on the screen show?

A. Okay. This is an index map on the left of three unitized fields that are referred to as EMSU-B, EMSU and AGU from north to south.

And on the right is a close-up view of the EMSU, with some key cored wells shown in numbers. And two of those numbers, 679 and RR Bell Number 4, will be shown a little bit later, as well. But it's a good reference slide so you know where they're located.

Q. And, Dr. Lindsay, as you know, these cases are focused on the EMSU, but do you have to consider the geology in the surrounding area in Eunice in your evaluation?

A. Yes.

Q. And why is that?

A. To get the big picture. To try to understand how these little unitized fields fit into the context of the geology that's to the east of them and to the west of them, and along strike, as well.

Q. And are the EMSU 679 and RR Bell 4 wells particularly relevant to your analysis?

A. Yes.

Q. Okay. Let's look at your next slide here. Can you explain what this slide shows?

A. Okay. On the left is a little index map that shows four fields, with the orange one being EMSU. And on the right is a cross-section that's going right through the middle of EMSU.

The black vertical bars are the cored intervals that I described. And the cross-section is what we call cycle-by-cycle correlation of all the stratigraphy, with the red being dolomitized ooid grainstones, that have the highest porosity and permeability.

The orange are what are called grain-dominated dolomitized packstone. The light blue being mud-dominated dolomitized packstones. And on the right, the gray being what are called dolopackstones.

The red have the highest reservoir quality. The orange has kind of intermediate reservoir quality. The blue has lower reservoir quality. And the gray has the least reservoir quality.

And the yellow that comes through are inner bedded dolomitic sandstones. And on the lower left, that is a few little beds of fusulinid dolostone.

Q. And, Dr. Lindsay, what is it that's important about this slide?

A. We wanted to correlate the stratigraphy from updip to downdip so we knew which layers of strata were laterally connected.

Q. Dr. Lindsay, what does this slide show, please? And it's Number 4.

A. This is an east-west regional cross-section through the Permian Basin that extends all the way to El Paso, Texas.

And the upper diagram is what happened to the west side of the Permian Basin. It tilted up the late Eocene to the early Miocene. And when it tilted up, it captured rain and snow and brought water into the subsurface of the Permian Basin, that we refer to as "meteoric recharge."

And this water passed these plutons that created this uplift and was heated up so it became hot, high-pressure, high-volume meteoric recharge. That's what the top illustration shows. That was from just the late Eocene to the early Miocene.

And then the area rifted and pulled apart and destroyed that recharge area in the middle to late Miocene, when the Rio Grande Rift formed. And at that point, just a little bit of cool, low-pressure, low-volume meteoric recharge will now come into the Permian Basin.

And in the upper slide, it's basically saying that there was a lot of high pressure that was able to push oil out of structural closures, even if those closures were 4- or 500 feet in height. The amount of pressure was greater than that and could actually push oil out of the structural closure and create what we call a "residual oil interval." That's what we initially called it. And then later, it become known as "residual oil zones."

Q. And why is this slide important?

A. Pardon?

Q. What's the relevance of this slide here, for our purpose?

A. The relevance of it?

Q. Yes.

A. Oh, this is the mechanism that created residual oil zones in the Permian Basin.

Q. Including in the EMSU?

A. Yes. And then when the area rifted and pulled apart, then some of the fields, but not all of the fields, that had residual oil were able to backfill completely or partially or not refill at all and remain a residual oil zone.

And in one case that we're aware of, instead of re-saturating with mobile oil, one field actually re-saturated with gas instead of oil.

Q. Dr. Lindsay, what does this slide show? And this is Slide Number 5, for the record?

A. Yes. This is a core description that I did on the RR Bell Number 4. On the left is the complete core description. The coring actually started just above the Grayburg in the base of the Queen Formation and went through the complete Grayburg section, and then extended down into the San Andres. That's the left.

And on the right is just a close-up of the San Andres part of that core description. And we've cut the core description into the well log and depth adjusted it so you can see what the Upper San Andres looks like.

And the little black bars in the middle show where there's oil saturation that was visible to the naked eye.

Q. And, Dr. Lindsay, does this slide show a residual oil zone in the San Andres?

A. Yes, yes. All of these intervals, I believe, are part of the residual oil zone.

And when I saw the oil at the very base of the cored interval, being a good exploration geologist, I realized that there has to be even more oil deeper. And the great question is: How much?

Q. Dr. Lindsay, what is shown on this slide, which is Exhibit B-26?

A. Okay. This is just a close-up again of the RR Bell Number 4, showing the oil-stained intervals in that core description, from top, just below the top of San Andres, to the base of the cored interval.

Q. Dr. Lindsay, what's shown on this slide, which is Number 7?

A. Oh, yes. This is the -- on the left is a box-by-box photograph of the EMSU 679 core. And on the right is box-by-box photographs of the RR Bell Number 4.

And on the lower left of each of these illustrations is the top of the cored interval. And on the upper right, is the base of the cored interval.

And when you look at this, there will be a plain light photograph of the core, and then next to it will be the same box with the ultraviolet light photographs.

And we've shown where, if we just look at the left to begin with, you can see where the base of -- and so you start in the lower left and you go up to the top to go down the section. And you can see the base of the Grayburg.

And the remainder of the core, where we have that yellow line, is all of the San Andres that was cored in this particular well. And the core was oriented down to 36 feet within the San Andres, with the idea being doing a fracture study besides doing a core description of both the Grayburg and the San Andres.

Then on the right is basically the same thing, with the lower left being the top of the core and the upper right being the base of the cored interval. And, again, we're showing what is in the Grayburg and what is in the San Andres.

And in both examples, if you look at very last box of core, whether it's in the 679 or in the RR Bell Number 4, you'll see the oil stain right at the base of both of these cores.

So that told us that there's oil saturations deeper into the San Andres.

Q. Dr. Lindsay, how can you tell -- well, what color is the oil staining for the --

A. It will be a gold color, a brown to gold color. And there will be lots of pieces that will be creamy color. And those creamy color pieces is where the core was completely cleaned of all the oil, and that is where the porosity and permeability was measured.

And then the brown intervals in the

plain light view is where -- the unclean pieces. So you can see the oil stain in the San Andres.

Q. And, Dr. Lindsay, can you explain what's shown on this slide?

A. This is just a close-up of a core on the left from the EMSU 679, which we actually have right here. This particular box. And it's showing the cleaned intervals and the porosity and permeability associated with that. And then the oil-stained intervals on the left, you can see how much oil stain is there. And this is in the San Andres.

And on the left, this particular core is available. I brought it here. And we have it just sitting here on the floor, if you would care to look at it.

Then on the right is the RR Bell, just a representative sample from it, showing some of the porosity and permeability data there. And both the plain light on the left and the UV light on the right.

And then on both of these cores, we're showing the oil saturation and water saturation associated with these.

Q. And, Dr. Lindsay, is the box in front of you --

A. Yes, this box is the box that's on the left.

And you can see the oil stain in the core, and you can also the see the cleaned intervals. And we actually made a thin section, as well, from this piece right here. And all the blue is the porosity.

So in that case, the porosity is just about 15 percent. It's 14.9 percent, with 19 millidarcies of permeability, and 38.4 percent oil saturation, and 28.4 percent of water saturation.

HEARING OFFICER HARWOOD: If the witness wanted to move around and stand up and show us stuff on that exhibit, he's welcome to do so. It's up to you.

MS. HARDY: Would the commissioners like him to do that?

THE WITNESS: I can do that.

CHAIR ROZATOS: Whatever is best for the witness. I know I can see.

I don't know, Dr. Ampomah, can you see?

HEARING OFFICER HARWOOD: Can you gentlemen see it okay?

CHAIR ROZATOS: He sees it that way, so I think we're okay, Doctor.

HEARING OFFICER HARWOOD: Okay. Great.

BY MS. HARDY:

Q. Dr. Lindsay, is it your opinion that the cores show oil staining through the San Andres?

A. Yes. And where we have core, yes, we see an oil stain in the San Andres. And we know what percentage is there with the core analysis.

Q. Can you smell the oil in the cores?

A. Oh, yes. Yes, you can smell it. And this was an old core. This was taken in 1990, and you can still smell the oil saturation. Just pick up any one. Yeah.

So that core has been out for 35 years. This was taken in 1990. Yeah. Okay. Great. Perfect. Okay.

Q. Dr. Lindsay, can you please explain what's shown on your next couple of slides. And these are Numbers 9 through 12, for the record.

A. This is the core analysis for the EMSU 679, the core that we just showed. And in this particular illustration, it's showing where the top of the San Andres is located. And the green column is the oil saturation foot by foot from the San Andres down.

And this next slide is the continuation of that. And, again, just the green interval is showing the oil saturations associated with that core. And then here's the lower part with the oil saturation shown as well.

Q. Dr. Lindsay, what is the range of oil saturations shown on this analysis?
A. I think the highest I recall seeing was up about 38 percent, and the lowest was just, like, 1 percent, just about 1 percent. There's quite a range in here.
Q. And in your opinion, are the numbers lower than you would find in the actual core?
A. These are the lowest possible numbers, because when you're coring these -- well, any well, you have to be able to -- when you're coring through it, you have to lift the cuttings up to the surface. And so these cores have basically been super flushed and so these are the lowest oil saturations you're going to see in these cores.
There's actually been some work done that actually shows, in another field, with an SVE paper, what the residual oil zone in that particular field looked like, with respect to conventional core, and then sponge coring, and pressure coring. And it showed a significant difference.
Basically, in this field is the Seminole San Andres, and it was some work done by Hess and published in an SVE paper. When they looked at their residual oil zone, they saw that if they had an

interval that had about 18 percent oil saturation via a conventional core, when they looked at a similar interval to that with a sponge core, they would see 24 percent oil saturation instead. And then when they went in and pressure cored, they found that the oil saturation in the residual oil zone was 32 percent.

So there's about a 14 percent rise when you compare a conventional core analysis to a sponge core analysis to a pressure core analysis.

So what we're showing here are the lowest readings. And they could be 14 percent higher if that data applies in EMSU in the San Andres.

Q. And, Dr. Lindsay, do these saturations reported here in this report show a residual oil zone?

A. Yes, yes. Basically, the way I've been kind of trained to understand what a residual oil zone would look like is, in a conventional core analysis would be anything with 20 percent or greater percent oil would be considered a residual oil zone.

Q. And were you working on the EMSU at Chevron when this report was done?

A. Yes. Yes.

Q. Dr. Lindsay, what does this exhibit, which is J-3, show?

A. Okay. This is actually two cores on the left, so you can see the complete Grayburg interval, the upper part of -- on the left, the upper part is from EMSU 649. It is continuously cored from the top of the Grayburg down to the -- not quite to the base of the Grayburg. And then an offsetting well, the EMSU 679, cored, the lower part of the Grayburg down through the San Andres, into the upper part of the San Andres.

And the upper part of the 679 was oriented, so we could do a fracture study, and the oriented core in the EMSU extended -- in 679, extended down to 36 feet into the San Andres. So we actually did a fracture study in the San Andres as well.

And on the right, that's just a close-up of the cored interval in the San Andres, and it's showing the interval that was oriented in the San Andres where we did a fracture study.

And then beneath that, the remainder of the core was not oriented, but we described it all. And, again, you can see the black bars were we saw visible oil saturation.

And the surprising thing was, when we looked at the UV light data, right at the very base of the cored interval, at the bottom of the core in the San Andres, we actually saw the UV light oil stain in the base of the core.

Q. Dr. Lindsay, what's shown on this slide, which is marked as Exhibit B-2?

A. Okay. On the left is a regional map, and it has been put together, of the San Andres showing porosity fairways, where, when the west side of the Permian Basin was tilted up into the air and water charged into the subsurface into the San Andres, the pathways, the porous pathways that the water took regionally from the west, entering into the subsurface, into the Permian Basin, and on the right -- and so as the water charged through, it could follow the porosity and it could also follow through fractures and faults, as well.

And so on the left, I've created what I call a fracture halo map, where you might have a small fault in the middle, and then when that fault moved a little bit, you created a series of fractures around that fault.

And all these fractures are three dimensionally interconnected. That's the key. It's hard to show that in a flat 2D view. But all of those fractures are interconnected.

Q. And, Dr. Lindsay, why is this information important with respect the EMSU?

A. Because when Eunice Monument, when the structure formed, that was in the Cretaceous into the early Tertiary, during the Laramide orogeny. And all the carbonate in Eunice Monument, whether it was a grainstone or a grain-domed impact stone or a mud-domed impact stone or a wackestone, or even the carbonate inside of sandstones was all dolomitized. And that creates a much more brittle rock.

And when the Eunice Monument structure formed and flexed and created an asymmetric anticline, the dolomite, being brittle, fractured.

And this is just a little cartoon to kind of shown what a fracture halo would look like.

Q. And what is shown on your next slide, which is Exhibit J-4?

A. This is the fracture study of just the upper 36 feet of the San Andres in EMSU 679. And in that 36 feet, we measured 129 vertical fractures. And this study was not done by a company like Core Lab. This was done in-house by myself.

And you can see trends to these vertical fractures, and you can see numbers here, it says 2, 4, 6, 8, 10. And that tells you how many fractures were found at each 10-degree increment in this slide.

And you tend to see that most of the

fractures tend to go northeast to southwest, with some going northwest to southeast, but at a lesser number.

Q. And what about Exhibit J-5?

A. And this is the fractures that were 1 to 3 feet in length; we call them large fractures. And this is just showing their trend. And there seems to be a very strong trend that's kind of east-northeasterly to west-southwesterly.

Q. And what about Exhibit J-6?

A. Pardon?

Q. And what does this Exhibit J-6 show?

A. Oh, this next one? Okay.

This is the small fractures that we found. So these are little fractures that are just a few inches in length. There's 109 of them in that 36-foot interval. And, again, you tend to see this stronger trend of fractures, and these are all vertical fractures that trending northeast to southwest, with a lesser trend northwest to southeast. And then another trend that's kind of more east-west oriented.

Q. And, Dr. Lindsay, do the fractures allow for the communication of fluids between the San Andres and the Grayburg?

A. Yes. Once you get a fracture the width of a sheet of paper, you're at infinite permeability. And a lot of these fractures we found were actually solution-widened, and they're much wider. We'll actually show an example here in just a little.

Q. Is that this slide, Exhibit J --

A. It's this slide here. These are some of these small fractures that are solution-widened. And to the naked eye, you wouldn't think that they're all interconnected, but they actually are.

And instead of being the width of a sheet of paper, they've been solution-enhanced by late-stage fluid. This meteoric water that charged through has actually solution-widened these fractures.

And they're all interconnected, because the oil has gotten into all of these. So they're oil stained as well.

Q. And does this confirm what was shown in your fracture study?

A. Yes, yes, and that's there a fracture halo. And it's really hard to see that when you're only looking at 4-inch width of core.

Q. Dr. Lindsay, what is shown on Exhibit B-21?

A. This is showing two things. It's showing a water chemistry study that was does in Eunice Monument, and it's showing the structure at Eunice

Monument, as well.

The Eunice Monument structure is a double-humped asymmetric anticline. And it's double-humped because beneath it, the basement is broken into smaller blocks, and they're differentially moving, creating this odd looking double-humped shape to the structure. And when that structure moved, that's when all the fractures were created.

And then we did a water chemistry study in-house, and this was when I was with Chevron. And we found three different water chemistries. We found connate water that had about 120,000 ppm total dissolved solids and was barium rich.

And then we found edge water that was being sucked in by a pressure drop in the reservoir that was less than 10,000 ppm and it was sulfate poor. And this was coming from the Goat Seep Aquifer, which is downdip to the west of the western unit boundary, just a couple miles.

And then bottom water in the San Andres was found to be less than 10,000 ppm, as well. But in this case, it was found to be sulfate rich.

And so we realized that we had three different water chemistries in the reservoir: connate water, edge water, and bottom water.

And so once we got this information, we had made this illustration before showing what the structure looked like. We then superimposed on it the water chemistry, and that's why we've got these little letters in here saying E for edge, B for bottom, and C connate. And then we added that into the illustration.

Q. And, Dr. Lindsay, just to be clear, did you prepare this illustration based on the Chevron data at the time you were at Chevron?

A. Yes, yes. As soon we got the water chemistry data, we went and superimposed it on the structure map, because then it made a lot of sense, what we were seeing.

Q. And does this information show the water was migrating from San Andres to the Grayburg before the waterflood?

A. What it's actually showing here, it's just showing where the bottom water is. It's not showing that the water is moving up out of the San Andres into the Grayburg. But it is showing the edge water moving into the Grayburg. And that's via a pressure drop. It's being basically sucked in a couple miles.

Q. And what is the impact of injection on the chemistry of the water?

A. Say that again.
Q. What is the impact of injecting into the reservoir on the water chemistry?
A. Oh. Well, we're using the bottom water. That's the source for the injection water in EMSU, in the Grayburg. It was easy to get to. It's just directly beneath the Grayburg Reservoir. And so it is being used as the fluids in the waterflood, to physically push from the injection wells to the producing wells.
Q. And what is showing on your next slide, Exhibit B-28?
A. This is showing where the edge water is coming from, on the bottom, with a 3D seismic cross-section here. It's shot east-west, right through EMSU. And the top illustration is basically that same area, only it's from the unitization hearing, when EMSU was being unitized.
And the color on the far left is showing where the Goat Seep Aquifer is located. And it's just downdip a couple miles from EMSU. And then you can see where EMSU is located on here, in the upper slide.
And then, on the right, you start to see all this yellow and orange, which is a stratigraphic trap that is creating the lateral stratigraphic trap

in Eunice Monument.

Then the bottom illustration is basically showing what you -- we can actually image and see the Goat Seep Reef on the far left. And the arrows, the top set of arrows, is showing the top of the Grayburg. And the bottom set of arrows is showing the base of the Grayburg and top of the San Andres.

And so water is being sucked from the Goat Seep through the Grayburg updip into EMSU and coming in as edge water.

Q. Dr. Lindsay, by analyzing the water chemistry, can you determine where water is moving within a reservoir?

A. Yes, yes. Because we have these three different water chemistries, you can identify edge water from bottom water from connate water. And that's the beauty of that water chemistry study.

Q. And in your opinion, does the water chemistry show that water was moving from the San Andres into the Grayburg?

A. Oh, yeah. When I was working in Hobbs full-time on EMSU, it was common knowledge that bottom water was being pulled up through what we call the little water plumes vertically into the Grayburg. And there was one example, EMSU 887, where there was a plume of water around this particular well, and we happened to core that well, and we actually oriented that particular core so we could do a fracture study on it.

And when we looked at the core with this plume all around it, we saw that it was highly fractured. So it was a perfect place to do a fracture study to understand how the water was getting up out of the San Andres up into the Grayburg via all of these fractures that we saw.

Q. Dr. Lindsay, what is shown on this slide, Number 21?

A. South of EMSU, this is Arrowhead Grayburg Unit. This is a unitization map that was made. And by this point in time -- this was in 1992, when this field was being unitized. And by this point in time, we started to realize how important it was to kind of understand where some of this bottom water coming out of the San Andres was coming up into the Grayburg.

So when this map was made, the purple areas, that say bottom water, or "B Wtr," those are the places in AGU where we found bottom water, meaning San Andres water coming up into the Grayburg.

And then the rest of the map, we were mapping where edge water was come into this particular field. And it was coming in through four little 18-inch grainstones, and so we mapped out each one of those so the engineers knew where to stay away from edge water.

Because originally, they kind of -- they didn't want to unitize the western third of the field because it produced water. And we had looked at cores enough there and described them well enough, that we realized there were just four 18-inch grainstones that had most of this edge water coming into the reservoir.

And so we mapped them out and said, "Well, the total thickness is 285 feet thick. Do you want to abandon the western third of the field because of just 6 feet of grainstones, these dolomitized grainstones?" And we said, "Just stay away from them. And if you do that, then you can produce all the rest of that strata."

And they said, "Okay."

This was a very handy map. But we showed bottom water besides edge water and where it was coming in.

Q. Dr. Lindsay, before we get to your conclusions, I just wanted to confirm for the record that all the slides that we've shown are included with your direct or rebuttal testimony.

A. Yes.

Q. Okay. Thank you. And can you please summarize your conclusions here for the Commission.

A. The first conclusion is that there's a residual oil zone in the San Andres. We've seen it in core. We know it's there. We just kind of don't know how much is there.

And the second thing is, we use these cores -- when we can cross the San Andres and we can find the top of the San Andres in core, that really helps us in our correlations through non-cored wells, just looking at well logs. And that helps us tremendously. That's kind of the second bullet point. And it's also showing us where the high is, the structural high in EMSU is compared to Goodnight's salt water disposal wells.

And then the third thing is in EMSU 679, the fracture study showed that there was fractures and what the orientations were like in both the Grayburg and in the San Andres.

Q. And, Dr. Lindsay, before I go to the next slide, is it correct that Empire's other witnesses have quantified the residual oil zone in the San Andres?

A. Say that again.

Q. I think you said just a minute ago that there is a residual oil zone in the San Andres, but you're not sure how much.
A. Oh, yes.
Q. And Empire's other witness quantified it?
A. Oh, yes. They'll explain that in more detail. I just saw it in these cores up in the upper part of the San Andres.
So we know it's there and it goes right to the base of the cores, so we know it has to go deeper.
Q. And let's go on through the slide.
A. Okay. Yeah. Another issue is this high-salinity water that is being not -- injected into the San Andres. It's going to pressure up and it's going to come up through these fractures and it's going to come into the Grayburg Reservoir. And that's going to create problems with the existing waterflood operations, by having these plumes of water come up into that Grayburg, as more pressure is created by putting more water into the ground.
And then, because it's a high-salinity, heavier-fluid, this injection water is going to eventually, with time, work its way back down, off structure, to the west side of the field. And it's

going to contaminate someday the Goat Seep Aquifer, which is a source of low-salinity water in the Chihuahuan Desert. And you don't want that to happen. You simply don't want that to happen.

And then there's this ROZ in the San Andres that we've been discussing. The water chemistry tells us that it's sulfate rich. And so if you're injecting the high-salinity produced water and if it has any free ions of calcium or sodium or potassium or barium, they are going to mix with the sulfate and they're going to create scale. And that's going to precipitate in the reservoir in this residual oil zone, and it's going to start to reduce reservoir potential. It's basically going to cement up the ROZ. And that's a problem.

And in my 48 years working in the petroleum business, the thing that surprises me about this is that a company that has no working interest in EMSU is allowed to inject this high-salinity produced water into the unitized interval. I've never, ever seen that before. Ever. And to me, that kind of -- that defies why the unit was even made.

MS. HARDY: Those are all my direct examination questions for Dr. Lindsay. He's available for cross-examination and questions from the commissioners. Thank you.

HEARING OFFICER HARWOOD: Commissioners first or parties?

Mr. Rankin, I suspect you may have some questions.

MR. RANKIN: Thank you very much, Mr. Harwood. I do have some questions and I will work my way through them.

CROSS-EXAMINATION

BY MR. RANKIN:

Q. Good morning, Dr. Lindsay. How are you today?

A. Morning.

Q. You and I had a chance to converse in January over your direct testimony that you presented in this case, and it was a pleasure to get to meet you at that time.

I want to just kind of touch on a few things as I walk through your testimony and presentation this morning. And as I do, I'll ask you to bear with me. Okay?

I understand from your summary here that you have an undergraduate degree in geology from Webster State College; is that right?

A. Yes.

Q. And then you obtained your master of science degree in geology from BYU?

A. Yes.

Q. And then you went on to get your Ph.D. in geology from University of Aberdeen in Scotland, right?

A. Yes.

Q. And that was in 2014?

A. Yes.

Q. And the Ph.D. was awarded based on a dissertation that you prepared that was focused on the Grayburg Formation, correct?

A. Yes.

Q. And that evaluation or study you did looked at the Grayburg across the shelf into the Central Basin Platform, correct?

A. Yes.

Q. And it included the EMSU as part of the overall study, correct?

A. Yes.

Q. How many fields within that area was included in your study?

A. It was EMSU-B, EMSU and AGU for right around EMSU. And then, to the east, was McElroy Field, which is on the east side of the Central Basin Platform, towards the south edge.

And then I included work in two mountain ranges, the Apache Mountains, where there's an equivalent to the Grayburg called the Munn Formation, the Lower Munn Formation. And then, in the Guadalupe Mountains, we measured multiple sections, lots of sections for years, so we could use those to guide us in our work, working on EMSU.

And then on the Northwest Shelf, we went to the type section of the Grayburg and described a core that is about 1.9 miles just downdip of the type section of the Grayburg.

The original type section was not cored. It was described via cuttings. So we found a nearby core and described it as well.

And so we tied from the mountain ranges, to the west, to the type section, to EMSU, to McElroy.

Q. It's a large area, right?

A. Yes, yes. Regional.

Q. How many miles across?

A. It was over 200 miles.

Q. Right. And the focus was on the Grayburg right?

A. Pardon me?

Q. The focus was on understanding the Grayburg?

A. On the Grayburg, yes.
Q. And then going back into time, you started with Gulf after your master's degree back in 1976, right?
A. Yes.
Q. And you were with Gulf up through 1985, when Gulf and Chevron merged; is that correct?
A. That is correct.
Q. And upon the merger with Chevron, remind me where you went when Chevron moved. Prior to that merger with Chevron, where were you working for Gulf?
A. I was working at the lab in Houston.
Q. So once Chevron merged with Gulf, where did you go then? Where were you assigned?
A. I was assigned to Denver, to work on mid-continent exploration.
Q. How long were you in Denver?
A. From 1985 to November of 1988.
Q. Okay. And so then after 1988 -- now, just as a reminder, your understanding is that the EMSU was unitized in 1984; is that correct?
A. Yes.
Q. So in 1988, where did you go from there?
A. Well, I was then transferred from Denver to Hobbs, New Mexico, to work full-time on EMSU.

Q. Was that a shock to your system, to go from Denver to Hobbs?
A. No, not really, because I was raised in a small farming town. So it kind of felt like I was going home. Only I wasn't in northern Utah, I was in southeastern New Mexico. It was kind of nice.
Q. So that's when you first came to work on the EMSU, when you were transferred to Hobbs?
A. Say that again.
Q. That's when you started working on the EMSU, when --
A. Yes. Late November 1988.
Q. Okay. And what were your responsibilities when you were assigned to work on the EMSU?
A. It was to describe the cores that were taken. And so the idea was to come in and identify where the cores were and start describing them.
And so the very first set that we started to work on was right through the middle of the reservoir so we could cleave EMSU in half. That's kind of like the old Roman divide and conquer. So we could get a good look-see east-west, right through the middle of the field. Then the idea was to go the north and quarter it, and go to the south and try to quarter it.

Q. And those cores that you were taking at that time, they were all limited to the Grayburg, correct?

A. Yes.

Q. And so you were hired, and your role at Chevron at that time was essentially to help characterize the Grayburg Reservoir?

A. Yeah. To do a reservoir characterization and to connect all the strata together. Because the fields had been unitized into what's called Zone 1, Zone 2, Zone 3, Zone 4, Zone 5 and Zone 6, from top to bottom, now the idea was to correlate in more detail.

Q. I'm going to ask you about that, because I think your description of the cycling was very fascinating, and I want to understand that a little bit better. But we'll get to that once we get to your exhibits.

So then you stayed with Chevron all the way up until approximately 2002; is that right?

A. Yeah. Till 2002, about September 14th or somewhere around there.

Q. Okay. And then at that point, you moved over to work with Saudi Aramco, correct?

A. Yes.

Q. And you finished your career at Saudi Aramco in 2015?

A. I started there in 2002 and worked there till December 4th of 2015.
Q. And then you hung a shingle and are now an independent consultant, correct?
A. Pardon?
Q. You hung a shingle and you're now an independent consultant, correct?
A. Oh, since then, yes. Since I left Aramco, yes. I'm just a consulting geologist now.
Q. Give me a sense for the kind of things you've been doing as a consulting geologist. What fields have you worked on and what kind of consulting have you done?
A. Well, I've done a few different things, because I started to work on things I wanted to do when I didn't have time to do them, when I was working full-time. So I've been doing some of that kind of work.
I went back to one field that I worked on and asked permission to look at some cores to identify a mobility-of-finds issue and shared that data with the company, with Chevron. That was kind of fun to do.
But I started to consult with different companies. I worked on a ROZ core for one particular

company in Midland in the San Andres. And then I worked on unconventional cores for another company, describing Woodford core, Barnett core and Wolfcamp core.

And then I've started to, with a friend of mine, put together a very large core workshop, where we're trying to -- next year, in 2026, the West Texas Geological Society is going to turn 100 years old. And the idea was to go back, 100 years back, and look at some of the original field discoveries that were made in the Permian Basin. And so we're looking -- we've been looking for old field discoveries from 1920 to 1930 and up to about 1934.

And we have identified 22 fields for this core workshop. And we've found 17 cores from some of those fields so people can see what the fields looked like that started up the Permian Basin, what made it tick right off the get-go. So I've been doing that.

And then I've been teaching some classes at my old alma mater, at BYU, free of charge. I'm trying to give back for them being kind enough to let me go to graduate school there and get a nice job. So I would go there and teach stuff of for free.

Then I've helped a couple of students,

one working on a master's degree, on an unconventional reservoir on the Barnett. I helped him get his master's degree. And then I helped another fellow work on his Ph.D. at Texas Tech, and I was on his committee. And he happened to be in one of my classes at BYU when he was a master's student. So it was kind of fun to help him out, too.

Q. Going back to your time at Chevron in Hobbs, when you were working at the EMSU, you were there from 1988 to 2002, during that time, did Chevron ever do any in-house analyses on the prospectivity of the San Andres, at the time you were there?

A. Yeah. That's where we saw the EMSU 679 and described it, and the -- let's see, I think I did the RR Bell-- well, I think both of those, we actually did those a little bit later when we -- because the office moved in 1990 to Midland. And so I think we were doing the description work on those two San Andres cores in Midland. And before that, we were working on the Grayburg cores in EMSU.

Q. What's your understanding for when the EMSU 679 well was drilled?

A. Pardon?

Q. What's your understanding for about when the 679 well was drilled?

A. Was drilled?
Q. Mm-hmm.
A. Well, they wanted to get a good look at -- they wanted to see the fractures and understand them and see if that might have any impact on production. Because at first, the waterflood wasn't working really well in the EMSU, and they wanted to see what the fracture trend looked like.
And so 679, part of it was oriented, and part of that orientation went down into the San Andres. And we tended to just focus at first just on the fractures in the Grayburg, because they were highly focused on the Grayburg.
Then there was another core, orienting core, taken in EMSU-B, the 887. And then we realized that was really valuable, so we went down, when AGU was being unitized, and got two more oriented cores in AGU so we understood what the fractures looked like.
Q. My question was, though, what was your understanding of when the 679 was cored and drilled?
A. When it was cored?
Q. Mm-hmm.
A. That was in 1990.
Q. 1990. Okay.
A. Yeah.

Q. Earlier during your summary presentation, you mentioned the EMSU-B of EMSU-B-887. That was one of the wells you were discussing in which a fracture study had been done, correct?
A. Yes.
Q. And I think at the time of your testimony, you referred to it as the EMSU 887. But it's actually a well that was drilled and cored in the EMSU-B, to the northwest of the EMSU, correct?
A. The only oriented core in EMSU-B is 887.
Q. Right. My point is, though, it's not in the EMSU, correct?
A. No. It's just north of it. It's right on trend. All that separates the two is a line.
Q. Understood. But my point is that it was not in the EMSU, correct?
A. That's correct, yeah. It's literally the next well out of EMSU into EMSU-B.
Q. As a result of Chevron's coring of the EMSU 679, did they pursue any further the San Andres during your time there?
A. To do what with the San Andres?
Q. Did they pursue the San Andres?
A. No, not that -- no.
Q. Did Chevron ever attempt to produce the

San Andres and any of its wells during the time that you were with them, with Chevron?

A. Not that I can recall, but that wasn't part of my job. My job was focusing on putting the architecture of the Grayburg together. So they may have been, they may not have been. But that wasn't part of my job.

Q. What specifically did Empire ask you to do in preparing your opinions and testimony for this case?

A. Oh, just to give an overview of the EMSU, of the kind of work that I've done in the past. Yeah.

Q. And you were seeking to be qualified today as an expert in -- you have been qualified as an expert in reservoir characterization; is that right?

A. Yes. Yes.

Q. Now, at the time you prepared your direct testimony that you submitted in August of 2024, did you review any of Empire's testimony or exhibits from any of its previous submissions to the Division?

A. Say that again. I'm getting old, hard of hearing.

Q. Am speaking too soft?

A. You might put the mic a little closer.

Q. Okay. So, at the time you prepared your direct testimony and filed it in August of 2024 --

A. Yes.

Q. -- had you reviewed any of Empire's testimony and exhibits from any of its previous submissions to the Division?

A. No.

Q. Had you reviewed any of Empire's exhibits or testimony that were filed with your testimony in August of 2024?

A. No, I don't think I did. No.

Q. Did you review any of Goodnight's previous submissions to the Division or Commission that were presented to the Division prior to this case?

A. Yes. When -- you mean for, like, rebuttal? Is that what you mean?

Q. No. Prior to this case -- because Empire and Goodnight have been in previous disputes. Do you understand that? There are other cases that went before the Division between Empire and Goodnight. Do you understand that?

A. Explain that again just a little bit. I'm a little confused here.

Q. Sure. So prior to this case that's currently before this Commission, do you understand the Empire and Goodnight have been in previous

disputes that went to hearing before the Commission?
A. No. I didn't know anything about this till I was contacted about this case.
Q. So at the time of your direct testimony that you filed in August 2024, had you reviewed any of the information, opinions, analyses that Goodnight had presented to the Division in any of the prior cases?
A. Oh, just what I rebutted. Just that. That's all.
Q. But nothing in any of the prior cases? You hadn't reviewed any of the testimony in any of the prior cases that Goodnight had prepared?
A. All I did was, if somebody had written stuff up, I read through that, line by line by line to see if I agreed or disagreed with what had been said. And then I wrote up some notes and sent it to Empire.
Q. Sure. Understood. I guess what I'm getting at is that prior to your review of the information and testimony that was submitted by Goodnight in these cases, you had not reviewed any of the earlier testimony or exhibits that Goodnight had submitted to the Division, correct?
A. I don't think so, no.
Q. Okay. Now, as part of your testimony and your analysis, you have not yourself conducted a study

or an analysis of whether residual oil or ROZ hydrocarbons are economically recoverable from the San Andres and the EMSU, correct?
A. No, no.
Q. And Empire did not provide you with any economic data to support such an analysis, correct?
A. Say that again.
Q. Empire did not provide you with any data to support such as an analysis, correct?
A. No.
Q. Because an economic analysis was not within your scope, correct?
A. No, not really. No.
Q. Okay.
A. Because there you have to get oil-in-place numbers, and that requires a lot of work, enormous amount of work.
Q. Have you previously provided any expert testimony on whether a ROZ could be economic?
A. Say that again.
Q. Have you ever previously provided testimony on whether a ROZ might be economic?
A. You mean the ROZ we're talking about in the San Andres?
Q. Actually, no. Any ROZ.

A. No.
Q. Okay. Have you ever been part of a project to develop a ROZ?
A. What?
Q. Have you ever been part of a project to develop a ROZ?
A. I just helped out by describing the core for this one client, yes.
Q. And in this case, you've not been asked by Empire to conduct an analysis on whether a ROZ in the EMSU is technically recoverable, correct?
A. No.
Q. Because your expertise is just in characterizing the rock, not in whether the oil can be extracted, correct?
A. Yes.
Q. And so you have no opinion about what the recovery factors or how much oil, if any, might be recovered from the San Andres in the area that you've identified as a potential ROZ?
A. No. Because there's not enough data right now.
HEARING OFFICER HARWOOD: Mr. Rankin, it's almost 10:30. We should probably take a ten-minute break.

MR. RANKIN: Now is a great time.
CHAIR ROZATOS: Let's do that. We'll be back at 10:40.
(Recess held from 10:29 to 10:40 a.m.)
HEARING OFFICER HARWOOD: Let's go back on the record, please.
MR. RANKIN: May I proceed?
HEARING OFFICER HARWOOD: One moment, please. The Commission members, during the break, would like to have a better idea of who Empire's witnesses are going to be for the rest of the day, after Dr. Lindsay. Can you help us out with that? Do you have a witness order, Ms. Hardy?
MS. HARDY: Yes. Our next witnesses are Ryan Bailey and Scott Birkhead after Dr. Lindsay.
HEARING OFFICER HARWOOD: And is that it for the day?
MS. HARDY: I think it depends on how far we get.
MR. RANKIN: I guess it would be helpful, Mr. Hearing Officer, to know. Because, you know, I guess based on the prehearing statement, we understood they were going to be in a different order. And in going forward, that certainly would be helpful. I know the Commission probably is reviewing

testimony based on the order that was described. And if it's going to be different going forward, I think we'd like to know.

HEARING OFFICER HARWOOD: Yeah, I think that's only fair. And, you know, over the lunch hour, maybe you could give Mr. Rankin and the other parties a better idea of who is coming up next over the next few days.

MS. HARDY: Sure. Happy to do that.

HEARING OFFICER HARWOOD: So for now, Ryan Bailey and Scott Birkhead are your next witnesses?

MS. HARDY: Yes. And then Jim Buchwalter.

HEARING OFFICER HARWOOD: Okay. So you have somebody else. All right. Great.

Anything further, Mr. Rubin, before we turn this back over to Mr. Rankin?

MR. RUBIN: Nothing further, Mr. Harwood.

HEARING OFFICER HARWOOD: All right, Mr. Rankin. The floor is yours.

MR. RANKIN: Thank you, Mr. Hearing Officer.

CROSS-EXAMINATION (continued)

BY MR. RANKIN:

Q. So, Dr. Lindsay, I think I was just getting ready to get into the testimony. Can you hear me better now?

A. Yes.
Q. Okay. I'm going to try my best to enunciate and have a little more diction and project.
A. Okay. Thank you.
Q. Now, Dr. Lindsay, you had been retained by Empire to provide testimony earlier in these cases, back in 2023, correct?
A. That's correct.
Q. Okay. And you had prepared written testimony that was filed with the Division, Oil Conservation Division, initially back for a hearing in November of 2023, correct?
A. Yes.
Q. Now I'm going to put on my screen that testimony, because I just want to make sure I have the right -- I have a couple questions for just about what changed and why. Okay?
A. Okay.
Q. Let me know when you can see the screen in front of you.
A. I see it.
Q. Now, just to confirm, I have on the screen here what I understand is your original testimony from November 2023 that was filed with the Division. And I'll go down to the signature page just so you can

confirm that's the date that you submitted this testimony and that this is that testimony.

Do you see your signature dated October 2023?

A. Yes.

Q. So this was your original testimony that you submitted to the Division in these cases, correct?

A. Yes.

Q. Okay. Very similar testimony that you submitted back in 2023. I'm not going to ask you to go through all the changes and differences today, okay, but I want to just point out a few things so that I understand better and maybe the Commission does, too, about what changed.

Here on the second page of your 2023 testimony, I've highlighted a couple passages that I want to just talk about.

Here you described, under your heading A, "The proposed SWD wells would inject into San Andres Formation which contains a residual oil zone."

Did I read that correctly?

A. Yes.

Q. And the SWD wells you're referring to here are Goodnight's wells, correct?

A. That's correct.

Q. And you go on to explain that while looking at cores and characterizing the Grayburg and San Andres reservoirs, it was discovered that the San Andres contains a residual oil zone, correct?

A. That's correct.

Q. Now, I understood that what Chevron was doing was not characterizing the San Andres but was characterizing the Grayburg; isn't that true?

A. That's true.

Q. Now, here, below that first entry I read under Paragraph 6, you go on to say that, "San Andres Reservoir at EMSU contains oil-saturated porosity down section to depths of minus 719 feet (subsea) to potentially minus 750 feet (subsea) and is a residual oil zone."

Did I read that correctly?

A. Yes.

Q. Okay. Now, I'm going to switch over to your 2024 testimony. Okay? This also is marked Exhibit B. And you'll see I have your signature page here, which indicates that you signed and submitted this testimony on August 13, 2024, correct?

A. Yes.

Q. And I'll go back up to the top of this

testimony just to see that -- in fact, this is the new one because it has all these other cases in it, right?
A. Okay.
Q. I'm going to skip through some of the initial stuff, but you'll see I'm going to get to an entry here in this testimony that's very similar to the one we were just reviewing, from 2023.
And again, it has a heading that says, "The proposed SWD wells would inject into San Andres Formation which contains a residual oil zone," right?
A. Yes.
Q. Now, here, again, similar entry, but under the first bullet, it says, "The Upper San Andres Reservoir at EMSU contains oil-saturated porosity down section to depths of minus 719 (subsea) to minus 750 (subsea)," and you go on to say, "and potentially deeper and is a residual oil zone."
Did I read that correctly?
A. Yes.
Q. Now, during your deposition back in January, you explained to me that the reason you made this change, and the change was that you added the language "and potentially deeper," right, deeper than minus 750?
A. Yes.

Q. And the reason you made that change to that portion of your testimony was because you went back and locked again at the core and took pictures of it and saw visible oil staining below minus 750, correct?
A. Well, at the base of the core.
Q. How deep is the base of the core subsea?
A. We would have to go back and look at that.
Q. Okay.
A. That's Plates 1 and 2.
Q. Okay, yeah. Off the top of your head, you don't recall?
A. Not off the top of my head. But being a good exploration geologist, when you see oil saturation at a base of a core, that tells you it must be going deeper.
Q. Okay.
A. That's why that statement is in there.
Q. Very well. But off the top of your head, you don't know how deep it was? I mean, it's about 760 feet, or what, is the base subsea?
A. We'd have to go back and look at that. But it's on both cores, the 679 and the RR Bell, both of them.
Q. Do you recall what plate or figure it was in your exhibits that have the images?

A. Well, it would be Plate 1 and Plate 2. So they would probably be at the end. Because these are figures.

Q. I guess we can just do it off the core report, too, couldn't we?

A. We could do --

Q. That doesn't have th subsea depth, does it?

A. No, it doesn't. No. Yeah. Oh, boy, now we'd have to zoom in and look at the -- let's see if we can get over and go down.

You'll still end up with just the -- now there's minus -- right -- right -- go back to the left. Go back to the left just a little.

There's minus 750 right there. Okay? And that's a 10-foot box of core. So if you go down, so there's 10. So that would be minus 760, 61, 62.

Q. So the base of the San Andres -- I'm sorry, the EMSU 679 core is minus 762 subsea, correct?

A. That would appear to be the answer.

Q. So when I zoom back out, and just to keep this in everybody's mind, and at some point I'll come back and refer to this core report, but it's in your tables, I think, B-1 through B-8, is that correct, for the EMSU 679?

A. Mm-hmm.

Q. So this is the core report for the EMSU 679, and it doesn't have subsea depths, but it does have the measured depths --

A. That's correct.

Q. -- on this column?

Okay. So that measured depth of 4357 is going to be equivalent to minus 762 subsea, correct?

A. That should be.

Q. Okay. Any reason to think it's not?

A. No.

Q. Okay. So you agree with me it would be minus 762, right?

A. It should be, yes.

Q. Why wouldn't it be?

A. Pardon me?

Q. Why wouldn't it be?

A. Well, we've got that listed on the plate. And we never do subsea in core analysis. We never show that. We show the measured depth. Okay? And we never, ever put subsea values in the core analysis.

Q. So the base of the core is minus 762, correct?

A. That's what it should be, yeah.

Q. Okay. And is there any reason to believe that the core report would have left any footages off the core report?

A. They always show the missing intervals.

Q. So there's nothing missing from this core report, agree?

A. It should be.

Q. It should be what?

A. It should be complete.

Q. But sitting here today, you have no reason to believe that this core report is incomplete?

A. Yes.

Q. Yes what? You have no reason to believe that it's not incomplete? You agree that it's not incomplete?

A. No, it's not incomplete.

Q. Okay. Thank you.

So going back to my questions, you went back and reviewed the core, took pictures of it, saw visible oil staining below minus 750 subsea, right?

A. Yes.

Q. And that's why you came back and updated, revised your 2023 testimony, to include this additional language that says "and potentially deeper," correct?

A. That's correct.

Q. Now, I guess my question to you is, so based on that, then, based on visual inspection of the core, you did amend or update this statement, right?

A. Yes.

Q. But all that information was available to you at the time of your 2023 testimony, correct?

A. Yes.

Q. Okay.

A. Oh, no. No, it wasn't. Because I don't -- I can't recall between the first statement and this one when we took the pictures of the core. And when we took the pictures of the core is when I saw the oil saturation at the base of the core.

Q. I guess my point, though, is that that core was there, and you knew where it was and you could go review it as part of your preparation of your 2023 testimony, correct?

A. No.

Q. Why not?

A. Because it was at the Bureau of Economic Geology, and I had to contact them and ask them permission to get the core to look at. And so it was not available to me.

Q. You asked for permission and they gave you permission to view it between the 2023 and 2024?

A. Yes, somewhere in there. And that's when we wanted to go and take photographs of it, so you could see visual oil saturation in the plain light views and UV light oil saturation views, as well. And so we took it over to Core Lab after I got permission to look at it.

And when we got the photos back is when I noticed in one of the cores, what you really couldn't see with your eyes that well showed up with UV light. And we realized right at the base of both cores we had oil saturation.

Q. My point is, though, Dr. Lindsay, is that in order to get access to the core, you just had to ask for it, right?

A. I had to ask permission, yeah.

Q. And you could have done that leading up to in preparation of your 2023 testimony, correct?

A. I could have, yes.

Q. Now, your amendment or your update to your 2024 testimony was not based on your review of the core report, correct?

A. Oh, this amendment?

Q. Right.

A. It was by seeing the oil saturation in the core photos. Then I went back and looked at --

Q. Right. But you had the core report, as well, back at the time of your 2023 testimony, correct?

A. Yeah, I did. Yeah.

Q. And that core report provides your oil saturations as measured in the core, correct?

A. That's correct, yeah.

Q. Now, looking at this header here, "The proposed SWD wells would inject into San Andres Formation which contains a residual oil zone," that sounds very definitive, right?

A. Mm-hmm.

Q. But your deposition with me, you testified that in your opinion the Upper San Andres in the EMSU has a potential ROZ. Do you agree?

A. Yes.

Q. So is it your opinion that there's a potential ROZ in the Upper San Andres?

A. Yes.

Q. But during your deposition with me in January, you testified that it's your opinion that there's a confirmed ROZ in the Grayburg within the EMSU, correct?

A. Yes.

Q. Okay.

A. And that's totally different than the

San Andres ROZ.

Q. Okay.

A. We're talking about two different animals.

Q. I want to explore that with you today. We'll get there.

Now, when we were discussing the different animals, okay, the two different ROZs, we discussed that, in your opinion, the Grayburg ROZ in the EMSU stops at the base of what you identify as Grayburg Formation, agree?

A. Yes.

Q. Okay.

A. Yes.

Q. And your testimony was in your deposition that there's another potential ROZ in the Upper San Andres, right?

A. Yes.

Q. And your opinion is that there's a composite sequence boundary. And it's in that beautiful chart you did with all the cycling within the Grayburg. You testified that there's a composite sequence boundary at the base of the Grayburg, correct?

A. Yes. That sits on top of the San Andres.

Q. And there's another composite sequence boundary at the top of the Upper San Andres, correct?

A. It's the same boundary.
Q. Okay.
A. The base of the Grayburg and the top of the San Andres is the same composite sequence boundary.
Q. Okay. Just to be clear, so you're saying -- I understood from your testimony in the deposition that there was a composite sequence boundary at the top of the Grayburg?
A. At the top of the Grayburg, yes.
Q. Let me rephrase. That there was a composite sequence boundary at the base of the Grayburg and another one, meaning underlying that, within the top of the San Andres?
A. They're the same.
Q. They're the same. Okay.
A. They're the same, yeah.
Q. Now, if you would, just explain what a composite sequence boundary is, if you would.
A. It's when you have a larger drop in sea level. That's the simple answer.
Q. And what happens when you have a large drop in sea level to the sediments when that occurs?
A. Being carbonates, when you have -- it's not only a larger drop in sea level, it's over a longer time, too. And so you have plenty of time for

rainwater to start to dissolve into the carbonate. And you start to etch it and you start to dissolve it. And ultimately, you start to karstify the rock if you have enough time and enough water.

Now, this was in a desert setting, so it was a slow process. But you can ultimately start to make sinkholes, and collapse breccias will fill into those sinkholes. And that's precisely what we see when we describe the EMSU 679.

Q. So when you and I were discussing this topic during your deposition, we talked about that composite sequence boundary, and you told me that it's generally reflective of a lower permeability and lower porosity interval, correct?

A. Yes.

Q. Okay. And generally, it serves as a barrier to flow, correct?

A. It can serve as a barrier.

Q. Okay.

A. But it might not be laterally continuous.

Q. Thank you. Now, the other topic, as we were discussing, these two different ROZs, that one that you believe is confirmed to exist in the Grayburg, and then another that is potentially in the Upper San Andres, at the time you and I were discussing this back in January during your deposition, I asked you if you were aware of any circumstance where there was a ROZ across a low-perm or no-perm boundary or composite sequence boundary. Do you remember that question?

A. Hmm.

Q. And you told me that you're not aware of any?

A. Say that again. Explain that.

Q. I asked you during your deposition if you were aware of any other circumstance, any circumstance where there was a ROZ across a low-perm or no-perm boundary.

A. Okay. So you're referring to the top as the San Andres. Okay. I --

Q. I'm referring to your testimony is that there's a confirmed ROZ in the Grayburg.

A. Yes.

Q. There's a composite sequence boundary that separates the Lower Grayburg from the Upper San Andres, correct?

A. Correct.

Q. And your testimony is that there's a potential ROZ in the Upper San Andres, correct?

A. Yes.

Q. And I'm asking you, do you recall your testimony in the deposition that you said that you're not aware of any other ROZ where there is a ROZ that goes across a composite sequence boundary?

A. Oh, you mean that you're communicating?

Q. No, I'm asking are you aware of any other circumstance where there's a ROZ above and below a composite sequence boundary?

A. Not off the top of my head.

Q. Okay.

A. There could be.

Q. There could be, I guess. But I asked you that question back in January and you said you weren't aware of one. And now, here we are in February, and you're still not aware of one, correct?

A. Yeah, yeah. To the best of my knowledge, yes.

Q. And at the time when we talked about a ROZ, and I think you kind of touched on this in your opening summary, I asked you what your definition of a ROZ is, and you told me that basically, it's a residual oil zone, it's anything that has oil saturations greater than 20 percent and up to about 40 percent or until you get to the point where you have mobile oil. Agree?

A. Yes.

Q. And just out of curiosity, do you have any sense for what oil saturations are required to achieve mobile oil in the EMSU?
A. No.
Q. Have you ever studied that?
A. No.
Q. So you're not sure, as you sit here today, and you haven't looked at it, what oil saturations would result in mobile oil?
A. No.
Q. Okay. And you and I talked about this, and I think you -- you told me in your -- at the time you're not aware of any ROZ projects that are pursued ROZ zones with average oil saturations below 20 percent, right?
A. Yes.
Q. And that's still true today?
A. Should be, yes.
Q. Okay. And potentially commercial ROZs, one with a baseline or a lower baseline, a lower threshold at the base of the ROZ of 20 percent oil saturation up to around the point of mobile oil, right?
A. Yes. Yes.
Q. And just to understand conceptually how these ROZs look, generally, when you go from the top

of the ROZ, top of the interval, where it may be defined as a ROZ, you go from higher oil saturations down to lower oil saturations, correct?
A. That is correct.
Q. And then in the upper part of the residual oil zone, some of the oil is going to be mobile generally; is that right?
A. Yes. It's how you define the word "mobile." Yes.
Q. How do you define the word "mobile"?
A. Well, I would first say that some of these ROZs actually have a little bit of mobile oil in them that has actually migrated back into them, and that's why you get slightly higher oil saturations at the top compared to the bottom.
And so when you come in and you try to do these long horizontals and produce them, that's how you get some of the mobile oil out, because there's a little bit of mobile oil in to begin with. Just a little, not much. But that's just my perspective and my interpretation.
Q. I want to talk a little bit more about the concept of how these ROZs are created. And you gave a little bit of preview of it in your summary, and I want to get into it some more because I find it

fascinating. Okay?

And I'm going to put up on my screen and I'm going to stop -- well, let's see. We talked about this during your deposition. This was a document that you produced to Goodnight, Dr. Lindsay, as -- I believe actually it was the only document you produced to us as a document that you referenced or relied on in preparation of your initial direct testimony. Do you recall that?

A. Mm-hmm.

Q. So this was the sole document that was produced to us that you had reviewed or had referenced or relied on in the preparation of your direct testimony. And I thought it was very fascinating and I want to just kind of talk through it with you here.

This was, I understand, an abstract from a talk that you gave in 2024 at the American Association of Petroleum Geologists annual meeting in Houston, correct?

A. That's correct.

Q. And the first part of the abstract is an overview of the process that the literature refers to as "Mother Nature's Waterflood," correct?

A. That's correct.

Q. And it explains the -- sort of the tectonic mechanism that you discussed in your opening that allowed for Mother Nature's Waterflood, or this meteoric atmospheric water, to flush through the various formations downdip, sweeping oil out of the formations, right?

A. Yeah. Out of the structural closures.

Q. And then it also explains the source of the water, right?

A. Yes.

Q. And that would be atmospheric or what's called "meteoric water"?

A. Yes.

Q. And then at some point, after multiple pore volumes, I guess, if you would maybe just -- I use that term, but if you would explain what a pore volume is?

A. If you look at, say, like, original oil in place, there's a pore volume of oil. Okay? So if you're sweeping something, you're putting that much pore volume through the rock.

Q. Okay.

A. Okay? And then the catch is: How many pore volumes swept through the rock between 40 million and 16 million years ago? That's an enormous amount of fluid.

Q. Yeah. And I think Mr. Melzer, who is here, and some of the other experts, you know, discussed ROZ, given an assessment of dozens and dozens of multiple pore volumes that swept through both the Grayburg and the San Andres during that period, correct?

A. Yes.

Q. Okay. And that's the process that moved the oil out of those formations downdip, down in the south and east of the Permian Basin, Delaware Basin and basically into Texas in the eastern side of the Central Basin Platform, correct?

A. Yeah. We don't know how far it got pushed, but it got pushed out of the closures.

Q. And that wasn't just the Grayburg and San Andres. It was any formation that had porosity and permeability, right?

A. That's correct.

Q. And I think in the slide that you presented in your summary, you had the Guadalupian and Leonardian formations all were included in that sweep, right?

A. What was shown was that -- the pathways was just the San Andres, when you look at Map 2, that one illustration.

Q. I'm referring to this one.
A. Oh, the cross-section here.
Q. Because I think you're showing here that across the Delaware Basin that you have Guadalupian, Leonardian and the Wolfcampian; Pennsylvanian even, I think.
A. You have the opportunity to do that because there was a study done in a field called "Indian Basin" where they found it was swept down into the Pennsylvania, and they assumed it was by Mother Nature's Waterflood. And they had pretty good data to prove that.
Q. So just to orient ourselves here, we're looking at a cross-section from west to east, I presume looking north?
A. No. This is east-west -- oh, I'm looking north, that's correct.
Q. Okay. So I see west on the left and --
A. And east on the right.
Q. Okay.
A. Yes.
Q. Okay. And the middle is the Central Basin Platform, right?
A. Yep.
Q. And approximately, based on that, the EMSU

would be located just on the sort of margin of the Central Basin Platform, correct?

A. Yes. Yes. In the Guadalupian.

Q. In the Guadalupian. Okay. And what's interesting about the EMSU in this particular location is it's on the shelf margin, right?

A. Yeah. You've got to move that over.

Q. To the right or to the left?

A. To the right.

Q. Yeah, it's a little bit more to the right, you think?

A. Yes.

Q. Okay. But it's still on that ramp, that --

A. It's right on the margin.

Q. So forgive me for my non-geologic location, but I was trying to -- so that's in the approximate location of the EMSU, correct?

A. That's correct.

Q. And when we get into your cycling, I think I want you to explore with me a little bit about how the fact that it's on this margin shelf makes the EMSU a complex system, okay, that you spent a lot of time exploring?

A. Mm-hmm.

Q. So you told me that the Guadalupian includes the San Andres and the Grayburg, right?

A. The San Andres is actually in the upper part of the Leonardian. The Grayburg is in the Guadalupian.

Q. Just to reiterate, any formation that had porosity along the west of the Delaware Basin then, had water entry into it, correct?

A. It could have, yes.

Q. And the Mother Nature's Waterflood, as we call it, is what swept all that mobile oil out of those zones, wherever it was, including the structural traps, including out of the Grayburg and the San Andres, right?

A. Mm-hmm.

Q. Okay. Now, that process continued, as you describe in this abstract, and as you did in your summary, until the Rio Grande Rift essentially interrupted the hydraulic dynamic, right?

A. Yes. It destroyed it.

Q. And so that hydraulic head that was pushing all that water downdip and sweep oil, was essentially terminated, right?

A. That's correct.

Q. Now, what I thought was fascinating is that, as a result of that termination and the loss of that hydraulic head, as you describe, some of that water that had been previously swept and migrated back and partially re-saturated some of the formations that had previously been swept, right?

A. Yes. It wasn't the water. It was the oil.

Q. I'm sorry. The water was backfilled and partially re-saturated some of those formation that had been swept, right?

A. Well, the water pushed it out. Then the head of energy went away and so the oil could migrate back into the trap, if it hadn't been pushed past a regional spill point.

Q. And in this situation here, I think we discussed during your deposition, that you told me that the Grayburg had partially re-saturated with mobile oil in the EMSU, correct?

A. That's correct.

Q. But not in the San Andres, right?

A. And the San Andres did not. Right.

Q. Now, in the abstract you write that this explains why ROZ plays exist in the Permian Basin, right?

A. Yes.

Q. And what do you mean by -- when you say "exists," you mean that's the process of re-saturation that explain why ROZ plays exist in the Permian Basin, correct?

A. Well, there's the ability to re-saturate just a little bit with mobile oil, and that just helps you out. And that's why you have a change of higher oil saturation in the top of a ROZ to a lower oil saturation at the base.

Q. Right. Now --

A. Otherwise, it would all be the same.

Q. If it had been completely saturated, right?

A. If it was swept and uniformly pushed out, it should be the same.

Q. That assumption is based -- that's based on the assumption that there was complete oil saturation prior to Mother Nature's Waterflood, correct?

A. Yes.

Q. Now, so then I think we talked about this, and this gets into the mobile oil. We discussed this during your deposition, that a lot of ROZs probably were re-saturated, this is your saying, with some mobile oil, so that when you pump them off with water to lower the pressure. You would get some production, you get some mobile oil coming out of that residual oil zone, correct?

A. Yes.

Q. Now, because generally, otherwise, right, residual oil zone wouldn't move, it wouldn't be mobile at in situ conditions within the reservoir because it's become essentially immobile, right?
A. Most likely.
Q. Most likely?
A. Most likely.
Q. And that process --
A. That's a very fine line.
Q. I'm sorry. Very fine line.
A. That's a very fine line.
Q. And you haven't looked at, you're not aware, you can't tell me what -- at what oil saturation oil will become mobile, right?
A. No.
Q. Okay. Now, the reason that oil is not mobile or not often mobile in the residual oil zone is because it had been swept so many times with multiple or dozen pore volumes of water, right?
A. Yes.
Q. And that water strips the oil from the pores and the rocks and overcomes the Van Der Waals forces, and whatever else is holding the oil in place, and moves it down out of the structural traps, right?
A. Yes.

Q. And all that's left then is the oil that is actually very well trapped to the rock and is unable to be swept, or poor quality rock, right?

A. Yeah. It's residual.

Q. Generally, after a residual oil process, such as that, the oil that's remaining is in the poorest quality rock, the lowest porosity, lowest permeability rock?

A. It could be, yes. It says even some of the porous rock, too.

Q. Some of the what rock?

A. In some of porous rocks.

Q. Some of the porous rocks?

A. Yeah.

Q. Even though it was swept by multiple pore volumes?

A. Mm-hmm.

Q. How would it stay in those porous rocks?

A. It just didn't have enough time to push it all out. Depends on the wettability of the rock. If it's oil wet, there's going to be a film around the pores, and there would be a little bit of oil left.

Q. My understanding is, Dr. Lindsay, that as a result of Mother Nature's Waterflood, generally the wettability changed from -- if it existed before as

water wet, it would generally change to oil wet. Is that your understanding as well?
A. We haven't done enough work to know that. Okay? So I can't answer that question.
Q. You haven't looked at that as part of your testimony today?
A. No.
Q. Okay. So we talked a little bit previously in your deposition about generally how and where these ROZs were. I'm trying to see if we have a good image, map view of how Mother Nature's Waterflood swept. And I don't know that it's in your testimony.
A. Well, you have that one map right there before you of the San Andres.
Q. This one here?
A. No.
Q. This one?
A. It's that right there.
Q. I guess we can use this. So it's a little hard to see, and I'm going to ask your -- this is Exhibit B-2 of your testimony, correct?
A. Mm-hmm.
Q. This shows the approximate location of the city of Hobbs, right?
A. Yeah. That's the Hobbs Field, yes.

Q. And just to the southwest, but approximately where my cursor is, is that approximately where the EMSU is?
A. Yes. That whole area right there.
Q. You're identifying here on this map the different fairways. And this Artesia Fairway, which I think is two arrows, is essentially where Mother Nature's Waterflood would have passed through the San Andres and the Grayburg, correct?
A. Yes.
Q. So it would have -- it followed this pathway down, along through the San Andres, pushing water out of the EMSU, down south, like, as you said, we don't know exactly how far.
A. Yes.
Q. But potentially down all the way down into Texas. And sometimes, I think there were these things called liniments that pushed some of the oil across the Central Basin Platform into the Midland Basin, correct?
A. That, I don't know.
Q. But that was the general pathway that Mother Nature's Waterflood followed, pushing all this water out of these zones, correct?
A. It followed regional porosity, yes.

Q. And Mr. Melzer and Dr. Trentham spent a lot of time evaluating what those porosities and permeabilities were in the fairways, correct?
A. Yes. That's their map.
Q. That's their map. And when we get to their testimony, we'll get into that.
Now, I asked you about this, and I asked you whether or not, based on your experience and review, whether you're aware of any ROZ developments, commercial, pilot, any kind of ROZ development, that's on the west side of the Central Basin Platform and the fairway that we just discussed.
A. On the Central Basin Platform?
Q. To the west of it.
A. To the west. So that would include the Northwest Shelf?
Q. I'm excluding the Northwest Shelf.
A. Okay. I'm not aware of any.
Q. In fact, all the ROZ developments, commercial, pilot, or otherwise, are either on the Northwest Shelf, up here, or just above the Central Basin Platform, or on the eastern edge of the Central Basin Platform to the middle third of the Central Basin Platform, correct?
A. It would be over, like, around Seminole and

other areas along there.

Q. Right. In fact, that's where all the major ROZ developments are located, correct?

A. Well, and further north.

Q. And further north, along the Northwestern Shelf, right?

A. Yes.

Q. Now, going back to your abstract here that we were discussing, you divide the ROZs between an upper and a lower ROZ, correct?

A. Yes.

Q. And in this abstract, you describe that the upper ROZs all have higher oil saturations, correct?

A. Yes.

Q. And those, as you described in your abstract, those are potentially productive, right?

A. Yes.

Q. And then you say the lower ROZ just remains a ROZ, right?

A. Yes.

Q. And in your abstract you say that evidence for these two reservoirs being completely swept of mobile oil is from this detailed reservoir characterization that you discuss in this abstract. And, really, in this case, we're focused on two

fields, the EMSU and the -- what was the other? -- McElroy Field, right?
A. Yes.
Q. And the McElroy Field was also the subject of -- was included in your Ph.D. dissertation?
A. That's correct.
Q. And as I scroll up, you give a long list of the types of data and the reservoir characterizations that you did that helped you to identify the Grayburg as a potential ROZ, correct?
A. Yes.
Q. And all these data points and reservoir traits were all limited to the Grayburg, correct?
A. That's correct.
Q. Okay. Now, I want to talk a little bit about what Goodnight has identified as a permeability barrier that separates its disposal zone in the San Andres from everything above it. Okay?
At the time you prepared your direct written testimony back in August of 2024, you did not evaluate where Goodnight had identified a permeability barrier in its wells, correct?
A. State that again.
Q. At the time you prepared your direct written testimony in August 2024, you did not evaluate where

Goodnight identified a permeability barrier in its wells, correct?
A. I think that's correct.
Q. When you and I discussed it at your testimony in your deposition, you confirmed that you had no looked at it when you prepared your testimony?
A. Okay.
Q. Right? Do you agree?
A. That's -- yeah. Yeah.
Q. Okay. Now, Empire did not ask you, as part of your analysis and opinion, to look at that, correct?
A. I don't recall them asking me that, no.
Q. Okay. And you did not discuss the location of Goodnight's permeability barrier with any of Empire's other experts before submitting your August 2024 testimony?
A. No, I think we talked about that.
Q. Who did you talk about it with?
A. It was with some of the other staff members.
Q. Okay. But you did not yourself evaluate where Goodnight had identified a perm barrier in its wells or across the San Andres, correct?
A. Let's see. I have to think about that. Because you kind of --

Q. Go ahead.
A. We thought -- when I was first doing my work, I thought there might be a barrier there. But then the more closer you start to look at the database, where you have a little bit of data, you find out those tight spots, less porous spots, come and go.
Q. Where?
A. That's the top of the San Andres.
Q. What you define as the San Andres, correct?
A. Which is the San Andres.
Q. I know. But in terms of where Goodnight had picked a perm barrier, you did not evaluate where that is located, correct?
A. No, because I kind of couldn't find one, to tell you the truth.
Q. But you didn't look at their testimony or their analyses or their experts --
A. No.
Q. -- to decide --
A. No.
Q. -- where they're putting it, right?
A. No.
Q. And Empire didn't ask you to do that, did they?

A. No.

Q. Okay. At the time of your August 2024 testimony, you had not evaluated the San Andres top picks used by any of the other saltwater disposal operators in and around the EMSU, right?

A. No.

Q. And at the time of your 2024 testimony, you also did not evaluate all the different picks that Empire had picked for the top of the San Andres across all its wells in its structure maps, right?

A. No.

Q. Sticking on the same topic, I'm going back to your testimony from '24, Exhibit B, and I'm going to the header labeled "F."

And here you say that, "Documentation shows there is not an effective seal between the overlying Grayburg producing zone and the underlying San Andres." And then it says in parenthesis, "(Can be found on is SPE papers)," correct?

A. Mm-hmm.

Q. Now, the phase in parenthesis, "(Can be found in SPE papers)," that's not your testimony, is it?

A. No.

Q. Mr. Jack Wheeler with Empire added that to your testimony, correct?

A. I think so, yes.

Q. And you do not adopt that statement as part of your testimony, correct?

A. Yes.

Q. Because you told me during your deposition that you don't have any SPE papers to show that, correct?

A. That's correct. But then I did get an SPE paper later.

Q. Which is that?

A. It's on a Seminole San Andres Unit.

Q. Who's the author?

A. There's a series of authors with Hess.

Q. Was that included in the any of documents that you reviewed, referenced or relied on that you provided to Goodnight?

A. No. It was more recent.

Q. When did you become aware of this paper?

A. About a month or two ago.

Q. Who brought it to your attention?

A. A friend of mine, Bob Trentham.

Q. So if I ask you for it during the break, is that something you can provide to me?

A. I can give that to you, yes. I'll have the attorney give it to you.

Q. But as you sit here, you don't know who the authors are or when it was published?

A. I have it my backpack. I could print it off and you could have a copy.

Q. Just so everybody's aware, because I think it would be helpful, the place where we're talking about here, so we're some distance to the southwest of Hobbs with the EMSU, but the Seminole San Andres Unit is over here, on the northern part, portion of the Central Basin Platform, correct?

A. Mm-hmm.

Q. So that's the location you're talking about?

A. Yes.

Q. Okay.

A. You know, now that you brought it up, on that SPE paper that you want a copy of it, that's the paper where they compared the residual oil zone, the conventional core, sponge core, and pressure core. Great piece of work.

And they found that if you're at 18 percent with a conventional core, a sponge core would find 24 percent instead, and a pressure core would find 32 percent. So all these numbers that I've shown for my core analysis is conventional. And

that's basically saying there's far more oil there, it's just been swept out by the coring process.
Q. While we're on that topic, okay, since you brought it up, I'm going to just take a small diversion in my examination to ask you about that.
Now, we're talking about two very different locations, the Seminole San Andres Unit, which is up on the northeastern part of the Central Basin Platform?
A. Yeah. The northeast corner.
Q. Okay. And then we're talking about the EMSU, which is on the southwest kind of margin of --
A. The northwest corner.
Q. -- the northwest corner of the Central Basin Platform. Okay. Now, have you yourself done any analysis or evaluation of the effect of the conventional core and bleeding off of oil saturation from that coring process?
A. It's a standards thing to know that when you're coring, you have to have a big head of energy to lift the cuttings all the way to the surface. So you're probably a thousand pounds of extra pressure that's sweeping through the core and pushing all this oil out. Then when you pull the core to the surface, more oil goes out on top of that.

And so the saturations you're looking at are pretty darn low compared to what they used to be.
Q. Understood. And I think nobody would argue that there's going to be some bleed, right, from conventional?
A. Right. And that's the beauty of the work that was done in the Seminole.
Q. So my question of you is specifically asking your background and experience. Have you yourself done any evaluations, assessments, studies about loss of oil from conventional core?
A. No. We just know that it happens.
Q. Okay. So based on that, are you aware, would you agree with me, that the gravity of the oil, the viscosity, how much dissolved gas may be in the oil, all those sorts of factors would influence how much oil may be bled or lost from a conventional core?
A. Yes.
Q. Of course, right?
A. Yes.
Q. So to evaluate bleed or loss from the conventional core, would you agree that it's important to understand what those other factors are and what the nature of the oil is at question?
A. Yes.

Q. Okay. All right. We got distracted a little bit. I was trying to get into this section here with the header F. And we talked a little bit about this header and the statement about these SPE papers.

Do you know, Dr. Lindsay, if the SPE paper you're referring to about these conventional cores in the SSAU, do you know if those are the papers that Mr. Wheeler was thinking about when he inserted that in your testimony?

A. I have no idea.

Q. Okay. Now, during your deposition with me, then again during your summary, and then your written testimony, you talked about that it was common knowledge while you were working at Chevron that there were water plumes extending up out of the San Andres into the Grayburg, correct?

A. That's correct.

Q. Okay. And I think you told me, and I don't recall if it was stated in your summary, but you told me during your deposition that no one had mapped them, right?

A. At EMSU, yes.

Q. Right. Okay.

A. There was one map by a guy named Tracy Love in an SPE paper where he showed higher water saturations versus lower water saturations on a well-by-well basis, and had an illustration.

Q. Do you happen to recall, was that a 1998 SPE paper?

A. Somewhere around there. I can't remember. No, I think it was -- well, I'm not sure of the date on it. But it was Love and McCarty.

Q. Is this the paper, Dr. Lindsay?

A. Let's see. Let me look at it. Yeah, it might be. There should be a map in there, if you scroll down. There should be a little map of this field. Yeah, there it is.

Q. This is the map you're thinking about?

A. Yeah.

Q. And this is the map that, in your recollection and your understanding, shows wells that have a higher water cut?

A. Yes.

Q. And your understanding is this map reflects pluming of San Andres water under the Grayburg?

A. Potential pluming, yes.

Q. Okay.

A. But that's about the only one. Because it was such a well-known fact that no one made a map.

And then years later, Tracy and Andrew put this map together that may show where the plumes are.

Q. So if I look at this map, I'm going to just go down and I'm going to highlight -- I've highlighted here what the title of this figure is, and it says, "Wells that have symptoms of poor reservoir performance are marked by a large circle."

So your understanding is that the wells with these big circles are the wells where there are higher water cut, correct?

A. There should be, yes.

Q. Okay. And I'll scroll back up, because I think they discuss this figure up here in the paper.

MR. RANKIN: And just to be, clear, just for the benefit of the commissioners, I'm going to ask that this paper, because I don't think it's already in evidence, I'm going to ask that this paper be marked as Goodnight Cross Exhibit Number 1. Okay?

I haven't yet marked it, but I will do so and I'll submit it for the record. But I haven't yet introduced it as an exhibit.

HEARING OFFICER HARWOOD: Does Empire object?

MS. HARDY: No, no objection.

MR. MOANDER: No objection from OCD.

CHAIR ROZATOS: Objections from Pilot or Rice?

MR. SUAZO: No objection from Pilot.

HEARING OFFICER HARWOOD: Hearing nothing from Rice, I'm assuming no one objects. It'll be admitted.

(Admitted: Goodnight Midstream Cross Exhibit 1.)

BY MR. RANKIN:

Q. And so this paper is titled, "Problem Diagnosis, Treatment Design and Implementation Process Improves Waterflood Conformance."

Did I get that right?

A. Mm-hmm.

Q. And the lead author here is Mr. Tracy Love, with Chevron, followed by Andrew McCarty of Chevron, and then some other folks, right?

A. Yes.

Q. And basically, without getting into the detail here, this paper is a summary of the issues identified by Chevron when they first initiated the waterflood through EMSU, problems with conformance, fast cycling, the water breakthroughs, permeability streaks, that sort of thing. Do you recall that in this paper?

A. That's correct.
Q. And they describe the numerous challenges that they had in developing this waterflood, especially from the initiation of the flood, right?
So part of the challenge here that Mr. Love was trying to review in this paper was to explain what those problems were and then how to try to resolve them. Is that your understanding?
A. Yes.
Q. Okay.
A. This follows up on earlier work that I did --
Q. Right.
A. -- with respect to conformance.
Q. Right.
A. They followed up on this, yeah.
Q. Yeah, the cycling of the -- I don't know, how many, 82 different cycle series? How many were there in the Grayburg?
A. Oh, you mean the little cycles of deposition?
Q. Yeah.
A. It was about 88.
Q. So 88 different cycles of deposition. And each one of those, is it representative of a sea-level

withdrawal?

A. Rise and fall.

Q. Rise and fall. So during the period of deposition that comprises the Grayburg and San Andres -- or actually, just the Grayburg, right, there are more than 88 different cycles of sea-level rise and fall?

A. There's 88 that I could count, if I remember correctly.

Q. And that results in a very complex reservoir. Agreed?

A. Yes.

Q. Okay. And part of the challenge of this waterflood was understanding the complexity from one zone to the next?

A. Yes.

Q. And even within those zones that you identified to me, Zones 1 through 6, there are highly variable permeability streaks within each of those zones, correct?

A. Yes. We identified which ones were the bigger problems. That's why we did the conformance work.

Q. Right. Some of them were bigger problems that others, right?

A. Yes.
Q. But so there was high variability in the horizontal permeability, but also in the vertical permeability, too, within the Grayburg, right?
A. There seems to be -- if you're looking at matrix permeability, there's more with respect to horizontal than vertical. Okay?
Q. There's more permeability horizontally? You mean --
A. It's more problems.
Q. More problems.
A. Higher. Now, you have these vertical fractures, and they're little hairline features. Okay? And they're solution-widened a little bit. A lot of those, we just had to kind -- they will have the most permeability. Okay? And that's what makes the plumes that come up.
But then there's these horizontal layers that have high permeability, too, where you can take water from here and go through like that. Very quick. Very quick.
And so this conformance work that this paper is talking about, and what I was trying to do, was trying to solve these problems, not these problems.

Q. Right.
A. Okay?
Q. Understood. And that's all within the Grayburg, right?
A. Yes.
Q. Okay. So just an overview, okay, of what this paper is all about, and as we discussed previously when you showed the map, where there's some wells where there are particular problems, I think this particular paper was focused, in particular, on a certain area that he calls the "conformance diamond." It's here in Figure 8.
And it's a diamond of a number of patterns, waterflood patterns, that were particularly troubling, as I understand. Is that correct?
A. I don't know if that was the worst spot. We worked on a spot that I thought was worse than this. But that's just life.
Q. By my understanding is that that conformance diamond is within this area with the greatest collection of these enlarged circles. Right?
A. Okay.
Q. So going back up to this section here where Mr. Love describes what the figure represents, he goes on to describe, he says, "Conformance problems were

observed over the entire field," and then he cites to that Figure 7, right?

A. Okay.

Q. And he says, "The focus that I referred to as the conformance diamond was defined as a pilot area for the conformance improvement work."

And then he cites to Figure 8, which is that conformance diamond showing the different waterflood patterns that he was evaluating, right?

A. Mm-hmm.

MS. HARDY: I'm sorry, I have an objection to Mr. Rankin really testifying and reading the article, I think.

MR. RANKIN: It speaks for itself. I'm just giving a summary. If Dr. Lindsay disagrees with my characterization, I think he can tell me.

A. Well, I'll just tell you this, that I think Tracy and Andrew were making something very simple much more complicated.

If we can go back to the map that shows the field, the worst spot was up in the northwest corner, where there was a well that injected water, 800 barrels a day, on vacuum. Never built a pound of pressure year after year. And we went in and found that it was connected from north to south to the nearest producing well.

And all we had to do was once we realized the path, is just go in and squeeze it off. That's all we had to do. And it's very simple kind of work. And what they're doing is they're kind of making it a little bit too complicated.

Q. Looking at this map, Dr. Lindsay, do you know roughly where Goodnight's existing saltwater disposal wells are?

A. I just have a rough idea.

Q. What's your rough idea?

A. To the south, in the southern part.

Q. Down in this area here?

A. Yes.

Q. Okay. So just going back to Mr. Love's description of this figure, he says, "It was verified during the reservoir characterization" -- that would have been your work, right, Dr. Lindsay?

A. Mm-hmm.

Q. -- "that the conformance diamond contained natural fractures, injection into a gas cap, and areally extensive permeability streaks, all of which caused the characteristics illustrated in Figs. 4-6."

So 4 through 6 are right above here, and I think what we're looking at here is a plot of

water-to-oil ratio, WOR -- right?
A. Mm-hmm.
Q. -- on the Y axis, against cumulative production over time, correct?
A. Mm-hmm.
Q. And what we see is, where the water injection begins, we see water-to-oil ratio go high, right?
A. Mm-hmm.
Q. And that's not what you want to see in a waterflood, right?
A. No.
Q. Figure 5 is a diagnostic plot for a production well in direct communication with an injection well. Again, on the Y axis, we have production, which is rates or barrels per day, and the X axis, we have cumulative --
A. That's Figure 6.
Q. You're right. That's what I meant to say, Figure 6.
We have production rates, barrels per day, on the Y, and then cumulative liquid production on the X axis, correct?
A. Mm-hmm.
Q. And again, we see where waterflood begins

and the circles are water and the diamonds there are oil. And so we see the circles go up, meaning water production goes up, and oil production drops, right?

A. Yeah.

Q. Okay. And then figure 6, is, again, another plot showing production and injection rates on the Y axis for water, oil and water injection, so water production, oil production, water injection. And on the X axis, we have cumulative production days. So a time on the X in production, and injection on the Y.

And we see when water injection commences, we see oil production drop and water production kind of continue up a pace, correct?

A. Mm-hmm.

Q. Okay. So those are the problems that he's referring to that were occurring in the field that they were trying to figure out.

Next sentence here, he says, "Furthermore, these problems were isolated to Zones 1 and 2 in the conformance diamond. The overall goal for the conformance diamond was to increase water production and decrease water cycling," correct?

A. Mm-hmm.

Q. So what he's telling me here is that the problems that they've identified in 1998 that you're

referring to here is isolated to just Zones 1 and 2.
And I'm going to go over to your Exhibit B, and I'm going to pull up your cycling image, as soon as I can find it. This is that intricate cross-section that shows us, essentially, the EMSU an the Grayburg, correct?
And so I think we're looking from west to east, and we don't quite see this pronounced here, but essentially, this is the double-humped anticline that you were referring to in your summary?
A. This is stratigraphically on here.
Q. Okay. So it's not as pronounced as the structure?
A. They're separate illustrations.
Q. Understood.
A. Okay?
Q. Understood. But nevertheless, I mean, my point simply is that you can still see the double-hump anticline, correct?
A. No. That's an anticline that was growing during deposition.
Q. Okay.
A. That was during Grayburg time. That has nothing to do with the Laramide orogeny and making the big double hump asymmetric anticline.

Q. Okay. Understood. So, my point here, though, was just to orient ourselves to where Zones 1 and 2 are, where the problems with conformance were identified in Mr. Love's paper.
A. Mm-hmm.
Q. And on the right-hand side of this stratigraphic cross-section, we see that the Zones 1 and 2 are the uppermost zones in the Grayburg, correct?
A. Mm-hmm.
Q. So in this paper that we're reviewing from 1998, the problems that were identified and the high water volumes that were identified in this Figure 7, were all limited to Zones 1 and 2, based on this paper, correct?
A. Yes, for that area.
Q. Okay. And in this paper, Dr. Lindsay, is there any discussion of San Andres pluming into the Grayburg?
A. Gee, I haven't read this for -- let's see, when was this published?
Q. 1998.
A. Yes. I got it in about 2000 or 2004. I haven't read it since then. So I'm not sure if they were talking about pluming. Because pluming was

fairly uniformly understood, that we had lots of little plumes. And those are just vertical plumes that basically go up around one well. Okay?

So what they're trying to do is solve a problem between multiple wells that's horizontally oriented in high permeability dolograinstones. That's the problem they're trying to solve. They're not trying to solve vertical plumes.

Q. I understood this paper was addressing all the problems that they were having in the EMSU, that they were not getting good conformance, to solve those problems.

A. From what I understand of this paper, they were trying to get the horizontal connectivity under control.

That's what we were trying to do before they did this paper, up in the northwest corner. And we were looking at the base of Zone 1, where there was a dolograinstone that in one area that it had 2.2 darcies of permeability, and in another area, it had about 750 millidarcies of permeability, and just a little bit of it was 5 feet thick.

That was the problem, because you're taking all the injected fluid through 5 feet and it's not going up in any other intervals, it's not going down in other intervals. You're wasting all this time and money cycling water through a dinky little 5-foot interval. So the whole idea was to isolate it and force the fluid to go laterally in other directions, in that little 5-foot bed, but then also go up into other beds of strata, up and below.

That's the whole idea with conformance work, and that's what these guys were trying to do as well. So it had nothing to do with vertical plumes.

Q. Dr. Lindsay, in your deposition to me and earlier today, I was asking about whether or not you had any maps showing vertical pluming, and you identified Mr. Tracy as having prepared maps that were representative of vertical pluming.

And in your deposition, you told me that he had written an SPE paper identifying the issues that reflected high water cuts for wells as a result of vertical pluming.

And I'm asking you -- you know, I've looked at this paper and I've looked for other papers that address it. This particular paper, Mr. Love was trying to evaluate impacts that were causing problems in the Grayburg waterflood, and he does not address or identify any discussion of vertical pluming of the San Andres or the Grayburg.

A. No.

MS. HARDY: I object to the question.

HEARING OFFICER HARWOOD: Overruled.

BY MR. RANKIN:

Q. Do you agree that he does not address any vertical pluming into the Grayburg?

MS. HARDY: Dr. Lindsay, you can wait until there's a ruling on my objection, please.

HEARING OFFICER HARWOOD: It's overruled.

A. They were chasing horizontal permeability problems. Not vertical. Okay?

Q. Dr. Lindsay, you told me, just before I pulled up this exhibit, that this exhibit, this paper, was going to address vertical pluming into the Grayburg. Do you remember that?

A. No, I just said that there was a map that would show where there's higher water production, and that might be where the plumes are.

Q. And in this paper, what Mr. Love is saying is that those higher water-cut values are a result of poor conformance within Zones 1 and 2. Do you disagree with that?

A. It could and it might not be.

Q. Okay. Very good.

MR. RANKIN: Mr. Hearing Officer, we're

about four minutes before noon, I think before we get into any other testimony, I think it might be a good time just to go ahead and take a break here. My stomach tells me it is, so I wondered if anybody else would like to take a short break.

HEARING OFFICER HARWOOD: Why don't we -- I'm sure lunch is on people's minds. So why don't we go ahead -- you're reading my mind, Mr. Rankin. Why don't we go ahead and break for lunch.

Is an hour enough time for everybody?

CHAIR ROZATOS: Let's give an hour and 15.

HEARING OFFICER HARWOOD: And hour and 15. Okay. Let's be back at 1:15.

And, Madam Court Reporter, we are going to be off the record for lunch.

(Lunch recess was held from 11:58 a.m. to 1:16 p.m.)

HEARING OFFICER HARWOOD: Let's go back on the record.

Mr. Rankin, are you ready to proceed?

MR. RANKIN: Just a moment, Mr. Hearing Officer. I'm just getting connected to the wifi.

HEARING OFFICER HARWOOD: Oh, one other thing. You have a habit of saying "Mm-hmm." Just for the record, if you can try to remember to say

"Yes" or "No." I think the court reporter is probably getting it down, but it's less ambiguous.

THE WITNESS: Okay. Thank you.

CROSS-EXAMINATION (Cont'd)

BY MR. RANKIN:

Q. Good afternoon, Dr. Lindsay. I'm going to pick up on a new topic from where we left off before lunch. I'm going to talk with you a bit more about your opinions, position on Goat Seep. And I'm going to go back to your Exhibit B, which is your February 2024 testimony. And I'm going to go down to the section of your testimony where you address potential contamination into the Goat Seep from the San Andres.

A. Yeah. Thank you.

Q. Let me share my screen so you can see what I'm talking about. Let me know when you can see my screen, Dr. Lindsay.

A. I see it.

Q. This is under the subheading E, and you say here, "It is more likely than not that Goodnight's injection of high-salinity water into the San Andres would contaminate the Goat Seep low salinity aquifer attached to the Eunice Monument and Arrowhead fields due to its greater density and increased pressure as more water is injected."

Did I read that correctly?
A. Yes.
Q. Okay. Now, your opinion that Goodnight's injection is more likely than not going to contaminate the Goat Seep is based on your understanding that the Goat Seep has a total dissolved solid concentration of less than 10,000 milligrams per liter or parts per million, correct?
A. Yes. And that it's connected to Eunice Monument pressure-wise. So that means porosity in the Goat Seep and porosity in the Grayburg are connected.
Q. Right. But my point is that, yeah, your statement and your opinion is that the Goat Seep has less than 10,000 parts per million TDS, right?
A. That's correct.
Q. In your statement opinion that the Goat Seep has less than 10,000 parts per million, it's based on your personal communications with Mr. Alden Carpenter at Chevron, right?
A. Yeah. Well, just not me. The whole office.
Q. Right.
A. He came from La Habra, California, where the office was that he worked in, to our office in Midland, and presented all the data. And so everybody working on EMSU, EMSU-B and AGU were all in

attendance, and anybody else that wanted to be there. So it's a fairly large group, just not me.
Q. Just not you. I guess my point, though, is that your statement, your testimony today about the water quality in the Goat Seep, is based on that presentation that Mr. Carpenter made to Chevron?
A. Yes.
Q. And you were in attendance?
A. Yes.
Q. And you took notes on that presentation, and that's those notes. And your recollection of that meeting and presentation is the basis for your testimony that the Goat Seep has less than 10,000 parts per million?
A. That's correct.
Q. But you haven't yourself conducted an independent investigation of the water quality in the Goat Seep, correct?
A. No, no. That was Alden's job. He was a geochemist.
Q. And you've not reviewed any other geochemistry or chemistry data for the Goat Seep as part of your analysis or opinion today, correct, other than Mr. Carpenter's presentation to you?
A. There was one other fellow that wrote a

Ph.D. on it, and his name was Hiss. And I've listened to some of what he had to say. But that's all.

Q. Okay. Yeah, we're going to talk about Hiss a lot at some point during this hearing, for sure.

So your recollection is that Hiss had some data showing that the Goat Seep had somewhat lower TDS then; is that right?

A. Mm-hmm.

Q. Below 10,000 TDS?

A. Yes.

Q. Okay. So the two points are Mr. Carpenter and Hiss?

A. Yes.

Q. But you haven't presented any data as part of your testimony today on Hiss, have you?

A. No.

Q. And you haven't cited to that. This the first I'm hearing that you're relying on his for that statement?

A. No, no, I didn't use any Hiss data.

Q. Right.

A. I just heard what he had to say.

Q. Just so it's clear for the record, you didn't reference Hiss in any other parts of your testimony, right?

A. No.

Q. Okay. So, now, on this water issue, okay, about Goat Seep, I'm going to go down to your Exhibit B-21. Okay? And I think this cross-section was shown as part of your summary and testimony, correct?

A. Yes.

Q. Okay. Only it was just the cross-section that was shown and not the caption to the right, right?

A. I think the caption was in there, too.

Q. Was it? Okay.

A. Yes, he's in there.

Q. So this cross-section, I guess I'll call it a stylized cross-section, of the EMSU, as I've seen from your summary, the written testimony shows the three categories or types of water that were identified by Mr. Carpenter in the EMSU, right?

A. Yes.

Q. And we have the edge water, which is coming up from downdip from the west, which is the Goat Seep. But it's symbolized here with a little E, correct?

A. Yes.

Q. And then we have the bottom water, which you've identified with a B, which is in the Upper

San Andres, and that is lower TDS and sulfate rich, right?

A. Yes.

Q. And I neglected to say that the edge water is also lower TDS and sulfate poor. Correct?

A. Yes.

Q. And then you got up here, with a C is the connate water, right?

A. Yes.

Q. Okay. And this representation that you depict here was done as a result of Mr. Carpenter's analysis, right?

A. That's correct.

Q. Okay. And I'm going to ask you about the chemistries as we walk through this, and I may come back to it later. But right now, I'm going to ask about the encroachment of the edge water.

When we spoke about this exhibit during your deposition, I understand your testimony to be that Chevron was able to actually measure the encroachment of this edge water up into the structure. You can actually see it in the pressure readings, right?

A. Mm-hmm.

Q. You could see the pressure wave --

A. Yes.
Q. -- of this water encroaching, right?
A. Yes.
Q. And you're able to measure that water coming up all the way to the top and across the crestal zone of the double-humped anticline, right?
A. Yes.
Q. And the vertical offset here is something on the order of, you know, about 300 feet, correct?
A. Yes. Depending on where you start, it gets up to minus 350. And as you go back into the reservoir, it'll be down about minus 600. So that's the interval.
Q. Yeah.
A. And then it thins out as you go up into the east.
Q. To the east.
A. It becomes center.
Q. And so, based on Carpenter's study, right, he was able to clearly identify, based on the water chemistry, a clear signal of Goat Seep water coming up, correct?
A. Yes.
Q. But at the same time, I understand that it was common knowledge that there was all this pluming

of San Andres water coming up from fractures through the crestal high and other locations throughout the San Andres into the Grayburg.

How was it possible that Mr. Carpenter was able to obtain a clear signal of sulfate-poor water in the Grayburg from the Goat Seep encroachment if, in fact, there was all this water coming up, pluming, from the San Andres?

A. Well, the plumes are just little water-well plumes coming up like this, like my finger. So if get away from those, you can get a good sample of the edge water.

Q. Okay. And if that were the case, if water is coming up from the San Andres continuously, prior even to the waterflood being commenced, wouldn't that pluming of water disrupt the pressure front and interrupt the encroachment of Goat Seep water updip?

A. Yes.

Q. Okay. But that's not what Mr. Carpenter saw, was it?

A. This is where he got his data and re-superimposed it on the structure.

Q. Okay.

A. Okay?

Q. At the time of your August 2024 testimony, and then again when I deposed you in January of this year, you were not aware that the EMSU has a produced water disposal well that was injecting into the San Andres, correct?

A. Yes.

Q. Okay. And you had been working at Chevron since 1988, but you were unaware that Chevron had, itself, and XTO after and Empire after them, operated a saltwater disposal well that was injecting into the San Andres within the EMSU?

A. No. That was an engineer's job, not mine. Okay?

Q. Yeah. And you didn't evaluate that or Empire didn't inform you of that as part of your preparation for testimony?

A. That's correct.

Q. And until your deposition in January of 2025, you'd not conducted an independent investigation of the potential impacts of that saltwater disposal well that's in the middle of the EMSU on the EMSU, correct?

A. No, I didn't. I didn't do anything like that. My job is reservoir characterization. Okay?

Q. I understand.

A. Not engineering and disposal and water.

Let's get that perfectly clear. Okay?

Q. Yeah, yeah. Understood.

On the same point, just to make sure I understand, okay, the EMSU was a waterflood, right?

A. Yes.

Q. And it had six water-supply wells. Do you understand that it had six water-supply wells that were providing water for waterflood operations?

A. Yes. I knew there was quite a few, yes.

Q. And you understand that there were within the interior boundaries of the EMSU?

A. Yes.

Q. And you understand that they were completed and producing water from the San Andres, correct?

A. Yes.

Q. Okay. But at the time of your testimony that you submitted in August of 2024 and your deposition with me in January of this year, you had not evaluated and you were unaware of where those wells were actually completed in the San Andres, correct?

A. Yes. That wasn't my job.

Q. Okay.

A. My job was to describe cores and correlate the stratigraphy inside of the Grayburg Reservoir.

Q. I understand.
A. Not to know where perforated intervals were in the San Andres. That's an engineer's job.
Q. I guess, though, Dr. Lindsay, you know, this issue before the Commission is a fairly complex issue, and it's not just -- it's not just understanding the stratigraphy, but it's also understanding what's in it, right?
A. Yes.
Q. And you're telling the Commission that there's a ROZ down through the San Andres. And I would think part of reservoir characterization would be to understand what the history of the reservoir is or was. Is that a fair assumption?
A. Yes.
Q. And part of understanding the history of the reservoir is to understand how it was treated, were there disposal wells and where they were located and what the volumes were that were disposed, were there water-production wells and where were they located, where were they completed and what zones and how much water do they produce. That seems to be the question.
A. That has nothing to do with the reservoir. My focus was on the reservoir and how -- the plumbing system, how it was connected. Okay? Not where water

was being disposed of or where water was being taken out of the San Andres for the waterflood. That was the reservoir engineer's job. My job was to focus on the architecture of the reservoir? Okay?

Q. And when you're talking about the reservoir, you're talking about the Grayburg?

A. Grayburg.

Q. Now, moving on from that topic, let's talk about water chemistry. I'm going to go back to your Exhibit B.

Well, before I do that, I do have a question, I guess. Go back to that question. Go back to that exhibit.

Earlier, when we were talking about the boundary between the Grayburg and the San Andres in I think it's your Exhibit 1, actually, where you show the many layers and different cycles within the Grayburg, I think you stated here, too, that there is a composite sequence boundary between the bottom of the Grayburg and the top of the Upper San Andres, right?

A. Yes.

Q. And the reason that you're seeing this edge-water encroachment that follows the structure and stays along the base of the Grayburg is because that composite sequence boundary is low porosity, low permeability, right?

A. It's either that, or you have better permeability and porosity in the Grayburg. And the water follows the pathway of least resistance. Okay? So it's probably coming up through porosity in the Grayburg. Okay?

And there tends to be maybe a little less porosity towards the base of the Grayburg, maybe at the top of the San Andres. But it's following the pathway of least resistance, and that's going to be through porosity in the Grayburg.

Q. And so in carbonate systems, when we have horizontal bedding and plane bedding, you're telling me that water is generally going to follow the horizontal bedding because, in this case, it's the path of least resistance?

A. Yes. And there's more permeability horizontally than there is vertically, unless you run into fractures. And then the fractures will overwhelm the horizontal permeability.

Q. Okay. But here, based on Mr. Carpenter's analysis of the water chemistry and the pressure front that you're seeing, there's no indication of

San Andres coming up into the Grayburg?
A. Not with this data, yeah. All we wanted to do was show the three different water chemistries and where they were located.
Q. Okay.
A. That's all. Nothing about plumes.
Q. On the point about water chemistry, just to be clear, when you prepared this testimony, Exhibit B, in August of 2024, you did not independently review any other chemistry data other than the notes that you took from Mr. Carpenter's presentation, right?
A. That's correct. Though there was one other water chemistry study by another independent fellow a few years later that got a few samples from Eunice Monument, as well. And that was actually published in ABG, in their bulletin.
Q. Do you recall the author of that paper?
A. I can't recall off the top of my head. I understand he's passed away.
Q. Okay. Was that a paper that you included in your references --
A. No.
Q. -- or cited to in your testimony?
A. No.
Q. Was it a paper that addressed the Grayburg

or did it address the San Andres?
A. It was looking at the water chemistry in Eunice Monument and anywhere else where he could get some data.
Q. I want to talk a little bit more about the sulfate enrichment question. In your direct testimony and in your summary, and we just talked about it, one of the key assumptions, as I understand from your testimony, is that the San Andres tends to be sulfate enriched, whereas the Goat Seep tends to be sulfate poor, correct?
A. That's correct.
Q. And because of that, if you were to take water samples, as Mr. Carpenter did, he was able to discern, he believes, the difference between the two sources, right?
A. That's correct.
Q. Okay. Now, as we discussed earlier today and reviewed in your earlier testimony, and as part of your presentation earlier, both the San Andres and Grayburg in the EMSU were swept by Mother Nature's Waterflood, correct?
A. Yes.
Q. And in your direct testimony here, I've highlighted a portion of your testimony where you say,

"Dissolution of evaporite strata" -- which is calcium sulfate, right?

A. Yes.

Q. -- "added sulfate to low salinity San Andres water as it recharged into the subsurface."

Did I say that correctly?

A. That's right.

Q. And then the next bullet, you say, "Through time recharging meteoric water delivered low salinity water (less than 10,000 parts per million) containing sulfate into the San Andres residual zone (ROZ) and EMSU-B, EMSU and AGU," correct?

A. That's correct.

Q. Now, my understanding is that evaporites are anhydrites -- or rather, anhydrites are evaporites, correct?

A. That's correct.

Q. And anhydrites are in the Grayburg in the EMSU, correct?

A. No.

Q. No?

A. No. They're updip of the EMSU. So, there's a little bit of anhydrite cement, but there's no bedded anhydrites in the EMSU.

Q. What's that based on?

A. Core studies.
Q. Core studies?
A. Yeah. The rocks never lie. The rocks never lie. So we look there and we see what's really there. And we look really close and make a lot of thin sections so we can look inside the pore system in great detail.
We do not see bedded anhydrites inside the EMSU. It is updip, and that's what makes the stratigraphic trap.
Q. But isn't the EMSU a stratigraphic trap? Oh, I see. You're saying stratigraphic trap --
A. Yes, only evaporites.
Q. Got it.
A. That's what makes the lateral stratigraphic trap.
Q. I understand. So you're saying there are no anhydrites in the EMSU?
A. There's no dense of anhydrite in the EMSU. There are evaporite cements in the EMSU. But there's no bedded anhydrite.
Q. Okay. What kind of evaporites are in the Grayburg?
A. I thought I just answered that. It's anhydrite.

Q. In the Grayburg?
A. Yes. It's anhydrite cement.
Q. Okay.
A. Okay?
Q. Are there evaporites in the EMSU in the Grayburg, or are they all just --
A. Now, are you talking about bedded anhydrite? There's none. There's anhydrite cement in EMSU. It's a small percentage, a few percent, but it's there. But it's just cement.
Q. So the distinction you're making is when you say "bedded anhydrite," you're talking thicker deposits of anhydrites?
A. A bed, a layer. A layer however thick. Okay? There's none in EMSU in the Grayburg.
Q. How are anhydrites formed?
A. By evaporation of sea water.
Q. But I thought when we went through this before, when we talked about this 88-layer stratigraphic representation of the EMSU, that there were 88 different sequences of sea water, ocean-level changes, correct?
A. That's correct.
Q. And every time we had a sea-level change, where the sea level receded off that shelf, we had

evaporites form, correct?

A. Not necessarily. Why don't you go to the other illustration that shows the regional cross-section and the 3D seismic, and I'll show you right where the evaporites are, the bedded evaporites.

Q. Is this the one?

A. No. It's the one with the seismic.

Q. This is not the one you're talking about?

A. No, it's not this. Go to the one with the seismic.

Q. I'm not sure which exhibit it is, but I'll keep scrolling till we find it.

A. All the orange on the right, which is updip to the east, the orange layers are bedded evaporites. The yellow are nonporous sandstone, dolomitic sandstones.

And if you look above where it says "EMSU," and come down, there's where the reservoir is located. So there's no bedded anhydrite in EMSU. There's just cement.

Q. But there are some anhydrites -- there's cemented anhydrites in the EMSU and the Grayburg?

A. There's no cemented anhydrite. That infers a layer of strata. It's just cement, maybe 5 percent, and the rest is dolomite. That's all.

Q. Now, we discussed that meteoric water swept the Grayburg, correct?
A. That's correct.
Q. And if I go Exhibit B-1, I think you had a nice image of the entire basin subject to the Mother Nature's Waterflood.
A. Oh, yeah, this is where you're getting it to the west, and it's coming downdip and into the basin. And it really doesn't go into the basinal facies. It sweeps around through the shelf margin where all the porosity is located.
So if you go to that other map, that kind of had a blue color to it, then you'll see the pathways.
Q. Yeah. I understood. So the overview map, which is this one, kind of shows you --
A. This one right here.
Q. Yeah. -- the direction of flow.
A. And that's for the San Andres.
Q. Okay. Now here, though, in the image at the bottom, where you show -- this is after termination, right, of the flooding process?
A. Yeah. As you lose your pressure and then you destroy the recharge area.
Q. And this image, you show that subsequent to

the flood, you have hydrogen sulfide moving up from the updip?

A. It's coming out of the basin, yes.

Q. It's what?

A. It's coming up out of the basin for H2S.

Q. So in both the Guadalupian and Leonardian Formation intervals, you're showing that there's sulfates in the system from hydrogen sulfide, correct?

A. Yeah, H2S.

Q. H2S.

A. So if you want to go out and see an example of that, just walk through Carlsbad Caverns. That's what made it, the H2S mixing with fresh water made sulfuric acid and dissolved the carbonate and made the big caverns.

Q. And where there's H2S, there's also sulfate in the system, correct?

A. Yes, H2S. Yes.

Q. Doesn't this also show that there would be or expected to see sulfates in the Grayburg?

A. Well, that's calcium -- anhydrite is calcium sulfate.

Q. Right.

A. And it's in the Grayburg. It's cement. Okay? So I thought we talked about that.

Q. Yeah, I guess I'm trying to get the point, though, that you're distinguishing, based on Mr. Carpenter, that there was no sulfate in the Grayburg?

A. This is sulfate cement. And Alden was talking about the water chemistry. That's totally different.

Q. Well, I guess my point is that, if there's sulfate in the Grayburg, it would also dissolve in the water, wouldn't it?

A. It would. Now, you'd have to have an awful lot of anhydrite to dissolve to get enough in solution so Alden's machines could detect it. And, apparently, he couldn't detect it.

Q. Okay. So even though he had all that anhydrite cement just to the east updip, there wasn't --

A. Well, that's bedded anhydrite updip. Okay? And in the reservoir was maybe like 5 percent anhydrite cement. It's a very small volume.

As a matter of fact, it was actually reduced when Mother Nature's Waterflood came through because it preferentially dissolved the anhydrite first and pushed it out of the reservoirs that was pushing out the oil. So that actually created less anhydrite cement inside of the EMSU and the Grayburg Reservoir.

Q. Okay. Very good. I'll move to Exhibit B-23 in your direct testimony. This is, again, your cross-section of the 88 different cycles within the Grayburg.

I don't think this is actually what I meant to be -- I meant to be on B-23. My apologies.

Okay. So this exhibit, B-23, as I understand it, is a composite of two different cores, correct?

A. That's correct.

Q. And on the left, the upper part of the core interval is from the EMSU 649 well?

A. Yes.

Q. And the lower part is from the EMSU 679 well that we discussed before, correct?

A. Yes.

Q. Okay.

A. And they're one location apart.

Q. I'm sorry?

A. They're one location apart. So just a few hundred feet is where the one core -- the 649 was taken to the north, and to the south, the 679 was taken.

Q. Got it.
A. So we could get a bigger, longer section to look at.
Q. So what you've done here is you've blown up a portion of the -- really, it's the lower portion of that core, the EMSU 679 on the right, correct?
A. Just in the San Andres and just a little bit of the Grayburg.
Q. And you've indicated here your pick for the top of the San Andres, correct?
A. Yes. And that's based from the core. It's a beautiful subaerial exposure surface.
Q. And based on your pick of the top of the San Andres, you've identified in the -- the portion that you've identified here as having porous oil-stained dolostone and collapse breccia, you've identified areas that have basically oil staining, correct?
A. The black bars are the oil staining. And the red intervals are the collapse breccia in the core description. So you'll see one, two, three, four, five, six, seven collapse breccias from the top of the San Andres down to the base of the core.
Q. Okay. And the black intervals, the black bars, are from the core-log description, correct?

A. That's visible oil saturation to the naked eye. And then there's a little extra oil saturation at the very base that you couldn't quite see with the naked eye, but the ultraviolet photographs showed it.

Q. So from this section here down, then there's a bit of missing core, correct?

A. Yes.

Q. So the portion that you're showing with oil shows goes down to about -- I'm not going to zoom in to see this, but this is the section you've identified as having the oil shows, correct?

A. Yes.

Q. And on this exhibit, there are no further oil shows below that depth, correct?

A. No, there is.

Q. There are?

A. We saw some with the UV photographs right at the very base of the core.

Q. But you didn't show that on this?

A. I didn't see them, yes, because they were so subtle. And the UV photographs made them stand out.

Q. But you went and took those photographs before you prepared this testimony, right?

A. I think we presented it between the first and second. I think -- it's whenever the two plates

were added to my testimony.
Q. This testimony has those plates at the end, right? Because we went through them.
A. And we had -- and we had done it.
Q. Okay.
A. So if you go to the plate with the 679, you can see the saturation right at the very base. It's very light, but you can see it right there. On the very last box on the lower right, you see the gold color?
Q. That right there?
A. There's the giveaway right there. Being a good exploration geologist, I had to say, "Ah, there's got to be more, deeper in the section."
Q. But you didn't update this exhibit to reflect your understanding that there's more oil at that depth?
A. Oh, no. No.
Q. Okay.
A. I just left it the way it was. That had been described, gee whiz, way back in the early 1990s.
Q. Well, if that's the case, why wouldn't you show it on your exhibit? If it was described back in the '90s, why wouldn't you put it on your exhibit?
A. You mean the oil stain at the very base?

Q. Yeah.
A. Because we never noticed it until this last yeah, when we got the core out to photographic it. And there it was staring us in the face.
Because, normally, you just look at the plain light photographs when you're describing the cores. You don't look at the UV photographs, and we didn't have those. So we photographed those just a few months back.
I called up Empire and I said, "You know, it might be a really good idea to photograph the 679 and the RR Bell so you can see, everyone can see where the oil saturation really is, not only in the Grayburg but in the Upper San Andres."
That's the beauty of those two illustrations. There's oil in the Upper San Andres and that's why we took the photographs. So anybody, me, you, the Commission, anybody can see it. It stands out like a sore thumb.
Q. And then it's recorded on the core-log report, correct?
A. Yes.
Q. And do you recall what the oil saturations are at from the core-log report?
A. Not off the top of my head.

Q. We can go back to that in a moment. I'm going to skip over that for now.

I want to discuss with you some parts of your rebuttal testimony. You prepared some rebuttal testimony, and this particular testimony here, let me go to it here at Page 3. Having a PDF problem. One moment. Let me take a five-minute break so I get my PDF to work properly.

HEARING OFFICER HARWOOD: Five minutes.

MR. RANKIN: Thank you.

(Recess held from 1:52 to 2:00 p.m.)

MR. RANKIN: Thank you very much, Mr. Hearing Officer.

BY MR. RANKIN:

Q. I apologize for the break, Dr. Lindsay. I was unable to get my PDF to cooperate with me.

I've got on my screen here your Exhibit B, which is your rebuttal testimony. It's Page 3 of your rebuttal testimony.

Do you recall this statement that I've highlighted here from your rebuttal testimony?

A. Yes.

Q. And in it, you're addressing one of Goodnight Midstream's witnesses, Mr. Preston McGuire, his testimony?

A. Yes.
Q. And you refer back to your Ph.D. dissertation which you had prepared in 2014, correct?
A. Yes.
Q. And you cite to your Ph.D. dissertation, and you say, quote, "There have been places found in the EMSU, EMSU-B, and AGU where faults/fractures have allowed Upper San Andres Formation fluids to move up section into Grayburg Formation strata, which form vertically oriented plumes of Upper San Andres Formation water within the Grayburg Formation."
And you go on to say that, "Injected matter that is not managed by proper water injection monitoring can cause nonuniform sweep in the reservoir and bypass reserves," correct?
A. Mm-hmm. That's correct.
Q. Now, you're citing to your dissertation, and I have it pulled up here. I'm going to just scroll down to it. I believe it's on the second page here. And what I've highlighted here in yellow I believe is the portion that you put in your rebuttal testimony, correct?
A. Yes.
Q. But you left off the last portion of that paragraph from your rebuttal testimony, correct?

A. Yes.
Q. And you say, "These localities tend to be only associated with one well, indicating that faults/ fractures are localized in small areas." Agree?
A. Yes.
Q. And when I asked you about this in your deposition, I asked you to identify any wells, if you could, in the EMSU where this had been documented. Do you recall that?
A. Yes.
Q. And what you gave me was the EMSU-B-887. Do you recall that?
A. Yes.
Q. Okay. But that's the unit to the north, correct?
A. Yes. It's one well into EMSU-B.
Q. Nevertheless, it's several miles away from where Goodnight's disposal operations are, correct?
A. Yes.
Q. Okay. Now --
A. But it's laterally equivalent. And the only difference between EMSU-B and EMSU is a line. That's all. It's a continuous reservoir across that. There's just a line there separating EMSU from EMSU-B. It's all the same reservoir.

So it doesn't matter where we find these plumes. And we happen to have a core there and it happened to be oriented and we got a beautiful fracture study, and there was this plume of water right around that one well, and it was highly fractured.

Q. And you included your description of that fracture study in your rebuttal testimony, did you not?

A. Yes.

Q. And in that fracture study, you would present a gross plot showing the orientation of the fractures?

A. Yes.

Q. But you don't provide any depths, do you?

A. No.

Q. Okay. Thank you. And just for the record, I'm referring to what's been marked as Goodnight Midstream Exhibit B-25, that was part of Mr. McGuire's direct testimony.

Now, earlier, you and I went through and discussed Mr. Love's 1998 SPE paper. And I wanted to just kind of -- not revisit that paper, but I wanted to address another paper.

This is a 997 SPE paper by Matthew

Miller and some other fellows who were with Schlumberger. Have you ever seen this paper before, Dr. Lindsay?

A. No.

Q. Okay. It's a paper that addresses the EMSU and water issues and permeability issues in the EMSU. And I'm going to scroll down to an entry here that addresses, in particular, the EMSU. And the section here is titled, "Field objections during Bullhead Gelant injection."

And it goes on to say, "The Eunice Monument South Unit produces primarily from the Grayburg Formation in southeast New Mexico." And the portion of I have highlighted here says, "The Grayburg Formation is broken into 6 zones between 30 and 100 feet thick."

My understanding is that each of those zones is about 30 to 100 feet thick; is that about right?

A. No. That's too thick.

Q. Too thick, you think?

A. Yes. That's much too thick.

Q. Thirty feet or a hundred?

A. A hundred feet is way too thick.

Q. Okay.

A. Yes, that's a misnomer.
Q. "Each layer contains horizontal laminations or stringers of different permeability."
Do you agree with that statement?
A. No, I do not. Because they're not laminations. A lamination is a centimeter thick. Okay? We're talking about bedding that's up to -- massive, up to 4 feet or greater than 4 feet thick in some cases. So he apparently doesn't understand the reservoir very well.
Q. But nonetheless, he also refers to them as stringers. Is that a fair characterization?
A. No. These are beds.
Q. Beds. Okay.
A. They're not stringers.
Q. All right.
A. Yeah. Stringer infers that they disappear laterally.
Q. Okay.
A. These beds are continuous.
Q. Through the EMSU?
A. Yeah, yeah. Yeah.
Q. Now, he goes on to call them stringers. He says, "The stringers have horizontal permeabilities as high as several Darcies. They're vertical

permeability is very low."

Do you agree with that?

A. The highest rock I've ever seen in a dolomitized ooid grainstone is 2.2 darcies. He better be careful saying "several darcies." That's incorrect. 2.2 is the highest, and I only saw 1. 1.

The next highest that I recall seeing was 750 millidarcies. So saying "several darcies," that's not quite correct.

Q. Okay. He goes on to say that, "Many wells had a poor waterflood production response."

Do you agree with that statement?

A. Absolutely. Yes.

Q. He goes on to say, "The response was characterized by water cycling through the high permeability," he calls them "stringers, which handicapped the pressure maintenance program to cause high water-to-oil ratios."

Do you agree with that statement?

A. Yes.

Q. And then he goes to say that, "The operator," meaning Chevron, "is working to minimize the water cycling to achieve several goals," including "increasing the reservoir pressure."

Do you agree with that statement?

A. Yes.
Q. Okay. So do you agree with his statement here that the vertical permeabilities are generally low within the EMSU Grayburg?
A. Yes, when you're looking at matrix permeability, that is correct.
Q. Okay.
A. But if you're looking at vertical fractures, that is incorrect.
Q. In this paper which addresses these water issues in the EMSU and Grayburg, there's no reference again of any San Andres water pluming up into the Grayburg. Now, you haven't seen this paper?
A. I haven't seen it, no.
Q. Okay. So you're not familiar with it?
A. No.
MR. RANKIN: Mr. Hearing Officer, I would move this as Goodnight Cross Exhibit Number 2.
HEARING OFFICER HARWOOD: Any objection from Empire?
MS. HARDY: Well, I think the witness testified he's not familiar with it. I think Mr. Rankin has used it in cross. I don't know that it should be admitted into evidence as an exhibit.
HEARING OFFICER HARWOOD: Well, he's been

examined on it and he's been examined on fine points within the paper, and he's demonstrated knowledge and understanding of the technical points of the paper, so I don't think that we can unring the bell.

Objections from Pilot or Rice?

MR. BECK: No objection.

MR. SUAZO: No objections from Pilot.

HEARING OFFICER HARWOOD: It'll be admitted over Empire's objection.

(Admitted: Goodnight Midstream Cross Exhibit 2.)

A. I might just say that I would be a little worried about what he's saying if he doesn't understand the reservoir.

Q. Dr. Lindsay, the lead author of that paper was the second author of the paper with Mr. Love in the next year, that we referred to previously. Do you see Mr. Miller is the second author -- third author in that?

A. Okay. And he works for Dowell, so he probably doesn't know much about the reservoir. That's a chemical company.

Q. Now, going back to your testimony from your rebuttal, okay, let's see if I have this correct. One moment, I apologize. Next page down from where you were talking about your Ph.D. testimony.

Actually, before I move off of that, I wanted to just touch on a couple things. You know, I pointed out the one section of your Ph.D. testimony.

In Mr. McGuire's Exhibit B-25, throughout your Ph.D. testimony, you had identified throughout that there was a seal that separates the Grayburg from the San Andres. Do you recall that from your 2014 dissertation?

A. Yes.

Q. And you go on to say throughout that, "The reason why the composite sequence boundary is not a porous pathway from the Upper San Andres Formation up section into the Grayburg Formation is explained by subaerial exposure and karstification associated with the Upper San Andres Formation was cemented to form a tight, non-porous interval of strata. Dolomitic sandstones at the base of the Grayburg Formation contain enough dolomitized carbonate matrix that they're also non-porous and nonpermeable. Between these two, the nonporous karst and nonporous basal sandstone a seal (aquiclude) was formed within the top of the Upper San Andres Formation and the basal Grayburg Formation."

Did I say that correctly?

A. Yes.

Q. Okay.

A. And I might point out that that seal is not laterally extensive. When you karstify a reservoir, you make sinkholes that tend to be round to oval in shape. And one might be here, one might be over here, and one might be somewhere else, and they fill in and they form rather tight rock.

They start out as an open, porous system, a cavern, and then they fill in with cement and sediment. And we see those in core in the Upper San Andres, but they're not laterally continuous. So you can get the seal, but it's not laterally continuous.

And then, when the Grayburg -- when the EMSU anticline formed and you take this flat-line strata and you flex it and make the asymmetric anticline, because it's dolomitized, dolomite is a brittle mineral, you fracture that and you break it.

So even if you do have something there that is acting like a seal, now it's fractured. And then you get Mother Nature's Waterflood sweeping through and solution enhancing those vertical fractures and making them wider.

And so to have a continuous barrier

there, yes, you kind of start out with one, but you don't end up with one. And it doesn't look laterally continuous on logs.

Q. Now, you didn't say that in your Ph.D. dissertation, did you?

A. No, I didn't.

Q. And in your Ph.D. dissertation, you said that, and this is the same portion here I'm quoting from, "The ultimate test has come from pressure data that shows one pressure system associated with the Upper San Andres Formation, and a different pressure system associated with the Grayburg Formation."

A. Yes.

Q. Isn't it true that if you're going to have a -- you would need a continuous seal in order to establish differ pressure zones or structure regimes between the different formations?

A. Yeah.

Q. You would, wouldn't you?

A. Yes, you would. But if it's fractured, you just lost it.

Q. If.

A. No, they're there. We've measured them. We've shown them to you.

Q. Which exhibit? Where do we have that?

A. EMSU 679, we 36 feet of oriented core in the Upper San Andres. I just showed it in my initial deposition. All those fractures are in the Upper San Andres. There's 129 in just 36 feet.

Q. Okay. So I'll get to that in a moment.

Now, in your preparation for this testimony, neither in your rebuttal nor your direct testimony, did you review any of Goodnight's drilling reports --

A. No.

Q. -- for any saltwater disposal wells?

A. No.

Q. Okay. I apologize. I want to pull up your fracture report, Dr. Lindsay. Thank you.

You testified in your direct testimony about your fracture study on the 679 well, correct?

A. Yes.

Q. And that was prepared back in 1991, correct?

A. That was the first one.

Q. Yeah, and this is the one that you referred to as having identified fractures into the San Andres, correct?

A. This was the one where I focused on the Grayburg.

Q. Right.

A. So I then did another one on the San Andres.
Q. Which was the one that you did on the San Andres?
A. It's the ones that we showed this morning.
Q. Okay. So the ones that you showed this morning, do you give any depths in that analysis?
A. It starts at the top of the San Andres and it goes 36 feet down.
Q. And how do you find -- and your definition of San Andres, how you define the San Andres, that's the depth that you're talking about, correct?
A. Yeah. We found out it via the cores.
Q. But you didn't give us any subsea depths or any measured depths in that analysis, did you?
A. No. I could give them to you, if you'd like them.
Q. Well, I didn't see them in your testimony. And I haven't had a chance to evaluate them. But they weren't in your rebuttal, were there.
A. To the best of my knowledge, no.
Q. Okay.
A. This was done in Hobbs, New Mexico, just on the lower part of the Grayburg. And then we did another fracture study more recently on the continuation of that oriented core that went down into

the top of the San Andres. So there's actually two fracture studies done on this particular core and well.

Q. There's things I want to address from this morning in your overview summary testimony. I'd like to pull up from your direct testimony Exhibit B-1. I want to understand a little more about this.

What are the gray zones?

HEARING OFFICER HARWOOD: This is Exhibit B-4, right?

MR. RANKIN: Thank you. I apologize. This is Exhibit B-5 in Dr. Lindsay's direct testimony.

BY MR. RANKIN:

Q. Looking at Exhibit B-5, Dr. Lindsay, what are the gray zones on this exhibit?

A. With the question marks?

Q. Yes.

A. Those are areas where we didn't have any data, and I did not want to guess what was happening. I only work with real data. Okay?

So in the lower part here, the cores didn't go down deep enough so we knew what kind of rocks were really there and how thick the beds were and how they laterally connected to lateral wells. So I didn't want to put anything in. No guesswork. No guesswork.

Q. Across the Grayburg, then, how do you identify -- what have you identified is the worst -- poorest quality rock?

A. The dolowackestones.

Q. And where are they on this?

A. They're the gray over on the far right side. Where the name is, "dolowackestone."

Q. Where I'm highlighting right here?

A. Yes. The word gray -- that will be up high, yes. Because they're the muddiest rock. They have the lowest reservoir potential.

Q. It's a little hard to see, but the gray intervals embedded in here?

A. Yeah, there's gray intervals in there. And then there's some blue intervals in there, light blue. They're more mud-dominated dolopackstones.

And then the orange intervals are grain-dominated dolopackstones.

And then the red are dolograinstones, and they are the best potential reservoirs.

Q. The red zones?

A. The red zones, yes. So best reservoir is red. The next best reservoir is orange. And then next reservoir, lower quality, will be the blue. And then the gray, to the right, will be the lowest potential reservoir.

Q. We talked about this throughout your testimony. I just want to make sure -- I want to summarize here.

But as I understand, you counted 82 to 88 different cycles within the EMSU Grayburg, correct?

A. Yes.

Q. And each cycle is representative of a change in sea level, correct?

A. Yes.

Q. And with the change in sea level, there may be the evaporites forming with each sea-level change?

A. Yes. Updip in the Inner Ramp, where we looked and saw the bedded evaporites. They're just east of the field. That right here.

Q. The two zones that had the worst conformance issues were Zone 1 and Zone 2, correct?

A. Yes.

Q. And within the Grayburg, within Zone 4, is there a perm barrier that functions as a pressure barrier?

A. When you go to the east side of the field, all of these dolomitic sandstones that are coming into the field -- if I kind of use my hands for this, if this is updip and this is downdip, the sandstones that are coming in on the east side, they tend to be tight and nonporous. If you follow them downdip into the reservoir, they become porous.

And the reason they're porous is when Mother Nature's Waterflood swept through, they dissolved out potassium feldspar grays and made secondary porosity in these dolomitic sandstones.

There should have been interparticle porosity in these sandstones. But when these sandstones were deposited, they were mixed in with carbonate, and the carbonates filled in all the interparticle porosity.

So these things are tight and nonporous to begin with, but when Mother Nature's Waterflood swept through, the downward, more porous part of the reservoir on the left side of the illustration, when you swept through, you dissolve potassium feldspar grains to make secondary pores.

And if you get about 15 percent porosity within the secondary porosity, you'll get one millidarcy of permeability, and that's all.

So these sands don't produce very well. And so updip, where they're first coming in, where the water couldn't get to them that well, they're tight, they're nonporous. As you come do into the reservoir, they become porous by secondary dissolution of feldspar grains, but they're not very permeable.

Q. Very good. I'm going to move on to another topic here. We haven't talked about it yet, but the RR Bell Number 4, and I believe it's in your Exhibit B-25.

Here, again, you've identified as the San Andres top, correct? That's your San Andres top?

A. Yes.

Q. And you discuss the oil saturations that you've identified in the RR Bell before, correct?

A. Yes.

Q. Now, at the time of your direct testimony, you were not aware of what Goodnight Midstream's San Andres tops are?

A. No.

Q. And at the time you prepared this, you were not aware of where Goodnight had identified its disposal zone, correct?

A. That's correct.

Q. And the 679 --

A. While this slide is up, could I just point something out to the Commission?

We talk about these little cycles. All

you have to do is look for the little red surfaces on the top of the blue, and those are exposure surfaces. And the arrows on the left, those little upward arrows, those are little individual cycles of deposition. Just so you're more clear about what this core description is showing. Okay? And that'll be the same way in the other core description, as well. Just to point a few things out.

Q. In your opening summary, Dr. Lindsay, you discussed core saturations and a study on Seminole San Andres that showed using sponge core and pressure core, that conventional core has the lowest saturations of core relative to these other coring techniques, correct?

A. Yes.

Q. And you gave us a range of I think 14 percent, that you would expect conventional core to be about 14 percent lower than --

A. 18 percent lower to start.

Q. And 18 is where you start with what, so I'm clear?

A. The oil saturation conventional cores. That was the number that the Hess engineers talk about.

Q. So they start at 18 percent, right?

A. Yeah.

Q. That was the lowest saturation they recorded in their conventional core?
A. In the residual oil zone at Seminole San Andres Unit. And so 18 percent. And then when they would come in and sponge cored, they would get 24 percent. And when the came in and pressure cored, they would get 32 percent.
Q. What's the increase in saturation from 18 percent to 32 percent, do you know? How much of a change in saturation would that be?
A. Well, that's 14 percent.
Q. The difference between --
A. And 32.
Q. Okay. So is there, in your view, based on that study, a 14 percent correction?
A. Yes, yes. So that tells you how much super flushing was going on.
Q. And as to the SSAU, given the viscosities, the API, the gravity of that oil, a 14 percent correction is appropriate for the SSAU?
A. Yeah.
Q. But you haven't done an assessment to determine whether that same correction is appropriate for the EMSU?
A. No. You'd have to compare the oil types,

the gravity, the viscosity, features like that, to find out how it might compare directly.

I have to take my hat off to the Hess people for doing that. Because sponge cores are very expensive and pressure cores are outrageously expensive. So I take my hat off to them for being willing to take that kind of data.

Q. I want to talk to you a little bit about how you picked the San Andres. My understanding from what you have said, and I want to be clear, if I can, is that in order to pick the top of the San Andres, you need to understand or have the core to do so; is that correct?

A. That helps. That's the best. That's best by far.

Q. Okay. And what is the indication to you in the core that you're at the top of the San Andres?

A. You have a very large subaerial exposure surface developed. Not a little dinky exposure surface that would develop on a little cycle within the Grayburg where you might see dissolution down a few inches.

You start to see massive dissolution down sections in the top of the San Andres, and that makes it stand out like a sore thumb in core descriptions.

Q. That's correlatable across the EMSU?

A. Yes, yes.

Q. But you need the core to identify it?

A. The core helps you the most. Then after that, then you just tie it into the well log where it fits, and then where you don't have core, you have to correlate the well logs.

Q. And what are you looking for in the well logs to identify that specific --

A. You look at the gamma ray, you look at the porosity, you look at the resistivity, you look at all them tied together.

And generally what you'll see in some cases is on that surface, there will be a sandstone called the "premier sandstone." It's not very thick, but it might be there. And in some cases, it's not there. And that helps a bunch, too.

Q. Is the top of the San Andres indicated by an erosional surface?

A. Yes. It's a big unconformity. There's a lot of missing time there.

Q. And isn't it true that throughout the Lower Grayburg, there are unconformities?

A. Yes. And they're smaller.

Q. They're smaller?
A. Much deep and shorter lived. So you can see dinky little subaerially exposure surfaces on some -- on most of these cycles, we see little subaerial exposure surfaces. But when you go to the unconformity, like on the San Andres, you see this much, much bigger subaerial exposure surface. And if you're really lucky, you start to see the sinkholes and the collapse breccia and features like that, if you're really lucky.
And once you get used to looking at these different levels of exposure surfaces, they're fairly easy to tell smaller services from bigger surfaces. But you need a core to do that. You can't do any of that on well logs.
Q. Understood. Now, at the opening of your testimony today, you mentioned that you're not aware, have never experienced a situation where operators of disposal wells were authorized or allowed to inject for disposal purposes into a unitized interval, correct?
A. That's absolutely correct. Because if you're not the working -- if you don't have working interest and if you're not the operator, you should not be allowed to inject inside of a unitized

interval. That should be against the law.

Q. So, Dr. Lindsay, are you aware that before the EMSU was even created, there were disposal well operations occurring within what later became the EMSU and the San Andres?

A. No.

Q. Okay. So this well here --

A. Is that by some other company other than Gulf or Chevron or XTO?

Q. Yes.

A. Mm-hmm. I would wonder how they ever got permission to come in. Because once you unitize an interval, you're the unit operator. Nobody else is allowed to come in and work. So how those companies ever got permission, that's a great question. Because it sounds like somebody's breaking the law.

MR. MOANDER: I'm going to object to some of this testimony. This is legal opinion, and I think this is out of the scope of expertise.

HEARING OFFICER HARWOOD: I think the objection is well taken. It's one thing to say that it should technically not be allowed. It's another thing to say it's breaking the law.

THE WITNESS: That's true. Maybe I should apologize for that.

HEARING OFFICER HARWOOD: No, you don't have to apologize. But the objection is well taken. Try and limit your testimony to technical stuff, and leave the law to the lawyers.

A. Of course now, I worked on unitization projects, and you try to unitize to the base of your oil saturation. And the base of the oil saturation has to be somewhere down in the San Andres. Okay? Is that a fair enough statement?

Q. Dr. Lindsay, have you reviewed the unitization information that was presented to the Commission in 1984?

A. No.

Q. Are you aware that the information presented to the Commission in 1984 represented that the base of the oil saturation was at minus 325 subsea?

A. That is incorrect.

Q. That's the information that was presented to the Commission.

A. They say that's the oil-water contact. It's the oil saturation beneath that. All you have to do is look at a core. We just looked at the San Andres cores and there's saturation there.

We became aware of it when we looked out on the west side of the EMSU, the EMSU 329. And that original number, minus 325, is completely incorrect. It's actually minus 350, is where -- above there is where you tended to get water-free oil production through time. And then from minus 350 to minus 540 is where you started to get a mixture of oil and water. And below minus 540 is where you got water production only.

So we had this well, EMSU 329, out on the west side of the field, and when we got down to minus 540, we found the core kept going down deeper and it had oil saturation through it. So we realized right then and right there that we were dealing with some kind of residual oil zone in the Grayburg.

And we didn't know where the base of the oil column is. So you call that spot, the minus 540, the producible oil-water contact. That's not the true oil-water contact. It is much deeper. And we don't know how deep it is.

Q. I understand that's your opinion, Dr. Lindsay.

A. That's the facts. That's the cold, hard facts, my friend.

Q. This Exhibit B-47 is Mr. McGuire's rebuttal exhibit, Number 347. And I just want to point out to you that there is a well here. It shows the date of first injection for this well, and I'll increase the size for you, but it's 1966 and it's a Rice-operated well. And it was pre-existing the formation of the EMSU.

A. Okay.

Q. But you were unaware of that, correct?

A. I am not aware of that.

MR. RANKIN: Mr. Hearing Officer, may I just take five minutes to determine whether I have any more questions? I apologize for the break. I know everyone wants to move on. But I just want to make sure I can confer with my client and make sure I have addressed everything I need to address.

HEARING OFFICER HARWOOD: How about I give you till 2:40 p.m., which is four minutes. And you have to bring us back on the record.

MR. RANKIN: Thank you.

(Recess held from 2:36 to 2:40.)

HEARING OFFICER HARWOOD: Mr. Rankin, are you done?

MR. RANKIN: Thank you, Mr. Examiner. I am done. I have no further questions for the witness and pass him for examination by the commissioners.

HEARING OFFICER HARWOOD: Well, first let's give OCD an opportunity, then Rice and Pilot, if you guys have questions.

I'd like to break at 3 o'clock for a midafternoon break. Not to constrain you, Mr. Moander. If you're not done by then, we'll just pick up afterwards. So we'll break for 15 minutes at 3 o'clock or thereabouts.

MR. MOANDER: Understand, Mr. Hearing Officer. Happy to comply. May I proceed?

CROSS-EXAMINATION

BY MR. MOANDER:

Q. Good afternoon, Dr. Lindsay. Let me move over a little so I can actually see you there.

MR. RUBIN: Mr. Moander, let's bring the microphone closer to you. The doctor has a hard time hearing.

MR. MOANDER: Can do.

MR. RUBIN: Thank you.

BY MR. MOANDER:

Q. So, Dr. Lindsay, you're under oath today; is that right?

A. That's correct.

Q. And you're here to tell the truth?

A. Yes.

Q. In your earlier summary, you didn't give the full body of your opinions; isn't that right?

A. That's true.
Q. And one of those opinions that you omitted was, and I'm going to quote you here and we'll discuss that in a moment, "There's no migration of injection fluids from the San Andres in the Hobbs Channel into the Capitan Reef," right?
A. Hobbs Channel into the Capitan Reef. Yes, that's correct.
Q. And you gave that testimony in your initial witness disclosure, right?
A. Yes.
Q. You also gave it in your rebuttal testimony, right?
A. Yes.
Q. And you also testified to that -- you testified to as much in your deposition?
A. Yes.
Q. And going back to your deposition, do you recall being asked what your basis for that opinion was?
A. Well, first of all, the Capitan is --
Q. Hold on, Doctor. I asked if you remember being asked that question.
A. Repeat the question, then.
Q. The question was, what do you base that on,

Dr. Lindsay? And that was your opinion.
A. Okay. My opinion?
Q. Yes.
A. As to why there's no communication from the Hobbs Channel to the Capitan Reef?
Q. Yes, in the deposition.
A. Well, I don't know the exact words I'd use, but I would just simply say it's too far away. There's no lateral communication between the Grayburg at EMSU and the Capitan. It's two townships away, if I remember right. But there is communication with the Goat Seep Reef.
Q. And did you share all of that with me when I asked you for the basis of your opinion in your deposition?
A. Yes.
Q. Are you sure of that?
A. I think I did. I told you there was no communication.
Q. You did. I'm going to share an exhibit here. So, Doctor, I'm going to zoom in a little. See the highlighted section there?
A. I don't see anything.
Q. Is the sharing not coming up? Well, that's no fun. Let me try again. Nothing like a good

old-fashioned technological issue. There we go.
Do you see that there highlighted, Dr. Lindsay?
A. Okay. Yes.
Q. So you do see it?
A. Yes.
Q. And if you look below, on Line 9 through 10, I asked what you based your opinion on, and you represented, "...go down to Figure B-3."
A. Okay.
Q. So let's take a look at that. I'm going to represent to you --
A. Okay. Here we go.
Q. -- that this is the exhibit you based your opinion on per your testimony, correct?
A. Yes.
Q. All right. So, Dr. Lindsay, do you recall being asked by me whether or not you factored in during your deposition the Safe Drinking Water Act?
A. I did not.
Q. No. Do you recall me asking about that?
A. Not off the top of my head.
Q. Would you like proof that that was asked of you?
A. Well, I'll believe you.

Q. Okay. But you did, in fact, say that you hadn't factored it in, but, and I'm going to quote you here, "No, but that's an issue. Because the Goat Seep is a source of fresh water. Well, low salinity, less than 10,000 ppm water."

A. Yes, that's the Goat Seep.

Q. And then I asked the second question.

"QUESTION: You said just a second ago that the Safe Drinking Water Act is an issue vis-a-vis the Goat Seep. Why is that the case?

"ANSWER: I've not reviewed that Safe Water thing, but just realize when we were studying this that the downdip is the source of fresh water and could potentially be contaminated."

Does that sound right?

A. Yes. And I'm talking about the Goat Seep, not the Capitan.

Q. So is it your testimony here today that you did incorporate Safe Drinking Water analysis for the San Andres?

A. No.

Q. Okay. And did you address the San Andres in your rebuttal filing before this Commission?

A. No.

Q. So let's shift topics a little bit.

My understanding is your area of focus primarily, not exclusively, is the issue of fractures in this case. Is that a fair statement?

A. Well, it's reservoir characterization, and fractures happens to be part of that.

Q. So fractures are part of your analysis, correct?

A. Yes.

Q. And you testified earlier today, as well as providing through your rebuttal, that there are fractures in play in this case at issue?

A. Yes.

MR. MOANDER: Okay. One moment. My apologies to the Commission. There's lots of paper.

BY MR. MOANDER:

Q. All right, Doctor. I'm showing what's been marked as Empire's Exhibit J-4.

A. Yes.

Q. Do you recognize that document?

A. Yes.

Q. On the left-hand side, it appears to say, "San Andres Total Fractures (129)"; is that correct?

A. Yes.

Q. And that 129 reflects the number of fractures you found in this analysis, right?

A. Yes. In 36 feet.
Q. In 36 feet. Okay. Let's scroll down to Empire Exhibit J-5. Now, this Exhibit J-5, again, you recognize this document?
A. Yes.
Q. And, again, on the left-hand side, it says San Andres Large Fractures (18)"; is that right?
A. Yes.
Q. And that would be 18 fractures within how many feet?
A. In a 36-foot interval. And they're somewhere between 1 and 3 feet in length.
Q. Let's take a look at Empire Exhibit J-6. Again, I'll direct your attention to the left side, "San Andres Small Fractures (109)." And that was done based on the same parameters that you described with the last two exhibits, correct?
A. Yes.
Q. And then finally, we'll come to Empire Exhibit J-7. Again, I'm assuming you recognize this document?
A. Yes.
Q. And, again, on the left-hand side, it says, "San Andres Collapse Breccia," if I'm pronouncing it right, "Fractures (82)"?

A. Yes.

Q. So between Exhibits J-4 and J-7, you've outlined what, over 200 fractures in the San Andres?

A. Mm-hmm. Yes. And some of them are in collapse breccias and some of them are small. So we're kind of repeating just a little bit, because there's only 129 total.

Q. Oh, so those are duplicative? Is that your testimony today?

A. Pardon?

Q. So those are duplicative exhibits? Is that your testimony?

MS. HARDY: I object to the form. I think that misstates his testimony.

MR. MOANDER: I'm just asking a clarification question. I don't understand the basis for the objection.

HEARING OFFICER HARWOOD: Go ahead and rephrase the question. That question is somewhat unfair.

BY MR. MOANDER:

Q. So, Dr. Lindsay, those 129 fractures, those account for the -- in Exhibit J-4, those account for the exhibits -- in J-5, 6 and 7?

A. Yes. Because there might be small

fractures, and some of those small fractures might be in collapse breccias.

Q. But the point being that there's 129?

A. There's 129 total.

MR. MOANDER: Thank you. I'll pass the witness.

HEARING OFFICER HARWOOD: We still have 10 minutes. Let's see, Mr. Beck, you look like you're itching for cross-examination. Do you have any questions?

MR. BECK: No, I don't. Thank you.

HEARING OFFICER HARWOOD: Then we'll pass it on to Pilot. Is it Mr. Suazo? He may be asleep. Is there anyone present in the room?

MR. PARROT: Pardon me, Mr. Hearing Officer. This is James Parrot, with Beatty & Wozniak, representing Pilot. I'm having a little trouble getting my microphone turned on. I'll be taking over the remainder of day for Mr. Suazo. And Pilot does not have any questions. Thank you.

HEARING OFFICER HARWOOD: Okay. Thank you.

Then I guess last but certainly not least, how about the Commission? Would you prefer to break and then do Commission questions, or you want to just start now?

CHAIR ROZATOS: I would say let's take a break. I think it's a good natural breaking point. And then we can start up again with the Commission questions.

HEARING OFFICER HARWOOD: Okay. How about 3:05 p.m.? That's 14 minutes, not quite 15, but better than 10.

Off the record.

(Recess held from 2:52 to 3:06 p.m.)

HEARING OFFICER HARWOOD: I guess it's time for Commission questions. Mr. Rozatos, is there any particular order you guys prefer to go in?

CHAIR ROZATOS: We don't. I'll just say that I don't have any questions.

HEARING OFFICER HARWOOD: Okay.

That leaves you, Mr. Lamkin and Dr. Ampomah. Between the two of you, who wants to volunteer to go first?

COMMISSIONER AMPOMAH: I'll go first. Thank you.

EXAMINATION BY THE COMMISSION

BY COMMISSIONER AMPOMAH:

Q. Dr. Lindsay, good afternoon to you. Thank you so much for your expert testimony.

I'm going to ask a couple questions, and if you feel like this one has to be a reservoir engineer question and you might not be able to respond to it, please do so.

So you categorized your testimony to different section, to I'll start with the A and the heading, "The proposed SWD wells would inject into the San Andres Formation which contains a residual oil zone." So I'm going to focus on that subheading.

So from your direct testimony, on Number 6, you talked about, while describing core and characterizing Greenburg in San Andres reservoirs in the EMSU, looking at that area, you just said it was discovered that the San Andres contains a ROZ.

When was this discovered?

A. Let's see. The first time I noticed this, it had to be back in the 1990s. The EMSU 679 was cored in 1990. And when it came in, I was asked to describe it. And so as we went down, getting sampling and looking at the cores, and finding the San Andres contact, we realized there was all of this oil stain into the San Andres. And that was the first time I got to physically see oil saturation in the San Andres. So that was the first time.

And then I was asked to do the RR Bell Number 4, and here was another core that not only went through the Grayburg but went down into the San Andres, and there was more oil saturation in the San Andres. So at that point, we realized, yes, there's some kind of reservoir in the San Andres.

And then when you look at the oil saturations they're really low. So what we called them back then was a "residual oil interval," that's how I termed it. Some people like to call them "transition zones."

And so I just called it a residual oil interval, but then later, terminology came along from Steve Melzer and another friend of mine, Bob Trentham, where they started to call them "residual oil zones."

Q. So which year was it called residual oil zones?

A. That, I don't know, when that first came out. Steve could tell you. I'm not sure. Because I think when that happened was when I was working in the Middle East, and I don't know exactly when that change occurred. But Steve could tell you about that.

Q. Okay. So in the EMSU, you're saying that it was way back in the '90s, 1990, that was when the first -- when the studies was done to identify these saturations in the San Andres?

A. Yeah. We'd never seen the San Andres before in EMSU. Well, there was one core that just got a couple of feet into the San Andres, the EMSU 459. But it was just a couple of feet, that was all, so we didn't get to see much.

But in the 679, by coring the EMSU 649, and then coring a little bit deeper in the EMSU 679, which is just one location to the south of the 649, they got this big, long core through all of the Grayburg, so we got to see all of that.

But then it happened to go down into the San Andres, as well. And that happened to be an oriented core at the top, and it stayed oriented for the first 36 feet into the San Andres.

And then the lower part of the core interval, they didn't orient it. And for whatever reasons, I don't know.

So we had that data. And then we started describing the core. You always start at the bottom and work your way up. So right at the get-go, we saw oil saturation in the San Andres, and so we said, "Oh, there must be something here."

And at the same time, there were geologists that were working EMSU that said, "Well, here's our potential oil-water contact, somewhere around minus 714 or minus 750, somewhere around there." And that oil-water contact would -- I don't know how they exactly come up with that, but they did.

So I saw this saturation in both the 679 and in the RR Bell Number 4. And right then, we realized there was some kind of saturation in there that was low, but there was oil saturations. And the great catch was how deep did it go. And we didn't have any deeper cores than those two, so I didn't personally know how deep it went after that. But there was some kind of residual oil zone there.

Q. So from the '90s up until now, has there been any pilot project on recovering from ROZs in the EMSU, that you're aware of?

A. No. Just a lot of talk that there's some kind of ROZ in there.

Q. Okay. So on that same Number 6, you go further to talk about potentially deeper and it's a ROZ. So I want to ask you, is this still in the prospecting stage, or is it proven, or is it probable reserves that we're talking about here?

A. Well, what happened, was at the base of both cores, we saw oil saturations. And, like I said before, being a good exploration geologist, you say, "Oh, if it's at the base of the core, there must be more. How many more is there?" But there was no more core. And so that's where my work ended.

And then other folks look at well logs and try to calculate oil and water saturations to see how much deeper that might extend down into the San Andres.

So that's where I kind of had to stop, because then I had to go on and describe the next core, the next core, the next core, the next core and the next core in the EMSU and EMSU-B and AGU. And chews up a lot of time.

So we knew there was some kind of residual oil zone there, but we just didn't know how thick it was.

Q. Has been there been any production, either water, oil, that you know of, in the San Andres?

A. Oh, there's plenty of water production, but there's very little to no oil saturation being produced out of the vertical wells. Because we're probably below what we call this producible oil-water contact, where we're just looking at residuals. And then vertical wells, you can't produce residual very well by primary recovery. You just can't.

Q. So in your testimony, you talked about ROZs could be from, let's say, 20 percent to about 40 percent saturation; is that correct?

A. Yeah, some range like. And 20 seems to be kind of a good number to start at, then you just hope it gets higher.
Q. I know you have a lot of experience in the Permian Basin. So what is the typical residual oil saturation to water injection in a typical reservoir? Let's say, Greenburg, for example, let's say even the San Andres that you might have a fair idea about.
A. That's a tough question, because you're getting into log analysis, and if you don't have a core, you don't know the -- how much oil saturation is really there. And that's -- I don't think I can answer your question, to tell you the truth.
Q. Okay. I will rephrase it in another way. In a typical reservoir, let's say -- I will just use a for instance. A typical residual oil saturation to water injection, probably about 25 percent, 26 percent 27 percent, depending on the area that you're working in.
So I'm asking, in the Permian Basin, in some of the rocks that we are talking about here, what would be the typical residual oil saturation to water injection? For instance, at what saturation level would you start CO2 injection in the Greenburg Formation?

A. Oh, boy. I don't think I'm qualified to answer that question. I worked with one fellow that tried to answer that question in Goldsmith Field, what's the residual oil saturation there, and this was years ago. This was back in the 1990s. A guy named Doug "Jassic," he was trying to figure that out. And it ended up being his master's thesis at Texas A&M. And I can't remember what kind of number he came up with. But he was looking at the -- I believe it was the San Andres, yeah, when we were working on that particular reservoir.

But I don't think I'm qualified to kind of answer that question. Because we're getting into the kind of the world of reservoir engineering more than geology there.

Q. Now, this one is all on the core analysis, because if you analyzed the core, you say that probably that is special core analysis, and you do a lot of routine core analysis?

A. Yes.

Q. Okay. Then I got you. I'll save my question.

A. Okay.

Q. Okay. Thank you.

Now, still, I believe, on the Number 6,

on the Capitan Reef Aquifer question, so I want to know, is the Goat Seep, is it in any way communicating with the Capitan Reef any way, anyhow?

A. No. If you go out to the Guadalupe Mountains, you'll see the Capitan -- well, I'll kind of do this. Here's the top of the Grayburg, and then the front of it is eroded away, like so. And then the Capitan glues itself onto it like that. Okay?

And then the overlying strata progrades much further out. And then here's the Capitan starting to prograde out into the basin. And that distance is several miles. And the progradation of just the Capitan in the one mountains is eight to ten miles of progradation, but it does not touch any of Goat Seep strata at all. It's further outboard, downdip. And then it progrades about eight or ten miles.

If you go up to the northern end of the Delaware Basin, there the Capitan progrades about 18 miles, quite a ways.

If you swing around to the west side of the Central Basin Platform, there it only progrades maybe three or four miles, not very far at all, just a short distance. And that's just downdip from the EMSU and southern AGU.

But the distance from the edge of it, from this field to where the Capitan is, where it's been mapped, the downdip limit of it is about two townships apart. So they're probably not connected at all.

But what is connected is the Goat Seep, because you can see it in outcrop in the Guadalupe Mountains. And people from the University of Wisconsin have actually described it and studied it back in the 1970s. And then it -- and it comes around -- this eroded edge comes all the way around the Delaware Basin.

And in front of EMSU, it is eroded away there, and there's the Goat Seep, like that. And that distance to this spot, to where the field is, is just a couple of miles. And there, the Goat Seep is in pressure communication with the Grayburg.

And that's how the edge water coming from the Goat Seep, that is being reached from the Guadalupe Mountains and Glass Mountains, is being recharged into the subsurface. And then that water is being sucked by production updip into EMSU, because there is this pressure drop. And this is higher pressure down here. So it's just simply being sucked updip into the reservoir, and that's how you get the edge water.

Q. And that is very interesting. The Goat Seep, can it be classified as USDW?

A. As what?

Q. Underground source of drinking water.

A. It's less than 10,000 ppm, so it's fairly fresh water. I don't know if I'd want to drink something with 10,000 ppm, but maybe somebody's cattle would.

Q. Okay. But there's no injection that you have a direct communication with the Goat Seep that you are aware of?

A. Oh, no, the Goat Seep is in communication with the EMSU. That's how all the edge water is coming in, into the reservoir sideways.

So if here's the reservoir, here's the edge water coming in, like this. It's coming from the Goat Seep through the downdip part of the Grayburg and coming into the west side of the field.

So it's in communication, but, to the best of my knowledge, we're not in communication with the Capitan at all.

Q. Okay. And Capitan is the one that NMOCD is more concerned about?

A. Yes, yes, yes.

Q. On your Exhibit B-1, what type of ROZ are we dealing with in this area, if you can respond to that?
A. Well, there's a couple different kind of ROZs. There's one that's called a brownfield and there's one that's called a greenfield. And the way you define a brownfield is you have a producing reservoir above a ROZ. So just in real simple terms, you can say, well, here's the reservoir in the Grayburg and here's the ROZ beneath, in the San Andres. So you could say that's a brownfield.
Q. Okay.
A. Okay?
Q. On your Exhibit B-2, where you show -- and I don't know if you can bring it up, but that is the porosity fairway's faults and fractures. And based on the cross-examination from Mr. Rankin, I got to know the location of the EMSU in relation to --
A. Oh, we didn't show it, did we?
Q. Yeah, you did.
A. Okay.
Q. It was shown here?
A. Where he pointed to, it was the right location.
Q. Yeah, okay. So how does the performance of the ROZ in the Tall Cotton, Goldsmith, and I don't

know if -- oh, it's Seminole, can you speak to that?

A. I don't have enough hands-on experience with Seminole or with Goldsmith to answer that. When I work on Goldsmith, what I can tell you is, we did -- we had all these cores in the San Andres, and one of them went down into the ROZ.

And we knew it was there, we had cored it and we had the oil saturations. And we could see this profile of higher oil saturation coming down to lower oil saturation. And that interval was probably 100, maybe a little more than 100, maybe just about 100 feet of section.

And you see it start at a higher oil saturation and drop down literally almost to zero at the bottom. Because at the bottom of the core, it turned out it wasn't dolomitized anymore, it was limestone. And the limestone was nonporous, so there was really no oil saturation in there.

So we had this really nice ROZ sitting there, and then above it was the San Andres main pay reservoir. And so it was another brownfield, but it was totally within the San Andres.

Then to the west side, we were going to try to put in a CO2 pilot in the main reservoir, and when they put it in, it didn't work well. And at first they thought it worked great because there was no early CO_2 breakthrough. But after a year or so, everyone said, "Where did the CO_2 go? Why don't we see a bank forming? What happened?"

Well, it turned out there was a wettability issue in that reservoir. And as you tend to be more oil wet, there's two ways a waterflood would work. It'll either go through the water pores or through the small pores. And if it's more oil wet, you'll flood through the larger pores. And that's kind of where we were at.

Well, the peripheral waterflood had flooded a lot of that movable hydrocarbon out. And when the CO_2 came in, it popped into these big -- little micro moldic pores. They weren't exactly small, but they were kind of maybe fingernail size and smaller, about this size and smaller.

And when the CO_2 popped in, it couldn't get back out of that big moldic pore. And so what we were doing, we didn't realize, was we were sequestering the CO_2 in the reservoir and there was no oil there in the pores for it to dissolve into. So it was a failed CO_2 flood.

But what people found out years later, was, after it was sold from Chevron to XTO, that that area up around there where the CO_2 was injected in, the wells around there started to produce better. So there was this long-term soaking effect of the CO_2 that mobilized some of the oil in that area. But it didn't really bank oil, because we were basically sequestering the oil for -- we sequestering the CO_2 in these large moldic pores.

And we did this really detailed study of: How big are the pores? How big are the pore throats? What's the ratio?

And the answer was, if these were 3,000, this was 1. And so once it popped in, it couldn't get out.

So once that didn't work, they never attacked the ROZ in the Chevron acreage. But across the street and to the north, in Goldsmith, there was an active CO_2 project in the ROZ, from what I understand. But I know nothing about it.

But my colleague, a friend of mine, Bob Trentham, he actually got to work on that and he could tell you about how that worked.

Q. Just to clarify, did I hear you saying that there is not enough data to make -- let's say, to assess the economics of the ROZ within the EMSU? Did I hear you say that?

A. Oh, for the San Andres, for the ROZ?
Q. Yes, yes.
A. There's just that little bit of data in the upper part, where we got core analysis. We got the logs and then we got logs deeper in the section, but we don't know the oil saturations. That's the problem.
So we need to get a core down through the deeper part of the section so we know what the oil saturations look like and how big -- you know, how in-depth the ROZ might be. And that's a real problem.
Q. But that is interesting. So if we do not know -- let me put it this way. Then would it be appropriate for, let's say, your client to drill to get this information?
You know, the decision that you're asking the Commission to make is a really difficult one, really complex, when you have saltwater injection going on, a lot of facilities being drilled, they're built out, and you're asking us to revoke these existing injection permits.
A. Yeah.
Q. And even the new ones, we should deny them.
I mean, do you believe that enough work has been in the EMSU to confirm that there is a

recoverable oil saturation enough, you know, to warrant these revokes that is being asked here?
A. We don't have enough direct evidence in the core. We've just got indirect evidence via well logs about how much oil saturation might be there.
But I believe some other folks are going to address that particular issue to help you out to make a reasonable judgment for your case.
Q. I appreciate that. So in your geological characterization work, you testified that you analyzed two wells; is that correct?
A. Yeah. In the San Andres?
Q. Yeah, in the San Andres.
A. Two cores.
Q. Yeah, two cores.
A. Just those two, that's all we had. Just a little bit of data. But the really surprising thing was, you get to the bottom, there's oil saturation. You say, "Oh, how much deeper does it go?" And that's the great question: How big is this ROZ? How much oil is there in place to try to be recovered by whatever process?
Q. So what is the distance between the 679 -- or is it -- the two wells?
A. There's a map.

Q. Yeah, there is a map. We can bring it up.
A. I think my first illustration, if we could bring that up, I could show you the distance. Because we've got them on there.
THE WITNESS: Is that possible to bring that up some way, somehow?
MS. HARDY: Is it in your direct testimony?
THE WITNESS: Yes. It's going to be, I think, the first slide after the introduction. It's the very first one.
CHAIR ROZATOS: It was B-4, Ms. Hardy.
A. You can see right in the middle of the field, you can see the 649 and the 679, yeah, it's right next to each other, right there.
So the 679 went down into the San Andres. And then the RR Bell is way over here to the east. It is up near the stratigraphic trap.
So we're kind of really losing a lot of reservoir quality right there. But those are the two that got into the San Andres a fair distance.
Now, the 458, there at the end, there on the east side, it got down into it just a couple of feet. That's about all.
So the two biggies are the 679 and the RR Bell Number 4. And that distance is about two and

a half miles apart.

Q. Okay. Now, I will get to the 679 --

A. More like three miles. Excuse me.

Q. Three miles?

A. Yeah, three miles. Yeah.

Q. Okay. I will get to that in a second.

Now, I'm still on the 6. You showed a table comparing Goodnight's saltwater injection water analysis compared to Empire's produced water analysis.

So where is Empire's produced water coming from?

A. I don't think I showed that. Did I?

Q. There's a table on Page 5 of your direct testimony.

A. Let's look at it and see what it was, yes.

Q. Right there.

A. Oh, okay. Yeah, this was added in later on that. So I can't say too much about that. Sorry about that. Yeah.

Q. So is it not part of your testimony?

A. This was added in later, okay, by one of the Empire folks.

Q. Okay.

A. That's not my data. But it's just showing the range and stuff. Because these are the ions you really have to worry about if you're injecting all of this high-salinity water into the San Andres. Because it could fix with the sulfate that's in there and create an enormous amount of scale and start to cement up the reservoir. That's the big worry. That's the big worry. You're going to start to destroy their ROZ basically.

Q. Yeah, but where is the source of Empire's produced water?

A. Oh, this data?

Q. Yeah.

A. I have no earthly idea. I'm sorry. They can respond to that.

Q. Okay.

A. That's a good question, though.

Q. And since you said you -- because I'm asking, my follow-up was, is this within the EMSU?

A. That, I don't know. I'm sorry. I don't know.

Q. Okay.

A. I would assume it is, but I don't know.

Q. Okay. Now, if we can go back to the map where we showed the 679 well.

A. Okay.

Q. So I'm going to show you, if you can

respond. But do you know where at least one of the wells from Goodnight is located?

A. I have a base map of where they are. I didn't bring it with me. They're basically to the south, is where most of them are, the southern part of EMSU. So I've got a base map, but I left it home. Sorry about that.

Q. So it's way south of the 679?

A. Yeah, where this line is of all these cored wells, a lot of them are just to the south of there. But I don't have a map to show where they're located. I had a hard copy and I left it home.

Q. So, you know, B of your direct testimony, you've categorized that. Under the B, you talk about, "Geologic and engineering interpretation will identify vertical fractures and plumes which would not prevent vertical migration of fluids."

Am I reading it wrongly?

A. Let's see.

Q. "Which would not prevent vertical migration of fluids"?

MS. HARDY: What page are you on?

COMMISSIONER AMPOMAH: Yeah, so I'm just on Page 4.

CHAIR ROZATOS: It's right here in B,

Ms. Hardy.
BY COMMISSIONER AMPOMAH:
Q. Right there. "Geologic and engineering interpretation will identify vertical fractures and plumes which would not prevent vertical migration of fluids."
So meaning there would be vertical migration of fluids?
A. Oh, yeah, the fluids. Because we've known about these plumes for years when I was working in the Hobbs office back in 1998 through 1990, before we moved to Midland and continued working there. They were well known about, and so the big issue was the fractures.
And so we started taking all of these oriented cores so we could do fracture studies. And this was in the 1990s. And then the idea was to try to understand the fracture distribution within these reservoirs and see if they were going to be our friends or if they were going to be our enemies.
And then this one core, the 679, when it was oriented and went down into the San Andres, so we could see fractures from the San Andres all the way up to the Grayburg. And initially, our work was so focused on just the Grayburg, that we only described

those fractures in the Grayburg for our initial report.

But then later, with all of this hearing coming up, these become really important. So I went back to my original fracture studies. I happened to have a copy because Chevron released all my data to me from my Ph.D., so I was lucky, because this work was done back in the early '90s.

So I went back just last a year and did the fracture study on the San Andres part of that oriented core. And luckily I had a hard copy of the data so I could put together the different diagrams showing the fracture orientations.

That became really important, not only in EMSU, but up in EMSU-B, we had a oriented core up there. And then down in AGU, instead of taking one oriented core, we took two, because that was such valuable data to understand these fractures. And in AGU, we actually mapped the area where we started to see bottom water out of the San Andres coming up into the Grayburg.

Before that, we just kind of took it for granted that we had these little plumes here and there, these little one-well plumes, kind of like my finger, coming up like this to where there was a little more intense fracturing, and we just took them for granted. Then after a while, I said, "Well, you know, it would be a good idea to maybe map these out."

So by the time we got to unitizing AGU in 1992, actually made a map showing where these plumes were kind of located in AGU so the folks could know that there might be bottom-water problems coming up into the Grayburg that would affect the waterflood.

Q. So based on what you described, I just want to be -- let's be clear. The EMSU 679, do have the plume that you are describing?

A. Right there, we didn't know of a plume. But to the north, which is one well out of EMSU into EMSU-B, we knew there was a plume there in the 887. And out of dumb luck, that happened to be the well that was cored with an oriented core and we got a fracture study. So here, we knew we had a plume around this well, and we happened to core it and we took an oriented core and we got a fracture study.

And I remember when I opened that core up to start describing it, there were all these fractures. And I thought, oh, boy, this is a real mess. But we went ahead and did the fracture study, and then I described the core.

So that's the best one that I can point

out, off the top of my head. And this is way back in the early 1990s when we were doing some of this work.

Q. So what I'm getting at is, let's say you described one core from 679, but you are using that to generalize, maybe I'm saying that wrongly, that there could be or there will be a vertical migration of water that is injected into the San Andres all the way to, let's say, the Greenburg.

Is that your testimony?

A. Yes, yes. There's a problem. The higher the pressure you generate in the San Andres, the more fluid will move up.

Q. So is there going to be a reservoir engineer to testify to confirm this, aside just one core?

A. That, I don't know. That, I don't know. Sorry about that.

Q. So it is your testimony that based on one particular well-core information, one well, 679 well, there is this 36 feet, as you describe, that is a fracture, right?

A. Yeah.

Q. So that is why I wanted to know the location of the Goodnight's saltwater injection well in relation to this particular 679 well and see that there could be an reservoir engineering explanation to see that, you know, whatever is happening here can be more than generalized to cover whatever is going on in the other areas.

A. I would assume, because you're on this -- you've taken this rock and you've flexed it like that. 679 is somewhere right about here. It's just not fractured right here. The whole area is fractured.

Because dolomite is brittle and it's easy to fracture and the tighter it is, the easier it will fracture. The more porous it is, it'll absorb some of the energy of flexing, but it will fracture. So I would assume you have quite a few fractures throughout EMSU.

Q. Do you know between which period was there injection in the San Andres? Do you know when it started?

A. Injection?

Q. Yeah, water injection.

A. I do not know. I do not know. I can't answer that. Somebody else would have to answer that for you.

Q. Yeah, so definitely from my point of view, what I want to see is that you do have actual engineering data. So you do have actual reservoir engineering data, which is going to be the injection, the injection rate, the pressures in the San Andres?

A. That, I don't know. That, I don't know. No, sorry. That's an engineer's --

Q. Yeah, so let me try to make my point. You do have this actual engineering data, water injection rate, pressure recorded, right, within the San Andres? And that's been numerous injection rates over the period. So I want to see that.

And then also, I want to see, within the Greenburg, I want to see the pressure profile. I want to see the production profile. I want to see the water-cut profile.

You know, when we see this, I mean, most of us, we are all engineers, we should be able to tell what is the impact of, let's say, if there's a fracture, is it really impacting whatever is going on out there.

A. Okay.

Q. It's so difficult, let's say, using only one well to generalize within the entire area to say that there could be a vertical migration of the water that has been injected in the San Andres all the way to the Greenburg, knowing that the first injection -- I know Mr. Rankin talked about it. When was it? Can someone remind me? Way back, 1950s.

So definitely engineering data -- you should have pulled probably all this to say Empire should use engineering data to back whatever for, let's say, the one well is saying.

A. Yeah, and that's an engineering question. I can't answer that. What I can tell you is, whenever we have these oriented cores and we do these fracture studies, there's a lot of fractures there. Some are large, some are small, but there's a lot of them. That's the key.

Q. Okay. Let's go to Exhibit B-7. If you can show the core snaps on the screen. B-7. Right there.

So are there fractures that are visible here?

A. There's just a few, but I wouldn't rely on those too much. You can see one there in the middle box at the bottom. You can see one to the side right there. This is in fairly porous rock right here. It would tend not to break as well as if you were slightly tighter.

But that's why I've shown it in that other sample, where you can actually see those fractures and solution-widened and see how they're oil stained, where it tends to be a little tighter. If you can show that one, that would help you out, too.

Yeah, this right here. Yeah. This is kind of -- oh, we got to back off a little -- we're a little too -- okay. There we go. Because you can -- that's a whole foot on the left side. It must have been cut off or something.

Okay. Well, anyway, there's about a half foot of section and there's how many fractures can be there. Now, that's nonporous rock. Well, less porous rock, let's put it this way. And so in that case, this is where you tend to fracture the most. So if you have any low porosity intervals, they're going preferentially fracture more than porous intervals.

Like that last slide we had before this one, you didn't see many fractures. Now, here, where it's less porous, you see more fractures. And these fractures, at first glance, they would look like they're not touching each other and they're not connected. Yet, the oil stain is telling you the oil has communicated through all of these. So three dimensionally, all of these fractures are connected.

This is what these fracture halos look like. It's a series of fractures, and when they pop, they're all kind of interconnected on the larger scale. And it's really hard to see these in just a little 4-inch core. But here's just a good example of one of these halos.

And then this late stage water, this Mother Nature's Waterflood has come through and actually solution-widened these fractures. So instead of just being little paper thin fractures, they're solution-widened, so they have quite a gap to them.

And then once the reservoir had a chance to try to re-saturate, when that head of energy went away and you could kind of backfill the reservoir, here's the oil coming in these fractures. So that's telling you these fractures are three dimensionally interconnected.

Q. Thank you. So back to the other one, the B-7, so you're showing saturations of oil, 30 percent, 25 percent, 38 percent?

A. Yes.

Q. You know, just out of curiosity, let's take one of them. Let's take the first one on your extreme right -- upper left.

A. Okay.

Q. So you have 34 percent water and then 30 oil.

A. Yeah.

Q. What is the remaining one? What is the remaining?

A. This is all they got with the core analysis. I don't know where the other part went.

Q. No, I'm just saying --

A. And part of the problem is, this has been super flushed when the coring took place, so you have to add extra oil back in. But that still won't get you to 100 percent. So I don't know where the rest of the numbers went.

This is where somebody who has done core analysis for years and years and years needs to come in and explain this phenomenon.

But these are the numbers that were generated. The numbering that I look at, though, is just the SO. I kind of tend not to look at the SW much.

Q. Okay.

A. Because that's where the money is, is in the oil. This is just a conventional core, so in this residual oil zone, this is the lowest saturations. But based on some of the work that was done in Seminole, that tells us, oh, they could be much higher, because this has been super flushed.

Q. They could be higher, but I think that they could be lower.

A. Oh, no. No, no.

Q. No?

A. Because this core has come from 4,000 feet down. That top depth is 4239, and so, as you bring it up to the surface and as pressure decreases, more oil will come out. And so as you go down --

Q. I got you.

A. And that's why they have to take these pressure cores to try to get more accurate readings.

But oooh, they're really expensive. I've only done one in my whole career, and it was up in North Dakota in the Wilson Basin, and it was so hard to just collect about 57 feet of core. It was really difficult and it was very expensive.

So I take my hat to the people at Hess, over at Seminole, for even doing a pressure core. Because they're time consuming and they're expensive, really expensive.

Q. I'm sure we all agree that in our industry, we don't necessarily just use only one resource to make a determination, right?

A. Yeah.

Q. So am I going to see a log that backs this up? Because the log data, unless you have a -- let's say you do have a consent with whatever is coming through the logs, definitely the logs is going to give us something --

A. Oh, yeah.

Q. -- and then we should be able to correlate that back to the core.

A. Yes.

Q. So irrespective of the method that is being utilized, we still have the core to confirm whatever, let's say, each of the methods that we did.

A. Yes. And that's a little bit beyond me, but there's a couple petrophysical guys that will explain that.

Q. I appreciate that. And I'm really interested in the typical residual oil saturation for, let's say, a typical reservoir in the EMSU, typical residual oil saturation. So if the engineers are in the room, hopefully they can get me some answers on that.

A. Okay. Fair enough.

Q. Okay. You said there will be a log with the core information. But is there any FMI data?

A. Not in these two wells that had cored into the San Andres, there isn't. To the best of my knowledge, there is no FMI data on that. That would be helpful. That would be very helpful.

As a matter of fact, that's an

alternative to coming in and a doing an oriented core deeper into the San Andres. But then you have to orient the core, and so that would chew up some money.

The other way is just where you drill down just to run an FMI and to see the fractures on the image log. That's the other way a fracture study could be done deeper.

But the catch is, you just see the fractures, you don't get the oil saturation. Okay? So there's this trade-off, what's more important? And to me, I think it's a little bit of both, to see the fractures and to get the oil saturation. That's the bottom line, to know how big the residual oil interval is, you know, what's the resource there, how much is in the San Andres.

Q. So would you say, based on your knowledge in this EMSU, would it be a recommendation to NMOCD that any well that would be drilled through this unit where, based on your testimony, there could be some fractures that could impair a producing zone, that there should be FMI run or there should be a detailed fracture study performed to establish whether there's going to be an impairment to understand, let's say, production zones?

A. Yeah. And I'm the consultant and all I can say do is say, "This would be a good idea. What do you guys think?" But they're the ones who have the money and have to shake their head this way, instead of no, no, you know. So I can just advise. But that's a good thought.

Q. So you mapped 313 vertical fractures?

A. Well, in the San Andres, the total fractures were 129. There's more up in the Grayburg study, and that might be the bigger number that you're thinking about. So if you add those two up, that's quite a few fractures.

So it took us a couple of weeks to do the fracture study, because we did it in-house. We did not send it out to Core Lab or anybody else to do it, because we wanted to get very familiar with the fractures in the reservoir.

Q. So am I going to see a log where we've mapped these fractures right depth? Are we going to be able to see, like, is there any estimate that shows that?

Or is it going to be as part of the physical analysis, where we are coordinating the core, as you've shown in some of the petrophysics, and then also showing the actual locations of the fractures for us to, more or less, see where are the fractures?

Are there any -- talk to us about that whole thing? Can we see something like that?

A. Well, the only thing that I've done with mine is, there's that one illustration of the 679 where we zoom in on the Upper San Andres. If we could take a look at that, then I can show you right where they're located. But we really can't see them, but, I can show you right where they're located.

THE WITNESS: Could we go to that illustration that shows 679, the core and the fractures? I don't know what number that is. We just have to move up and down a little bit.

MS. HARDY: Oh, J-18?

CHAIR ROZATOS: I don't see a J-18.

MS. HARDY: That would be rebuttal testimony.

CHAIR ROZATOS: We're thinking B-18, Ms. Hardy.

HEARING OFFICER HARWOOD: B-18, maybe.

COMMISSIONER AMPOMAH: No. B-18 is the fracture.

THE WITNESS: There should be one that shows EMSU 679, the whole core, and then to zoom in on just the San Andres.

COMMISSIONER AMPOMAH: So one would be B-25.

I don't know if that works.

THE WITNESS: There we go, yeah. There's one other. I think we need to go down one, because we've got arrows pointing to the fracture study. Oh, no, that's not it. I don't know.

COMMISSIONER AMPOMAH: I see arrows on the B-25.

THE WITNESS: If we just -- where did that go? There's one where we're actually pointing to the top and the bottom of the fracture study, and it looks just like this. But we actually had to decide arrows. But it's on 679. Then you can see that little interval where there's 129 fractures that we measured.

HEARING OFFICER HARWOOD: Is it B-23?

COMMISSIONER AMPOMAH: So you said it's only 679.

MS. HARDY: J-3? I believe it's in the rebuttal testimony. So let me see if I can get that. B-23?

A. There, yes. There, yeah. In that little interval, that's the part of the oriented core in 679. That's the base of the oriented core. All the rest of the oriented core is up in the Grayburg.

So beneath that lower arrow, of those

two arrows pointing out where the fracture study was, the rest of that core was not oriented. But this is the base of the oriented core. So we thought hey, well, let's go in, let's get those fractures. We already had them measured. Let's just make the diagram to show how many fractures are there, how big or how small they are. So that's the interval right there.

Q. So on this particular paper, Exhibit J-3, so one is the red, and then you have the black kind of strings in that, what is that?

A. These black areas, those are collapse breccias. These are these little sinkholes that developed with subaerial exposure of the San Andres. So those -- and the catch is, we don't know how deep the subaerial exposure extended. Because if we look at the red line that is the top of the San Andres, that's the unconformity. And when sea level dropped, it probably dropped, let's see, 10, 20, 30 -- 60, at least about 70 feet to create a series of collapse breccias.

Because one of the problems is, with a sinkhole, they're kind of shaped like this, but sometimes they'll go like this down section. And so here we are coring, with only 4 inches to look at, and you're in the sinkhole, it's in the side of you and you miss it, then it comes back and you're back in it.

So each one of these red intervals could be all tied together. So that would mean that you have at least a 70-foot sinkhole. But vertically, as we cored through it, we were in and out of it, because it was kind of doing this down section.

Q. Okay. So based on your knowledge in the EMSU or working in the Permian Basin, is there in there reported or published material talking about the movement, the potential movement of injected water into the Greenburg from the San Andres?

A. Other than right here, at EMSU, somewhere else, I'm not aware of. I can't answer that, I'm sorry.

Q. Thank you. I think I'm going to pause here so other commissioners can also ask some questions.

HEARING OFFICER HARWOOD: Mr. Lamkin.

EXAMINATION

BY COMMISSIONER LAMKIN:

Q. Good afternoon, Dr. Lindsay. Thank you for your testimony. I've got a couple questions for you, probably a little bit more pedestrian than Dr. Ampomah, to try to arouse your interest.

So the fracture halos on that slide, it

indicates that those are generally created as the result of movement of a fault. Are there any known faults in the EMSU or the EMSU-B that you're aware of?

A. We found one in AGU, and we found a long fracture -- I can't remember if it's in the EMSU-B or EMSU. Because you're only able to see this much, 4 inches. So it could be to just right there, or it could be over here. So it's really hard to find these faults. And they don't appear to be very big. Very small.

And you really kind of don't need a fault. When you're taking strata like this and you're bending it like that, it's going to break without a fault. I just put one in the middle for kind of convenience sake. Because if you do have a little bit of fault movement, then the bigger fractures will be right adjacent to it and then a little further out, smaller, smaller, and then you'd lose it, making these halos. So we don't know how big these are. We have no earthly idea.

When I was in the Middle East, we were actually doing a bunch of laterals through the field, and we went in and out, in and out, in and out of fracture halo. So that's where we kind of learned about these.

And so before, when I was describing the core, I just saw all these fractures and we just tried to map them as best we could. But we didn't understand there was this potential genetic way of generating a halo here, maybe a halo over here. And then we honestly don't the distribution of them, how wide or how narrow they are, and if they're all attached to a small fault or not. We just know there's something there where they're three dimensionally interconnected.

Because the real surprise is looking at these dinky little fractures that are only this long and solution-widened, and they're all oil stained. And that means that oil had a way to get into all of them. So they have to be three dimensionally interconnected. So it's kind of like there's a halo of these fractures, not just a fracture.

When I was younger, I used to just think it's a fracture, with no movement, maybe next to a fault that had a little bit of movement. I didn't realize that if you faulted it or if you just folded it, you could create a halo of fractures instead.

But one structural geologist years ago actually published a paper. I can't remember the name of it. But he actually showed a surface outcrop where he had a photo looking down, you could see the fault and you could see the halo of fractures. And I wish I had a copy of that. This was back in the 1970s into the '80s that this one guy did this official outcrop that you could actually look down and see this halo of fractures around a fault.

But I don't know how big the fault was, I don't know what the movement was on it. But you could see the halo effect. And I just remember it because I thought that was really neat.

Well, here we are looking in the subsurface and we're seeing these dinky little fractures and all of a sudden, they're solution-widened, meaning fluid got in to solution-enhance it, and that oil was able to migrate back into them and stain them. And how did it get in there? Well, that infers that they're all interconnected. That's the important thing.

So there's some kind of fracture halo there. But how big or how small these are, I have no earthly idea.

Q. Okay. Thank you. Do you have insight into the core-orientation method that you guys used? Was it paleomagnetic or mechanical?

A. Paleomagnetic.

Q. Paleomagnetic?
A. Yes.
Q. You mentioned that the core analysis that you did when you were with Chevron was later revisited by Core Lab; is that correct? Is that another agency or another organization outside of Chevron?
A. For doing, like, the oil saturations and water saturations and porosities and permeabilities?
Q. I'm assuming that's what you were talking about.
A. Yeah, that's all done by Core Lab.
Q. Did you guys do one initially in-house at Chevron?
A. No, because -- well, we had one core facility in Houston, but it's just a very small set-up, and they only kind of worked on international projects.
Q. Okay.
A. So we basically -- when the core would come in, we'd call Core Lab. They'd come out, pick it up, take it in. And they're right in Midland, and so it was just a short drive to -- well, a couple hours to get there, to Midland, and then they would start analyzing the core. So I spent a lot time with Core Lab.

Q. The UV imaging, was that technology that wasn't around during the first analysis, or was that performed there?
A. It was there, but I didn't have any copies of it.
Q. Okay.
A. And so it's -- being a retiree from Chevron, it's kind of hard to go back when you don't know anybody there, because it's like a new staff of people, and ask, "Can I get a copy of the photographs?"
And there's better technology now with these digital images than the older film cameras. And so the idea was, let's just -- if we can get the core from the Bureau of Economic Geology, that's where it was stored, can we get permission to take it back to Core Lab and have them photograph it.
So we did that last year, once we got permission, and got a nice set of photos. And then they said, "We can do UV, too."
And I said, "Well, these are such old cores, I don't think UV is going to work." And they showed me some, and I said, "Oh, this works great. Let's do both plain light and UV."
Even though it's an old core, from --

like the EMSU 679 is from 1990, you can see still with UV the oil saturation.

That was a real surprise. I thought all the light ends would be gone and we wouldn't get an image worth beans. And they got beautiful images.

And they have these digital cameras. They can see more in lower light settings than the old film cameras can. So it was actually to our advantage to take these pictures with a digital camera versus the old film cameras.

Q. Another one of the things that you mentioned was how waterflooding can change the wettability of a reservoir. Can you expand on your understanding of that or the process by which that would occur?

A. That's a tough question. How would I say this nicely? If I were trying to explain that, not being a reservoir engineer, I think I'd be prostituting myself, just to be very blunt. I wouldn't want to try that.

Wettability is incredibly important, though. Because what we found is, there was a guy up in Canada at the University of Calgary that did a study of how oil wet and water wet reservoirs flood. And he made little glass models and he coated one with oil, and the glass was basically acting like it was already water wet. And then he put in real crude from a reservoir and heated it up and had a little entry point and a little exit point, and he put the water through to simulate a waterflood. And they flood completely differently.

In the water wet case, they flood through the smaller pores. In the oil wet case, they flood through the larger pores. And that was really significant.

And so years later, when we were having this CO2 flood in Goldsmith that didn't work, and we were just sequestering CO2, I said to them guys, I said, "Hey, guys, I think we might have a wettability problem here. I think this tends to be oil wet. All the flooding has went through the larger pores, it's displaced the oil, and all we're doing is putting in CO2 into vacated moldic pores," and that's kind of what we were doing. So we proved up what not to do in a CO2 flood in that particular case, because it didn't work.

Q. Well, maybe I'll pose that question to our reservoir engineer later.

One final question. In the section of the 679 that you guys cored, on the bottom of it, where you guys saw evidence of staining that prompted you to think that the saturation went further, did you guys make any estimations on what that saturation was at the lower end of the core?

A. Just what Core Lab was able to tell us. That was all.

The thing that caught my eye was the UV fluorescence. That's what caught my eye.

Q. Okay.

A. And so right there. In one core, it stood out really well and we saw it right at the base of the core.

In the other core, I think it's the 679, it didn't stand out well. But it did in the UV photographs.

And so when I saw it in -- I think it was the RR Bell -- I said, "Oh, it's got to be deeper." But then the great question was: How deep?

And we don't know, other than if you talk to some guys that really know how to analyze logs. They can tell you from a log perspective how deep they are.

But me, being kind of a core guy and working on rocks, I like to see the numbers of the oil saturation myself. In this case, we have no data once go past the base of those two cores.

And they're just in the Upper

San Andres, so there's all the rest of the San Andres that needs to be evaluated, and you have to do that with the logs. And that's beyond me.

Q. Okay. Thank you. Those are all my questions.

MR. RUBIN: Mr. Hearing Officer, if I may, I have one or two questions.

EXAMINATION

BY MR. RUBIN:

Q. Maybe it's just idle curiosity, but Dr. Lindsay, I'm asking you, just based on your testimony about the communication between and the Goat Seep and the San Andres, how large is the Goat Seep Aquifer?

A. Oh, it's not very wide. It's not very wide.

Q. Can you share maybe acre feet or...

A. Well, at outcrop, where you can see it, I would guess the width of it would be a quarter mile, half mile, something like that, from updip to downdip, the massive part of it that stands out like a sore thumb, yeah. It's probably even bigger than that. But that's where I've seen it.

On the seismic, you can see a width to it, as well. You can see the edge of where the -- here's the Grayburg, here's the eroded interval. It

eroded through the Grayburg, down into the San Andres, actually. And then the Goat Seep is here, like this.
And that width, I'm not sure how wide it is. But it could be a quarter mile, half mile, maybe a little bit wider. Something like that. Not too wide, not too wide that we see on the image, on the 3D seismic.
But it extends all the way around the basin from the Guadalupe Mountains, down to the EMSU and probably connects with the Glass Mountains some way that I -- that's kind of beyond me because we have no data.
Q. Do you know if there were having any geologic studies about the size of the aquifer?
A. No. But there was a Ph.D. on the outcrop Goat Seep by the University of Wisconsin back about somewhere around 1970 or so. I can't --
Q. That's okay.
A. I can't remember the guy's name. And it was that thick. It was real well done stuff.
MR. RUBIN: Let the record reflect that's about an inch and a half.
A. A couple inches, yeah. A couple inches.
Q. Okay.
A. Probably 300, 350 pages, quite a bit of data

in an incredibly difficult spot to get to, because it's cliffs that are literally that steep. So you have to be a mountain goat to do that kind of work, and this guy did it. It was at the University of Michigan -- no, University of Wisconsin. Excuse me.

And his professor was known to be a mountain goat, and so these students had to go work with the professor on these sheer cliffs on the western escarpment of the Guadalupe Mountains. And so there were three studies done there, two master's degrees and then this Ph.D. on the Goat Seep.

Q. Is it fair to say, then, that we don't know the size of the Goat Seep Aquifer, sitting here today?

A. Yeah, yeah. That's a fair question. Because you'd have to get a few wells through it and see how thick it is, how porous it is, and then try to look on the 3D to say here's the updip limit, here's the downdip limit, here's my width, here's thickness, here's my porosity. And then you'd know.

Q. Okay. Thank, you, Doctor.

MR. RUBIN: Thank you. Nothing else.

HEARING OFFICER HARWOOD: Chair Rozatos, you get a second chance, if any of the commissioners' questions and answers spurred your curiosity.

CHAIR ROZATOS: I appreciate it, but I

don't. Thank you, Doctor, for your testimony, but I have any other questions.

HEARING OFFICER HARWOOD: So, Doctor, is it because of this guy who was a mountain goat that it's called the Goat Seep Aquifer?

THE WITNESS: No. This guy's name was "Lapray" --

HEARING OFFICER HARWOOD: Okay --

THE WITNESS: -- and he would take field trips out to the western escarpment, with these students, with the University of Wisconsin, and at the end of the day, he'd say, "It's time to go stroke the Goat." And that meant they were going to have to climb up through these cliffs to touch the Goat Seep. And I felt sorry for those students, because it was really steep. But he could do it. He was a very healthy guy.

HEARING OFFICER HARWOOD: He was, right, till he fell? All right. Thank you, Doctor.

So let's see, what time is it? 4:24. I'm hoping we can get poor Dr. Lindsay off the stand today. No pressure.

MS. HARDY: I have very few redirect questions. I think they will be quick. Because I would actually like to get to Mr. Bailey, if we can do that. So I will be brief.

REDIRECT EXAMINATION

BY MS. HARDY:

Q. Dr. Lindsay, when Mr. Rankin was questioning you this morning, he asked questions about a composite sequence boundary. Do you recall those questions?

A. Yes, yes.

Q. And I just want to be sure it's clear here, is it your opinion that there is a ROZ above and below a composite sequence boundary at the EMSU?

A. Yes. There's one ROZ associated with the Grayburg. And then there's another associated with the San Andres. So there's actually two. Yes, there's actually two. Yeah.

Q. And, Dr. Lindsay, did you do a drawing of the composite sequence boundary?

A. Yes, I did. Because I think there was a little bit of confusion about where the composite sequence boundaries are located, and so I just drew a cartoon for you folks.

It's basically, here's the top of the San Andres, where my thumb is right there. Okay? And here's the -- this is the first interval here; it's called the Upper San Andres. We used to just call it the San Andres, but then people studying that outcropping above the mountains realized there's an Upper San Andres that has a composite sequence boundary on it that the Grayburg rests on.

And then there's a Lower San Andres with another composite sequence boundary, right here. And then the Lower Grayburg is really thick. It can been 100 feet think with no problem.

And then there's another composite sequence boundary at the base on top of what's called the Glorieta. So those are the big exposure surfaces.

And then, in the Upper San Andres, you can divide it into an upper half and a lower half. And there in the middle is an another smaller unconformity. And then on top of that is what's called the Lovington Sandstone.

And then on top of the composite sequence boundary at the top of the Upper San Andres there's another sandstone. It's called the premier sandstone.

Now, down here, we don't see a sandstone on this composite sequence boundary because this is the bounding surface where the complete Brushy Canyon Formation went across this surface and poured into and was deposited into the Delaware Basin.

It's this huge volume of sand that went

over this round surface right here. So that meant this surface was exposed for a long time, but we don't know how long. We have no earthly idea. We just know that there's a lot of missing time right here where my finger is, right there.

And then the next big missing time is up here at the very top. And this is where you start to create sinkholes in the San Andres. What I was showing you in that core description, those red intervals, those were some of the sinkholes.

But just to clarify, this stratigraphy, it's like there's an Upper San Andres, there's this much, much thicker lower San Andres. Composite sequence boundary here, another composite sequence boundary down here. And then one at the base.

MS. HARDY: I'd like to offer this as Empire Exhibit J-13, which would be Dr. Lindsay's next rebuttal exhibit.

HEARING OFFICER HARWOOD: Any objection from Goodnight?

MR. RANKIN: I don't know what it is. Are you talking about that piece of paper?

MS. HARDY: Yes.

MR. RANKIN: I guess my question is, I don't know if it's different than what any of other witnesses have testified to.

HEARING OFFICER HARWOOD: Is this a brand-new exhibit that he did over lunch?

THE WITNESS: I drew it at lunch, yes.

MS. HARDY: It's his drawing to clarify the questions that were asked earlier.

THE WITNESS: Because there was a little confusion about where are the composite sequence boundary, and I don't know if I answered it very well. And so I just thought I would just draw a little section to clarify where composite sequence boundaries are, the bigger unconformities, and where they're not. Just to be real simple.

CHAIR ROZATOS: Mr. Hearing Officer --

HEARING OFFICER HARWOOD: Let's take a five-minute break.

CHAIR ROZATOS: Let's give it a ten.

HEARING OFFICER HARWOOD: Let's make it a ten-minute break. It's only fair. This exhibit was a lunchtime exhibit. Let's give people a chance to look it over. So for now, it's not admitted. We'll wait and see. We'll be off the record.

(Recess held from 4:30 to 4:37 p.m.)

HEARING OFFICER HARWOOD: Has Goodnight had a chance to look over this exhibit, Mr. Rankin?

MR. RANKIN: Thank you, Mr. Hearing Officer. Yes, we've reviewed the exhibit and have no objections to its admission. I've asked counsel to send me a picture of it and they have done so.

HEARING OFFICER HARWOOD: Pilot and Rice, any objection to this exhibit?

MR. BECK: No objection.

MR. MOANDER: None from the OCD.

MR. SUAZO: No objection from Pilot.

HEARING OFFICER HARWOOD: Okay. It will be admitted.

(Admitted: Empire New Mexico Rebuttal Exhibit J-13.)

HEARING OFFICER HARWOOD: I don't remember where we were. I'll leave that up to you.

MS. HARDY: Thank you.

BY MS. HARDY:

Q. Dr. Lindsay, is it correct that A composite sequence boundary may or may not be a barrier to fluid flow?

A. Yes, that's true.

Q. Mr. Rankin asked you a number of questions about Goodnight's cross-examination Exhibit 1 which was the article by Love. Do you recall that?

A. Yes.

Q. And is it true that the conformance problems discussed in that article were addressing the Grayburg?
A. Yes, that's correct.
Q. And they were not -- the article was not addressing vertical plumes, was it?
A. That's correct, too.
Q. In your opinion, does the article have any bearing on the issues that the Commission is evaluating here?
A. No, no.
Q. Do you defer to Empire's reservoir engineering experts on recovery of the residual oil zone in the EMSU?
A. Yes. Yes.
Q. With regard to the core data that you've discussed extensively, the conventional core, it shows a ROZ in the EMSU even at those conventional saturations; is that correct?
A. That's correct.
Q. Mr. Rankin asked you a number of questions about the depths of the fractures in your fracture study. Do you recall those questions?
A. Yes.
Q. Okay. And let me try to just turn my screen

here. And I've pulled up here Exhibit J-12 to your rebuttal. Are those the depths that you were analyzing in your fracture study?

A. Yes. We have wrote them all and put all the orientations in the per depth. And then to the right, are the large or small fractures, information like that, yeah.

Q. And with respect to the wells that have fractures, and we've talked extensively about two of them, but are there actually three?

A. Fractures in the EMSU?

Q. Yes.

A. There's just the -- well, how did we do -- what I would describe fractures, I've seen them in all the cores that I've studied. And they're different sizes. You know, they can be a foot or two, they can be less than a foot, they can be inches. And even in core where it's not oriented, you see these fractures all the time.

And the surprising thing was, there's a lot of these little fractures. And they make up a huge number of the total fractures. So there's a lot of fractures in the core. You can't get away from them because of the flexing and making of the anticline. There's just a lot of fracturing.

Q. Dr. Lindsay, Mr. Moander, OCD's counsel, asked you a number of questions about the Capitan Reef the Safe Drinking Water Act. Do you recall those questions?

A. Yeah.

Q. But you're not a lawyer, are you?

A. No.

Q. In fact, Mr. Moander objected to you earlier testifying about a legal opinion, correct?

A. Yes.

Q. And with respect to the fracture studies that Mr. Moander asked you about, those are the studies in your testimony that we've been discussing here today, is it correct that those deal with the vertical fractures that allow fluid migration between the San Andres and the Grayburg?

A. Yes.

Q. And so your fracture studies are not -- well, let me ask it this way. Do you fracture studies show that there would be any migration to the Capitan Reef?

A. There's no way that can happen. It's too far away. It's absolutely too far away.

Q. And just to sum up here, and I think this is clear, but I want to make sure. Do you disagree with

Goodnight's position that there is no ROZ in the San Andres?

A. Oh, yes, yes, there's a ROZ.

Q. And is that based on your study and characterization of the reservoir, including the core analysis?

A. Yes.

Q. And do you disagree with Goodnight that there is a barrier to fluid flow between Goodnight's injection zone and the residual oil zone?

A. Yes. Because there's too many fractures. And it seems to be there's discontinuous tight intervals. They don't seem to be continuous.

MS. HARDY: Those are all of my redirect questions.

HEARING OFFICER HARWOOD: Okay. Well, then, may this witness be excused?

MS. HARDY: Yes.

MR. RANKIN: Mr. Hearing Officer, based on Ms. Hardy's questions of Dr. Lindsay, I have to ask him a question about the SPE paper that he referred to.

HEARING OFFICER HARWOOD: I hate to open the door to recross-examination, so unless it has to do with something that was brought up on redirect only.

MR. RANKIN: It was redirect only.

HEARING OFFICER HARWOOD: Lawyers always say one last question. How many do you have, Mr. Rankin? I guess we can run out the clock. It's 4:43. So if you have a few more questions.

I don't think, Ms. Hardy, we're going to get to another witness today. That was, in hindsight, very wishful thinking, apparently.

All right, Mr. Rankin.

RECROSS-EXAMINATION

BY MR. RANKIN:

Q. Dr. Lindsay, I'm showing here on the screen a portion of your transcript from your deposition. Okay? And I'm going to show a portion of this discourse between yourself and me. Okay?

And here, where it says "Q," that's me talking, where there's an "A," that's you.

So here I start and I say...

"QUESTION: The question I have, though, is about -- back to these wells. You referred to Tracy Love and the work he did showing the high-water-cut wells, and your opinion is -- is your opinion that the high-water cut is associated only with the water from the San Andres?

"ANSWER: Most likely, yes."

A. Yes.
Q. "QUESTION: And that would be from the Upper San Andres, right?
"ANSWER: It would be -- yeah. However water comes out of the San Andres itself and the Upper San Andres is right there are the top, so it's probably coming out of it. And it would be coming out of the Lower too."
My response, "Okay.
"ANSWER: We just know that it's San Andres water that's ascending up." And then you said, "From plumes of water."
My question to you was...
"QUESTION: Your opinion is the San Andres water coming up. That's your --
"ANSWER: No. That is a fact, because we analyzed the water and it was sulfate rich.
"QUESTION: And that's based on Mr. Carpenter's presentation to you," right?
"ANSWER: And basic water chemistry studies done by Hobbs Division in Hobbs, New Mexico, before that:
"QUESTION: So do you have the data on the Hobbs Division water chemistry?
"ANSWER: No. No. It common knowledge,

though.

"QUESTION: Okay. So you're telling me it was common knowledge that there were these plumes --

"ANSWER: Yes.

"QUESTION: -- coming up?

"ANSWER: Yes.

"QUESTION: But Mr. Love would know that, right? He would be informed of that, right?

"ANSWER: Yes. And he wrote an SPE paper on it so you can look it up.

"QUESTION: Okay. Very good.

So now, today, Dr. Lindsay, I presented to you that SPE paper, and if there were such San Andres plumes, which I understood you to say that there were, they were not addressed in the SPE paper.

So you're telling me that it's not relevant to the Commission's review?

A. No, it's -- what Tracy and his co-author were chasing were horizontal high-perm streaks that made it conformance work done on it. That was the focus of their work. Not vertical plumes.

Q. If they were worried about waterflood operations and improving the waterflood, why wouldn't they have addressed in their paper an issue that was affecting the waterflood, if it truly were the case?

If it truly were the case that water was pluming up and it was common knowledge, why wouldn't it have been addressed in this paper?

A. Because they were talking about conformance. They weren't talking about plumes of water.

MR. RANKIN: Very well. No further questions.

MR. MOANDER: And, Mr. Hearing Officer, based on a response to a line of questions from Commissioner Ampomah, OCD has a couple of questions they would like to ask on recross that took things a little deeper than they had been on cross-examination.

HEARING OFFICER HARWOOD: Well, all right. This is why I try not to open this door, but now I have. And I guess everybody is going to drive right through it. So go ahead.

MR. MOANDER: Thank you.

RECROSS-EXAMINATION

BY MR. MOANDER:

Q. So, Dr. Lindsay, I'm going to go back to your deposition in this case during my examination of you. I'm assuming you still recall that?

A. Mm-hmm.

Q. And I asked you a question on where you would place any doubt that was had concerning communication between the EMSU and the Capitan. And I asked if those were your opinions within a reasonable degree of scientific probability. Do you recall that?
A. Yes.
Q. I'm sorry, what was that, Doctor?
A. Yes.
Q. And do you recall what your response was to that?
A. No.
Q. Well, you initially asked what I meant by that. And when I posed the query, you said you doubted there was communication, which would bring into question, meaning there's a possibility.
You testified: There's no communication between the Capitan and the EMSU?
Do you recall that?
A. Yes.
Q. And then you stated further: If you wanted a little more rock solid, there's no communication.
A. Yes, that's correct. That's because they're --
Q. Well, that's all right, Doctor.
A. -- too far apart.

Q. Thank you.
A. That's why. It's too far apart.
MR. MOANDER: I'm going to ask that the continuous answer be stricken. Dr. Lindsay has got a habit of continuing to answer questions after the answer has been provided.
HEARING OFFICER HARWOOD: I'm going to strike it. I think it's probably the third time we've heard it. But he's been consistent in his testimony throughout. You asked the question. Yes, does he over-volunteer, that's why you've been here all day. But, you know, it is what it is. This is going to be a long hearing and all this stuff is interesting.
So I, for one, thank you for your time.
You have 12 minutes to put on another witness, or we can close for the day, Ms. Hardy.
MS. HARDY: Yeah, let's just start fresh tomorrow at this point.
HEARING OFFICER HARWOOD: I think that's a great idea.
MR. MOANDER: As a housekeeping question, I assume we're going to lock the hearing room, so perhaps binders could be --
CHAIR ROZATOS: So before we start with your

housekeeping, Mr. Moander, I think Commissioner Ampomah had a question regarding the case itself.

HEARING OFFICER HARWOOD: Yeah, would like to know the order of witnesses, and I think Mr. Rankin needs that courtesy as well.

MS. HARDY: Sure. And I gave it to Mr. Rankin earlier and I can give it to you, as well.

Our next witness is Ryan Bailey.

HEARING OFFICER HARWOOD: And then after that, is it Mr. Birkhead?

MS. HARDY: Yes.

HEARING OFFICER HARWOOD: And then maybe overly optimistic, but if we get to more than two witnesses tomorrow, who is going to be the third?

MS. HARDY: Dr. Jim Buchwalter.

HEARING OFFICER HARWOOD: Anything else, Mr. Rozatos?

CHAIR ROZATOS: I don't have anything else for the case, unless anybody else on the Commission does.

MR. RANKIN: May I just pipe up on the order of witnesses? My understanding is that Empire only has one witness who has a limitation on availability, and that was Dr. Trentham; is that correct?

MS. HARDY: I believe at this point that's correct. Dr. Trentham needs to testify on Thursday.

MR. RANKIN: And then after Dr. -- after Mr. West, we had discussed what the other sequence would be. Is that going to change, do you think, between now and the time that's been presented?

MS. HARDY: I don't think so. We might have to make minor adjustments.

MR. RANKIN: Okay. And that will be Melzer, Dillewyn, McShane, Wheeler and then Trentham and then Marek. Is that right?

MS. HARDY: Yes.

MR. RANKIN: Okay.

CHAIR ROZATOS: I will just state, everybody start looking at your calendars, because we're not going to get through all of these people by Friday. And the scheduling is getting tight.

We, as the Commission, are looking at calendars, and I think everybody in the audience also needs to start looking at calendars, because we're going to have to start proposing dates by Friday. So just keep that in the back of your minds, please.

MS. HARDY: Thank you.

CHAIR ROZATOS: Mr. Hearing Officer, if we're done with the actual case part, we do have the housekeeping question that came up.

HEARING OFFICER HARWOOD: We don't need to have that on the record, so we can release the long-suffering court reporter with our thanks for today.

And we'll reconvene the hearing again tomorrow morning, promptly at 9 o'clock.

(Proceedings adjourned 4:51 p.m.)

AFFIRMATION OF COMPLETION OF TRANSCRIPT

I, Kelli Gallegos, DO HEREBY AFFIRM that on February 24, 2025, a hearing of the New Mexico Oil Conservation Commission was taken before me via video conference.

I FURTHER AFFIRM that I did report in stenographic shorthand the proceedings as set forth herein, and the foregoing is a true and correct transcript of the proceedings to the best of my ability.

I FURTHER AFFIRM that I am neither employed by nor related to any of the parties in this matter and that I have no interest in the final disposition of this matter.

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