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PUBLIC HEARING  
STATE OF NEW MEXICO  
OIL CONSERVATION COMMISSION

Pecos Hall, 1st Floor, Wendell Chino Building  
1220 S. Saint Francis Drive  
Santa Fe, New Mexico

TRANSCRIPT OF PROCEEDINGS  
April 21, 2025  
VOLUME XII

HEARD BEFORE:

HEARING OFFICER RIPLEY HARWOOD

COMMISSION MEMBERS:

GERASIMOS ROZATOS, Chair

BAYLEN LAMKIN, Member

DR. WILLIAM AMPOMAH, Member

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1 (On the record at 9:02 a.m.)

2 TRANSCRIPT OF PROCEEDINGS

3 CHAIR ROZATOS: My name is Gerasimos  
4 Rozatos. I am the acting director of the Oil  
5 Conservation Division. I'm also the acting Chair for  
6 the Oil Conservation Commission.

7 Today is April 21st, 2025. We have our  
8 meeting and hearing today. So what I would like to  
9 do is start our meeting this morning, and I'd like to  
10 do a roll call.

11 As I stated, I am Gerasimos Rozatos. I  
12 am the acting director, and the acting Commission  
13 Chair for the Oil Conservation Commission. And then  
14 I'll turn it over to Commissioner Bloom. I'll start  
15 with you.

16 COMMISSIONER BLOOM: Good morning, everyone.  
17 Thank you, Mr. Chair. Greg Bloom, designee of the  
18 commissioner of Public Lands. And I am just here, I  
19 think, for the Apache and Northwind cases. And I'll  
20 step out and Baylen Lamkin will take my place for the  
21 Goodnight/Empire case. Thank you.

22 CHAIR ROZATOS: Commissioner Ampomah.

23 COMMISSIONER AMPOMAH: Good morning. I'm  
24 Dr. William Ampomah, professor of petroleum  
25 engineering at New Mexico Tech, and also designee of

1 the Energy secretary. Thank you.

2 CHAIR ROZATOS: Excellent. Thank you.

3 And just to let everybody know,  
4 Mr. Zachary Shandler is also going to be appearing  
5 via Teams this week, as well. So he will be on  
6 platform also if we need anything.

7 Excellent. So our roll call is done.

8 So let's move to the approval of the  
9 April 21st through the 25th, 2025, agenda. May I get  
10 a motion for that approval.

11 COMMISSIONER BLOOM: Mr. Chair, I so move.

12 COMMISSIONER AMPOMAH: I second.

13 CHAIR ROZATOS: Excellent. Thank you. So  
14 the agenda for this meeting has been approved.

15 (Motion approved.)

16 CHAIR ROZATOS: Our third item is the  
17 approval of the March 11th, 2025, meeting minutes.  
18 Commissioner Bloom, I just wanted to make sure. You  
19 had wanted some time to be able to review it. Were  
20 you able to review the minutes?

21 COMMISSIONER BLOOM: Mr. Chair, yes, I did.  
22 I suggested a couple corrections, and I think those  
23 sent around by Sheila, so we should be good for a  
24 motion on that.

25 CHAIR ROZATOS: So you're moving for the

1 motion.

2 If we could get a second, please.

3 COMMISSIONER AMPOMAH: I second.

4 CHAIR ROZATOS: Excellent. So those minutes  
5 have been approved, as well.

6 (Motion approved.)

7 CHAIR ROZATOS: I don't know if Mr. Shandler  
8 is on right at the moment. But did we have any  
9 pending litigation?

10 As I stated, I don't think he's on right  
11 at the moment. So I don't think we have any other  
12 pending litigation. And did we have any other  
13 business that we needed to address, Commissioners?

14 COMMISSIONER BLOOM: No, Mr. Chair.

15 CHAIR ROZATOS: Commissioner Ampomah?

16 COMMISSIONER AMPOMAH: No.

17 THE CHAIR: So our next meeting is scheduled  
18 for May the 15th, 2025. So let's mark that on our  
19 calendars, as well.

20 We did have some cases that we wanted to  
21 do before we actually went into the actual hearing.

22 So our first pending case is Case Number  
23 24881, application of Northwind Midstream Partners,  
24 LLC, for approval of an additional redundant acid gas  
25 injection well, and to amend Order Number R-20913, as

1 amended, and SWD-2622, to authorize an increased  
2 shared maximum daily injection rate in Lea County,  
3 New Mexico.

4 Are all individuals for this particular  
5 case present?

6 MR. RANKIN: Mr. Chair, Commissioners, Adam  
7 Rankin with the Santa Fe office of Holland & Hart,  
8 appearing on behalf of Northwind Midstream Partners,  
9 LLC.

10 HEARING OFFICER HARWOOD: Thank you,  
11 Mr. Rankin.

12 MR. TREMAINE: This is Jesse Tremaine for  
13 the Oil Conservation Division.

14 CHAIR ROZATOS: Excellent.

15 Mr. Rankin, so this is a presentation of  
16 final order, correct?

17 MR. RANKIN: Correct, Mr. Chair. We  
18 circulated a proposed draft final order middle of  
19 last week, for the Commission to review and consider,  
20 proposing the adoption or granting of the  
21 application, as requested, with the modifications  
22 that came up from the hearing and adopting the  
23 Division's proposed conditions as modified during the  
24 hearing.

25 CHAIR ROZATOS: Mr. Tremaine, just making



1       sure that you agree and you have no issues?

2               MR. TREMAINE:   We reviewed the proposal and  
3       agree with the content.

4               CHAIR ROZATOS:   Commissioners, did you have  
5       any questions on the final order?

6               COMMISSIONER BLOOM:   No, Mr. Chair.

7               COMMISSIONER AMPOMAH:   No, Mr. Chair.

8               CHAIR ROZATOS:   Excellent.   Okay.   So we  
9       will process that final order and we will continue on  
10      with that.

11              Any questions, Mr. Rankin or  
12      Mr. Tremaine?

13              MR. RANKIN:   No.   Thank you very much  
14      Mr. Chairman, Commissioners.

15              MR. TREMAINE:   None for OCD.   Thank you.

16              CHAIR ROZATOS:   Excellent.   Thank you.   So  
17      that one is completed.

18              We'll move on to Case Number 24912, the  
19      application of Apache Corporation for an adjudicatory  
20      hearing to contest the Division's condition of appeal  
21      on Apache Corporation's scope of work for additional  
22      investigation in Lea County, New Mexico.   It's a  
23      matter to be heard.   Motion to amend Order R-23728.

24              Are all parties present?

25              MR. MOELLENBERG:   Mr. Chair, Members of the

1 Commission, Dal Moellenberg, from Gallagher &  
2 Kennedy, for Apache Corporation. Along with me is  
3 Samantha Catalano.

4 CHAIR ROZATOS: Thank you, Mr. Moellenberg.

5 MR. TREMAINE: And this is Jesse Tremaine  
6 for the Oil Conservation Division. Thank you.

7 CHAIR ROZATOS: Excellent. Thank you.

8 Mr. Moellenberg, we'll turn it over to  
9 you for your motion.

10 MR. MOELLENBERG: Thank you, Mr. Chair,  
11 Members of the Commission.

12 You'll all recall that we had a hearing  
13 in this matter in January. We then had an order that  
14 was issued by the Commission in February. Apache  
15 moved for rehearing of that matter. The Commission  
16 didn't act on that; so with that, the order became  
17 final, other than subject to a court appeal.

18 Since the hearing, Apache had conducted  
19 another round of groundwater monitoring, reported the  
20 results to the Division, and also conducted, along  
21 with others, some of the investigations prompted by  
22 the groundwater monitoring conducted before the  
23 hearing.

24 We then, after reporting those results,  
25 consulted with the Division, and discussed whether we

1 could reach agreement on a slightly modified  
2 groundwater monitoring plan, after having looked at  
3 all of the additional information.

4 We were able to come to an agreement on  
5 that. The agreement makes some slight adjustments to  
6 some of the monitoring wells. There are, I think,  
7 about four fewer monitoring wells. But, essentially,  
8 the monitoring wells that were dropped are, more or  
9 less, replaced by a good spacing around the perimeter  
10 of the area. I would say the interior monitoring  
11 wells have largely been untouched.

12 The joint motion on behalf of the Apache  
13 and the Division summarizes those changes for you,  
14 provides a map. And with that, we would ask the  
15 Commission's approval of the joint motion. And along  
16 with the joint motion, there is and Exhibit A that  
17 would be essentially the new directive for  
18 groundwater monitoring at the site.

19 CHAIR ROZATOS: Thank you, Mr. Moellenberg.

20 Mr. Tremaine.

21 MR. TREMAINE: Thank you, Mr. Chair,  
22 Commissioners.

23 As you recall, we had a contested  
24 hearing in this matter. I think a couple things to  
25 point out are that at the time of the hearing, we had

1 had fourth-quarter monitoring that was concerning to  
2 the Division. And the consultant -- or new  
3 consultant for Apache was newer to the case.

4 Since that order was issued, we've had  
5 multiple meetings with Apache and the consultant.  
6 OCD has reviewed the technical aspects of the revised  
7 proposal and met all of the asks that OCD has made in  
8 terms of content of the reports and the sampling.  
9 This does revise the position of certain of the  
10 wells.

11 But this is -- this proposal is well  
12 within a range that OCD was seeking when we went to  
13 hearing, so we are satisfied with this as a  
14 worthwhile proposal in terms of the next step of  
15 remediation and characterization.

16 So I agree with Mr. Moellenberg that  
17 certain of the wells that are removed are replaced  
18 based on the positioning of other wells. There are  
19 some other changes, such as there are areas of  
20 concern identified by both OCD and Apache related to  
21 landscape scarring, potential sources of the  
22 chlorides from historic or potentially newer  
23 releases.

24 And so some of the wells have been  
25 changed to a monitoring well downgrading of that

1 location, but a soil boring in the scarring location.  
2 And we think that that is actually a net positive  
3 from the result of the hearing. That was something  
4 that was not discussed before.

5 And lastly, one of the primary  
6 objectives of the Division in this case was to get us  
7 to a resolution on the next stage of characterization  
8 and identification of contamination. We believe that  
9 this does that, because with this proposal, Apache  
10 will waive their right to appeal. And there are  
11 still legal arguments between the parties.

12 So we believe that this is something the  
13 Commission should strongly consider and we ask you to  
14 approve. It gets us to where the Division believes  
15 that we need to be for the next stage of remediation  
16 and, in a modified way, it achieves, we believe, what  
17 the order issued by the Commission would have  
18 achieved.

19 THE COURT: Thank you, Mr. Tremaine.

20 Commissioners, any questions?

21 COMMISSIONER AMPOMAH: Mr. Chair, do we have  
22 a map for the new proposed locations?

23 CHAIR ROZATOS: I am not sure. I know the  
24 exhibits were submitted. I am kind of looking  
25 through it myself. My apologies.

1           Exhibit A does not have a map on it.  
2       There was also an Exhibit B.

3           COMMISSIONER BLOOM:   Exhibit B does have the  
4       map, yeah.

5           CHAIR ROZATOS:   Yeah.   It's on Exhibit B.

6           Mr. Moellenberg, I will ask a question.  
7       So on this Exhibit B, the wells that are designated  
8       as new, 1 through 6, are the new wells, correct?

9           MR. MOELLENBERG:   Yes, Mr. Chair, that is  
10       correct.   As Mr. Tremaine indicated, some slight  
11       adjustments of the location of a few other wells in  
12       the interior.   But those six wells are the new well  
13       locations.

14          CHAIR ROZATOS:   Okay.   Thank you.

15          Commissioner Ampomah, did you have any  
16       questions on that?

17          COMMISSIONER AMPOMAH:   Yeah, Mr. Chair.

18          So if you look, it sounds like the new  
19       wells are more on the exterior side.   So can the  
20       parties explain how they, more or less, reach an  
21       agreement to site these new wells right at the  
22       exterior?   Even during the hearing, OCD did have a  
23       concern that even the interior portion has not been  
24       fully delineated.

25          MR. MOELLENBERG:   Mr. Chair, Commissioner, I

1 can explain that briefly. And if you have more  
2 technical questions, we do have Mr. Grahams, our  
3 consultant, online who could respond to that.

4 But mostly, Mr. Grahams took a look at  
5 where we were with the spacing of the perimeter wells  
6 and made some slight adjustments, in some cases  
7 moving wells slightly outward at locations where it  
8 would be expected to be fully outside of the plume  
9 and provide a clear delineation in that area that  
10 it's not affected.

11 In other cases, for example, in the  
12 southern portion, there's new 5 and new 6, which were  
13 intended to just provide better spacing. I think  
14 there was a well down there, it's not shown on the  
15 map proposed by Apache. That was TMW 25 that was  
16 more or less in between and perhaps a little to the  
17 south of those. So it was really just to improve the  
18 spacing of the perimeter delineation to make sure  
19 that the monitoring captures all of the potential  
20 areas where the plume might be or in the northern  
21 area, obviously, to space the up-gradient wells more  
22 appropriately.

23 COMMISSIONER AMPOMAH: So is it my  
24 understanding that, let's say assuming new 5 and then  
25 new 6, new 4 and new 3 and also the northern one, so

1 once you drill these wells and then you sample and  
2 then you do not see any chloride in the analysis,  
3 then more or less shows that you've been able to  
4 delineate the boundaries of the plume?

5 Okay. Thank you, Mr. Chair, I do not  
6 have any further questions.

7 CHAIR ROZATOS: Mr Tremaine, you wanted to  
8 add on, correct?

9 MR. TREMAINE: I did just want to point out  
10 for the record that those are revised wells. But the  
11 green wells on the map do reflect that we retained --  
12 so one of the questions was how are we delineating  
13 the interior and addressing OCD's concerns with the  
14 interior.

15 And so those are not represented in the  
16 yellow wells. Those are the green wells on map. And  
17 so the bulk of those wells from the order have been  
18 retained. So the interior is resolved by those.

19 And then, for instance, if you look up  
20 at the upper right-hand corner of the map that  
21 reflected as existing well TMW 13, the green TMW 33  
22 from the order and the SB-1, Soil Boring 1, so in  
23 OCD's proposals and our discussions, we've previously  
24 proposed a groundwater monitoring well at SB-1,  
25 because we wanted to know what was up with that



1     scarring at that location, right, on the lack of  
2     vegetation?

3                     And conferring with the parties, the  
4     proposal is to, instead of relying on a new well  
5     there, rely on the two down-gradient wells in those  
6     locations, and put a soil boring that does not extend  
7     down to groundwater because we don't want to create a  
8     new conduit through potential contamination down to  
9     groundwater.

10                    So we're doing kind of a combination  
11     platter there of the existing and new well, both  
12     down-gradient and the soil boring.

13                    So I wanted to clarify that for the  
14     record, that those are -- from OCD's technical  
15     review, we believe that those locations are  
16     appropriate and the revision still captures what was  
17     represented in OCD's original ask in the order.

18                    CHAIR ROZATOS:   Okay.   Commissioner Bloom,  
19     did you have any questions yourself?

20                    COMMISSIONER BLOOM:   No, Mr. Chair.   I had  
21     the opportunity to review the materials prior to the  
22     meeting today, and I'm very comfortable with this.  
23     Thank you.

24                    CHAIR ROZATOS:   Commissioner Ampomah, any  
25     other questions?

1 COMMISSIONER AMPOMAH: No, Mr. Chair.

2 CHAIR ROZATOS: So I think we're all in  
3 agreement that we're comfortable with these changes.  
4 So we'll definitely get the order amended and written  
5 up and get it all out for everybody. So we'll do  
6 that.

7 Any questions from the parties?

8 Mr. Moellenberg? Mr. Tremaine?

9 MR. MOELLENBERG: Mr. Chair, no questions.  
10 Appreciate your consideration of the revision. And  
11 with this, Apache will not be filing an appeal.

12 CHAIR ROZATOS: Excellent. Thank you.

13 Mr. Tremaine.

14 MR. TREMAINE: Nothing further. Thank you,  
15 Mr. Chair, Commissioners.

16 COMMISSIONER BLOOM: Mr. Chair, just  
17 curious. Do we need to vote on this?

18 CHAIR ROZATOS: I think we actually do. I  
19 was going to kind of move on to that part, so I  
20 agree. So all those in favor for the amendment.

21 COMMISSIONER BLOOM: Mr. Chair, if you'd  
22 allow me, I would move to adopt --

23 CHAIR ROZATOS: All right. Please, can we  
24 move to adopt it?

25 COMMISSIONER AMPOMAH: And I second.

1 CHAIR ROZATOS: Excellent. Okay. Now, all  
2 in favor, say aye.

3 ALL MEMBERS: Aye.

4 CHAIR ROZATOS: Okay. So it's now  
5 officially approved. Thank you, Commissioner Bloom.  
6 I appreciate.

7 Excellent. Thank you to all the parties  
8 for that.

9 (Motion approved.)

10 CHAIR ROZATOS: We'll move on to our next  
11 case, which is the consolidated cases by Goodnight  
12 Midstream and Empire New Mexico. It's Case  
13 Numbers 24123, 23614 through 17, 23775, 24018 through  
14 24020, and 24025. It is a continuation of an  
15 evidentiary hearing.

16 We have our hearing officer.

17 Commissioner Bloom, thank you. We  
18 appreciate it. And we'll get Mr. Lamkin on.

19 COMMISSIONER BLOOM: Thank you. And  
20 Mr. Lamkin is on his way up. Thank you. Have a good  
21 day. Thanks.

22 CHAIR ROZATOS: Thank you.

23 Mr. Harwood, we will transfer the  
24 hearing over to you.

25 HEARING OFFICER HARWOOD: Thank you,

1 Chairman Rozatos. Good morning, everybody.

2 I'm assuming, but I'll ask anyway that  
3 we do have the court reporter and we are on the  
4 record. Is that correct?

5 All right. Great.

6 We have what I understand is an agreed  
7 switch-up of witness order at this point. Empire,  
8 you're aware of this, right? You guys discussed it  
9 with Mr. Rankin?

10 MR. WEHMEYER: That's correct. Our  
11 understanding is that it will be Dr. Davidson,  
12 followed by Mr. Knights, followed by Mr. McBeath.

13 HEARING OFFICER HARWOOD: All right. That's  
14 my understanding as well.

15 Let me just remind everybody, put your  
16 phones on silent. We don't need to be rudely  
17 interpreted by any ducks this week.

18 So it looks to me like Dr. Davidson is  
19 here in person.

20 MR. RANKIN: Correct, Mr. Hearing Officer.

21 HEARING OFFICER HARWOOD: Doctor, if you'll  
22 raise your right hand.

23 MR. RANKIN: He's in the back. He'll make  
24 his way up to the stand now.

25 HEARING OFFICER HARWOOD: All right.

1           MR. RANKIN: And another point of order,  
2           Mr. Hearing Officer. Dr. Davidson, did have recent  
3           cataract surgery and has been having difficulty. So  
4           he's bought printouts of his portions of a slide  
5           presentation so it's easier for him to see, and  
6           perhaps for the commissioners as well.

7           HEARING OFFICER HARWOOD: Been there, done  
8           that, so I understand perfectly.

9           Good morning Dr. Davidson.

10          JAMES ALEXANDER DAVIDSON, Ph.D.,  
11          having first been duly sworn, testified as follows:

12                       DIRECT EXAMINATION

13          BY MR. RANKIN:

14               Q. Dr. Davidson, will you please state your  
15          name for the record.

16               A. James Alexander Davidson.

17               Q. And by whom are you employed and in what  
18          capacity?

19               A. Netherland, Sewell & Associates, senior  
20          technical advisor in petrophysics.

21               Q. Have you previously testified before the Oil  
22          Conservation Commission?

23               A. I have not.

24               Q. Can you please give a brief summary of your  
25          education.

1           A. BS, MS, Ph.D. in petroleum engineering.  
2           University of Texas for the MS and Ph.D.

3           Q. Is our resume attached to your written  
4           direct testimony and marked at Exhibit D-1?

5           A. Yes.

6           Q. Will you also please give us a brief summary  
7           of your work experience as a petroleum engineer and as  
8           a petrophysicist, in particular as it relates to your  
9           experience working in complex carbonate systems and  
10          your experience in and around the Central Basin  
11          Platform.

12          A. Well, I started about 45 years ago working  
13          for Arco Oil and Gas Company. But previous to that,  
14          while I was going to undergraduate school at Texas  
15          Tech, I worked part-time for what was at the time  
16          Amoco Oil and Gas Company. Subsequently went away, as  
17          did Arco.

18                 But part-time work was involved with  
19          Levelland Slaughter Field. They were evaluating doing  
20          some coring, log analysis work, evaluating that field  
21          for potential CO2 recovery operations. That was during  
22          my undergraduate.

23                 After I -- and I also worked in the  
24          summers for Amoco in some of their Permian Central  
25          Basin Platform waterfloods, where they were doing

1     infield drilling, and also doing evaluations for CO2,  
2     potential CO2 flooding. And then that would have been  
3     in Henson Farms, North Cowden, South Cowden, those  
4     fields.

5                 When I graduated, with a BS, I went to  
6     work for Arco, and my first job was in Midland, Texas,  
7     and I was assigned to the North Foster Unit, J.L.  
8     Johnson 8 units. And, again, Arco was doing the same  
9     thing as everybody else at the time, evaluating the  
10    waterfloods for potential CO2.

11                The reason for that was at that time,  
12    there was incentives. There were oil price controls  
13    at that time, in the early '80s, and there was  
14    incentives if you went to CO2 injection. As an EOR  
15    project, you got additional dollars for each barrel of  
16    oil. So all the majors at that time were evaluating  
17    their waterfloods, San Andres Grayburg waterfloods,  
18    for CO2. So that was my introduction to this type of  
19    work.

20                I worked for Arco for a year there, then  
21    was transferred to California. And there I worked  
22    several conventional waterfloods. And then moved to  
23    Indonesia, where I worked offshore Indonesia and was  
24    involved again with a large carbonate, the Bima Field,  
25    where we were doing an evaluation there as log decor

1 and trying to figure out how to map dissolution  
2 precipitation fronts diagenetic that were affecting  
3 the performance of that field.

4 I left Arco and went back to graduate  
5 school at University of Texas and got a Ph.D. there.  
6 During that time, I worked periodically with the  
7 Bureau of Economic Geology. And at that time, the  
8 Bureau was doing an extensive study of the Grayburg  
9 San Andres as far as rock typing and developing  
10 petrophysical models that could be upscaled for  
11 reservoir simulation. It was a huge, interesting  
12 reservoir simulation in the Grayburg San Andres. And  
13 this would have been '90 to '98.

14 And that was the time that Jerry Lucia  
15 and Charlie Kerans were doing all the work on the  
16 outcrops out here in New Mexico and a bunch of them  
17 working in West Texas, where they were evaluating the  
18 different rock types and turning the rock types into  
19 reservoir simulations descriptions.

20 I didn't work directly with Jerry Lucia.  
21 I worked with one of his colleagues, Fred Wang. Jerry  
22 did the core work, the geology work, and Fred was  
23 charged with the doing the correlation of well logs to  
24 the core work. And they worked together to develop a  
25 pretty sophisticated model for a carbonate ramp



1 environment.

2 After I left University of Texas, I went  
3 to work for Netherland, Sewell & Associates, been  
4 there about 26 years. And we do carbonates all over  
5 the world there. There I've worked some of the  
6 largest carbonates in the world, North Field, and  
7 Qatar, Taq Taq and Chemchemal in Iraq; worked large  
8 carbonate discovery up on the Guinea.

9 We -- from the time I joined Arco in  
10 1998 until about 2019, we did Pemex reserves every  
11 year. And during that time, I worked every carbonate  
12 reservoir they had in Mexico and basically looked at  
13 every -- described and looked at every core from the  
14 carbonate fields in Mexico and the clastics, as well.  
15 I spent quite a bit of time down there in  
16 mosquito-infested core facilities, describing cores  
17 and building reservoirs models from there.

18 So that's a summary of my carbonate  
19 experience.

20 Q. Pretty extensive. Tell the Commission a  
21 little bit about what Netherland, Sewell & Associates  
22 is and what they do and what your role is with them.

23 A. We're reserve auditors, reserve consultants.  
24 The Security and Exchange Commission requires publicly  
25 owned companies to have an independent reserve

1 estimate each year with their SEC filings, and we  
2 provide that service for publicly traded companies.  
3 We're the largest company that does that. We have  
4 more clients for SEC than any other of the major  
5 consulting companies.

6 The other thing we do is reserve  
7 certification, independent estimates for project  
8 financing for large projects. And, again, we work on  
9 a lot of the larger projects in the world. For  
10 example, the offshore Northwest Australia, Chance  
11 Gorgon. We reserve certification for the North Field,  
12 which is the giant LNG project in Qatar. We did the  
13 certification for the pipeline from Azerbaijan into  
14 Europe, which was pinned down by the reserves in the  
15 ACG Field.

16 The other thing we do is equities, when  
17 there's equity disputes. We've been involved in some  
18 of the largest equities in the world, the largest  
19 probably being Elk Hills National Petroleum Reserve  
20 equity dispute between the Department of Energy and  
21 Chevron. Our job is to provide independent reserve  
22 estimates for the purposes protecting capital,  
23 basically.

24 Q. Now, in this case in particular, Goodnight  
25 Midstream retained you for purposes of this case.

1 Will you explain what it was you were asked to do in  
2 this case.

3 A. We were asked to provide an independent  
4 petrophysical evaluation of the San Andres Grayburg  
5 interval, both inside the EMSU, from selected wells  
6 inside the EMSU, and from wells outside, some of the  
7 outside operated water disposal wells, for the  
8 purposes of basically determining or estimating oil in  
9 place -- or not oil in place, but to determine whether  
10 or not a residual oil zone existed and whether there  
11 were significant amounts of residual oil in the Lower  
12 San Andres where the disposal operations were going  
13 on.

14 The other thing that we were tasked to  
15 do was to identify potential flow barriers between the  
16 disposal zone in the lower part of the San Andres and  
17 the upper operations in the Upper San Andres and  
18 Grayburg, where Empire is operating.

19 Q. So, in other words, to look to see if you  
20 could identify any potential hydrocarbon reserves and  
21 also to evaluate whether or not there was a potential  
22 for a productive residual oil zone in that disposal  
23 zone where Goodnight is injecting; is that right?

24 A. That's correct.

25 Q. And have you then conducted a petrophysical

1 study of the San Andres in and around the EMSU?

2 A. Yes, we have.

3 Q. Just at a high level, would you let the  
4 Commission know what it is that you did, what you  
5 looked at to come to your opinions?

6 A. Well, we looked at all the well logs, we  
7 looked at the core data. I did a significant deep  
8 dive into the petrophysics of the San Andres Grayburg  
9 and the literature. I had a lot of background from my  
10 work at the Bureau of Economic Geology on the type of  
11 work that had been done.

12 We drew all that information into our --  
13 to build a petrophysical model to evaluate the  
14 potential of oil in place and the potential for  
15 barriers.

16 Q. And in the process of doing that, did you  
17 pursue independently your own independent  
18 investigation? You went and dug through data on your  
19 own and found --

20 A. Yeah. Again, I had quite a bit of  
21 experience. I was with the Bureau when the outcrop  
22 study at the Guadalupe Mountains was being carried out  
23 want. And the purpose of that study was to build a  
24 general model for a carbonate ramp environment that  
25 could be applied to any carbonate ramp, you know,

1 anywhere in the world. So I was there when that work  
2 was being done.

3 We relied heavily on that study because  
4 it was the San Andres that they were studying, and  
5 specifically, they were studying the part of the  
6 San Andres that's in the -- that's associated with the  
7 disposal zone below the EMSU. So we relied heavily on  
8 that information.

9 At the time, we kind of had a faux pas,  
10 in a way. I was aware of the 679 core; we studied it  
11 extensively. There was also another core that was  
12 available for the RR Bell 4. Unfortunately, we  
13 discovered that there's two RR Bell 4s associated with  
14 the EMSU. One of them was drilled sometime in the  
15 late '40s, I believe, and one was drilled in the '80s.

16 We found the well that was drilled in  
17 the '40s, and it -- the log quality wasn't going to be  
18 sufficient for us to do anything. And there seemed to  
19 be a hundred-foot discrepancy in the strapping on the  
20 core. So we weren't quite sure where it was within  
21 the system, so we kind of used it for the purposes of  
22 defining porosity ranges and permeabilities, but we  
23 didn't really use that data significantly. We relied  
24 more heavily on the 679.

25 I became aware that the RR Bell was

1 drilled in the '80s and there was a full log sweep for  
2 it when we got the rebuttal from the Ops group. And  
3 we were able to go out and get that log. And we'll  
4 talk a little bit more about that later.

5 Q. So in addition to doing your own  
6 investigations, did you also review all the data and  
7 information that was provided to you by Empire and  
8 Goodnight?

9 A. Yes, we did.

10 Q. And have you prepared written direct  
11 rebuttal and surrebuttal testimony, exhibits and  
12 figures in the appendices that are attached to your  
13 materials that are marked as Exhibit D and then in  
14 your resume, Exhibit G-1, to provide your opinions and  
15 analyses?

16 A. Yes, I have.

17 Q. Were the exhibits and figures included in  
18 your direct, rebuttal and surrebuttal testimony  
19 prepared by your or under your directions and  
20 supervision?

21 A. Yes, they were.

22 Q. Any corrections or changes to the testimony  
23 figures or exhibits that were filed with the  
24 Commission?

25 A. No.

1 Q. Dr. Davidson, do you adopt the testimony and  
2 self-affirmed direct testimony, rebuttal testimony and  
3 your surrebuttal testimony that's marked as Exhibit D  
4 as your sworn testimony today?

5 A. I do.

6 MR. RANKIN: Mr. Hearing Officer, I would at  
7 this time tender Dr. Davidson as an expert witness in  
8 petroleum engineering and petrophysics.

9 HEARING OFFICER HARWOOD: Any objection,  
10 Empire?

11 MR. WEHMEYER: Without objection.

12 HEARING OFFICER HARWOOD: OCD?

13 MR. MOANDER: No objection.

14 HEARING OFFICER HARWOOD: Rice?

15 MR. BECK: No objection.

16 HEARING OFFICER HARWOOD: Pilot?

17 MR. SUAZO: No objection.

18 HEARING OFFICER HARWOOD: He'll be so  
19 recognized.

20 MR. RANKIN: Mr. Hearing Officer, I'd also  
21 move the admission into evidence of Dr. Davidson's  
22 direct testimony, his rebuttal testimony and  
23 surrebuttal testimony and attached exhibits, figures  
24 and appendices that are marked at Exhibit D and his  
25 resume as Exhibit D-1.

1 HEARING OFFICER HARWOOD: Empire, any  
2 objection?

3 MR. WEHMEYER: Without objection.

4 HEARING OFFICER HARWOOD: OCD?

5 MR. MOANDER: No objection.

6 HEARING OFFICER HARWOOD: Rice?

7 MR. BECK: No objection.

8 HEARING OFFICER HARWOOD: Pilot?

9 MR. SUAZO: No objection.

10 HEARING OFFICER HARWOOD: They will be  
11 admitted.

12 (Admitted: Goodnight Midstream  
13 Exhibits D and D-1.)

14 BY MR. RANKIN:

15 Q. Dr. Davidson, have you been present for or  
16 did you listen to the summary testimony, the  
17 cross-examination and redirect testimony provided by  
18 Empire's experts during the first and second week of  
19 testimony in this proceeding?

20 A. I did.

21 Q. And did you also hear Mr. McBeath's direct  
22 testimony and part of his cross-examination that has  
23 been conducted to date?

24 A. Yes, I did.

25 Q. Did you prepare summary slides reflecting



1 your up-to-date opinions, including any additional  
2 opinions based on observing that summary testimony,  
3 cross-examination and redirect testimony from Empire's  
4 witnesses during this proceeding?

5 A. I did.

6 MR. RANKIN: Mr. Hearing Officer, I'm going  
7 to share my screen so that Dr. Davidson can review  
8 with the Commission his opinions.

9 BY MR. RANKIN:

10 Q. Dr. Davidson, I know you have a hard time  
11 seeing it on the screen, but you've prepared some  
12 slides, and I'm going to put them up on the screen  
13 here, and I'm going to ask you just, if you would,  
14 Dr. Davidson to walk through so the Commission  
15 understands exactly what you think is most important  
16 about this case and other factors that, in your  
17 opinion, should be considered in assessment and  
18 analysis.

19 A. Okay. Ready to go?

20 Q. Yeah.

21 A. So first part is my interpretation summary.  
22 And basically I wanted to kind of start -- I'm going  
23 to be using some terms that are associated with a  
24 carbonate ramp environment and different rock types.  
25 We feel like it's very important to understand the

1 petrophysical characteristics of the different rock  
2 types present in the petrophysical modeling process.

3 Basically what this is showing is a  
4 cartoon of a carbonate ramp environment. And I'll try  
5 to get through this pretty rapidly. In the high  
6 energy, where there's a lot of wave energy at the top  
7 of the system, that's where the coarser grained  
8 sediments, carbonate sediments, reside. And those are  
9 generally described as grainstones, relatively large  
10 grains, very little mud content.

11 You move down where the wave energy is a  
12 little bit lower and you get into what's called a  
13 grain dominated packstone. And what that is is coarse  
14 grains with some mud material, carbonate mud material.  
15 Mud meaning not clastic mud, but mud-sized particles,  
16 which is very small grain carbonate sediments. And  
17 they start mixing together.

18 You get a little deeper in the system  
19 and you get into something called the mud dominated  
20 packstone. And that's where the volume of mud exceeds  
21 the volume of the coarser grains. And then, when you  
22 get even deeper into the system, you get into  
23 something that's called the wackestone. And there,  
24 the mud grains almost totally dominate the grain  
25 system.

1                   And then at the bottom of the system in  
2     the deep water, you usually have lime mud. And,  
3     again, this is mud in terms of grain size. Very, very  
4     small grain sizes.

5                   And in the environment where the sea  
6     level is changing or there's subsidence and uplift,  
7     you can get these different -- this depositional  
8     system stacked on top of one another. So when you  
9     drill a well, sometimes you drill through several  
10    sequences that represent different piece of this  
11    carbonating ramp.

12                  And typically what happens is as you  
13    move deeper in the system, you get higher gamma ray  
14    readings because gamma ray in this environment is  
15    dominated by uranium content, and uranium absorbs onto  
16    the grains. And the smaller the grain size the larger  
17    the surface area for the uranium to absorb upon. So  
18    the gamma ray goes up.

19                  So the other thing that happens is in a  
20    shallow water environment, for example, where I'm  
21    showing the grainstones, you have high wave energy,  
22    and in that environment, uranium content is typically  
23    pretty low.

24                  So we use the gamma ray curve very  
25    extensively to kind of tell us where we are in the

1 depositional environment. It's basically an indicator  
2 of mud content. The grains get smaller, the  
3 permeability typically decreases the deeper you get in  
4 the ocean, the deeper you move into the ocean. And  
5 with the higher mud content, the grain size is smaller  
6 and the permeabilities typically go down and the  
7 reservoir quality goes down. So we're very cognizant  
8 of the different rock types when we're trying to do an  
9 evaluation in a carbonate ramp field.

10 Let's go to the next slide.

11 So this is -- first thing we have to do  
12 is get an understanding of what the core data is  
13 telling us. And one of the problems that you have  
14 with conventional core is, when you cut the core,  
15 you're cutting into reservoir pressure and then you're  
16 bringing it up to surface. And as the pressure is  
17 released, the gas expands in the oil, and some oil and  
18 water are expelled. And we have to be cognizant of  
19 that when we look at the surface oil and water  
20 saturations that are reported in the core reports.

21 The other thing that happens is, as the  
22 gas expands out of the oil, the volume of oil shrinks  
23 due to the loss of the gas, and that's the shrinkage.  
24 So we have bleeding and shrinkage.

25 And then the other thing that occurs in

1 a conventional reservoir is, when you're coring with  
2 water, oil is flushed from the near well bore area.  
3 However, in this situation, that's not the big of a  
4 problem because the core was drilled in a residual oil  
5 zone. So arguably, the oil is going to be relatively  
6 immobile, it's not going be to flushed. Now, we still  
7 have the bleeding, we still have the shrinkage, but  
8 we're probably not going to have much flushing.

9 Now, there's been another loss mechanism  
10 that's been discussed earlier in this hearing. I  
11 think it was referred to as super flushing. And the  
12 more correct term for that is stripping. And that has  
13 to do with the fact when you have a high pressure at  
14 the coring bit and low pressure in the formation,  
15 sometimes you can get high velocity water movement at  
16 the bit that can strip oil out of the rock due to very  
17 high viscous drag forces, due to the high pressure  
18 differentials.

19 However, we did an analysis on that and  
20 the permeabilities in the matrix at EMSU, at least in  
21 the 679 core and in the RR Bell core, were too low.  
22 It takes permeabilities in excess -- roughly a darcy  
23 or higher for stripping to occur, and we just don't  
24 have that much rock. Most of our rocks are in the 10s  
25 of millidarcies to 1 darcy range.

1           So the stripping, we did the modeling to  
2       check was it present. We came to the conclusion it  
3       wasn't. So we concentrated on the shrinkage and the  
4       bleeding.

5           And so originally, I used a little rule  
6       of thumb that was developed by Jake Rathmell out of  
7       the Arco Research Center for use when -- again, when I  
8       started in the industry, there was a big push to try  
9       to evaluate fields very rapidly for potential CO2. And  
10      our research department developed some simplified  
11      procedures that we could use to correct the core data  
12      so that we could, you know, evaluate in-place volumes  
13      and determine whether or not we potentially had a CO2  
14      project that could follow a waterflood. So I used  
15      that little rule of thumb method.

16           And I got some pushback on that during  
17      my verbal testimony. It seemed the implication was it  
18      was too simplistic and that a more rigorous approach  
19      might be needed. So I went back and did the full  
20      rigorous evaluation.

21           What we did is we took data from where  
22      we had -- pressure core data from the Seminole  
23      San Andres and Maljamar Field up to the north. And we  
24      looked at the oil properties, gas content, initial gas  
25      content, gas content at minimum reservoir pressure, we

1 looked at viscosities, we looked an oil gravities at  
2 those two locations.

3 And then we moved -- at those two  
4 locations, we actually had pressure core data, where  
5 we had a pretty good idea of what the shrinkage and  
6 the bleeding values actually were. And we actually  
7 had core measurements where those could be quantified.  
8 And we took that data and we moved it back to the  
9 conditions that exist in the EMSU.

10 And you have to realize that kind of as  
11 you move off the central part of the Central Basin  
12 Platform toward the edges, you go to the east or the  
13 west edges, the oil properties tend to degrade.

14 For example, EMSU up in the Grayburg,  
15 the gravity was on the order of 30, 31 degree API,  
16 whereas, at Seminole, it's 35 to 38 degree API. And  
17 so you have to take those changes into account.

18 The other thing you have to take into  
19 account is changes in the gravity resulting from going  
20 below the producing oil-water contact. And at  
21 Seminole they found that oil gravity went from roughly  
22 35 down to about 27 degree API below the oil-water  
23 contact. And that's very common, but it has to be  
24 taken into account that the 679 core was taken below  
25 the producing oil-water contact.

1                   And basically, when I went through the  
2     mathematics to kind of figure out what the gravity was  
3     that would be what you'd expect below the contact, it  
4     was about 26 degree, not the 31 degree that Grayburg  
5     oil -- original conditions above the contact was  
6     measured at.

7                   The other thing that happens is the  
8     viscosity goes up, so we took the viscosity at  
9     Seminole and also the viscosity data at Maljamar. We  
10    corrected that back to the EMSU conditions, and what  
11    we found was that the viscosity that -- for example,  
12    the viscosity below the oil-water contact at EMSU was  
13    roughly three times the viscosity that they had  
14    observed below the oil-water contact in the Seminole.

15                  And bleeding is directly  
16    proportionate -- and this is some work that was done  
17    by Jake Rathmell at the time I was working with Arco  
18    in the research company. Bleeding is directly  
19    proportional to the gas content, and we found that the  
20    gas content at -- the gas content depends on the  
21    amount the reservoir has been depleted prior to the  
22    initiation of the CO2.

23                  And we had some pressure measurements  
24    that were available, MTD measurements, that kind of  
25    defined a range of potential reservoir pressures at



1 the location of the 679 core, and we evaluated that  
2 whole range.

3 But long story short, the gas content of  
4 the oil below the oil-water contact at the EMSU was  
5 roughly maybe 60 percent of what it was below the  
6 oil-water contact in the Seminole, you know.

7 So the bleeding is directly proportional  
8 to the gas content, inversely proportional to the  
9 viscosity of the fluid. The higher the viscosity, the  
10 less bleeding you get; the higher the gas content, the  
11 more bleeding you get.

12 So we had to make all those corrections  
13 back to EMSU conditions, and we came up with a  
14 range -- so then there's also -- you have to do the  
15 B sub o calculations, which are directly proportional  
16 to gas content as well. So we went back and we took  
17 the original B sub o, we used the Grayburg B sub o,  
18 and then we corrected it to bottom hole conditions,  
19 considering a range of potential pressure drawdowns  
20 prior to the coring of that well.

21 And long story short, the final  
22 correction factor kind of varied. When we lumped all  
23 that stuff together, it varied from about 1.1 to about  
24 1.25. And if we assume that there has been no  
25 pressure drop at all in the San Andres, in other

1 words, it had never experienced any pressure drop,  
2 then that 1.25 became 1.3.

3 And the little Jake Rathmell rule of  
4 thumb gave me a correction factor of 1.22, which seems  
5 to fit pretty well within that 1.1 to 1.25 range. So  
6 we were pretty comfortable that we didn't need to make  
7 any changes to our original core corrections.

8 Go to the next slide.

9 Then the next thing to do was to  
10 identify the different rock types that were available  
11 in that 679 core. And basically what I did there was  
12 use a rock typing procedure that was developed by  
13 Jerry Lucia at the Bureau of Economic Geology. And it  
14 was -- the major data for that at the time -- that  
15 procedure has undergone an evolution with time, as  
16 Jerry learned more and more about San Andres and  
17 Grayburg.

18 But the interesting thing is that he  
19 developed an original version of that cross-plotting  
20 technique with the Lower San Andres at that outcrop,  
21 which is exactly where we're evaluating the core for  
22 the EMSU. So I was able to go back and use his  
23 cross-plotting technique to identify the different  
24 rock types that were present in the core. So we did  
25 that.

1                   And then so now I've identified the  
2   grainstones, the packstones the grain dominated, you  
3   know, packstones, the mud dominated packstones and  
4   wackestones. And we were able to identify each of  
5   those in the core.

6                   And then the next that you have to do,  
7   we don't have core in every well, so I have to be able  
8   to you identify, predict the different types of rock  
9   facies present using the oil log measurements. And we  
10  did that. Of course, we have well log measurements we  
11  can use. We used the gamma ray density, neutron  
12  porosity measurements. If we have sonic, which is  
13  great, that provides some very important data.

14                  And the other thing that we brought to  
15  bear was a modeling process developed by George  
16  Asquith, out of Texas Tech University, where you  
17  basically calculate an estimate of what the porosity  
18  of the rock is from the shallow resistivity  
19  measurements. And then by comparing that resistivity  
20  based porosity estimate to the actual porosity, you  
21  can determine kind of whether you're in a uni-modal  
22  pore system or a multi-modal pore system. And that  
23  helps you in a buggy environment. And when you have  
24  something like a mud mixed with a grainstone, you have  
25  a multi-modal pore system.

1           So using that porosity, you can kind of  
2   start developing a model on differentiating, for  
3   example, between a grainstone and a grain dominated  
4   packstone and a mud dominated packstone. So we used  
5   that information.

6           The other thing that we used is the  
7   uranium content. You know, that tells us something  
8   about the depositional environment.

9           And then the other thing that we found  
10   that was very useful was looking at shallow, medium  
11   and deep resistivity measurements in evaluating the  
12   invasion characteristics. And we were able to see, by  
13   looking at the invasion characteristics, that the  
14   different rock types had different invasion  
15   characteristics into the formation. So we brought  
16   that to bear in the rock typing.

17           Now, the other thing that we used and  
18   didn't discuss here, but -- because most of the wells  
19   in the EMSU, at least the ones that we were given to  
20   evaluate, didn't have sonic measurements, which I  
21   found to be quite unusual. But that was the hand we  
22   were dealt.

23           Now, the wells that -- some of the wells  
24   we were given, the disposal wells outside the EMSU,  
25   did have sonic data. And Jerry Lucia built a very

1 comprehensive model when you have sonic measurements  
2 to do rock typing based on looking at the volume of  
3 calculated bugs to the total porosity. And they had  
4 done quite a bit of work at the outcrop study where  
5 they were actually able to kind of tie what's called  
6 the BPR, the bug to total porosity ratio, to rock  
7 typing and permeability.

8 So we were able to adopt that model, and  
9 that gave us -- that was actually a pretty neat thing,  
10 because it gave us a way to do rock typing without  
11 having to look at all this invasion profile and all  
12 these other things. It's kind of an automatic. And  
13 it's a really nice model. The problem that we had  
14 with it, we can only apply it on wells that we weren't  
15 really interested in.

16 But, on the other hand, what we were  
17 able to do, because we had the highest confidence in  
18 the model that had the sonic measurements, we able to  
19 take our model that we developed without the sonic,  
20 run it through the wells where we had the sonic and  
21 see did we get the same type of distribution of  
22 facies, the same type of oil saturations, the same  
23 porosity.

24 So we went through a process where we  
25 iterated through that to ensure that our model was

1 predictive in a situation where we didn't have sonic.  
2 And why is that important? It's because up in the  
3 area where the core was drilled, there wasn't that  
4 much -- there was bug porosity, but it wasn't as high  
5 as it is deep in that disposal zone.

6 When you get into the disposal zone,  
7 the bug porosity karsting stuff starts becoming very  
8 significant. And we were very concerned that our  
9 model be predictive when we got to very high bug  
10 porosities because we didn't have it in the core. So  
11 it was very important for us to have a model that we  
12 could take to that Lower San Andres and have decent  
13 predictions of oil volumes in the area where the bug  
14 porosity was higher.

15 We found that that -- that the model did  
16 match when we run what we call the no-sonic model in  
17 the wells where we had sonic and compare it to the  
18 sonic porosity water saturation, oil saturation  
19 calculations. They agreed very well. At that point,  
20 we felt like we had a predictive model.

21 Now, since that time, we've had the  
22 opportunity, particularly at Maljamar, where we have a  
23 sonic and -- sonic measurements, a pressure core where  
24 we have the highest confidence in the oil saturations  
25 and porosities, and we were able to run our sonic and

1 no-sonic model on that well, and we got a really good  
2 match to the core measurement.

3 So at the end of the day, we felt very  
4 comfortable that our model was predictive in all  
5 environments.

6 Q. Now, the Maljamar well that you're referring  
7 to, that was the 522 well; is that correct?

8 A. Yes. No, it's not. 522 is the north well.  
9 358 Maljamar I think is the one in the Maljamar Field.

10 Q. Thank you for correcting me.

11 And just so it's clear, you prepared two  
12 models, petrophysical models, one that employed the  
13 sonic data and another that followed the Jerry Lucia  
14 approach, correct?

15 A. They're both Jerry Lucia approaches. It's  
16 one of them works without sonic. It depends on a  
17 facies model. The other one is pretty much -- the  
18 Jerry Lucia model that employs the sonic is pretty  
19 much an automatic rock-typing model. As soon as you  
20 have the sonic measurements, you calculate the bug  
21 porosity ratio, you can pretty well -- it figures out  
22 the rock types for you and assigns the parameters that  
23 we can do the saturation calculations.

24 Q. Dr. Davidson, before we move off this slide,  
25 you heard some criticism of your approach from the

1 petrophysicist from Ops Geologic criticizing that you  
2 did not evaluate or did not -- you excluded certain  
3 rock types from your assessment. Can you just address  
4 that?

5 A. Yeah. Our model, all rock types are  
6 available in every interval. And I can talk later on  
7 why that appears to be so to somebody who is not  
8 familiar with our modeling. But all rock types are  
9 available.

10 The Upper and Lower San Andres contain  
11 grainstones. The Upper and Lower San Andres and  
12 Grayburg contain wackestones, they contain mudstones.  
13 All rock types are present.

14 It's just that there's a change that  
15 occurs in the Lower San Andres where you change the  
16 depositional environment where some of the better  
17 quality rock types are less prevalent than are present  
18 up in the Grayburg Formation.

19 It appears that the Grayburg Formation  
20 was a pretty high energy environment its entire life.  
21 But in the Upper San Andres, to some extent, and what  
22 we call the Lower San Andres, and I'll show that  
23 distinction here shortly, it appears that it was more  
24 cyclical, where we have high energy, high frequency  
25 sequences. Sea level changes were happening pretty



1 rapidly and rock types were changing pretty rapidly.  
2 And as a result, the relative amount, for example, the  
3 good quality grainstones is lower as you get deeper in  
4 the system. And I'll go over that shortly.

5 Q. Next slide.

6 A. This is important I think for several  
7 reasons, because what it's showing, this is the data  
8 from the outcrop study. And the outcrop study  
9 occurred at the Guadalupe Mountain outcrop to the west  
10 of the EMSU. I think it's maybe 60, 80, 100 miles  
11 away, but it's the San Andres section outcrops and  
12 they're able to actually get in.

13 When you do an outcrop study, you have  
14 to go in and kind of dig off the surface rock, get  
15 deep into the rock to get some of the things that are  
16 ruined by weather out of the way so you can actually  
17 kind of see what the reservoir rock looks like.

18 The point I wanted to make on here was,  
19 in the better quality rock, let's talk about that, the  
20 grainstones, the grain dominated packstones, those are  
21 generally considered to have the better quality.  
22 There's not that big of a porosity range. We're only  
23 talking maybe 10 to 14 percent for the better quality  
24 rocks. However, you see there's like an order or  
25 magnitude of more change in the permeability. It's

1     incredibly important to be able to distinguish between  
2     the different types of rocks, and porosity is not the  
3     proper way to do it.

4                     And the other interesting thing here,  
5     they found in general, until you got to the situation  
6     where you're actually developing karst, where it  
7     connected bug porosity, the presence of bugs -- when  
8     porosity increases, it's generally as a result of the  
9     presence of bugs. And the interesting thing here is,  
10    the presence of bugs doesn't necessarily mean --  
11    higher porosity doesn't necessarily mean higher water  
12    quality. And that's a very important thing to  
13    consider.

14                    Ultimately what happens is, the bugs --  
15    bug are created in dissolution precipitation  
16    experiments. So you dissolve the material out of the  
17    rock to make a bug, but then at some point, that  
18    dissolved material gets reprecipitated and you  
19    actually wind up, in many cases, with lower  
20    permeability associated with the higher porosity.

21                    Now, in the situation we'll talk about  
22    later, where we have huge throughput of meteoric  
23    fluids and H<sub>2</sub>S counterflow and all that, now we're  
24    creating connected bug networks and karst, and that's  
25    a whole different ball game.

1                   But for the purposes of what we're  
2     talking about right now, I just wanted to point out  
3     that porosity, in and of itself, is not a good  
4     indicator of rock quality.

5                   Q. You mentioned the term "bugs," and we've  
6     heard that throughout the testimony earlier. Will you  
7     just explain what a bug is, just at a high level?

8                   A. Well, what happens, a lot of times you'll  
9     have, for example, a simple example, you'll have a  
10    critter shell, a shell from some sort of sea animal.  
11    And sometimes -- it's usually a limestone  
12    calcite-based thing. Ascitic fluid coming through, a  
13    high pH fluid coming through, will actually dissolve  
14    that shell out and leave a hole where the cast --  
15    where the shell actually was, and then that water  
16    migrates through. And then later on, ultimately the  
17    water becomes super saturated and calcium carbonated  
18    and it reprecipitates out.

19                   So a lot of times what you'll see, for  
20    example, you'll see bugs, and then there may be  
21    fractures nearby and water will migrate into those  
22    fractures and those fractures will become calcite  
23    filled as that calcium carbonate comes out of the  
24    solution. And sometimes it occludes porosities, you  
25    know, the pore throats, sometimes it occludes

1 fractures.

2 But in general what they found at the  
3 outcrop, at least, was increased porosity due to  
4 increased bug content didn't necessarily mean  
5 increased permeability and increased reservoir  
6 problem.

7 Q. So the bugs are the voided space?

8 A. The big voids in there, yeah.

9 Q. Let's go to your next slide.

10 A. Here's kind of the -- we're kind of jumping  
11 ahead, but what I wanted to show here is situation --  
12 I'm plotting what's called the resistivity index,  
13 which is just the deep resistivity, the RI. RI is the  
14 deep resistivity measurements divided by the  
15 resistivity of 100 percent water through the rock.  
16 And that's a typical thing that you do with any  
17 petrophysical model.

18 But what I'm showing here is the RI  
19 derived from the core measurements and the log  
20 measurements of deep resistivity versus the water  
21 saturation derived from the core measurements.

22 Now here, because -- we didn't use the  
23 water saturations from the core because, as I told  
24 you, what happens when you bring the core out is you  
25 expel water. And, for example, the cores for 679, for

1 example, if you add the oil and the water up, you only  
2 come up with about 65, 66 percent of the pore space.  
3 So in a situation where you're below an oil-water  
4 contact, you would expect the core to be completely  
5 full of fluid. Well, it's not full of fluid anymore  
6 because when we brought it to surface, gas expanded  
7 and we expelled the water and we expelled oil.

8 I don't pay much attention to the water,  
9 but I know I can correct -- if I know enough about the  
10 permeability, the characteristics of the rock,  
11 characteristics of the oil, I can correct the oil  
12 saturations back to fairly decent representation of  
13 what they were back downhole.

14 So what we did here, the water  
15 saturations that are reported here are basically 1  
16 minus the corrected oil saturation, because that would  
17 have been the water saturation we would have expected  
18 in a residual oil zone at bottom-hole conditions.

19 So then, you know, with the Archie  
20 models that have been used here, for example, original  
21 model I think that NuTech used, they used an  
22 Archie-like model, it's a Simandoux model. But in a  
23 situation where there's not much shale, and there's  
24 not much shale in the system, Simandoux basically will  
25 reduce to Archie. And I think Ops used an Archie-type

1 model, as well.

2 And what you typically do is you plot  
3 the data up and then you find the data will typically  
4 fall on a slope on one of these cross-plots. And a  
5 plot on there, for example, the  $n$  equals 2 line, you  
6 see that almost all the core data falls above that.  
7 So  $n$  equals 2 is not a very decent representation.

8 And then I think Trentham and Melzer  
9 have recommended for this San Andres maybe somewhere  
10 in the 2.3 to 3.4 rang for  $n$ . So I plotted that line  
11 on here, what that line would look like. And you see  
12 again there's some data that falls on that line, but  
13 there's still quite a bit of data that falls to the  
14 right of the line. And, again, each rock type kind of  
15 falls on its own.

16 So what we wound up doing was using an  
17 alternate model that was developed by Schlumberger for  
18 oil wet reservoirs, and this is an oil wet reservoir,  
19 that uses a different equation in a parameter called a  
20 critical saturation. And the critical saturation  
21 lines you see here are those little curved lines that  
22 you see above the  $n$  equals 2 line, the little curved  
23 linear line.

24 What we wound up doing was taking each  
25 rock type, plotting each rock type independently on

1 this plot, and then fitting one of those lines, what  
2 we call Sc lines, to each rock type. So you see for  
3 the grainstone, which is the G on this plot, the  
4 grainstone points we fit a line to it. And we went to  
5 the grain dominated packstone, we just plotted those  
6 points alone, and then we fit a curve to those lines.  
7 Then we did the mud dominated packstone. We did the  
8 Sc model to that one.

9 And that way, we built a model where if  
10 we could identify the rock type, we could actually use  
11 that rock type and the Sc value that represented that  
12 rock type in the equation in the bottom left here to  
13 calculate the water the saturation.

14 And the beauty of this is it takes all  
15 the data into account. And as long as we can  
16 reasonably identify the rock type, we can reasonably  
17 estimate what the water saturation is. That was the  
18 calibration procedure. We used this calibrated data  
19 in both the sonic and non-sonic models.

20 Q. Dr. Davidson, you mentioned that you don't  
21 pay much attention to the water saturation in the  
22 core. Just if you would, just briefly touch on why  
23 that is.

24 A. Well, it's hard --

25 MR. WEHMEYER: I do have a quasi objection

1 point. So, Mr. McBeath was first, and that went over  
2 an hour and a half. This is a 30-slide-deck  
3 presentation. We're at Slide 6 and we're over  
4 30 minutes in at Slide 6.

5 I think the longest Empire presentation  
6 was Mr. West at the end, maybe an hour and a half.  
7 You know, the comments that came from Friday, we have  
8 no problem with a little bit of leeway off of kind of  
9 the rough parameters set for direct, but this is  
10 going to be a two-and-half, three-hour direct  
11 examination at this pace. And this is not the way  
12 that Empire understood the proceedings were working  
13 procedurally.

14 HEARING OFFICER HARWOOD: Mr. Rankin.

15 MR. RANKIN: Well, Empire has 11 witnesses,  
16 we have fewer, three fewer. This is a very complex  
17 issue. I think I'll leave it to the Commission. We  
18 can curtail, I can ask Dr. Davidson to go up at a  
19 higher level.

20 I do think it's helpful for the  
21 Commission, and the Commission can tell us what their  
22 pleasure is, to understand exactly how Dr. Davidson  
23 did his analysis so it's understood.

24 I think the bottom line in this case is  
25 understanding whether and to what extent there is oil



1 down here. And this analysis that Dr. Davidson is  
2 presenting explains that, how they came -- how he  
3 came to his determination.

4 A lot of this is in his written  
5 testimony, it's true. It's complex. And I can ask  
6 Dr. Davidson to, at a slightly higher level, to  
7 discuss it. But I leave it to the Commission. If  
8 this is helpful for them, then I'm happy to have  
9 Dr. Davidson continue at this level. Or if not, then  
10 we can go at a slightly higher level.

11 But I'll just say, I did not object at  
12 all to any of the time frames that Empire put forward  
13 with their witnesses. But they did have eleven and  
14 we just have eight, so it's not -- they had two  
15 separate sets of petrophysicists presenting, and we  
16 just have one.

17 MR. WEHMEYER: May I be heard briefly in  
18 reply?

19 HEARING OFFICER HARWOOD: Sure.

20 MR. WEHMEYER: So the number of witnesses  
21 doesn't matter. Secondly, with respect to the  
22 examination here, I am hopeful for Mr. McBeath and  
23 Dr. Davidson, that given Mr. Rankin is spending all  
24 this time, that there wouldn't be any redirect  
25 because he's covered everything in detail.

1                   Additionally, with respect to the  
2     witness statements, Dr. Davidson, I know you all are  
3     reading and preparing for three things, I'm not  
4     making fun here, he's quite loquacious. I think we  
5     have over 120 pages of direct witness testimony out  
6     of Dr. Davidson, including him being able to submit a  
7     surrebuttal for three rounds.

8                   So, again, we're just trying to keep  
9     some reins on this because we're running out of the  
10    weeks that are allotted for the proceeding, and at  
11    this pace, we're going to be here a very, very long  
12    time.

13                  HEARING OFFICER HARWOOD: Well, you know,  
14    there's some merit to the quasi objection. I mean,  
15    what I'm hearing from the witness is a lot of  
16    narrative. Now, I understand there needs to be some  
17    leeway because, frankly, it's all so technical that  
18    it's way over my head. But there is some merit to  
19    the objection.

20                  I would ask that you make sure that the  
21    answers are responsive to the questions. And to the  
22    extent possible, avoid these long narrations.

23                  MR. RANKIN: Sure. I understand. I'll work  
24    with Dr. Davidson to direct his testimony more  
25    succinctly.

1 HEARING OFFICER HARWOOD: Okay. Thank you.  
2 And to be fair to everybody, I mean, all of this is  
3 in the record already in written, sworn testimony.  
4 And these are high level people you're talking to.  
5 If you were explaining it to me, you could be here  
6 for a day. But you're not, you're explaining it to a  
7 highly sophisticated technical audience.

8 MR. RANKIN: Most of this is in the record,  
9 that's true, Mr. Hearing Officer. There's some  
10 elements that Dr. Davidson would like to address that  
11 are particularly responsive to the arguments and  
12 issues that have arisen. And I'll ask him to try to  
13 focus his recitals on those issues as we go forward.

14 HEARING OFFICER HARWOOD: That's fair  
15 enough. And I'll be listening for objections that  
16 the witness' answers are narrative.

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

18 BY MR. RANKIN:

19 Q. So anything further on this particular  
20 slide, Dr. Davidson, in terms of how you came up with  
21 your petrophysical model to address each of the rock  
22 types.

23 A. No.

24 Q. If you would, just explain what this next  
25 slide shows and how it relates to our analysis with

1     respect to the 679 core.

2             A. At the end of the day, the goal is to get a  
3     good match to the core data. So this is a match of  
4     our non-sonic model to the core measurements. In the  
5     right hand, you see the last two tracks to the right  
6     are porosity and oil saturation. And we feel like we  
7     did a fairly decent job of matching the core  
8     measurements.

9             In fact, if you take the oil saturation  
10    at each point and sum it up, our model over-predicted  
11    hydrocarbon pore volume by about 4 percent. But we  
12    felt pretty comfortable that we did a reasonable job  
13    matching the core measurements.

14            Hopefully that's short enough for  
15    everybody.

16            Q. Next slide here, Dr. Davidson, looking at  
17    the RR Bell 4, you also --

18            A. Okay. As I said, we didn't realize early on  
19    that the RR Bell had open hole well log measurements  
20    that were reasonable enough for us to use.

21            Ultimately, after we saw the Ops  
22    rebuttal, we found that there were raster images for  
23    the RR Bell logs. So we digitized the core section,  
24    ran our model blind against the core measurements, and  
25    this is the result.

1           And again, we felt that our model did a  
2     reasonable job for predicting the porosities and oil  
3     saturations from the RR Bell.

4           And, again, I hope that was fast enough  
5     for everybody.

6           Q. Next slide here, you're addressing the  
7     Maljamar core that you referred to briefly with me  
8     previously, the MCA 358. Explain that this shows with  
9     respect to your analysis regarding the corrected --

10          A. This was a -- yeah, this was an example --  
11     again, this is one we got this data and evaluated late  
12     in the evaluation phase.

13          And Maljamar, the neat thing about that  
14     well, it was drilled and cored with a pressure core,  
15     which gives us the very best estimates of the oil  
16     saturations that can be corrected very accurately back  
17     to the reservoir conditions.

18          And what I'm showing here is the results  
19     from both of our models, the sonic model well where  
20     you can utilize the sonic data, and the model where we  
21     don't have the sonic data. And you see that both  
22     models, in my view at least, did a fairly decent job  
23     of matching the actual core oil saturation  
24     measurements.

25          Again, we just ran this model as it was

1 against this well and we ran both models of sonic,  
2 non-sonic. Now, it's not perfect, but we got a fairly  
3 decent match, at least to order of magnitude to the  
4 oil saturations for this well.

5 Q. If you would, just next slide here, explain  
6 to the Commission your understanding of what an ROZ is  
7 and how it applied to your assessment.

8 A. Well, we modeled this ROZ for the EMSU using  
9 this definition. It's oil remaining in a column below  
10 a trap that has been swept by vertical or horizontal  
11 flow to establish a shallower oil-water contact.

12 In our understanding, that's what 679  
13 represented and that was what the ROZ in the EMSU is  
14 represented, where oil had been swept out of the  
15 interval below the current oil-water contact, and we  
16 were modeling it as a residual oil zone.

17 Now, the other thing that we're showing  
18 down here, this is data that BEG did, published for  
19 the Seminole Unit, where they had gone in and they --  
20 for each rock type that I described, they kind of  
21 described what a residual saturation would look like.

22 You know, for example, if a well had --  
23 or an interval had originally been full of oil and had  
24 been swept, what kind of residual oil would you  
25 expect? And looking at that, it says like, well, we

1 would expect to see maybe 25 to 40 saturation units of  
2 oil in a residual oil zone. So what's kind of what we  
3 would be looking for.

4 Q. Just so it's clear, this is the basis for  
5 your assessment about whether or not or to what extent  
6 the disposal zone that Goodnight is injecting into  
7 would qualify as a potential residual oil zone?

8 A. Yes. And we'll a little bit more about the  
9 profiles here shortly. Again, I'm trying to speed up  
10 as best I can.

11 Q. So this next slide here, I think, goes  
12 further into this analysis. And you got it up on your  
13 paper here. Explain what this shows and why this is,  
14 in your opinion, critical to your assessment of the  
15 ROZ in the EMSU.

16 A. What we're showing here is the 746 well.  
17 This is our interpretation of the 746 well. To the  
18 right, I'm showing a well log from the Seminole  
19 San Andres Unit. And unfortunately, Hess decided  
20 they'd hold the cored well and the core information  
21 for Seminole as being confidential. However, we were  
22 able to find a well that was drilled as part of the  
23 ROZ development plan from Seminole.

24 So again, we went in and just ran our  
25 model blind against that well. And what you see there

1 on the right-hand side is the Seminole well. And on  
2 the right track is the oil saturations.

3 And interestingly enough, we were able  
4 to duplicate -- down there, there's an MPZ which had  
5 been CO2 flooded for about 40 years. And you see the  
6 residual oil saturations there, oil saturations, on  
7 the order of 20 percent. You get down below the main  
8 production zone in what they classified as the ROZ,  
9 and we have oil saturations.

10 And, again, if you look at there, we  
11 kind of have a wall that's relatively flat, about 40,  
12 45 percent. So we see the residuals kind of like what  
13 we would expect to see based on what we got out of the  
14 BEG for what the residual saturations would be.

15 So if we move to the left, we see the  
16 results from our calculations for 746. Why is 746  
17 important? It's because it goes all the way through  
18 from the Grayburg all the way to the Glorieta. So  
19 we're going through the disposal zone in this well.  
20 And what you see is, in the Grayburg area and what you  
21 guys would call the Upper -- or we would call the  
22 Upper San Andres, does have what appears to be  
23 something that approaches what an ROZ would look like.  
24 It looks very similar to the ROZ over in the Seminole  
25 San Andres.



1                   However, we get below that, you see  
2                   there's a little bit of oil that shows up in the  
3                   disposal zone in the interval below that. But the  
4                   point is, the profiles just aren't the same. You get  
5                   little wisps here and there and there's a hundred feet  
6                   between them. Yes, there's little bits of oil down in  
7                   that disposal zone. We think those are probably more  
8                   likely paleo migration pathways, not an ROZ.

9                   MR. WEHMEYER: Objection. Narrative.

10                  MR. RANKIN: I've allowed Mr. Hardy to  
11                  testify with her witnesses on direct.

12                  I've asked him to explain why this is  
13                  critical to his analysis and he's explaining it.

14                  HEARING OFFICER HARWOOD: Overruled.

15                  A. I'll try to make this as short as possible.  
16                  We think the disposal zone predominantly consists of  
17                  abandoned paleo migration paths. We think that the  
18                  target, if there is one for CO2 injection exists in the  
19                  Grayburg, and maybe the upper part of the San Andres,  
20                  above what I call the gamma ray marker there, that  
21                  very high gamma ray below where the high oil  
22                  saturation are.

23                  The other thing I wanted to point out on  
24                  this slide, it's very important if we're moving west  
25                  to east, and the top of the San Andres goes -- even

1 using Mr. Wehmeyer's definition of how to pick the top  
2 of the San Andres, we go are from 400 feet down to  
3 1800 feet for the top of the San Andres. So I'm just  
4 pointing out that going west to east, that the  
5 San Andres is downdipping.

6 Q. Before we move off this, Dr. Davidson, you  
7 explained that this profile in the EMSU 746 is  
8 indicative to you of a potential for a migratory  
9 pathway as compared to the profile you're seeing in  
10 the Seminole San Andres Unit well.

11 Can you tell the Commission why it is  
12 that you believe that this profile in the EMSU 746  
13 within the disposal zone indicated here is more  
14 indicative of an oil migratory pathway rather than a  
15 zone that has been previously saturated with oil?

16 A. Because the oil saturations, when we can't  
17 calculate them to be present, are generally under 20  
18 percent. And the oil that does show up, where we do  
19 have oil saturation, tends to be in the grainstones.

20 And what happens when oil migrates, it  
21 migrates through the best quality rock. And then all  
22 rock has some level of high permeability pathways at  
23 least partway, so oil, when it's migrating, small  
24 saturations can get into some of the poorer quality  
25 rock. But the higher soil saturations tend reside in

1 the best quality rock.

2 And you never really build a trap in a  
3 migration path. And then if there's subsequent fluid  
4 flushing, the intervals that have very low saturation,  
5 say sub 20, the saturation doesn't change much. But  
6 the saturation -- you do wind up with a residual in  
7 the better quality rock and you don't get that nice,  
8 flat profile of high residual saturations that you see  
9 in the EMSU 746 up in the Grayburg and the SSAU well  
10 down in the San Andres. It's just a different  
11 profile. The saturation profile is just different.

12 Now we're going to talk about Tall  
13 Cotton. I've heard the interval below the oil-water  
14 contact in the Grayburg in EMSU described as both a  
15 greenfield ROZ and a brownfield ROZ. So I don't know  
16 which one that Empire actually believes it is.

17 But I went to look for what -- you know,  
18 assuming that Seminole is defined as a brownfield ROZ,  
19 where you have a trap below an existing oil column,  
20 Tall Cotton was described as a greenfield ROZ, where  
21 you have an ROZ that's not associated with a trap. So  
22 I wanted to look at what does the profile of an ROZ  
23 look like in a greenfield.

24 So we can go to the next slide.

25 And this is -- again, we ran our model

1 blind against the Tall Cotton. Unfortunately, Kinder  
2 Morgan, like Hess, held the core data and the log data  
3 for the cored well confidential, so we weren't able to  
4 get that. But I was able to find one of the  
5 development wells for Tall Cotton, and we ran our  
6 model there.

7 And, again, you can see that we have  
8 that kind of a flat 40 percent front for a hundred  
9 feet or more, where, you know -- it defines what I  
10 would consider an expected profile for a residual oil  
11 zone. Again, 20 to 40 percent residual saturations  
12 based on kind of found they found at the BEG.

13 Go to the next slide.

14 And this is the -- out of I think  
15 Mr. Melzer's or Dr. Trentham's paper where they're  
16 showing core data in an ROZ. This may be Seminole, it  
17 may be Goldsmith. I don't know for sure. But what  
18 they're showing again is a 20 to 40 percent oil  
19 saturation range through the ROZ.

20 To the left here is the core data  
21 from -- these are the corrected core points for the  
22 EMSU 679. And we're kind of not seeing that same kind  
23 of profile. We have a few feet there that kind of get  
24 up into the 40 percent range, 40, 50 percent range.  
25 But it just doesn't look to me like an ROZ.

1                   However, it doesn't matter what I think.  
2   Empire wants to go and flood this, that's their  
3   prerogative. My argument is that what's going on  
4   deeper in the San Andres, below what I call the high  
5   gamma ray marker, the injections on there aren't going  
6   to affect their operations up in the shallow part of  
7   the ROZ.

8                   Q. Just to be clear, Dr. Davidson, you  
9   referenced this chart on the left-hand side of your  
10   exhibit. Here it shows the corrected core values for  
11   the 679 and the EMSU well. Those are the core  
12   corrections based on your analysis, correct?

13                  A. Yes, sir.

14                  Q. What were the core corrections that you came  
15   up with for the EMSU 679?

16                  A. Well, at the end of the day, the correction  
17   factor was about 1.22. For the pressure range  
18   present, it could vary between 1.1 and 1.3.

19                  Q. Okay. Thank you. This next slide here,  
20   just explain -- you mentioned this previously as you  
21   were discussing your rock typing in understanding the  
22   system here. Explain how you determined how this  
23   gamma ray plot helped you evaluate and determine rock  
24   typing in your analysis for the EMSU.

25                  A. Well, basically, once you do this for a

1 while -- and it's important to realize that the gamma  
2 ray here is associated predominantly by uranium.  
3 There's not a whole lot of clay minerals in this rock  
4 that affect the gamma ray. So what we're actually  
5 seeing is variations in uranium. And like I said,  
6 uranium deposits based on surface area and wave  
7 energy.

8 Up at the top, above what I call the  
9 gamma ray marker, you see the gamma ray baseline is  
10 pretty low, those are the grainstones. Those are the  
11 high -- that's a high energy environment. And you  
12 notice above that high gamma ray marker, the rock is  
13 predominantly deposited in a high energy environment.  
14 That's the Upper San Andres Grayburg interval that  
15 we're talking about. Then you get what I call the  
16 high gamma ray marker.

17 Below that, you see there's a  
18 discernible shift to the right of minimum gamma ray  
19 measurements. And that's indicating higher surface  
20 area, which is indicating higher mud content. And  
21 when you have higher mud content, that's indicating  
22 poor reservoir rock quality.

23 So what we did is we found -- what we  
24 found is a gamma ray level above the baseline that  
25 would return the proper grainstone interpretation up

1 in the Grayburg. Then we used that shifted gamma ray  
2 baseline to identify the grainstones below that high  
3 gamma ray marker.

4 So we do have grainstones in that deeper  
5 section, but what it's telling me is, as we move  
6 deeper in that section, I'm getting higher and higher  
7 mud content, meaning the reservoir quality, as we get  
8 deeper in the section, is deteriorating.

9 Now, what you have down there, below  
10 that high gamma ray marker, is a little spiky  
11 interval. And then there's an interval where the  
12 gamma ray kind of settles down, maybe about 4275 and  
13 down, and that's the interval where we'll see the  
14 karsting in the lower San Andres. We'll talk a bit  
15 more about that.

16 But basically, we go from an interval  
17 above that marker that's predominantly high energy to  
18 an interval below where we have high frequency  
19 sequences and we're getting lower and lower energy  
20 deposition. And, ultimately, we get into where we're  
21 actually starting to see deep water deposition, more  
22 mudstone, wackestone type deposition. That would be  
23 the poorest reservoir quality.

24 HEARING OFFICER HARWOOD: Mr. Rankin, would  
25 this be a good time to take a mid-morning break?

1 It's 10:31.

2 MR. RANKIN: I think that's just fine,  
3 Mr. Hearing Officer. We'll take a mid-morning break.

4 HEARING OFFICER HARWOOD: Let's be back at  
5 10:45. Thanks.

6 (Recess held from 10:31 to 10:44 a.m.)

7 HEARING OFFICER HARWOOD: All right,  
8 Mr. Rankin.

9 MR. RANKIN: Thank you, Mr. Hearing Officer.  
10 I think we're on Slide Number 16 of Dr. Davidson's  
11 presentation, summary of his testimony.

12 BY MR. RANKIN:

13 Q. Dr. Davidson, the next slide, Number 16,  
14 would you explain how this slide reflects your  
15 analysis regarding the presence of anhydrites through  
16 the Lower San Andres that you analyzed?

17 A. Basically, we identified what I've called a  
18 high gamma ray marker. As I stated previously, what  
19 we see just below that marker, there's a marked shift  
20 in the minimum gamma ray values above the -- that are  
21 present up in the Grayburg.

22 Then what you see in the gamma ray track  
23 are very spiky gamma rays, and those gamma ray spikes  
24 typically correspond to low porosity intervals and,  
25 many times, higher resistivity intervals.



1                   And we interpret those to be bedded  
2   anhydrites that are associated with a very high  
3   frequency depositional environment where we're  
4   basically probably prograding out into the ocean.  
5   We're moving from maybe a ramp crest to maybe the  
6   outer ramp. We're still getting some good quality  
7   rock being deposited. But then when the sea level  
8   falls, we get evaporites forming on the exposed rock.  
9   And when you evaporate sea water, you concentrate  
10  uranium. So the little gamma ray spikes you see below  
11  there are where we've concentrated uranium.

12                  And then if you go to the right track,  
13  I'm color blind, but I think the color is purple,  
14  we've kind of identified the anhydrite intervals, or  
15  intervals with elevated anhydrite, as being purple.

16                  And then the other thing we did is we  
17  want back to make sure that we had this right. We  
18  went back and used a cross-plotting technique that  
19  Jerry Lucia developed to identify anhydrites that  
20  hadn't been altered by any kind of diagenesis.

21                  So a bedded anhydrite wouldn't be  
22  altered by diagenesis. And we would expect embedded  
23  anhydrite, we'd expect to see elevated gamma ray, we'd  
24  expect it to be unaltered and we expect to see an  
25  elevated presence of anhydrite.

1           So basically, that interval below what I  
2   call the high gamma ray marker consists of a high  
3   frequency sequence where there were multiple sea level  
4   changes. And we actually did have fairly good quality  
5   rock deposited because we're in a relatively high  
6   energy environment. But then they're capped by these  
7   intervals where the rock gets elevated above sea level  
8   and we're able to create some evaporites and create  
9   laminated bedded anhydrites. Now, these bedded  
10  anhydrites will be very good barriers.

11           Q. Dr. Davidson, were you able to corroborate  
12  your interpretation of these anhydrites with  
13  literature?

14           A. Yeah. And actually, Dr. Trentham describes  
15  this process as being part of the upper part of the  
16  Lower San Andres, this high frequency depositional  
17  environment, with the capping of evaporites at the top  
18  of each sequence. So I'm not the only person that  
19  identified this. Dr. Trentham described this  
20  depositional environment in the upper part of the  
21  Lower San Andres as well.

22           And I'm defining the Lower San Andres.  
23  I'm not a geologist, and I don't care to become one,  
24  to be honest with you. But the -- I'm defining the  
25  Lower San Andres as the San Andres interval below what

1 I call the high gamma ray marker.

2 Q. This next slide here, Dr. Davidson, goes  
3 into some detail about your analysis of these  
4 anhydrites. If you would, explain what this shows and  
5 how it reflect your analysis and determination of the  
6 existence of these anhydrites across the EMSU area.

7 A. So we had a -- I had a relatively limited  
8 data set and I didn't -- a lot of the logs that I  
9 wanted to have access to, we couldn't get in public  
10 available sites like Drilling Info and OCG and what --  
11 OCD.

12 But what I was able to do, after we got  
13 the Ops rebuttal, they had access to whole lot more  
14 well logs than I did, and so we were able to get some  
15 well logs that penetrated through the Grayburg and a  
16 good part of what I call the Lower San Andres. And we  
17 war able to do mineralogy interpretations on those.  
18 And then I also went through the cross-plotting  
19 technique that Jerry Lucia developed, to identify the  
20 bedded anhydrites.

21 And what I found was, there's an  
22 interval -- and, again, the top line there on that  
23 yellow shaded area, I connect the dots between what I  
24 call the high gamma ray marker. And then below that,  
25 if you see the little flags next to the depth track,

1 those were the intervals where we identified the  
2 bedded anhydrites.

3 And this is I believe a northwest-  
4 southeast cross-section through the EMSU, and you can  
5 see that there's an interval of bedded anhydrites that  
6 exist all the way across the field. And in my opinion  
7 at least, these would provide -- and, again, the  
8 majority of the injection, as I understand it, in the  
9 disposal wells are occurring below this interval that  
10 I've highlighted in the yellow there.

11 So in my view, the injection interval is  
12 isolated from the Upper San Andres above what I call  
13 the high gamma ray marker by several layers of bedded  
14 anhydrites.

15 The other thing on here that you can see  
16 is the porosity associated below that marker is quite  
17 a bit higher, indicating quite a bit of dissolution  
18 has occurred. And that's probably as a result of the  
19 meteoric water and the H2S migration that Dr. Lindsay  
20 and Dr. Trentham and Melzer have hypothesized.

21 Q. So I think the next series of slides,  
22 Dr. Davidson, specifically go to items that are  
23 identified in your rebuttal testimony in responding to  
24 NuTech specifically and I believe also Ops Geologic.

25 If you would, just explain what this

1 slide shows. I think it's information from Dr. Melzer  
2 and Dr. Trentham's assessment of ROZs. Explain how  
3 this relates to your rebuttal and what you have to  
4 say, your critique and response to Empire's  
5 petrophysical analysis.

6 A. Again, this is going to be my critique of  
7 Trentham and Melzer as well. They published kind of  
8 what they call a "Cookbook" of how to identify ROZs.  
9 And this is based on I think either four or eight  
10 counties, and they kind of defined m and n values for  
11 the Archie model. They defined water resistivities  
12 used and kind of tell you: Where am I on the Central  
13 Basin Platform, and after I know my location, how  
14 should I do the petrophysical calculation?

15 And in my opinion, and it's used in the  
16 Archie model -- and I'm going to talk in a few minutes  
17 about why the Archie model in any of its -- any way  
18 that it's presented is not the right type of model to  
19 use for this environment. But I think what -- the  
20 thing that bothers me is I can apply this Cookbook  
21 approach and I can find an ROZ almost anywhere, but  
22 the disturbing thing is, I almost always overestimate  
23 the amount of oil that's in place in the ROZ that I  
24 think I found.

25 Let's go to the next slide.

1           Q. This I think shows a core interpretation  
2 that you conducted on the 679. Explain what this has  
3 to do with your critique of the Trentham models.

4           A. And, again, what I've done here is I've  
5 shown, I believe, our -- I can't see very well, but I  
6 believe our interpretation is on there, and I've shown  
7 the oil saturations.

8                     But then what I've done is I've  
9 displayed Dr. Trentham's model using the salinity that  
10 he said I should use. I think I used the Gaines  
11 County and we're in Lea County. So we're right across  
12 the border. But I used the model that he suggested in  
13 this Cookbook, in he and Melzer's Cookbook, and you  
14 see that it predicts a pretty constant oil saturation  
15 in the 60 percent oil all the way through the interval  
16 and doesn't match the core well at all.

17                     Then the other model, I said, well,  
18 let's give them the benefit of the doubt, and we did  
19 not use the salinity that he pointed out in his  
20 Cookbook, but used the actual salinity that we knew to  
21 be present. And we see it does a little bit better  
22 job, but it still over-predicts the amount of oil in  
23 the ROZ. And my concern is this type of analysis may  
24 get people overly excited about their potential.

25                     Let's go to the next slide.

1 Q. Just for clarity of the record, this slide  
2 is 20. And the two far right tracks are your  
3 application of the Trentham models to the core data,  
4 correct?

5 A. Correct.

6 Q. And the first -- the second from the right  
7 is the one where you applied -- from the Cookbook?

8 A. Right.

9 Q. And then the farthest to the right is the  
10 one where you applied the --

11 A. The correct Rw.

12 Q. Right. And the core data is in purple,  
13 right?

14 A. Yes.

15 Q. Next slide here is your analysis or  
16 assessment of I think NuTech's revised analysis  
17 relative to what you have done. Can you explain what  
18 your critique analysis is of NuTech's revised approach  
19 and how it relates to your analysis?

20 A. I've shown the original -- we didn't have  
21 curves for the original. The original was  $m$  equal --  
22  $n$  equals 2, which basically resulted in the  
23 overestimation of oil saturation all the way through  
24 the interval.

25 We were given, in October or November, a

1 revised NuTech analysis. And that one, we talked  
2 about that quite a bit during the testimony of  
3 Mr. Dillewyn. But that model was calibrated to the  
4 water saturations from the core. And I've got the  
5 core water saturations in that far right track. I  
6 think they're blue. And you see how they did a fairly  
7 decent job of matching to the core water saturations.

8 The problem is, the core water  
9 saturation don't represent the oil -- are not  
10 representative of what the oil saturations would be in  
11 reservoir conditions. And what I've shown, I believe  
12 it's green, are the corrected oil saturations. And  
13 you see that even the revised model overestimates the  
14 oil saturations all the way through the interval.

15 And we were told that, well, maybe we  
16 should look at the original model as a high side and  
17 the revised model as a low side and that develops a  
18 range that we would consider, so therefore, we've  
19 considered uncertainty in the petrophysical model.

20 I would argue that it's calibrated to  
21 the water saturation, which is the wrong thing to  
22 calibrate to. And both what they would consider the  
23 low side and high side overestimate the amount of oil  
24 in place in that 679 core.

25 Q. Next slide here. I think you do the same



1 thing with the Ops Geologic analysis. Explain your  
2 critique of the Ops Geologic petrophysical analysis  
3 relative to what you have prepared in your analysis.

4 A. And here -- and we'll talk a little bit more  
5 about Ops. But the thing I wanted to point out here,  
6 what I plotted here are our estimates of the corrected  
7 core measurements. And what I would argue here is  
8 that both the Ops low side and the high side more  
9 often than not overestimate the amount of oil present  
10 through that interval.

11 Now, part of the reason that they gave  
12 for that was that they were trying to account for oil  
13 that was lost by the super flushing that we talked  
14 about, the stripping and super flushing. They said,  
15 "We're going to match as best we can to the data, but  
16 we're going to be a little optimistic to account for  
17 the fact that there was super flushing or stripping  
18 going on."

19 And, again, our analysis indicates that  
20 the pressure differentials at the bit weren't high  
21 enough for the permeabilities present for the super  
22 flushing or stripping to occur.

23 And, again, if you go back and do kind  
24 of what we did, we went back and looked at the  
25 hydrocarbon pore volume associated with each core

1 point. And our model predicted that hydrocarbon pore  
2 volume within 4 percent.

3 The Ops model, their low side case, they  
4 said, "Well, in the low side case, we used the raw  
5 core data without any correction."

6 Well, even if we use our corrected core  
7 measurements, their low side is 30 percent higher than  
8 the corrected core measurements as far as the in-place  
9 volume, and 87 percent higher than the corrected  
10 saturation for the upside case.

11 So my argument is, the low side and high  
12 side on the Ops are still optimistic compared to what  
13 the core data -- the actual core measurements say that  
14 the presence of oil is. And in a minute I'll kind of  
15 show why that may have happened.

16 Q. So just to be clear, this is Slide 22, the  
17 second track from the right is NSAI, your analysis,  
18 showing the core data plotted in purple, with your  
19 model in the dash blue, correct?

20 A. Correct.

21 Q. And then on far right track, the blue solid  
22 line is Ops Geologic's low side analysis?

23 A. I can't tell the color, but it's the lower  
24 of the two.

25 Q. Okay. And then the higher side, on the

1 right, is the red, and that's Ops Geologic's high side  
2 interpretation, correct?

3 A. Correct.

4 Q. And then same thing, you've got the  
5 corrected core saturations on the same plot?

6 A. And my conclusion here is, while there was a  
7 range established with the Ops model, it seems to  
8 violate the core measurements. And, again, you know,  
9 I was criticized earlier on for not having a range.  
10 So what I -- we went back and looked at -- Ops  
11 established the precedent of: Well, we're going to  
12 look at the corrected core, the range of uncertainty  
13 in the core measurements as the uncertainty in the  
14 petrophysics. And then they said, "Well, we're going  
15 to model our low side to uncorrected or high side to  
16 maybe an optimistically or slightly optimistically  
17 corrected core measurement."

18 Well, if I do that with ours, our  
19 correction factor for the core range from 1.1 to 1.3,  
20 and if I look at that in terms of uncertainty, that's  
21 about a plus or minus 10 percent uncertainty on each  
22 core saturation, that gives you a standard deviation  
23 of about .31, if you're interested in statistics.

24 But the point is, if you want to look at  
25 the uncertainty in our petrophysical model, take the

1 saturation calculations and vary them by plus or minus  
2 10 percent, and that would be a reasonable uncertainty  
3 range based on the uncertainty that we see in the core  
4 measurements.

5 Q. Thank you. Next plot, I think you do  
6 something similar again and look at a core that Ops  
7 Geologic had evaluated. Explain how this assessment  
8 of your model against the GSAU 522 well reflects your  
9 analysis as to your petrophysical approach.

10 A. Again, I won't belabor this one too long.  
11 There was a -- some early concern about the fact this  
12 522 well indicated very high oil saturations in the  
13 San Andres, up to 60 and 70 percent, in an interval  
14 that arguably has been waterflooded. And that was put  
15 forth as evidence that hey, there's high oil  
16 saturations in the San Andres in the waterflooded  
17 intervals. We went back and looked at the data and  
18 found that oil has been added to the drilling mud just  
19 prior to the coring operations.

20 And I won't go into it in great detail  
21 now. It's in my testimony. We identified an interval  
22 where we think maybe some spontaneous inhibition may  
23 have occurred at the lower part of the core. And at  
24 high part of the core, there may have been mobile oil  
25 present. I think there was some testing done that

1 indicated some mobile oil present in that green  
2 perforated interval in the depth track.

3 And basically, we took our model -- we  
4 didn't have this data early on. We had some  
5 electromagnetic propagation tool data. And we came to  
6 the conclusion, based on analysis of that data, with  
7 the Ops rebuttal we were able to get the actual open  
8 hole log curves for this, which I didn't have at  
9 rebuttal time. Again, we ran our model in the blind  
10 test and we were able to pretty much reproduce the  
11 conclusions that we had drawn from the analysis of the  
12 electromagnetic propagation tool in this well.

13 And basically, we concluded that oil  
14 contamination was the reason for the high saturations,  
15 not that they were actually there from the beginning.

16 Q. Thank you. This next slide here I think  
17 goes into more detail, I'm back onto the EMSU 660, and  
18 evaluates NuTech's revised analysis relative to some  
19 of the well tests that were conducted.

20 If you would just explain what this  
21 slide shows and how it relates to your critique of  
22 NuTech's analysis.

23 A. This argument can go with either the  
24 original NuTech or the revised NuTech, because up in  
25 the Grayburg, they're the same model. We've talked

1 about this before in some of our previous testimony --  
2 previous cross. This well is predicting the NuTech  
3 60 percent oil saturations and above up in the  
4 Grayburg and upper part of San Andres in the intervals  
5 that tested basically very high water cuts. And we  
6 wouldn't expect the high water cuts, you know, 93  
7 percent plus cuts in intervals that were 60 to 80  
8 percent water saturation.

9 And I'll tell you that a conventional  
10 model, in the shallow part we would be running 2 and  
11 2, Archie with 2 and 2, that's been demonstrated that  
12 that just flat doesn't work below producing oil-water  
13 contact. I discovered the hard way when I went to  
14 work for Arco. Jerry Lucia produced a bunch of  
15 documents showing that using Archie at almost any  
16 constant m and n value generally results in the  
17 overestimating the oil saturations.

18 So I think the NuTech model -- you know,  
19 they were moving in the right direction at NuTech,  
20 because they were going from a constant m and n to a  
21 variable m and n, which is the right direction in  
22 trying to tie it as best they could to facies. The  
23 problem is, they calibrated to the water  
24 saturation rather than the oil saturation.

25 And, again, we look at the actual

1 physical measurements, which is the produced oil. It  
2 just doesn't seem to match with our higher oil  
3 saturation from the modeling.

4 Go to the next slide.

5 Q. This next one, I think, again, you're  
6 looking at a mud log for the 746 well, and you're  
7 looking, in this case, at the Ops Geologic high and  
8 low assessments.

9 Explain how your interpretation or  
10 assessment of the Ops Geologic petrophysical analysis  
11 conflicts with what your understanding is of the mud  
12 log data.

13 A. And we're going to talk a little bit about  
14 why -- and by the way, I'm nearly done for all you all  
15 that are watching their watch.

16 The Ops model, interestingly enough,  
17 calculates very high oil saturations and very low  
18 porosity rock. And the reason for that is, more often  
19 than not, when you get low porosity rock, you get less  
20 than 5 percent porosity. A lot of those pores aren't  
21 talking to one another anymore. They become occluded  
22 with cement materials, pressure solution, which is,  
23 you know, the overburdened pressure at the  
24 grain-to-grain contacts, basically melting the grains  
25 and causing precipitation -- dissolution prescription

1 reactions that could occlude the pores so one pore is  
2 not communicating with the other. It's a very typical  
3 problem in low porosity carbonates.

4 So what you see is, you get low porosity  
5 because it can't conduct electricity very well  
6 anymore. The resistivities are elevated. And if you  
7 just use an Archie model, regardless of whether it's  
8 variable m and n or any type of model, you can  
9 calculate the presence of oil where there isn't any.

10 And what I was trying to point out here  
11 is we're going down to an interval that's a low  
12 porosity rock, and I happen to have the mud log and I  
13 show the mud log through that interval shows  
14 absolutely no oil staining, no fluorescence, no  
15 anything. Yet, we're getting 60 to 80 percent oil  
16 saturation with the Ops model. And I'll show you in a  
17 minute why that these occurring.

18 But at one point, we scratched our head,  
19 you know, how can we come up with oil where the mud  
20 logs are showing nothing is there? And particularly  
21 in a situation where we have oil wet rock. This is  
22 oil wet rock, and in oil wet rock, oil is going to  
23 coat the surfaces of the carbonate grains, so you'd  
24 expect to see something on the mud log. And the fact  
25 that there's no shows of any kind -- the other



1     giveaway is that your C-1 is at background level. So  
2     there was never any hydrocarbon there.

3             So, you know, what you're seeing there  
4     is a low side and high side from the Ops model in an  
5     interval that doesn't contain any hydrocarbon  
6     that's -- where they're counting that hydrocarbon in  
7     their oil-in-place estimates. And, again, this well  
8     tested, you know, zero oil.

9             Q. Next slide. I think another kind of similar  
10    analysis showing mug log relative to what Ops Geologic  
11    had identified as having high levels.

12            A. Yes, and I may have gotten these slides just  
13    backgrounds from one another. But it's the same  
14    thing. We're seeing oil saturation in an interval  
15    that produced very little to no oil at all in a low  
16    porosity rock.

17            Q. Next slide here is your --

18            A. This is the back one. Which way are we  
19    going? We went the wrong way.

20            Q. I skipped a slide, Dr. Davidson. I  
21    apologize. This next one here is the EMSU 746 mud log  
22    showing the Lower San Andres. If you would just  
23    explain how -- and this shows your analysis.

24            A. This shows our analysis. And granted, in  
25    that same interval, we calculated a little bit of oil

1 in place. And I didn't put any limiters in to say,  
2 you know, if the porosity gets below a certain level,  
3 don't calculate oil anymore. And we actually  
4 calculated a little bit of oil in there, as well.

5 So, you know, this is kind of like the  
6 pot calling the kettle black, I'm saying that Ops kind  
7 of fouled up. Well, you know, to be honest, we  
8 calculate a little bit of oil there, too.

9 But rather than eliminate it, we left it  
10 there because we don't know for sure and we don't have  
11 mud logs in all the wells. So in order not to be  
12 overly pessimistic, I didn't say if the porosity gets  
13 to 5 percent, set oil saturation to zero. We just let  
14 it be what it was.

15 Q. In this particular slide, your  
16 interpretation, your petrophysical interpretation is  
17 the second track from the right, correct?

18 A. Yes.

19 Q. And I think you also show the farthest right  
20 track, you show NuTech's original and revised  
21 analysis?

22 A. Yes, in that one there.

23 Q. Okay.

24 A. Everybody is calculating oil in that  
25 interval.

1 Q. Okay.

2 A. I'm as guilty as everybody else.

3 Q. Very good. I think your point here, though,  
4 Dr. Davidson, correct me if I'm wrong, is that the  
5 saturations that are being calculated by both NuTech  
6 and Ops Geologic don't -- are not reflected in the mud  
7 logs, correct?

8 A. That's correct.

9 Q. Okay. Next one is the Meyer B 4-34, and I  
10 think you're showing your interpretation and the Ops  
11 Geologic interpretation. And I think you had a  
12 comment here about floating oil. Explain --

13 A. Well, what that --

14 Q. Explain that this shows and why their  
15 analysis doesn't jibe with what you understand the  
16 reality to be here.

17 A. And what we're seeing here, again, it's an  
18 interval where we have low porosity, and we're  
19 calculating reasonably high oil saturations in a  
20 portion of the rock that has low porosity. Then you  
21 go around that, what I'm calling the floating oil  
22 above and below, and you get elevated porosity values  
23 with water saturations at 100 percent.

24 And, you know, at one point, I think  
25 they stated they hypothesized that a residual oil zone

1 could reside all the way from the Glorieta up into the  
2 Upper San Andres.

3 And I'm having trouble with the physics  
4 of oil only existing in the very poor quality rock and  
5 being completely flushed out with no residual at all  
6 in the better quality rock. It certainly doesn't seem  
7 to fit the data that we have on -- if that interval  
8 had -- thea higher porosity interval had been full of  
9 oil and had been swept away, we'd at least expect to  
10 see residuals in the 20 to 40 percent range in that  
11 higher porosity interval, and we're not.

12 So I think this is an artifact of the  
13 way that they chose their m and n values. And I think  
14 I'm going to show that in just a second.

15 Q. Now, this next slide I think goes into that  
16 analysis where you've got a correlation. Explain what  
17 what this shows and how, in your opinion, it reflects  
18 that Ops Geologic's petrophysical analysis is flawed.

19 A. So what we did is we went back and we took  
20 the core measurements and I followed the procedure  
21 that Ops said that they followed. We took the core  
22 measurements. We corrected the saturations for each  
23 core point used in the resistivity values. We  
24 calculated using the Archie model what the m and n  
25 values would be. And I believe this -- hang on. I

1 can't see. The Archie saturation. So this is N.

2 So if I took each core point with the  
3 resistivity measurements, the porosity, what we knew  
4 the formation water salinity was, and I calculated  
5 what would the N value be for that core point, and  
6 then we plotted it as a function of our corrected oil  
7 saturation, what turned into water saturation, so 1  
8 minus oil saturation to get the  $S_w$ , and you see indeed  
9 there is a trend there.

10 But you see there's quite a bit of  
11 variability in the n values as a function of porosity.  
12 For example, you know, in a 5 percent porosity, I  
13 could have a couple of orders, two to three orders of  
14 magnitude variation in the n value for a given  
15 porosity.

16 Now, the other thing we did is we took  
17 the 746 data and we backed out what the -- what Ops  
18 did was, as a function of porosity, they calculated  
19 what an n value would be. And then they applied an m  
20 and n -- I think a constant m and then variable n  
21 value using Archie's model to calculate the saturation  
22 as a function of porosity.

23 And that line there represents the n  
24 value they would have selected for each porosity  
25 point, and you see it ignores probably 80 percent of

1 the measurements that were in the core. The core had  
2 intervals which would have calculated much higher n  
3 values that were used in final model.

4 And I think that's why we're getting  
5 these floating oils and the 60 percent oil when you  
6 have 5 percent porosity, because the way it's  
7 designed, let's go to the next slide, and it's colored  
8 such that the best quality rock, the lowest -- highest  
9 oil saturations to the lowest water saturations I  
10 think are the green colors, and it's all along that  
11 leading edge.

12 So what they've done is, by choosing the  
13 correlation along the front end of that data, they've  
14 made every possible porosity return the highest  
15 possible oil saturation. And I think that's why their  
16 model is overestimating in the core generally leads to  
17 overestimation of the oil saturation in a lot of the  
18 points. And in the Lower San Andres when we get the  
19 lower porosity intervals, it's putting oil in the low  
20 saturation rock.

21 So, again, I think there may be an  
22 implicit bias based on the way that they modeled --  
23 the Archie model they selected and the way they chose  
24 to select their variable n value.

25 Q. Thank you, Dr. Davidson. I think that's

1 your last slide. A few questions to sum up your  
2 opinions.

3 Dr. Davidson, what's your opinion about  
4 whether Goodnight's disposal zone is a residual oil  
5 zone?

6 A. The disposal zone I don't believe is.  
7 There's several reasons for that. Predominantly  
8 because -- there's going to be oil in there in  
9 migration paths. It literally -- probably billions of  
10 barrels of oil have flowed through the San Andres to  
11 accumulate up into the Central Basin Platform over  
12 geologic time. There's going to be migration paths  
13 all through the San Andres.

14 However, when I look at the profiles,  
15 that's why we're talking so much about profiles, I  
16 don't the profile of an ROZ anywhere below that high  
17 gamma ray marker. And where we reduce the oil, it's  
18 spread out -- you know, disparate, spread out by  
19 hundreds of feet. Typically, the better quality rock  
20 where the oil does appear to be high saturation, it's  
21 usually less than a couple of feet thick. And the  
22 profiles around it don't have the nice, flat front  
23 edge that you normally see.

24 The other thing is, as far as an ROZ,  
25 it -- for example, let's look at Seminole. It was

1 created by a situation where they think they had a  
2 trap breach. And so the water moved up after the trap  
3 was breached, and there was a little bit of sweep,  
4 very little sweep, you know, maybe a pore volume or so  
5 of sweep as that oil-water contact moved up after the  
6 trap breach, creating that residual zone.

7 It hasn't seen the lateral displacement  
8 that would exist in the ROZ -- or, excuse me, the  
9 sub -- what I call the Lower San Andres, below that  
10 marker. That's had multiple pore volumes of water  
11 through it, and there's been a lot of dissolution  
12 reactions. And then it's probably had a lot of H<sub>2</sub>S.

13 In Dr. Lindsay's model, the way he's got  
14 it described is the water was moving down from the  
15 outcrops through this interval, and then H<sub>2</sub>S was  
16 bubbling back up through it. In that world, you  
17 create sulfuric acid, and that would create the karst  
18 they we're seeing.

19 We're losing circulation when we get  
20 below those layers of anhydrite. So we're entering a  
21 karstic -- almost karstic-type environment, very  
22 buggy. Bugs are connected. Very high permeability.  
23 That's why we're losing circulation.

24 It's a different environment. That  
25 interval in the -- below those anhydrite layers has



1 seen multiple volumes of water move through, a lot of  
2 H2S move through. A lot of water has been -- a lot of  
3 rock has been dissolved. So it's a different beast.  
4 It's a different environment.

5 If we got up into the interval, the  
6 Grayburg and the Upper San Andres, that Dr. Lindsay  
7 described, he's describing the karsting there as  
8 coming from more of a top-down, where you had  
9 subaerial exposure and meteoric waters were flooding  
10 in, moving down through the rock and dissolving --  
11 creating karst and filling it with sand, silt filled  
12 into the karst, creating the San Andres Grayburg  
13 boundary.

14 There's karst up there. But the  
15 karsting that occurs in the -- below that high gamma  
16 ray marker is whole different beast. It's the  
17 Trentham-Melzer model that describes the large volumes  
18 of water movement through there. In that world, a  
19 couple of things that would occur. There would be a  
20 massive sweep. You'd be sweeping through intervals  
21 that probably contained only migration paths.

22 And the other thing that would happen,  
23 any oil that would be down there would be dead because  
24 there's too much water by, there's been fresh water  
25 by, the sweep would reduce -- would move all the light

1 ends. The gas content would go low. It would be very  
2 poor quality and it would probably exist only in those  
3 migration pathways. So I don't see an ROZ below that  
4 high gamma ray marker, per se.

5 Q. On that basis, Dr. Davidson, do you have an  
6 opinion about whether that disposal zone that  
7 Goodnight is currently injecting produced water,  
8 whether it's potentially productive as an ROZ?

9 A. I don't believe so.

10 Q. What's your opinion about whether Empire's  
11 producing zone above your gamma ray marker and  
12 Goodnight's disposal zone below that gamma ray are in  
13 communication?

14 A. I see very little evidence of it.  
15 Predominantly, one, those bedded anhydrites are going  
16 to be very good layers. I think there's other  
17 barriers as well. Up in that interval -- there's a  
18 lot of the low porosity intervals that would  
19 potentially be barriers I think. Bill Knights is  
20 going to address that more in some of his testimony.  
21 But there are ample barriers between the two.

22 The other thing that bothered me is, I  
23 don't see any evidence -- I'm seeing maybe 70,000  
24 barrels a day injected, 70,000 barrels a day produced.  
25 I think Dr. -- the modeler, Buchwalter, it seems to me

1     that his testimony indicates the fact that there's  
2     somewhere on the order of 20,000 barrels a day was  
3     leaking up into the San Andres. I don't see any  
4     evidence of that from the production.

5             There was a description of fractures,  
6     you know, that might connect the two. The problem  
7     with that is that there's multiple intervals that have  
8     variable ductal behavior. And it would be very hard  
9     to keep a fracture open in that environment between  
10    the San Andres and -- with all the diagenesis and the  
11    ductility of the different rock variations.

12            I don't see a condition where you can  
13    have fracture communication. And if there were  
14    fracture communication, I expect you would see -- with  
15    the amount of water, again, on order of I believe  
16    about 120,000 barrels a day injected, I believe I  
17    would see a bigger impact up in the Grayburg and no  
18    increase in water at all. I would expect to see that  
19    they would be producing more water than they were  
20    injecting if there were major fracture communications  
21    between the two.

22            Q. Dr. Davidson, what's your recommendation to  
23    the Commission about what decision the Commission  
24    should make based on everything we've heard and your  
25    analysis today?

1 MR. WEHMEYER: Objection. This is outside  
2 the scope of this witness' testimony. And it's  
3 improper to speculate by this witness in terms of  
4 what the Commission should act on. But chiefly, this  
5 is outside the scope of any of the direct testimony.

6 HEARING OFFICER HARWOOD: Rephrase the  
7 question.

8 MR. RANKIN: Sure.

9 BY MR. RANKIN:

10 Q. Dr. Davidson, do you have an opinion about  
11 whether Goodnight's injection is causing waste in the  
12 purported San Andres dis- --

13 A. No, I don't believe --

14 MR. WEHMEYER: Objection. With respect to  
15 the definition of "waste," the witness has offered  
16 zero testimony in any of his filed statements about  
17 waste. You can keyword search the word "waste," it's  
18 nowhere in there. The idea of testifying to this  
19 Commission about waste is outside the scope of  
20 anything that we've had an opportunity to prepare  
21 for.

22 HEARING OFFICER HARWOOD: Mr. Rankin?

23 MR. RANKIN: Mm-hmm.

24 HEARING OFFICER HARWOOD: Response?

25 MR. RANKIN: Well, I think waste is a

1 question -- it is a legal term, but it's also a  
2 question of whether or not there's actually waste  
3 occurring. It's a technical issue that Dr. Davidson  
4 has evaluated in detail about whether or not there's  
5 any impact on ultimate recovery in the purported ROZ  
6 below his gamma ray marker.

7 And I'm asking him whether or not in his  
8 analysis there's any, in his view, adverse effect to  
9 ultimate recovery from the zone below his gamma ray  
10 marker.

11 HEARING OFFICER HARWOOD: I'll sustain the  
12 objection. I think he's already answered that  
13 question.

14 BY MR. RANKIN:

15 Q. Dr. Davidson, is there any basis, in your  
16 opinion, for the Commission to suspend Goodnight's  
17 existing disposal?

18 MR. WEHMEYER: Same objection. This is  
19 outside the scope of anything he's testified on. And  
20 it would be so multi-disciplinary, it is absolutely  
21 inappropriate for this witness to offer speculation  
22 on this point.

23 MR. RANKIN: If I may respond, Mr. Hearing  
24 Officer. At the very outset of Dr. Davidson's  
25 testimony, it's outlined in his direct testimony,

1 that one of the things he was directly asked to do  
2 was to determine whether or not there's any impact  
3 from the injection. And this goes right to his  
4 opinion, that he's directly -- and it's within his  
5 scope of testimony.

6 HEARING OFFICER HARWOOD: Well, we've heard  
7 his opinion, and I think it's up to the Commission to  
8 decide the question that you're asking him to --  
9 you're basically asking the witness to tell the  
10 Commission how to decide the case. So sustained.

11 BY MR. RANKIN:

12 Q. Dr. Davidson, we've heard a lot of testimony  
13 from Empire's witnesses about whether or not there's  
14 enough data for the Commission to make a decision.

15 In your opinion, does the Commission  
16 need more data to make this decision today?

17 A. I don't believe so.

18 Q. Why is that?

19 A. Well, the San Andres has been very well  
20 studied. And we brought all the data and we got the  
21 core data from the zone that arguably is one that  
22 would be amenable to some sort of EOR-type operations.  
23 In looking at what's going on in what I call the  
24 injection zone, we see no evidence of the existence of  
25 an ROZ.

1           You know, that increased injection, I  
2   don't think is going to be a problem. One, it doesn't  
3   appear that the pressure is significantly increasing  
4   down there.

5           And, again, I've looked at this thing  
6   regionally. I think everybody has maybe got a little  
7   bit of blinders on. The Trentham-Melzer theory  
8   speculates water movement from even west of the  
9   Guadalupe Mountains all the way into the Central Basin  
10   Platform. That's a big area.

11          And you go back and look at the Central  
12   Basin Platform before major waterflood operations  
13   started, there's been something like 7 billion barrels  
14   produced out of that. Well, this aquifer is attached  
15   to that. So there's been a tremendous amount of  
16   withdrawals.

17          And arguably, you know, Trentham, Melzer  
18   and one of my former colleagues at Arco, Alton Brown,  
19   have speculated that the aquifer to the west in  
20   Southeast New Mexico is connected to the Central Basin  
21   Platform. Dr. Brown actually --

22          MR. WEHMEYER: Object to the hearsay.  
23   Additionally, what he's speaking to he has  
24   characterized himself as speculation. So the hearsay  
25   statement about speculation would also be

1 speculation.

2 HEARING OFFICER HARWOOD: We have a relaxed  
3 standard for hearsay in these administrative  
4 proceedings, but, you know, speculation on top of  
5 speculation --

6 MR. RANKIN: Maybe I can ask Dr. Davidson to  
7 maybe kind of reconsider or rephrase his statement.

8 BY MR. RANKIN:

9 Q. But I think, Dr. Davidson, you were  
10 testifying about the connectivity of the San Andres  
11 with broader reservoirs or formations. And I guess  
12 you can explain why you believe that's important for  
13 the Commission to consider.

14 MR. WEHMEYER: And with respect to  
15 communication amongst -- water communication outside  
16 of the EMSU, none of this is in the witness  
17 statements. So this is nothing that has been  
18 disclosed prior to today. We object that it's  
19 outside.

20 MR. RANKIN: Dr. Davidson is responding to  
21 the testimony of Empire's witnesses that he heard  
22 throughout the course of the hearing for the last two  
23 weeks.

24 HEARING OFFICER HARWOOD: You still have  
25 lots of witnesses to go. Are you not going to cover



1 this testimony with anybody else?

2 MR. RANKIN: I think it will be addressed.  
3 So that said, I think Dr. Davidson had something to  
4 say about it and he was letting the Commission know.

5 HEARING OFFICER HARWOOD: Well, Dr. Davidson  
6 has a lot of say about a lot of things. I think, you  
7 know, it's not fair to Empire to bring up stuff that  
8 is new and wasn't disclosed in his testimony. So if  
9 you're going to cover it with another witness, I'll  
10 sustain the objection.

11 BY MR. RANKIN:

12 Q. Dr. Davidson last topic I want to discuss  
13 with you is one that has come up in response to  
14 questioning from Empire and also in response to some  
15 of the Commissioners' questions. And this goes to  
16 obtaining core for the Lower San Andres, the disposal  
17 zone within the EMSU.

18 Based on your experience, Dr. Davidson,  
19 in response to those questions and the questions from  
20 the Commission, what's your opinion about coring in  
21 the interval below your gamma ray marker and whether  
22 that can be done and whether it should be attempted?

23 A. Well, above the marker, you basically have a  
24 pretty tame environment without a lot of karsting.  
25 Below that marker, all indications are there's quite a

1 bit of karsting. And I've got a lot of experience  
2 with that working with the Pemex Oil Fields. The  
3 Alcala Field is a field that I've done extensive work  
4 with, and it's got a tremendous amount of karsting.

5 And what they find when they try to core  
6 through the Alcala Field is when they get into the  
7 karsted intervals, you had tremendous loss circulation  
8 problems, and more often than not, they stick the core  
9 barrel, stick the pipe due to the loss circulation,  
10 and then when they do finally get the core barrel out,  
11 it contains maybe 10 percent of the core interval, and  
12 the remaining rock that's in the core is poor quality  
13 rock, and so you really don't learn much.

14 In drilling below those anhydrite  
15 layers, Goodnight has loss circulation and many times  
16 had to drill for long periods of time with no returns  
17 at all and losing tens of thousands of barrels into  
18 the wells. And, you know, I would caution anybody to  
19 go in and try to do a pressure core or a sponge core  
20 or anything like that the first time through until you  
21 learn about the coring conditions. It's going to be  
22 difficult because of the karsting and the loss  
23 circulation.

24 And, I mean, I can understand why  
25 Goodnight wouldn't do it, because you're basically --

1     it's an expensive operation and you're potentially  
2     going to lose a lot of equipment in the hole. And  
3     then, if you do get the core barrel out, the data is  
4     not potentially going to be that good.

5             Now, occasionally, a blind squirrel  
6     finds a nut. And you drill into an area where there  
7     hasn't been, you know, the extensive karsting, you may  
8     be able to get a conventional core out. But I think  
9     it would be a crapshoot.

10            MR. RANKIN: Thank you, Dr. Davidson.

11            Mr. Hearing Officer, at this time I have  
12     no further questions of Dr. Davidson.

13     BY MR. RANKIN:

14            Q. Dr. Davidson, before I let you go, I just  
15     want to make sure that you've addressed everything  
16     that you wanted the Commission to understand about  
17     your analysis and your assessment of the situation in  
18     the ROZ, purported ROZ, in the Lower San Andres.

19            A. I'd just like to make a statement.  
20     Hopefully I won't get objected to; I expect I will.

21            But I see the Upper San Andres above  
22     that marker as being a conventionally karsted  
23     interval, where it's top-down due to meteoric water  
24     input, with subaerially exposed rock.

25            Below that marker, it's the

1     Trentham-Melzer-Alton Brown we've had multiple pore  
2     volumes of water through. And it's karsted. How do I  
3     know it's karsted? Because we can inject so many  
4     volumes, so much high volume injection on the vacuum.  
5     It's got to be karsted.

6             Because if you look at the permeability  
7     of the rock that's there, it's not sufficiently high  
8     enough of the rock types present to handle the  
9     injection that's being injected.

10            I haven't seen evidence of an ROZ in a  
11     highly karsted interval. The Seminole San Andres was  
12     not. That was a situation where you had the contact  
13     move up due to a breach of a trap.

14            And we're moving into undocumented  
15     territory. I haven't seen a sustained ROZ project in  
16     a highly karsted interval, I haven't seen evidence of  
17     it anywhere. So I think this is potentially -- we're  
18     treading into new world looking for an ROZ in a highly  
19     karsted interval that's had this much water and H<sub>2</sub>S  
20     through it.

21            Q. Just to clarify, based on your assessment,  
22     it's your determination that it's not a potential ROZ  
23     in that zone, correct?

24            A. I do not believe so, no.

25            MR. RANKIN: Mr. Hearing Officer, I have no

1 further questions of this witness and make him  
2 available for cross-examination by the other parties.

3 HEARING OFFICER HARWOOD: Okay. It's almost  
4 11:35. We have a couple of options. We could -- and  
5 Chairman Rozatos, are you there?

6 CHAIR ROZATOS: I am.

7 HEARING OFFICER HARWOOD: I'm just thinking  
8 we could give Empire the lunch hour to work on their  
9 cross-examination and come back sooner, or we could  
10 start it now, and break conventionally at noon. What  
11 would be your thoughts?

12 CHAIR ROZATOS: I was just thinking that we  
13 break conventionally at noon.

14 HEARING OFFICER HARWOOD: Okay.

15 Are you okay with that, Mr. Wehmeyer?  
16 You've got enough to keep us going for the next 25  
17 minutes, I suspect.

18 MR. WEHMEYER: Absolutely. We're happy to  
19 proceed now.

20 HEARING OFFICER HARWOOD: All right. Great.  
21 Then it's your cross-examination, Mr. Wehmeyer.

22 MR. WEHMEYER: Thank you. And just for  
23 record reference, the direct was two hours and 12  
24 minutes, as we keep track of time.

25 THE WITNESS: That was shorter than your

1 longest witness, if I remember properly.

2 MR. WEHMEYER: Dr. Davidson, I'm not going  
3 to argue with you. My goal is to just get some of  
4 this testimony out so that we can get the Commission  
5 to some decisions.

6 HEARING OFFICER HARWOOD: Just make sure  
7 that that comment doesn't end up being a boomerang.

8 CROSS-EXAMINATION

9 BY MR. WEHMEYER:

10 Q. Dr. Davidson, as we talked about -- I always  
11 like to divide expert things up into qualifications,  
12 data relied on, methods and conclusions. I want to  
13 talk a little bit by way of qualifications first.

14 In terms of EOR experience in the  
15 Permian Basin, was the last time you had that was a  
16 little bit over 40 years ago, with Arco?

17 A. In the Permian Basin, yes; not in the world.

18 Q. Okay. So if the Commission wants to know  
19 your last EOR experience in the Permian Basin, that  
20 was about 41, 42-ish years ago at ARCO?

21 A. My last EOR experience in the world was a  
22 few weeks ago.

23 Q. Prior to this engagement, you've never had  
24 any experience at all in New Mexico?

25 A. Not in New Mexico, no.

1           Q. Now, in terms of the data relied on here, I  
2 want to visit a little bit about that. The core, we  
3 obviously have the 679 core in the EMSU that extends  
4 partially into the San Andres, correct?

5           A. Correct.

6           Q. Was there any other core within the EMSU  
7 that you had available here by way of data?

8           A. Well, eventually, the RR Bell.

9           Q. But you didn't use that as part of your  
10 first two analyses; is that right?

11          A. We used it for purposes of looking at ranges  
12 and porosities and permeabilities. But we weren't  
13 quite sure whether it was Grayburg or San Andres.

14          Q. Any other core inside the EMSU?

15          A. No.

16          Q. Now, in terms of -- I'm not talking about  
17 triple combo logs, but in terms of spectral gamma,  
18 what wells did you have available as part of your  
19 original analysis with spectral gamma in the EMSU?

20          A. None in the EMSU. I think one of the wells  
21 we had was in the AGU.

22          Q. Again, if you'll just listen to the  
23 question. The question is, within the EMSU, if the  
24 Commission wants to know what wells you looked at,  
25 analyzed, studied, correlated that had spectral gamma,

1 the answer would be zero?

2 A. I answered that question when you asked it  
3 the first time.

4 Q. Is it zero?

5 A. No. I said no, there was no wells in the  
6 EMSU that had spectral gammas that we had available to  
7 us.

8 Q. Now --

9 A. Why are we beating this to death?

10 Q. And, again, earlier, do you remember telling  
11 the Commission that they would not need any additional  
12 data to make their decisions here?

13 A. I do.

14 Q. So the only core we have is the 679 and the  
15 RR Bell, which you didn't use the RR Bell in the  
16 opening analysis. We have zero spectral gamma in the  
17 EMSU. What about sonic logs in the EMSU?

18 A. I wasn't aware of any. We went on a wild  
19 goose chase with some of the NuTech data only to find  
20 out that it was synthetic sonic data.

21 Q. So is the answer, as you've testified to the  
22 Commission that they have all the data they need, on  
23 sonic logs within the EMSU, you have exactly zero  
24 sonic logs, correct?

25 A. That's correct.



1 Q. Now, in terms of going back briefly to  
2 qualifications. You are not a geologist?

3 A. No.

4 Q. And you don't hold yourself as doing any  
5 expert work in this case in a geology capacity; is  
6 that right?

7 A. That's correct.

8 Q. And as we talk about tops and where the  
9 San Andres is and where the Grayburg is, I didn't take  
10 your deposition, but I've reviewed your deposition,  
11 and you were emphatic and repetitive that you did not  
12 pick any tops here; is that right?

13 A. That's correct.

14 Q. And in terms of where the Goodnight tops  
15 would have even come there, that required speculation  
16 on your part? You didn't know where the tops would  
17 have even come from for sure, did you?

18 A. Sure.

19 Q. And with respect to Netherland, Sewell,  
20 Netherland, Sewell didn't do any analysis by of the  
21 work of Mr. Knights or anyone else to identify tops  
22 here, did they?

23 A. No.

24 Q. Is that work you could have done, had  
25 Goodnight asked you to do it?

1           A. I wouldn't have gone down that path. I  
2 don't believe that -- Jerry Lucia used to tell me  
3 that --

4           Q. My question is -- if you just listen to my  
5 question. The question is, is identifying a top of  
6 the San Andres work that Netherland, Sewell could have  
7 done if it was asked? Yes or no?

8           A. I wouldn't have done it. Netherland, Sewell  
9 could do it.

10          Q. Netherland, Sewell could do it?

11          A. Yes.

12          Q. Okay. Coming back to just Netherland,  
13 Sewell and some of your experience, with respect to  
14 your day-to-day, like what you're doing on the  
15 majority of days that just occupies your 8:00 to 5:00.  
16 You with me so far in what we're talking about?

17          A. So far.

18          Q. Is that predominantly reserve evaluation or  
19 bank lending and for SEC filing?

20          A. Well, we do that, as well as advisory  
21 studies for national and regular oil and gas  
22 companies, as well.

23          Q. My question is you personally. Is the vast  
24 majority of your day-to-day, 8:00 to 5:00 work, Monday  
25 through Friday, spent performing reserve evaluations

1 on behalf of companies that need them for SEC filings  
2 and/or banks that are using it for lending?

3 A. It would probably occupy maybe 50 percent of  
4 my time.

5 Q. The remaining 50 percent is what?

6 A. Doing speciality studies for national oil  
7 companies where we're hired to do specific field  
8 studies for major and independent oil and gas  
9 companies, equity work, working when there's equity  
10 disputes between different owners in a common oil  
11 field.

12 Q. Can you tell the Commission about when the  
13 last time you would have been personally engaged to  
14 identify impermeable barriers?

15 A. That would be probably a few weeks ago.

16 Q. In what context?

17 A. We're working on another lawsuit in  
18 Australia, where migration up and down the wellbore is  
19 one of the contentions. I can't give you any details  
20 on it. It's confidential.

21 Q. Coming back to just what Netherland, Sewell  
22 does -- and, again, I'm just -- I heard in your  
23 description and response to Mr. Rankin's questions you  
24 specifically mentioned assisting with reserve  
25 evaluation and bank lending and for SEC filings.

1                   You would agree here, as we just talked  
2 forest for the trees, forest for the trees, NuTech  
3 performed two rounds of oil-in-place evaluation here  
4 that would both be significantly more optimistic than  
5 what you came up with. True?

6                   A. Correct.

7                   Q. And Ops Geologic performed work here and  
8 arrived at oil-in-place estimations that would also be  
9 significantly optimistic to what you and Netherland,  
10 Sewell did here. Isn't that true?

11                  A. That's correct. But they're also optimistic  
12 to the core measurements.

13                  Q. Well, let's speak to the core measurements  
14 just briefly. But before I do that, you've also been  
15 in the examination room when the Exxon sales brochure  
16 has been published? You've seen that?

17                  A. I have.

18                  Q. And you can tell the commissioners that  
19 Exxon is also significantly more optimistic about its  
20 estimations of oil in place at EMSU as compared to the  
21 work here that Netherland, Sewell did. Yes?

22                  A. Yes. And if you look at their 25 percent  
23 average through the 679 core, the core data doesn't  
24 support that.

25                  Q. With respect to the 679 core -- well, let's

1 just put a bow around this. So we've seen two rounds  
2 of analysis from NuTech, we've seen Exxon's analysis,  
3 and we've seen Ops Geologic analysis. And you can  
4 tell the commissioners that, this is just a yes or no,  
5 Netherland, Sewell here is pessimistic to all four of  
6 those evaluations. Yes?

7 A. I'd say Netherland, Sewell is correct and  
8 the others are all overly optimistic.

9 Q. Your testimony is they've all got it wrong?

10 A. Yes.

11 Q. As we talk about -- do you remember visiting  
12 about certainty back in your deposition?

13 A. Mm-hmm.

14 Q. And you said here that in terms of your oil  
15 in place, if you were to put a percentage on it, that  
16 would be 50 percent certain.

17 A. No. I said it was a 50 percent probability,  
18 which is a most likely case. If you read my corrected  
19 version of my verbal testimony, I made that  
20 correction. I didn't -- I was talking about a P50,  
21 50 percentile probability, which is a most likely  
22 case. And that was corrected in my written response  
23 to the verbal deposition.

24 Q. So you wouldn't use the testimony you  
25 changed from the first time you swore to the

1 50 percent?

2 A. I misspoke in the first time, which  
3 Ms. Shaheen tripped me up. I was talking about  
4 probability. Not uncertainty. I was talking about  
5 50 percentile of a probability range. And, again, I  
6 corrected it in my -- in the testimony to reflect that  
7 properly.

8 Q. Let's look briefly at the testimony, since  
9 you just said that Mr. Shaheen tripped you up, that  
10 this was something she did.

11 A. It wasn't on purpose.

12 Q. You said --

13 A. I misunderstood the statement when it was  
14 given and I said yes, when I should have clarified  
15 that it was 50 percentile uncertainty, on the  
16 uncertainty range, not 50 percent uncertainty.

17 Q. So I'm going to try to share the screen, if  
18 I can do this correctly.

19 As we talk about this 50 percent and  
20 Ms. Shaheen tripping you up, do you recall what she  
21 was asking you about was the certainty with respect to  
22 potential residual oil zones and oil in place? Do you  
23 remember that?

24 A. Mm-hmm.

25 Q. And you said, I'm reading from Page 46,

1 Line 21, "I'm saying we can't say that we could  
2 differentiate between 35 or 36 percent, but the  
3 evaluation would be reasonably certain to identify  
4 intervals that would be potentially residual oil  
5 zones."

6 She asked you again, "And so, again, I  
7 don't think you've answered my question yet. What do  
8 you mean by 'reasonably certain'?"

9 "ANSWER: I would be reasonably certain  
10 that we identified potential intervals containing  
11 mobile oil under CO2 flood.

12 "And does reasonably certain mean that  
13 you are 50 percent sure?

14 "ANSWER: That would probably be a  
15 reasonable estimate. That would be a most likely  
16 estimate."

17 And then you were asked about the aerial  
18 continuity as a result of sparse well control, and you  
19 said, "That's part of the problem; we don't know the  
20 aerial continuity."

21 So, again, when you told Ms. Hardy  
22 that -- strike that. When you told Ms. Shaheen that  
23 you were reasonably certain, that is, 50 percent  
24 certain, that you've identified intervals that would  
25 be potential residual oil zones, it's now your

1 testimony that you meant something else?

2 A. I meant that the -- our estimate would be a  
3 mostly likely case, which I said in the very next  
4 sentence. It's mostly likely -- I corrected the  
5 testimony to represent that it wasn't 50 percent --  
6 I'm 50 percent certain that it's a P50, or a  
7 50 percent probability, which is a most likely case.  
8 Our answer is a most likely case.

9 Q. Now, the core, we visited with Mr. McBeath a  
10 couple weeks ago, he said core is direct evidence.  
11 And you would tell this Commission that based on the  
12 opinions of Netherland, Sewell, we don't need a core  
13 down to the bottom of the San Andres here, right?

14 A. I'm not saying you don't need one. I'm  
15 saying it would be very difficult to get one. I'm not  
16 sure of the value of it, given the fact that there  
17 doesn't appear to be much oil down there.

18 Q. In terms of your oil-in-place assessments,  
19 isn't the rock facies very important to that?

20 A. Yes.

21 Q. You have to know what is the rock facies  
22 down in the San Andres, because if you're off on the  
23 rock facies, everything else falls apart; isn't that  
24 right?

25 A. Yes.



1 Q. With respect to the different rock facies,  
2 there's been a lot of discussion about wackestone.  
3 And I've heard it different ways. Do you pronounce it  
4 wackestone or wackestone?

5 A. I prefer wackestone, because the other  
6 sounds silly to me. But geologists would disagree.

7 Q. Okay. I'm been calling it wackestone, but I  
8 thought I heard somebody today call it differently.

9 And then you would say, that's the least  
10 desirous rock facies, or there's even worse than that?

11 A. Mudstone. Lime mudstone is worse.

12 Q. Do you have lime mudstone in your  
13 interpretations?

14 A. We did. When we found thick limes less than  
15 5 percent, it was generally classified as lime  
16 mudstone.

17 Q. Is that what you're calling the  
18 non-reservoir?

19 A. It's generally non-reservoir, yes.

20 Q. I'm just trying to get to your terminology,  
21 because in your papers, you discuss non-reservoir. Is  
22 that what you're calling --

23 A. That was the non-reservoir facies, yes.

24 Q. So we have wackestone, and then you would  
25 move over one to mud dominated packstone; is that

1 correct?

2 A. That's correct.

3 Q. And then you would move over to a  
4 grainstone?

5 A. Grain dominated mudstone.

6 Q. And then as you continue moving over, what  
7 would be the next?

8 A. Grainstone and then a moldic grainstone.

9 Q. Now, as we come back to the core here, did  
10 you ever personally look at the core?

11 A. Never had the opportunity.

12 Q. What did you do to try to gain access to the  
13 core to be able to actually evaluate the core?

14 A. I wasn't aware that it was available at the  
15 Bureau, or I would have gone to look.

16 Q. Why were you not aware that the core was  
17 available at that time Bureau?

18 A. I didn't know where it was.

19 Q. As we talk about studying the core being our  
20 direct evidence here in terms of rock typing, can you  
21 tell the Commissioners about everything you did to try  
22 to get access to that core?

23 A. I didn't try at all. I assumed that it  
24 was -- that Empire had it and we couldn't get  
25 availability to it.

1                   However, looking at the core, being  
2     valuable in and of itself, I had the core  
3     measurements, and with the core measurements and with  
4     the data we had from the outcrop, I was able to do a  
5     reasonable job of rock typing based on what I learned  
6     from the outcrop study.

7                   Q. Okay. And I may have forgotten my -- I  
8     thought my question was: Can you describe to the  
9     commissioners everything you did to get access to the  
10    core?

11                  A. I told you, we didn't know that we could get  
12    access to.

13                  Q. The RR Bell, did you ever get access to the  
14    RR Bell core to evaluate that core?

15                  A. To be honest with you, I was a little  
16    surprised that Dr. Lindsay went back and looked at  
17    both cores and we weren't invited to go look at it  
18    with him.

19                  Q. So the first time was Ms. Shaheen's fault  
20    and this one is --

21                  A. I'm not saying it's --

22                  Q. -- Dr. Lindsay's?

23                  A. I'm just saying, we weren't aware that the  
24    core data was even available.

25                  HEARING OFFICER HARWOOD: Doctor, it's human

1 nature, but for the court reporter's sake, you guys  
2 please try not to talk over each other. She can only  
3 take down one person at a time.

4 MR. WEHMEYER: And I apologize to Madam  
5 Court Reporter for my part in it.

6 BY MR. WEHMEYER:

7 Q. Now, coming back to the RR Bell, you said,  
8 Doctor, you were surprised, was how you described it,  
9 that Dr. Lindsay didn't invite you to look at the RR  
10 Bell core or the 679 core.

11 And so earlier, when you said that you  
12 would maybe be 50 percent certain on your oil-in-place  
13 estimations, and you said that was the fault of  
14 Ms. Shaheen, for tripping you up, the reason you  
15 didn't look at the cores here as part of your work,  
16 your work being very important by way of facies of  
17 work, that one's Dr. Lindsay's fault for not inviting  
18 you?

19 A. I don't know if it's anybody's fault. It  
20 just seemed like if data was being evaluated, both  
21 parties would have been invited to take -- you know,  
22 that's not my -- that's not my position to lay fault.  
23 It seemed like it would have been a fair thing to do.

24 Q. But Dr. Lindsay, who you've heard testimony  
25 in this case, the first witness that Empire called, he

1 did actually study the RR Bell core, didn't he?

2 A. He did.

3 Q. He also studied the 679 core, didn't he?

4 A. Yes.

5 Q. Now, in terms of any fracture studies, did  
6 you perform any fracture studies from any of the core?

7 A. No.

8 Q. But you did see that Dr. Lindsay performed a  
9 fracture study in connection with the 679?

10 A. Yes.

11 Q. He's also prepared one for the RR Bell. I  
12 don't want you to say you wanted information. Would  
13 you like to see the RR Bell fracture study?

14 A. At this late stage, it wouldn't be of any  
15 value to me.

16 Q. Why is that?

17 A. We're coming to the end of the hearing.

18 Q. But isn't the goal here to get it right?

19 A. Yes.

20 Q. Okay. Now, in terms of any other fracture  
21 studies, did you see any other fracture studies by way  
22 of data relied on here besides the one prepared by  
23 Dr. Lindsay?

24 A. I did not.

25 Q. As you talk about the concept of

1 communication between the Grayburg and the San Andres,  
2 wouldn't fracture studies be something you would want  
3 to see?

4 A. Assuming it was available. But in my view,  
5 the fracture studies up in the Upper San Andres  
6 wouldn't have much impact on what's going on down in  
7 the Lower San Andres.

8 Q. Do you know what areas Dr. Lindsay performed  
9 his fracture study on in terms of in relation to the  
10 Lovington Sand?

11 A. I assume it was above. But below the  
12 Lovington, it would be very hard without core data to  
13 infer much of anything because of the high ductility  
14 of some of the intervening layers. And it would be  
15 hard to predict whether the fracture penetrated down  
16 or not, whether there had been any diagenesis that had  
17 closed the fractures, what the stress field was, you  
18 know, what's the arc of the formation top, where in  
19 the system do I go from extensional to compressional?  
20 Again, do I have ductal layers that would isolate the  
21 two? I didn't see anything that went to that level of  
22 sophistication.

23 Q. Is your testimony to the commissioners that  
24 you don't even know where, by way of depth interval,  
25 the fracture study that Dr. Lindsay performed is?

1           A. I suspect he did a regional study that would  
2 include projecting down. But that's a very hard thing  
3 to do without direct evidence to support other than  
4 the geomechanical model that would predict such an  
5 extension.

6           Q. My question is, do you know where, by way of  
7 depth interval --

8           A. I do not.

9           Q. -- Dr. Lindsay's fracture study was  
10 performed?

11          A. I do not.

12          Q. But that didn't stop you from offering  
13 opinions to the commissioners here under oath about  
14 communication between the San Andres and the Grayburg,  
15 correct?

16          A. That's correct.

17          Q. The other thing I want to ask, as we talk  
18 about the core on 679, did you anything to depth shift  
19 that core in relation to the wire line?

20          A. Yes, we did.

21          Q. How far did you depth shift it?

22          A. If you'll remember, it was variable, but it  
23 was a few feet up and down, up and down the core.

24          Q. Now, as we talk about how important your  
25 rock facies is, wouldn't it be important to look at --

1 the only core description you've seen here was the one  
2 prepared by Dr. Lindsay on the 679, right?

3 A. No. I saw the core description prepared by  
4 I guess it was Western Atlas, whoever wrote the  
5 report, the digital report.

6 Q. Did you rely on either one?

7 A. I relied on both.

8 Q. Now, I want to see if I can get over -- I  
9 have this on a poster board, if it helps.

10 What we've done is actually compare your  
11 rock facies against Dr. Lindsay's core description and  
12 core interpretations. Have you ever actually tried to  
13 correlate here by actually mapping your different  
14 facies against Dr. Lindsay's descriptions in a graphic  
15 such as this?

16 A. I have not.

17 Q. I'm trying to get to this. Is it coming up  
18 where you can read it?

19 A. I'm never going to be able to see this, so  
20 get on with your point.

21 Q. I guess, how --

22 MR. WEHMEYER: May I approach with the  
23 poster board just in case it helps?

24 BY MR. WEHMEYER:

25 Q. I knew you had some vision issue, so I



1 wanted to be sensitive to that, so I have this in hard  
2 copy.

3 HEARING OFFICER HARWOOD: Mr. Rankin, if you  
4 need to move to see.

5 MR. RANKIN: I don't know who prepared this.  
6 It wasn't part of anybody's direct testimony or cross  
7 or rebuttal. I don't know where this came from. I  
8 guess that's one of my initial questions.

9 BY MR. WEHMEYER:

10 Q. Do you see Dr. Lindsay's core description on  
11 the right?

12 A. Mm-hmm.

13 Q. And they've been compared against your  
14 facies model off of this board --

15 MR. RANKIN: Mr. Hearing Officer, additional  
16 objection for clarification on the origin or  
17 providence of this exhibit or potential exhibit. I  
18 don't know where it came from, I don't know who  
19 prepared it, and I don't know the foundation for it  
20 at this point.

21 HEARING OFFICER HARWOOD: Well, it's not  
22 being offered as far as I can tell. So far it's a  
23 demonstrative aid.

24 Is that correct? Mr. Wehmeyer?

25 MR. WEHMEYER: That's exactly correct.

1 Thank you.

2 HEARING OFFICER HARWOOD: By the way, we're  
3 at the noon hour. But go ahead if you want to finish  
4 your point.

5 MR. WEHMEYER: If you'll indulge two  
6 minutes, I think I can finish.

7 HEARING OFFICER HARWOOD: All right.

8 BY MR. WEHMEYER:

9 Q. So here, for example, in your facies model  
10 in the 679, do you see this large interval as you're  
11 showing as non-reservoir?

12 A. In our model any interval below 7 percent  
13 porosity is considered non-reservoir.

14 Q. I'm just saying, in your model do you see  
15 that there's this large interval that you describe as  
16 non-reservoir?

17 A. I don't know how you got to those -- how you  
18 got to that figure.

19 Q. The figure -- this is straight out of your  
20 work, where you showed this interval right here as  
21 non-reservoir.

22 A. And we eliminated intervals that indicated  
23 high anhydrite saturations as non-reservoir, yes.

24 Q. But if you go over to Bob Lindsay's core  
25 description, he actually has laid eyes on this core,

1 studied it, wrote about it is, in fact, peloidial  
2 packstone where the core reports oil saturation of 13  
3 percent. Can you just explain to the commissioners  
4 how, under your modeling, when the direct evidence we  
5 have comes out of the 679 core, you could be showing  
6 something as non-reservoir, that under Bob Lindsay's  
7 description, is 13 percent oil saturation and  
8 peloidial packstone?

9 A. In our modeling, we eliminated intervals  
10 that were lower than 7 percent porosity that had  
11 indicated elevated anhydrite contents from the core  
12 measurements that we used to calibrate the model.

13 I realize that some of those intervals  
14 in the core -- we also pointed out that we were  
15 concerned that intervals that had indicated high  
16 anhydrite intervals could be potentially damaged  
17 during the core handling procedures, and we felt like  
18 they were somewhat unreliable from the perspective of  
19 doing a core match.

20 So from the combination of eliminating  
21 low -- what indicated low porosity rocks, indicated --  
22 our modeling indicated a high -- potentially high  
23 anhydrite values, we eliminate some of the rocks, that  
24 actual core measurements, from the modeling procedure  
25 so as to try to concentrate on the better quality

1 rock.

2 Q. If we move just a little bit deeper in the  
3 wellbore, we have sections with 30 percent saturation,  
4 oil saturation, actually measured in the core and  
5 described by Bob Lindsay, Dr. Lindsay, as reservoir  
6 rock. And you're showing that non-reservoir. How can  
7 that be?

8 A. Again, those would be intervals where the  
9 log indicated they had high potential anhydrite.

10 I'm curious how you got to that  
11 description. That was never delivered.

12 Q. What was not delivered?

13 A. The facies model values.

14 Q. Did you actually take the facies model to  
15 see where in relation to Dr. Lindsay's descriptions  
16 the rock types --

17 A. We did. And, again, there was concern some  
18 of that data was associated with karsted intervals  
19 that potentially contained anhydrite that wasn't there  
20 anymore by the time the core came to surface.

21 So rather than try to deal with the  
22 uncertainty, we eliminated it and concentrated on  
23 modeling where we didn't have the uncertainty in the  
24 presence of anhydrite.

25 Q. Well, at 4200 feet TDB, did Dr. Lindsay

1 describe karsting?

2 A. He did. And karsted interval is potentially  
3 one where you would have had anhydrite, and that  
4 anhydrite may not be there anymore by the time -- this  
5 well wasn't cored with salt -- the salt-saturated  
6 fluid. And there's a potential that anhydrite that  
7 may have been there wasn't there anymore.

8 They certainly saw that in the outcrop  
9 barriers, intervals in the outcrop, that anhydrite  
10 would be completely dissolved away.

11 I wasn't sure enough, I wasn't sure  
12 whether or not that potential existed. So rather than  
13 deal with the uncertain data, we ignored it when we  
14 were doing the core modeling.

15 Q. You ignored what?

16 A. The intervals that had indicated high  
17 anhydrite content from the logs.

18 Q. Your facies model doesn't even identify the  
19 Lovington Sand, does it?

20 A. I don't know what the Lovington Sand is.

21 Q. So as we talk about how important your  
22 model -- facies is to your model, you do not even know  
23 what the Lovington Sand is. True?

24 A. It's described as a dolomitic sandstone.

25 MR. WEHMEYER: I'm trespassing on the

1 goodwill of folks who want to eat. I'm happy to pick  
2 this back up after lunch, or proceed at the  
3 Commission's pleasure.

4 HEARING OFFICER HARWOOD: Okay.  
5 Mr. Chairman, what is the Commission's pleasure?  
6 When do you want to reconvene?

7 CHAIR ROZATOS: I'm sorry, can you repeat it  
8 please.

9 HEARING OFFICER HARWOOD: It's six after  
10 12:00. Mr. Wehmeyer is at a stopping point for now.  
11 What's the Commission's pleasure in terms of when we  
12 reconvene?

13 CHAIR ROZATOS: Let's come back at around  
14 1:15.

15 HEARING OFFICER HARWOOD: 1:15 is it. Thank  
16 you we'll be off the record until then.

17 (Lunch recess was held from  
18 12:06 to 1:15 p.m.)

19 HEARING OFFICER HARWOOD: So I'll just  
20 remind Dr. Davidson, you're still under oath, and  
21 turn it back over to Mr. Wehmeyer.

22 MR. WEHMEYER: Thank you.

23 BY MR. WEHMEYER:

24 Q. Going back to qualifications and some of the  
25 data we relied on here, have you had experience with

1 residual oil zone development before this engagement?

2 A. Directly, no.

3 Q. So, as we talk about the work of Mr. Melzer  
4 and Bob Trentham, this would be your first residual  
5 oil zone project, correct?

6 A. As they define it, yes. But we deal with  
7 the residual oil all the time and why I do it. So, it  
8 wouldn't be the first time I've dealt with doing  
9 evaluation through an interval that has residual oil.  
10 It'd be the first time that I've done it in terms of  
11 an ROZ as defined by Trentham as an EOR project.

12 Q. Now, in terms of -- I want to talk about  
13 some of the work done. Jonathan Martel actually did a  
14 great deal of the work here for you, didn't he?

15 A. He did the actual push the buttons to run  
16 the model.

17 Q. Did he not also build the databases and  
18 build the computer models?

19 A. Well, we built the models together jointly.  
20 We write the code. He's responsible for populating  
21 the databases and getting the data ready for input and  
22 output.

23 Q. And so Mr. Martel did all of that work.  
24 Yes?

25 A. It's Markell, by the way.

1 Q. With a K?

2 A. Markell.

3 Q. Okay. And we haven't seen any witness  
4 statements in this case for Mr. Markell, have we?

5 A. You have not.

6 Q. Now, coming back to the facies, and visiting  
7 about how important the rock facies are, and I want to  
8 kind of frame some of this oil in place, if for  
9 purposes of your oil in place, if there was less,  
10 based on your modeling, if there was less than 20  
11 percent residual -- strike that. If there was less  
12 than 20 percent oil saturation -- you with me so far?

13 A. Mm-hmm. Yes.

14 Q. -- you can tell the commissioners that your  
15 model credits zero oil towards the oil-in-place  
16 volumes; isn't that right?

17 A. In the summations that are generated to --  
18 I'll put it this way. In the intervals that exceed  
19 20 percent oil saturation, all oil is counted. In the  
20 intervals that are less than 20 percent oil  
21 saturation, we don't count them because, one --  
22 there's two reasons for it. One, after 40 years of --

23 Q. And, Dr. Davidson, this is a yes or no  
24 question. In your model, in terms of telling these  
25 commissioners about opinions as to oil in place, if it



1 is below, under your modeling, 20 percent oil  
2 saturation, zero of those volumes are credited; isn't  
3 that true?

4 A. Zero of those feet are credited.

5 Q. Likewise, as we talk about permeability, if,  
6 based on your modeling, an interval has less than  
7 1 millidarcy of permeability, your model credits zero  
8 oil for any oil in place that would be in an  
9 environment at, according to you, less than  
10 1 millidarcy; isn't that correct?

11 A. That's not correct.

12 Q. Explain that.

13 A. Okay. Our cutoff is a tenth of a  
14 millidarcy. And when that's our cutoff and we don't  
15 actually use the permeability calculated to calculate  
16 that, we use a 7 percent porosity cutoff, which came  
17 from a -- that's the permeability porosity cutoff with  
18 the available core data, using the tenth of a  
19 millidarcy as a cutoff permeability. So the  
20 permeability cutoff is actually .1 millidarcy.

21 And then for the assumption of, is there  
22 a vertical barrier or not, we take the vertical -- the  
23 horizontal permeability that came out of Seminole  
24 San Andres and then used that to generate flags that  
25 indicate the existence of potential barriers. But

1 those barriers aren't used in our modeling for oil in  
2 place. Those were flags to demonstrate the location  
3 of potential barriers at the request -- because I was  
4 asked to identify potential barriers as part of my  
5 evaluation. But as far as the cutoffs, as far as oil  
6 in place, those were not used.

7 Q. Additionally, just big picture so that we  
8 don't lose the forest, did you use 7 percent effective  
9 porosity or 7 percent total porosity?

10 A. As it came out of the model, it would have  
11 been effective.

12 Q. And so if there was oil in intervals that  
13 you assessed as being less than 7 percent effective  
14 porosity, there's also zero oil credited in your oil  
15 in-place volumes at those intervals; isn't that right?

16 A. That's correct.

17 Q. With respect to data here, you also have had  
18 zero oil samples out of the EMSU; isn't that correct?

19 A. Oil samples out of the EMSU. I don't hold  
20 an oil sample from the EMSU. No, I don't have one in  
21 my office.

22 Q. You also performed no oil miscibility  
23 studies within the EMSU, and you haven't seen any  
24 either, have you?

25 A. That wasn't part of my job. That wasn't

1 part of what I was hired to do.

2 Q. With respect to EOR and CO2 injection, that's  
3 going to lower the porosities and the permeabilities  
4 that otherwise might be perceived as cutoffs in a  
5 conventional primary recovery; isn't that right?

6 A. I don't agree with that.

7 Q. Let's get into -- we've talked about some of  
8 the geology and that you're not a geologist. I want  
9 to go to one of the slides that you used earlier.

10 So would you agree that there was a lot  
11 of geology discussed in your opening remarks with  
12 Mr. Rankin?

13 A. I discussed depositional environments.

14 Q. That's really more of the geology thing,  
15 isn't it?

16 A. It's part of petrophysics. It's a big part  
17 of petrophysics.

18 Q. I want to ask, in terms of the karsting that  
19 you described, can you describe to the commissioners  
20 how this karsting occurs?

21 A. There's a lot of different ways that it can  
22 occur. Shallow, the theory is that you have meteoric  
23 waters, which would be fresh waters, penetrating  
24 exposed carbonate surfaces and creating dissolution  
25 where the water penetrates. And that could create

1 karst.

2 But the way it was described by  
3 Dr. Lindsay was it created kind of sinkholes that  
4 ultimately filled in with other materials. That would  
5 be what I would call top-down karsting. We see that  
6 sort of thing routinely in the San Andres.

7 Another type of karsting occurs due to  
8 the movement of acidic waters through the rock where  
9 you get dissolution precipitation reactions where the  
10 rock is dissolved. It generally moves through the  
11 higher -- fluids move through the higher permeable  
12 rock and you start generating pathways, dissolution  
13 pathways between the bugs. And then, ultimately, the  
14 bugs get connected and enlarged. And then when they  
15 become large enough, you can get something called a  
16 collapse breccia, where the rock actually collapses it  
17 on itself. And that's a different type of karsting.

18 Q. All of that is happening at the surface  
19 level in shallow water environments, isn't it?

20 A. I don't think -- I don't really agree that  
21 the massive karsting that comes from the model that  
22 Bob Lindsay put together with the counterflow of H<sub>2</sub>S in  
23 meteor waters, I'm not sure -- I don't think that's a  
24 surface phenomenon, no.

25 Q. In terms of evaporation and evaporative

1 cycles, this isn't happening? To get this  
2 evaporation, that has to happen at the surface?

3 A. Well, evaporation doesn't have anything to  
4 do with the karsting. Evaporation has to do with the  
5 development of the evaporate layers.

6 Q. I want to go -- because I think we can short  
7 circuit a lot of this. At Slide 16, in response to  
8 Mr. Rankin's questions, you shared with the  
9 commissioners your opinion that the San Andres was a  
10 high energy environment; is that right?

11 A. The Upper San Andres is in a high energy  
12 environment. So above what I'd call the high gamma  
13 ray marker, it was a higher energy environment. And  
14 then below the gamma ray marker, I'm moving more  
15 towards, I guess, the outer ramp environment, where  
16 sea level changes can dramatically change the  
17 characteristics of the rock over short distances.

18 Q. In your earlier testimony, you described all  
19 the way through the San Andres that it is a high  
20 energy environment. Are you changing that testimony  
21 now?

22 A. I didn't -- No, that's not what I testified  
23 at all. I said the Grayburg San Andres interval above  
24 that marker is generally a high energy environment.  
25 Below that marker, where the gamma ray baseline

1 shifts, I'm moving to a high frequency environment  
2 where I'm seeing very rapid sea level shifts where the  
3 rock quality is changing from good to medium with  
4 these evaporite boundaries on it. Then, as I move  
5 deeper in the San Andres, I'm moving more and more  
6 into a deeper water, lower energy environment.

7 Q. You describe anhydrites throughout the Lower  
8 San Andres. Yes?

9 A. We see evidence of them. Now, they're not  
10 all layered, they're not all bedded anhydrites.

11 Q. Anhydrites are going to be formed at the  
12 surface, aren't they?

13 A. That's correct.

14 Q. And you heard Dr. Lindsay's testimony that  
15 this was not a deep water environment here at the EMSU  
16 for the San Andres. Do you remember that testimony?

17 A. I don't know what he said for the  
18 San Andres, because I don't think he looked at any  
19 San Andres cores here.

20 He said that there were no bedded  
21 anhydrites in the Grayburg or in the Upper San Andres  
22 in the cores that he reviewed. He said there was only  
23 anhydrite cement.

24 Q. My question is, you do not recall  
25 Dr. Lindsay testifying that the San Andres, at this

1 particular EMSU location, would have been a shallow  
2 water environment, not a deep water environment?

3 A. Well, if he said it, I don't agree with it.

4 Q. And with respect to the qualifications of  
5 the geologists, you would have to tell the  
6 commissioners that Dr. Lindsay is far more qualified  
7 than you as a geologist; isn't that right?

8 A. I don't know that he -- he was describing  
9 the San Andres underneath the -- underneath the gamma  
10 ray marker.

11 There tends to be a tendency to define  
12 the San Andres as what has been seen in the core and  
13 ignore that it could be different deeper in the  
14 section.

15 Q. Would you want core to be able to say it is  
16 different?

17 A. I can see that it's different from the gamma  
18 ray response.

19 Q. Well, let's talk about the gamma ray  
20 response. Now, the gamma ray there would be,  
21 according to you, measuring uranium, correct?

22 A. That's correct.

23 Q. How do you know, since you don't have  
24 spectral gamma, that it is not measuring potassium or  
25 thorium?

1           A. Because everywhere I've looked at spectral  
2 gamma rays, Maljamar, I believe in the AGU, at  
3 Seminole, everywhere I've seen a spectral gamma ray,  
4 the thorium and potassium are extremely low and the  
5 gamma ray is responding predominantly to uranium.

6           Q. In terms of any actual logs in the EMSU, you  
7 have no spectral gamma to be able to make a  
8 differentiation between uranium, thorium or potassium  
9 within the EMSU, do you?

10          A. No. But I haven't been outside it.

11          Q. Now, you've talked about the gamma response  
12 I think at where you would call the -- what you're now  
13 speaking to in terms of an impermeable barrier, the  
14 gamma kick?

15          A. I don't know if it's impermeable or not. I  
16 just see that that's a mappable high gamma ray marker  
17 that can be mapped across the entire EMSU.

18          Q. So as we talk about that gamma ray kick that  
19 you've described that's mappable across. You've  
20 shared before the break that you don't know where the  
21 Lovington Sand is, you don't know what it is. It's  
22 not your testimony that that is an impermeable  
23 barrier; is that right?

24          A. I don't know anything about the Lovington  
25 Sand.



1           Q. So, just in terms of illustrating the gamma  
2     ray kick, did you hear Mr. Bailey's testimony about  
3     the Lovington Sand is basically arkosic sands that  
4     have blown off of the ancestral Rocky Mountains and  
5     deposited at that location?

6           A. I heard that testimony, yes.

7           Q. That would be a shallow water environment,  
8     wouldn't it?

9           A. It would.

10          Q. Okay. So we know that the Lovington Sand  
11     would be shallow water environment. And you don't  
12     have any basis to disagree with Mr. Bailey's testimony  
13     about that coming from -- arkosic sands being blown  
14     off of the ancestral Rockies. Why would those have  
15     uranium in them?

16          A. I don't agree with that. There's been work  
17     that's been done at Slaughter on the Lovington Sand  
18     that shows that they're not arkosic at all; that the  
19     elevated uranium comes from organic matter.

20          Q. Okay. Wouldn't this be a question for a  
21     geologist?

22          A. I'm just reading what geologists say about  
23     the Lovington Sand.

24          Q. And you've heard Mr. Bailey's testimony in  
25     here. Would arkosic sand create a gamma ray response?

1           A. Arkosic sand would imply the presence of  
2   feldspathic inputs that would have radioactive  
3   potassium in them. But what I'm telling you is, I was  
4   told that early on, that that was the theory about  
5   what was going on, but I've also done some research  
6   and it's been determined, at least north of the EMSU,  
7   that that elevated gamma ray is a result of the  
8   presence of organics in what's called the Lovington  
9   Sand. I don't know if the Lovington Sand makes it to  
10  the EMSU or not. I don't know.

11           Q. Now, as we talk about the gamma ray marker  
12  in the EMSU, and if you just assume with me that the  
13  gamma ray is Lovington Sand, is that basically where  
14  you change from a shallow water rock facies and then  
15  begin using a deep water rock facies?

16           A. That's not true at all.

17           Q. Explain that.

18           A. I go from a predominantly shallow water  
19  environment above that, due to the low gamma ray, the  
20  typically low gamma ray, and then I go to a cyclic  
21  shallow to medium depth back and forth, back and forth  
22  with evaporite caps.

23           Q. Is the gamma ray different above the  
24  Lovington Sand versus below?

25           A. That value, if you draw a baseline through

1 the middle, yes, there's a shift below the Lovington  
2 Sand.

3 Q. Is it a significant shift?

4 A. Well, it's significant in that if the  
5 response is predominantly dominated by uranium, which  
6 I believe it is, then that shift would indicate,  
7 roughly, two to three times the uranium content.

8 And the uranium content of the ocean  
9 didn't magically increase below that marker. What  
10 happened below that marker was that the grain size,  
11 the average grain size of the material, got smaller.  
12 And basically, the way it works out, a three times  
13 increase in uranium would imply about one-third the  
14 average grain size.

15 And Lucia has shown that as the grain  
16 size mud content increases, the permeability goes  
17 down. And if it's a three times increase in uranium,  
18 you would lose about an order of magnitude of  
19 permeability. So there would be a change in the rock  
20 behavior below that marker in my opinion.

21 Q. And the question was just, was it a  
22 significant change in the gamma ray? And I think,  
23 after all that, the answer is it's not a significant  
24 change.

25 A. No, it is significant in that it would imply

1 a major change in average grain size and a loss of  
2 permeability.

3 Q. With respect to the change in rock facies,  
4 we've talked about the data that we don't have, would  
5 you agree with me that you could at least be off by  
6 one level of rock facies, instead of -- agree with me  
7 that instead of mud dominated packstone or -- let me  
8 strike that -- agree with me that instead of  
9 wackestone, this could be mud dominated packstone?

10 A. Well, one, we don't have wackestone in the  
11 model at all. And two, that there's a spectrum of  
12 rock types between those that we model so that we can  
13 model the entire range that was present in the core  
14 data set.

15 So, for example, we can model between a  
16 mud dominated packstone and a grainstone to determine  
17 a grain dominated packed stone. When the porosity  
18 starts increasing in the grainstones -- the average  
19 porosity of a typical grainstone is 10 to 14 percent.  
20 When we start getting higher porosities of that, it's  
21 indicative of the presence of bugs. So we move from a  
22 grainstone to a moldic grainstone.

23 Q. The question was, would you agree with me  
24 that there's at least sufficient uncertainty here that  
25 you could be off on your facies by a magnitude of one?

1           A. I don't know what that means.

2           Q. For example, moving over from wackestone to  
3 dominated packed stone, Could you be off by one  
4 facies? Is there enough uncertainty in the data to be  
5 off by one?

6           A. For one, there's no wackestone in the model.  
7 And two, there's a continuum between. So there  
8 wouldn't be a quantum jump from one to the next.

9           Q. Would you agree that you could be off by  
10 approximately that magnitude if you want to average  
11 them overall to the depths?

12           A. I don't know -- again, I don't know what  
13 that means, because there's not one facies. I mean,  
14 it's -- it's not a -- it's not a quantum shift from  
15 one to the next. It's a transition from one to the  
16 next.

17           Q. In terms of just moving from one to the  
18 next, could you be off by the next?

19           A. I suppose I could.

20           Q. What does that do to your oil saturations in  
21 your model if you were off by one magnitude?

22           A. Again, it's not -- the oil saturations  
23 aren't predicted based on discrete rock types.  
24 There's a spectrum of rock types between -- that sweep  
25 that entire range presented in the core data.

1           Q. I'm going to try to work through these in  
2 order here.

3                   At your Slide 2, you said you did review  
4 the facies descriptions from Dr. Lindsay?

5           A. As best we could. We didn't have a good  
6 picture of it. We tried, and we could make out the  
7 facies. The problem that we had there was I had no  
8 idea what the resolutions were of those. We built a  
9 model based on discrete core plug by core plug  
10 measurements tied back to the Lucia-Kerans model.

11                   And I don't know whether Dr. Lindsay was  
12 describing individual core plugs, or was he going up  
13 and down the core and describing what he saw at a  
14 different resolution. So I don't know -- there could  
15 certainly be a disconnect between the plug-based  
16 cross-plot to determine the facies of a specific plug  
17 versus a general description of looking at the core  
18 and describing a depositional environment.

19           Q. Do you agree with Dr. Lindsay that the  
20 San Andres is high on the carbonate ramp?

21           A. I would -- the Upper San Andres probably is.  
22 The problem is, you keep saying "San Andres" and it's  
23 not just the San Andres. There's an Upper San Andres,  
24 and then there's a San Andres deeper in the section  
25 that's below that gamma ray marker.

1           Q. I'll indulge the difference that you're  
2       trying to draw here.

3                     The Lower San Andres, you'd disagree  
4       with Dr. Lindsay that that would be high on the  
5       carbonate ramp? Or you don't know?

6           A. The very upper part of that, where we have  
7       the high frequency sections, would be just at wave  
8       base and just below wave base, depending on where I am  
9       in that high frequency sequence.

10                    As I get deeper in the San Andres, as I  
11       go below that high frequency interval, I'm getting  
12       increased mud content, which would indicate that I'm  
13       moving down the carbonate ramp more into the basin.

14           Q. The question is, are you disagreeing with  
15       Dr. Lindsay that the Lower San Andres is high on the  
16       carbonate ramp? Or is your answer, "I don't know"?

17           A. There's portions of it that are near wave  
18       base on the carbonate ramp; I guess you could say that  
19       would be high on the carbonate ramp. And there's  
20       portions of it that are in the deeper water portion of  
21       the carbonate ramp.

22           Q. And that's, according to you, in the Lower  
23       San Andres?

24           A. In the Lower San Andres.

25           Q. How many feet of the Lower San Andres,

1 according to you, are on the upper carbonate ramp?

2 A. In the Lower San Andres?

3 Q. Yes.

4 A. I haven't quantified it.

5 Q. In talking on the core earlier, before we  
6 broke, you said that you did depth shift the core. If  
7 you didn't have core gamma ray, on what basis did you  
8 shift the core?

9 A. Basically, we calculated the porosities  
10 using our porosity model. And then we looked at the  
11 core porosities and then moved the core sections up  
12 and down in order to get the core porosities to best  
13 match the right porosities.

14 Q. On your core oil saturations, did you come  
15 to the opinion here that a lot of the water was lost  
16 as a result of hydrocarbon expansion, dissolved gas?

17 A. Yes.

18 Q. So if that water was lost because of  
19 dissolved gas, that means we have oil in that core,  
20 don't we?

21 A. Yes.

22 Q. Do you agree that the adjustment would not  
23 be uniform from top to bottom and that you're going to  
24 have differences at different places in the core?

25 A. Yes.



1 Q. Did you hold it constant or did you make  
2 adjustments throughout the core on the saturation  
3 correction?

4 A. We pretty much -- what we did is we  
5 determined the average value of the bleed factor and  
6 applied it throughout the interval.

7 Q. I'm sorry, so was it held constant?

8 A. The bleed factor was. The B sub o I think  
9 it was as well.

10 Q. But you would agree for the commissioners  
11 that that would actually be -- you would need variable  
12 corrections throughout the core?

13 A. Well, the interesting thing was, when we  
14 went back and looked at the bleed that occurred at  
15 Maljamar, it was variable, but it wasn't uniform from  
16 top to bottom, as you would expect.

17 And what we found when we did the  
18 evaluation in the Maljamar core, in order to get the  
19 best match between what we would call corrected  
20 data -- because basically with a pressure core, you  
21 can get an equivalent of what an uncorrected core  
22 would be. And because of the way they do the  
23 analysis, the bleed is quantified separately, and you  
24 can get, I guess, a mimicked picture of what a  
25 conventional core saturation would have looked like.

1           In looking at that, you look up and down  
2 the core and you can see it's not exactly it -- I  
3 think there the average was about 19 percent. It  
4 wasn't necessarily 19 percent at every interval, but  
5 there wasn't a discrete trend noticed from top to  
6 bottom.

7           And so the best match we got when we  
8 went back and practiced with the Maljamar data set was  
9 used in the average. That gave us the least  
10 uncertainty between the corrected core saturations and  
11 the actual measured saturations. So we didn't see the  
12 variation that you're talking about when we were  
13 working with the Maljamar core. We certainly checked  
14 for it because I wanted to see is there a depth  
15 related.

16           Because in Maljamar, we went from the  
17 main production zone to the interval below the  
18 oil-water contact. And I was curious whether I needed  
19 to change the bleed factor based on those factors. We  
20 saw that we didn't need to get the best match.

21           Q. I'm not talking about a match. My question  
22 is, you would agree that the correction factor is  
23 going to be different as you move through the core,  
24 it's going to be different in different places, it's  
25 not a static? And in this particular case, you used a

1 static one. You did not attempt to vary it. True?

2 A. That's true.

3 Q. Thank you. Now, as we continue moving  
4 through, we're now at Slide 5 of your presentation.  
5 Now you're talking about Guadalupe Mountain outcrop  
6 here. Yes?

7 A. Mm-hmm.

8 Q. So obviously, this is weather exposed?

9 A. They dug down -- they actually described the  
10 process of peeling off the surface and getting that  
11 deep enough to try to get the interval where the  
12 weathering was not impacting the results. I'm very  
13 careful about that.

14 Q. So you think that this outcrop study was not  
15 affected in any shape, form or fashion by the  
16 weathering of the stone?

17 A. It was affected by the fact -- again, they  
18 made every effort to get past the weathering layer, if  
19 you want to call it. There's a proper geologic term  
20 for that; I can't remember the name for it.

21 But they dug down deep enough into the  
22 rock to convince themselves, at least, that they were  
23 below the interval with which weathering -- however,  
24 they did point out, because of all the water that had  
25 gone through, that they could not quantify accurately

1 the amount of anhydrite that may have been there  
2 originally.

3 The other problem that you get to with  
4 outcrops is because of the ice fracturing, you can't  
5 really do accurate fracture analysis on an outcrop.  
6 And they didn't attempt to do so.

7 Q. The permeability in the San Andres here at  
8 EMSU is higher than the permeability that was measured  
9 at the Guadalupe outcrop, isn't it?

10 A. Not necessarily. These are average values.  
11 And if you go back and read the paper, you see that  
12 there's a range of permeabilities that were associated  
13 with each rock type. And these written here are the  
14 averages based on multiple samples of each rock type.

15 Q. The averages in the San Andres are above the  
16 average permeability reported at Guadalupe Mountain;  
17 isn't that correct?

18 A. I don't know that that's correct. It really  
19 doesn't matter. In the calibration procedure, the way  
20 that the cross-plot is defined is divided into  
21 regions. And when the core -- permeable -- the  
22 cross-plot crosses the permeability, it lands in a  
23 space, and that space defines the rock class or rock  
24 facies, not the specific point.

25 For example, we went and assigned a 12

1 percent porosity and a 17 percent permeability to the  
2 grainstones in our model. We just used the cross-plot  
3 technique to identify the different facies present.

4 Q. I'm moving now to Slide 6. Here we have the  
5 resistivity index is on the Y axis, and water  
6 saturation is the X axis; is that right?

7 A. That's correct.

8 Q. What is the reference for the data used to  
9 make the critical water saturation lines?

10 A. That's in the paper. It's a Schlumberger  
11 model. And basically, what you do is -- the process  
12 was this, I described it earlier, we identified --  
13 based on the cross-plot that was prepared from the  
14 outcrop, we identified the rock class or rock facies.

15 We grouped the rock facies -- for a  
16 particular face, for example, let's just say  
17 grainstone, we grouped all the points that were  
18 identified on that cross-plot analysis as grainstones.  
19 And then we plotted them on this plot.

20 And then, if you take that equation on  
21 the bottom left-hand side of the figure and solve it  
22 for  $Sc$ , you can get an  $Sc$  value for each core point,  
23 and then we just average the  $Sc$  values. And then we  
24 plotted that line as a function of saturation to make  
25 sure that it actually did -- it was a reasonable

1 representative expression of the behavior of those  
2 points that were identified as grainstones.

3 Q. Is the answer that this was not your data,  
4 this came from a Schlumberger reference?

5 A. No. This is the data from the EMSU. The  
6 model that describes it was developed by Schlumberger  
7 to handle this type of analysis for an oil carbonate.

8 Q. The reference data.

9 A. No, no. That --

10 Q. The reference data used to make the water  
11 saturation lines, is that reference data Schlumberger?

12 A. No. It's -- that data on that -- the data  
13 on that cross-plot is EMSU data from the core. The  
14 model, the equation at the bottom left, is based on a  
15 model developed by Schlumberger to handle oil wet  
16 reservoir. And it's in my -- the references are in my  
17 testimony.

18 Q. If we move over onto the right side, is the  
19 W, is that wackestone?

20 A. It is.

21 Q. What is the water saturation there in your  
22 plot for wackestone?

23 A. In the plot, it would probably be north of  
24 90 percent. However, I'll remind you that wackestone  
25 wasn't included in our model.

1 Q. What is your poorest rock then, if it's not  
2 wackestone?

3 A. My dominated packstone.

4 Q. What is your water saturation from that  
5 dominated packstone?

6 A. It's variable. You can see it varies  
7 depending on the resistivity index.

8 Q. Up at the very top, at 100 percent, I guess,  
9 do you know what the critical water saturation there  
10 would be?

11 A. 100 -- that would be 100 RI. There's not a  
12 percent.

13 Q. Yeah, at 100 RI.

14 A. I have no idea what it would be. It doesn't  
15 matter what it is at a particular depth. It's the  
16 curve fit parameter that defines that curve. It's not  
17 a value at an RI. It's the curve fit parameter that  
18 describes the saturation found at each point on that  
19 curve. If I remember -- I don't remember the exact  
20 number for that. It seems like .78 or something like  
21 that, the exact number.

22 But that .78 doesn't plot anywhere on  
23 there. The .78 is the Sc parameter that describes the  
24 curve that goes through those data points. In the  
25 model, the Sc is not a discrete value. There's a

1 spectral model that exists all the way across there so  
2 that we can include all the different rock types in  
3 the analysis and we don't exclude anything.

4 Q. And so each of the data point plots, explain  
5 what each plot is.

6 A. Okay. Well, let's go to the grainstone.  
7 What we should have done that we didn't, and it's  
8 because it would have been useless for me because I  
9 can't see it, but basically the way the model was set  
10 up is we identified the rock class based on the  
11 Lucia-Kerans model. We gathered all the rock for a  
12 particular class or facies. We gathered all the  
13 samples that were identified with that facies and we  
14 plotted them on this cross-plot to see where they  
15 fell. And then we fit a line through that data cloud  
16 based on the Sc equation.

17 Basically, what we wound up doing is  
18 calculating an Sc for each one of those data points  
19 and then averaging it and then plotting that average  
20 Sc back to this equation to see was it a reasonable  
21 representation of the data points from which it was  
22 derived.

23 Q. I'm confident I didn't understand any of  
24 that. What I'm trying to understand, so if we have a  
25 dot that is on this, what is the dot?



1           A. It's a core point.

2           Q. It's a core point measuring --

3           A. It's the saturation from the core and then  
4 the resistivity index calculated from the porosity of  
5 the core and the formation water resistivity and the  
6 deep resistivity measurement recorded at the depth in  
7 which that core plug was recorded.

8           Q. And you can tell the commissioners that  
9 there's a great deal of uncertainty in the water  
10 saturation correction on this plot; isn't that right?

11          A. The water saturation correction? There's no  
12 water saturation correction.

13          Q. None of this involves any corrections to  
14 water saturations?

15          A. The corrected water saturations for my  
16 analysis go into this, yes.

17          Q. And there's a great deal of uncertainty in  
18 that correction to the water saturation from your  
19 analysis; isn't that true?

20          A. In my world, it was plus or minus 10  
21 percent.

22          Q. And that's off of the core, which is --

23          A. Yes, that's based on my core analysis -- my  
24 analysis of how to correct the core data.

25          Q. With respect to the inputs on here, which of

1 these are assumptions or something that you've  
2 corrected as opposed to actual data measured?

3 A. The porosity comes from the core. The  
4 resistivity comes from a measurement from the log.  
5 What the assumption, the piece where there would be  
6 some interpretation would be the water saturation.  
7 Because what I'm doing is I'm correcting the oil  
8 saturations to the best of my capabilities, and then  
9 saying the water saturation is 1 minus my corrected  
10 oil saturation.

11 Q. Using this plot, if I'm understanding it,  
12 at, like, the mud dominated packstone, if you make the  
13 decision that the facies here is mud dominated  
14 packstone, what is the maximum amount of oil  
15 saturation that you could get into that particular  
16 rock facies?

17 A. It depends on what packstone resistivity  
18 that exists, and I don't know what that is.

19 Q. Is it Less than 20 percent?

20 A. Oil saturation?

21 Q. Yes.

22 A. It could be. I don't know. Like I said, it  
23 depends on where you are on that plot.

24 Q. By merely selecting a facies of mud  
25 dominated packstone, you can tell the commissioners

1     that if you've selected that facies for a rock type,  
2     that can never have an amount of oil saturation that  
3     would exceed 20 percent; isn't that right?

4             A. I don't know if 20 percent is the right  
5     number, but that would be what the core data is  
6     telling us.

7             Q. And again, I'm trying to get this as simple  
8     as I can in my mind and maybe help some of the  
9     commissioners. By you selecting mud dominated  
10    packstone, here, based on your data throughout the  
11    entire San Andres, if it's mud dominated packstone,  
12    based on that facies, it can never go over 20 percent  
13    residual oil saturation, can it?

14            A. I guess that would be true.

15            Q. And we know that if it's less than -- if  
16    it's 20 percent or less residual oil, you exclude all  
17    of those oil volumes from your oil-in-place summation  
18    in this case that you're offering the commissioners,  
19    correct?

20            A. If it's less than 20, we did.

21            Q. And also, in terms of Mr. McBeath and his  
22    number, you know he relies on your oil in his numbers,  
23    correct, for his opinions?

24            A. Yep.

25            Q. And so here, simply by selecting a rock

1 facies of mud dominated packstone, we know from that  
2 point on, it can never have more than a 20 percent oil  
3 saturation, and we know that you credit none of those  
4 volumes for the purposes of Mr. McBeath's economic  
5 work. True?

6 A. That's true. And it's based on Trentham's  
7 work.

8 Q. And here, we come back to the -- as we talk  
9 about uncertainty, we do not have core through the  
10 San Andres, we do not have pressure or sponge core in  
11 the San Andres at EMSU. You're working off of a gamma  
12 ray. You don't have spectral gamma to be able to  
13 parse out thorium, uranium and potassium.

14 You would agree with me that there is at  
15 least one rock facies of variance possibility here  
16 based on your lack of data? For example, moving over  
17 from a mud dominated packstone to a grain-dominated  
18 packstone?

19 MR. RANKIN: Objection. Asked and answered.

20 HEARING OFFICER HARWOOD: It's a long-winded  
21 sentence. Maybe you can break it into discrete  
22 questions.

23 BY MR. WEHMEYER:

24 Q. We've talked about the porosity of data here  
25 in terms of core. We have zero spectral gamma in

1 here. We have zero sonic inside the EMSU. You're not  
2 a geologist, but we've heard from Dr. Lindsay, who is  
3 a geologist.

4 What I'm coming back to is, you would at  
5 least give me that with this porosity of data, it's  
6 possible that you would be off by one rock facies?  
7 For example, what you classify as mud dominated  
8 packstone could be a grain-dominated packstone. True?

9 A. I suppose it's possible.

10 Q. At that point, the oil volumes here look  
11 much closer to the volumes that have been estimated by  
12 NuTech and by Exxon and by Ops Geologic; isn't that  
13 right?

14 A. I disagree. Those models are invalid. I  
15 don't agree with any of the saturations coming out  
16 with any of those models.

17 Q. What were some of the n values that -- I'm  
18 going to jump here for a moment and try to find a  
19 slide that I think -- are you looking on Slide 29?

20 A. I am.

21 Q. The red squares, will you tell the  
22 commissioners what the red squares represent.

23 MR. RANKIN: Mr. Examiner, objection, I  
24 guess. Dr. Davidson is color blind. So maybe we can  
25 figure out how to sort that out.

1           A. Those are just differences between 679 and  
2   RR Bell.

3           HEARING OFFICER HARWOOD: Okay. It's  
4   overruled. But can you see what he's talking about,  
5   Doctor, the squares versus the --

6           THE WITNESS: Well, there's a legend in the  
7   upper right-hand corner.

8           MR. WEHMEYER: Yeah, I didn't make the  
9   objection. I asked what the red squares are. I  
10   don't see anything that's not a red square on here.

11           And additionally, he didn't have any  
12   problems testifying about the slide when Mr. Rankin  
13   had the mic.

14           HEARING OFFICER HARWOOD: Overruled.  
15           Do your best, Doctor.

16           A. Now, goddamn it. Look, there's blue circles  
17   or something down at the bottom, and then there's red  
18   squares. There's both colors on there. And there's a  
19   label up in the right-hand corner explaining what they  
20   are.

21           Q. And, again, I didn't make -- your lawyer  
22   made the objection. I thought you and I were tracking  
23   on red squares.

24           A. I can't see the colors, but I'm guessing the  
25   colors. But I can see squares versus circles.

1 Q. So if we take the very upper left one, tell  
2 the commissioners, what does that data plot represent?

3 A. That's a core point, and I guess that's a  
4 square, so that would be a core point for the EMSU 679  
5 where we took the porosity and the saturation and the  
6 resistivity values and backed out what an n value  
7 would be to make this water saturation that was  
8 measured -- the corrected water saturation that was  
9 measured in that core match the core data.

10 So in other words, we're going through  
11 Archie's law backwards, knowing the saturation,  
12 knowing the n value, knowing the  $R_w$ , knowing the  $R_t$ ,  
13 and we're back in solving that equation for n to see  
14 what the n value would be. And this is based on what  
15 Ops did.

16 Q. You solved for this n value, didn't you?

17 A. From the core data using the procedure they  
18 gave us.

19 Q. And weren't some of your n values here  
20 actually over 100? They were like 113, were some of  
21 your n values?

22 A. Yeah. And that's -- it could have been.

23 Q. And Ops Geologic, they used the variable n  
24 as well, right?

25 A. This is the calibration procedure that they

1 told me that they used.

2 Q. My question is, it's just a yes or no, did  
3 Ops Geologic use a variable n? Yes or no?

4 A. Yes, they did.

5 Q. And their variable n's looked something from  
6 like 2 and a half to maybe 9, 10 at some places,  
7 right?

8 A. Yeah. And it's that line that's fit  
9 through the bottom of the curve.

10 Q. My question is, your n values, some of those  
11 actually went as high as 113?

12 A. That's right.

13 Q. Which doesn't seem reasonable at all, does  
14 it?

15 A. It doesn't, but that's the point. This is  
16 using the calibration procedure that Ops said they  
17 used. And we went through the exact same procedure  
18 calculating N for each core point to try to figure out  
19 what they did.

20 We took their model, which you're right,  
21 does have a variable m and n, and that came from the  
22 746. We backed out what the N had to be for each of  
23 their saturations as they calculated, and we plotted  
24 it. And so it's a line on the bottom.

25 So what they did was, they did exactly



1 the same thing I did, they looked and they fit a line  
2 through the bottom part of the data to build their  
3 saturation model, their variable n model. Their  
4 variable n model is that bottom line.

5 My point is, that bottom line represents  
6 the highest possible oil saturations for a given  
7 porosity, and it ignores about 80 percent of the  
8 actual core measurements.

9 Q. So you built your own model and you came up  
10 with your own variable n values?

11 A. We didn't use N.

12 Q. Well, you have to have an N in your  
13 equation.

14 A. No, we don't. The equation is the one  
15 that's on the bottom left-hand corner of that plot we  
16 were arguing about a while ago.

17 Q. This is going back to our Slide 6, I think.  
18 What is the maximum oil saturation possible if  $S_c$  is  
19 .78? And I can go back to 6 if you need to see that.

20 A. I have no idea. It depends on what the  
21 maximum RI would be.

22 Q. What is the equivalent N for an  $S_c$  of .78?

23 A. I have no idea. I'd have to calculate it.  
24 We didn't use Archie.

25 Q. You understand that in their variable n, Ops

1 Geologic made adjustments to the core analysis, right?

2 A. I know that they made -- I know that they  
3 used a model to calculate the correction factor to  
4 correct the raw measurements to what they considered  
5 as the corrected.

6 Q. As there's measured oil saturation in the  
7 core, would you expect the lower oil saturations to be  
8 closer to accurate or the higher oil saturations to be  
9 closer to accurate?

10 A. I don't have any idea which ones are more  
11 accurate. Bleeding occurs from all of them. It's  
12 proportional to the amount of gas that's in the oil  
13 and the viscosity of the oil. So the relative bleed  
14 is probably relatively simple.

15 For example, if a core has 1 percent  
16 oil, it's not going to bleed as much as a core that  
17 has 50 percent oil simply because it's an expansion  
18 based on the amount of oil that's originally left in  
19 the core. So there's not more bleed at one level than  
20 the other unless there's more oil at another.

21 Q. As we come back to -- with respect to the  
22 porosities and permeabilities, you've seen that --  
23 numerous ROZ discussion that oftentimes the highest  
24 oil saturations will, in fact, be found in the lower  
25 porosity, lower permeability rock?

1           A. Well, that could be the case if it was  
2 originally filled with oil and then displaced. For  
3 example, this is -- Seminole, the theory is that there  
4 was an oil column there, and then there was a trap  
5 breach, the oil-water contact moved up and displaced  
6 oil out.

7                   And if you go back to my -- if that were  
8 the case, you could go back and look and see that  
9 saturations would be expected, that, in that  
10 condition, be somewhere in the 20 to 40 percent range.  
11 And the 40 percent can be associated with some of the  
12 good rock, and it can be associated with some of the  
13 poor quality rock.

14           Q. I want to put up a paper to see if you're  
15 familiar with this paper. This is Journal of  
16 Petroleum Science and Engineering by Bo Ren and Ian  
17 Duncan. Have you seen this paper before?

18           A. I have not.

19           Q. I'm going to get down to Section 4. Is that  
20 large enough for you to read it?

21           A. If you just tell me what you want me to  
22 answer.

23           Q. This study has not attempted to specifically  
24 model the Seminole Field. Rather, we have modeled the  
25 formation of a generic ROZ by starting with an

1 oil-saturated reservoir. Its thickness is equivalent  
2 to the sum of the current SSAU ROZ in producing MPZ.  
3 Our simulations reproduce many of the features  
4 reported from the San Andres ROZ. The simulation  
5 results are consistent with an effectively steady  
6 state being reached, at least with respect to oil  
7 saturation, on a time scale of 50,000 years. It is  
8 significant that even after 1 million years of  
9 regional water flush, the oil saturation in several  
10 patches remains similar to the initialized values, .7  
11 to .8. These patches are local areas of lower  
12 porosity and permeability. This observation is  
13 consistent with the observed presence of oil stains in  
14 the less permeable patches of the San Andres core  
15 samples.

16           You would give me that there is  
17 literature that would document the Ops Geologic  
18 conclusions that oftentimes some of the best residual  
19 oil saturations are actually found in the lower  
20 porosity, low permeability rock?

21           A. I wouldn't agree with that, because it's  
22 based on model results. And I would add that our  
23 model did a reasonable job of reproducing what they  
24 actually saw in the core measurements from SSAU.

25           Q. I intended to ask this earlier, I forgot.

1 On the core oil saturations in your analysis there,  
2 what was the pressure in the San Andres?

3 A. Well, we modeled the range and it was based  
4 on the available MDT data. Prior to the start of the  
5 waterflood, I believe the lowest pressure that we had  
6 was about 365 psi. And then we've argued about this  
7 point, whether it's San Andres or Grayburg or  
8 whatever, but I think the highest pressure in that  
9 interval was about 1264.

10 If we go back and look at what would the  
11 pressure be in the San Andres had there been no  
12 withdrawal at all, it seems to me like it's about 1700  
13 psi, assuming it wasn't under pressure. So we  
14 modeled -- when I did the modeling, we modeled that  
15 entire range. I said, well, what if the 679 core had  
16 been depleted all the way down to 350, what would my  
17 viscosity B sub o bleed be?

18 Then I modeled all the way through that  
19 entire range, all the way up to -- assuming there had  
20 been no pressure depletion at all at the EMSU 679,  
21 which is not practical because it's up in -- it's just  
22 below the producing oil-water contact you'd expect at  
23 least there would be some.

24 Now, if you go back and you look it up,  
25 I believe it's the 211 data where all these MDT

1 measurements were made, It's roughly the same depth  
2 equivalent to the 679 core. So it seems to me that  
3 the pressure range of 1265 to 364 would be a valid  
4 range. So that's where we did most of our analysis.

5 And so when we calculated the bleed and  
6 the expansion and all of the factors that go into that  
7 correction factor, we modeled it over a range from the  
8 365 to the 1264 psi.

9 And then, just for an upside, because  
10 you guys weren't including uncertainty, I went ahead  
11 and modeled the point, assuming that there had been no  
12 pressure drop at all at the 679, which is 1700 pounds.

13 So then we derived a range of potential  
14 correction factors for each one of those conditions  
15 based on the B sub o, the gas content and the  
16 viscosity that was associated with each one of those  
17 pressures. And then we got a range of a final  
18 correction factor from 1.1 to 1.25 for the condition  
19 where we said 1265 is the maximum pressure it could  
20 be. But if we assume that there had been no depletion  
21 at all, it gave us the 1.3 correction factor.

22 Once you reduce the reservoir pressure  
23 and gas bleeds out of the oil, you don't get to go  
24 back and use the original B sub o to do your  
25 calculations, which I think a lot of people do. And

1       that's an error.

2               Q. I'm going to try to use these slides to  
3       illustrate. As we talk about just your model, what  
4       I've endeavored to do here is illustrate your cutoffs.

5               In terms of your values, do I have this  
6       correct, that, for example, if we're looking at  
7       effective porosity on the bottom X, that if you get  
8       below .1 -- I'm sorry, .7, at that point, is this  
9       correctly illustrating that you would give zero oil  
10      volumes to anything below that 7 percent porosity?

11              A. We conclude that below 7 percent is  
12      non-reservoir rock, and we don't do any additional  
13      evaluation beyond that.

14              Q. Okay. And now I'm showing an Ops Geologic  
15      prepared slide to just illustrate in terms of plotting  
16      against the core measurements from the 679, the RR  
17      Bell, the 458 and the North Monument. Do you see at  
18      .7 effective porosity, we place the dash line that  
19      goes up that's on the X axis between the 6 and the 8?

20              A. I can't see it, but go ahead.

21              Q. Well, I want to make sure you can see it,  
22      because I just want to bring it back to just show the  
23      commissioners graphically kind of what we're talking  
24      about here by way of volumes. Can you see the cursor  
25      at least?

1           A. Yeah, I can see it.

2           Q. Okay. The cursor is at 7 percent porosity.  
3 And that would be where you cut off. Yes?

4           A. Uh-huh.

5           Q. If we move over to the left at 4 percent  
6 porosity, this would be the Ops Geologic cutoff,  
7 right?

8           A. Right.

9           Q. And then on the Y axis, do you see the  
10 permeability of 0.1?

11          A. Right.

12          Q. And you're saying you did not cut that off  
13 at point one, or you did?

14          A. Well, basically what we did, we applied I  
15 think -- the cross-plot is in my testimony. You can  
16 see what we did. It's one of the attachments in my  
17 original testimony.

18                 We cross-plotted the core data from 679.  
19 And then we get a line to it, and then we selected 1  
20 millidarcy -- 1 millidarcy, read over to the right,  
21 saw where the regression line was, read down, picked a  
22 7 percent cutoff.

23                 At that level, the way that we've drawn  
24 it, we would be excluding as many points that were  
25 permeability above .1 as we would be including that



1 were below. And that's -- you know, typically in the  
2 San Andres, a .1 millidarcy is chosen, and most  
3 operators use cutoffs in the 6 to 8 PU range. It's  
4 pretty standard in the San Andres. That's what people  
5 do to calculate pay.

6 Q. Earlier, we were talking about the core  
7 corrections and end values. And what I'm trying to do  
8 here is graphically illustrate. You would agree that  
9 the core has to be corrected, the core volumes of oil  
10 saturation have to be corrected, right?

11 A. Yes.

12 Q. And the correction here that Ops Geologic  
13 performed needed larger corrections down at the lower  
14 volumes of oil measured in core, smaller corrections  
15 up at the higher saturations of oil in core?

16 A. I don't believe that that's what was in  
17 their write-up. They basically said they used a rule  
18 of thumb based on the paper that was published, and  
19 I've got the same paper, and used that correction in  
20 order to do -- my view, it was one number. And if  
21 it's not one number, that's not what Mr. Birkhead  
22 stated in his write-up.

23 Basically, he said their low side was  
24 based on uncorrected measurements and their high side  
25 was corrected -- was based on the correction based on

1 the rule of thumb that came out of the paper. I may  
2 have that wrong, but that's what I understood.

3 Q. And here, this is just a modification slide  
4 you had earlier. This is basically Ops Geologic  
5 demonstrating that if you're not filtering out the  
6 poor or the questionable data, you're going to have to  
7 have unreasonable n values that would get up into the  
8 100 plus?

9 A. And maybe it was -- we didn't -- we didn't  
10 use those for anything in our analysis. What I was  
11 trying to understand is how they calibrated their  
12 model. And I see how the model -- and if that thing  
13 that has three lines on it is their model, then fine,  
14 they still are excluding measurements from probably  
15 more than half the core.

16 There's nothing magical about our  
17 points. We're just plotting the core data in terms of  
18 n that comes from backing n out of what it takes to  
19 match the core measurements.

20 Q. And again, what do your n values look like  
21 in your equation? I understand that you didn't come  
22 up with your own n, but in your equation, what did the  
23 n end up at?

24 A. I don't know. I'd have to calculate them  
25 because we didn't use n in our model. We used Sc in

1     our model. So for each point, I can calculate an n,  
2     but that would only correspond to that RI and that  
3     porosity and that saturation. And if I moved a foot  
4     down, even though I was in the same rock type, I would  
5     have a different n, but I'd be on the same Sc value.

6             That's the beauty of that model, is I  
7     can characterize a variable n for all practical  
8     purposes with one curve set. And it is possible, I  
9     guess you could go through and calculate an n for each  
10    one. We didn't bother to do it because we didn't use  
11    an Archie model.

12            Q. Do you know approximately what n's would  
13    have been calculated -- I hear you on your Sc. Do you  
14    know about what the n's would have been?

15            A. They would probably have been, I don't know,  
16    6 to 10, 6 to 20. I don't know. I didn't do the  
17    calculation. I'm just speculating based on gut feel.

18            Q. Let me go back to your presentation.

19                    With respect to the residual oil  
20    saturations that you're reflecting here in Slide 10,  
21    would you just explain for grainstone, moldic  
22    grainstone, grain-dominated packstone, what are you  
23    demonstrating with this slide?

24            A. I'm just showing that based on the  
25    measurements that the Bureau of Economic Geology made,

1 I think some of these were outcropped or some of them  
2 were Seminole. San Andres cores, there's a variety of  
3 sources for those. But these are average residual oil  
4 saturations to water that were reported for the rock  
5 types.

6 And I'd point out that, you know, you  
7 say, well, you're assigning something, and therefore,  
8 you're limiting it, I would point out that when we  
9 take our model and apply it at SSAU in the ROZ, we can  
10 reproduce this range of residual oil saturation.

11 So the model will work and provide the  
12 right outputs. And obviously, we're picking facies in  
13 the model and we've been able to verify it at  
14 Seminole, we've been able to verify it at Tall Cotton,  
15 we've been able to verify it at Maljamar.

16 Q. I guess what I'm trying to understand is  
17 that it's been the testimony of Goodnight in this case  
18 that the San Andres is an ideal place to inject  
19 saltwater.

20 In looking at the facies that you've  
21 actually selected for the San Andres and the critical  
22 water saturations that would be in there, maybe your  
23 Slide 6 helps illustrate it, but how on earth could  
24 you move water through that if your facies are correct  
25 and the water saturations are as high as you've

1 represented in your testimony to the commissioners?

2 A. San Andres is full of karst.

3 Q. So your explanation for these rock types and  
4 the critical water saturations that you've come up --  
5 and these water saturations you're up to are over  
6 90 percent in the majority of the San Andres, isn't  
7 it?

8 A. Well, there's places where there are that I  
9 would call migration paths where that's not true. I  
10 don't know that San Andres ever had any.

11 The point is, the matrix of the rock in  
12 the San Andres would be relatively poor compared to  
13 the better quality rock up in the Grayburg. What  
14 makes the injectivity so high is the fact that we've  
15 had sulfuric acid going back and forth through there  
16 and the multiple meteoric paths -- pore volumes of  
17 meteoric water going through.

18 Q. So ignore the water saturations and the  
19 critical water saturation that you've come up with,  
20 and ignore the facies that you've assigned to these  
21 rock types. Your explanation for why Goodnight is  
22 able to inject into this is all on karsting as opposed  
23 to the rock type?

24 A. I think so. I think the karsting is the  
25 major component of why we're able to -- however, the

1 rock -- the permeability -- like I said, the increased  
2 gamma ray content indicates an increased mud content,  
3 which indicates, indirectly, poor permeability.

4 So the rock type -- and there are high  
5 permeable grainstones in there. It's not that I've  
6 excluded grainstones and mud dominated grainstones  
7 from the Lower San Andres. They're there. All rock  
8 types are there.

9 As you move deeper in the system, you  
10 get more and more of the poor quality rock types and  
11 they're not going to -- they calculate as having very  
12 high water saturations.

13 So my conclusion is, there's not a lot  
14 of ROZ down there, or any at all. It's probably  
15 migration paths. And the injectivity that they're  
16 getting has to do with the karsting.

17 Q. So again, I'm just trying to figure out,  
18 with my simple mind, how two of these things can be at  
19 the same time. How is this rock type which you've  
20 selected as being either non-reservoir -- is  
21 non-reservoir even worse than wackestone? Right?

22 A. Well, we don't have wackestone in the model.  
23 But the non-reservoir would be the lower than  
24 7 percent of the mudstones, the lime mudstones.

25 Q. Okay. The non-reservoir, is it between

1 wackestone and mud dominated packstone, or is it on  
2 the other side of wackestone?

3 A. Non-reservoir is anything under 7 percent,  
4 basically.

5 Q. Okay. Under 7 percent effective porosity?

6 A. Yes.

7 Q. And you've chosen that facies for the vast,  
8 vast majority of the Lower San Andres, Upper  
9 San Andres, all of it, haven't you?

10 A. I don't know that that's true.

11 Q. If it's your facies, how do you not know  
12 what rock is in your own model?

13 A. -Well, we can see that there's grainstones  
14 and mud dominated grainstones, or we wouldn't have --  
15 that's where the oil saturations are. When we get  
16 into the high gamma stuff, that's poor quality rock,  
17 and that's going to be those poor facies.

18 Q. And isn't that, according to you, the vast  
19 majority of the Lower San Andres?

20 A. I don't know if it's the vast majority.  
21 It's certainly a good swath of the interval where you  
22 have high gamma ray that appear to me to be almost a  
23 carbonate shale.

24 Q. My question, isn't the vast majority of the  
25 Lower San Andres, according to you, the non-reservoir

1 rock?

2 A. I don't believe that's true. I don't  
3 believe I'm calculating low saturations in the vast  
4 majority of it. I don't know what the highest or what  
5 the major distribution of rock types in all of  
6 San Andres. Again, we didn't put out rock type  
7 curves, and we didn't do analysis on that.

8 Q. So the very first batch of questions I asked  
9 you was that your model is very facies-dependent. It  
10 comes down to the rock facies that you assigned and  
11 that you picked for the Lower San Andres? We talked  
12 about that?

13 A. That's true, but --

14 Q. And I'm asking --

15 A. I can get a grainstone and a very low RI and  
16 calculate a high saturation in the grainstone, and  
17 that's the best facies.

18 Q. Your model is very facies-dependent and  
19 facies-specific based on what you picked.

20 A. It's also resistivity-dependent.

21 Q. Now, in the Lower San Andres, the vast  
22 majority of what you picked in the facies is  
23 non-reservoir, or you don't even know?

24 A. I don't know what the vast majority is.

25 Q. How can it be that the facies is so poor



1 that it lacks such permeability and lacks such  
2 porosity that you're calling it non-reservoir and  
3 you've got it at nearly 100 percent critical water in  
4 some places, but it is so ideal for injecting  
5 saltwater that you --

6 A. Because it's karsted --

7 Q. How can those two things exist at the same  
8 time?

9 A. If you'll look at where the karsts are,  
10 they're in the high porosity intervals with low  
11 resistivities. And so what's happening is, the water  
12 is moving through there and what we're doing is we're  
13 creating bugs and we're connecting bugs. The bugs can  
14 be present in any of those lithologies.

15 And with the long-term passage of the  
16 meteoric water and the H<sub>2</sub>S, sulfuric acid, I'm creating  
17 permeability due to dissolution. And that occurred  
18 over long periods of time.

19 If you look where the EMSU is, it sets  
20 right on top of what Trentham and Melzer have  
21 described as the Artesia Fairway and the Capitan  
22 Fairway. Those two fairways coming together have  
23 pumped a bunch of water through there.

24 And if Lindsay is right and we had  
25 counterflow of H<sub>2</sub>S at the same time we had meteoric

1 water, we've put sulfuric acid through that thing  
2 multiple times, maybe up to 20 times. And that's  
3 going to create the karsting system.

4 And that's why it's different. This  
5 thing is karsted to heck below that marker, but it's a  
6 different karst style than exists above the gamma ray  
7 marker.

8 Q. You just mentioned bugs. As I understand  
9 it, bugs are critters, fossils, that type of thing?

10 A. No. It's where you've dissolved out a  
11 critter or fossil and created a void in the rock.

12 Q. That happens at a surface, yes, a shallow  
13 water environment?

14 A. No, it doesn't. It can happen anywhere. It  
15 can happen anywhere that acidic waters move through.  
16 And that's the whole point, that acidic waters -- in  
17 the Trentham, Melzer and I'll say Alton Brown model,  
18 multiple flow volumes had been through there, and it  
19 was after the whole San Andres interval was uplifted  
20 and water came through. So it wasn't depositional.

21 The creation of the bugs in the water  
22 disposal interval occurred way after deposition, after  
23 the uplift of the Guadalupe Mountains and the exposure  
24 of the San Andres to meteoric fluid input. So it's a  
25 totally different system. It's not a shallow water

1 environment.

2 Q. I'm going to move over now and talk about  
3 your idea of impermeable barriers. First, what's the  
4 difference between a baffle and a barrier?

5 A. I don't -- well, Ops described their low  
6 permeability/low porosity zones as baffles, which  
7 implied that they don't aerially go very far.

8 A barrier would be one that would exist  
9 where you could map over long distances.

10 Q. Okay. Well, I'm thinking of a baffle, like,  
11 in a truck, like a milk truck or a fuel truck. You're  
12 familiar with, like, a baffled truck that's moving  
13 liquids?

14 A. I have no idea what you're -- no.

15 Q. Baffles do not stop flow. What a baffle  
16 would do would inhibit, slow, impede flow?

17 A. Yes.

18 Q. Okay. And so you appreciate that there is a  
19 difference between a baffle and a barrier. Agreed?

20 A. Yes.

21 Q. Now, in terms of the -- I was reading your  
22 surrebuttal, and nowhere in there do you actually say  
23 that it is your opinion that there is an effective  
24 barrier across the EMSU. It is not the opinion of  
25 Netherland, Sewell to this New Mexico Oil Conservation

1 Commission that there is an impermeable barrier all  
2 the way across the EMSU between the Grayburg and the  
3 San Andres, is there?

4 A. My testimony is, as a result of the  
5 anhydrite layers that exist in that yellow highlighted  
6 interval, that the injection that is occurring below  
7 that yellow highlighted interval is isolated from the  
8 production that is occurring above that yellow  
9 highlighted interval.

10 Q. Let's take the highlighted interval. I  
11 would just like Netherland, Sewell to be on the  
12 record. Are you here under oath testifying for  
13 Netherland, Sewell that the yellow highlighted area,  
14 since we can't speak of Grayburg and San Andres and  
15 you don't know where the Lovington Sand is, is it the  
16 testimony of Netherland, Sewell here, are you swearing  
17 that there is an impermeable barrier across the EMSU  
18 at the yellow highlighted area? Yes or no?

19 A. I'm swearing that there's likely no  
20 communication through that yellow area.

21 Q. So if Mr. Rankin wants you to swear to this  
22 OCC that the yellow area here is an impermeable  
23 barrier, no fluids shall pass across the EMSU, for  
24 Netherland, Sewell, are you swearing to the OCC to  
25 that or not?

1           A. We haven't seen evidence that there's been  
2 water movement from the injection zone into the EMSU.

3           Q. Is your answer that you're unable to swear  
4 one way or another?

5           A. I guess that's true. But we haven't seen  
6 evidence of movement -- even though 120,000 a day is  
7 going into that interval below, we haven't seen  
8 evidence that has penetrated about that yellow  
9 interval.

10          Q. And so again, so that I've got one question  
11 on this, one question and answer, your testimony for  
12 Netherland, Sewell, you are not --

13          A. The testimony is not from Netherland,  
14 Sewell. The testimony is from me.

15          CHAIR ROZATOS: Doctor, wait for the  
16 question. I know you can anticipate it, but remember  
17 the poor, long suffering court reporter.

18 BY MR. WEHMEYER:

19          Q. All of the revenue that Mr. Rankin or his  
20 client are paying is not going to Dr. Davidson, it's  
21 going to Netherland, Sewell here. Yes?

22          A. That's correct.

23          Q. Netherland, Sewell is the firm engaged as  
24 part of this case; isn't that right?

25          A. I'm engaged as the expert in this case.

1 Q. As an employee of Netherland, Sewell?

2 A. Correct.

3 Q. If the Commission wants to know what the  
4 testimony of you, for Netherland, Sewell, is as to  
5 impermeable barrier at the yellow area, from your  
6 demonstrative Slide 17, you cannot testify one way or  
7 the other as to whether that is, in fact, an  
8 impermeable barrier all the way across the EMSU that  
9 does not allow fluid to pass. True?

10 A. I cannot. But I can say that the  
11 evidence --

12 MR. WEHMEYER: Object to the nonresponsive  
13 after that.

14 A. I can say that the evidence indicates that  
15 it is.

16 MR. WEHMEYER: Object to the nonresponsive  
17 after it is not.

18 CHAIR ROZATOS: Doctor, it sounded to me  
19 like a yes or no question. You'll have a chance to  
20 explain your answer on redirect if Mr. Rankin goes  
21 there.

22 THE WITNESS: He's got my answer.

23 BY MR. WEHMEYER:

24 A. It is not your testimony. True?

25 CHAIR ROZATOS: Mr. Hearing Officer, it is

1 getting a little heated right at the moment. We  
2 should probably take a short break, about 15 minutes.

3 And I want to remind everybody:  
4 Decorum. I have said this multiple times, we're not  
5 going to accept anything else but decorum. So  
6 everybody needs to be on their best behavior.

7 Mr. Hearing Officer, let's take a  
8 15-minute break.

9 HEARING OFFICER HARWOOD: Okay. That's  
10 great. Let's call it 2:40 and be back at 2:55.

11 CHAIR ROZATOS: Thank you.

12 (Recess held from 2:40 to 2:55 p.m.)

13 HEARING OFFICER HARWOOD: I'll just remind  
14 counsel and Dr. Davidson, try to remember to wait for  
15 the end of the question and answer before speaking  
16 again. Think of it like a radio transmission, where  
17 people say "over" at the end of the presentation  
18 without the need to say "over." Thanks.

19 Go ahead, Mr. Wehmeyer.

20 MR. WEHMEYER: Thank you. I think I have  
21 less than five or six minutes of questions here,  
22 based on the last answer that I got.

23 BY MR. WEHMEYER:

24 Q. On the geomechanical studies, are you aware  
25 of any geomechanical studies that Goodnight would have

1 performed before commencing saltwater injection into  
2 Empire's oil unit?

3 A. I'm not.

4 Q. With respect to the frac gradient, any frac  
5 gradient studies, that is, at what pressure will  
6 existing fractures expand, any frac gradient studies?

7 A. I'm not aware of any.

8 Q. Do you agree that there would be a ROZ in  
9 the Upper San Andres?

10 A. Could be.

11 Q. Are you aware that Goodnight's Ryno well is  
12 injecting into the Upper San Andres, has perforations  
13 and injects into the Upper San Andres?

14 A. I'm not aware of that.

15 Q. And then these are two cleanups.

16 How did you calculate the resistivity of  
17 the water?

18 A. We used picket plot analysis.

19 Q. And at Slide 6 that I'm publishing right  
20 now, we've talked -- you made corrections to the data  
21 that's plotted on here?

22 A. To the --

23 Q. What -- the data plots.

24 A. Those are water saturations based on  
25 corrected oil saturations.



1 Q. That you prepared?

2 A. Yes.

3 Q. And so as we try to get back to your n, do  
4 you see that there are two curves drawn through the  
5 graph, and one is an n of 2, one is an n of 3.4?

6 A. Yeah. But those are just for display  
7 purposes. We did not use those.

8 Q. But as we talk about where n would be drawn  
9 through your plot, that would obviously be -- farther  
10 to the right would be a significantly higher n,  
11 wouldn't it?

12 A. If we had used n, it would be. We didn't  
13 use n.

14 Q. I understand you're saying you didn't use n.  
15 But we can see where n would be based on your work.

16 A. That's going to be higher than the 3.4.

17 Q. Can you just eyeball this? What about would  
18 n be based on your work?

19 A. Where?

20 Q. How about for a grain-dominated packstone.

21 A. I have no idea. It looks like -- if I just  
22 had to pull a number out, speculating, that might be a  
23 6.

24 Q. How about for a mud dominated packstone?

25 A. Maybe an 8. I don't know. Again, I could

1 calculate for each one, but we didn't use it, so I  
2 didn't bother to go through that analysis.

3 Q. And what would n be for a wackestone off of  
4 here, just eyeballing it?

5 A. I don't know. Maybe 10.

6 MR. WEHMEYER: I'll pass the witness.

7 HEARING OFFICER HARWOOD: Okay.

8 Mr. Moander, cross-examination for the OCD?

9 MR. MOANDER: I do indeed, Mr. Hearing  
10 Officer. Thank you.

11 CROSS-EXAMINATION

12 BY MR. MOANDER:

13 Q. Good afternoon, Dr. Davidson.

14 A. Good afternoon.

15 Q. This shouldn't take us very long, unless you  
16 shock me here. So you were deposed in this case; is  
17 that correct?

18 A. I was.

19 Q. And you also submitted rebuttal testimony in  
20 this matter on behalf of Goodnight, correct?

21 A. That's correct.

22 Q. And in your deposition, you had testified  
23 that you didn't have any opinions on communication  
24 between the San Andres to the Hobbs Channel to the  
25 Capitan Reef. Is it still the case you don't have

1 opinions on that issue?

2 A. Well, I guess if I -- based on what I've  
3 learned, my opinion now is that water would most  
4 likely move to the east rather than to the west. But  
5 that's based on what I've heard and getting a little  
6 bit better understanding of the Trentham and Melzer  
7 model and the implications of potential water  
8 withdrawal -- oil and water withdrawals from the  
9 central part of the Central Basin Platform.

10 Again, this is simply an opinion, but my  
11 opinion would be the water would more likely move to  
12 the east than to the west.

13 Q. And you'd agree with me, then, that this is  
14 a new opinion not previously disclosed in any filings  
15 or during the deposition?

16 A. That's correct.

17 Q. All right. And then as to the particulars  
18 of your opinions, what you're testifying to us, if I  
19 understand it correctly -- well, actually, what was  
20 the basis for this new opinion factually?

21 A. Again, as I've learned a little bit more  
22 about the Trentham-Melzer theory and revisited some of  
23 the work that Arco did back in the early '90s, there  
24 was an establishment of tilted oil-water contacts in  
25 the middle of the Central Basin Platform, which the

1 tilted oil-water contacts would imply a hydrodynamic  
2 gradient across the Central Basin Platform.

3 And since that time, I've gone and  
4 looked and looked at the withdrawals that occurred.  
5 And again, before waterflood and CO2 started in earnest  
6 on the top of the Central Basin Platform, roughly 7  
7 billion barrels of oil had been produced, and who  
8 knows how much water had been produced from the  
9 central part of the Central Basin Platform.

10 And, you know, given that the  
11 Trentham-Melzer theory would connect the water in  
12 Southeast New Mexico to the Central Basin Platform, it  
13 makes sense that, you know, those sort of oil-water  
14 contacts become a little bit more credible to believe  
15 that maybe they do exist. And that would imply the  
16 movement of pretty large volumes of water from  
17 New Mexico into the Central Basin Platform in Texas.

18 Again, this is all opinion. I haven't  
19 done -- I'll tell you right now, I haven't done the  
20 hydrodynamic studies. I wouldn't even begin to try to  
21 do something like that.

22 However, I understand that Bob Trentham  
23 did do quite a bit of hydrodynamic work and concluded  
24 that quite a bit of water had moved across it. I  
25 think in his world, something about 15 to 20 pore

1 volumes of water had moved out of New Mexico and into  
2 the Central Basin Platform. So if that's consistent  
3 in the tilted water context, or consistent, it would  
4 suggest that water is moving from west to east.

5 But again, am I an expert in that? I am  
6 not. Have I done the hydrodynamic work? I have not.  
7 That's simply an opinion based on the preponderance of  
8 the data I've looked at.

9 Q. And do you base this opinion on your  
10 background with knowledge, skill, experience, training  
11 and education?

12 A. That's correct.

13 MR. MOANDER: Mr. Hearing Officer, I'm going  
14 to go ahead and move to strike this opinion since  
15 this was absolutely not disclosed in any way, shape  
16 or form. I fleshed out that this has been developed  
17 outside the various deadlines in this case. This is  
18 100 percent ambush testimony, which I am not in a  
19 position to refute at this point or cross-examine  
20 effectively upon.

21 HEARING OFFICER HARWOOD: Mr. Rankin.

22 MR. RANKIN: Well, I guess my understanding  
23 is Dr. Davidson was asked a question and he listened  
24 to all the testimony during this hearing and did some  
25 additional investigation. It wasn't within the scope

1 of what we asked him to look at and so there are  
2 other witnesses who will be testifying on the  
3 questions that. Mr. Moander is asking. So I don't  
4 have an objection to striking the testimony.

5 However, I understand that it's based on  
6 everything that Dr. Davidson has reviewed and  
7 listened to today, to this point.

8 HEARING OFFICER HARWOOD: Well, this is a  
9 bit of a difficult ruling. On the one hand, you  
10 know, Mr. Moander, you asked the question, you got  
11 the answer. On the other hand, the witnesses said  
12 he's not an expert in this field. So it seems to me  
13 that the opinion that he gave at least deserves  
14 little weight. I'm not inclined to strike it  
15 entirely. I mean, you know, we can't unring the  
16 bell; what's been heard is what's been heard.

17 But I think the Commission can take into  
18 consideration that Dr. Davidson has self-admitted  
19 that this is just basically a lay witness opinion in  
20 an area calling for expertise that he lacks.

21 MR. MOANDER: Well, that's fine. I can ask  
22 him some other questions and we'll suss this out a  
23 little further then.

24 HEARING OFFICER HARWOOD: All right.

25 BY MR. MOANDER:

1 Q. So, Dr. Davidson, give me one moment here.  
2 So you'd agree with me you were deposed in this case  
3 on November 22nd, 2024?

4 A. Yes.

5 Q. And at that time, you were to render your  
6 opinions from examination from the parties opposing  
7 Goodnight; is that your understanding?

8 A. Yes.

9 Q. Do you recall testifying when you were asked  
10 specifically by me whether you had any opinions on the  
11 existence of migration of injection fluids in the  
12 San Andres into the Hobbs Channel of the Capitan Reef?  
13 Do you recall that question?

14 A. I do.

15 Q. And then you answered, "I haven't looked at  
16 any of that. You know, that's more of a geologist's  
17 bailiwick than it would be for me. And we have not  
18 looked at -- in fact, I haven't looked at any of the  
19 wells. I assume, from what little I do know, that  
20 would be to the east -- or excuse me, to the west of  
21 the EMSU. And I haven't looked at any of the data  
22 from that direction."

23 That was your answer?

24 A. That's correct.

25 Q. And then, let me share a little something

1 here. All right. Doctor, you recognize this  
2 document? Let me zoom in for you. My apologies, I  
3 forgot.

4 A. Yeah. That's my self-affirmed statement.

5 Q. Okay. More importantly, this is your  
6 self-affirmed rebuttal statement, correct?

7 A. Right.

8 Q. Is that right?

9 A. That's correct.

10 Q. And can you point to me in here where you  
11 recite anything you just told the Commission about  
12 your opinion on migration from the San Andres?

13 A. It's not in there.

14 Q. All right. Thank you.

15 All right. Turning back to your prior  
16 testimony, at that same deposition, do you recall that  
17 you testified you had no opinions on the broad-scale  
18 impacts of injection into the San Andres?

19 A. That's correct.

20 Q. And you also testified that you had no  
21 opinions on the effects of subsidence in relation into  
22 injection into the San Andres?

23 A. That's correct.

24 Q. And you also testified that you have no  
25 opinions on seismicity related to the injection at



1 issue?

2 A. That's correct.

3 Q. And I've got to ask this, since we've got a  
4 changed opinion here. Have you altered your opinions  
5 on any of these three topics since you gave that  
6 testimony and/or filed your rebuttal testimony?

7 A. I have not.

8 MR. MOANDER: All right. With that,  
9 Mr. Hearing Officer, I'll go ahead and I will pass  
10 the witness over to Mr. Beck.

11 HEARING OFFICER HARWOOD: Thank you,  
12 Mr. Moander.

13 Mr. Beck, for Rice Operating.

14 MR. BECK: No questions. Thank you.

15 HEARING OFFICER HARWOOD: I assume that it's  
16 Mr. Suazo for Pilot Water Solutions.

17 MR. SUAZO: Correct. Pilot has no  
18 questions.

19 HEARING OFFICER HARWOOD: All right.  
20 Instinct tells me that Dr. Ampomah may have some  
21 questions. I'll turn it to you first, Dr. Ampomah.

22 EXAMINATION

23 BY COMMISSIONER AMPOMAH:

24 Q. Thank you, Dr. Davidson, for your testimony.

25 I just want to clear this. So you are a

1 petrophysicist or you are an engineer? Just for my  
2 own clarity?

3 A. I do both. My Ph.D. is in oil engineering.  
4 I specialize in petrophysics and reservoir description  
5 for modeling.

6 Q. You know, let's say within the petroleum  
7 engineering discipline, you are more -- you have a lot  
8 of expertise in formation evaluation specifically?

9 A. Yes.

10 Q. Okay. I do have a couple of questions, so  
11 I'll try to go through that as quickly as I can.

12 If we can bring up the slides that you  
13 went through, that would be much helpful. Now, you  
14 showed a depositional environment. And I want to  
15 know, is this one for -- so that would be Slide  
16 Number 2. Would this one be for the San Andres?

17 A. It should be for either one, but it --  
18 because the depositional environment is the same in  
19 the Grayburg and San Andres. It's just that the  
20 Grayburg that has spent more time in the high energy  
21 environment than it has the lower energy environment.

22 Q. Okay. Let's go to Slide Number 3.

23 Okay. So did you use a constant  $B_0$  for  
24 the estimation of the correction factor?

25 A. Well, again, I estimated a range of

1 correction factors based on my assumption of what the  
2 lowest reservoir pressure that had been obtained  
3 before the core was cut. But when I -- I used the  
4 constant  $B_o$  from the top of the core to the base of  
5 the core. But then I estimated a range of pressure,  
6 so there was actually a range of  $B_o$  values.

7 At the end of the day, I used an average  
8 correction factor that was kind of in the middle of  
9 the range, based on the uncertainty in the pressure  
10 range that existed for the pressure that was -- the  
11 lowest pressure that would have existed at the coring  
12 location at the time of the core.

13 Q. So was the correction applied to the core  
14 measurements?

15 A. Yes.

16 Q. Now, as you look at multiple conditions or  
17 situation at which there could be oil losses during  
18 coring, now, and based on all the discussions that  
19 we've had today, at least based on your testimonies,  
20 do you believe that the oil saturation that has been  
21 completed, or more or less even from the core  
22 analysis, could be underestimated?

23 A. Well, the analysis I did, I tried to include  
24 all the variables that would be involved in that  
25 correction factor, and I came up with a range. And

1 again, the range that I came up with was about 1.1 to  
2 1.3 correction factor, depending on the assumptions on  
3 how low the pressure had gotten. I settled for, I  
4 think, a 1.22 correction, which is kind of in the  
5 middle of that range.

6 And then, however, you know, if the  
7 reservoir pressure had not significantly fallen from  
8 original conditions, the correction factor could be  
9 the 1.3. And I testified earlier that that would  
10 result in about a 10 percent increase in saturations.

11 For example, if I had calculated a 20  
12 percent oil saturation, then, you know, if the  
13 pressure had not fallen as lost as I thought it did,  
14 then it could be a 22 percent oil saturation.

15 Q. Now, you talk about -- so right on your  
16 number point, point 2, Number 2, you talk about, just  
17 getting to the end of the sentence, "...a pore volume  
18 reduction to account for reservoir stress conditions."

19 Can you discuss a little bit about the  
20 reservoir stress condition you are referring to here?

21 A. What I did is I went back and looked at a  
22 range of -- I calculated pore volume compressibility  
23 for a range of pressure drawdowns. And then, it turns  
24 out it's a very insignificant number.

25 But basically I said, well, if the

1 reservoir pressure had fallen to 300 pounds, what  
2 would the net effective stress be? And then I used  
3 the net effective stress in a model that we use  
4 internally at Netherland, Sewell to estimate what the  
5 pore volume compressibility was.

6 And then after I knew the estimated pore  
7 volume compressibility, I estimated how much the pore  
8 volume would have contracted as a result of the net  
9 effective stress. And I did that for the full  
10 pressure range that I looked at. And, in fact, they  
11 turned out to be relatively insignificant values, but  
12 I wanted to include all the possible mechanisms that  
13 would change the oil saturation when I did the  
14 analysis.

15 Q. You made mention of the pressure reduction.  
16 So did you see any pressure reduction in the  
17 San Andres?

18 A. The core -- again, these are just the  
19 corrections that I applied on the 679 core. And the  
20 problem is, I don't know for certain what the lowest  
21 reservoir pressure that was seen in the area that was  
22 cored prior to the coring operation, how far had the  
23 reservoir pressure been drawn down.

24 I did have some -- I think it's the EMSU  
25 211, there were some MDT measurements at roughly the

1 same depth, and the range of pressures that were  
2 exhibited in that MDT I think were 367 to 1264. I may  
3 have those numbers wrong. But I ran that full  
4 spectrum of possible lowest bottom hole pressures and  
5 calculated the B sub o, the R sub s, the viscosity,  
6 and then the correction factors for each one of those  
7 conditions. And that's where I came up with a range  
8 of a correction factor of 1.1 to 1.3 -- or 1.25.

9 Again, if I assume that there was  
10 absolutely no pressure drop in the San Andres and that  
11 whole core was at initial reservoir pressure and it  
12 had never been depleted, I'd get a 1.3 correction  
13 factor.

14 So that's the range of correction  
15 factors given the in situ conditions of the oil at the  
16 time that well was performed or the potential  
17 conditions that could be present at that location.

18 Q. So you said you looked at various ranges of  
19 pressures?

20 A. Yes.

21 Q. Now let me ask you. So, in your estimation,  
22 what is the initial reservoir pressure within the  
23 San Andres?

24 A. Well, I would -- the initial -- I would  
25 assume it would be the hydrostatic gradient. I think

1     that turns -- I haven't got the numbers in front of  
2     me. It seems like it was about 1700 psi if I assume  
3     that the San Andres had never been depleted and it was  
4     at a normal hydrostatic gradient.

5             Q. So then, it is your testimony that the  
6     San Andres is not under-pressured?

7             A. I think the San Andres is under-pressured.  
8     For example, I think, if I remember right, and I may  
9     have these numbers wrong, but I think that the  
10    gradient that they're measuring in the injection zones  
11    is roughly about .38. If it were not under-pressured  
12    or somewhat depleted, I think that number would be  
13    more like .43 or .44, somewhere in that range.

14            So, again, I don't know what that -- the  
15    problem is, I'm not sure anybody knows what the  
16    initial pressure in the San Andres was before any of  
17    these fields were put in production, whether it was  
18    under-pressured or not. I don't see a reason it would  
19    be under-pressured, but maybe it was.

20            Q. You know, Dr. Davidson, I asked you about  
21    what the initial pressure in the San Andres was based  
22    on your analysis, because you talk about you looked at  
23    multiple pressure ranges, and then you told the  
24    Commission that it is hydrostatic, which is about 0.43  
25    or .44, 1700.

1                   Now, I asked you is the San Andres  
2 under-pressured, and then you are saying yes, so I'm  
3 confused. Can you help me out?

4                   A. Well, the current measurements of what was  
5 purported to be the Upper San Andres in the MDT  
6 measurements -- and again, I don't know where the top  
7 of the San Andres is, so I don't know. I'm just going  
8 based on what was put forward by Empire. The  
9 San Andres interval would have had about a 1264 psi  
10 pressure. That would be under-pressured. They  
11 attribute that pressure as being evidence of flow from  
12 the San Andres into the Grayburg.

13                   Now, the other piece of information that  
14 I'm aware of is that the injection -- the gradient in  
15 the injection interval, that disposal interval which  
16 is below that yellow band that you see on this figure,  
17 if we go down into what I'm calling the lower  
18 San Andres, which exists below that yellow band, the  
19 pressure gradient there today is, I think, about .38.

20                   In my view, that would indicate that the  
21 lower San Andres is under-pressured. But what I don't  
22 know is has it always been under-pressured. What was  
23 it in 1921, before any of the production started? I  
24 don't know what that pressure was.

25                   Q. Dr. Davidson, then my question to you is, do



1 you believe that there is an uncertainty associated  
2 with even the correction factor that you calculated?

3 A. Well, the correction factor I calculated  
4 used the nearest pressure measurements to that well  
5 that I had at the time. And at that time, my  
6 conclusion would be that the San Andres around that  
7 well would have been at a pressure somewhere between  
8 364 and 1265 or whatever that -- somewhere in that  
9 range, because that's the pressure measurements for  
10 the MDTs that I had available to me at about the depth  
11 of the core, at about the -- just before waterflood  
12 operation started.

13 And the B sub o and all that needs to be  
14 calculated at the lowest pressure that it was obtained  
15 prior to the initiation of the waterflood. Because  
16 the waterflood has the potential of re-pressuring the  
17 reservoir. I don't know if it did, but it has the  
18 potential of re-pressuring. But you can't put the gas  
19 back in the oil once it's escaped.

20 So you need to know what the lowest  
21 pressure was prior to the initiation of the waterflood  
22 at about the depth at which the core was recorded.  
23 And there was a range of pressures that were  
24 available, so I evaluated the full range. And those  
25 ranges would indicate that that part of the San Andres

1 and Grayburg were reduced pressure from the  
2 hydrostatic conditions.

3 Q. So you utilized the same correction factor  
4 for the Grayburg and then the San Andres?

5 A. I used the average through that whole  
6 interval because I couldn't tell for sure what the  
7 actual pressure to use, what was the proper pressure.

8 It was somewhere between 364 and 1265.  
9 So I evaluated the full range. But for the  
10 corrections, I used something that was roughly in the  
11 middle of that range.

12 And, you know, the fact was, this  
13 evaluation of the correction factor occurred after I'd  
14 already done the original calculations. The original  
15 calculations were carried out using an Arco Oil and  
16 Gas Company Research rule of thumb that I had used  
17 back in the early '80s when we were evaluating core  
18 data to evaluate potential CO2 floods. That number  
19 from that analysis came out as 1.22.

20 If I take the average of all the  
21 measurements that I made from the 365 to 1264, you  
22 come up with 1.22. So I'm like, gosh, no matter what  
23 I do, I'm coming up with somewhere in that range. So  
24 I didn't go and change all of my corrections. I just  
25 said one of my original corrections seems to be in the

1 right range. And that would be somewhere average  
2 between 365 and 1264, maybe 1,000 pounds or so would  
3 be that average that I assumed would have existed, the  
4 lowest pressure that existed in that cored area prior  
5 to the drilling of the core.

6 Q. Dr. Davidson, so are you telling the  
7 Commission that the correction factor that you  
8 actually used was based on your experience?

9 A. That's correct.

10 Q. And not necessarily based on the actual data  
11 from the San Andres EMSU?

12 A. Well, it was from the Grayburg San Andres  
13 pressure measurements. What I did was, because there  
14 was concern voiced by Empire, that was a very  
15 simplistic way to do the corrections, I went and did a  
16 full rigorous evaluation of what the possible range of  
17 those correction factors could be. And the evaluation  
18 of that full range came out to be 1.1. And if I  
19 assumed absolutely no pressure drawdown at all, the  
20 1.3. And so the point is, I saw no reason to go back  
21 and change anything.

22 Then when pressed on well, what's the  
23 uncertainty, I followed the Ops model, and what Ops  
24 did is they decided that the biggest uncertainty was  
25 in the correction of the core measurements, and then

1 they defined an uncertainty range based on the core  
2 correction factor. So I followed that same path.

3 In following that path, basically, you  
4 know, my correction factor range was from 1.1 to 1.25,  
5 realistically, for the conditions that were actually  
6 present. So I felt like the 1.22 that I had  
7 originally used was a pretty reasonable place to be,  
8 so I didn't make any changes.

9 So in answer to your question, yes, I  
10 used the experience of the rule of thumb, but I backed  
11 it up with a rigorous analysis that proved that that  
12 rule of thumb really wasn't a bad place to be.

13 Our core guy, Jake Rathmell, is probably  
14 one of the best core analysis people on the planet.  
15 And he developed that rule of thumb so that new  
16 engineers could apply it very easily and not have to  
17 go through all the rigorous analysis that I ultimately  
18 did.

19 Q. So has this been a normal practice in our  
20 industry that we always apply a correction factor to,  
21 let's say, a core measurement?

22 A. Yes, that's standard practice.

23 Q. And since you said it is a standard  
24 practice, did you check -- assuming Core Labs did  
25 perform this core analysis, did they apply the

1 correction factor or not?

2 A. They did not. They don't report it. They  
3 report the saturations as measured.

4 Q. Okay. Let's move to Slide Number 4.

5 So there has been a lot of great  
6 discussion about the rock types. And then even  
7 looking at your cross-section right there, you've  
8 talked about the karst and then also the collapse.

9 My question to you is -- you know, and  
10 this will be the first question, you know, and I do  
11 have a series of questions on that.

12 You know, how does that impact CO2 EOR,  
13 assuming, let's say, with Empire's CO2 injection into  
14 the San Andres.

15 A. Well, again, I looked at the San Andres, the  
16 shallow part of the San Andres, above what I've  
17 defined as that gamma ray marker. I see that as a  
18 situation where the karst is certainly present, and I  
19 think they potentially would be much more limited in  
20 the aerial extent than they would in the Upper  
21 San Andres because they were created from exposure,  
22 surface exposure of the carbonate ramp at the ramp  
23 crest periodically in meteoric water, you know,  
24 rainwater basically, moving down through that and  
25 creating dissolution of the carbonate materials. So

1 that's more of the typical karst that you see in a  
2 ramp environment.

3 And so again, this is my opinion. The  
4 CO2 operation would be probably -- could be potentially  
5 advantageous in that environment because the karsting  
6 wouldn't have large aerial extents.

7 However, when I moved down into the  
8 San Andres Center, which I call the Lower San Andres,  
9 below that gamma ray marker, that interval appears to  
10 be, at least, to have been more affected by the  
11 massive water and CO2 movement that Dr. Lindsay and  
12 Dr. Trentham have hypothesized.

13 And those karsts would be developed post  
14 depositionally at the time that the Guadalupe  
15 Mountains -- I don't know the proper geologic term for  
16 the uplift that occurred. But the rock had been  
17 uplifted and the San Andres was exposed at the  
18 surface, and you had meteoric waters moving through.

19 In Dr. Trentham's model, and it may be  
20 Dr. Lindsay's model, I don't know who actually came up  
21 with it first, but there was first a hot water --  
22 geothermal water moving through there as a result of  
23 volcanic activity near the mountain ranges. And then  
24 there was a further uplift and shut that hot water  
25 off. And then you had cooler water that was just

1 migrating in from the outcrops. And in their model, I  
2 think they hypothesized somewhere between 15 to 24  
3 volumes of water had moved from that mountain range  
4 across Southeast New Mexico and into the Central Basin  
5 Platform.

6 Now, Dr. Lindsay has a theory that H<sub>2</sub>S  
7 was coming out of the oil, the Wolfcamp oil was being  
8 liberated and it was moving the other way. But the  
9 water would be moving downhill from the mountain range  
10 into the Central Basin Platform, and gas, because it's  
11 lighter density, would be migrating upward. So he has  
12 kind of a cross flow in that. And the commingling of  
13 that fresh water in the H<sub>2</sub>S would create a sulfuric  
14 acid. And I think that's a perfect recipe for karst.

15 In fact, I think that's the theory for  
16 the development of the Carlsbad Caverns, if I'm  
17 thinking properly, that the H<sub>2</sub>S and the meteoric water  
18 is what leached out Carlsbad Caverns.

19 And, you know, I'm unconvinced, you  
20 know, based on the -- you're looking at the gamma ray,  
21 seeing that there's smaller grain size material down  
22 in that Lower San Andres, the fact that they're able  
23 to inject on vacuum and they're able to inject  
24 thousands of barrels a day and over long periods of  
25 time, not seeing much of a pressure increase, that

1 seems to me to indicate that the aquifer is very large  
2 and the permeability that allows that to happen would  
3 have to come from a karsting environment.

4 So, you know, and -- so I think that the  
5 Lower San Andres may fit the Trenton-Meltzer model  
6 extremely well. The Upper San Andres may or may not  
7 fit that model. It seems to be that the karsting is  
8 more localized.

9 But again, I haven't looked at all the  
10 data and that's just an opinion. I'm certainly not an  
11 expert on any of that, but I'm relying on the expert  
12 testimony I've heard to give you an opinion on the  
13 different styles.

14 Q. Well, so from the cross-section that we are  
15 seeing here, which I believe was Slide Number 16, so  
16 all the -- I believe, all the purple or the violet  
17 color, more or less, is showing the karst?

18 A. Right.

19 Q. Okay.

20 A. What this is actually showing is that the  
21 existence of what I think are bedded anhydrites  
22 through that yellow interval. And if you get below  
23 there, if you look at my computed well logs, you'll  
24 see that the porosities below that highlighted  
25 interval start getting very high.



1           For example, in the outcrop and in the  
2       cored interval, the average porosities of each of  
3       those rock types are in the vicinity of maybe 8 to 10  
4       percent. So the porosities in the -- what Trentham  
5       and Melzer would call the main production zone up  
6       there, would be in the 8 to 10 percent range. The  
7       core data pretty much is consistent that you don't  
8       really have high porosities in that cored interval.

9           If you get below that yellow highlighted  
10      interval, you get into long intervals where the  
11      porosities start to approach 20 percent. And the  
12      other thing that you see in those intervals, again, if  
13      you look at my computed logs, is the resistivity falls  
14      to very low values. And those two conditions together  
15      indicate that there's quite a large mud volume in  
16      there. And the fact that they lose circulation as  
17      soon as they drill out of the bottom of that yellow  
18      interval and they lose returns, suggests that there's  
19      very high permeability down there, that there will  
20      allow a lot of fluid to flow, and they're able to  
21      inject 120,000 barrels a day or more into that  
22      interval, and they haven't seen any major pressure  
23      increase. To me, that suggests the presence of a  
24      karsting system.

25           Q. Well, so my question was very simple.

1 Within that yellow-shaded region, you're saying that  
2 there is a lot of karst in there?

3 A. There could be karst in that interval as  
4 well, but the anhydrites would be -- the anhydrites  
5 that would be indicated by those little flags would  
6 tend to isolate those intervals from one another,  
7 because the anhydrite is going to be impermeable.  
8 It's very -- it's impermeable. And if they're layered  
9 bedded anhydrites, they would present barriers to  
10 vertical flow.

11 Q. So those violet flags are not karst, but --

12 A. No. Those are the -- those are the bedded  
13 anhydrites, as I've interpreted them.

14 Q. But I thought one of your slides, you were  
15 showing that those are karst. You use that same  
16 color.

17 A. Oh, well, I apologize for that. Again, I'm  
18 colorblind, and maybe I choose these wrongly. But  
19 those flags in that exhibit are bedded anhydrites.  
20 Your question, could there be karst between those  
21 bedded anhydrites, the answer is yes, there could be.

22 But the major karsted intervals are  
23 those below that highlighted yellow interval, down in  
24 what I call the Lower San Andres, or the injection  
25 zone.

1           Q. So what will you term the yellow-shaded  
2 region?

3           A. In my view, that's a region that contains  
4 multiple potential vertical permeability barriers in  
5 the form of bedded anhydrites.

6           Q. So you think that the entire yellow-shaded  
7 region is anhydrite?

8           A. It's not anhydrite. The anhydrites are --  
9 the bedded anhydrites are denoted by the little flags,  
10 and you see that they exist in all the wells.

11                 Now, you can argue that, well, they  
12 don't exist -- you can't correlate them. And I would  
13 agree with that. You can't correlate one bedded  
14 anhydrite all the way across the field. However,  
15 there are enough of them that I think en masse that  
16 they provide a reasonable barrier.

17                 Now, Mr. -- the counsel for Empire --  
18 I'm sorry, I'm getting really tired. But counsel for  
19 Empire wanted me to say that I'm 100 percent sure that  
20 those are barriers, and I'm not. I don't know that I  
21 can map them all the way across.

22                 However, the preponderance of the data,  
23 when you look, it's loss circulation, you look at the  
24 injection volumes. You look at the fact that we don't  
25 see direct evidence that major water is moving up

1     that's impacting the Grayburg waterflood. In other  
2     words, we're not seeing that we're producing way more  
3     water than we're injecting, which would imply that  
4     there's major communication up.

5             My conclusion is, the preponderance of  
6     the evidence suggests that that yellow interval is  
7     providing reasonable protection between the injection  
8     zone and the waterflood operations above that yellow  
9     highlighted area.

10            And until we see evidence, concrete  
11     evidence, by way of pressure or the fact that we're  
12     producing more water than we're injecting, I'm pretty  
13     comfortable in saying that I think those two zones are  
14     isolated from one another.

15            Q. Okay. So you said that there might be some  
16     karst present within that yellow-shaded region. At  
17     the same time you do have anhydrite. So those are two  
18     things.

19            Now, is there a situation where, based  
20     on the karst, there could be a potential conduit  
21     between the Grayburg and then the San Andres?

22            A. There certainly could be a potential  
23     conduit. Again, I haven't seen evidence of it.

24            Q. Okay. So if you look at Dr. Buchwalter's  
25     model, Mr. William West really made it clear to us

1 about the production history. So there was a map,  
2 there was a bubble map, that showed the oil production  
3 and then also water production.

4 So when you say that we do not -- you  
5 know, so the karst could be a conduit. Now, we are  
6 all petroleum engineers, so I want you to comment on  
7 the scenario where he also said this could be  
8 fractures that are existing, look at fractures that  
9 are existing. And then he utilized that in his  
10 simulation history matching effort.

11 So can you tell the Commission that that  
12 strategy that he used, looking at existence of  
13 fractures in the core, and then even you've also added  
14 karst to it, is there any strong evidence to suggest  
15 that what he did was wrong?

16 A. Well, I used to do a good amount of  
17 reservoir modeling early in my career. And to be  
18 honest with you, the reason I moved more into  
19 petrophysics and reservoir description is because I  
20 found that I could make a reservoir simulator to do  
21 dang near anything I wanted. I think your experience  
22 is probably the same. So what it told me was that we  
23 needed to spend more time doing the reservoir  
24 description before we started simulating.

25 And I guess the things that bothered me

1 a little bit about Dr. Buchwalter's model was that,  
2 for one, he modeled the entire San Andres interval, I  
3 guess, you know, from -- he moved the water contact  
4 down and then modeled everything under the water  
5 contact with, like, a 6 percent porosity and a single  
6 permeability.

7 Well, you can see -- again, it's not  
8 clear on this particular cross-section, but if you go  
9 back and look at the computed logs, and it doesn't  
10 matter whether you're looking at my computed logs,  
11 NuTech's computed logs, or Ops computed logs, when you  
12 get down into the lower part of the San Andres, the  
13 porosities are not 6 percent. You know, they get  
14 up -- you know, I don't know what the average would  
15 be, but you get porosities approaching 20 percent down  
16 there.

17 So the fact that he used a 6 percent  
18 porosity, in my opinion, too low of a permeability to  
19 represent the aquifer. If you choke the -- if you  
20 choke the aquifer with low permeability and you  
21 restrict its volume by using too small of a porosity,  
22 well, of course, you have to have a large volume to  
23 explain the pressure response you're seeing.

24 And I would argue that he might have  
25 been able to do exactly the same thing if he modeled

1     what I call the Upper San Andres, above that yellow  
2     area, and modeled it with a high permeability. And  
3     edge water drive coming in, he might have been able --  
4     and again, his was not really a simulation. I saw it  
5     as more of a large scale material balance model.

6             And I think you could probably build a  
7     material balance model that would explain the same  
8     thing, with not having to include the San Andres from  
9     the oil-water contact all the way to the Glorieta, and  
10    come up with an identical history match.

11            Now, I haven't -- well, you're going to  
12    say, "Well, have you done that, Dr. Davidson?" I'm  
13    going to tell you, no, I haven't. But I'm just  
14    saying, those are the things with the Buchwalter model  
15    that made me nervous, that I would have done  
16    differently had I built the description for it.

17            Q. Dr. Davidson, so my question was very  
18    simple, saying that -- my question was very simple.  
19    In our reservoir engineering principle, when we have a  
20    higher water production well localized, a higher water  
21    production well localized, similar to what was shown  
22    to us by Mr. West with that bubble map, I'm asking you  
23    a very simple question, is it typical in the oil and  
24    gas industry that with the knowledge of fractures from  
25    a core, and then also with the karst that you've even

1 added to it, is it reasonable for a reservoir engineer  
2 to assume that there could be a localized either karst  
3 or fracture causing this high water production?

4 A. And I would agree with that. It's a  
5 reasonable assumption. Where I differ from  
6 Dr. Buchwalter is that I think that that water could  
7 be edge water coming in through a karsted system  
8 through a tortuous pathway from the edge. It could be  
9 water coming, you know, from the Upper San Andres at a  
10 localized area through a karst.

11 The other thing that nobody talks about  
12 that I have experience with, a lot of the early wells  
13 were open hole completions completed with  
14 nitroglycerin. And it's perfectly possible that water  
15 could be entering from the San Andres into those  
16 wellbores, and then migrating to the place where they  
17 saw the plumes.

18 I don't know that that's the case. I  
19 just know there's multiple possible scenarios that can  
20 explain those high water. They don't all necessarily  
21 have to go back to point out that the Lower San Andres  
22 is communicating all the way up through fractures or  
23 karst or whatever.

24 Q. Dr. Davidson, so I think you and I agree  
25 that that is an option. You know, and as a petroleum



1 engineer, you have multiple options that are on the  
2 table. But when he chose that strategy, you and I  
3 agree that it's not wrong.

4 Now, my question to you is, you're  
5 describing to the Commission all the other potential  
6 options that could have happened. Why did Goodnight  
7 not perform a similar reservoir simulation model to  
8 debunk Dr. Buchwalter's scenario?

9 A. I don't have an answer to that question.

10 Q. Okay. Let's go to Slide Number 6. If we  
11 can go to Slide Number 6.

12 Okay. So there's been a lot of  
13 discussion on this slide as well. I want to ask you,  
14 can this approach, you know, using, let's say, a  
15 resistivity index and all of that, can that equate to  
16 the Archie's equation?

17 A. Yeah, you could get to an Archie's equation  
18 from that. The problem that you wind up with is, if I  
19 used Archie, every point on that cross-plot would have  
20 to have a different n value in order to return the  
21 proper saturation.

22 And the beauty of -- and I can't  
23 remember the gentleman from Schlumberger who designed  
24 this. But the beauty of this model is, with those Sc  
25 curve fit values, I could represent a whole range of

1 RI values with a curve fit model. It's simply  
2 easier -- it's easier to calculate.

3 Now, what I could have done, which would  
4 have been very tedious, is to go through and use the  
5 Sc value to calculate the n value, and then use  
6 Archie, the normal Archie's equation with the n value  
7 derived from the Sc curve fit, and I could have used  
8 Archie's model. Or I could use the equation at the  
9 bottom left-hand corner of that slide, which uses the  
10 Sc value directly with the resistivity index. So we  
11 chose to go that route because it makes the  
12 computations so much easier.

13 Q. It makes the computations so much easier.  
14 So your testimony is that the San Andres is an oil wet  
15 reservoir; is that correct?

16 A. I think that's correct. But the reason is  
17 not because of any particular attributes of the  
18 San Andres in and of itself. It's because of the  
19 relative ratio of asphaltenes to the lighter  
20 hydrocarbon components in the crude.

21 Most people believe in fingerprinting  
22 and showing that the majority of this crude probably  
23 originated in the Wolfcamp. In the Wolfcamp, the  
24 asphaltene concentration is relatively high. And when  
25 you get a situation where you have high asphaltene

1 content, rocks, regardless of whether they be clastic  
2 or typical carbonates, tend to become oil wet. And it  
3 has to do with Van der Waals forces at the surfaces  
4 and the fact that the asphaltenes are polar molecules.

5 Q. So is it your testimony that the oil that  
6 probably might be in the Grayburg and then the  
7 San Andres is from the Wolfcamp?

8 A. That's what the general consensus in the  
9 industry is.

10 Q. Okay. So when Empire says that the  
11 reservoir might be mixed wet, what is your comment on  
12 that?

13 A. It could be mixed wet in a situation --  
14 let's kind of drive the series of events. When oil is  
15 migrating, it migrates as though the rock is water  
16 wet; in other words, there's water on the outside, the  
17 oil migrates through to the point where it gets into a  
18 trap.

19 After it's trapped, and billions of  
20 years pass, there's plenty of time for those  
21 asphaltenes to be attracted to the surfaces of the  
22 carbonate grains. And it spreads wettability from oil  
23 wet to water wet. And most carbonates tend to be oil  
24 wet.

25 Now, a mixed wet condition can exist in

1 a situation where you have very high mud content, mud  
2 particle content. In that world, because the pore  
3 throats are so small and the Van der Waals forces that  
4 are attracting the polar water molecules, that those  
5 forces are so strong, that the oil can never penetrate  
6 in there to begin with. And that condition, the  
7 larger pores in the system would be oil wet and what  
8 basically would be the mudstone or the mud component  
9 that could still contain water. And that creates a  
10 very complicated conductivity environment.

11 And that's part of the reason,  
12 particularly when we get down to the mud dominated  
13 packstones and the wackestones, that that behavior  
14 becomes finally nonlinear, because you have a very  
15 complicated conductivity system with some of the  
16 currents passing through the mudstone and some of the  
17 currents trying to pass through the larger pores in  
18 the other portions of the rock.

19 Q. So, Dr. Davidson, are you saying that, let's  
20 say, you -- based on your analysis, you're saying that  
21 it is an oil wet reservoir?

22 A. I believe it's predominantly an oil wet  
23 reservoir.

24 Q. And --

25 A. And the -- okay. I'm sorry.

1           Q. Yes, sir. I'm just asking a very simple  
2 question.

3                   And then, Empire is also saying that it  
4 could be a mixed wet. Now, based on the discussion,  
5 it sounds like you believe that this reservoir could  
6 also be a mixed wet.

7           A. There's portions of it that could. The  
8 portions that contain very high volumes of mud-sized  
9 particles, you could have a mixed wet system. But,  
10 you know --

11           Q. Okay. So if you have a mixed wet system,  
12 now what are the assumptions that you utilize on this  
13 particular slide?

14           A. Well, again, I'm taking the saturations as  
15 they appeared in the core and I'm plotting them versus  
16 the resistivity index. And I'm fitting the model by  
17 rock type to each one of those clusters of data.

18                   So I really wouldn't -- the wettability,  
19 while, I believe it's an oil wet reservoir -- and  
20 arguably, one of the methods that -- for example, one  
21 of the methods that's used to identify the presence of  
22 an oil wet reservoir is to create a plot just like  
23 this. And this comes from Jerry Lucia and comes from  
24 George Asquith and it comes from the folks from  
25 Schlumberger. When you make this cross-plot, if the

1 majority of the data falls above the  $n$  equals 2 line,  
2 then you conclude that the reservoir is oil wet.  
3 That's one of the uses of this cross-plot in the  
4 industry.

5 But regardless of the wettability, I've  
6 taken the core data, corrected it, plotted it on the  
7 cross-plot and I've fit a model to the data, the  
8 corrected core data. So the model is going to be  
9 applicable whether or not it's fully oil wet or  
10 partially water wet or mixed wet or whatever, because  
11 I've built a model that's calibrated to the actual  
12 core measurements.

13 Q. But wasn't your testimony to the Commission  
14 that it doesn't necessarily matter the type of  
15 wettability, your analysis is still valid?

16 A. That's correct.

17 Q. Now, the  $m$  and  $n$ , more or less, inherently,  
18 some way, somehow can be within this equation?

19 A. Yeah, you could turn this into Archie if you  
20 want to.

21 Q. And is it your testimony that the  
22 wettability doesn't impact the rock type?

23 A. No.

24 Q. Not at all?

25 A. No.

1           Q. Okay. So on this particular map -- on this  
2 particular plot that you're showing us, can you  
3 identify oil saturations above 20 percent?

4           A. Well, yeah. They would be a little bit  
5 difficult. Whoops, they just lost it.

6           Q. Yeah, we can just draw a line --

7           A. But, yeah, you just draw --

8           Q. Yeah, just draw a line.

9           A. Yeah. It's a long scale, so it's not  
10 trivial. It's .1 on the left, and so it'd be probably  
11 a little -- see the .69 down there at that green  
12 arrow? It would be -- the 80 percent would be  
13 somewhere to the right of that, between that .69 and  
14 1. So obviously, I'll -- it may be that where you've  
15 got the cursor.

16          Q. So when we look at that -- and then you're  
17 saying that these points are oil saturation points  
18 from the EMSU 679?

19          A. They were above -- they were above  
20 80 percent water saturation or they wouldn't be  
21 plotted on there, on the points above that line.

22          Q. Now, I'm just asking you that, these points  
23 that you are showing us, whether it's a complete point  
24 or not, these are all actual core measurements from  
25 the EMSU 679 well; is that correct?

1           A. That's correct.

2           Q. And we've established that there are oil  
3 saturations above 20 percent, as you've plotted here;  
4 is that correct?

5           A. Yes.

6           Q. Then tell the Commission why you say that  
7 there is no ROZ.

8           A. I didn't say there's no ROZ in the Upper  
9 San Andres. Again, I have -- I may have a little bit  
10 of difference of opinion from Trenton and Melzer.  
11 When I look at actual ROZs that have been established,  
12 I see a pretty repeatable profile in saturations for  
13 the top of the ROZ to the bottom. And I don't see  
14 that nice straight line at about 40 percent in the 679  
15 or the RR Bell data.

16                   That doesn't mean that it's not an ROZ.  
17 It just means it doesn't have a profile that matches  
18 what other ROZs have.

19                   Again, I would be perfectly happy if  
20 Empire went in and installed a CO2 project in that  
21 Upper San Andres and made money with it. It would be  
22 great.

23                   My contention is that the injection  
24 operations that are occurring below this yellow band  
25 are not likely to impact it.



1 Q. Well, so, you know, let me pick up on your  
2 last point that you made, your last statement. You  
3 said that it would be great if Empire can go in there  
4 and do a CO2 project up in the Upper San Andres?

5 A. Yes.

6 Q. Is that not what they are requesting from  
7 the Commission?

8 A. What -- what -- yeah. The problem, as I see  
9 it, is they're trying to shut down injection  
10 operations in an interval that, in my opinion, is not  
11 affecting their potential ROZ development in the Upper  
12 San Andres.

13 I think both companies can continue on  
14 and not interfere with one another. And at minimum,  
15 we could probably install some sort of a monitoring  
16 process to ensure that they're not interfering with  
17 one another and come up with a way to handle it if  
18 there is -- if communication is established.

19 But I don't see anything right now  
20 that's preventing Empire from moving forward with the  
21 development of the ROZ in that upper interval. And I  
22 don't think that the injection operations for all this  
23 little yellow band are necessarily endangering that  
24 project.

25 Q. Well, Dr. Davidson, so is it your testimony,

1 are you concurring with Empire that at least there is  
2 an ROZ in the San Andres?

3 A. I think there's probably -- there's  
4 indications there's one in the Upper San Andres above  
5 what I call the gamma ray marker.

6 Q. So is it your testimony that -- you know  
7 because Mr. McBeath was saying -- he used the word --  
8 he used a statement called -- I forgot. He had a --  
9 he used "alleged." Thank you. Alleged --

10 A. Alleged resources.

11 Q. -- ROZ. He said alleged ROZ.

12 A. And in my understanding, Mr. McBeath's  
13 testimony was concerning the interval beneath this  
14 yellow -- in the San Andres beneath this yellow band.

15 Q. I don't remember --

16 A. In fact, the testimony was he went in and  
17 took the San Andres interval above that yellow band,  
18 calculated the oil saturations in there and came to  
19 the conclusion that the economics may be questionable.  
20 But then when questioned on whether or not there was  
21 an ROZ that existed all the way down to the Grayburg,  
22 I think he coined the term "alleged resources" for  
23 that. And we're talking about two different  
24 San Andreses, in my opinion.

25 Q. Well, so, I mean, we're all here. I don't

1 think Mr. McBeath showed us even the anhydrites, the  
2 karst, the yellow-shaded regions that you are  
3 referring to. I mean, this is the first time I'm  
4 seeing that. So he said there is an alleged ROZ.

5 But based on the discussion that we're  
6 having now, it sounds like you're saying that at least  
7 there's this ROZ in the Upper San Andres.

8 A. I think there very well could be. But  
9 again, I have a different opinion. I think they look  
10 more like migration pathways. They may or may not be  
11 aerially continuous. But I can't say with certainty  
12 they're not there. They've seen residual oil in the  
13 two wells and cored into that Upper San Andres.

14 And, again, if Empire feels strongly  
15 about going for it, I think they should go for it.  
16 But I don't think the injection operations deep are  
17 going to impact it. And I think the Commission could  
18 probably put in place some monitoring protocols to  
19 make sure that they're not interfering and come up  
20 with a game plan for how to move forward if  
21 interference is ever found.

22 Q. So, Dr. Davidson, on your cross-section that  
23 we've seen there, using the yellow-shaded region as  
24 your reference, where is the Upper San Andres?

25 A. Well, again, I don't know where that top of

1 the San Andres pick is. I don't know, and to be  
2 honest with you, I don't know whether anybody does.  
3 But it would probably be this little region right in  
4 the middle.

5 MR. WEHMEYER: For record reference,  
6 indicating about four inches above the yellow deal.

7 A. Yeah. And, again, I don't have the top --  
8 or is it -- I don't think I have the tops.

9 But this interval here is probably the  
10 Grayburg. This little interval right down here would  
11 be what everybody, in my view, is calling the Upper  
12 San Andres. The ROZ, I think, resides along this  
13 interval. And then we have a long interval that is --  
14 this high frequency interval, where I think we  
15 potentially have the bedded anhydrites.

16 And then the injection operations are  
17 occurring down here, and then that's the 700 TBD,  
18 below this interval. And the fact that we can drill  
19 through this thing, move circulation down here, we can  
20 inject down here for long periods of time, you don't  
21 see pressure increases, which indicates it's a very  
22 large aquifer, and thus far up here, I haven't seen  
23 concrete evidence that significant volumes of water  
24 are moving up, such that the produced water volumes  
25 exceed the injected water volumes.

1                   So again, I'm in the position to -- and  
2 I'm just saying the preponderance of the evidence at  
3 this point that I can see indicates that they are two  
4 different systems.

5                   Q. So, Dr. Davidson the yellow region.

6                   A. Yes, sir.

7                   Q. Now, the anhydrites that you've picked, do  
8 we have any core data supporting that or mud log data  
9 supporting that?

10                  A. Anhydrites show up at the mud logs, but  
11 they're not going to be able to tell whether they're  
12 bedded or not. That conclusion comes from my viewing  
13 of cores, particularly in the Levelland Slaughter area  
14 where you see this, the combination of elevated gamma  
15 ray, the low porosity and the high grained and high  
16 bolt densities became the presence of anhydrite.

17                  And Jerry Lucia developed a  
18 cross-plotting technique to identify bedded  
19 anhydrites. In those intervals, they fit the fact  
20 that there's elevated gamma ray, they fit the fact  
21 that the density neutron cross-plots indicated the  
22 presence of anhydrite. The mineralogy model suggests  
23 the presence of anhydrite. And I've seen this log  
24 signature in places where core data exists and bedded  
25 anhydrite have been observed.

1                   Have I seen core in EMSU in the  
2 San Andres that shows bedded anhydrites? I have not.  
3 This is just based on my experience.

4                   Q. So you've not -- and even based on the  
5 cross-examination, it sounds like you cannot put on  
6 record that you believe that this is a barrier to,  
7 let's say, flow?

8                   A. I believe it's a barrier to flow. I can't  
9 say with 100 percent certainty that every one of those  
10 is a bedded anhydrite.

11                  Q. And you also testified that the Commission  
12 doesn't need any additional data.

13                  A. I don't believe so. I think that there's  
14 enough data from the injection, the lack of  
15 interference, the loss circulation that there's not  
16 communication between the two. Again, I'm just  
17 looking at the preponderance of the data that I see.

18                         And I would argue that it may be very  
19 difficult to get reasonable core data down there  
20 because of the loss circulation issues.

21                  Q. So let's go to Slide Number 5, right here.  
22 So this is the rock type analysis that you performed;  
23 is that correct?

24                  A. Well, this is based on the outcrop analysis.  
25 These were averages of the petrophysical properties

1 for the different rock types present. What I was  
2 trying to show here was there's not a very big  
3 porosity variation, but there's a big permeability  
4 variation. And it's therefore important to try to  
5 identify the different rock types in the petrophysical  
6 parameters when you're doing the analysis of this type  
7 of ramp environment.

8 Q. So did you utilize this rock type that  
9 you've developed based on outcrop data for the  
10 subsurface analysis?

11 A. Well, the process was this. The Bureau of  
12 Economic Geology was tasked with developing a model  
13 that could be applied in a carbonate ramp environment.  
14 And they identified the major rock types that are  
15 available or present in a carbonate ramp environment.

16 Then what they did, they went to the  
17 outcrop, they dug down into the face of the rock  
18 outcrop to get the surface weathering features off.  
19 They collected core samples out of the -- they  
20 identified the rock types present, calculated or  
21 obtained core samples out of the rock type. Then they  
22 took those core samples and they cross-plotted them by  
23 facies type, for example, grainstones.

24 They cross-plotted all the grainstones  
25 together, across the permeability cross-plot, and they

1 defined a region on that porosity permeability  
2 cross-plot that is associated with the grainstones.

3 Then they did the same thing, for  
4 example, for the mud dominated packstones. They  
5 collected several samples of mud dominated packstones.  
6 They plotted them in the cross-plot. They found that  
7 they existed below the grainstones in the translated,  
8 you know, density neutron cross-plot trend. They did  
9 the same thing for each one of them.

10 And then they went through and they  
11 said, okay, for each one of these -- Jerry Lucia calls  
12 them classes rather than rock types. But for each one  
13 of these classes, I'm going to determine an average  
14 value, a standard deviation, and I'm going to create  
15 this cross-plot model so that anybody can take core  
16 data, put it on this cross-plot, or even identify the  
17 region associated -- the porosity permeability region  
18 associated with each of these different rock types,  
19 and they can make a preliminary estimate of what the  
20 rock type is.

21 So I did the same thing with the EMSU  
22 679 data. I found all the -- and I took Jerry Lucia's  
23 cross-plot and I plotted all the core data up so I  
24 could -- all the -- for example, there's a band of  
25 data that represents the grainstone that they found in



1 the outcrop.

2 I took all of those grainstones, the  
3 core samples, that fell within that grainstone  
4 cross-plot region, then I plotted them on that RI  
5 versus Sw plot, and I did a curve fit of that Sc value  
6 through those grainstone values using the log  
7 saturations.

8 That provides a reasonable estimate of  
9 how a grainstone would behave as a function of RI,  
10 given the corrected oil saturations and water  
11 saturations that were measured in the core. And I  
12 used that model rather than an Archie's model because  
13 it's much easier to use than trying to come up with a  
14 variable n model.

15 And I tried to demonstrate that the  
16 variable n model is somewhat difficult because for a  
17 particular porosity, there's a variety of n values  
18 that can occur, so then you have to go and you have to  
19 do the same thing. I could have done the same thing  
20 with Archie, granted, if I wanted to go to the trouble  
21 to come up with that n model for each rock type. But  
22 this Sc model is so much easier and faster to  
23 calibrate. I used this Schlumberger model because  
24 it's simply much easier to use than the Archie in this  
25 environment.

1 Q. So, sir, it was a simple question.

2 Let's go to Slide Number 11, and I'll  
3 try to wrap up here. So here, I'm asking you, do you  
4 see any oil saturation within the San Andres?

5 A. In the San Andres, as it's defined here,  
6 it's below that region of the high frequency. If you  
7 can see -- I can't see the depth. Move your cursor up  
8 to that gamma ray, maximum gamma ray.

9 It looks like it's about 525. So that  
10 interval from 525 down, go down about an inch on this  
11 thing, that's that high frequency interval. And I  
12 think this is one of Preston's picks. He's picked the  
13 San Andres to correspond to the interval that's the  
14 injection zone. Again, I'm not going to get into the  
15 pick argument. That just happens to be where this  
16 San Andres is.

17 If you go down, you'll see in the oil  
18 saturation track, periodically I do calculate  
19 relatively high saturations. I mean, there's some up  
20 to 30 and 40 percent in there. They show up  
21 periodically up and down the system.

22 So yes, there is oil down in there.  
23 They tend to be associated with some of the lower  
24 gamma ray readings. And that makes sense because the  
25 lower gamma ray readings, down there in that yellow

1 San Andres interval, correspond to the grainstones and  
2 the better rock types.

3 So yes, there are grainstones and better  
4 quality rock types all the way through the San Andres.  
5 If you get deeper in the system, you see the gamma  
6 rays starting to get higher and higher. That's  
7 indicating a higher mud content.

8 But when a gamma ray does clean up and  
9 the resistivity is high enough, we do get oil  
10 saturations down in the San Andres. The problem with  
11 that is -- I mean, so yes, there's oil in the deeper  
12 San Andres. The problem is they're separated by  
13 hundreds of feet. They don't necessarily have the  
14 profile.

15 If you look on the right of that diagram  
16 for the Seminole San Andres Unit, at the water  
17 saturations in the right track there, you see that  
18 there's kind of a wall of 40 percent, 45 percent  
19 saturations from the top of the interval to the bottom  
20 of the interval.

21 When I'm looking at the oil saturations,  
22 for example, at the bottom left of the EMSU 746, they  
23 don't really have that flat profile. In my view,  
24 those are more indications of abandoned migration  
25 paths. I may be wrong on that, but in my view, that's

1 what they are. They certainly don't seem to represent  
2 the profile that I would associate with an ROZ.

3 The other problem is that the  
4 majority -- when I do calculate the presence of oil,  
5 the majority of it is less than 20 percent. And  
6 Dr. Trentham excludes intervals with less than  
7 20 percent. Ops excluded intervals with oil  
8 saturations less than 20 percent. We excluded oil  
9 saturations less than 20 percent.

10 And if we go over here to the right, and  
11 let's go up to what's the MPZ in the SSAU, can you put  
12 the cursor up there for me, that interval, that's been  
13 CO2 flooded for over 40 years and the oil saturations  
14 don't -- rarely exceed 20 percent.

15 So to me, that tells me CO2 is not going  
16 to be effective at oil saturations at 20 percent or  
17 less. And, you know, Dr. Trentham agrees with me on  
18 that. And so, in my view, counting the oil  
19 saturations less than 20 percent down there and  
20 including that as potential economic oil is not  
21 prudent.

22 There are some intervals, and if you  
23 look down there, particularly at the bottom, let's go  
24 down to the bottom on the 746, there's intervals up  
25 there that are 30 and 40 percent oil saturation. But

1 they're very thin and, in my view, they're probably  
2 not ROZ. They're probably migration paths.

3 But there's just not going to be enough  
4 down there, at least in my opinion, to be economically  
5 attractable to go after. And if they're migration  
6 paths, they're not going to have any aerial  
7 continuity. And if there's major karsting down there,  
8 it's going to steal the CO2 and prevent it from being  
9 able to displace any of that in the first place.

10 Q. So, sir, you know, as a petroleum engineer,  
11 and based on your extensive experience, I want to ask  
12 you, what is the typical residual oil saturation to CO2  
13 injection?

14 A. It might be about 20 percent.

15 Q. Residual oil saturation --

16 A. To CO2, yes. Now, in the lab, they can get  
17 it down to about 12 percent. But the problem is, in  
18 the lab, you have a confined tube, and the CO2 can  
19 escape.

20 In reality, when you have an unconfined  
21 CO2 injection, dispersion will drive a bunch of that  
22 CO2. Unless it's confined between the very good  
23 barriers, dispersion will drive it out and you don't  
24 get a nice sweep across the entire interval.

25 And, again, I go back. The interval in

1 the MPZ on the right has been CO2 flooded for 40 years,  
2 and there's very few saturations, less than  
3 20 percent. So I think that's kind of the bottom. In  
4 a practical field operation, that may be the bottom.  
5 And it's not because the CO2 couldn't do it more. And  
6 in a core plug, you can get it down to maybe 12 to  
7 14 percent, but in the reservoir, dispersion kicks you  
8 out where you can't really get it that low.

9 Q. Just help me understand why in our industry,  
10 where, let's say, oil saturation, irreducible oil  
11 saturation to about -- let's say residual oil  
12 saturation to about 27 percent, 25 percent is where we  
13 kickstart CO2 injection.

14 A. And I believe that -- and what you find is  
15 that you get a lot of the oil between 20 percent and  
16 27 percent. And if you've got a lot of area, that's  
17 turned out to be quite a bit of oil.

18 Q. Well, I'm not sure any company will go in  
19 and say that I do have movable 7 percent saturation  
20 points that I'm going to throw in huge amount of  
21 capital to proceed with the CO2 injection.

22 A. I wouldn't put a large amount of money into  
23 doing anything when the saturations are less than  
24 20 percent, because I don't believe it's been  
25 demonstrated that you can reduce the saturations much

1 lower than 20 percent. And I think Dr. Trentham would  
2 agree with me on that.

3 And what they -- and I actually did the  
4 analysis. I mean, it's in my write-up. I went back  
5 and looked at Seminole. Seminole's very well defined  
6 in their CO2 project. And I went back and I did the  
7 analysis, and I said what was primary, what was  
8 secondary?

9 I calculated in the main production zone  
10 what the residual, average residual saturation  
11 post-secondary recovery was, and then I looked at what  
12 happened, what the projections were going to be post  
13 CO2.

14 And, basically, I found that if I took  
15 the residuals that were present at the end of the  
16 waterflood and reduced those residuals down to the 20  
17 percent, I was able to match the production, the CO2  
18 performance that they actually obtained.

19 And that was a method, a secondary  
20 method, and it's in my rebuttal testimony. Because I  
21 got such pushback on this 20 percent, "Why are you  
22 excluding the intervals that have 20 percent oil  
23 saturation? They're going to sweep, too."

24 I'm like, there doesn't appear to be any  
25 indication of that. So I went back and looked at

1 Seminole, and when I did the analysis, I said -- you  
2 know, I showed that, yeah, you could -- the average --  
3 post waterflood, the average residual is about 35  
4 percent. If I take that 35 percent and reduce it to  
5 20 percent, I could reproduce the recovery that  
6 occurred from CO2.

7 Q. So, sir, when we say that typical -- based  
8 on Steve and then Bob's testimony, did you find ROZ  
9 more or less from 20 percent upwards?

10 A. Yes, sir.

11 Q. So are you saying that that is a wrong  
12 definition?

13 A. No, I think that's a perfect definition.  
14 They're smart enough not to include the intervals with  
15 oil saturations below 20 percent and their in-place  
16 estimates when they calculate the ROZ potential.

17 Now, I'm not saying that it -- don't  
18 calculate -- don't count from 20 down. If an interval  
19 has got 35 percent oil saturation, you count the  
20 entire oil saturation.

21 I'm just saying that if an interval  
22 doesn't have at least -- it doesn't exceed 20 percent,  
23 it's probably not going to flood economically and it  
24 shouldn't be calculated in the in place.

25 The recovery factors are based on the



1 in-place estimates, right? And if you look at  
2 Seminole and you look at the in-place estimates on the  
3 intervals above 20 percent, and you calculate what  
4 happened, what you find is that they got roughly  
5 25 percent of the oil that was in place in the  
6 intervals that exceeded 20 percent oil saturation.  
7 That recovery factor goes with that oil in place.

8 Now, if we had included the whole  
9 interval, all oil is oil, it's all oil in place, then  
10 that recovery factor would probably fall down to 5 or  
11 6 percent, which is fine. But you've got to  
12 understand that recovery factor and in place are  
13 implicitly tied together, you cannot separate them.  
14 And if you're going to include oil that's not going to  
15 move, then you've got to reduce the recovery factor to  
16 account for the fact that it doesn't move.

17 And as a result, Dr. Trentham and Melzer  
18 have basically said 20 percent and above is what we  
19 need to consider as intervals that contain ROZ that's  
20 commercially retrievable.

21 Q. You also talked about using a 7 percent  
22 cutoff. I mean, you said that is an industry  
23 practice. Is there any reference to a carbonate where  
24 7 percent is used as a cutoff, any reference that you  
25 can share with the Commission?

1           A. You could probably go up and look at the  
2 Maljamar data. I think they use 6 percent there. The  
3 industry standard, to my understanding, is typically  
4 for carbonates on conventional analysis, conventional  
5 waterflood, primary production. You usually use a 1  
6 millidarcy cutoff. And then you look at your porosity  
7 perm, because we can't calculate permeability with  
8 well logs. Some people think they can, but we need --  
9 in reality, we can calculate porosity, we can  
10 calculate saturations, if we have core data, we can  
11 build a porosity permeability cross-plot.

12                   And then we say, okay, let's look at  
13 down there. And in most cases, you say, okay, for an  
14 oil, we'll use 1 millidarcy and then I'll curve fit  
15 that line, and I'll say, okay, at this point, I've got  
16 as many points that I'm excluding that are above 1  
17 millidarcy as I'm including that are below 1  
18 millidarcy. So I'll use that porosity cutoff in lieu  
19 of a permeability cutoff and I'll say that porosities  
20 below that interval or that level are non-reservoir.

21                   I didn't want to be that strict, so we  
22 actually went -- because, again, and you made the  
23 point, because this is gas injection and gas can move  
24 in places that liquids can't, I said, okay, let's use  
25 a .1 millidarcy cutoff. And that .1 millidarcy cutoff

1 with that 679 data indicated a -- I mean,  
2 permeability -- a .1 millidarcy permeability cutoff  
3 corresponded to about a 7 percent.

4 And I went and talked to Bill Knights,  
5 who is our geologist, and I said, "What are people  
6 using for cutoffs in the San Andres:

7 He said, "Well, generally, somewhere  
8 between 6 and 8 percent."

9 And I said, "Fine. We're right where  
10 everybody is."

11 So I was comfortable with that and I was  
12 comfortable with it because we allowed the fact that  
13 not using the traditional 1 millidarcy, going to a  
14 tenth of a millidarcy, because we were evaluating a  
15 potential CO2 operation rather than a waterflood  
16 operation. So it's a little bit more inclusive. I  
17 felt like I was being generous. And I'll say --

18 Q. Okay?

19 A. -- Empire and those folks are going to say,  
20 "My, God, you're killing this. It's a 4 percent."  
21 You know, and there's different opinions on that. And  
22 believe me, as a petrophysicist for a reserve  
23 consulting company, cutoffs come up every day and I  
24 get hammered. I've never been right in my 45 years on  
25 a cutoff with anybody else.

1           So I always argue it needs to be  
2 different than what I've selected. So, you know, I've  
3 got a pretty thick skin on that. I get criticized  
4 regularly for my cutoffs.

5           Q. So, my question to you was, do you have a  
6 reference, a documented reference --

7           A. Well, I can --

8           Q. -- to show the Commission?

9           A. I guess I can show you where -- for example,  
10 at Maljamar, in their waterflood study, where they did  
11 the pressure core, their oil-in-place estimates are  
12 based on a 6 percent cutoff, which -- but, on the  
13 other hand, that's better quality rock in the Upper  
14 San Andres using a 1 millidarcy cutoff.

15           So, you know, I would say that I'm even  
16 more aggressive because I'm using a tenth of a  
17 millidarcy in the porosity that goes with that?

18           I can show you that reference. I've got  
19 it with me. We can take it out and look at it, if you  
20 want to see it.

21           But as far as are their general  
22 references that say what the cutoff should be, I  
23 haven't seen it. And, if there are, I haven't found  
24 one that I can show you.

25           Q. Yeah. So, I was curious, during the cross,

1 you said in the industry, we use 7 percent. So, I was  
2 curious to know that.

3 Now, my last question to you, hopefully  
4 to be the last one, it depends on how you respond to  
5 it, are you familiar with the water withdrawal wells  
6 within the vicinity --

7 A. Yeah.

8 Q. -- of the EMSU?

9 Now, so, you do have excessive high  
10 volumes of higher salinity water injected by Goodnight  
11 into the San Andres.

12 A. Right.

13 Q. Don't you believe that, at some point, that  
14 injection is going to impact the water supply wells,  
15 where you have higher salinity with different types of  
16 TDS, different types of, let's say, composition  
17 withdrawn and utilized as a waterflood in the  
18 Grayburg? Is that not going to impact the activity in  
19 the Grayburg?

20 A. Well, again, I haven't looked at where the  
21 water supply wells are completed. I would have to  
22 think that if the water supply wells were all the way  
23 down into the Lower and you continually inject  
24 isolated into the Lower San Andres, that you're --  
25 potentially there's going to be communication.

1                   However, the other option is to take  
2     water out of that shallower interval above what I call  
3     the gamma ray marker. Again, those operational  
4     considerations will have to be considered as -- you  
5     know, I guess at the end of the day, I think both of  
6     these companies could get along just fine and an  
7     equitable solution to this problem can be found.

8                   And it may mean that different water  
9     supply wells have to be drilled other places. It may  
10    mean that they have to install pressure monitoring and  
11    all those sorts of things. But I don't see any reason  
12    why both of these projects can't go on. And that's  
13    just my personal opinion. Nobody from Goodnight talks  
14    to me about this stuff. I'd just be looking at the  
15    practical aspects and wanting the best for everybody.

16                  I want everybody to succeed. Our  
17    company wants everybody to succeed. What we try to do  
18    is identify risk and help people make the best  
19    decisions possible. And when I look at this, I think,  
20    guys, there's potentially some great projects here for  
21    everybody.

22                  You know, the disposal -- disposal is  
23    valuable to the producers in New Mexico as well.  
24    They've got to have somewhere to put the water they're  
25    producing or they're going to have to shut wells in.

1           You know, there's a lot of people, a lot  
2 of moving parts in this thing. And in my view, it's  
3 one of those deals that everybody can get along, we  
4 just need to figure out how to work together on this.

5           Q. Well, you said everybody can get along. So  
6 you are not aware of any discussion between Goodnight  
7 and Empire, where Goodnight is proposing to Empire  
8 that just focus on the Upper San Andres and let us do  
9 our own thing in the Lower San Andres.

10          A. I wasn't involved in any of that, so yeah,  
11 I'm not aware of that.

12          Q. You know, so based on what you discussed,  
13 then could there be a scenario where the Commission  
14 will say that, "Okay. Let's give Empire the time  
15 frame they are requesting for probably two or three  
16 years and let them do their characterization analysis  
17 and come back to the Commission and prove to the  
18 Commission that 'we drilled, we saw it, and it's  
19 recoverable'?"

20          A. That's fine, but I'm not sure that  
21 curtailing injection for the Goodnight wells during  
22 that process is necessary.

23                 Again, I think Goodnight could go -- if  
24 they wanted -- I mean, Empire, if they wanted to go  
25 ahead and try to do the work to establish an ROZ in

1 the Lower, in my view, there's nothing right now from  
2 stopping them.

3 If it's truly immobile oil, you know, in  
4 other words, it's not mobile, the injection operations  
5 aren't going to move it. And you could drill and core  
6 it and see whether or not the ROZ profile exists. I  
7 don't think there's anything stopping them from doing  
8 that. For whatever reason, they're hesitant to make  
9 that jump.

10 And again, when you look at the big  
11 picture of everybody that's depending on this disposal  
12 and the fact that it's an ROZ and the oil is not  
13 mobile, this is just me, I don't know why you couldn't  
14 go out and drill a well if you wanted to do it and  
15 core it right now. Because the injection is not  
16 moving the oil anywhere. What you're interested in  
17 is, is there an ROZ in that lower section.

18 You know, I don't see any reason why  
19 they couldn't do that. And I don't see any reason why  
20 injections couldn't continue while they do it. And I  
21 don't know why they're not doing it. You'd have to  
22 ask them that.

23 But I'm looking at it, and it's like, I  
24 don't see any real reason to change anything until  
25 there's definitive evidence that you need to.



1 COMMISSIONER AMPOMAH: Thank you, sir, for  
2 testimony.

3 HEARING OFFICER HARWOOD: Thank you,  
4 Dr. Ampomah.

5 Mr. Lamkin, questions for Dr. Davidson?

6 COMMISSIONER LAMKIN: Yeah, I have a couple.

7 EXAMINATION

8 BY COMMISSIONER LAMKIN:

9 Q. Good afternoon, Dr. Davidson. Thank you for  
10 your testimony.

11 With regard to this slide that's up  
12 right now, did you perform any analysis on other wells  
13 that were logged through the Lower San Andres to see  
14 if their saturations conformed to what you found in  
15 this well?

16 A. We did. When I was able to do -- the wells  
17 that penetrated into the San Andres that were  
18 available to me, some of them didn't penetrate all the  
19 way through. I was also able to -- the other thing  
20 that we did is I had wells inside the EMSU that were  
21 disposal wells and a few wells outside the boundary of  
22 the EMSU that were disposal wells that did penetrate  
23 the entire section.

24 And yes, we did find evidence of small  
25 intervals of residual oil up and down the system, much

1     like is displayed in this exhibit here, one that  
2     you're looking at.  However, when we made efforts to  
3     try to correlate them, can we correlate aerially, we  
4     couldn't really correlate them very well.

5                 And when I saw that, I'm like, there's  
6     not a layer that exists over long -- that we could  
7     identify at least, a layer that exists over long  
8     intervals or a big aerial extent where they're  
9     correlatable.

10                That's part of the reason I came to the  
11     conclusion that I think they're migration paths.  But  
12     there's probably a whole lot more wells out there that  
13     could be interpreted that we didn't have access to.  
14     But I'll tell you, of the wells we had access to, all  
15     of them had little tiny intervals here and there of  
16     oil saturations in them, and I wouldn't expect it to  
17     be anything different.

18                I mean, hell, this thing, oil migrated  
19     through Southeast New Mexico into the Central Basin  
20     Platform.  You know, the oil that's there, a lot of it  
21     came from New Mexico and migrated up into the Central  
22     Basin Platform.  It would be impossible for there not  
23     to be a little bit of oil through the San Andres.

24                The question is, did traps occur in the  
25     Lower San Andres that would create an ROZ?  We can't

1 see evidence of that. But we do see evidence of  
2 little elevated saturations periodically through the  
3 Lower San Andres that, thus far, I've been unable to  
4 correlate from well to well, which indicates to me,  
5 again, that they are migration paths and not ROZs.

6 Q. What can you tell the Commission to  
7 alleviate any concerns that this was not a well that  
8 was cherry-picked for low oil saturations in  
9 comparison to the other ones that you analyzed?

10 A. What you might do -- I don't remember how  
11 many of the water disposal -- the -- I think  
12 there's the -- again the data set I had early on  
13 consisted of the 746 went all the way through.  
14 There's other wells that penetrate some distance into  
15 the San Andres. They're included in my original  
16 testimony.

17 And then I think in the rebuttal, I  
18 included one of the outlier water disposal wells. I  
19 can't remember which one. It may have been Yaz, the  
20 well that is designated as Yaz. And you can see in  
21 those wells that yeah, there's periodic saturations  
22 that show up.

23 I'm not sure how many of the wells that  
24 I've -- in fact, I think we turned over all of them,  
25 didn't we? We turned over all the wells that I

1 interpreted that penetrated the whole distance. Those  
2 PDFs are available. You're welcome to look at them  
3 and see where we actually did, and each well will  
4 calculate a little bit of oil periodically.

5 And I think there's four or five wells  
6 that we actually handed over that were water disposal  
7 wells, but they penetrate the entire interval. And  
8 you can see those periodic oil saturations calculated  
9 in them, so we've provided that data.

10 Q. Is that part of the exhibit packet that was  
11 submitted with the case?

12 A. I believe it is.

13 THE WITNESS: Mr. Rankin, is that the case?  
14 I mean, it's certainly something we could.

15 MR. RANKIN: My PDF is not cooperating, but  
16 I believe, Dr. Davidson, you included them in your  
17 appendix to direct testimony. So I don't --

18 A. They were there, and we provided -- after  
19 Ms. Shaheen determined that we use those, that they  
20 were important, we provided them to the Empire at that  
21 time. And so I don't know what the final disposition  
22 was. I know they've been provided to some of the  
23 parties here at least.

24 Q. With regards to the loss circulation zone  
25 above the high gamma ray marker, have you seen any

1 other drilling reports or mud logs or anything like  
2 that outside of Goodnight's claims that would indicate  
3 that that is consistent across the formation in that  
4 area?

5 A. Again, this is my understanding, and so just  
6 understand this is what I understand, what I've been  
7 told. In the wells I evaluated, I had Goodnight  
8 provide the top of the loss circulation interval for  
9 every well -- when they lost circulation, I said to  
10 tell me where that top is, and those are posted,  
11 they're posted on my logs, where the loss circulation  
12 occurred.

13 Now, anecdotally, I've heard that the  
14 Pilot and the other injection operators experienced  
15 the same type of loss circulation when they penetrate  
16 these anhy- -- as soon as they get out of the bottom  
17 of the anhydrite intervals, that they lose  
18 circulation. Again, the Pilot and the others could  
19 provide that information.

20 Potentially, I have -- again, I haven't  
21 interpreted their logs. I'm told that loss  
22 circulation below this little yellow band is common  
23 with all the water disposal wells that are present. I  
24 can't confirm that. But I do have loss circulation  
25 tops for all the Empire wells -- I mean, all the

1 Goodnight wells.

2 And it's consistent that once you get  
3 down into this interval, I want to say, and I'm told  
4 that tens of thousands of barrels are lost and they  
5 drill for long periods of time with no returns, and  
6 that's -- when I found that out, that's when I said  
7 this thing's got to be karsted; you just don't get  
8 that kind of behavior.

9 And it's always been unusual to me that  
10 we could drill entirely through the Grayburg Upper  
11 San Andres interval and maintain circulation. It's  
12 roughly the same pressure. I think it's 1300 psi up  
13 in the -- or higher up in the Grayburg San Andres  
14 interval. It's maybe 1,500 psi down below. Right?

15 But we could drill through that entire  
16 interval, and as soon as we get through -- into this  
17 interval with what I call bedded anhydrites, when we  
18 drill out of the bottom of that, we consistently lose  
19 circulation. I'm going, how can that happen if it's  
20 not a karsted interval? And how could we have all  
21 this volume injected and not see a major pressure  
22 increase?

23 And so I did -- the conclusion that I  
24 draw, that aquifer is huge and we have isolation, you  
25 know. And Mr. Wehmeyer was trying to, you know, paint

1 me into a corner: Well, can you say for certain?

2 No, I can't say for certain based on  
3 this diagram. But the preponderance of the evidence,  
4 at least that I've seen so far, makes me comfortable  
5 with saying that this interval and this interval are  
6 separated from one another.

7 And I think Mr. Knights has even talked  
8 about other potential barriers that exist in the Upper  
9 San Andres and the Grayburg that also help isolate  
10 these two. So it's not just me talking. There's  
11 going to be other evidence presented as well.

12 Q. Okay. And I think that that leads into my  
13 last question, which was, in the scope of work that  
14 you had, you didn't do any analysis into a barrier to  
15 fluid migration between the San Andres and the  
16 Grayburg, just the Lower and Upper San Andres?

17 A. No.

18 COMMISSIONER LAMKIN: Okay. Thank you.

19 HEARING OFFICER HARWOOD: Thank you,  
20 Mr. Lamkin.

21 Mr. Rozatos, last but certainly not  
22 least, questions for Dr. Davidson?

23 CHAIR ROZATOS: Mr. Hearing Officer, I'm  
24 sorry, I'm having technical difficulty as I was  
25 trying to unmute.

1                   No, I do not have any questions. Thank  
2     you.

3                   HEARING OFFICER HARWOOD: Let me ask you,  
4     Mr. Rankin. It seems, based on everything we've  
5     heard from Dr. Davidson, which seems like everything  
6     he conceivably knows on this subject, do you have any  
7     redirect examination you even need to do?

8                   MR. RANKIN: Mr. Hearing Officer, I do -- I  
9     think I would like to do a little bit of redirect  
10    with Dr. Davidson. Although it's possible that after  
11    I have a meeting to evaluate it, I may curtail it  
12    significantly. There are a few points that  
13    Mr. Lamkin raised that I think I would like to  
14    address. And there are a few others that I would  
15    like to address as well, given that we have, you  
16    know, just about 20 minutes left before 5 o'clock,  
17    and it was a long day.

18                  I may suggest, with the Commission's  
19    approval, that we reconvene in the morning to  
20    complete the redirect.

21                  HEARING OFFICER HARWOOD: Chairman Rozatos,  
22    what's your preference on that?

23                  CHAIR ROZATOS: I'm good with that. We can  
24    call it a day. It's already 4:40. So why don't we  
25    call it a day, and then we can start back up again in



1 the morning.

2 HEARING OFFICER HARWOOD: All right. I  
3 mean, I assume this is a captive witness, that it's  
4 not going to inconvenience Dr. Davidson if we don't  
5 get him off the stand today?

6 CHAIR ROZATOS: I agree. And the doctor is  
7 tired.

8 Thank you, Doctor, for your time.

9 HEARING OFFICER HARWOOD: I think your voice  
10 needs a break anyway, Dr. Davidson.

11 THE WITNESS: That's fine. I'm happy to  
12 keep going on forever.

13 HEARING OFFICER HARWOOD: All right. So,  
14 let's break for the day and pick back up again bright  
15 and early and fresh tomorrow at 9 o'clock.

16 Thank you all and thank you, Madam  
17 Court.

18 CHAIR ROZATOS: Thank you. We'll meet  
19 everybody at 9 o'clock tomorrow.

20 (Proceedings adjourned at 4:41 p.m.)  
21  
22  
23  
24  
25

1 AFFIRMATION OF COMPLETION OF TRANSCRIPT

2  
3 I, Kelli Gallegos, DO HEREBY AFFIRM that on  
4 April 21, 2025, a hearing of the New Mexico Oil  
5 Conservation Commission was taken before me via video  
6 conference.

7 I FURTHER AFFIRM that I did report in  
8 stenographic shorthand the proceedings as set forth  
9 herein, and the foregoing is a true and correct  
10 transcript of the proceedings to the best of my  
11 ability.

12 I FURTHER AFFIRM that I am neither employed  
13 by nor related to any of the parties in this matter  
14 and that I have no interest in the final disposition  
15 of this matter.

16 

17 Kelli Gallegos

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[curve - davidson]

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[davidson - depositional]

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**[depositional - different]**

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[different - disturbing]

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[dive - drill]

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[drill - empire's]

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**[pressure - productive]**

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[square - subsurface]

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