STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION FOR THE PURPOSE OF CONSIDERING:

APPLICATION OF PENDRAGON ENERGY PARTNERS, INC., AND J.K. EDWARDS ASSOCIATES, INC., TO CONFIRM PRODUCTION FROM THE APPROPRIATE COMMON SOURCE OF SUPPLY, SAN JUAN COUNTY, NEW MEXICO

CASE NO. 11,996

ORIGINAL

REPORTER'S TRANSCRIPT OF PROCEEDINGS, Volume I

EXAMINER HEARING

BEFORE: DAVID R. CATANACH, Hearing Examiner

RECEIVED
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Oil Conservation Division

July 28th, 1998

Santa Fe, New Mexico

This matter came on for hearing before the New Mexico Oil Conservation Division, DAVID R. CATANACH, Hearing Examiner, on Tuesday, July 28th, 1998 (Vol. I), at the New Mexico Energy, Minerals and Natural Resources Department, Porter Hall, 2040 South Pacheco, Santa Fe, New Mexico, Steven T. Brenner, Certified Court Reporter No. 7 for the State of New Mexico.

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I N D E X

July 28th, 1998 (Volume I)
Examiner Hearing
CASE NO. 11,996

* * *

E X H I B I T S (Volume I)

Applicant's	Identified	Admitted
Exhibit N1	11	92
Exhibit N2	20	92
Exhibit N3	22	92
Exhibit N4	21	92
Exhibit N5	29	92
Exhibit N6	36, 37	92
Exhibit N7	38	92
Exhibit N8	42	92
Exhibit N9	46	92
Exhibit N10	49	92
Exhibit N11	49	92
Exhibit N12	54	92
Exhibit N13	58	92
Exhibit N14	60	92
Exhibit N15	63, 72, 73	92
Exhibit N16	73	92
Exhibit N17	78	92
Exhibit N18	82, 83	92
Exhibit N19	85	92
Exhibit N20	88	92
Exhibit N21	88	-

* * *

Exhibit B1	188	217
Exhibit B2	189	217
Exhibit B3	191	217
Exhibit B4	193, 194	217
Exhibit B5	195	217
Exhibit B6	199	217
Exhibit B7	201	217
Exhibit B8	202	217
Exhibit B9	207	217

(Continued...)

E X H I B I T S (Continued)

Applicant's	Identified	Admitted
Exhibit B10	210	217
Exhibit B11	212	217
Exhibit B12	213	217
Exhibit B13	213	217
Exhibit B14	204	217
Exhibit B15	204	217

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Whiting/Maralex	Identified	Admitted
Exhibit 9	103	285
Exhibit 37	218	-
Exhibit 39	219, 240	-
Exhibit 40	219, 242	-

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A P P E A R A N C E S

FOR THE DIVISION:

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By: J.E. GALLEGOS
and
MICHAEL J. CONDON

ALSO PRESENT:

FRANK T. CHAVEZ
District Supervisor
Aztec District Office (District 3)
NMOCD

ERNIE BUSCH
Geologist
Aztec District Office (District 3)
NMOCD

* * *

WHEREUPON, the following proceedings were had at 8:23 a.m.:

EXAMINER CATANACH: Call the hearing to order this morning for this special docket, and at this time we'll call Case 11,996

MR. CARROLL: Application of Pendragon Energy Partners, Inc., and J.K. Edwards Associates, Inc., to confirm production from the appropriate common source of supply, San Juan County, New Mexico.

EXAMINER CATANACH: Call for appearances at this time.

MR. HALL: Mr. Examiner, Scott Hall from the Miller Stratvert Torgerson law firm, Santa Fe, on behalf of the Applicants. And I've also entered an appearance in this case on behalf of Pendragon Resources, L.P.

I have five witnesses to be sworn as well.

MR. CARROLL: And who is Pendragon Resources, L.P.?

MR. HALL: Pendragon Resources, L.P., is the owner of the working interest dedicated to the Chaco wells that are the subject of this Application. Pendragon Energy is the operated of the Chaco wells.

EXAMINER CATANACH: And you're also representing J.K. Edwards Associates?

MR. HALL: Yes.

EXAMINER CATANACH: Okay.

MR. GALLEGOS: Mr. Examiner, appearing on behalf of Whiting Petroleum, Inc., and Maralex Resources, Inc., Gene Gallegos and Michael Condon, Santa Fe.

MR. CARROLL: And how many witnesses do each of you have?

MR. HALL: I have five.

MR. GALLEGOS: We have four, I believe.

MR. CONDON: We may have five if there's an issue on land, title description.

EXAMINER CATANACH: Okay, call for additional appearances?

MR. GEORGE SHARPE: Mr. Examiner, Merrion Oil and Gas requested the opportunity to appear. We don't anticipate giving testimony at this hearing but would like to retain the right to do so if it's continued or appealed. Tommy Roberts will be representing us if we do.

EXAMINER CATANACH: Okay. Any additional appearances?

Okay. I'd just like to mention that we have some Division staff from the Aztec District Office. Mr. Frank Chavez and Mr. Ernie Busch are here today to sit in on the proceedings, and they will be allowed to ask questions of the witness.

And if need be, Mr. Busch may testify, if he needs to clarify some Division policies or issues. I don't know that, but we'll see at the end of the hearing.

So Mr. Hall, are you prepared to --

MR. CARROLL: I'll swear in the witnesses.

EXAMINER CATANACH: We need to swear in the witnesses here.

(Thereupon, the witnesses were sworn.)

MR. HALL: Mr. Catanach, we had not planned on giving an opening statement. We will do so if you request one. Otherwise, we'll go straight to the first witness.

EXAMINER CATANACH: Mr. Gallegos, did you plan on making an opening statement?

MR. GALLEGOS: No, I think we can just proceed.

EXAMINER CATANACH: Okay, let's just proceed, Mr. Hall.

MR. HALL: Call Al Nicol to the stand.

<u>ALAN B. NICOL</u>,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. HALL:

Q. For the record, Mr. Nicol, state your name.

A. My name is Alan B. Nicol.

Q. Mr. Nicol, where do you live, and by whom are you employed and in what capacity?

A. I live at 5895 Fig Court in Arvada, Colorado. I'm the President of Pendragon Energy Partners, Incorporated.

Q. And have you previously testified before the Division or the New Mexico Oil Conservation Commission?

A. No, I have not.

Q. In view of that, why don't you give the Hearing Examiner a brief summary of your educational background and work experience?

A. I have a bachelor of science degree in geological engineering from Michigan Technological University and a master of science in geological engineering from the university of Utah.

I began my career in the oil business in 1969 with Shell Oil Company and have been working steadily in the business since then. I spent four years with Shell and then with a series of independents as exploration manager, vice president of exploration and operations, those sorts of positions.

One of the companies was Resources Investment Corporation in Denver, which grew in the five years I was there from a $5-million drilling fund company to $35 million, and at one point I had a staff of 22 geologists who were either on retainer or as employees, generating and screening prospects.

In 1980 I was co-founder of Bellwether Exploration Company, and when that was sold in 1985 I became a consultant for a period of time with a number of clients, both on retainer and occasional clients, and then in 1992 formed Pendragon Energy Partners, Incorporated, with two other individuals.

Q. Mr. Nicol, are you familiar with the lands and the wells that are the subject of this Application?

A. Yes, I am.

Q. And you're familiar with the Application itself?

A. Yes.

Q. We'd offer -- By the way, are you in-house geologist for Pendragon now?

A. Yes.

MR. HALL: We'd offer Mr. Nicol as expert petroleum geologist.

EXAMINER CATANACH: Any objection?

MR. GALLEGOS: No objection.

EXAMINER CATANACH: Mr. Nicol is so qualified.

Q. (By Mr. Hall) Mr. Nicol, if you would, please summarize what it is that Pendragon is asking for by this Application.

A. We're asking the Commission for an order that states we are the -- this concerns the six Pendragon Edwards wells in question, that they are Pictured Cliffs wells, that we are producing from the proper source of supply.

Q. All right, if you'd refer to what's been marked as Exhibit N1, why don't you identify that and familiarize the Examiner with the properties?

A. This first exhibit is simply a picture of our leasehold position and ownership in the area in question. We're discussing portions of Township 26 North, 12 West; 26 North, 13 West, in San Juan County, which is roughly 20 miles south of Farmington.

And there are a total of 11 wells that we will be referring to frequently as being wells in question here.

Starting just from the top of the map, the Chaco 2-J well, operated by Pendragon, sometimes shows up as the Chaco Limited 2-J, and that's in Section 1 of 26-13.

Also in Section 1 is the 1-J well, in the southwest quarter.

And in the southeast quarter, the Chaco 5 well.

And then down in 26-12, Section 7, we have the Chaco 4, Chaco 2-R, and then south of that in Section 18, the Chaco Number 1.

Offsetting Whiting/Maralex wells that are a part of this debate are the 26-13 1-1, which is only a few hundred feet from our Chaco 1-J well; 26-13 1-2, which is about 600 feet from our Chaco 2-J well; the 26-12 6 Number

2, which is in the southwest quarter of Section 6 of 26-12; the 26-13 12-1, which is in the northeast quarter of Section 12, diagonally south of the 6-2; and the 26-12 7 Number 1, which is about 800 feet from our Chaco 2-R in the west half of Section 7, 26-12.

The color coding is what you get when you ask a person to color-code a map and don't tell them what color you want, so we're working with pink and magenta here.

The pink is acreage under which Pendragon and Edwards own the Pictured Cliff rights and/or Pictured Cliffs and below.

The purple color or magenta color is where we own Fruitland and Pictured Cliffs, or Fruitland, Pictured Cliffs and below, which in effect is all of the rights under consideration here.

And then there's a blue tract here in Section 8 where we own only the Fruitland rights.

Q. Tell us how Pendragon acquired these particular properties.

A. These properties were purchased through an offering that Merrion made at an EBCO auction, so we bid at them -- or bid for them at auction jointly with J.K. Edwards.

At that time J.K. Edwards, when we acquired them, became the operator. So there was a period of time here where J.K. Edwards was operating the wells, and then Pendragon took over operations early in 1996. The wells were acquired late in 1994.

Q. All right. Generally, what rights did Edwards and Pendragon acquire from Merrion?

A. The sale was advertised as Pictured Cliffs rights only, and that was the intention of the parties, that we buy Pictured Cliffs wells.

The wells were perforated and producing or had produced in the Pictured Cliffs formation.

Q. All right. When Edwards and Pendragon acquired these wells, I assume some due diligence was done, review of the completion reports. What do those completion reports reflect with respect to completion interval?

A. The completion intervals are -- Usually there were two sets of perforations in the wells. The Chaco 2-R is perforated in only one zone, the other wells were perforated in two zones each. And the completion reports and production reports all showed those as Pictured Cliffs production, Pictured Cliffs perforations.

Q. All right. Tell us about the dispute that grew up between Whiting and Maralex on the one hand, and Pendragon/Edwards on the other, that led to these Applications before the OCD.

A. This dispute actually started, to my knowledge --

I believe it was probably late spring, May or June of 1996, when I got a call from J.K. Edwards saying that Maralex had asked for a -- I don't want to call it a hearing, but an audience in front of the Aztec Oil and Gas Commission office to register a complaint that they felt that we were producing their coal reserves out of our Pictured Cliff wells.

So we attended a meeting in Aztec shortly after that where Maralex made a presentation of what they thought was the problem to a group of people, including interested operators and representatives from the BLM, and made the demand, basically, that we shut in our wells based upon that presentation until something could be determined as to what the proper split would be for the production.

We didn't come prepared to make a presentation, and didn't make one, and refused to shut in our wells until a lot more work was done. And Mr. Busch with the Aztec office made a plea that the parties settle this among themselves and meet to sort out what the questions and the problems were and have a general exchange of data to further investigate whether or not, in fact, there was a problem.

That led to --

MR. GALLEGOS: Excuse me, excuse me. I hate to interrupt the witness, but this is far from responsive.

This has gotten way on off the question.

MR. HALL: Well, I think it's --

MR. GALLEGOS: I think we're proceeding by question and answer here. I object to the witness just going off on a narrative.

Also, beyond this, I object to the relevancy of this. Efforts of the parties to compromise are not relevant to the issues here to be decided on the evidence.

EXAMINER CATANACH: Well, I think it's good to have some background information on those negotiations. Don't get too far into it, though, Mr. Hall.

Q. (By Mr. Hall) Go ahead, Mr. Nicol.

A. Let's see if I can make this a little more brief.

That led to at least one other meeting in our office in Denver with Mr. O'Hare from Maralex to discuss the problem further and exchange data.

We still did not see that there was a problem here that needed to be -- that required some sort of compromise. We didn't feel that we had any indication that we were producing Fruitland Coal gas, and still don't.

The last meeting with Maralex, I believe, was in November of 1996, and then nothing more was heard until late in 1997 when we began to hear that Maralex and Whiting were going to make an application to the Commission to have this matter heard, and that was actually formally done in

1997, January of 1997, I believe.

That application, then, led to another plea from the staff, Commission staff, in Aztec to have the parties meet under their auspices to try to work out the problems and again address what exactly the questions were and whether or not there was a problem.

We had three such meetings in Aztec, from February through March of 1998. Have I lost a year there somewhere? Did I say 1997 the first time? I mean the Application was made in January of 1998.

And the sequence of events was that again Maralex and Whiting presented what their problems were and their complaints, their evidence for the problem.

We came back the next meeting and rebutted and refuted as we could, and the third meeting was basically an effort to see where we go next.

There was a lot of information exchanged in these meetings and a lot of presentations made. There was no agreement among the parties as to what the resolution was. I think the only agreement we might have was how well it was handled by the Aztec staff from the standpoint of monitoring it and providing the venue for that effort.

Not too long after the last meeting, we were notified that Maralex and Whiting had taken the case directly to Santa Fe District Court. That resulted in a court hearing, I believe a month ago today, here in Santa Fe, in front of Judge Encinias.

And at that hearing Whiting and Maralex presented their side of the case. And at that point, without hearing anything further, Judge Encinias issued an injunction shutting our wells in until the matter could be further determined from the Commission.

Q. During the course of the discussions before the District Office in Aztec, were Whiting and Maralex contending that fracture-stimulation jobs on certain of the Chaco wells were communicating through to their Fruitland Coal and interfering with their Fruitland Coal wells?

MR. GALLEGOS: I object to the relevancy of this. Numerous discussions of what various people said at various times are neither here nor there. Are we going to -- I think this matter is to be decided on the evidence to be presented here under oath.

EXAMINER CATANACH: Go ahead and answer the question.

THE WITNESS: Yes.

Q. (By Mr. Hall) In the course of those meetings, did you take the opportunity to look at the production profiles of the Fruitland Coal wells and Pictured Cliff wells and model them and compare them side by side?

A. Yes.

Q. What did you determine from that?

A. Well, our determination was that the Fruitland Coal wells were acting as you would expect coal wells to act and that the Pictured Cliff wells were acting as you expect the Pictured Cliffs to act.

As an example -- and this will come up as a formal exhibit a little later, but we have a composite here of --

MR. GALLEGOS: Well, I object to going into the contents of an exhibit that hasn't been qualified. I guess there's some other witness that's going to attempt to qualify this information. We don't have any basis of the data, anything whatsoever, and now the witness is going to bring this out as evidence.

I assume you're going to -- Pendragon is going to present some witnesses that are technical experts and attempt to prove something of this sort. But this isn't the witness, this is a geologist.

MR. HALL: Mr. Catanach, we are presenting this particular exhibit through an engineering witness, and he will authenticate it to your satisfaction, I'm sure.

The purpose for revealing it to you at this point is simply to provide you with some context and some background, and I think you can give it the appropriate weight at this stage of the proceedings for that particular purpose, and that's all. That's the only reason we're revealing it to you right now.

EXAMINER CATANACH: We'll go ahead and allow the witness to testify on that.

THE WITNESS: All I wanted to demonstrate is that the -- Can you see the yellow that --

EXAMINER CATANACH: Yes, I can.

THE WITNESS: -- from where you are?

The yellow is a composite of the curves of the five Whiting wells' production, the five Whiting wells in question that I've marked in blue on that map. The orange is the decline curve for our Pictured Cliff wells.

And the point of that is simply that the Pictured Cliff wells, when they came on after our restimulations, came up to a maximum and have been declining since then. There's a jog in here when we put a well on that wasn't immediately put on at the beginning of the production, whereas the coal wells have been continuing to increase and dewater and improve in production as you would expect coal wells to do.

MR. CARROLL: Mr. Hall, what exhibit number is this going to be?

MR. HALL: That will be -- I'm sorry, I don't have the exact number. It will be one of the M-numbered exhibits that will be introduced through Jack McCartney, petroleum engineer. We'll provide that to the Examiner and the parties.

MR. GALLEGOS: We move the testimony be stricken, no foundation.

MR. CARROLL: Motion will be noted.

Q. (By Mr. Hall) Mr. Nicol, let's talk about the geology in the area. Have you prepared certain exhibits in conjunction with your geologic testimony?

A. Yes, sir.

Q. All right, let's refer to those. If you would turn to Exhibit N2, if you could identify that for the Examiner.

A. That's a structure map on the top of what I have labeled the basal Fruitland Coal. The basal Fruitland Coal, for the purpose of my discussion, is a coalbed that is ubiquitous throughout the area as the base of the Fruitland formation that is about 20 feet thick, 19 or 20 feet thick.

And I chose to do a structure map on the top of that coal to give a general picture of the structure in the area. Again, the wells in question are colored in the yellow and blue code, as was the first exhibit.

What we have is a general dip to the north northeast. There's very little structure of any moment here. There is a suggestion of a nosing through the general area of the Chaco 4 and 5 wells, which could possibly enhance permeability because of the enhancement you get with a little bit of folding and microfracturing or whatever, but otherwise generally a dip to the north northeast.

And from that I'd like to go right to the cross-section.

Q. All right, let's go to Exhibit N3.

A. In the books we've provided, behind that cross-section there is a cross-section index map that just shows where all the cross-sections we're going to be discussing go.

Q. Mr. Nicol, before we delve into Exhibit N3, let's provide further context. Would you explain some of the geologic assumptions made by the parties in the course of the meetings in Aztec, briefly familiarize the Hearing Examiner with what you understood the positions of the parties to be.

A. Well, at that time I understood the positions of the parties to be that we were producing from perforations in the Pictured Cliffs formation and that they were concerned that our restimulation jobs, fracturing of these -- for these wells, had provided an avenue where we were producing gas from the basal Fruitland Coal.

Now, I should point out that the term "basal

Fruitland Coal" is one that I have used here and placed on this map to -- for reference standpoint and so we know what bed we're talking about here.

And while I'm on that subject, I have used the term "upper Pictured Cliffs" sand here to reflect the sand -- the top sand that we are perforated in, in all but one of our wells. And I don't mean that to be a definitive term or a definition of "upper Pictured Cliffs" sand. It's -- I'm using that to refer to the sand here that we'll be referring to over and over again.

Q. All right, let's go to N3. Why don't you explain what that's intended to reflect?

A. This is a structural cross-section, using the resistivity logs, and it reflects the majority of wells in question but not all of them.

It starts with the Whiting/Maralex Gallegos Federal 12-13 1-2 in the southwest of Section 1 and goes through our Chaco Number 5 well, to the Whiting/Maralex well in the southwest of Section 6, to our Chaco Number 4 well, to the Whiting/Maralex Coal well in the west half of Section 7, to our neighboring Chaco 2-R well, and then to the Chaco Number 1 well, down in Section 18.

The Whiting/Maralex wells are perforated, as you see, in the basal Fruitland Coal. One of the wells -- the one in Section 1, the southwest of Section 1 -- is also perforated in three other stringers of coals up above the basal. The other Whiting/Maralex wells, as far as we know, are all perforated only in that basal Fruitland Coal.

The perforations for the Chaco wells, the Pendragon/Edwards wells, are in the thicker yellow sand, and then the thinner Pictured Cliffs sand just above it, which generally runs from, oh, two or three on up to about six or seven feet thickness.

That sand does not exist in the two wells shown in Section 7. As we get into the geology, I'll show how that occurs and fact that we're running kind of on the edge of this sand with this particular cross-section. This picks up again down in Section 18.

These are the perforations that we inherited when we bought the wells as Pictured Cliff wells, and we have not changed them. In two cases we've re-perforated wells, and those were the Chaco 4 and 5, but we re-perforated them in the same intervals. The other wells we did not re-perforate.

The four wells that were fracture-stimulated, that raised the question, are the Chaco 5, the Chaco 4, the Chaco 2-R and the Chaco 1. A lot of my discussion kind of leaves out the Chaco 2-J and 1-J wells because we did nothing to them beside the 500-gallon acid job back in 1995.

You will see that there's a thin shale separation between the basal Fruitland Coal and the top of the Pictured Cliffs. This shale generally runs four or five thick.

In the two wells in Section 7 you can see an indication that we're very close to the upper Pictured Cliffs sand and that the shale at the base of the basal Fruitland Coal is about the same four feet, and then you see an indication of maybe it's getting a little bit silty on the resistivity log, or trying to clean up into the sand, some indication of that, a little bit, on the Chaco 2-R.

And then by the time you get back down to Chaco 1 there's about four feet of shale again, and back into the Pictured Cliffs sand.

So basically we have coal, four feet of shale, anywhere from two or three to seven feet of Pictured Cliffs sand, another thin shale with generally a little bit of coal indication in that.

Now, there is also a little of coal at the base of the sand I've colored in yellow, in most of these wells, and in both cases we have indications that that coal is less than a foot thick, perhaps just a matter of inches, and is encased in shale. And as we go through I'll present that evidence. But that's basically the case.

So in reality, this upper Pictured Cliffs sand, which isn't -- is a matter of contention -- We were surprised at the District Court hearing a month ago to find that Maralex and Whiting have taken the position that this upper sand here is not Pictured Cliffs but it is, in fact, Fruitland Sand, so that consequently we wouldn't own it.

Whiting/Maralex also made an allegation that we had perforated in the coals. They stated in one document that they had knowledge and belief we had perforated in the coals. At that point, just to clear up the issue, we ran some new gamma-ray casing collar logs on the wells, and again we'll show that that's not the case. We have only re-perforated two wells, and we've re-perforated them in the exact same intervals that were perforated the first time.

The basis, as I understood it, for the premise that this was all of a sudden a Fruitland sand --

MR. GALLEGOS: Mr. Examiner, this is not responsive to the question that -- which was asked ten minutes ago, to explain the cross-section. Now we're going -- The witness is just going off into all sorts of other subjects. It's not responsive, it's not relevant. We object.

MR. CARROLL: What was the question, Mr. Hall?

MR. HALL: Well, in context the question is to elicit testimony to give a geologic overview of the area. That was the specific question. And that's what all of these exhibits and his testimony relate to.

It also provides further context about the dispute between the parties over the geology in the area. I think it's wholly responsive.

EXAMINER CATANACH: I think it's relevant. Let's -- Let's proceed.

THE WITNESS: At the court hearing, geological testimony was presented by Walter Ayers, and he began by describing the difference between Pictured Cliffs and Fruitland formations and the deposition, method of deposition, and did a reasonably nice job of explaining the difference between the marine deposition of the Fruitland and the -- or the marine deposition of the Pictured Cliffs and the nonmarine continental facies on the Fruitland.

But when it came down to defining this particular sand, he addressed a paper written by Fassett and Hinds in 1971, and quoted a statement in there as being definitive of what is Pictured Cliffs and what is Fruitland.

MR. GALLEGOS: Mr. Examiner, now we've got the witness testifying about what some other witness supposedly said at some time, what he thinks about that. That's improper testimony.

The record in the court -- If we want to talk about what went in the court proceeding, there's a record of that.

I object. Mr. Ayers is here to be examined, what his opinions are, and not have his opinions stated by somebody else, in this witness's words.

MR. HALL: Well, Mr. Examiner, the fact is that the issue of what certain literature contained was raised earlier. Mr. Nicol is a qualified geologist. He's also qualified to review that same literature and draw his own conclusions from that and point out to you, as an aid to help you understand the geology of the area, what the general literature says, and that's exactly what he's doing.

MR. GALLEGOS: That --

MR. HALL: The testimony is directed towards the literature.

MR. GALLEGOS: That is not the testimony. If we're arguing and Mr. Nicols [*sic*] wants to argue with the evidence that was accepted by Judge Encinias, I don't think this is the place to do that.

If Mr. Nicols has something, anything, to support his testimony, that he should do that. Dr. Ayers will present what he has to support his testimony. You'll weigh it and decide which should be accepted.

But for one witness to decide he's going to take off to criticize -- say what somebody else says and the why it's incorrect is not proper testimony.

MR. HALL: Let me just briefly address that.

EXAMINER CATANACH: Go ahead, Mr. Hall.

MR. HALL: You previously allowed testimony which framed the debate between the parties, and there is a dispute over geology. I think that's helpful to the Examiner's understanding of the issues behind this Application. I think it's entirely appropriate that we explore the context of the dispute and then some of the materials, the literature, et cetera, et cetera, that's relevant to that dispute.

MR. CARROLL: All right Well, Mr. Hall, we'd like to hear Mr. Nicol's characterization of the geology and not have him characterize Mr. Ayers' interpretation of the geology. So if you could confine your testimony to what you think is going on in this area, rather than characterizing Mr. Ayers' interpretation.

THE WITNESS: Okay.

Q. (By Mr. Hall) With that, let me ask a question of you.

Have you reviewed certain geological literature that's relied on by experts in your field in connection with this case?

A. Yes.

Q. And was one of those the Fassett article you referenced earlier?
A. Yes.
Q. And is that Exhibit N5?
A. Yes.
Q. Why don't you turn to that exhibit and point out to the Hearing Examiner the relevant portions of that, to facilitate his understanding?
MR. GALLEGOS: I'm sorry, what exhibit number are you --
MR. HALL: N5.
THE WITNESS: In that group of papers, it's the second paper. It's entitled "Geology and Fuel Resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado", by James E. Fassett and Jim S. Hinds, Geological Survey Professional Paper Number 676, printed in 1971.
On the second page of that, that I've provided, on the right-hand side, there is a discussion of contacts, and I'd like to read that, if I may, and then comment on it.

The Pictured Cliffs Sandstone is conformable with both the underlying Lewis Shale and the overlying Fruitland Formation throughout most of the basin. The lower contact is gradational in most places; shale beds of the Lewis intertongue with sandstone beds of the Pictured Cliffs. The contact is arbitrarily placed to include predominantly sandstone in the Pictured Cliffs and predominantly shale in the Lewis.

The contact of the Pictured Cliffs and the overlying Fruitland is usually much more definite than the lower contact with the Lewis. On electric logs the Pictured Cliffs...contact is placed at the top of the massive sandstone below the lowermost coal of the Fruitland except in areas where the Fruitland and the Pictured Cliffs intertongue. On the surface, the contact is placed at the top of the highest *Ophiomorpha major*-bearing sandstone...

...that being the fossil, and then it goes on into a discussion of that.

The term "massive sandstone" turns out to be an area of concern, because that term can be misused as a definition. In this case what Fassett and Hinds have said is that usually the contact is much more clear than it is between the Lewis and the Pictured Cliffs.

And then they go on to point out that where you have additional information such as fossils, that information is used.

"Massive" by itself doesn't define anything. And I think a good example would be if there were a Pictured Cliffs sandstone in the interval where we have what I call the upper Pictured Cliffs, and at some point it were 30 feet thick, perhaps most of us in the room would say, Yeah, that looks like a massive sandstone, standing there at the outcrop. Very few might ask, Massive compared to what?

But if that sandstone gradually thinned down to nothing, if you try to use the term "massive", then at some arbitrary point that's totally undefined it would no longer be a Pictured Cliffs sandstone. And that is the issue that I took with what was presented previously.

Q. (By Mr. Hall) Do you accord some particular significance to Fassett and Hinds' use of the term "usually" in that text you read?

A. Yes. And the real problem with the definition here is that you shouldn't use it in terms of whether it's massive or whether it's white. The proper technical definition of Pictured Cliffs is whether it's marine sandstone or whether it's not. And if it's not, it probably belongs in the Fruitland formation.

So the real question is, Is it marine? And that's the purpose of several of these other exhibits of papers in this packet.

Now, you have to be a little careful using papers and be careful not to take things out of context and use information or statements where they're not supposed to be used. And I have underlined or excerpted parts of these papers to try to use statements that I think are applicable throughout the Basin, and particularly to this area.

Q. Why don't you point some of those out to the Hearing Examiner?

A. The first paper, written by Paul Umbach, is a 1950 paper put in the *Guidebook of the San Juan Basin*, Colorado/New Mexico, of the New Mexico Geological Society.

And on page 83, which I think is the third page in the -- that I've copied here, he's describing the various formations for the guidebook and he says:

> The Pictured Cliffs sandstone, 50 to 500 feet thick, contains interbedded shale and thin coal streaks within the massive white marine sandstone. This sandstone thickens northeastward at the expense of the overlying Fruitland formation.

Well, the term "massive" shows up again. And this may be where it started; I'm not sure. I don't think I'm old enough to have read all the papers that have been written on this stuff. But in this case he is including within the "massive" term interbedded shales and thin coal streaks, which is exactly the circumstance we have here.

Here again, he points out that it's a white marine sandstone, and it's clear that he's talking about outcrops, because the Pictured Cliffs tends to weather white on the outcrops, as opposed to being a gray or a tan color subsurface.

So the main points are that it has interbedded shale and coal, it has a marine sandstone and it thickens northeastward, all of which apply to our circumstances here.

The next paper, by Molenaar, which was in the *New Mexico Geological Society Guidebook*, 28th Field Conference, in 1977, on the second page which is actually page 165 of the book, under "Pictured Cliffs Sandstone" it says:

> The Pictured Cliffs Sandstone is a regressive coastal-barrier sandstone that represents the final retreat of the western interior sea from the San Juan Basin...

...again, that's a marine sandstone. And further, he says,

> ...the Pictured Cliffs prograded at different rates; and, as a result of still-stands or small transgressions and subsequent regressions, greater

thicknesses were built up.

Down below, under "Fruitland", Molenaar states,

The Fruitland Formation represents nonmarine, lower coastal-plain deposition behind the Pictured Cliffs shoreline.

And then skipping past the Fassett and Hinds paper that I've already discussed, there's another paper by James Fassett, also in the 28th Field Conference *Guidebook*, 1977. And on the last page of that, which is page 197 of the book, he's referring to the Point Lookout, Cliff House and Pictured Cliffs sandstones in general and refers to them first as "littoral marine sandstone units" and then goes on to discuss "the strandline fluctuations which resulted in deposition of these units...on the west edge of the old [*sic*] continental" freeway -- "seaway..."

These are a few of many, many papers and articles and discussions that have been written to the effect that the Pictured Cliffs are marine.

On the first page of that Fassett article is a little map showing a cross-section that he has provided. That cross-section is also in the packet, but I have enlarged it because I'd like to make a couple points on that.

On the cross-section, the wells numbered 3, 4 and 5 on the Fassett paper are on roughly strike, or would be roughly on strike with the wells in question here, this cross-section being a little bit to the south southeast of the area we're discussing.

Fassett picked in those wells the top of the Pictured Cliffs at the base of the basal Fruitland Coal.

And the second point to be made here is that he shows that the Pictured Cliffs stairsteps upward into the Basin as compared to a time line at the bentonite marker that was laid down early in geologic history.

Now, the point here is that you can stairstep upwards as you come into the Basin, with additional Pictured Cliffs sands prograding over previous sands, and that's mentioned in these articles in more than one place and I think is well accepted.

And then the last reference is one by W.A. Ambrose and W.B. Ayers, and that was in the *RMAG Coalbed Methane of Western North America*, both put out in 1991. And on the second page of the document I've provided, which is page 43 of the book, under "Pictured Cliffs Sandstone" they describe:

The Pictured Cliffs Sandstone, which forms a sandstone platform at the base of the Fruitland Formation, consists of northwest-trending, strike-elongate shoreline deposits of barrier-island and wave-dominated delta systems that prograded northeastward.

So once again, clearly a marine depositional environment, and I don't think there's any argument in what I've heard from Mr. Ayers on that issue.

Under the "Fruitland Formation" on the next page he says -- or they say --

The Fruitland formation, the primary coal-bearing formation in the San Juan Basin, is nonmarine facies tract consisting of interbedding sandstone, mudstone and coal beds...deposited landward of the marine (barrier-island and delta-front) facies of the Pictured Cliffs Sandstone.

Now, that particular article was written about the Cedar Hill field, but it applies here, and the same description was given by Dr. Ayers a month ago for this area.

Q. Let's look at Exhibit N6, please, sir. Would you identify that for the Hearing Examiner?

A. This is an isopach of the upper Pictured Cliffs sand by itself. The red is -- I've colored in the red from zero sand thickness to eight feet. It's orange from eight feet to about 13 feet, and then in several places I've marked a yellow circle where it coalesces into the rest of the Pictured Cliffs sand and can't be differentiated from the rest of the sand.

This little salient right here is where we find the Maralex/Whiting coal well and our Chaco 2-R well that didn't have that sand in it. So our cross-section A-A' that you've already seen is skirting the edge of this thinner part of the sand here and cut across this little part right here.

So here we have a sand that is correlative over, just on this map, six or seven miles. It gradually thickens to the northeastward, has been described. It moves from zero to -- maximum I think I picked was about 13 feet before it coalesces into the rest of the Pictured Cliffs -- and it trends northwest-southeast. Everything that I've just said is a description of marine sand, Pictured Cliffs sand.

It's -- I have been unable to think of an example of how you could lay down or how a sand would lay down in a nonmarine environment where you get a consistent appearance on the logs and a deposition where it's only maybe averaging six or eight feet thick and where it's laid down over miles and miles and miles of territory.

You've got to do that on a stable platform in a marine environment where the sand can be winnowed and laid out and worked until it's laid out in a sheet fashion, and that works in a barrier, bar and marine, littoral environment. It doesn't work in a fluvial environment where you have streams coming in at, on the average, right angles to the shoreline. And this is not the kind of sand that you associate with nonmarine deposition, with fluvial or stream deposition.

Q. Let's turn to Exhibit N7, the cross-section.

A. This I've labeled cross-section F-F', and this is hung on the base of the basal Fruitland Coal, so it's no longer a structural cross-section; it's just a stratigraphic correlation. There is no relationship in the distances between the logs, it's just to -- They're all laid out about the same distance apart for the purpose of showing the correlation.

It begins in the southwest quarter of Section 7 in the Merrion and Bayless Chaco number 2 well, which does not have the upper Pictured Cliffs sand, goes to the Lansdale Federal well in the southeast of Section 7, which has the upper Pictured Cliffs and the rest of the sand, and then down to the Fusselman 2-R well in the northwest of

Section 17, the Dugan Chaco Plant Number 1 in the southeast of Section 17, back up to Chaco Plant Number 3 well in the northeast of Section 17, then over to our Pendragon-operated Cowsaround 16-11 well in Section 16.

And here you see how this little shale between the upper Pictured Cliffs sand and the rest of the Pictured Cliffs gradually thins out and disappears so that the sand coalesces into the rest of the Pictured Cliffs to the east.

Nowhere did I find an indication that this shale break between the upper Pictured Cliffs sand and the rest of the Pictured Cliffs moves up and joins the shale below the base of the Fruitland Coal. Nowhere did I find an indication that this upper Pictured Cliffs sand is not connected to the rest of the Pictured Cliffs.

Q. What do the red arrows depict on the exhibit?

A. Oh, these red arrows are that point where the operator of these wells reported the top of the Pictured Cliffs formation when the wells were completed.

One of characteristics of a marine sand, which you can sometimes infer from log character, is a cleaning upward sequence, where the sands started to be deposited in deeper water -- let's say in a lagoon or out front of a beach -- and as the sea regressed and beach moved over, what originally had been seaward deposition, the energy at the shoreline where the waves and the tidal currents are higher heaves up the sand and winnows out the finer materials and makes it cleaner.

That shows up sometimes as cleaner gamma ray on top of a sand, and more frequently as cleaner SP on top.

And you can see that happening -- Here's a good example right here, down in the PC, that kind of cleaning-up character in these two sands.

We also see it happening -- it's a little more subtle -- in the upper Pictured Cliffs sand. You see it right there, and here. It's a little ratty and hard to see in the Chaco Plant Number 1 well, but it's apparent there after you get to looking for it, and then we're off into the coalesced sand again.

The same thing happens, back on the cross-section A-A', in the Whiting well in the southwest of 1, cleaning up, in our Chaco 5 well. It's a little harder to see, but it does happen in the Whiting well in Section 6 where there's some kind of hard streak right in the middle of the sand, but the SP carries through with cleaning upward throughout the whole sequence.

Can't make much out of it at our Chaco 4, only got a couple feet.

And it's very apparent again over here in the Chaco 1.

For this to happen, it has to start with the sand being laid down in quieter water and the sand getting cleaner as the energy increases, as the water gets shallower. Again, it's a marine environment.

You get the opposite effect, in general, if you're looking at a fluvial sand or channel sand where it tends to be coarser and more porous at the bottom of the channel, and as the channel works its way over you get muddier and muddier sediments on top so that it has the opposite shape. You get a bell shape instead of the funnel shape.

Q. By the way, was the Chaco Plant 1, reflected on that cross-section, was that the discovery well for this field?

A. The discovery well for this field was the Chaco Plant Number 1 by Dugan. It's on Section F-F', right in the middle of the section, and that's one of the two wells that are of interest on this cross-section.

The other one is the Lansdale Federal where we have a core through the intervals being discussed. As a matter of fact, the core through the coal, as I'll come to later on in my testimony, and also through three different benches of sand here, is separated by the coal and the shale streaks.

That core analysis is the next exhibit. Shall we go on to that?

Q. Yes, go ahead, turn to Exhibit N8.

MR. CONDON: Which number are we on?

MR. HALL: N8.

THE WITNESS: This is a composite of the Core Lab core analysis on the Lansdale Federal Pictured Cliffs core.

On the right-hand is just a normal analysis. The middle is the log, density log, of the Lansdale Federal. Then over on the left-hand side I've reduced the Core Lab lithology description, where they actually show what they're seeing in terms of sand, shale, coal, what have you -- reduced it to the same scale as the log and correlated it so you can see what they're describing there.

Looking first at the core analysis itself on the right-hand side, the first striking thing there is that you look at the permeabilities and the porosities on this Pictured Cliffs sand, this is not a tight sand. Even in the upper five or six feet of sand in the upper Pictured Cliffs, we've got permeabilities of 24, 6.7, 142 millidarcies. Down in the main part of the sand, the permeabilities go over 200 millidarcies. And the average for that entire column is 55 millidarcies, top to bottom.

The average porosity is over 20 percent.

And then if you look at their description of the sand, it's sand -- starting at the top, sand, gray, fine-grained, clay filling -- clay with filling. And that description carries pretty much throughout. It cleans up a little bit to trace of clay in a few places down in the second bench. But basically, it's sand, gray, fine-grained. There's no graded bedding, there's no change in sand size, top to bottom. This, again, is a marine sand. It's all very surprisingly uniform.

It's the kind of sand you get along a shoreline, separated by some distance from the source material where the tides and the wave action have had an opportunity to sort the sand out by the amount of energy available into graded sizes, and this is the size that happened to be available for deposition in this area.

If you look at the density log, this is an old log, and there was no backup scale provided, but if you just look at the two streaks where there's coal and shale, one of them at 1070 and the other at 1086, on the log you'll see that without any further investigation you'd give those streaks three or four feet of thickness.

However, when you look at the lithology description over to the left, you see that there's a description of coal there at the equivalent interval, right in the middle of that upper three-foot streak of apparent shale or coal, that's less than a foot thick.

The one at the bottom is shown to actually be, if anything, just a tad larger. That's probably due to the thickness of the pencil of whoever was putting this. But in both cases, they're shown to be less than a foot thick.

So there's shale there and there's some finger of coal there. In fact, as we go on to other exhibits I'll show that that was described as a finger of coal. But it's not a big, thick coal section. It's a pretty inconsequential little bit of coal, which is very common in the Pictured Cliffs. I've run across a number of descriptions and discussions of coal, one of which I've already referenced, in shale, in the Pictured Cliffs.

Q. (By Mr. Hall) Mr. Nicol, is there a contemporary analogy to the depositional environment presently at work, similar to what was happening in the San Juan Basin?

A. Yes, I think it's similar in many ways to what's happening in the Gulf Coast.

Q. Could you explain?

A. This is not offered as an exhibit because it's my only copy, but I thought it might be of interest. May I bring this up?

EXAMINER CATANACH: (Nods)

THE WITNESS: This is a Landsat photograph of --

MR. CARROLL: Can you turn that so Mr. Gallegos and Condon can see it also?

THE WITNESS: What I'm showing is a Landsat photograph of the United States. I've got the east half.

This is the Gulf of Mexico, and this being the Mississippi delta and Louisiana.

What you see here is a series of barrier bars, barrier islands, running the whole length of the Gulf Coast, Galveston Island probably being the most noted one, Padre Island down here, and right off the coast of south Louisiana.

This right here is Terrebonne Bay, and Terrebonne Bay is 30 or 40 miles across, and most of it you can walk without getting in over your head. Very shallow, and most of what you walk on there is sand.

You can see the Chandeleur island barrier, island, building up to the edge out here, and then behind it you see the shaded color, which is actually underwater sand, sheet sand, behind that island. That's the kind of thing we're talking about here.

And the same thing can happen out in front of these islands. If you walk out hundreds of yards past where the waves are lapping here on these little islands, you're still sometimes only waist-high or chest-high, and you're still walking on fine sand.

Now, in this area there are buildups where you get a few feet above the water, and there's spots that get quiet, fill up with mud and organic debris. So the thickness comes and goes a little bit in there, but you're talking about a matter of a few feet at most. That's the kind of deposition we're talking about for a barrier island/littoral/marine complex.

Q. (By Mr. Hall) All right, let's turn to Exhibit N9 now. Would you identify that, please, sir?

A. These are two papers by Jim L. Jacobs of Dugan Production Corporation, done in the late Seventies.

The first one discusses the N-I-P-P, NIPP Pictured Cliffs gas field, and on the second page of it he shows the discovery well type log and the distinction between the Fruitland and the Pictured Cliffs. That cutoff is at the top of their perforations. The perforations are right here, and --

Q. Which well is that, by the way?

A. This is the Dugan Production Corporation Chaco Plant Number 1 well. It's in the southeast quarter of Section 17, 26-12.

Q. I'm sorry, go ahead.

A. And he simply describes the Pictured Cliffs as being below this point right here. I've tried to exactly duplicate his point on the log there out of that paper, this correlation right here.

EXAMINER CATANACH: Can you specify what depth that is, Mr. Nicol?

THE WITNESS: 1131.

EXAMINER CATANACH: And that's been picked as the top of the --

THE WITNESS: That's where I put it here, based upon my effort to duplicate what he did on this log, is, you'll see that it's a little hard to read it off this little log. But yes, that's been picked in this write-up of the discovery well for that field as the top of the Pictured Cliffs.

The next paper is also by Jim L. Jacobs, and it's entitled "Some Recent Shallow Pictured Cliffs Gas Discoveries", the key words there being "Pictured Cliffs", and it's in the *28th Field Conference Guidebook* again, the 1977, New Mexico Society.

And before we get to the Pictured -- or the discussion of this particular pool, I would like to point out some language that comes into play on the first page that comes under "Geology", because this will come up again and I want everyone to know where I've referenced it: "Some of the wells have been perforated in the massive sand below the main producing sand -- " again referring to Pictured Cliffs " -- but our experience indicates that while some gas may be produced from this zone the water production is greatly increased causing production problems."

Water source is an issue here, and water production is an issue that we'll come to, and this reference is a bit helpful in some of the background.

Now, on page -- on the next page -- it's up in the left-hand corner, page 248, the second page of this write-up, in the far lower right-hand corner, there's a misprint where he references this well being in Section 26 North 13 West. However, it's correct in the rest of the write-up and certainly correct on the logs. So I would like to avoid some confusion over that.

And on page 249 under "Geology" Jacobs states, "The NIPP Pictured Cliffs pool produces from thin sand lenses above a more massive and more easily traceable unit in the Pictured Cliffs Sandstone." Keep in mind, this is a description of Pictured Cliffs fields, but he is describing a sandstone above the more massive sand.

And then in the next paragraph, "Producing sands are thin and discontinuous from well to well occupying an interval from the base of the Fruitland Coal which, in this field, is approximately 20 feet thick, to the top of a massive water bearing sand."

Now, this was written when the field was still being developed and, as you see from my isopach, once you put all the information together it's not nearly so discontinuous as he apparently felt at this time. But you can see how, just looking at cross-section A-A', you would consider it discontinuous until you had enough information to really see how it lies in there.

On the base map that I'm using there are -- I've found 34 wells -- I think there are probably some more, but I've listed 34 wells that were completed by various operators in that upper Pictured Cliffs sand. Generally it was done in conjunction with other sands, sometimes it was done by itself. But in each case the operator in those 34 wells reported it as a Pictured Cliffs completion.

I'd also like to point out that of those 34 wells, seven of them were fractured on initial completion in the Pictured Cliffs. We currently operate four of those seven, not including the ones that are in question here, and there's been no indication, no charge, no evidence, and certainly no pressure information or anything like that to suggest that those wells are in any way connected with the Fruitland Coal.

Q. (By Mr. Hall) All right, let's turn to Exhibit N11, if you would, please, sir.

A. This is another stratigraphic correlation section, and it starts from the definition well for the Fruitland Coal Pool, which is the Schneider -- the Amoco Schneider Gas Com B-1 well, in the southwest of Section 28 of 32 North, 10 West, and carries correlations down into the area we're discussing here.

Now, this is certainly not an effort to correlate well to well to well, to show exactly what's happening in the Pictured Cliffs. It's an effort to show the logical use of the terminology and definition that was given when that order was issued.

And the language is -- this is describing the Fruitland Coal Pool -- Vertical limits comprising all coal seams within the equivalent of the stratigraphic interval, from a depth of approximately 2450 feet to 2880 feet, as shown in the gamma-ray bulk density log for the Amoco Company's Schneider Gas Com B Number 1 well -- and it gives the location there in Section 28 of 32-10.

That's about 35 miles from the area we're discussing. This cross-section picks a few wells in between to show what's happening, because I'm pursuing the definition of "stratigraphic equivalent".

The point picked for the definition is right here on the log at the 2800 approximately, 2880 feet in the Amoco B-1 well. That's the top of the Pictured Cliffs -- Actually, the top of the Pictured Cliffs as picked by Amoco was 2878 feet. It's also the first sand below the Fruitland Coal, and it's also the first marine sand in the sequence.

Now, the definition of "stratum" that I found in the *AGI Dictionary of Geological Terms* is "a section of a formation that consists throughout of approximately the same kind of rock material. A stratum may consist of a definite number of beds, and a bed may consist of numberless layers -- " et cetera.

The *American Heritage Dictionary* said, "a formation containing a number of beds or layers of rock of the same kind of material.

So the defining criteria is -- for strata, for stratigraphic equivalent, then, is approximately the same kind of rock material.

We've already shown that the upper Pictured Cliffs sand that we're talking about down in the Chaco area is the same kind of material, same kind of rock as the rest of the Pictured Cliffs in that area. And we've shown that it can have layers of coal and shale within it.

Following through on the cross-section, this second well is also in Section 32 -- it's actually north of the Amoco Schneider -- and I put that in because it shows some changes in stratigraphy right at the base of the Fruitland, even within that section. We lose the bottom six or eight feet of coal -- or of shale, there. And in this case there's a thin coal stringer below what I've been calling the basal Fruitland Coal that lies directly on the Pictured Cliffs sand.

Well, the stratigraphic equivalent between the definition well and this next well is the top of the Fruitland sand again, right here at the base of the coal in this well, as compared to the base of the shale for the Schneider Gas B Number 1 well.

Then I move down several townships to Section 18 of 29 North, 12 West, and here again the stratigraphic equivalent is the base of the shale below the basal Fruitland Coal, with another coal stringer, another stringer included, and then once again there's another coal shows up, so that here the stratigraphic equivalent is the Fruitland sitting on top of the Fruitland Coal, a thin coal here on top of the Pictured Cliffs sitting on the Pictured Cliffs sand.

By the time you get down to Section 1 of 27 North, 12 West, the shales and coals below the basal Fruitland Coal are gone.

Here's a circumstance where you've got the coal sitting right directly on top of the Pictured Cliffs sand, and the stratigraphic equivalent is that contact up there.

One of the frustrating things for us in this process the last couple years has been the position taken by the other side that they have a right to come into a circumstance like this and fracture this coal with, as they do, 110,000, 120,000 pounds of sand, but apparently we don't have the right to come in and stimulate our sand right below it, because we might be taking some of their coal, coal gas.

The next correlation point is the Maralex/Whiting well in the southwest of Section 6 of 26-12, which is one of the wells in contention. And here you see the beginning of the upper Pictured Cliffs sand as I've described it, with the shale separation between it and the rest of the Pictured Cliffs sand. But the stratigraphic equivalent point is the top of that upper Pictured Cliffs sand.

I've got two other cross-sections to tie this together, because this is a long stretch from Section 1 of one township to Section 6 of the southern township.

Cross-section D-D' picks up the three wells in Section 5, which is just east of the Section 6 well that was on the previous cross-section. And then again, this stratigraphic correlation section, and it ties into a well in Section 2 of 26-12.

And once again I'm showing that you've got the upper Pictured Cliff sand in the three wells in Section 5 with excellent correlation, and it's basically a laydown correlation of the well in Section 6, and then it's coalesced into just total sand and PC, with no connection -- or no shale between the basal Fruitland Coal and the top of the PC over here again in Section 2.

MR. HALL: Mr. Examiner, just briefly to orient you, we're offering three cross-sections, D-D', E-E' and G-G', all under Exhibit Tab 12, as one exhibit.

Go ahead, Mr. Nicol.

THE WITNESS: Did we confuse you with that? Do I need to back up?

EXAMINER CATANACH: I have it.

THE WITNESS: Section G-G' ties together what happens between Section 5 and Section 2, and the left-hand well in this case is our Chaco Number 5, showing the upper Pictured Cliffs sand again, and the shale and a finger coal break there.

It ties into a well in Section 4 where the upper Pictured Cliffs sand is getting thicker, and then by the time you get over here into Section 3, it's coalesced into one big sand again.

And once again, we've got the indication of cleaning upward sequence that I mentioned before, tending to confirm marine deposition.

And you see it a little bit in this well, you certainly see it here. Back in here there's a hard streak in the SP, and here it breaks up the sand a little bit. And I don't quite know what that is.

Q. (By Mr. Hall) For the record, you're referring to Section D-D'?

A. Section D-D', the wells in Section 5.

On the south end of the area in question, one more cross-section down there -- This is Section E-E', and again this is a stratigraphic correlation section.

It runs from the Gallegos Federal Well in Section 19, south of the area of question, in the northeast corner of Section 19, back up to our Chaco Number 1 well, showing a gradual thickening of that upper Pictured Cliffs sand, and then over to the Hard Deal Number 4 well in the northeast of Section 18, and it once again ties into our Chaco 16-11 well -- I'm sorry, Cowsaround 16-11 well, where the sands are all coalesced.

And once again, we have that indication of cleaning upward in that upper Pictured Cliffs sand. And you can see the gradual thickening of the sand to the east, the onlapping sequence, and the tie into -- well down into the section down here, the PC where it's all coalesced.

Do you need some more of that? I took it before you were done.

EXAMINER CATANACH: No.

Q. (By Mr. Hall) From your testimony so far in geology, Mr. Nicol, what in summary can we conclude about the characteristics of the PC?

A. Well, we're talking about the upper Pictured Cliffs --

Q. Yes.

A. -- sand?

Q. Yes.

A. It coalesces into thicker, undifferentiated thicker Pictured Cliffs sands to the east, to the northeast and to the north. It is part of the same deposition of environment. It correlates and is very consistent in character over a large area, portions of three townships, even though it averages only six or eight feet in thickness.

It has a uniform grain size, or sorting. and a cleaning-upward characteristic on the logs. It's elongate, northwest to southeast, strike-oriented to the Basin axis. It unlaps to the northeast and thickens to the northeast.

And to lay down a sand like this, you've got to do it in a marine environment. It's just not consistent with something that happens behind a shoreline. In fact, it's amazingly uniform when you think about a sand that thin being laid over that area.

And it's been recognized as Pictured Cliffs by numerous operators and by all the regulatory authorities for at least 23 years.

MR. HALL: Mr. Examiner, I would suggest this is a good place for us to break, or we're prepared to proceed, however you wish.

EXAMINER CATANACH: Let's take a ten-minute break here.

You're done with this witness on direct?

MR. HALL: I have more direct through him on a different subject matter.

EXAMINER CATANACH: How much more do you have?

MR. HALL: I'd estimate an hour. Don't hold me to it.

EXAMINER CATANACH: All right, let's take a break.

(Thereupon, a recess was taken at 9:48 a.m.)

(The following proceedings had at 10:12 a.m.)

MR. HALL: Mr. Examiner, I want to introduce Marte Lightstone from our Albuquerque office, who's joining me at the table.

Q. (By Mr. Hall) Mr. Nicol, let's go back again to the earlier meetings with Whiting and Maralex when they brought their perceived problem to your attention. Would you explain what your understanding of their underlying premise to the perceived problem was?

A. At the first meeting, which was held in the spring or the summer of 1996 in Aztec, my understanding was, the basic premises were twofold:

One, that we had to be producing Fruitland Coal gas because the Pictured Cliffs no longer held the kind of reserves that we were seeing from our wells. There just wasn't that much gas left, according to Whiting and Maralex, and they had assumed that the Pictured Cliffs was depleted.

They also attempted to show that their wells had had an immediate adverse reaction to the commencement of production of our Pictured Cliff wells, and that resurfaced in the formal complaint that was made to the Commission in January of 1998.

Q. All right, let's talk about the interference issue. Have you prepared certain exhibits addressing that issue?

A. Yes, sir.

Q. Let's turn to Exhibit N13, if you would identify that, please, sir.

A. This is a montage of production curves on the Whiting/Maralex wells, the Coal wells.

The wells on the left-hand side are the five wells in question that they alleged have been affected by our wells when our wells were put on, after we re-fractured them in -- or fractured them for the first time, restimulated them -- in mid-1995.

The five wells on the right are five other Whiting/Maralex coal wells operated by them in the same area. These are in Sections 19 and 31 of 26-12 and Sections 14, 24 and 25 in 26-13.

Their contention was that when we put our wells on in mid-1995 their wells went down. What they said is, Our wells decreased or declined, is the term they used.

Well, there was a problem in mid-1995, and it had to do primarily with the El Paso Gas Plant. Our recollection is that in about August of 1995 El Paso was having fits with installing new compressors or changing out compressors. We had numbers of wells that they asked us to shut them in for six, seven, eight days because they wanted to reduce flow to the plant.

And pipeline pressures were fluctuating and climbing, and I don't know whether any of the Whiting wells were actually shut in during that period. We have a gap in our data. We do not have Whiting/Maralex production data for August of 1995.

The *Dwight's* data from which this is taken, in addition to data that Whiting and Maralex did provide, shows that in June of 1995 many of their wells had produced only part of the time, and even fewer days in July of 1995. I presume that they had a similar problem in August. *Dwight's* shows them as zero, and I've been told by Whiting and Maralex that it's not zero.

But the point here is that if you compare the wells that they didn't complain about with the wells that they did complain about, that generally the wells they complained about are much better wells than the ones they didn't mention, and that all the wells had similar problems in 1995 with down time, lost production, in that period, June through August. And actually line pressures stayed high on into September of 1995.

Now, this does not conform to what should happen in an interference situation in dewatering coal wells. The classic example of what happens in a coal well when you interfere by adding wells to the dewatering process is that the older wells go up in production.

Now, next on the -- in the packet, is a series of decline curves --

Q. Those are marked Exhibit N14.

A. -- on the five Whiting/Maralex wells in question.

The Gallegos Federal 26-13 1-2, which I believe is on top in these -- section, seems to have had a problem from the time that production declined in 1995 well on into 1996. Both gas and water were down. I don't know what the problem was, but it appears to have been solved late in 1996.

But if you look at all of the other decline curves, you see that after production was off in mid-1995, water production increased. This is a dewatering process, and when the rate of water withdrawal decreased, the water actually come up, and it took a period -- came up.

And it took a period on into early 1996 in virtually every other case where water production actually increased and had to be drawn down again, and the production decline curve for water actually took a step over to the right. In some cases it lasted as much as six months, and in some cases it was only three or four -- two, three, four months.

But that appears to be part of the problem they had, is, they had to start over on the dewatering process. And that, combined with the description I've already given of high line pressures and down time at the plant, is an operational problem they had in 1995. It had nothing to do with our wells.

It's interesting to note that their wells had a water problem during this period where water -- the water decline curve jumped to the right, they had to start over a little bit on water withdrawal. Because their wells were on pump all through this period, our Chaco wells, when they were put back on after being shut in or suffering high line pressure, came right back up, and our Chaco wells were not on pump, they were just flowing.

So if we had had the kind of water problems or water production that these wells, the coal wells, were having, we should have seen infinitely more problems with the water not having pumps on it than they did. And the fact is that our wells came right back on to where they were on the curve when we had to shut them in and put them back on.

Q. By the way, Mr. Nicol, when Edwards and Pendragon acquired the PC wells from Merrion, did you have much water data to look at?

A. We had no water data. The wells, of course, had been producing at a very low rate for some time, but little if any water production was reported, and when we bought the wells there was no water production.

They were not set up to handle water. The gas went through a separator, and whatever water came out of that process went right into an earthen pit. So there was no tankage set up, no way to measure water.

When we restimulated these wells, we didn't take any steps at that time to change that. The water production certainly increased from zero and they were making some water, but we didn't feel that it was a significant amount, and it never affected the productivity of the wells. It came right on at peak rates and produced from there.

With the exception of the Chaco 2-R. We had trouble unloading the 2-R. It's a slimhole completion, and we were trying for a while to unload it with a plunger lift, I believe, and that didn't work very well. So it took us a period of time to get the Chaco 2-R on, and we finally installed compression on that one.

Q. All right. Mr. Nicol, were Whiting and Maralex contending that there was some pressure interference between the Fruitland Coal and the Pictured Cliffs --

A. Yes.

Q. -- after your fracs?

A. In one statement, again, in the Application, they stated that when we frac'd our wells our pressures came up to at or close to their pressures. That's simply not the case, and it wasn't true. And we have another exhibit that shows what the pressure history was out there.

Q. Let's go to Exhibit N15. Let's direct it towards that.

A. This is a plot of pressure histories we have taken from our files and what we've gotten from *Dwight's Data* on other wells in the area, in proximity to the wells in question. This chart addresses only Pictured Cliff wells.

The yellow dots are the wells we operate that are in question, prior frac'ing, or if the wells were never frac'd we continue with the yellow dots.

The green dots are the same wells after being frac'd in 1995. The uncolored circles are other wells in the area.

The red lines connect our wells so you can follow a little bit where they're going. Otherwise, it's kind of hard to find them.

And the red triangles are the first pressure point given for each well that's on the chart.

In early 1997, it appears that the pressures for the Pictured Cliffs wells in this area were running between 225 and 250 pounds. This is an underpressured part of the Basin, underpressured part of the area, and that's normal pressure for those wells, and apparently also for the Fruitland Coal.

By 1979 it starts to become apparent that some of the new wells are seeing a little bit of pressure depletion on initial completion, they're starting to see pressures a little lower than what had originally been picked up in early 1997.

The wells follow a general decline in pressure on into 1994, after which we have virtually no data until 1995. That was nineteen ninety-eight four [*sic*], I'm sorry, 1984. It was the end of that period where pressures are required to be given yearly.

But the general trend is that the wells followed kind of the same pattern in pressure down into the 90- to 130-pound range. What's interesting is, in many cases this happened regardless of whether the well was initially put on or whether it had been producing for a while, and regardless of how much it had produced.

So there's a general indication here that the whole Pictured Cliffs reservoir in the area is being drawn down and is reasonably well connected.

By the end of 1983, beginning of 1984, our wells are down as low as -- oh, something in the 70-pound range for the 1-J and the low hundred pounds for the Chaco 4, on up to maybe 135 pounds for the Chaco 1. As you see, new wells produced or coming on stream in that area for the most part showed some pressure depletion.

One well that we have an interest in -- it's over in Section 4 of 26-13, the Armour 1-Y well -- showed a pressure of 200 pounds way back in 1976. I presume there was some water in the hole there, because that would have been an initial pressure even before these others.

The interesting thing is that that well seems to have declined, and it's never been produced. We take pressures on it now, we get pressures down in the 140-, 145-pound range.

In 1995, Edwards was the operator of the well, J.K. Edwards, and they contracted Walsh Engineering to do the underground operation. And Walsh began taking pressure readings. And we have pressure readings in early 1995 on the Chaco 4 well, the Chaco 1-J well and the 2-J well.

We had three readings for the Chaco 4 that were in the -- 140 to almost 150 pounds -- I think it was 140 to 147, was the range there -- before that well was frac'd.

The Chaco 1-J at the same time was reading between 150 and 160, and the 2-J 190 to 198 pounds. These are surface shut-in pressures. So they're the minimum pressure, because we assume that if tubing and casing are reading the same that we don't have any water to worry about in the hole, but we really don't know absolutely.

The 2-R well -- Well, let me back up a minute.

Those are the readings we have on those wells prior to doing any of four frac jobs.

But here we have a situation where we have 147, 150 pounds, up in the 198 pounds, in the Pictured Cliffs. If we just extrapolated what happened through 1983, 1984, we would assume that they would be down 100 pounds or less. That wasn't the case.

Now, during this period the wells produced -- and if you look at the production decline curves, they weren't making much; they were just barely perking along, an MCF a day, two MDF a day, this kind of thing.

And there appears to have been some pressure recharge in the Pictured Cliffs, either equalization of pressures or pressure building. And there were some potential sources of that, one of which is -- If we go back to my cross-section, the correlation sections, these zones all tie into big, thick Pictured Cliffs sections downdip to the northeast and the east and the north. And even at 150 pounds or 100 pounds differential, there could be some very low-grade water encroachment and repressurization through the downdip water leg in the Pictured Cliffs.

The other is -- possibility that there's recharge from lower zones in the Pictured Cliff, below where the wells have been perforated.

When we frac'd our 2-R well, we had a series of readings down in the 110 to 110, as high as 117 pounds, which was below the other wells here. This is the period of time when we were trying to unload it with a slimhole completion and a small plunger lift, and it wasn't working.

In early 1996 we shut it in for three months and ended up with a pressure of 150 pounds.

The first pressure we took on the Chaco 1 was right after it was frac'd in February of -- I'm sorry, it was frac'd in January of 1995, and we got 170 pounds.

The Chaco 5, also first pressure we got was after it was frac'd right there at about 150 pounds, 152 or 153, if I recall. And that's right where the Chaco 4 and Chaco 5 settled in after the frac treatments.

This was not a depleted reservoir. If you consider a well that starts at 230 pounds back here and has produced down to 100, that well now had an opportunity to produce from 150 to 170 pounds here, back down to whatever you could deplete it to, which might be well below 50 pounds.

So for all practical purposes, there's as much reserves left as has been produced out here, but there are far fewer wells pulling on them. So what this had the effect of doing is changing the P/Z curve of the wells.

Here, you've got a bunch of wells in the reservoir, pulling it down at this kind of a rate. Here we've got a few wells with, as I've shown earlier, excellent porosity and permeability, capable of draining far more than 160 acres, with enough pressure left to produce and drain a large area.

My comment on the P/Z curve is, if I can make an analogy, if you've got compressed gas in a tank with two outlets and you run the P/Z curve, as those two outlets reduce you're going to get each of them seeing about half the reservoir. But if you shut one in, all of a sudden the other one is going to see the whole reservoir. And that's basically what's happening here when we bring wells back on.

Now, these wells had not been performing like wells that had 150 pounds. They were, you know, 20 MCF a month, 50 MCF a month, this kind of rate, all through this period, and had not seen or given any indication the pressure was building in the reservoir. That's damage.

We have production rates here, for example, on the Chaco 4 and 5 wells that are less than one percent of the same rate that they were producing back in, say, 1979 at about the same pressure. So something was wrong with the wells.

When we recompleted the Chaco 1 and the Chaco 2-R by refrac'ing it, we attempted first of all to just acidize the 4 and 5 to see if we could get by without having to do a frac to get past the damage. We didn't see the kind of benefit we got from these two wells, so we went ahead five months later and frac'd the 4 and 5 well.

And then you see what happens after that. We've got pressures on into 1997 that are gradually declining, and in 1998 they've started to drop off pretty good.

This curve here may be the time it took for us to overcome whatever was happening in the repressuring of the reservoir. We don't know, but that's one explanation for why you have this dropoff in production like this. It may be that we're -- or the dropoff in pressure, not in production. But it may be that we're just -- it just took a while to overcome whatever was happening here to increase the reservoir pressure.

In the meantime, we have the 1-J and the 2-J out here with pressures at 158 pounds, and this is a shut-in bottomhole pressure, just recently taken in the 1-J, and 178 pounds in the 2-J.

And these -- Well, the 2-J, for example, is only a couple hundred feet from the Whiting/Maralex that was given a 112,000-pound frac. It appears to be drawn down a little bit from the pressures that were recorded back here in 1995. We've been producing this well a little bit. I don't know whether this 20 pounds of drawdown here is due to depletion because of the production that we've done or depletion because it may be some way very inefficiently connected to the Whiting/Maralex well. But whatever it is, over that period of time it's very minimal.

And as I say, these wells were not frac'd.

Q. Mr. Nicol, the damage you referred to, it's what we ordinarily call skin damage; is that correct?

A. Yes, although it was much more pervasive than just skin, apparently, because we had to get the wells frac'd in the past.

So what we -- We weren't working on trying to stimulate a well that was already well connected to the reservoir. That well had basically shut off. We're working on the same basis that if you run cement on a well, you've got to get past the cement to get the well to producing, otherwise you get nothing. Whatever we had was kind of like the well was cemented up.

Q. Did you know the damage to exist at the time the fracs were performed?

A. We thought so. I wish I was as smart then, or had been as smart then as I am now in retrospect, having to go through all this.

But our initial assessment was that the wells had not made nearly as much gas out of the Pictured Cliffs as they should have, based upon volumetrics and based upon expectations of even the original operators.

I felt that the Chaco 1 was a good frac candidate for that reason and put the Chaco 2-R next on the list. I was a little skeptical on the Chaco 4 and 5 because they had made more gas than the other -- the first two I mentioned, even though they still hadn't made nearly the gas that we thought they were capable of.

So it was a learning process for us going through it. But in fact, it was the frac job that got us past the damage and turned them into nice wells.

Q. So your post-frac production results, were they what you expected?

A. Actually, they were better than we expected.

Q. Anything further with respect to Exhibit N15? N15 is the time-versus-pressure plot.

A. The only other point I would make is that the allegation that our wells came up to their pressures when we completed them, and my statement that that wasn't the case, we have since been supplied some pressure data from Whiting and Maralex, and most of it is flowing casing pressure data but occasionally there's a reading up in the higher ranges which we take to be shut-in pressures.

And using those high points and connecting them, comparing them to what we see here, at the time we had 150 pounds, 160 pounds, 170 with the Chaco 1 in 1995, our projections are that all the Whiting/Maralex wells were at well above 200 pounds, and it appears that they started in the 240- to 250-pound range.

Now, there are some of those wells that they listed that show pressures in the 180 pounds as the first shut-in pressure that we received on those wells, early on in 1994, if I recall.

There's no information as to what the water levels might have been in those wells, however there is the possibility that those wells that started at lower pressures could have frac'd into the Pictured Cliffs. It's a consideration, and it's not something we can sit here and pound the table about or whatever, but it's an open question.

Q. By the way, let's identify an additional part of the exhibit, N15. Just behind the blow-down version of the pressure-versus-time plot there is a single sheet with some tabulated data.

A. That was just the tabulation that I used to construct the plot originally, and it was dated from our files, where I show the date and the wellhead shut-in pressure and the date the well was frac'd.

So it's a tabulated compilation of the same information that's on the chart, and the data goes on into an occasional point in 1997. And after that, I took it directly from the pressure data in the office to update the charts. So it goes through -- early into 1997.

Q. All right. Let's refer to Exhibit N16 now. If you would identify that, please, sir.

A. This is a series of pressure-data readings, and I think on your copy the first several pages are the bottomhole shut-in pressures on the 1-J and 2-J wells, and that conforms to the points I've already mentioned here for the 1990 readings on those wells.

And then in May we did a three-day shut-in on the Chaco Number 5 well with a dead-weight tester and got a buildup of 95.3 pounds.

And in June we did a shut-in, a three-day shut-in, on the Chaco Number 1 well and got a buildup with the dead-weight tester of 88.6 pounds.

Q. Let me ask you, is there a summary page for the information that's contained --

A. There is a summary of what I consider to be pertinent parts of this information at the end of this package of pressures, but it doesn't contain all of it.

Q. All right.

A. When we were shut in by District Court on the 30th -- we actually shut the wells in on the 30th of June, we began taking daily shut-in pressures on our wells. And that tabulation through the 21st is given in typewritten form, in table form, for the six wells, the next batch of information.

Our wells built up relatively quickly and have stabilized at where -- the 1-J and 2-J, where they would be expected, perhaps a little higher than the bottomhole pressures, and I'll come back to that in a moment.

The Chaco 1-R is in the 98-pound range on these tables.

The 2-R at the end of -- on the 21st of July, was at 68 pounds.

And the Chaco 4 was at -- call it 84 pounds.

And the Chaco 5 at 100 to 101.

Back toward the end I've got the last three days we had available, 22nd, 23rd and 24th of July, just handwritten. I took those verbally from the pumper over the phone on Friday. But between that handwritten note and the tabulation is wells that we have been getting by agreement with Whiting/Maralex, readings we've been getting by agreement, off of their wells.

And for example, on their Gallegos Federal 6-2 well there, you see a day on the 15th of July when they were flowing at 82 pounds flowing casing pressure, while our Chaco Number 4 well was shut in at 88 pounds that day, I think, and the last 24 hours that well, the Maralex well, had made 437 MCF.

They have two wells that compressors run pretty much full time, and one, the 12-1 well, looks like it only runs sporadically.

And then the two wells that they operate up in Section -- "they" being Whiting, operates up in Section 1, apparently don't have compressors on them. My understanding is that they have automatic shut-downs at 100 pounds. So the production comes and goes if line pressure goes over 100 pounds.

And if you will be kind enough to turn to the second to the last page, which is a tabulation of -- comparison of the key points of this data, you'll see the column with the first information is the date, and I start with the shut-in on the Chaco 5 at 95 pounds in May, and then a series of readings from July 15th through July 24th.

The first column, if you will look at the Chaco 1 shut-in pressures, those are surface shut-in pressures at 98, 99 pounds.

It began to look like we were getting higher shut-in pressures from the pumper's gauge than we were getting from the dead-weight tester, so I asked them to calibrate the dead-weight tester to the pumper's gauge, and it turned out the pumper's gauge is reading about 7.5 pounds high.

So you get two columns to look at for each of our wells, and one is the actual shut-in pressure that we recorded with the pumper's gauge and the second is a correction for 7.5 pounds to compare it to the dead-weight tester.

You'll notice as we go through this that our wells are continuing to build in pressure. You get down to the 24th of July, and in each case we have the highest pressure so far, so they're continuing to build, even though the Whiting/Maralex coal wells are producing at, in some cases, some pretty astronomical rates.

Now, if you'll look at the line marked July 15th, 1998, under the Chaco 2R well, you'll see that it shut in with a gauge pressure of 67 pounds and a corrected pressure of 59.5, while the Gallegos Federal 7-1 coal sell, which is 800 feet away based on my scale, had produced 308 MCF the last -- 308 million cubic feet, the last 24 hours, and had a current flowing casing pressure of 74 pounds, or considerably higher on their flowing casing pressure than we had in the shut-in of our closest frac'd well.

At that same time the Chaco 4 was shut in at 88 pounds, corrected to deadweight at 80.5, while the Gallegos 12-1, which is -- my estimate -- 2200 feet away, but one of the two closest coal wells, had a flowing casing pressure of 91 pounds and it made 298 MCF the last 24 hours.

At that same time, the Gallegos Federal 6-2 was flowing at 82 pounds flowing casing pressure and made over 400 million -- 400,000.

These don't look like wells that are connected. If we have flowing casing pressure on coal wells that are higher than our shut-in pressures, it's very difficult to get too concerned that those wells are connected.

Q. By the way, how would you characterize the range of the pressure data in dealing with Exhibits 15 and 16?

A. We're talking about a total available range to these wells from initial pressure of 250 pounds or less down to a depletion pressure, eventually, somewhere hopefully below 50 pounds, or something in the range of 200 pounds total p.s.i. available for comparison of these wells.

So it should not be unusual to see wells that have been producing for a period of time, regardless of what formation, to be -- to show similar pressures. And it would be easy to get off on a tangent as to comparing pressures between wells that may be more coincidental than indicative of any particular problem.

In this case we have some very specific data that shows that it's not just similarities in pressures, but in fact that they can produce wells at higher pressures than we can shut ours in.

Q. Anything further with respect to Exhibit 16?

A. (Shakes head)

Q. All right, let's turn to Exhibit 17, please, sir, if you'd quickly identify that, explain that to the Hearing Examiner.

A. Yet another cross-section. This is my record-breaking longest cross-section. Section B-B' is designed to show in a qualitative way that there's additional gas saturation available to the Pictured Cliffs below the zones that are typically perforated.

The section starts up in 35 of 27-13 with the High Roll Number 4 well, comes down to the southwest corner of Section 1 and then jogs over to a couple wells in Section 11, back to the southwest of Section 12, to our Chaco Number 4 well, the Chaco 2-R well, and then over again to the Lansdale Federal.

And part of the reason for that deviated section was trying to find sufficient logs and sufficient quality to show what we needed to show. In this case, it's a structural cross-section, and it contains both the porosity log and the resistivity log.

And if you start looking at the well on the far right, which is the High Roll Number 4, it's perforated in three Pictured Cliffs intervals, the top of which I correlate to be the upper Pictured Cliff sands, the next interval down being equivalent to the main sand that's perforated, the second sand that's perforated in all of our wells.

And then what I for this purpose call the third bench of the Pictured Cliffs, which I've colored in red. And on your cross-sections you'll see that sometimes I've colored it intensely red toward the top and then faded out a little bit toward the bottom. That's just a qualitative picture of my impression of the gas saturation that exists here.

But this High Roll well has made a little better than a half a BCF out of those zones, and recently enjoyed a 12-fold increase in production, simply by the installation of the compressor. So it's still producing at a very commercial rate.

And you'll notice here on both the conductivity and resistivity a third bench, that the resistivity is increasing, conductivity is backing off as you come up through that third-bench section, at a time when the porosity is also increasing. And so you've got divergence of the curves, and you've got increasing gas saturation up through that section in that well.

If you go to the Merrion Bayless Chaco 7 well in Section 1, it has the same phenomenon. Looking again at the third bench colored in red, you've got increasing density porosity, and in this case I recommend you look at the conductivity, which is backing off, because it's an exaggerated scale and it's a little hard to see what in the world's going on in some of these resistivity curves. But the conductivity is backing off at the time when the porosity is increasing, again indicating increased gas saturation toward the top.

Same phenomenon in the well in the northwest northwest of Section 11.

And then we have two wells in Section 11 -- well, two wells, the next one in Section 11, the cross-section right here, and the one in Section 12, that have density neutron crossover on the top of this third bench. Now it's only -- call it three feet in the well in Section 11 and probably four feet in Section 12, but the one in Section 12 is perforated only in that zone, initially, and I have no record of it ever having been reperforated, but the cumulative production, apparently, from that zone is about 93 million cubic feet. So it's clearly gas-productive and contains gas.

We go to our Chaco 4 well -- And incidentally, I'll back up and mention that this gas column down here in the High Roll Number 4 well is the structurally lowest well on the cross-section. So you've got plenty of gas column down here, even in a structurally low position.

On our Chaco 4, we don't have the classic funnel shape of the conductivity backing off in a particular zone while the porosity increases. We do have increasing porosity, and we do have a reduced conductivity as compared to the next zone down. So between these two zones we see a very definite increase in gas saturation in the third bench, compared to the next sand down.

We do not have a porosity log on the Chaco 2-R. It appears that the conductivity has backed off again compared to the next bench down, if you go to that porosity log and compare it.

And then we come to the Lansdale, which has the classic funnel shape between the two curves of reduced conductivity and increased porosity.

And there is another bench showing up in the Lansdale between the lowest perforated interval and what I'm calling my third bench. We have a little sand builds up here, and it looks a little bit tight on the SP, but four feet of that was caught in that core, and it has a little bit poorer gas saturation, residual gas saturation, in the core of the Lansdale but still some of the same quality with porosities in the 20s and permeabilities in the 20s in this zone right here. So that's a zone that's fully capable of producing some gas.

And that brings me back to the comment I pointed out earlier by Jacobs when he wrote up this field, that the lower bench tends to produce gas but may also cause some water problems. This is higher water saturation than this stuff that's traditionally been perforated.

Q. Let's turn to Exhibit 18 now. Let me ask you, does that conclude your testimony with respect to the geology, reservoir characteristics of the Pictured Cliffs sand and the Chaco wells?

A. Yes.

Q. All right.

A. One more comment I'd like to make about this. I turned this information over to Jack McCartney, who is one of our witnesses, and asked him to either confirm or refute what I thought I was seeing there, and there will be some more discussion of what came of that.

Q. Mr. Nicol, again during the course of the public meetings in Aztec before the District Office up there, what were some of the other methodologies the group discussed to help evaluate the perceived problem?

A. One of the activities we undertook was to investigate whether or not the gas analysis and/or water analysis could be used to determine where the production is coming from. The Commission staff actually undertook to go out and test the wells in question and other nearby wells to get gas samples and water samples.

My conclusion was that both were inconclusive and not useful, and I had the impression that that was the general conclusion of the rest of the parties. But I'd like to show why I concluded that.

The next page in your book is a tabulation of production -- I'm sorry, of gas analyses on Designated Hitter Number 2 well.

Q. That's Exhibit N18?

A. Yes, sir. I've lost the numbers here, but...

That well is a Pictured Cliffs well that was perforated but not fractured in Section 27 of 26 North, 12 West, so it's a little southwest of the area that shows up on the maps I've been presenting -- or southeast, I'm sorry, of the area I've shown. And I've ranked the data here by date, starting in 1978.

When the well first came on, it had a BTU content of 1111. By 19- -- In late 1979 it was down to 1029.

Virtually all of these are El Paso Company analyses, and they do them regularly. And it stayed in that range of low 1000, occasionally bumping up. There's one there that's as high as 1055, and there are some that are down as low as 1007. It seems to bounce around.

We see this indicated in the other data we have where Pictured Cliff wells can come on with an expected high BTU out of the Pictured Cliffs to start with, but that it drops off.

I have made some columns, there's a bunch of columns there of what happened to ethane, propane, CO_2 and nitrogen, and the percentage change where a negative percentage change is actually an increase. And the maximum change that seemed to occur seemed to be in the propane, as far as the components of the -- the burnable components of the gas go.

That well was frac'd in the Pictured Cliffs, in the same perforations, in 1994 -- December, 1994 -- and we have three readings since then, but it appeared to actually, on the average, go up in BTU content for two years after the frac job. And then the last reading is back to 1018.

I don't think this is atypical, and we will show on in our case why this should actually be expected out of the Pictured Cliffs.

Q. Let's turn to Exhibit N19, if you would identify that and explain that, please?

A. This is a two-page tabulation of 149 gas analyses we were able to find, either in our files or supplied by Whiting and Maralex, and this particular page is ranked by BTU, top to bottom -- or two pages of the exhibit.

It starts by listing a line number so you can refer to it, and then the well name, the date the sample was taken, the location of the well, whether it's a PC or a Coal well, whether or not it was stimulated, fracture-stimulated, and then columns for the various contents of ethane, BTU, propane, CO_2 and nitrogen. As I say, it's sorted by BTU.

I'd like to point out that under whether or not it was stimulated on the Chaco 5 on line 1, I've got a little asterisk, and the same is true for the Chaco 2-J on line 46.

Both of those wells had been originally frac'd when they were completed with 2500-pound fracs, back in 1978 or 1979, when they were drilled. That's not a sufficient frac to really do a frac job, and it's certainly no indication of any communication with other reservoirs at that point. So I've listed it as a "no" with the asterisk, so that you recognize that there is at least a little stimulation on those wells.

I think points to be made here are, first of all, that there is a general trend in the compilation to have PC wells at the high-BTU end and coal wells at the low-BTU end.

Now, it's interesting to note that there are a lot of coal wells with lower BTUs than what the Whiting/Maralex wells are seeing.

But if you just look at that column of BTUs from top to bottom, there is no break, there is no definitive break from one category to the other. You just start picking up more and more coal as you go down through the section.

And a lot of these wells bounce around quite a bit. They do not maintain a consistent and steady BTU from well to well.

For example, if you look at the Chaco 1-J well, which was never frac'd, on lines 108 and 129, which are on the second page, there are two readings for the 1-J that are in the 106-to-112-BTU range. And one was done in -- It was done by us in March of this year, and the other was done in 1996.

The same well shows up on lines 26 and 29, where at one point in 1997, after the low BTU reading, it was gauged at 1078 BTU. And on line 29, again in 1997, it was gauged at 1071.

I had a conversation with the gentleman who does this testing, or manages this testing, I should say, for El Paso, and he commented that they don't --

MR. GALLEGOS: Object to the hearsay.

MR. HALL: Mr. Catanach, it's not offered for the truth of the matter asserted; it's simply, again, contextual to show the utility or lack of meaningful conclusions that could be drawn from BTU data.

MR. CARROLL: What information are you offering?

THE WITNESS: Let me see if I could make my point in another way without quoting somebody else and avoid that issue; is that all right?

MR. HALL: (Nods)

THE WITNESS: My -- I anticipate that the reason two readings were taken on the Chaco 1-J close together in 1997 was that it was a significant enough difference in BTU from the previous readings that El Paso wanted to confirm it and took another reading.

Q. (By Mr. Hall) All right. Can you explain some of the variabilities that may affect BTU readings over time from various wells?

A. I believe it's affected by the quality of gas in the rock. There are different sources for this gas. It can be sourced from the coals as well as from other organic material, or the Lewis shale down below, and I think it changes with producing rate, producing characteristics.

Q. All right. Let's turn to Exhibit N20, some additional literature. Would you identify that, please, sir?

A. This is an article by Andrew Scott, W.R. Kaiser and Walter Ayers, entitled "Composition, Distribution, and Origin of Fruitland Formation and Pictured Cliffs Sandstone Gases, San Juan Basin, Colorado and New Mexico.

Q. Would you -- In the interests of time, why don't you summarize the points that are made in this article?

A. There are five different places in this article where they state basically that you cannot use gas analyses to differentiate between Fruitland Coal and Pictured Cliffs gases in this part of the Basin, in the underpressured reservoir.

Q. Have you highlighted those --

A. I've highlighted -- Yes.

Q. -- particular points in the exhibit?

Let's turn to Exhibit N21. If you would identify that and explain that to the Hearing Examiner.

A. That's the second part of the core analysis on the Lansdale Federal well that I promised, and this was a desorption analysis done on the Fruitland Coal portion of the core by P-V-T, Inc., on behalf of the operator at that time, which was Southern Union.

Q. What conclusions may you draw from this?

A. A number of interesting things come out of this analysis.

First of all, the tabulation at the bottom of the final page -- or the first page of what's termed "Final Report", the second page of the exhibit, is done in cc's per gram of gas content and coal. And when we received the report there was a tabulation here that you see done in pencil where someone had calculated what that meant in cubic feet per ton.

I ran my own numbers on that and came up with virtually the same numbers. I came up with an average of 85 cubic feet per ton, top to bottom, through samples 1 through 6. Sample 7 was done down in a little coal stringer down in the Pictured Cliffs.

Now, the other parts that are interesting show up back a little farther under what's described as Table III, "Composition of Desorbed Gas". And it shows ethane content of the desorbed gas from the various samples, 1 through 6, of frequently over four percent. The percentage that we're seeing from the Whiting/Maralex wells is usually less than two percent.

So the ethane content in the core seems to be different from the ethane content in production. It's very high in that sample 7, which was, as I said, a finger down in the Pictured Cliffs.

And then the next page, under "Comments", comment number II states that the amount of adsorbed gas was greatest at the center of the seam and somewhat less at the top and the bottom. So you've got difference in coal gas content, even in a 19-foot coal seam, from top to bottom.

The amount of ethane present in the adsorbed gas increased with depth.

And then comment number V, "Although it is not shown in this report, a general trend followed for most samples was an increase in ethane evolution and a decrease in carbon dioxide evolution with time."

So you've got a changing gas content in the desorption analysis, even in a single core, which doesn't give you much confidence that you can watch a well produce and come up with a consistent, usable, continuous, constant gas content to use as an analysis to see where it was coming from.

Q. By the same token, does the variation within the core, from this core analysis, tell you about the applicability of BTU analysis over a wide area, such as the subject of review that's the subject of this Application?

A. No, it's a very specific single point. And you have variations within that single point. I don't know how you would use it over a wide area with any confidence.

Q. All right. Mr. Nicol, in your opinion, was it reasonable, prudent and necessary for Edwards and Pendragon to fracture-stimulate the Chaco wells?

A. Yes, it was.

Q. Did the fracture stimulation result in the recovery of additional hydrocarbon reserves from the Pictured Cliffs sandstone that would have otherwise gone unrecovered?

A. Yes.

Q. In your opinion, from your analysis, are the Pendragon Pictured Cliff sandstone wells producing from the appropriate source of supply?

A. Yes, they are.

Q. Were Exhibits N1 through N4, N6 through N8, N10 through N19 prepared by you or at your direction and control?

A. By me.

Q. And the literature exhibits, N5, N9 and N20, are they literature of a type that's typically relied on by experts in your field?

A. Yes.

MR. HALL: Mr. Examiner, that concludes our direct.

We'd move the admission of Exhibits N1 through N20.

EXAMINER CATANACH: Any objections?

MR. GALLEGOS: No objection.

EXAMINER CATANACH: N1-N20 exhibits will be admitted as evidence.

Mr. Gallegos?

CROSS-EXAMINATION

BY MR. GALLEGOS:

Q. Mr. Nicol, you were standing at one of the cross-sections about midway through your testimony, and you said it was frustrating to you that Whiting has the right to fracture their wells and get into the Pictured Cliffs, but we don't have the right to fracture ours.

MR. HALL: I'm going to object --

MR. GALLEGOS: I think that was the closest --

THE WITNESS: I didn't say that.

Q. (By Mr. Gallegos) Well, what is the frustration that you were expressing?

MR. HALL: Let me state an objection to the record, to the previous part of that question. I think it mischaracterizes earlier testimony.

If you understand the question now as rephrased, go ahead and answer.

THE WITNESS: My frustration was, the circumstance where if the Pictured Cliffs and the Fruitland Coal are unseparated or that they are separated by a minimum of shale, that somebody who comes in and fractures their well with a massive frac and apparently makes no effort to control where the frac goes or what it catches, really doesn't have much complaint when somebody else comes in and tries to do a stimulation on their well with a very carefully controlled frac.

Q. (By Mr. Gallegos) Okay, so what you're suggesting, first of all, is, there is little or no stress barrier between the Fruitland Coal formation and the Pictured Cliff formation. Do you agree?

A. No. In that circumstance that I was pointing to with no separation between them, there couldn't be any stress barrier.

Q. Okay, so there's no separation. One is virtually lying in connection with the other?

A. On that log, on that well.

Q. Well, which --

A. I do not agree with what you're trying to say for the other wells that were in contention here, because there are very clearly soft shale stress barriers between the zones.

Q. Well, first of all, what log and what well are you specifying?

A. I made that comment about the well in Section 1 of 27 North, 12 West.

Q. You're talking about your Chaco 5 well?

A. 27-12, sir. It's the township to the north on that cross-section.

Q. Oh, okay. Not one of the wells in question here, either the -- what we refer to, either the Chaco wells or the Whiting wells?

A. That's right.

Q. All right. So let's address the wells that we're interested in. You're saying in that case there is what barrier between the formations?

A. What I characterized as a soft shale.

Q. How thick?

A. Generally about four feet. It varies.

Q. And are you suggesting that that shale was fractured by the Whiting stimulations of their wells so that they have opened up communication between the Pictured Cliffs and the Fruitland?

A. I think that's a possibility in some of their wells.

Q. Okay, and --

A. We have some evidence that it didn't happen in all of them.

Q. And your frustration is that if you frac your wells and the same thing happens, you don't think there should be any criticism?

MR. HALL: I'm going to object to, again, mischaracterization of prior testimony. There was no testimony that the Pendragon fracs reached up into the coal. That's what Mr. Gallegos is --

Q. (By Mr. Gallegos) Well, I'm trying to figure out what this frustration was that he expressed, something about, seemingly, one party could do something with their fracture stimulations, but Pendragon, in other words, couldn't. Well, explain to us, what's the problem?

A. My problem was the -- my belief that the fractures were done on the coal wells without any consideration as to where that frac was going or what zone it was going to connect to, whereas we very carefully tried to avoid getting any fractures into the coals because we didn't own them and we didn't want to connect with the coals.

Q. Okay, so did you run some temperature surveys immediately following your fractures to trace where they went, where they grew vertically, how they performed?

MR. HALL: Mr. Examiner, I think I may be able to short-circuit this here, but by the way let me object. I think this is going beyond the scope of direct examination. There was no specific testimony from Mr. Nicol about the design and manner of performance of the frac jobs on the Chaco wells, just that they were frac'd, period.

We have another witness who will testify this afternoon about the design implementation of the frac job, so maybe these questions are best reserved for that time.

MR. GALLEGOS: Well, no, they're best asked of Mr. Nicol, since he expressed some sort of frustration, as he put it, about the -- one party being able to fracture-stimulate and another party not being able to, and that's what I'm exploring.

Q. (By Mr. Gallegos) So did you do temperature surveys?

A. No.

Q. Pendragon Energy Partners is the owner of these, what I'm referring to, this group of wells that's -- call them the Chaco wells, if we can have that understanding?

A. Let me clarify it. Pendragon Energy Partners is the general partner of a partnership that owns the wells.

Q. Okay, and what's the partnership that owns the wells?

A. It's Pendragon Resources, L.P. Pendragon Energy Partners is the operator.

Q. Pendragon Resources, L.P., is the owner?

A. Yes.

Q. Okay. And that's a partnership of which you are a partner, correct?

A. The -- Pendragon Energy Partners, Inc., is the general partner, yes.

Q. And are you a partner of Pendragon Resources?

A. Are you talking about me personally?

Q. Yes, you personally.

A. No.

Q. Who is the --

A. I'm a stockholder in the general partner.

Q. And the general partner is -- What is the entity that's the general partner?

A. Pendragon Energy Partners, Incorporated.

Q. Which is a different entity than the operating company?

A. That is the operating company.

Q. Pendragon Energy Partners --

A. Yes.

Q. -- is the operating company and is also the general partner of Pendragon Resources?

A. That's right.

Q. And you're a stockholder of Pendragon Energy Partners?

A. Yes.

Q. Okay.

A. And, go a step farther. We are one of the owners of the wells, the partnership.

Q. Yeah, I'm going to get to that. Just exploring your pecuniary interest in these wells, Mr. Nicols.

And is -- Your stockholding in Pendragon Energy Partners is to what extent?

A. Fifty percent.

Q. And who owns the other 50 percent?

MR. HALL: Mr. Examiner, I'm going to have to object at this point. This is getting so far afield from direct testimony, and I don't think it's relevant here at all.

MR. GALLEGOS: I'm entitled to examine the witness's --

EXAMINER CATANACH: What's --

MR. GALLEGOS: -- pecuniary interest --

EXAMINER CATANACH: What's the point, Mr. Gallegos?

MR. GALLEGOS: -- in the matter. He's expressing opinions here, and I think you're entitled to know what his interest is, as opposed to somebody who has no particular interest in the outcome, who's just here as an expert expressing their opinions.

MR. HALL: Well, the interest has been established. Why do we continue to dwell on it?

MR. CARROLL: How far are you going to go with this, Mr. Gallegos?

MR. GALLEGOS: I want to know who the other interest owners are.

MR. HALL: I don't see any relevance to that.

Q. (By Mr. Gallegos) Who are the other partners?

MR. HALL: Do we have a ruling?

EXAMINER CATANACH: Hold on.

MR. CARROLL: You can ask about his financial interest, but not other people's. I mean, you're attacking his credibility as a witness, as an expert witness, based upon his financial interest in this case --

MR. GALLEGOS: I --

MR. CARROLL: -- is that correct?

MR. GALLEGOS: -- think that's something to be weighed, as to -- taken into account --

MR. CARROLL: I agree, but where are you going with other people's financial interests in this?

MR. GALLEGOS: If there are others -- Let me phrase it --

Q. (By Mr. Gallegos) Are there other interest owners who are to be witnesses?

A. There's one.

Q. And who is that?

A. Roland Blauer.

Q. And what is his ownership interest?

A. Roland owns an interest in another corporation which is a co-general partner to the partnership.

Q. And what is the extent of his ownership in the partnership?

A. Let me see if I can explain this in a way that helps clarify it.

Originally there were three people who started Pendragon Energy Partners, Incorporated. A year ago we split Roland's interest out into a separate corporation as a co-general partner.

So originally Roland owned one-third, and still owns one-third, of the Pendragon Energy Partners, Inc., interest in the partnership. And that interest varies depending on whether or not the properties have paid out.

Q. All right. And anybody else who is an owner, who is going to be a witness in this proceeding?

A. No.

Q. Okay. Tell us, Mr. Nicol, about your experience in coal stratigraphy.

A. I've been working on coals in general for just a few years. I really started with our involvement in the San Juan Basin back in -- I don't remember if it was late 1993 or early 1994.

Q. About the time that you acquired these properties?

A. Yeah, shortly before we -- perhaps a year before we acquired these properties.

Q. Okay, so you've worked in no other coal basins?
A. Well, that's not true, I --
Q. On coal strati- -- No, on coal stratigraphy.
A. On coal stratigraphy, that's not true. I have -- Our company buys production, so I have looked at a number of other coal properties to purchase. And in doing that, I have to do very detailed analysis of the geology and the economics.
So I have looked at a number of other properties, including large properties in Alabama and the Raton Basin and Green River Basin and the Piceance Basin.
Q. And what does your experience consist of in the San Juan Basin? What have you done, other than these properties and this study?
A. Well, by far my greatest experience has come from being involved here when we bought properties in 19- -- Call it 1993. But I have been involved in other prospects in drilling interests in the San Juan Basin since way back in the early Seventies with Zoller and Danneburg and Resources Investment Corporation.
I think some of the wells on this map, I may have participated in Ray Dietrich at one time, i.e., the company that I was speaking for.
And I have -- The period that I was consulting, I did consulting for Santa Fe Energy when they wanted to

divest their interest down here and established values and whether or not there was any additional drilling completion potential development, potential --

Q. Coal properties?

A. Coal properties. And I have an ongoing client in Denver, another sizeable independent that contracts for me to do geological evaluations of the properties where they have a large spread of royalties and mineral interests down in the San Juan, most of that on the Colorado side.

Q. Okay. And would you consider yourself a sedimentologist?

A. I don't -- Well, I've been, since 1969, working in the oil business, which has all been in sediments, so I'd have to say yes. Not in term of some sort of academic teacher or sedimentology or anything like that, but I've worked with it daily.

Q. The group of roughly, I guess, six or seven Chaco wells that we're talking about -- or maybe, I think you -- Did you say there were 11 total wells that were in the purchase from Merrion and Bayless?

A. No. We're talking about six Chaco wells that we purchased at that EBCO sale and five coal wells that are involved in the debate, so there was --

Q. All right.

A. -- a total of 11.

Q. Well, I'm talking about the Chaco wells that you purchased.

A. Six.

Q. Six. Six Chaco wells. All right.

Is that accurate, that they were purchased at an EBCO auction?

A. You know, when I said that I was trying to remember whether we bought them outside of the auction, but they were originally offered at an EBCO auction, and I frankly don't remember the circumstances or whether we actually bought them at an auction or bought them Merrion aside from the auction.

Q. Isn't it a fact, Mr. Nicols, that those six Chaco wells, those properties, were given to Edwards by Merrion and Bayless? Nothing was paid for; Merrion and Bayless simply wanted to rid itself of the plugging-and-abandoning liability?

A. Not to my knowledge.

Q. Well, Mr. Edwards handled that transaction?

A. If there was that transaction, he would have handled it, yes.

Q. All right. And what you bought -- And if I might approach the witness here, I'll just use the reporter's copy. This is the Whiting/Maralex Exhibit Number 9.

What you bought, if you will look at Exhibit

Number 9 and turn to the second page, is represented by one of the transfers from the Merrion Bayless group to J.K. Edwards and Associates; isn't that correct?

Do you have that, Mr. Examiner?

MR. CARROLL: Where is it?

MR. CONDON: It's Number 9, it's a packet that's got the area map on top.

MR. GALLEGOS: I think what happened is, I took yours instead of the --

MR. CARROLL: Oh, the reporter's --

MR. GALLEGOS: -- the reporter's, I'm sorry. His is over here.

THE WITNESS: That describes --

Q. (By Mr. Gallegos) Does that describe --

A. Yes, that describes the acreage for the 2-R and the Chaco 1 wells.

Q. And that describes the formation that was being transferred, or at least the operating rights, transferred from the Merrion Bayless group to J.K. Edwards and Associates, does it not, Mr. Nicols?

A. Yes.

Q. And it's described as limited from the base of the Fruitland Coal formation to the base of the Pictured Cliffs formation?

A. Yes.

Q. And then I take it through some transaction this interest passed from Edwards to the Pendragon entities?

A. A portion of it.

Q. A portion. Edwards still retains what quantity?

A. Twenty-five percent.

Q. Okay. Now, do you have some knowledge of the experience that Merrion and Bayless have in the San Juan Basin?

A. Yes.

Q. About how long have they been operators in the Basin?

A. I guess I don't know the answer to about how long, but I've recognized the names and being operators for, I'm going to say, probably as long as I've been in the business.

Q. As far as you know, are they competent and successful operators?

A. Yes, sir.

Q. But we're to understand that they could not recognize this extraordinary potential of remaining reserves in the Pictured Cliffs formation that you were able to --

MR. HALL: You know, I'm going to object. It asks for the witness to conclude about the thought processes of a third party, nonwitness. Foundation.

EXAMINER CATANACH: I agree. You don't have to answer that.

Q. (By Mr. Gallegos) These were properties in which the wells were producing three or four MCF a day or, in the case of one or two of them, actually shut in and producing nothing --

A. That's right.

Q. -- isn't that true, when you obtained them?

A. (Nods)

Q. And are you acquainted with Paul Thompson?

A. Yes, sir.

Q. Is Mr. Thompson employed in some capacity for Pendragon and Edwards?

A. We hired Paul's firm to operate the wells for us.

Q. Okay. And for how long has he provided that service?

A. Since these wells were purchased by Edwards.

Q. Or before these wells were purchased, or acquired?

A. On other wells, yes, sir.

Q. Maybe since -- What year, would you say?

A. Well, he was operating them for Edwards when we bought our first interest from Edwards, so I would have to guess 1993.

Q. And isn't it true that Mr. Thompson was checking on the Whiting coal wells in this area and reporting to you the production of those wells, dewatering process and the gas production?

A. When? He has been --

Q. From --

A. -- the last few weeks.

Q. No, I'm talking about since 1992, 1993.

A. If you're asking about an occasional passing comment, sure. If you're asking about regular reporting, absolutely not.

Q. Well, however we want to characterize it. He was providing information to you that the Whiting wells were being dewatered, and approximately how much water was being produced and when they began to successfully produce gas; isn't that true?

A. No.

Q. Well, what were the passing comments that he reported to you?

A. The only comments that I recall at all are the fact that they sure have a lot of water tanks out there, or something to that effect. I'm not trying to quote him, but that was the gist of it.

I don't -- I don't know where you're going, but there has been no effort on our part through Thompson to try to monitor what those wells are doing. If I want to know, I call them up on *Dwight's*.

Q. Since you acquired the properties, or as you've acquired these properties, what studies did you make before the fact as to support or reason to do the stimulation jobs that you did on the wells?

A. It was really rather simplistic at that time. We looked at what the wells had made, did a volu- -- I did a volumetric calculation of about how much gas I thought they should have made and then selected which wells we wanted to participate in frac'ing.

Q. And you just decided that the wells were damaged? Is that what you testified?

A. Basically, yeah. We didn't know what, exactly, the problem was, but it was clear that if you could get back into the reservoir there was a lot of gas left to be had.

Q. You will agree, will you not, that if there's so-called skin damage, the level of production might be adversely affected, but on a shut-in basis you're going to see -- the well's going to see whatever pressure exists in the reservoir?

A. Eventually, yeah.

Q. Yeah, if you shut in for a sufficient period of time, the pressure is going to build up?

A. Uh-huh.

Q. So the pressures that existed before the stimulations you did on these wells would represent the reservoir pressures?

A. Yes, sir.

Q. Okay. Now, you have used the terminology "upper Pictured Cliffs" throughout, and I think you testified at one point that this has been a formation recognized for 25 years by the regulatory agencies and many operators?

A. No, I thought I clarified at the beginning that I was using the term "upper Pictured Cliffs" so that everybody in the room would understand which sand I was talking about. I don't -- I did not say that's a formation that's been recognized. What I said is that the completions in the Pictured Cliff wells in that zone and the other zones in those wells have been recognized as Pictured Cliffs completions.

Q. Okay. There is no place that you will find in the literature, or in a declaration of pools by the OCD, or any other place, a use of the term "upper Pictured Cliffs"; don't you agree?

A. I would agree. I haven't seen it. My purpose was simply for clarification for this discussion today, as to which zone I was talking about.

Q. Well, did you -- For purposes of the determination that you said you seek by this Application, which is a declaration that your wells are producing from a common source of supply, did you refer to the pool rules concerning the Basin Fruitland Coal formation?

A. Yes, sir.

Q. Okay. So you would have referred to orders that were entered in 1988, 1989 and later, in connection with the -- with that pool, correct?

A. You're talking about the coal pool now, yes.

Q. Yeah, and you're familiar with that?

A. Yes.

Q. Well, and you're familiar with the fact that in the declaration of that pool considerable attention had to be given to the other adjoining formations; isn't that true?

A. Yes, sir.

Q. Okay. In Order 8768, which was the case in 1988 declaring the -- actually creating the pool for the Basin Fruitland Coal formation, the Division found, and let me quote this:

> Geologic evidence presented by the Committee indicates that the Fruitland formation, which is found within the geographic area described above, is composed of alternating layers of shales, sandstones and coal seams.

End quote. Do you agree with that?

A. Yes, sir.

Q. Then Rule 3, which I think is referenced in your Application that you are proceeding here, among other things, under Rule 3 of the special rules pertaining to the Basin Fruitland Coal Pool, that rule says, and I quote:

> The Division Director may require the operator of a proposed or existing Basin Fruitland Coal gas well, Fruitland sandstone well or Pictured Cliffs sandstone well to submit certain data described in Rule 2 above, which would otherwise not be required by Division Rules and Regulations, in order to demonstrate to the satisfaction of the Division that said well will be or is currently producing from the appropriate common source of supply.

End quote.

So you're proceeding under that rule for that kind of a declaration; isn't that true?

A. Yes, sir.

Q. All right. And there has been no mention in any of your testimony that I was able to take note of, of the Fruitland sandstone. That is not a factor in Pendragon's Application; is that correct?

A. That's correct.

Q. All right. Let's just, if we might, maybe -- I think your early cross-section was N3, Exhibit N3. Could we put that up?

A. Is that A-A'?

MR. HALL: Yes.

Q. (By Mr. Gallegos) A-A', yes, sir.

Okay. Now, first of all, I understand you just -- you coined the phrase "upper Pictured Cliffs" for this proceeding?

A. That's correct.

Q. All right. Now, tell us -- help us locate on this cross-section the Fruitland sandstone.

A. What I've got on this cross-section are resistivity logs. I can't identify lithology just on resistivity logs, but I do not see any Fruitland sandstone below this 20-foot coal. I have not seen any Fruitland sandstone. The only sandstone below that coal is Pictured Cliffs.

There may be Fruitland sandstones here. These two intervals were perforated as coals, and I believe they are. I don't recall what that zone is. It could possibly be a Fruitland sandstone. But I don't have enough information here to point to a Fruitland sandstone and say, That's one.

Q. So on the coal that you show on your cross-section, Exhibit N3 there, is -- there are no layers within the Fruitland Coal formation of Fruitland sandstone?
A. There are no layers of Fruitland sandstone below what I've labeled the basal Fruitland Coal.
Q. Well, if there are any, then they would be above --
A. Above.
Q. -- out of the coal formation?
A. The coal formation has been separated from the Fruitland sandstones, different pools. So yes, any Fruitland sandstones that existed up in here would not be in the Fruitland Coal formation -- Fruitland Coal Pool. The use of the term "formation" is a little bit confusing there, but --
Q. Well --
A. I guess I don't quite understand your question, I'm sorry.
Q. Well, what do you understand the definition of the pool -- The Fruitland Coal Pool includes all coal formations. That's what the order says, all coal formations. Not a single coal formation.
A. Exactly.
Q. Isn't that true?
A. That's true.

Q. And your cross-section shows an upper coal and a lower coal. The blue?

A. It shows all the coals in the pool as defined by the Amoco well and the stratigraphic equivalent to that cutoff point. There can be coals down in the Pictured Cliffs; they're not Fruitland Coal.

Q. That's fine. But you show in your cross-section, you have colored in blue a -- what I'm just referring to as the upper, and I think a lot of people refer to it as the B coal section. The thicker coal formation, correct?

A. The one I refer to as the basal Fruitland Coal? Yes, sir.

Q. You refer to as the basal.

A. Yeah.

Q. All right. And then below it, varying as one would read these logs, with a thickness of from six feet to maybe two feet, one foot, is a lower coal formation; isn't that what --

A. Yes.

Q. -- the logs show?

A. Yes, there's another coal there, yes, sir.

Q. All right. And as you understand the pool rules, the definition of the Basin Fruitland Coal formation is inclusive of all of the coal formations, all the layers from the uppermost to the lowermost?

A. No.
Q. You have -- There's something in the orders of the Commission or the rules that you rely on to give that answer?
A. It's defined as the coals found above the stratigraphic equivalent of a point in a particular well, and I went through that in my testimony as to what I see as the stratigraphic equivalent to that point, carrying it down into the Chaco gray.
Q. Okay, so if we --
A. There are --
Q. Excuse me.
A. -- coals below that point. They're not included in the Fruitland Coal pool.
Q. Okay. So just to be clear, let's -- so that we understand your testimony, if we take Exhibit N3 and we have a lower -- the lower coal, the thin lower coal and the upper coal, then as you understand it, what is the Basin Fruitland Pool in that area?
A. The Basin Fruitland Coal Pool starts at the top of what I have termed the upper Pictured Cliffs sand, and it goes up from there.
Q. Okay. So you exclude the lower coal?
A. Yes.
Q. That's your testimony?

A. Yes.
Q. Okay. All right.
Do you understand that this specific area, Mr. Nicol, is -- has been recognized as an area where there occurs what's called the WAW Fruitland Pictured Cliffs Pool?
A. Yes, sir.
Q. Are you familiar with that?
A. Uh-huh.
Q. What is that?
A. When the original development started here in the NIPP Pictured Cliffs Pool, it coalesced with the development of the WAW Pictured Cliffs Pool. Sometime after that, as I understand it --
Q. I'm sorry, I -- Let me interrupt you. But you said this was not the WAW? You said when it coalesced with -- What was the other pool?
A. This is the N-I-P-P, the NIPP Pictured Cliffs.
Q. Okay.
A. At least the Chaco 4 and below. I think that the log heading shows Chaco 5 may have been in the WAW PC Pool. There was some -- The two pools coalesced.
And then sometime later, the pool was changed to include both Fruitland sands and Pictured Cliffs sands, and that, as I understand it, is the WAW PC Fruitland Pool.

Q. To include the Pictured Cliff and the sandstone interval within the Fruitland formation?

A. Correct.

Q. All right. And your testimony is that what we see on this cross-section and you've labeled "Upper Pictured Cliffs Sand" is not the sandstone interval within the Fruitland formation?

A. That's correct.

Q. Okay. The literature you referenced us to in some place supports that, that what you have recognized as the upper Pictured Cliffs, you've labeled for purposes here the upper Pictured Cliff, as contrasted with being a sandstone within the Fruitland formation?

A. Yes, sir.

Q. All right. And that specifically is what? And I'm not asking you to go back through, but what piece of the various literature -- We went through those fast.

A. Specifically the publication by Jim Jacobs of Dugan when he wrote up the description of the NIPP Pictured Cliffs discovery and the development of the pool.

Q. Was there any reason that in your testimony you didn't refer to Mr. Fagrelius's description of the WAW Fruitland Pictured Cliffs? He's also a geologist with Dugan Production Company.

A. Probably the best reason is that in no way was I able to go through all available literature, or even find it. So I'm sure there's an awful lot of literature that I haven't even seen, and I don't recall that one.

Q. Okay, the key, as I understand it, to your classification of what you've elected to call here the upper Pictured Cliffs formation is the depositional environment?

A. Correct.

Q. And your testimony rests on your conclusion that that particular sandstone was laid down in a marine environment?

A. Yes, sir.

Q. And if it was not laid down in a marine environment, then it would be a sandstone within the Fruitland -- within the coal formation; do you agree?

A. Yes, sir.

Q. Okay. How was the -- In particular I'm interested, how was the lower coal that's shown on your cross-section here deposited at a depth below what you refer to as the upper Pictured Cliffs? What was the depositional sequence there?

A. Well, I don't know what the depositional sequence was. There's possibilities that it was laid down in a quiet backwater area of a lagoonal environment.

Q. Are you saying that that's also a marine deposition, this coal, the lower coal?

A. You can have coals laid down in a predominantly marine environment, certainly, in a lagoon that's still subject to tides and has a shoreline in it and you've got organic material being brought in and laid down and -- sure, in quiet water.

Q. Okay, you're talking now about a coastal environment --

A. Yes.

Q. -- is that what you're --

A. Yeah, all of this --

Q. Just on -- well, but -- Back on the edge of the sea?

A. Uh-huh.

Q. But the marine environment accounts for the deposition of the -- what you call the upper Pictured Cliffs?

A. Yes.

Q. Okay. And one of the keys to that was the sand size, the grain size. Is that what you were saying?

A. Not the grain size, the consistency of the sorting.

Q. The cleaning up?

A. The cleaning up and the consistency of the sorting where you have fine-grain sand described from top to bottom in that core.

Q. Okay. And what's the nature of the sand in the Fruitland sandstone? We find it somewhere there. I guess in your case -- or in your view, it's up above the coal. But wherever it is, what's the nature of that sand, compared to what you're labeling as the upper Pictured Cliffs?

A. I have seen one mudlog description of some Fruitland sands, and some of the mudlog description goes from fine to very fine, some of it was described throughout the sand it was penetrated as fine also.

Q. So essentially the same?

A. Yeah. And if your deposition is close to your source that's bringing the sand in, you would expect that.

Q. Okay. So you see the -- what you would recognize somewhere at a shallower level as the Fruitland sand as being essentially the same as the sandstone of the Pictured Cliff formation?

A. It could be. Could be the same grain size, yeah, if that's what you're --

Q. Well, from your studies, is it or is it not?

A. I don't have enough information to generalize. I saw one mudlog where some of the sand was described virtually the same as the Lansdale Federal core in the PC.

Q. What do you hypothesize is the source of the sand, laid down either in the Pictured Cliffs formation below the lower coal or what you refer to as the upper Pictured Cliffs?

A. Well, the source would be a land source originally. It would be brought down by streams and rivers that are flowing into the marine environment, and then it's redistributed by wave and tidal action, current action.

Q. So that could be deposited either in a marine environment or a nonmarine environment, being brought down from flow -- water flowing toward the sea? Is that a simplistic way --

A. Are you saying the sand would be deposited that way?

Q. In either deposition, the source would be the same?

A. The original source would be the same, yeah.

Q. Is there a definition you apply to a massive sandstone layer? You used that term, and I wasn't clear if that has some definition?

A. No, you're exactly right, it does not have definition and should not be used to define anything.

Q. Okay. The -- Your Exhibit 7 in some of your other discussion -- Exhibit 7, I think, was the core samples on the -- No, that's 8, excuse me, Exhibit 8 was the core samples on the Lansdale Federal Number 1, and the -- 7 was the -- We've covered a lot of ground here. It's a little hard to come back to all of this.

Based on Exhibit N8, and I think some of the other data that you saw, it's your conclusion that the Pictured Cliffs formation in this area has a very high permeability?

A. Yes.

Q. Okay. In fact, this core is showing some places where you've got millidarcies of 194, even over 200 --

A. Yes, sir.

Q. -- and also very good porosity, 25-percent or so porosity?

A. Uh-huh.

Q. Okay.

A. Average is over 20.

Q. So this is clearly not what one would refer to as a tight formation; do you agree?

A. I agree.

Q. So -- Do you know, by the way, how that might compare to, say, the Mesaverde formation in the San Juan Basin?

A. I'm not as familiar with Mesaverde in the San Juan as other areas. But generally speaking, the Mesaverde would be many degrees tighter at lower permeability.

Q. Okay. Now, I think also it was Exhibit 15, you said what it taught you was that the pressures of a large number of wells in this area, Pictured Cliffs wells in this area, indicated basically a stability or a communication? In other words, the pressure declines were fairly uniform across a large area?

A. Yes.

Q. Okay, and that would indicate to one, again, that you've got very good permeability, and it's --

A. Good perm.

Q. Good perm.

A. And the corollary is an opportunity to drain a surprisingly large area with the well.

Q. Okay. Probably drain more than 160 acres, wouldn't you think, with this kind of porosity and permeability?

A. Yes.

Q. Okay. And so what we have here, then, is, you came into wells that were drilled in, oh, I think, 1977 or 1978 --

A. 1977.

Q. -- and been on production for almost 20 years --

A. Uh-huh.

Q. -- when you obtained the wells, however you got them?

A. Uh-huh.

Q. Okay. So they had an opportunity to produce and, with this kind of permeability and porosity, accomplish a very effective drainage of the reservoir. Do you agree?

A. They had that opportunity.

Q. Okay. And the capability to do it, until something happened, I suppose.

A. Until something happened.

Q. Okay. And when did something happen so that they were no longer performing this efficient drainage?

A. Well, some things -- some things -- several things probably happened.

First of all, the reservoir was being drawn down, so they were fighting pressures approaching 100 pounds back in 1984, or less in some cases. And somewhere in there they began to see some damage. I don't know when it happened. I'm not even quite sure how it happened. I think it was mostly moveable fines, but that's just an opinion.

But they had two problems going on. One was that they were fighting a low bottomhole pressure with vastly reduced energy, and secondly they were getting some kind of damage buildup.

Q. Well, first of all, the low bottomhole pressure would be a natural phenomenon. That would be a characteristic of the reservoir?

A. You bet.
Q. Okay. And that would result from the fact that almost every 160 in this particular -- these particular townships, had a well completed in the Pictured Cliffs formation?
A. Yes.
Q. Okay. Then the other possibility is that -- I think you say fines were --
A. Moveable fines --
Q. Moveable fines --
A. -- clays, uh-huh.
Q. -- were collecting near wellbore?
A. Uh-huh.
Q. Originating in the formation?
A. Yes, sir.
Q. Okay. And it would be your supposition, then, that Merrion and Bayless did nothing to overcome that particular problem, if that was a problem?
A. Yes, sir.
Q. Okay. They just let the wells deplete or go into lower and lower volume of production?
A. That's what our well files and records indicate, yes.
Q. Well, what do your well files indicate as to when you would begin to see that?

A. See what?

Q. See the drop in production because of what you hypothesize to be a collection of fines.

A. You're probably seeing it from day one as the wells gradually decline. You can't attribute how much is due to damage in a situation like this, or even loading up with some water, and how much is due to natural decline interference from offset wells. There's simply not enough information to answer that.

Q. Well, what did the well files of -- I think Merrion was actually the operator of these wells, wasn't it?

A. That's right.

Q. What do the well files show as to their internal studies or reports? You know, were they examining and asking themselves the question, is there damage, are there more reserves than we're getting, and what can we do about it?

A. I have found virtually nothing along that line in their files. There are some early calculations in some of their files of what they thought the reserves should be. Some of it is rather refined, and some is kind of back-of-the-envelope.

But later on in the lives of the wells, I have virtually nothing that we've inherited that tells me what their thinking was or what they were doing about it, even when the wells weren't producing the kinds of reserves that they had originally calculated.

Q. Let me turn to another subject, Mr. Nicols. See if I can locate your Exhibit N13. This is the 10-well comparison study of Whiting wells, and the purpose of this study was to compare the production levels of the wells that are in close proximity to your Chaco wells, to those that are not affected, or allegedly affected, by your Chaco wells. Is that a correct statement?

A. Close.

Q. All right, make it correct.

A. My purpose was to address the allegation that their wells had gone down in production, declined or decreased in production, when we put our wells on. And it was to demonstrate that there were other factors at work in 1995 that caused changes in the rate of production in the wells, besides what was being claimed as the effect of our putting wells on.

Q. Well, was the point that you were making regarding the Whiting wells that are in issue here that they did not decline in production when your wells came on?

A. The point was that if they did, it was for reasons other than our wells going on.

Q. Well, did they --

A. Some did --
Q. -- decline?
A. Some did, some didn't.
Q. Had the Whiting wells, to your observation, been inclining in their production levels prior to your wells coming on?
A. Generally yes, yeah.
Q. Okay.
A. Some of it started to flatten or go down a little bit earlier in the year than when our wells went on. But generally, yeah, they were coming up just like they should.
Q. Are you aware of whether or not, after your wells came on, Whiting installed compression on their wells to keep the production levels at least even, what they had been?
A. I know that there was compression installed early this year or late last year. Prior to that, I guess I don't have a good knowledge of when if any compression was installed.
Q. You don't know -- In the time period that's shown on your exhibit, you don't know when or whether compression was installed, do you? Installed by Whiting?
A. That's correct, until early this year.
Q. Tell us at what rates your wells came on. I never did -- Maybe you told us and I missed that in the

testimony. 1995, the -- you acidized -- Let's see, you acidized the 1-J in January?

A. Yes, sir.

Q. Okay. And have never frac'd that well?

A. Correct.

Q. And at what rate is it producing?

A. We have one those alternative-measurement agreements with El Paso where they allocate 5 MCF a day to the well.

Q. Because its production rate is so low?

A. That's right.

Q. And that well is in this same reservoir that has these huge reserves that have never been exploited by other operators, correct?

A. Yes.

Q. But you haven't frac'd it?

A. That's right.

Q. And the Chaco 1, that well was frac'd?

A. Yes, it was.

Q. In May of 1995?

A. In May of -- No, it was frac'd in January, I believe, of 1995.

Q. January or early February?

A. (Nods)

Q. Okay. And what production level did you get?

A. You're testing my memory, okay? But it was in the neighborhood of 300 MCF a day.

Q. Three hundred or more a day, right?

A. (Nods)

Q. Do you know what that well made when it was completed in 1977 or 1978, when it was originally completed? Do you know what production level it achieved?

A. My recollection is that it was half to two-thirds of the rate we achieved after a frac job. And again, I'm going by memory. I could pull some curves. It would take me a few minutes to dig them out, but it was not as high as we got after the frac job.

On the other hand, it was completed naturally with just perforating and no, you know, clear stimulation.

Q. Yeah, but completed in a very high-quality reservoir, good permeability, good porosity?

A. Good-quality reservoir. I don't know the quality of the connection to the reservoir.

Q. And the Chaco 4, that was frac'd in --

A. That was --

Q. -- hydraulically fractured in May --

A. -- frac'd in May, yes.

Q. -- 1995?

A. Right.

Q. And that came on with production levels of 500

MCF a day?
A. I don't believe so.
Q. Something like that?
A. I don't believe it was that high. Now, I -- My recollection is that the best we had was in the neighborhood of 350 or 400 on any of the wells, but --
Q. All right, I wanted to get some idea.
And what was the best that well ever did when it was a virgin Pictured Cliffs well, originally completed?
A. Well, again, it was not that high, but I don't recall what it was.
Q. And the Chaco 5 was also hydraulically fractured in May of 1995?
A. Yes.
Q. And what rates of production did you get?
A. Again, around that 300.
Q. Now, we should understand that you have not put pumping units on these wells, correct?
A. That's correct.
Q. So whatever volume of gas production those wells are making, they are making it notwithstanding whatever liquid accumulation there is in the wellbore, correct?
A. Correct.
Q. And on that note, do you have some idea of what kind of a column of water you'd have?

A. No, I don't know how you would determine the kind of column.

Q. Well, I didn't mean the kind, I meant the depth.

A. The depth? They unload water. There's probably water coming somewhere in the tubing with gas above and below it.

Q. But you can shoot a water level? I mean, there's a way to determine what your water level is?

A. You can shoot a water level once it's shut in. It doesn't do you any good while it's producing.

Q. Well, so -- what, the well -- Let's see if we can be clear about the liquids we're talking about. These wells do not make any condensate?

A. That's correct.

Q. So liquids in the wellbore, we're talking about water?

A. We're talking about water.

Q. All right. And you say there is no means being used to artificially remove that water --

A. That's right.

Q. -- from these wells?

And by the way, when you were making a comparison, you were saying since the shut-in, as a result of the court proceeding, that you're showing wellhead shut-in pressures that are slightly lower than the wellhead flowing pressures of the Whiting wells. That was your testimony, wasn't it?

A. Uh-huh, uh-huh.

Q. You're comparing oranges and apples, aren't you? The Whiting wells have pumping units that are lifting and removing the water, as opposed to yours who have an accumulation of liquids?

A. You -- There is that danger. You have to be careful not to compare apples and oranges.

Now, what happens is, when you shut our wells in, very quickly the tubing in the casing equalizes the pressure. One thing you can assume from that is that the water in the tubing and the casing, at whatever level they are at, is exactly the same. So the pressure building up above them exactly the same.

The other assumption is that whatever water is in there is below the base of the tubing, if any.

Now, I got concerned when we had a blip where the pressure actually went up a few pounds and went back down during this shut-in period in the middle of the month in Chaco 4, so we asked Walsh to run a fluid-level test to see if we had water building up in that well, and we did not. We saw all 36 joints.

So what really seems to happen is that the water imbibes back into the formation. If there is any in the tubing, it drops out and seems to imbibe back into the formation, so that when you have a tubing and a casing pressure that are virtually equal, you can be reasonably comfortable that that well is clean.

Q. By "clean" you mean no accumulation of liquids?

A. No accumulation of liquids.

Q. Okay. I thought you just said a few minutes earlier that these wells were unloading on their own?

A. Well, they do make a few barrels of water. We had tests back in February run by the Commission that found that, for instance, Chaco 4 was making five barrels a day. It unloads that water.

Q. And in fact, in February of 1998 was the first time you ever reported any water produced by that well; isn't that right?

A. That's right.

Q. That was the time when the OCD was going to be out and check on the wells?

A. Well, actually, we started reporting after that.

Q. But you had never reported water production before that, had you?

A. We hadn't.

Q. What was the -- What disposition was being made of the water?

A. It was going into a pit.

Q. And do you understand that the C-115 reports of the Commission require the reporting of water production?

A. Yes.

Q. These were slimhole completions of these wells. What, 2 7/8?

A. Some of them are. Some of them are 5-1/2-inch or 4-1/2-inch casing. They're not all slimhole.

Q. The six wells we're talking about, any of them are not slimhole completions?

A. I probably ought to defer that to Paul Thompson, but my recollection is that some of them are not slimhole completions.

Q. And did any of them have a production string, a tubing?

A. They all do.

Q. They did not, did they?

A. They all do.

Q. They all do now, but I mean when they were acquired by you and acquired by Mr. Edwards, they did not, did they?

A. I don't recall.

Q. Well, didn't you install, at least on some of them, an inch-and-a-quarter tubing so that you could gain some velocity and lift water off these wells?

A. Well, we probably did, but you're testing my memory of something that was done when Pendragon wasn't the operator, several years ago. I just don't remember what exactly we ran in what well, or what was or wasn't necessary to re-run or repair or whatever. And I'm not being cute, it's just not something that I memorize.

Q. Well, there's a period of time -- What we're focusing on is when you stimulated these wells and brought them on production in 1995, and you're saying that Pendragon -- your knowledge doesn't cover that entire period?

A. It doesn't cover that question.

Q. Well, was Pendragon the operator during that period?

A. No.

Q. So when did Pendragon become the operator so that you are knowledgeable about the handling of the wells?

A. I think we took over these wells in February of 1996.

Q. And before that, who had been the operator?

A. Edwards.

Q. Edwards?

A. (Nods)

Q. Did you have the agreement with Edwards that you acquired your interest with Edwards -- You had acquired that interest prior to the stimulations, hadn't you?

A. Oh, yeah, we acquired the interest jointly, yeah.

MR. GALLEGOS: All right. What do you think?

EXAMINER CATANACH: How much longer are you going to be?

MR. GALLEGOS: Probably 15 or 20 minutes with the -- If I get a chance to go over these extensive notes I probably can do it a little better. Maybe it would be a good idea to go ahead and break. Whatever the Examiner wishes.

EXAMINER CATANACH: All right, let's go ahead and break at this point. We'll shoot for an hour, but we'll definitely start by 1:30.

(Thereupon, noon recess was taken at 12:18 p.m.)

(The following proceedings had at 1:30 p.m.)

EXAMINER CATANACH: Okay, let's resume the hearing. And I think Mr. Gallegos was still cross-examining the witness

MR. GALLEGOS: Yes. Thank you, Mr. Examiner.

Q. (By Mr. Gallegos) Mr. Nicols, I have my notes concerning your testimony on the -- what you view as the present characteristics of the Pictured Cliffs reservoir, and if I correctly noted that testimony, you said that the reservoir started with an initial pressure of about 220 pounds, and you think it's back to about 150 pounds now?

A. No, it was back to 150 pounds, in that range, in

1995, when we restimulated our wells.
Q. Okay. Original pressure would have been about 220 pounds --
A. 225 --
Q. -- at least on that part of the question?
A. Yes, we are. Yes. 225 to 250.
Q. All right. And then I believe you testified that you believe that as of 1995, the Pictured Cliffs in this area contained as much gas as had previously been produced from that reservoir. Was that your testimony?
A. No, not exactly.
Q. Okay, what is your testimony?
A. I was referring to a specific well.
For this to have repressured, the area of the Pictured Cliff reservoir had to have been reduced to bring the pressure back up, whether it's water encroachment from downdip or whatever. Something had to happen. Unless it was gas recharge from the lower zones.
Q. Well, which is it?
A. There's no way to tell. I was referring to a specific well when I said a well that had produced from, let's say, your 220 pounds down to 100, and had seen a drawdown of 120 pounds, would have virtually the same opportunity to produce from, now, 150-pounds-plus down to hopefully below 50 pounds eventual abandonment pressure, so

that there was about the same reserves available to that well, starting in 1995, as it might have seen under the original scenario, going down to about 100 pounds, ending in 1984.

Q. All right, let's see if we've got this clear. At a point in time, at least, when deliverability tests were required and there were required and there were pressures recorded and reported to the OCD, this reservoir generally, across the board, was showing in the neighborhood of 90 to 100 pounds of wellhead shut-in pressure; is that --

A. It ranged from 90 to maybe 130, yeah.

Q. All right. And then something happened, and you hypothesize either the container was --

A. Shrank.

Q. -- shrunk because of water intrusion, or the reservoir -- the rock received some gas from some other source?

A. Uh-huh.

Q. Okay. And if it received gas, if it was, say recharged, from some other source, what is the source?

A. One logical position -- or possibility -- would be that -- what I referred to as the third bench of the Pictured Cliffs, the lower Pictured Cliffs, below where the wells were mostly perforated.

Q. On one of your -- I think it's on 17, that's the

strata that you colored in sort of a red color?
A. Yes, yes.
Q. All right. And then your testimony is that in 1995 the pressures of the wells in this area would be back up to 150-plus?
A. Yes.
Q. So that you would then conclude that a well either newly drilled on 160-acre spacing or recompleted on 160-acre spacing would be able to produce as much as a well that had been completed when the field was first opened in the Seventies?
A. Actually, there were two components to that equation, and you're correct as far as you went.
The second part was that it also had an opportunity to drain a larger area now because there wasn't the competition there was back in the Seventies. Most of the other wells either were abandoned, shut in, or weren't producing any significant amounts of gas, so that a well really had the opportunity to drain a larger area with the same range of pressure differential, start to finish, that it originally had back in the Seventies.
Q. I'm not sure I followed that, I'm sorry. The earlier wells would have had a larger area to drain?
A. No, the earlier wells had -- As you pointed out earlier in the cross, the early wells had a lot of

competition, virtually every 160, as you mentioned, had a PC well out there.

However, by 1995 there were very few significant PC producers in the area. So the recompleted -- not recompleted -- restimulated wells had an opportunity not only to benefit from pressures starting at 150-plus pounds, but also to benefit from not having offset drainage from other wells that would be in competition with what they could drain.

Q. Okay. Had any other operator besides Pendragon, by 1995, uncovered this discovery that you had that these wells could be recompleted and you would see and recover this large quantity of reserves?

A. My belief is yes. I can't put my finger on who it was or exactly when it was, but I remember in conversations with Keith Edwards, he was pointing out that, Look, other folks are getting new wells or getting better wells by frac'ing the wells.

Q. But in your study here you didn't collect data and have any analogies where you could show that other operators had made this quite remarkable discovery?

A. That's correct.

Q. So just so we'll be clear, so -- Your testimony would be that wells recompleted today, or a new well drilled on 160 acres, you would expect or project that it would produce at the rates and recover as much by way of reserves as one drilled in the Seventies? Or are you saying there's a difference because there's less wells competing for the gas?

A. When you say "today", are you talking about today or 1995?

Q. Well, let's use 1995.

A. Okay. I think the answer to your question is yes. I was saying that the -- there was no way to predict what rates we would see, but the reserves available to us from in excess of 150 pounds down to less than 50 pounds is -- which we hope we can draw the reservoir down to, certainly projected enough from the standpoint of economics to go ahead and frac the wells.

Q. Okay, did you consider drilling a new well, a replacement well, so you would have larger casing, be able to have larger size tubing and the benefits of, you know, better completion in terms of the equipment?

A. Well, first of all, as I said earlier, I think some of the wells have large casing and didn't need that consideration.

It was certainly talked about and discussed that our first effort was to go ahead and try to use the wellbores we had because it's so much cheaper.

Q. On the pressures, this 150 pounds plus, by my notes, I think you talked about seeing those kind of pressures in the Chaco 4 before it was frac'd --

A. Yes.

Q. -- and then observing those pressures in the Chaco 4 and 5 -- 1, excuse me, the 1 and 5, but after those wells were frac'd?

A. Yes.

Q. Is that correct?

A. That's correct.

Q. And isn't it true in the case of the 4, the pressure, which I think was 147, 143, something in that neighborhood, was a reading that was taken approximately three weeks after that well was acidized?

A. I don't know the answer. I don't know the -- I don't recall having checked the timing of the acid job versus that reading.

Q. Well, the acid job was on January 30, 1995. And the reading I think you gave us was on -- what date? Didn't you have a date for that?

A. 140 pounds in February of 1995. I didn't specify a day.

Q. Okay. Do you have your well file, in case -- Do you have any issue that it was January 30th, 1995, when the well was acidized?

A. No.

Q. Have you looked at the shut-in pressure taken, recorded by the -- on the rig report when the rig moved on to do the acid job? In other words, so you have a pressure you can see before the acidization?

A. No, the pressure I have before the one in February was in July of 1983. Now, if there are --

Q. And that was 97 pounds, wasn't it --

A. Yes.

Q. -- p.s.i.?

A. Yeah.

MR. GALLEGOS: Okay.

MR. HALL: Excuse me, were you finished with your answer?

THE WITNESS: Yes.

MR. GALLEGOS: I'm sorry.

Q. (By Mr. Gallegos) All right, let's talk about the quantity of gas, then. Beside what you've told us about pressure, did you do or have somebody do for you reservoir modeling so you could get some kind of a projection of the probable performance of these wells?

A. No.

Q. But I believe you indicated that you did perform some volumetric calculations; is that right?

A. That's correct.

Q. Okay. Do you have those so we could have the benefit of seeing those calculations?

A. No, they're long gone.

Q. They have not been retained?

A. They have not been retained.

Q. You did the study?

A. Yes, sir.

Q. Well, what parameters did you use -- can you tell us that? -- for your volumetrics?

A. That was 1995, and I couldn't sit here and tell you exactly what parameters I used.

Q. That has not been retained?

A. No.

Q. You don't -- There's no place that you can go to refer to for that information?

A. I haven't found it.

Q. You just threw it away?

A. Probably.

Q. If my notes are correct, I think you said that these wells, after your volumetrics and then these wells were hydraulically fractured, the results were better than expected. Is that your testimony?

A. Yes.

Q. And that's true?

A. That's true.

Q. Okay, well, better than expected by what quantum?

A. Well, I frankly would not have expected to get the kinds of flow rates we saw. We didn't know what to expect, but I -- when you go into a partially depleted reservoir and do a restimulation, generally speaking you don't get as good a well as you started with when it was initially completed. These were actually better than when they were initially completed. That was a pleasant surprise, and that's --

Q. Why, generally, when you take a 20-year-old well and do a restimulation do you not get better results than you would with the original well?

A. Well, if you have properly connected with the reservoir to start with and you have -- Let's take the 250 or 230 pounds initial pressure. That will result in a flow rate of X. And if you come back later and restimulate a well that only has 150 pounds, in that range, the expected rate would be less.

What I think this indicates to me is that the initial connection to the reservoir was not particularly good in these wells. They were just perforated; they weren't cleaned up, given a small frac or whatever, in most cases, after they were perforated, so that there was not the kind of connection that we enjoyed after giving the frac job.

Q. Do you think with the wells or with the reservoir exhibiting the high values of porosity and permeability, that fines would collect at the near wellbore?

A. Yes.

Q. Do you have some experience to base that on, the same values of permeability and porosity?

A. Not exactly. It has more to with permeability than porosity [*sic*]; it has to do with what are the fines and what fluids are moving through the reservoir and what are the rates, and --

Q. Well, permeability and porosity -- I'm sorry.

A. Excuse me.

Q. Did interrupt you?

A. No.

Q. Well, the permeability and porosity would have something to do with whether or not the fines would collect or not; isn't that true?

A. Yes, and it's a double-edged sword. If you have very tight rock, your flow rate through the rock is so slow that you might not be moving the fines, and you might actually have a bigger problem with better-permeability rock that allows a flow rate that carries the fines and moves it.

Q. Well, it carries the fines, and the fines are able to move on through, with good permeability and porosity. Isn't that generally thought to be the case?

A. Well, you certainly hope so, but it isn't always the case.

Q. Mr. Nicol, let's take a look at Exhibit N17. It's one of your cross-sections. We kind of referred to that because --

A. Which cross-section is it?

Q. It's N17, and it's B-B'.

All right. Now, you've got a formation colored in yellow, and that's your -- Is that the upper Pictured Cliffs sand, or is that the Pictured Cliffs sand as we generally refer to it?

A. Yes.

Q. Yes, what?

A. Where there are two sands shown in yellow, the top yellow sand is upper Pictured Cliffs sand. Where there is just the thicker sand shown in yellow, that is -- what I refer to as the second bench or the main bench of the Pictured Cliffs.

Q. Where is the -- Can you take any one of these logs and pick for us, for the Examiner, the Fruitland sandstone?

A. I don't think I've got enough log here to pick the Fruitland sand for certain. There may be Fruitland sand in this little streak right here.

Q. You'll need to identify for the record what you're referring to.

A. The interval from --

Q. What well is it?

A. Lansdale Federal --

Q. Okay.

A. -- the one on the far right-hand side of the cross-section.

Q. All right.

A. There may be Fruitland sand in the interval from about 1015 to 1020, in that range. But the log is a little ratty in there, and the resistivity is not -- or the SP isn't showing anything there. So it's iffy. I don't think there's a good, clear indication of Fruitland sand on that cross-section.

Q. Which kind of log particularly identifies the coal, while we're looking at these logs?

A. The coal is more easily identified on the density or the density neutron log.

Q. And can you give us an example there? Why don't you take your Pendragon 4, Pendragon 2-R well, and point that out to the Examiner?

A. The Pendragon 4 well on the density log --

Q. Could you come over to the table, maybe? It's so far away --

A. Read it upside down. Chaco 4 --

Q. Well, do you want to stand on this side?

A. No, that's all right. From eleven hundred and -- probably 1140 to 1160 feet is coal.

Q. All right. Do you see any other coal there?

A. Yeah, there is an indication of a very thin coal finger down below the upper Pictured Cliffs sand, just at the top of the -- what I call the main bench, and another one of about the same thickness and size at the base of that. And then there is a coal up here at about 1108.

You notice that these coals here, down in the Pictured Cliffs, aren't nearly as thick and don't have the kind of response that you see in the big, thick coal.

Q. And I notice, and we're still referring to the Chaco --

A. -- 4.

Q. -- Number 4, this -- the area colored in red, again, what can we use to refer to that?

A. Third bench.

Q. Third bench, okay. And the third bench is -- What's the significance of that? Why have you shown that on these --

A. I've shown that --

Q. -- cross-sections?

A. -- to show the existence of gas saturation in the third bench, and this is a qualitative picture of gas saturation building up toward the top of that bench, increasing toward the top, and the fact there is gas saturation and, in two wells, actual gas production out of that zone.

Q. Well, I notice that in your wells there are no perforations in that zone.

A. That's right.

Q. Don't operators typically perforate where the log indicates they have a gas-productive zone?

A. Not always. It depends on how much gas versus how much water you think you're going to get, just how good your evaluation is.

Q. Well, so what was your evaluation here? Why have you not perforated that zone?

A. I frankly was a little skeptical up until very recently that there was enough gas for us to be concerned about.

Q. How recently have you changed your mind?

A. Changed your mind -- Changed *my* mind when it was suggested at one of hearings in Aztec by George Sharpe with Merrion that we look at the possibility that that lower zone had gas in it.

Q. So it doesn't play any role in the volume of production from the Chaco 4 well today, and it has not since 1995; isn't that right?

A. I wouldn't say that at all. It could very well play a significant role in the volume.

Q. Okay, how so?

A. Because we probably frac'd in.

Q. Because your frac, these perforations in what you're calling the second --

A. -- second bench.

Q. -- second bench, probably opened up the third bench?

A. Yeah, and that's likely, because first of all, the coal here is a matter of inches. And the apparent tight streak between the porosity in the third bench and the porosity in the second bench is not a shale. It generally shows up as tight and low porosity on the SP log, but on the gamma ray it's usually clean and so it's a tight streak. Brittle tight streaks have a tendency to break easily under frac jobs, as opposed to the soft shale, so I would expect --

Q. What was the word? What kind of tight streaks?

A. Brittle.

Q. Brittle.

A. Brittle. And I'm not a frac expert. That's a geologist's term, but we have testimony we'll offer as to how that would happen and what we think has happened and what the volumetrics are on the gas.

Q. Okay. Remember, I was asking you about the existence of a barrier between your Pictured Cliff formation and the thick -- the upper coal?

A. Yes.

Q. And you said you thought there was a four-foot shale?

A. Usually about four feet, yes.

Q. Can you show us where that is here --

A. That's this --

Q. -- on your Chaco 4?

A. -- this shale right in here, above the upper Pictured Cliffs sand and the coal. It's this little shale right here. It shows up right here on the gamma ray.

Q. That looks like four foot to you?.

A. Well, that's about three feet in this well, and I said generally about four feet. Over here, for example, you've got four feet.

Q. Lansdale.

A. Lansdale.

Q. And how about -- Isn't your Chaco 2-R on here someplace?

A. Chaco 2-R is here, and the Chaco 2-R doesn't have the upper Pictured Cliffs sand. Remember, it was back behind where that sand started to build seaward, and it's got just a trace of a little tighter streak where the sand exists in the Chaco 4.

So you've really got between the top of the sand in the Chaco 2-R and the base of the coal 12 or 14 feet here.

Q. And that -- the 2-R well also -- Not only have you perforated only in the second unit, but your perforations are high in the second unit, in the 2-R? I mean, you haven't perforated even down the whole depth of the second unit?

A. That's right.

Q. And so the third unit is productive or is not productive? Did you frac down into that?

A. We think it's likely we frac'd into it.

Q. Okay. How far do you think your frac went, then, south into the third unit?

A. I have no idea.

Q. So that would account for the water in the wells?

A. It could account for some water in the wells. That goes back to the comment that I referenced in Jacobs' article where he said that they frequently didn't perforate the lower sand because it made some gas, would also cause water production.

Q. Hasn't that been generally accepted by operators in this area, to stay away from anything other than the upper unit of the Pictured Cliffs because of the water?

A. Generally. So that's the same reason a lot of them haven't tried frac'ing.

Q. I notice on the Pendragon 2-R, still looking at your Exhibit N17 --

A. I'm sorry.

Q. I've got another question or two. The logs lists the field for this well as being, quote, the WAW Fruitland Pictured Cliffs. Do you see that?

A. Yes.

Q. What is the definition -- What is your understanding of the definition of the WAW Fruitland Pictured Cliffs?

A. I don't recall when that pool was formed or redesignated, but my understanding of the pool as it now exists encompasses all of the sands of the Fruitland formation and the Pictured Cliffs formation, sands.

Q. Okay, and what did it mean -- or what do you think it meant in 1979? What did it designate?

A. Well, I don't -- You know, I don't know when it was -- when the pool was changed, but in 1979 whoever wrote the heading on that log wrote that information, and I have no idea what they had in mind or what the source of it was, and I certainly can't project that to be a definitive --

Q. Okay, but definition- --

A. -- description of which pool.

Q. Excuse me. But definitionally, today, that means that it includes the sands within the Fruitland formation?

A. That pool includes the sands within the Fruitland formation. It doesn't say that that well is completed in the Fruitland.

Q. Well, what is typically the purpose of making the entry on the log as to what field a well is in? Isn't that an attempt to identify --

A. That identifies --

Q. -- the formation?

A. That identifies the field.

Q. And the Chaco Number 4 is identified as being in the N-I- -- the NIPP --

A. NIPP, N-I-P-P.

Q. -- N-I-P-P, Pictured Cliffs?

A. Yes, sir.

Q. And that -- What is that pool? Are you aware there is a pool by that name?

A. Well, that was a field name at the time. The pool now is all consolidated under Fruitland Pictured Cliffs Pool.

Q. Inclusive of the sandstones within the Fruitland formation?

A. Yes.

Q. If the fracturing applied by your company to the

Chaco 4 and Chaco Number 5 wells extended vertically into the upper Fruitland Coal formation, do you have an opinion as to how much gas these wells would produce?

A. If they frac'd into the coal, I don't think it would produce much gas. I think the frac would stop when it got to the soft coal.

Q. It would just stop when it got to the coal? That's --

A. Yes, sir.

Q. Well, if it didn't, if a fracture -- if the coal will fracture by reason of a hydraulic fracture being applied to it, I'm just asking your opinion, what do you think the Chaco 4 and Chaco 5 would reflect by way of production?

MR. HALL: Mr. Examiner, I'm going to object at this point. This is beyond the scope. It also calls for speculation on the part of the witness.

EXAMINER CATANACH: I agree with you, Mr. Hall.

Q. (By Mr. Gallegos) When Whiting and Maralex placed their wells on compression, isn't it true that in a very short period Pendragon installed compression on their wells?

A. Yes. We had a problem, because the line pressure was going up.

Q. And you wanted to continue to produce at an equivalent rate as the Whiting wells?

A. No, we're -- No way we could be equivalent rate to the Whiting wells. We just wanted to continue to produce at a reasonable rate for our wells.

Q. But the line pressure's gone down, Mr. Nicols, and you continue to keep the compression on, haven't you?

A. You say it's gone down?

Q. Well, there's been periods of compression shut-down by El Paso, but otherwise it's -- the line pressure is what it was when these wells were first put on production?

A. Not right now, it isn't. If you look at the line pressures on the wells, for example, your Whiting wells that we have the line pressures on for the middle of July of this year, they're running in the 60-to-80-pound range. A couple years ago we were running in the 30-to-40-pound range.

Q. Well, I wasn't trying to talk about just the immediate last week or two, but in terms of an overall basis.

On an average, is the line pressure -- You're saying the line pressure now on El Paso's gathering system is higher than it was in 1995?

A. Yes.

Q. All right. Okay. And what would the values be, speaking across the board, average? What was it in 1995, and what would you say it is, typically, now?

A. 1995, typically, if I recall, it would have been in the 35-to-45-pound range, something that we would expect to see out there for most of our wells. It varies from well to well and what part of the system you're on. And right now we're fighting pressures in excess of 60 pounds very frequently.

Q. Frequently, but I mean just recently there's been some purported problems at the Chaco plant --

A. No, I think we've hit higher pressures since your folks kept putting on those bigger compressors, because we're all in the same basic system.

Q. All right. These wells are what distance from the Chaco plant, El Paso's Chaco plant, approximately?

A. Three miles.

Q. One other thing, Mr. Nicol. You came up with a map of the United States and were showing the Gulf of Mexico?

A. Yes.

Q. That was meant to be an analog to the depositional circumstances that occurred in the San Juan Basin?

A. To the extent that I was showing a barrier island, lagoonal, marine-dominated depositional system, yes, sir.

Q. And so your testimony, then, is, in that circumstance -- and by "that", you showed us the Gulf of Mexico and the Mississippi delta and some barrier islands?

A. Yes.

Q. That's the area that you --

A. That's the area.

Q. -- were focusing on?

A. Uh-huh.

Q. And so your testimony is that coal is being formed there in that environment?

A. Not there. I wouldn't say that coal is being formed now, there. There's not that much organic matter down there. It sure is mucky and swampy, but it's not making coal that I can tell.

But I think what I said was that there are places in the areas behind the outermost barrier bars where you get quiet water and where you get organic material building up, and by analogy that could have caused some of the coal deposition in the Pictured Cliffs when it was deposited. Same sort of situation.

Q. Well, so then you are saying that the situation you called attention to the Examiner in the Gulf of Mexico is a circumstance where coal deposition is going on?

A. Well, it could be. I don't know of any great thick peat bogs or beds down there, but yes, you can get layers of organic material that could be forming coal.

Q. So what is your testimony? That is happening? Coal is forming, is that your testimony?

A. It's possible.

MR. GALLEGOS: That's all the questions I have. Thank you.

MR. HALL: Mr. Catanach, I have a very brief redirect if you'll permit it.

EXAMINER CATANACH: Go ahead.

REDIRECT EXAMINATION

BY MR. HALL:

Q. Mr. Nicol, let's refer back again to your Exhibit N6, isopach. Earlier you were asked by Mr. Gallegos whether there's any way you could determine the source of sand in the Fruitland and then in the PC. Will this exhibit help explain that?

A. Well, as I said, I've seen mud logs where there was a Fruitland sand cut up well above that basal Fruitland Coal. It was described as a fine-grained sand. It's certainly reasonable to have streams bringing in fine-grained sands if that what's they're bringing in [*sic*], but it really doesn't bear on whether or not this is a marine sand.

First of all, sands in the Fruitland well above that coal are millions -- well, hundreds of thousands or perhaps millions of years later in geologic time than the source for this sand right here.

And this sand is laid down in a shallow-water or marine-beach environment, and it parallels the shoreline and it thickens out into the Basin when the whole -- All of the geology I have seen written up on the Pictured Cliffs talks about it thickening out into the Basin, thickening seaward, and that's what's happening here. It runs parallel to the shoreline and thickens out.

So I was a little confused about the question of source in the Fruitland. The Fruitland source streams, if they existed at this same time and were the source back here, would be flowing this way. They'd be running northeast and probably meandering, and they'd be losing energy as they get down to water level where there wasn't much slope left, not much energy left, and it would actually probably be thinning, certainly thinning when they got right out here to the edge of the beach. And then marine deposition takes over and takes that sand and spreads it into this sort of a sandbody.

Does that answer your question?

Q. Yeah. More specifically, is there any way that the Pictured Cliffs sand is one and the same as the Fruitland sandstone?

A. No.

MR. HALL: That's all I have, Mr. Examiner.

EXAMINER CATANACH: Okay.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Nicol, what would the Fruitland sands typically exhibit in this type of situation? They wouldn't -- Well, have you looked at the Fruitland sands?

A. Yes.

Q. How would they be different in terms of this type of scenario?

A. Well, there's not a lot of difference in the one mud log I've seen, as far as the description goes. Some of it was a little more coarse than what we saw in that Lansdale description, some of it was the same, described as fine-grain. Of course, you're always at the mercy of how good was the mudlogger, what was he seeing at the time?

As near as I've been able to see from the logs I've looked up in the Fruitland, it's a little dirtier sand. It tends to be more erratic on the development of the SP and the gamma ray, and they look like channels. They generally tend to look like channel deposition that gets cleaner toward the bottom. Sometimes it's so stacked with these kinds of things you really can't sort them out. But generally, you would expect them to be oriented in a northeast-southwest direction.

The slope being this way, then they should have come this way and deposited in streams or meandering streams or channels or whatever was bringing the sediment out into the basin, into the ocean, running in this direction.

Am I answering your question?

Q. Uh-huh. So are they more discontinuous than this particular sand is?

A. Oh, yes. Yes, it's very -- I have been unable to visualize any circumstance where you can get this sort of continuous deposition in a continental environment.

And that's pretty remarkable, really. You're talking about something as thick as this room, or less, that's spread over ten miles. That's pretty uniform deposition.

Q. So that's the only difference you can see right now? There's not much differences to the grain size or anything else?

A. I can't point to anything specific in the information I have on grain size.

Now, the cleaning-upward sequences that you see on the logs is also, I think, an important consideration that's opposite of what you'd expect in the channel environment. And this sand is not associated with any downcutting or any channel deposition. It starts at the edge of the beach and it thickens out into the ocean. It doesn't back up into channels or downcut sands.

Q. Okay. Mr. Nicol, have you see any literature that would indicate that there may be some natural communication between the Fruitland and the PC?

A. Yes, I have, and the answer is yes. I don't recall exactly which papers it was, but there are some papers out there suggesting at least in some parts of the Basin there's natural communication and fracturing. And I think even one of the papers included here addresses the possibility that the Coal could be a source for some the gas in the Pictured Cliffs.

Q. Do you know if that is in this area or not? I mean, the literature that you've seen, does it refer to this area?

A. It doesn't refer to this area specifically. Very little of the literature refers to this specific area, and -- at least that I've found. And we see no indication over the years that there's been that sort of natural communication.

We don't see -- For example, if you completed a Pictured Cliffs well and you had good communication with the Coal, I would expect that that pressure drawdown on the Pictured Cliffs would be dewatering the coal and that you'd get either damage to your well or a bunch of water quicker than you expected, or that you'd get some sort of water-drive situation, and we don't see any of that. They've acted historically like two very different reservoirs.

Q. Okay, now, prior to you guys operating the well, you didn't keep records on water production?

A. That's right.

Q. So you don't really have an idea of how much water they've produced?

A. We really don't. It was enough that they lifted the water by themselves and didn't have to be pumped and dewatered. I mean, it was little enough that they lifted the water by themselves, and that's one of the reasons that we didn't make it a priority to measure the water, is we felt that it was pretty minimal.

Q. If there was communication with the coal, would you expect to see an increase in water production in your wells?

A. If we had communicated in our frac jobs, I would have expected to see massive amounts of water very early, right away.

Q. Let me stop you there. Was that at a point in time when they were still dewatering their --

A. Yes, sir.

Q. -- coal wells?

A. Yes, it was.

Q. So there should have been plenty of water in the --

A. There should have been plenty of water.

Q. What do your wells typically produce now in terms of water?

A. I'll give you two answers, because it's recently changed.

February through, say, March, the wells were producing -- The Number 4, for example, was producing five barrels a day, and the Number 5 was producing zero, the Number 2-R was producing 14. Chaco 1 I don't have a record on, that I recall.

And then when we put the Chaco 4 and the Chaco 1 on compression, we started off with quite a bit of water early on. We put them on in April, I believe. And the Chaco 4 went up to 11 barrels a day, and the Chaco 1 had a period of a week or two where it was in the 20s and 30s and now has come down to about 18 or about half of what it started out in April.

Q. Do you know the typical water producing rates of the Whiting wells?

A. There's a range in the Whiting wells right now from something in the -- and again, I'm going by memory -- seven barrels a day to in excess of 20.

At the time that we fractured these wells, I think their water production was in the range of 30 to 100 barrels a day.

Q. Now, I believe you said that none of these PC wells were frac'd initially when they were first drilled, back in 1972?

A. 1977.

Q. 1977.

A. With the exception of a 2500-pound frac on the 2-J and the Chaco 5.

Q. 2-J and the Number 5 were frac'd initially?

A. Yes, that is a -- 2500 pounds.

Q. And that is a relatively small --

A. It's very small frac.

Q. To your knowledge, did these wells exhibit higher producing, initial producing rates than the other wells?

A. No.

Q. They did not?

A. The did not. Part of that is rock quality. The 2-J, it's an unfair comparison. It's thin and tight in both zones, by comparison to the others.

Q. Okay, I believe it was your opinion that gas analysis probably is not going to help us in this case?

A. That's correct.

Q. Is there a significant CO_2 in your PC gas?

A. No, we don't have a CO_2 problem. It's down in the same range as the coal, whether it's one of our frac'd wells or not.

Q. Okay, it's i the same range as the coal then --

A. Yes.

Q. -- is what you're saying?

A. Down in that one-percent range.

Q. You can't really use that as an indicator?

A. That's correct. I tried to sort that exhibit I gave you by nitrogen and CO_2, as well as by ethane and propane, and I don't come out with anything that looks like it breaks or makes a cutoff.

Q. And you don't have any volumetric calculations of gas in place in this area?

A. We -- Jack McCartney is prepared to present volumetric calculations. I don't have any of the old calculations I did.

Q. I don't remember which exhibit it was, but you had the Amoco well on one of your cross-sections.

A. Yes.

Q. That was the --

A. -- C-C', I think.

Q. I think it was the Schneider well?

A. Yes, sir.

Q. Let me ask you, in that area where that Schneider well is, are there any coal stringers below the basal coal?

A. Yes, in that particular field there is a coal stringer about -- well, we'll call it eight or ten feet below the -- what I call the basal Fruitland Coal.

But there are no coal stringers. These two wells are -- In that section, 28, there are no coal stringers down in the Pictured Cliffs here.

Q. Okay. Is it your understanding, though, that we based or we -- We used the Schneider well to define the limits of the Basin Fruitland Gas Pool.

A. Yes, sir.

Q. And we define those as being essentially at the base of the basal coal? Is that correct?

A. No, it wasn't really what the definition was. It was a stratigraphic Fruitland at this point right here, at the top of the Pictured Cliffs basin and Fruitland --

Q. Now, you're going to have to -- You can't say "at this point".

A. I'm sorry. 2880 feet, so it was defined as a point in feet. It's that mark right there on the --

Q. 2880 feet would be right here?

A. Yes, sir, in that well, stratigraphic equivalent, or the equivalent stratigraphic -- I forget exactly what the language, but the basic stratigraphic equivalent, that zone, that point.

Q. Okay. So --

MR. GALLEGOS: We have that order; it's Exhibit 1.

Q. (By Examiner Catanach) Okay. So within at least that Schneider well, that coal string below the basal coal would have been classified in the Basin Fruitland Coal Gas Pool?

A. Yes, sir.

Q. Okay. But you've extended that downward to your area, and it's your interpretation that that stratigraphic equivalent would not -- that's not the same coal stringer?

A. That's correct.

Q. Okay. But you did pick up an additional coal interval in your area?

A. Yes, a very thin one in our area. Actually, two thin ones show up in most of our wells, and this one is one little thin one down here, below that upper -- or upper Pictured Cliffs sand. Now he's got me calling it upper...

Q. But as far as you can tell, that's the same stratigraphic equivalent to the Schneider well as you picked in your area?

A. Yeah. And the key is the stratigraphic equivalent. It has to be the same type of deposition, the same type of rock. And here you're going from shale and coal into the first sand and the top of the Pictured Cliffs, and that's the stratigraphic break.

If I understood the intention of that order, that would be the -- The point of definition is where you're getting into that first sand below the coal sand, getting into the top of the Pictured Cliffs. It's also the first marine sand.

Q. What you're calling the upper Pictured Cliffs sand?

A. Yes, when you get over here and it starts to break up because of the shale string.

Q. Could another geologist define that stratigraphic equivalent different in your area?

A. Oh, I'm sure.

Q. Okay. All right, thank you.

There is separation, and there is some kind of barrier between what you've called the third bench --

A. Yes.

Q. -- and the producing sands?

A. Appears to be, yes.

Q. Okay, so there's nothing natural in there that would cause communication?

A. Well, it's a -- it appears to be just a tight streak. Whether it's a calcareous sand -- That seems to be what it would crossplot as. It's a hard tight streak in there.

It would be natural to expect that to be more fractured than the softer shales and sands around if there's any natural fracturing. I don't know that it is a barrier between the two zones.

Q. Okay, there are some wells that are producing from that third benchmark? You said the upper section of that third bench?

A. Yes, there was one well on that cross-section B-B' that had produced about 93 million, if I recall, from that sand, that top portion of that third bench.

And that High Roll Number 4 well, which was the one on the far right of the -- or, I'm sorry, left of the cross-section, is perforated in that same interval.

Q. Were those wells structurally higher on that?

A. The High Roll Number 4 was structurally the lowest well on the cross-section.

Q. You've not attempted to produce that sand in your wells?

A. No, we've not perforated that sand and produced it by itself or in conjunction with other perforations, no.

Q. And why is that?

A. Well, it's -- as you say, it's just within -- recently, that -- in the course of this study that I first built that cross-section to see if the idea had merit, and then I asked Jack McCartney to see what he came up with for gas saturations and possible reserves, and it's too recent

an idea on our part to have done anything about it yet.
Q. So is it your opinion that your wells initially only drained small areas of the reservoir?
A. Yes.
Q. Do you have an idea, maybe, how much that might have been?
A. Less than 160 acres originally.
Q. And you believe that now they're capable of draining in excess of 160 acres?
A. Yes. There's no competition anymore.
Q. And that's due to the frac job?
A. And the lack of offset interfering wells, yes.
Q. I believe you had a list somewhere of 34 wells -- Was it 34 wells?
A. Yes.
Q. -- that had -- Was it that it had been perforated in that upper -- what you're calling the upper Pictured Cliffs sand?
A. Yes, either by itself or in conjunction with the next bench.
Q. The lower massive PC; is that right?
A. Yeah, this -- the second bench. I'm objecting to the term "massive" again.
Q. Okay. Are all those wells located in this area?
A. Yes, they are. They're all on the base map.

Q. They're all on the base map.

So typically it's been the practice for an operator to perforate that sand as if it were in the PC?

A. That's correct.

Q. And that's been -- As far as you know, that practice has been approved by the OCD in Aztec?

A. Yes, sir.

Q. Did these wells -- Did your wells produce all along, even after -- Was it 1985 when they were very marginal producers?

A. For the most part, yes. But they were very low-rate wells, and you'd see production -- Sometimes they'd be shut in for a month or a few months, and I -- the answer varies a little bit, but generally speaking, they were on most of that time and frequently have production in anywhere from a few hundred MCF a month to as low as 10 or 25 MCF a month, one a day.

Q. So the increase in pressure in these wells happened as a result of the fracturing?

A. No, the increase in pressure was there before we fractured any of the wells.

Q. So at what point did they recharge? Was it over time?

A. I think it was over time, of that whole period.

Q. Wouldn't you maybe have seen an increase in production rates?

A. You would expect to, and I mentioned that earlier. They did not seem to increase in production as that recharge occurred, and I don't know whether that's a problem with the damage or ongoing damage or just continuing to load up with water or what it was, but there was not that indication that the wells were coming back.

Q. Your rates didn't start to increase until you actually did some work on the wells and frac'd them?

A. That's correct.

EXAMINER CATANACH: Frank, did you have some questions?

MR. CHAVEZ: Yes, sir.

EXAMINATION

BY MR. CHAVEZ:

Q. Mr. Nicol, in your review of the literature did you find very many typical logs where the authors had designated what they considered the top of the Pictured Cliffs, such as the Molenaar's work and others?

A. I found several examples of that, yes. The ones I included here apply to this specific field, but I have seen some others, yes.

Q. Do you find that they're, in general, the tops that are called by these other authors for the Pictured Cliffs are in line with yours for this area?

A. Yes. I think I mentioned that earlier when I had the blow-up of the Fassett cross-section where he was basically placing the top of the Pictured Cliffs in their regional sense, where I have put it in more detail.

Q. Okay. A question was asked about the issue of addition of compression and the effect that has on the productivity of the wells. Whenever you're comparing wells or looking at an individual well, don't you have to take into account the addition of compression, as how that might affect the productivity of the well and analyzing the production over time?

A. Yes, sir.

Q. Had you done that in any of the production plots that you did for the Whiting/Maralex wells?

A. No, I had no information as to when their wells went on compression, except for the comments we received in our meetings in Aztec about the compression being put on early this year. If there were compressors prior to then, I don't know when they were put on.

Q. Did I hear you correctly say that you thought that these wells after -- I'm sorry, that the wells that you ultimately -- Edwards purchased, did not meet Merrion's expectations for production?

MR. HALL: Mr. Examiner, I believe that may have been one of the questions I objected to because it called for speculation about Merrion's state of mind at the time, so...

Q. (By Mr. Chavez) Did you have any information from Merrion, any -- that you found in the records, to indicate what their expectations might have been for the productivity of the wells that -- purchased?

A. I did not. As I said, we bought those at an EBCO auction, and that's usually the case when people want to get rid of wells the don't want anymore, is to sell them at an auction. There was nothing in the files after we got the wells that indicated what their thinking was or what their expectation was late in the life.

Now, there are some calculations in some of the files very early on about what the volumetric production should be. In other words, volumetric calculations, what they expected. And those -- the wells in general did not live up to the volumetrics that were expected of them by those calculations.

Is that what you were getting at?

Q. Yes, that's what I was getting at.

After frac'ing the wells, have you compared to -- what those calculations were to what you're getting now after frac'ing the wells?

A. Total cumulative production after we frac'd the wells is in excess of those volumetric calculations, which were done on 160s.

Q. Okay. When the productivity of the wells exceeded your expectations, what type of work did you do to find out why that occurred, why they exceeded your expectations?

A. Really, we didn't do any work at that point. We were delighted enough with the outcome to start looking for other candidates to be able to do the same thing, but we didn't do any detailed reservoir work or anything to try to figure out why that was happening.

MR. CHAVEZ: Okay, that's all I have.

EXAMINER CATANACH: Okay.

FURTHER EXAMINATION

BY EXAMINER CATANACH:

Q. Did you guys analyze the production data on the Whiting wells in a more -- on a smaller scale, to where maybe you could see instantaneous -- any instantaneous interference when you brought your wells on line or anything?

A. No. There really wasn't that information available.

Q. Okay.

A. As an example of that, as I mentioned earlier, most of those wells had several days of down time in June of 1995 and even more in July. So you've got, first of all, only a limited amount of information that was available, only commercial sources, and then the fact that the wells apparently were not on full time for the period that was in question.

And that, combined with the problem of all the stuff that El Paso was going through, we just didn't have enough information that would be definitive to do anything in detail.

Q. Were these wells producing at the time you brought your wells on line?

A. Yes, they were. Yeah, we brought our wells --

Q. But you didn't look at that data? I mean, in any -- on a smaller scale of any great detail?

A. No.

EXAMINER CATANACH: Are there any other questions of this witness?

MR. GALLEGOS: Yes, I have a few.

EXAMINER CATANACH: Good.

MR. GALLEGOS: Like to support you.

EXAMINER CATANACH: Okay, go ahead.

FURTHER EXAMINATION

BY MR. GALLEGOS:

Q. Mr. Nicol, let me ask you first of all, for the purpose of my question, see if we can agree on some definitions.

If I refer to common ownership, can we understand that that means that one working interest owner, or a combined group, owns from the surface to the base of the Pictured Cliffs or below? That would be -- when I use the term "common ownership"?

A. All right.

Q. And when I use the term "divided ownership", I mean that one working interest owner owns from the surface to the base of the Fruitland formation, and another owns from the base of the Fruitland formation to the base of the Pictured Cliffs.

A. All right.

Q. Right? Now, when these Chaco wells were perforated at a level in which you identify as the upper Pictured Cliffs, there was common ownership at that time; isn't that true?

A. To the best of my knowledge, yes, sir.

Q. All right. And when you say perforations in the Fruitland sand or in the sands within the Fruitland have been a common practice, can you tell us of any case you know of where that has occurred, where there has been divided ownership?

A. First of all, I didn't say that.

Q. Well, I thought you said that -- or you were asked by -- and responded affirmatively to the Examiner's questions that, have there been perforations -- has there been a practice to perforate the sands within the Fruitland, and has that practice been approved by the OCD in Aztec?

A. No, that was the Pictured Cliffs, if I recall the question correctly, not the Fruitland. We were talking about, has it been the practice to perforate that 34 wells that I have on the list here as Pictured Cliff wells and report them as such, and that's correct. But I didn't say they were perforated in the Fruitland.

Q. All right. Well, are you saying that it has been a common practice for perforations to be placed, of the nature that we see in these wells, and to use your vernacular, that is, perforations in the second unit of the Pictured Cliffs and in what you call the upper Pictured Cliffs? Are you saying that that's -- that you have seen in other wells beside the ones question?

A. Yes.

Q. All right. Now, I'm asking you, do you know of that occurring in any instances where there was divided ownership?

A. No.

Q. Okay. Do you know of any instances where that type of practice has been approved by the OCD in Aztec, where there is divided ownership?

A. I'm not aware of any.

Q. When you speak of the approval of the OCD in Aztec, are you talking about just accepting a C-104 form? Or what do you mean?

A. Yes, accepting the reports as presented as being accurate and correct based upon what we show as where the perforations are and what the logs show, yeah.

Q. Do you know whether the OCD District Office in Aztec undertakes any investigation as to the ownership of the working interest and accepting the filing of a C-104?

A. I don't know what the practice is.

Q. All right. By the way, I'm just curious about your volumetric studies that are not available now. Were those done by hand, or was that done by -- on a computer?

A. No, it was just a hand calculation, a back-of-the-envelope sort of thing.

MR. GALLEGOS: Thank you.

EXAMINER CATANACH: Is that it?

MR. HALL: Nothing further.

EXAMINER CATANACH: Anything else?

This witness may be excused.

THE WITNESS: Thank you.

EXAMINER CATANACH: Let's take about five minutes just to get set up here.

(Thereupon, a recess was taken at 2:45 p.m.)

(The following proceedings had at 3:00 p.m.)

EXAMINER CATANACH: Okay, let's go ahead and call the hearing back to order and turn it over to Mr. Hall.

MR. HALL: At this time we call Roland Blauer to the stand.

ROLAND BLAUER,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. HALL:

Q. Mr. Blauer, for the record, if you would, please state your name.

A. Roland Blauer.

Q. Where do you live, by whom are you employed and in what capacity?

A. I live in Larkspur, Colorado. I'm employed by Resource Services International, and I'm the president.

Q. All right. Have you previously testified before the OCD in New Mexico?

A. Not in New Mexico.

Q. Why don't you give the Hearing Examiner a brief summary of your educational background and work experience?

A. I received bachelor's and master's degrees in petroleum engineering with specialties in mathematics and rheology from Colorado School of Mines, went to work for

Diamond Shamrock Corporation, primarily in the western United States and Canada, with some excursions to the North Sea and the north slope.

After I finished graduate school I invented a little thing called foam fracturing, and for about four years after graduate school I spent my time with a small consulting company and then ultimately Scientific Software, developing foam fracturing and taking it to industry and doing all the reservoir engineering around to convince people to use the thing.

And then approximately 22 years ago I left Scientific Software and started Resource Services as an independent consulting company and have been so involved since then.

The majority of my experience has been hydraulic fracturing with special emphasis in coals, low-permeability reservoirs and unusual situations which require careful use of fracturing to achieve a client's desired result.

Q. Do you hold any patents?

A. Yes, I have certainly the foam-fracturing patent. I have two or three other patents in the oil industry. The other major patent is the use of a foam-slurry pipeline, and it's used primarily in mining.

And I have a couple patents on, believe it or not, recovery of gold from slurry ponds using hydraulic fracturing as a way of introducing the leachate to the slurry pond.

Q. All right. Have you previously testified before regulatory agencies in other jurisdictions and other courts?

A. Yes, sir, I'm a registered professional engineer in Colorado, I've testified in Oklahoma, Texas, Colorado, Wyoming, Montana. I've also appeared in federal, state, local courts. I've also appeared in Denmark.

Q. And we -- Previous testimony established that you have an interest in the subject Chaco wells?

A. Yes, sir, I do.

Q. You are familiar with the wells in the subject area?

A. Yes, I am.

Q. And you're familiar with the Application in this case?

A. Yes, I am.

Q. Did you have any hand in designing the frac jobs for the Chaco wells here?

A. Yes, I did. At the time that the wells were fractured I was an active partner in the Pendragon organization, and Mr. Keith Edwards, the operator, involved me in the design and the monitoring of the fracturing completions and the process of doing the frac job in these wells.

MR. HALL: We tender Mr. Blauer as a qualified petroleum engineer.

EXAMINER CATANACH: Any objections?

MR. GALLEGOS: No objection.

EXAMINER CATANACH: This witness is so qualified.

Q. (By Mr. Hall) Mr. Blauer, I believe you were in the hearing room when previous testimony on the use of BTU analysis, gas analysis, was rendered; is that correct?

A. Yes, sir.

Q. Have you prepared certain exhibits and testimony with respect to that issue?

A. Yes, sir, I have.

Q. All right. Can you tell us generally what you conclude with respect to the use -- the propriety of using gas analyses, BTU analyses, in this case?

A. In this particular case we have a couple unusual situations in the reservoir conditions, which provide a very interesting and difficult-to-evaluate situation as to the face changes and the face behavior of the five major hydrocarbons that we see in the reservoir.

Those two situations are, the hydrocarbons exist, other than methane, in relatively small quantities, but the second condition is temperature and pressure of the reservoir is such that all except methane and ethane can exist in the reservoirs, both liquid and gas, depending on the current pressure of the reservoir. This makes for a very difficult-to-predict behavior or BTU ratings and gas. and the use of BTU as an identification of source between the Fruitland and Pictured Cliffs is almost impossible because of that.

Q. All right. Have you prepared certain exhibits to demonstrate that?

A. Yes, sir, I have.

Q. Refer to what's been marked as Exhibit B1.

A. I'm going to talk briefly about everybody's favorite subject, thermodynamics, and just as a very quick review, this is a phase-change graph, and it's very simplified. Typically, they're presented with a pressure function and some kind of an energy function.

There is a region that's identified in which the material that's being examined is neither liquid nor gas. It also defines regions where materials are liquid, over here but not shown would be solid, and on the other side of this region materials would be gaseous.

Just to refresh everybody's mind and to place this, a constant-pressure process, as presented in this diagram, would be taking liquid water, applying heat, increasing the temperature, the energy generally.

At some point you'll see small bubbles of gas appear at the bottom of a pot of water. At that point you've already crossed through the phase envelope, but -- You've gone through the phase envelope, and you convert your water to steam.

The same process can happen with any other material. And as with steam, it's reversible. Two very important considerations.

The second one is a little more difficult. It's shown by the blue line and then the red line in this graph, of the constant-temperature process. And probably the closest common analogy here would be opening a bottle of pop where, at the temperature of the pop -- and we'll assume that there's no temperature change in the pop -- high pressure inside the bottle when it's capped, your liquid phase, you can't see bubbles. As soon as you pull the cap, you drop the pressure inside the bottle, you cross the phase envelope, and you get some of the liquid portions, usually CO_2 converted to gas. This process is also reversible.

I just do this to set the background for the next exhibit.

In Exhibit B2, which are the enthalpy diagrams, for the first five hydrocarbons -- methane, ethane, propane, butane and pentane -- the green areas in each of these curves are the phase envelopes, and the red or blue lines are constant-temperature lines at 90 degrees, which is approximately the reservoir temperature, starting at 300 p.s.i., and dropping to 10 p.s.i.

Now, the significance of these are that methane and ethane are gaseous at all conditions that we would expect in these reservoirs, maximum pressure of 300 p.s.i. However, propane at 300 p.s.i. and to approximately 270 p.s.i. is liquid. At 270 p.s.i. it reaches the bubble point, becomes gaseous. And then above 275 p.s.i. is gaseous.

Butane is liquid down to a pressure of approximately 45 p.s.i., it crosses the phase envelope and becomes gaseous.

And finally, pentane is liquid clear down to about 18 p.s.i. -- and these are p.s.i. absolute, incidentally -- becomes liquid -- I mean becomes gaseous, and is gaseous below.

Now, again, the importance here is, at the reservoir conditions that we have in the Pictured Cliffs reservoir is within this temperature and pressure. And as you can see, the methane and ethane are gaseous under any conditions, but the propane, butane and pentane can be either gas or liquid. And the significance there, of course, is, the gas moves through the reservoir a lot easier than the liquids.

So. I'm going to refer to Figure B3 now, which is a pictorial representation of a reservoir at two different points in the production life of the reservoir.

On the left I've shown in the center of a square, rectang- -- a square reservoir, a well drilled and having produced at some point, and the line is a constant-pressure 180 p.s.i. line.

Looking at the same well and reservoir at some later time when the production has been taken out and the pressure has been dropped, the 180-p.s.i. line now is quite a ways away from the wellbore. And I've just drawn in some contours, constant pressure contours.

Down in the propane, butane and pentane, the blue color represents the pressure and temperature conditions at which those materials would be liquid. The white areas represent areas where the material is gaseous.

Well, we see in methane and ethane at any time in the life of the well, both materials are gaseous. However, with propane, early in the life of the well, the small area around the wellbore, the propane flashes to gas and is gaseous and is able to flow through the reservoir as a gas. At later time, the area is much larger.

The significance here is, you'll notice the BTU of pure methane is about 911 BTUs per pound, propane is 2353. The point here is, a small amount of propane could have a significant impact on the BTU rating of the commixture of the gases that are being produced at the well.

Similar with butane and pentane, but we will go to pentane -- but we will go to pentane just to save a little bit of time -- only a very small amount of pentane is produced early in the life of the well. Later on, there's a larger area that the butane is gaseous, but it's still relatively small.

Now, the significance of all this is, that since this process is reversible, if a well is shut in or put on compression or there are some mechanical things done to the reservoir to change the pressure, the liquid and gaseous phases of these three heavier hydrocarbons can revert, making it harder for the heavier hydrocarbons to produce.

And when Mr. Nicol was talking about the High Roller well where the BTU of the well had been falling, then the well was fractured and the BTU went up, that's very logical, because the fracture would have gone into areas where some of the butane, some of the propane were still liquids, and by dropping the pressure in that fracture, at the tip of the fracture, you could have a sudden influx of the heavier hydrocarbons.

My conclusion from all this is, when we try to simulate this reservoir with these conditions we have a multi-component reservoir with multi phases, where the very small quantities of the heavier hydrocarbons, when they exist as liquids, are very hard to predict when they produce.

And this is very sensitive to the pressure history of the wells. When you look at data taken in the Basin, wells that are shut in and opened up will have a different -- a BTU rating. Putting wells on compression, you'll see a sudden change in BTU. So we don't consider this as a reliable indicator of the source of gas.

Q. All right, let's talk about fracture technology now, if you would.

Let me ask you, do you have any specific experience in coal-reservoir fracturing?

A. Yes, I do.

Q. Would you tell us about that?

A. For approximately the last fift- -- well, twelve years, I've been very actively involved in fracturing coal and producing coal. In this area, probably the most notable and famous is the Evergreen Resources, the Raton Basin, but I've also fractured Mesaverde coals in the San Juan, Piceance, some reservoirs in the Wasatch, the Black Warrior Basin, Germany, Poland, Australia now, Lithuania. It's been a part of my practice for many years.

Q. All right. Why don't you turn to Exhibit B4 and just give us a brief overview of the basis of the fracturing technology?

A. This cartoon was pulled from *Recent Advances in Hydraulic Fracturing*, and I did this primarily to have a way of making definitions, just so that I am consistent in the rest of my presentation.

We have a fracturing -- a reservoir that we choose to fracture -- it's shown here, and this diagram is yellow -- and a wellbore penetrating that, and we're looking at the face plane and fracture. The blue area on this is the created fracture, which is where fluid has been pumped in and created the fracture.

And we call the distance through the tubing to the tip of the fracture the half-length. The shaded part in here is the proppant bed, and of course it won't extend beyond where the fluid is. And fracture height, as shown in this diagram, would be from the top of the fracture to the bottom of the fracture.

And I might note that this diagram was made in 1980 or 1982, and I definitely differ with the smaller height at the wellbore and then the -- some ways away from the wellbore. But we'll talk about that later.

At the top and the bottom of the reservoir, I'll call those lithology changes or facies changes. Where the fracture has crossed above one of the lithology or facies changes, I would call that out-of-zone fracture, and it can happen above and below the desired pay zone.

Again, I'm just doing this for providing a vocabulary.

Now...

Q. By the way, is this Exhibit B5?

A. Yes, sir.

One of the very interesting situations about fracturing coals, and especially coals that are thin and surrounded with sands and shales, is that you have two very dissimilar materials in contact with each other. And there's all sorts of interesting things that happen at the interface of these two dissimilar materials.

As it turns out, coal is -- we'll call, a relatively soft material. It has a Poisson's ratio typically around .5.

Now, Poisson's ratio, again, going to strength of materials, which is our second favorite subject, if you -- if you compress -- if you had a block of material and you compressed it one unit by applying axial stress on that unit, then measured the displacement at the perpendicular to that and you found that the displacement was 50 percent of the displacement of your compression, that would be a Poisson's ratio of .5. That's very soft, squishy material.

Sandstones and shales will have lower Poisson's ratios. Sandstones are .2, .3 maybe. Shales are .25 to .35.

Well, one of the things that happens when you put a composite layering of materials together such as coals and sands, or a common one that we all are experienced with but we probably never thought of it this way, is plate-glass windows -- which is two layers of hard glass with a rather soft, squishy plastic center -- is, when you go about fracturing these materials you get some unexpected behavior.

Using the plate glass as the example, when the inevitable rock hits the front window of the car, the outer hard glass cracks immediately, but the fracture stops at the barrier between -- it's a facies change between the glass and the plastic. You can do that on either side of the glass. In fact, you can take a piece of glass and a hammer and beat on it and you can get both sides of the glass to fracture, but you won't see the cracks go through the soft plastic center.

Well, as it turns out, the same exact thing happens in petroleum reservoirs when you have a coal surrounded by two sandstones or two shales. The interface between the coals and the sands becomes a barrier to fracture growth.

Now, the other interesting thing that happens with this is that if you initiate your crack in your soft, squishy material, your coal, and you get that crack to extend to the top and the bottom of the coal, and it encounters this brittle material, your fracture will immediately go right through the hard material. And I've seen demonstrations with the plate glass where they've actually drilled a hole and initiated the fracture in the middle of the plastic, and both sides of the glass crack.

Well, in practice, we see this in practice in coal-sand sequences.

And I have here a composite well log, which is the well log -- a radioactive log -- well, two versions of a radioactive log, for a well in Las Animas County, Colorado. And I have chosen this well because it's about the same depth as the one -- as the Fruitland-Pictured Cliffs sequence. Probably more importantly, I chose it because I have a lot of data in this area that I can present and talk about. And we spent a lot of time studying the phenomena of growth of fractures in coal-sand sequences.

And what we have here is the gray-shaded bars are coals or possibly organic shales, high organic shales, and the yellow ones are sands. This particular operator was interested in completing in the coals, and we wanted to confine our fractures to just the coals.

If you look at the top perforation on this well, what we see happening is that the radioactive tracer shows that the fracture grew out of the coal, through the sand, and stopped at the lower boundary of the next coal.

Now, the way I see that is, first of all on this log -- This is a gamma-ray log, taken after the radioactive material and the frac job is completed, and there's a huge kick in radioactivity right here.

I've shaded in the area where there was a change between the after-fracture radioactive log and the pre-fracture radioactive log, which is on this side, just for reference.

We look at this top perforation, the fracture grew up and stopped at that coal barrier. It also grew down, or possibly this one the fracture grew up and down.

Now, if we look at the bottom perforation in this well, the very bottom, the last hole, again we see the fracture grew out of the zone, through the sand, and stopped at the top of the next coal.

And if we look at the bottom set of perforations, what we see is, the fracture grew out of the coal and up to a facies change.

And how do we identify the facies change? We see that there's a facies change right here. If we look at this perforation on the fourth interval from the top, the fracture grew out of the coal, down to a facies change and stopped.

But more interestingly, if you look at the relative radioactivity here, you see that the majority of the fracture stopped growing here at 1102, which is actually the first facies change.

So when I look at this log and evaluate it, what I see is, thin barriers of coal act as growth barriers to fractures. Fractures initiated in the coal will grow out of the coal through a sand to a lithology change.

Let's see. Now, let me give you another example of this. It's a little more complex than this one. This is another composite log with the open-hole well log, a radioactive log this time. We have liquids and two proppant tracers, so we've traced with three different radioactive tracers --

Q. By the way, this is Exhibit B6.

A. This is B6.

Q. Excuse me, go ahead.

A. Excuse me. And this is again a well in Las Animas County, Colorado. There's a number of things on here that we'll take a look at.

First of all, if you look at the top perforation, again the operator was desiring a contained fracture, and he was desiring to complete just the coal.

We notice that this top perforation, the fracture grew out of the coal and upwards to the first facies change. But we also notice that there was a minor facies change just two feet above the top of the coal, and the majority of the fracture growth stopped at that two-foot interval. And if you look at the two traces in the radioactive log, you notice that proppant stopped at that two-foot interval.

The same thing can be said for the growth downward. It did grow down, but the majority of the growth stopped at this first lithology change, facies change. No proppant in between.

We look -- We can look at the rest of the log in the same way. We can see that fracture growth from the coals, grow out of the coals, stop at a facies change. Again, we see here at the bottom -- this is the bottom coal, perforated in the coal. It grew through the coal, through the sand, and stopped at the next coal. Now, this was actually a shaly coal, so a little bit grew through. But most of the fracture growth stopped right at the top of that organic shale. No proppant went down there.

This well I would call a contained fracture, using the natures of the barriers between the coal and sand as growth barriers.

Now, I have one more example of this, which is a little closer to home. This was a radioactive tracer log we found for the -- I'm sorry, this is Exhibit B --

Q. -- 7.

A. -- 7. This is for the Dome Federal -- I mean, sorry, the Dome Petroleum Corporation. It's the Dome Federal 17-27-13 Number 3.

What's interesting about this well is that the perforations are in the top of the Pictured Cliffs formation. There's a shale barrier in this blue color, and the bottom of the Fruitland Coal is several feet above.

Notice the fracture grew into the perforations and down in the Pictured Cliffs. It grew up to the bottom of the coal layer -- I mean, I'm sorry, the bottom of the shale layer, the facies change, and stopped its upward growth.

If we look down, if you want to spend some time pondering this, you'll see that there's a strong correlation between the amounts of the radioactivity at the gamma-ray log, and we see the bottom growth was arrested by a significant facies change right here.

One of the other things that we also know about fracture growth is that fractures tend to grow to low-pressure reservoirs. So another containment feature in a well like this Dome Federal well is if we have a lower-pressure PC sitting beneath a higher-pressured coal, not only will the coals act as a growth barrier, but the higher pressures in the coal will prevent growth into the coal.

Now. I'm not the only one that has these kinds of beliefs about lithology change and facies changes in hydraulic fracture growth.

Exhibit B8 is a composite diagram of three figures from SPE Number 36449 -- Peterson was the primary author -- 1996. The rest of the people in this group happen to be the DOE/GRI M-Site contractors' group.

There's a number of interesting things on this chart that I'd like to show, that are consistent with what we've said about fracture growth and barrier control.

First of all, the paper concerns fracturing in the MWX Number 2 with telemeters and buried geophones in observation wells. And the goal here was to actually measure the location of the fracturing events and then compare it with other ways to determine fracture height growth.

Figure 4 is a composite plot of the A-sand fracture diagnostic results. The A sand are these two little benches -- I have the depth here somewhere. 4900 and 4950. Is that right? No, I'm sorry. Yes, 4900 and 4950.

In figure 4, in this diagram with the ellipse, there's a bunch of little dots. Those little dots are microseismic events, indicating that fracturing was measured at some point in time from the process.

The big ellipse is the best FRACPRO simulation that could be made from the pressure data and bottomhole pressure measurement. They were using bottomhole pressures; they didn't have to do the conversion from surface to bottomhole.

The red strip on the side of this figure, this little hached-in thing, is the radioactive tracer measurement of the fracture location, and this is the stress profile that was used from the stress measurements of this reservoir.

Now, what we see is that the fracturing event occurred in a band from approximately 4725 to 4975 and matched very closely to the radioactive tracer measurement of that event. The Fracture Pro model, the FRACPRO model, indicated the fracture growing higher than was measured and significantly lower than measured.

The other thing is that if we look at the microseismic events, they're not symmetrical. The fracture grew less to the left and more to the right. And of course, the Fracture Pro model showed none of that.

Now, Figure 8c -- Oh, also in Figure 4, notice that the actual fracturing stopped at a lithology change, both top and bottom. And in the body of the article it says that the fractures were more contained when they did their minifracs using thinner fluids but had some upward growth when they switched to high-rate and high-viscosity cross-linked polymers.

Now, if we look at Figure 8c, which is the comparison of the actual measured microseismic events in the B sand and the Fracture Pro model, we find that the B sand, which is approximately from 4525 to 4575, this little 50-foot thick interval -- and if we look at the logs, it's this little sand interval right here -- the fracture was entirely contained in that sand interval. The FRACPRO model calculated a total height of nearly 200 feet.

What I brought this in for was really to show that this containment of fractures -- and Peterson, in another paper which is included as Exhibit B15 in my exhibit package -- Warpinski, both have comments that say that fracturing in a layered reservoir is a little bit ore complicated than the current models would show.

For example, in reference B14, which is this paper, on page 318 -- it's the back of the -- my exhibit book -- in the left-hand column, the sentence at the very top, first full sentence, "Fracture growth upward is one feature that found agreement between the techniques: radioactive proppant height was almost identical to microseismic height, and both agreed with the model at the top of the fracture. Fracture growth downward found more of a difference between the microseismic and the model calculations."

Later on, down, under -- right -- the sentence under the bulleted portion of the paragraph on the same page, "Also note in Figure 4, the significant discrepancy in the surface areas of the hydraulic fracture as determined by 3-D modeling and microseismic analysis. This phenomenon was...observed in the B-Sand...analysis and will be discussed in that section." And he goes on at quite great length to talk about that.

In the other paper, which is Exhibit B15 -- this is the Warpinski paper, on page 332 of this paper, and Norm in his usual way wrote an almost unintelligible sentence, but that's okay, we'll let him do that. The left-hand column, the second full paragraph, I'll read the whole sentence, but it's really one down in there:

> Comparisons of fracture models with the imaged results were quite good for cases where the fracture was contained, but some discrepancies developed for the latter treatments. Of particular significance was the lack of downward growth, as it suggests that there may be other containment features which are not included in current models (i.e., inefficiency

crossing bedding).

And that's again where we're looking.

The latest work I've seen from the people who are doing this research -- Chris Wright with Pinnacle, Paul Branagan with Branagan and Associates, and so on -- are all finding that lithology changes and facies changes have a great deal to do with the ability of fractures to grow and to be contained.

Q. Now, from Exhibits B14, B15 and B8, your excerpt, what do you conclude with respect to the reliability of fracture-simulator models, such as FRACPRO?

A. The fracture-simulator models that are based upon the same mathematics as FRACPRO and FRACADE and the pseudo-3-D models, such as NSI's model, do not accurately provide a method of determining fracture geometry in layered reservoirs or in reservoirs with significant permeability changes, which is also layers.

Q. All right. And is that the case we have in the area of the Chaco wells?

A. Absolutely. And the experience that we have had, my professional experience of fracturing layered coal reservoirs is, I can very well use the interfacies changes of coals and sands for growth barriers if I'm cautious with my use of fluid rates, the volumes and viscosities. And

I'll discuss that here in a minute.

Q. All right. Let me ask you, is there any way to determine from fracture-treatment data the direction of vertical fracture-height growth and extension of the fractures?

A. Yes, sir, there is.

Q. How do you do that?

A. I refer now to Figure B9, which is Figure 2 out of Ken Nolte's 1981 paper on fracture pressure analysis. I need to explain a little bit of what the concept is of the Nolte plot, or some people call it the Nolte-Smith plot.

When we do a hydraulic fracture, one of the things we determine, often, with the mini-fracture is the closure pressure of the fracture. And essentially that is the minimum pressure at which the fracture is just starting to open.

If we know that number accurately and we then measure the difference between that number and the pressure anytime during the frac job, we're essentially measuring the frictional pressure loss, plus whatever stresses it takes, additional stresses it takes, the fracture and keep it open.

As it turns out when you go through the mathematics, the frictional pressure loss is a couple orders of magnitude higher than the additional stresses to open the fracture. Now, that's true whether you have one fracture propagating, two fractures propagating, four fractures propagating, so on.

The best analogy, and it's exactly the same -- it is exact -- an analogy is, if we had a fracture that was growing in length but was contained in height, we would essentially have the same situation as pumping a constant quantity of fluid into a pipeline that is constantly getting longer. The pressure at the discharge end of the pipeline is constant. As the pipeline lengthens at a constant flow rate of fluid into the pipe, we would see the pressure increase. I mean, that's just -- Long pipelines take more pressure to pump than short pipelines.

Well, Nolte-Smith converted that into a fracture model and said if we had a contained fracture where the height was contained and the fracture was getting longer, we would expect the net pressure to increase.

And if we look on this figure, he identified this as Type I. This is a log-log plot of net pressure and a log of time. And he said if the slope of that curve was between an 8 and a 4, positive, it was restricted height and unrestricted extension. The height was contained, the fracture was getting longer.

Now, it's a little harder to explain, but if we had a real weird pipe, it was some kind of pipe that was a fixed length but we could change the diameter of the pipe with time, and we started pumping a constant rate of fluid through this pipe and we increased the diameter of the pipe, we would expect our pressure at the inlet to drop. Lower pressures in the bigger pipelines.

That's exactly what we would have in a hydraulic fracture if we had a fracture that was growing vertically but the length was relatively fixed. Nolte called that Type IV. He said there would be a negative slope. And you see down here, Negative, Type IV fracturing, "unstable height growth, (i.e., Run-away)". Notice in this case he didn't identify a slope, because you could have small rates of height growth, you could have large rates of height growth. But you'll get a negative slope.

He also identified the case where as you -- in fractured reservoirs or fissured reservoirs you see no net -- pressure in the net change, as your fracture changes geometry, you continue to put more fluid into the reservoir.

The other interesting one, though, was screenouts, and we're all familiar with that. If the slope is 1, one wing is screening out; if the slope is 2, both wings are screening out.

Now, this piece of technology has been through several decades now, almost two decades of use. The service companies included almost every treating report that they issue. Most engineers at some time will look at one.

But more importantly, a number of people, myself included, have tested this procedure with actual data where they have things like I have here where we know the fractures were contained, or some other reason we know the fractures were contained or not uncontained. And we're able to look at pressures and determine the type of growth that we have.

Give you an example of that.

This is Figure B10, and it is the same well as I showed before with the radioactive tracer where the fracture was very well contained. The height was contained to specific zones. And we knew that from radioactive logging and later pressure transient testing.

I have here the treating report -- Oh, we also had bottomhole pressure bombs in the well while we were fracturing this well, and this well was fractured with a 70-quality foam, treated about 22 barrels a minute. So it's very similar to the frac jobs that Pendragon employed in the Pictured Cliffs fractures.

The blue line, which is the circles, is the major bottomhole pressure from the bottomhole bomb. The square data, the red line, is the surface treating pressure.

Now, what I'm showing here is that for foam fracs at this depth, these rates and these tubing conditions, the slope of the bottomhole pressure that's actually measured is going to be very similar to the slope of the surface pressure. So even if we don't have bottomhole pressures or we're uncertain of the calculation of the bottomhole pressures from surface pressures, if we look at the slope of the surface pressure we have a pretty good idea what's happening underground.

If we look at the net pressure plot on this well, which is the lower half of this exhibit, B10, notice that this thick line completely covers all the data. I mean, we have bottomhole pressure, we had very good data, we knew what the closure pressure was very closely. Notice there's a positive slope, indicating that this fracture was contained. The slope of that line is about plus 1/4. Everything fits.

Now, if we take -- One of the advantages of the Nolte plot, of course, is that it's data that we typically have on a well. We have the surface reading pressures, we may have a calculated bottomhole pressure. Even on old, old wells where we didn't have a lot of technology, it gives us a piece of data to let us understand how the fractures grew.

So, I've put Exhibit -- I've put an exhibit together with seven wells that were fractured by Maralex and/or Whiting. And I've taken the net treating pressure plots out of those reports as presented by the service companies.

Some of these net treating pressure plots, like the second one, which is the Gallegos Federal 26-12 7 Number 1, has three different lines on it here. All that indicates is either the operator or the service company wasn't sure what the closure pressure was, so they did this curve at three different closure pressures.

What we see on these seven wells, with the exception of the Federal 25-12 31 Number 1, is negative slopes, indicating vertical height growth through some or all of the frac job.

Some of them we see a reversal of the slope, indicating screenout. These slopes are high enough that the wells were starting to screen out. And when we look at the actual treating reports, the screenouts typically started shortly after the sand arrived at the location.

The Gallegos Federal 26 13-1 Number 2 shows either a sudden drop in injection rate or a runaway, that the tried to get back into it and couldn't.

But the importance here is, every one of these net treating plots show negative Nolte treating slopes, which is a direct indication of unrestricted height growth.

Now, if we compare those to figures B12, which are the five Pendragon wells, first of all we notice something distinctly different. The slopes in all of these, except the Chaco Number 4, are positive. Whether we believe in Nolte or not, there is a distinct difference between the character of the Maralex wells and the character of the Pendragon wells. If you calculate the slopes of the Nolte plots on those Pendragon wells, you'll see that they're within the 1/8 to 1/4 slope.

It looks we've got a screenout here in the Chaco Number 5, and we clearly -- late in the treatment. We had a very early screenout in the Chaco Number 4. The Chaco Number 4, we only got about 4000 pounds in the ground.

All of these wells were treated at about 20 to 25 barrels a minute, small volumes of liquid, 70-quality foam. So Maralex wells were treated significantly higher rates and larger volumes.

Exhibit B13 is a table -- and I apologize, this doesn't reflect all of the data received very lately from Whiting because I was out of the country and just didn't get it done.

First of all, the analog coal wells I used in the Raton Basin, notice that we treated with 20 to 25 barrels a minute, 15,000 to 20,000 gallons of fluid, and nearly 78,000 pounds of proppant.

The Pendragon wells were all treated with essentially the same kind of treatment, 20 to 25 barrels a minute, 32,000 pounds of proppant and 38,000 gallons of fluid -- I'm sorry, 32,000 gallons of fluid and 38,000 pounds of proppant.

The Whiting wells, from the data that I could gather, were treated at 45 to 60 barrels a minute, 41,000 gallons of fluid. But notice, two of them were treated with excesses of 80,000 gallons of fluid and much excess of 100,000 pounds proppant.

Now, the significance of the rate of these is that in any fracture simulator, in any kind of calculation of frictional pressure loss on a well, any of the models -- including Cleary's model, which is the basis of FRACPRO, or Nolte's model which is the basis of FRACADE or Myers', which is the basis of Myer Frac -- any of the simulators, you look at the height functions and width functions, and they're all a function of viscosity times rate. There will be that function in there.

Stated simply, the higher the rate or the higher the viscosity, or both, the higher the fracture geometry -- the more likely you are to have unrestricted height growth.

And if you remember back to the references I made in the two SPE papers, that comment was made that fractures grew out of zone later in the treatments when they converted to a higher viscosity fluid.

Q. Mr. Blauer, from what you presented today, your fracture-treatment data compared against the Nolte plots, can you conclude whether the fracture-treatment jobs that Pendragon performed on its wells remain contained within the Pictured Cliffs sandstone?

A. Yes, sir, and I say that for three reasons.

The wells were treated with low rates, relatively low viscosity fluids.

They were treated into a low-pressure reservoir, which is in itself a containment.

The reservoir -- The Pictured Cliffs reservoir had a shale or coal at the top of that reservoir which would arrest any growth, any upwards growth.

And we have from an offset well indications that Pictured Cliffs fractures grow downwards into the Pictured Cliffs as it is, which, from stress considerations, we would agree with.

So for those three reasons, we believe that the Pendragon fractures did not breach the Fruitland Coals, stayed contained. The small size of the treatments and the upward slopes of the Nolte show that we had fracture extension length, which is also consistent with strong increases in productivity from the wells.

Q. Can you make the same conclusion with respect to the fracture-treatment jobs that Maralex did on their coal formations? Did they remain contained within zone?

A. Based on my analysis and experience, the Maralex fractures grew out of zone. I cannot say for a certainty whether they grew upwards, downwards, or both; but they clearly grew out of zone.

If they breached the top of the Pictured Cliffs formation, because the reservoir pressure is much lower in the Pictured Cliffs than the Fruitland, there would be a tendency to grow rapidly into the Pictured Cliffs.

And also, once you've breached into the sand of the Pictured Cliffs, you would probably have growth until you reached a significant lithology change. And we could go into some detail of where that might occur, but if it breached it went down into the Pictured Cliffs quite well.

Q. Mr. Blauer, in your opinion were the fracture-treatment jobs applied on the Pendragon Chaco wells done in a reasonable and prudent manner?

A. Absolutely.

Q. And were those fracture-stimulation jobs necessary to recover additional Pictured Cliffs formation reserves that would have otherwise gone unrecovered?

A. Yes, they were.

Q. Were Exhibits B1 through B7, B10 through B14 prepared by you and at your direction?

A. Yes, sir, they were.

Q. And with respect to the literature exhibits -- B8, B14, B15 and B9 -- are those articles of a type reasonably relied on by experts in your field?

A. Yes, sir, they are.

MR. HALL: We'd move the admission of Exhibits B1 through B15.

MR. GALLEGOS: No objection.

MR. HALL: That concludes our direct of Mr. Blauer.

MR. GALLEGOS: No objection.

EXAMINER CATANACH: Exhibits B1 through B15 will be admitted as evidence.

MR. GALLEGOS: May we have a short break? There's a lot to deal with here.

EXAMINER CATANACH: Yes, it is. Let's take ten here.

(Thereupon, a recess was taken at 3:55 p.m.)

(The following proceedings had at 4:10 p.m.)

EXAMINER CATANACH: Okay, let's reconvene the hearing and turn it over to Mr. Gallegos.

CROSS-EXAMINATION

BY MR. GALLEGOS:

Q. Mr. Blauer, when did you acquire your interest in these Chaco wells?

A. At the formation of Pendragon, which would have been about 1993 -- oh, well, when -- I acquired the interest when the Chaco wells were acquired. I was a partner from the beginning.

Q. Okay. And can you be a little bit more exact than Mr. Nicols as to when that was?

A. I'm sorry, I can't. I'm not much on dates.

Q. Okay, late 1993 or early 1994?

A. In that time frame, yes.

Q. Okay. As I understand it, you designed the frac jobs on the Chaco wells?

A. Yes, sir.

Q. And at that time you were working in conjunction with J.K. Edwards?

A. Well, J.K. Edwards was the operator of the property, and I was a partner in Pendragon, one of the working interest owners in the well, and I am in some circles an acknowledged fracturing expert, so Keith called and asked if I would assist in the design and the execution of the frac jobs.

Q. I have placed on the witness file -- I mean on the witness stand, next to you, the well files as produced to us by your company for the Chaco Number 1, and that's Exhibit 37, our Exhibit 37 --

A. Okay.

Q. -- the Chaco Number 4, that's our Exhibit 39, and the Chaco Number 5, which is our Exhibit 40.
A. Okay.
Q. All right, and unfortunately these pages aren't numbered, but what I'd like to do is see if we can locate the fracture-treatment information. I think it's under a tab that says "Frac Treat Information".
A. I have a black page.
Q. Right, the black page says "Fracture Information", and then it's followed by a page that's kind of a title page. Do you find it? Western Company --
A. Yes, sir.
Q. -- Frac Treatment Summary?
A. Yes, sir.
Q. All right. Now, you're familiar with this kind of a report by the service company that did the stimulation?
A. Yes, sir.
Q. It's a typical --
A. Yes.
Q. -- report that you --
A. Yes.
Q. -- prepare?
A. Yes.
Q. Okay. And this relates to the Chaco Number 1

well in Section 18, which was treated January 27, 1995?

A. That's what the cover page says, yes.

Q. All right. And the cover page says that -- makes a reference to the Pictured Cliffs formation --

A. Yes, sir.

Q. -- correct?

Okay. And within that group of documents, back under the tab, Walsh Engineering Recommendation --

A. Okay.

Q. Do you find that?

A. Yes, sir.

Q. This is the stimulation recommendation. It says Prepared by [*sic*] Mr. Paul Thompson, Walsh Engineering, and this is for the Chaco Number 1, Pictured Cliffs formation?

A. Yes, sir.

Q. Now, you actually prepared this or participated in the preparation of this stimulation design?

A. The actual procedure was -- I'm not sure. I think Paul Thompson was actually the person talking to the Western Engineers. He may have had a phone conversation with me, or he may have had the Western people contact me directly. And we had telephone conversations with different people in that loop, and we arrived at an agreeable design.

Q. All right. Would it comport with your recollection that two wells were done on that day, the Chaco Number 1 and the Chaco 2-R? By "that day" I refer to January 27, 1995.

A. Again, if I look at the records and if that's when the wells were done, I would say yes. But I wouldn't have a recollection.

Q. All right. What was the reason behind your doing stimulations, hydraulic fractures, on these wells?

A. Well, the wells were acquired and were nonproductive. The first effort was to do relatively small amounts of cleanout and stimulation, go into the wellbores, clean them out, make sure that the tubing casing was clean, and small acid jobs were attempted to see if production could be regained.

Q. Well, no, I wasn't asking so much about procedure, rather the thinking behind the idea that there was some economic reason to do a hydraulic fracture on the wells.

A. Well, the wells had not been hydraulically fractured. They were nonproductive, and at that point my involvement was just, would it be possible to design or execute a fracture job in these wells? And --

Q. Well, wouldn't -- I'm sorry.

A. And I wasn't at that point particularly concerned with specifics on why, other than we would expect an increase in productivity.

Q. Well, that's what I'm getting at. One view could be that these wells have been producing for 20 years, they're depleted, there are no more reserves to economically recover. That could be one view?

A. That could be one view.

Q. Evidently, you held another view?

A. Yes, I did. I wouldn't have participated in ownership if I didn't.

Q. Was your view that there was some sort of damage, as Mr. Nicol said? And I think often people speak of skin damage to account for low productivity of the wells?

A. There was some problem with the wells that it -- that they were low productivity, and it produced too small a volume of gas, from my estimation.

Q. Too small a volume of gas, as compared to what?

A. Well, unfortunately, I did the same thing Mr. Nicol did. When the prospect was put in front of me, I sat down and did my own estimate of volumetrics. No, I do not have them; they were the back of the envelope. Convinced myself, though, that this was an under- -- this was an underproduced reservoir and that there was a good chance that there would be additional production in this reservoir, if we could figure out the mechanical problems of achieving -- of acquiring it.

Q. Well, isn't good engineering practice such that if you have that suspicion, one of the things you would do would be to do a drawdown test?

A. Well, the wells were producing at very low rates, three or four MCF, and there wasn't much production coming out of them. The wells weren't very productive, they weren't very responsive. Hard to do a buildup test.

I kind of have troubles with the concept of skin, because skin usually involves a relatively small invasion in the reservoir, and there could have been physical damage several feet into the reservoir. So if that is the case, buildup tests, drawdown tests, pressure-transient tests often aren't very instructive.

Q. Well, I suppose you would deny that your reason for going in to hydraulically fracture these wells was to obtain communication with the Fruitland formation and get the coal gas, right?

A. Well, we didn't know --

Q. You admit that?

A. No, we wouldn't -- We didn't own the Fruitland Coal, and one of the things that I was very adamant about when I was talking about fracturing was conducting a fracture in a way which would not breach the coal.

Q. I understand that, but what I'm trying to get at is what you did as an engineer, it would be ordinary practice to say that fracturing is indicated. There's Fetkovitch type curves that engineers use if they think there's some reserves there that aren't being produced; you're familiar with that?

A. Yes, sir.

Q. You didn't do that, did you?

A. No, sir.

Q. You didn't do a drawdown test?

A. No, sir.

Q. That's a common practice among operators if they think there's some reserves not being produced?

A. I wouldn't call it necessarily a common practice, and I think that there's different levels of prudent engineering.

This was an acquisition, remember. The cost of acquiring the wells was relatively low. There was a gamble of some reserves, and we were probably thinking that the reserves were relatively small. Three-tenths of a BCF is a small well. You're not going to spend a whole lot of money doing tests and analyses on wells like that. You probably step the line, do some small of work. Remember, we're poor boys, we're just entering into this field. We're not going to spend a lot of money doing high-tech engineering.

Q. Okay, so you got the wells for nothing?

A. Not nothing, but reasonably priced. I don't know what the exact cost was, but it was low.

Q. And you were going to spend $15,000, $16,000 to do a hydraulic fracture?

A. Well, I think the initial procedure was, we were going to spend $2000 or $3000 to do a small acid job. I mean, the intention there was to go in, clean up the wells as minimum costs, put them on production and go from there.

Q. But you wanted to be -- I think you said you wanted to be really sure that in doing this fracture stimulation you stayed within zone?

A. When I was asked to design the frac job, that was one of my considerations, yes, sir.

Q. Well, it would particularly be a consideration because you did not have ownership of the near-proximity Fruitland Coal formation; isn't that right?

A. That is why we wanted to stay in the Pictured Cliffs.

Q. Okay. And evidently a client of yours, Evergreen, had a similar-type interest. You showed us a number of tracer surveys on Evergreen wells --

A. Yes, sir.

Q. And I think you said that that operator particularly wanted to be sure that it stayed in the coal?

A. Yes, sir.

Q. Okay. Was there a reason that you know of for that?

A. In that particular reservoir, Evergreen felt that the majority of the reserves were in the coal, and they were producing a coal gas reservoir. They wanted to have all the fracturing and the maximum amount of fracture length and the maximum conductive proppant bed in the coals. They didn't want to waste their fractures on what they thought were nonproductive shales and sands.

Q. Okay. So in order to have some assurance that the stimulations on these Evergreen wells were going to stay in the formation, should we understand that these were some of the early jobs? In other words, they were done with a tracer survey so somebody could know that they were designed so they would stay in the target formation?

A. Are you talking about Evergreen now?

Q. I'm talking about Evergreen.

A. Well --

Q. You showed us Exhibits 5 --

A. -- these --

Q. -- 6 and 7.

A. -- these treatments, these two treatments that I presented, I think it was the Eureka and the Don well, they were -- I would call them mid-time. They were after we had gone into the field, done some fracture treatments at higher rates and higher volumes and different designs, different fluids, had taken radioactive tracer surveys in those wells, started calibrating our understanding of the rock properties and the mechanics of fracturing in those wells.

These wells were probably the first of what we'll call the Evergreen Raton frac design, which includes the containment feature.

Now, at the time we were doing Evergreen and Pendragon, one my professional efforts for all of my clients was to design fractures that were contained, not just in coals and sands. I mean, this was one of the things that I spent a lot of time doing, and we did -- as a professional fracturing engineer, I spent a lot of time in lots of different reservoirs for lots of different clients designing contained fractures and learning how to treat a reservoir and have a fracture contained where the client wanted it contained.

Q. Okay, if we could, let's try and stay on the subject and --

A. I am.

Q. Well, I was asking you about the Evergreen wells in Raton Basin, and I think you've indicated that the earlier tracer surveys indicated something that led you to change the design parameters of the hydraulic fractures?

A. Yes, sir.

Q. You're going out of zone?
A. Yes, sir.
Q. Okay. Were tracer surveys done on all the wells?
A. Not all of them, no, sir.
Q. But on the early wells, tracer surveys were done, fracture grew out of zone, and now you've shown us the surveys where fracture stayed within zone?
A. In the early development of Evergreen --
Q. First of all, can you answer my question? Is that what happened?
A. I'm going to answer your question.
In the early development, I think we did three frac jobs which were essentially driven by service company designs, and we traced those to convince ourselves of how the fractures were growing.
When we found that a substantial portion of the frac jobs were growing out of zone, we not only changed the fracture system, but we also changed the perforation program. Then we changed the treating rigs.
And these two wells were probably the third and fourth wells which we felt we had containment from our radioactive tracer. I don't remember the exact process, the exact numbers of wells. But these were early in a fracture-optimization process that we were conducting for Evergreen.

Q. So on the earlier wells, by reason of the tracer surveys, you learned some valuable information, to wit, your fractures were growing out of zone?

A. Well, not just the tracer surveys. I mean, we had pressure data and we had the rate-treatment data of the wells. We also had some production data later on, which indicated some -- indirectly, fracture lengths and fracture heights.

Q. Did Evergreen --

A. We had other information, yes.

Q. Excuse me. Did Evergreen also do some temperature surveys?

A. I believe they did one or two very early on and found that because of the depth of the reservoir and the fluid we were using, we weren't putting a lot of mass into the reservoir, and the temperature of the fluid and the temperature of the reservoir were very close, and so temperature surveys weren't a reliable indicator of fracture growth.

Q. Because what? The depth of the -- You said the depth of the reservoir and the quantity of fluids present?

A. Well, the first level was -- the temperature of the reservoir and the temperature of the fluids that were injected were nearly identical. We were using a 70-quality foam, so the mass of the fluid was only about 30 percent the mass of water.

So if there was any temperature difference between the injected fluid and reservoir temperature, there wasn't a lot of mass to be injected. But that delta T was very small. So essentially the only pressure drop you'd see was if you had cooling of the fluid going through the perforations.

As a result of that, when we tried running differential temperature surveys, we would see some indications, but it wasn't -- There wasn't enough differential temperature between the fluid and enough mass of fracture fluid and the temperature of the reservoir to be a reliable indicator of fracture growth.

Q. What depth are these wells?

A. These are -- Well, the Don well is the top zone, and this was -- The lowest zone in the reservoir was 1100 feet, 1200 feet. The Eureka was about the same depth.

Q. And the formation, the target formation, is approximately what -- What's the vertical size of the formation?

A. Well, the entire Raton coal and Vermejo coal formation, the entire interval can be as much as 500 feet. When we design fractures, one of the optimization procedures, in fact, is determining what the optimum thickness you could treat with one frac job.

Q. What was the temperature at the face of the formation?

A. Well, we don't know what the temperature at the face of the formation is, but just so I don't give you a wrong number -- It's not reported, but as I recall, it was 85 degrees, possibly 90. But that's a recollection.

Q. And that's what made it difficult to use temperature surveys --

A. Yes.

Q. -- because you had such a low formation temperature?

A. Unless we were fracturing in the winter and the fluid temperatures were 40 degrees, there wasn't much of a temperature differential.

Q. All right. And so once, by reason of these tracer surveys, you gained some knowledge, then you were able to redesign the fracture treatment so that you stayed in zone as you illustrated with, I think, Exhibits 5 and 6.

A. Yes, sir.

Q. All right. Now, I take it -- You know, there's a school of thought that says that when you have a borehole you have this deformation sort of near stress in the hole, and therefore when you're talking about a hydraulic fracture, there's an area where the fracture growth doesn't start till it gets away from the wellbore, then it begins

to grow. Do you accept that --
A. No, sir, I do not.
Q. -- concept or not?
You do not?
A. I do not.
Q. All right. And there's also a school of thought that when you use the tracer surveys, the problem with those tracer surveys is that they only read out maybe eight inches, maybe 12 inches from the wellbore, and anything that's happening beyond that distance is -- becomes an unknown, and you don't accept that?
A. The fact that they have a limited depth of investigation is true, and I think eight to 12 is probably reasonable. And certainly anything that would happen beyond that, you would not be able to measure, that's correct.
Q. All right. Now, coming back to the situation that you saw in the San Juan Basin with the Chaco wells, you were quite aware, I think -- maybe this is repetitious -- that you had another owner whose formation was right in proximity with the formation that you owned?
A. Yes, sir.
Q. And was there any effort made to do a tracer survey on these January hydraulic fraction [*sic*] jobs in the two wells that were done in January so that before you

did any other frac jobs you would know the behavior of your simulations?

A. They were not done.

Q. Okay.

A. There was an effort to do them, but they were not done.

Q. What do you mean, there was an effort to do them?

A. I begged, pleaded, whined, cajoled, and at that time I think the cost of that treatment -- of the radioactive tracer and logging, was about $10,000. And again, that was an expense that, considering that we were trying to enter what we considered very low-productivity wells at the time and we were gambling that it was going to work, that was an unreasonable expense.

Q. Okay, but you as a one-third partner, you certainly would have borne your share of that expense to gain that information?

A. Well, there again, I got caught between a rock and a hard spot, because the professional engineer said, I want radioactive logging, but I was going to ante up some portion of that, which was difficult.

So I put the request forward and we discussed it as a group of working interest owners, and we went forward without it.

Q. You got -- You were outvoted?

A. On the technical side, I was outvoted. But in all honesty, I was probably -- I didn't have to pay for it.

Q. And another alternative would have been a temperature survey, because in that area you would have the temperature differentials that would be meaningful if you did that kind of survey; isn't that true?

A. Well, I don't think so, because the temperature in the reservoir was 95 to 100 degrees, in that neighborhood. Possibly in January you could have had cold enough water. A temperature survey might have worked. I don't recall, though, that it was anything that was discussed.

Q. Well, you would agree in January of the year, though, if you decide to use a temperature survey, it would have been meaningful, it would have told you something --

A. No, I don't agree with that.

Q. -- of materiality about what your fracture behavior was?

A. No, I don't -- I don't agree with that. Again, these jobs were designed to 70-quality foam fracs, and so the mass of the liquid that we were pumping -- And also, if you notice, I was designing very small treating volumes. We're talking about 10,000 gallons of water pumped into this reservoir, and that's not a lot of mass to cause a significant cooling. And I would not agree that a temperature log would give me a lot of meaningful information at this depth, this quantity of water that was pumped.

And of course, not knowing what the exact temperature of the fluids in the reservoir are would even be -- make it harder to speculate.

But it wasn't something that I think was seriously considered, and I certainly didn't push for it.

Q. Since you've mentioned something about the quantity of fluids, there was two or three other factors I was sort of interested in, in these -- particularly in your comparison of these fracture stimulations.

Do you know whether or not the Whiting well procedures were done with a gel-type fluid or a non-gel?

A. I could not tell from the data that I had at the time I prepared this, but the standard procedure was a linear gel base for the fluid. But I do not know.

Q. All right. You would agree that a non-gel fluid would have a significantly lower viscosity than a gel-type fluid?

A. In a foam?

Q. Yes.

A. No, I would not agree with that.

Q. Well, in the water.

A. The water phase of the fluid, a gel fluid would have more viscosity than a non-gel fluid.

Q. Okay. And your wells, your fracture treatments used a gel fluid; isn't that true?

A. Yes, sir.

Q. What were your -- I didn't get any pressures. You gave us the barrels per minute, the gallons and the quantity of sand proppant, but at what surface pressures? What was the high surface injection pressure on the wells? Can you give us that?

A. I can't recall that, no. I can certainly look it up if you want me to look through the data.

Q. Okay. Well, isn't that significant if we're talking about what we think the fracture growths are?

A. Well, the fracture growth is, first of all, a net pressure, and so that is usually calculated and presented by the service companies as the bottomhole pressure minus the closure pressure. Whether or not they calculated the bottomhole pressure is -- may be a mystery.

But the net pressures are on these plots, and this is where we're really using the Nolte-Smith plots, and they're showing somewhere between 800 and 1000 p.s.i., and the net pressure is --

Q. That's at the face of the formation?

A. Pardon?

A. You're talking about at the face of the formation --

A. If you --

Q. -- or at the surface?

A. At the face of the formation, if you know the closure pressure. And from the looks of both the Maralex and the Pendragon wells where there's multiple plots on the Nolte-Smith plot, it looks like people were uncertain of their closure pressures, so they did three or four plots to see what happens.

But the significance of the Nolte plot is the slope of the line, not necessarily the absolute value of the pressure.

Q. Okay, we'll come back to that. Let me talk a little bit more with you about the design. When the fracture stimulations that were designed in January were applied, which would have been to the Chaco 1 and the 2 -- Let's see, Chaco 1 and the 2-R, January of 1995. Tell the Examiner what results you got in terms of well performance after the procedures.

A. I don't have that in mind, sir.

Q. Well, were they successful? Did you start getting the levels of production that you expected?

A. Well, we have decline curves for those wells, and I think I would -- I think Mr. Nicol introduced them, or Mr. McCartney will, and I'd feel more comfortable looking at those curves instead of trying to recall what the performance was.

Q. There was a gap, then, the records indicate, after the hydraulic fractures in January on the 1 and the 2-R, until May, when the Chaco 4 and 5 were done. Can you explain why that occurred?

A. No, sir.

Q. What information was being gathered concerning the Whiting wells and, in particular, I refer, when I use the term "information", to the volume of water the wells were producing and the volume of gas that they were producing.

A. At what time, what period of time?

Q. Between January, 1995, and May, 1995.

A. As far as I know, none. I mean, I wasn't aware of any. I mean, it wasn't in front of me and I wasn't looking at it.

Q. Okay. Is it just sheer coincidence that the Chaco 4 and 5, which were fracture-stimulated in May of 1995, were in very close proximity to the two Whiting wells that had most successfully been dewatered and were producing the most gas out of that group of wells?

A. Boy, I don't know how to answer that. The wells were there, and we purchased old wells, and they were where they were. I don't know how that's a coincidence.

Q. Well, you purchased six wells. Two wells have not yet, to this day, been fracture-stimulated.

A. Okay.

Q. And so I'm asking if it's just coincidence you selected the 4 and 5 to be stimulated, and they just happened to be close to those particular Whiting wells.

A. I don't think that the selection of the wells for fracture were based upon proximity to other wells or based upon the quality of the reservoir in -- of the Pictured Cliffs formation in those wells, in our anticipation of successful fracturing and recovery.

Q. Did you get that? Successful fracturing and recovery?

A. That was our anticipation when we were going to -- before we did the frac job.

Q. Did you achieve that?

A. I assume so, because we have some producing wells that weren't producing before we fractured them.

Q. Well, and having the -- If you assume that, why are there two of these six wells that have never been fracture-treated?

A. As I recall the conversations at that time, the consensus was, the reservoirs in those two wells were not particularly high quality.

Q. Well, after this passage of time from January and the 1 and the 2-R were done, then Exhibits 39 would contain the information on the fracture treatments for the Chaco 4 and 5?

A. Yes, sir.

Q. Okay, let's look at Exhibit 39 under the tab "Fracture Information" --

A. Okay.

Q. -- and we'll turn over the same kind of cover page, "BJ Services", the Chaco Number 4 in Section 1, May 10, 1995, Fruitland Coal Formation --

A. Yes, sir, that's what --

Q. -- Formation.

A. Uh-huh.

Q. Fractured. And the transmittal letter from Loren Diede, the district engineer, to J.K. Edwards of the same date, May 10, 1995, the treatment summary refers to the Fruitland Coal formation.

A. Okay.

Q. And if you want to go back to the treatment report, which is kind of this Western Company form with colored printing, do you find that?

A. I'm looking. Yes, sir.

Q. The formation is listed as the Fruitland Coal?

A. Yes, sir.

Q. And the design stimulation recommendation, which is under the Walsh Engineering Recommendation tab --

A. Again, a Western document?

Q. And again, just the same kind of document that we previously referred to, you, in the case of the Chaco Number 1 as reflecting your design, collaboration with Mr. Thompson, and what formation does it list?

A. It says Fruitland Coal.

Q. So having the experience in January of doing the two wells, was there a recognition by you, or by your company, that what you were really doing was fracture-stimulating the Fruitland Coal formation?

A. No, sir, and I -- I didn't prepare these documents, and I probably -- I hate to admit this, but I probably didn't look closely at the formation when the proposals came in. I don't know why BJ and Western wrote "Fruitland Coal". If you notice on my net treating plot on those two wells it says "Fruitland Coal" also, but it's not Fruitland Coal.

Because of the -- Because of this hearing we checked the perforations in these wells, and they are perforated in the appropriate reservoir. They are not in the Fruitland Coal.

Q. So you're telling us that you got this stimulation recommendation May 5th, 1995, which would have been five days before the work was done, and you either ignored or did nothing to correct, if this was an error, that it says the formation is the Fruitland Coal?

A. I think probably the first one -- Well, I wouldn't say ignored. I think I probably didn't even look at it. I certainly didn't do anything to correct it. I wasn't aware of that problem until we got into preparations for the hearings.

Q. And Exhibit 40 is going to show the same information for the Chaco Number 5 well, that in each and every place where there's a reference to the formation that is being fractured, it is described as the Fruitland Coal formation, not the Pictured Cliff formation?

A. I'll accept that that's what it says.

Q. Let me talk to you about your theory here of -- which goes, as I understand, like this: The fracture treatments on the Pendragon wells were contained, but the fracture treatment on the Whiting wells were not contained?

A. That is a summary statement, yes.

Q. All right. And one of the reasons, one of the three reasons that you gave, was that the Pictured Cliffs is a low-pressure reservoir?

A. That would -- It's a lower pressure reservoir than the Fruitland Coal, and so its fracture would tend to grow more readily and robustly in that reservoir than the Fruitland Coal.

Q. Okay. Well, give us the information concerning what the pressure of the reservoir was at the time of -- in January of 1995, of the fracture treatment of the 1 and the 2-R and, in May of 1995, the Chaco 4 and 5.

A. Well, Mr. Nicol has presented the pressure data that was known, and we had a general sense of the low pressure of the Fruitland and the relatively higher pressure of the Fruitland and the lower pressure of the Pictured Cliffs. I don't think I was acutely aware of that until preparation for this hearing.

Q. Well, these are your opinions, Mr. Blauer, that I'm trying to get to the basis of, and I'm asking you, give us the information you have concerning what the reservoir pressure was in the PC at that time --

A. What my information --

Q. -- have calculations or --

A. What my information was in 1994 and 1995, or today?

Q. No, what it was whenever you were doing these treatments and concluding that they were staying within zone.

A. Okay. At the time I was doing the designs, the formation pressure was not an overwhelmingly important consideration, and particularly the difference in formation pressures between the Fruitland and the Pictured Cliffs was not a tremendously important design parameter. I knew I was pumping into 100- to 200-p.s.i. reservoir, I knew about the depth.

But I was more interested in the existence of the coals, the barriers of the coals, where the locations of the perforations were in relationship to the coals. And we had a large body of experience in a very similar reservoir at similar depth, which pretty much led us to understand how we would do a fracture in this, this particular kind of reservoir.

That was the information. I was more concerned with the barrier growth at that time than the reservoir pressures.

Q. Okay. Well, you made conclusions back contemporaneous in time with these fracture stimulations that the fractures had stayed in zone?

A. Yes, sir.

Q. Okay. But at that time, if I'm understanding your testimony, you weren't basing that on the factor of the relative pressures of the formations?

A. No, sir, that was additional information that came to light when we were looking for this --

Q. Preparation for this?

A. -- for this, yes, sir.

Q. Okay. So what you were relying on back at the

time the procedures were done was the barriers, you say?
A. Yes.
Q. Okay.
A. The presence of them there.
Q. The presence of, I think you said, a shale at the top of the target formation?
A. Well, I said a sand or -- I'm sorry, a coal or a shale. A change --
Q. A coal or a shale?
A. A change of formation, a strong lithology change.
Q. Okay. So it could have been a coal? In other words, on top of the target formation it could have been a coal rather than a shale, is what you're saying?
A. No, let me try to say --
Q. I thought you just said a coal or a shale. Isn't that what you said?
A. I'm not sure what you're asking, so let me make a statement and see if this answers your question, which I'm not quite sure of the question.
There is -- At the top of the Pictured Cliffs there is a strong lithology change. There certainly is a coal up there somewhere. There also might have been a small, thin shale in some wells, not a coal but not a sand.
The presence of the coal was an absolute barrier to me with the fracture procedures we were following. The

shale might be a fracture barrier, but certainly the coal was.

Q. Okay, so your testimony is, the probability is that the barrier to fracture height growth was the coal?

A. The strongest probability is, the coal is the fracture height-growth barrier. The shale probably is also.

Q. And when you refer to the coal, are you referring to the -- what we've been calling the upper coal, the thick coal formation, above the upper Pictured Cliffs?

A. Yes.

Q. All right, so the growth, the vertical growth of the fracture being applied to the Pendragon wells, reached up to the coal, and the coal itself became the barrier that stopped the height growth?

A. If it reached that far, and in the Dome Federal well, which is perforated -- this was the Pictured Cliffs well; I had a radioactive log, Exhibit -- this one, whatever that one is, B --

MR. HALL: -- 5

Q. (By Mr. Gallegos) You're going back to Raton Basin, Evergreen --

MR. HALL: Six.

THE WITNESS: No, no, this is in a WAW Pictured Cliffs reservoir.

In this particular well, the perforations are indicated about 1308 to about 1320. There is a lithology change, which is probably a shalier interval, and that shalier interval was sufficient to stop the upper growth in this zone. Had it breached that shale and had it breached that lithology change, the coal would have absolutely stopped it.

Q. (By Mr. Gallegos) Okay, let's use one of the wells that we're interested in. Could we have the -- put up the log for the Chaco 4 or Chaco 5? You've got cross-section for those logs.

A. Chaco 4. Let's see, this is Exhibit --

MR. HALL: I don't know.

MR. NICOL: Cross-section A-A'. I don't remember -- I think it's 3.

Q. (By Mr. Gallegos) Yeah, I think 3 is --

A. Exhibit 3?

MR. HALL: N3 is correct.

THE WITNESS: The Chaco 4 well is the fourth well from the left.

Q. (By Mr. Gallegos) All right. Give us a moment, Mr. Blauer, so we can -- if I can find the exhibit.

Okay, the fourth -- The Number 4 is the fourth well from the left?

A. Yes, sir.

Q. It's also the fourth well from the right.

A. Coincidentally.

Q. All right. And what we're looking for -- What kind of a frac pressure are you going to tell us is needed in order to constitute a barrier to the height growth?

A. Well, my --

Q. What kind of pressure is it -- in p.s.i., is it going to have to withstand, given the stimulations that were applied to these wells, in order to stop the growth?

A. My experience in the Raton Basin, where I have bottomhole pressure data and lots of data, are that to breach a coal interval from a well that was initiated in a shale would require between 2500 and 3000 pounds net pressure, if the fracture was initiated in the sand or shale. So a significantly higher pressure, the net pressures, during the treatment, around 1000 p.s.i.

Q. It would take -- to breach it? Was that the word?

A. To breach it. If you initiated your fracture in the sand/shale, to breach that barrier you need an extra -- between 500 and 1500 pounds of pressure, net pressure to do that.

Q. I'm sorry, I took down 2500 and 3000. Is that --

A. That's absolute. I'm saying net, net pressure.

Q. Oh, net opening pressure?

But absolute pressure -- If we look at the Number 4 and you see you've got the perfs, you have separated perfs but you have a set that's the higher set.

A. Well, let's look at the Number 4. I think that's one of the exhibits that you gave me --

Q. Yes, sir.

A. -- your Exhibit Number 39. And I'll probably look at graphs instead of tables. I'm looking at the treatment graph, which is this thing.

Q. Yeah -- oh, not --

A. Not the net treating pressure plot, now, the actual treating graph --

Q. Right here, okay.

A. -- which is the pressure --

Q. It's after the Nolte plot.

A. It's the next page after the Nolte plot.

MR. CONDON: Now, what section?

THE WITNESS: I'm sorry, it's in the section, "Post Frac Treatment Study". It's about halfway back.

MR. GALLEGOS: Got it? Okay.

THE WITNESS: Okay, the bottomhole treating pressure, which is calculated in this case, according to this chart, which looks to me like it's the red line -- or the pink line, the pinkish line -- is 800 to 1000 pounds until the screenout starts. And then when the screenout starts, it increases to about 2000 p.s.i.

To breach the coal-shale boundary in this well, we would have had to have seen a bottomhole calculated absolute pressure of somewhere around 1500 to 1800 p.s.i. In other words, if we want to look at it a different way, it is something in excess of a 1.0-p.s.i.-per-foot gradient.

Q. (By Mr. Gallegos) 1.0 or more fracture --

A. -- p.s.i-per-foot-gradient --

Q. -- fracture --

A. -- maybe that's the better way to say it. No, bottomhole-treating-pressure gradient greater than about 1 p.s.i. per foot.

Q. Well, a fracture -- In other words, a fracture gradient that would lift the overburden?

A. No, sir, it has nothing to do with lifting the overburden at this point. It has to do with overcoming the energy of the compression of this rather squishy coal enough that you can press the coal down, that you actually create a fracture.

The problem you have is, the energy to create the fracture in that relatively high Poisson's ratio material is less than the extension pressure laterally into the sand.

And so unless you get a very long fracture or you do something like increase your viscosity, your rate, significantly and you get a much higher frictional pressure loss to overcome that 1-p.s.i.-per-foot boundary breaking pressure, you'll never break into the coal.

Q. We'll discuss that, but as I read this chart, if I read it correctly, it's showing a surface pressure from 1500 climbing up to 2500 --

A. Yes.

Q. -- p.s.i.

A. The surface pressure is not what we're worried about in the breaching. I mean, the surface pressure is going to be controlled by the size of the tubing and the roughness of the tubing. There's other factors. What we're really concerned about is the bottomhole treating pressure.

Q. And so you're saying when you have a surface pressure and you add to that the hydrostatic head of the fluids, that you're going to have a lesser pressure formation?

A. Well, you subtract the hydrostatic head and add the friction, and in this particular case the bottomhole treating pressure was lower than the surface treating pressure.

Q. Well, as -- you're reading the -- I don't know what color that is, kind of a red or violet, the line under the surface pressure line?

A. Yes, sir.

Q. I guess it's red. And that climbs up to something that you might read as being 2100 p.s.i.?

A. Yes, sir. We were in the process of screenout in this well. We were filling up the fracture.

Q. All right. And so that amount of pressure, 2100 p.s.i. at the formation, would not be sufficient to break into the coal?

A. Well, clearly in this case it did not, because had it broken into the coal we would have seen a sudden decline in pressure. In fact, you see that sometimes when you're fracturing wells: If you break across a barrier you'll be seeing some kind of a pressure increase; when you break across the zone you'll see a very rapid decrease in pressure.

And had we broken across this shale/coal barrier, we would have seen a very rapid drop in our pressure. And this is pretty clear that in this particular reservoir, that the breaking pressure of a boundary of a fracture initiated in a sand is going to be in excess of 1000 p.s.i. net.

Q. Now, I thought you already told us that these formations were in communication because back a couple years earlier Whiting's fracture treatments had frac'd down into the Pictured Cliffs?

A. Well, I didn't exactly say that. I think the question I answered was, based upon my analysis of the data, were the Whiting wells contained? And my answer was, based upon my analysis, no, they are not contained. I do not know if they grew up, down, both.

My belief in my study -- I have no data to support that, though -- is that the probability is that they grew both upwards and downwards, and they did grow into the Pictured Cliffs.

Q. Okay. So assuming that that was the case, then you already had formations that were in communication, and you wouldn't see anything by way of a break in the plot, because there was no breaking to do. The Pendragon treatment --

A. Well --

Q. -- was flowing on up into the coal formation because channels were already made?

A. Huh?

Q. When you said -- you said that Pendragon -- the Pictured Cliffs had been fractured by the fracture stimulations on the Whiting wells back in 1992, 1993, when they were completed.

A. Okay, at the location of the Whiting wells --

Q. Okay.

A. -- in the Whiting wells, which is some distance -
- it's either -- as close as 200 and as much as, I guess, 2000 feet from a Pendragon well -- when Whiting fractured the wells and they grew out of zone, and assuming they grew down into the Pictured Cliffs, there would have been hydraulic fracturing, probably proppant, in the Pictured Cliffs, and there would have been a connection between the Whiting wellbore and the Pictured Cliffs reservoir at that site, yes, sir.

Q. Okay, but it wouldn't have any effect over at the Pendragon wells? Is that what follows from what you're telling us?

A. I don't know that it would or wouldn't. I mean, you now have a connection between the two reservoirs, and if you have established a connection and a flow connection, yes, you could possibly have gas movement between the two reservoirs, yes.

Q. Okay. And if you already have a connection, then you don't have any barrier to break when you applied your fracture treatments in 1995?

A. That's totally incorrect, because the barrier is at the Pendragon well, and we're talking about the wellbore and within probably the first 50 or 100 feet away from the wellbore, we're talking about the ability of a fracture that is initiated in the Pendragon Pictured Cliffs well to breach the barrier into the coal from the perforations in the Pictured Cliffs.

Whatever happened at the Whiting wells, in this sense -- i.e., breaking a barrier, growing out of zone or whatever -- whatever happens at Whiting well probably -- and I say "probably" because you could -- if you wanted to get really wild and really bizarre, you could build a case where the two wells were right in line in the fracture, and not only did the fracture in the Whiting well breach the Pictured Cliffs well but actually intersected the wellbore of the Pendragon well. That would be a possibility, but it's tiny, tiny.

Excluding that, nothing that happened in the fracturing of the Whiting well in the Fruitland Coal would affect the fracturing at the Pendragon Pictured Cliffs well, in terms of breaching a barrier. Those are not connected at all.

Q. Okay, and nothing that happened at the Whiting well, if the fractures did go into the Pictured Cliffs, would affect production of gas from the Pictured Cliffs formation, because the formation -- the coal formation is a higher pressure and the perforations in the Whiting wells are open in that formation; isn't that right?

A. I don't know that I can answer that question. I haven't studied that.

Q. All right. Now, just finally, speaking of the coal as a barrier, with your extensive experience in coal formations, you are aware that it is believed that these formations have what is sort of commonly referred to as natural cleating, are you not?

A. Yes, sir.

Q. There is a permeability that exists within the coal by reason of sort of a matrix of breaks or cracks that exist in nature, in the --

A. Absolutely.

Q. -- deposition?

A. Absolutely.

Q. All right. So we are to understand that your view is that when the fluids from the fracture treatments on the Pendragon wells reached the coal, in spite of the existence of this natural permeability in the cleating, those fluids would not go up into the coal?

A. Well, actually, one of the explanations for the reason that coals are a very good fracture-growth barrier deals with cleating. There's -- Right now, there's three plausible explanations. One is the difference in the Poisson's ratios of the sands, shales and coals.

The other one is the higher permeability of the cleat system of the coals. When you encounter a coal with fracture fluid, you essentially encounter a reservoir with a significantly higher leakoff. Often it's two orders of magnitude higher leakoff.

And one of the laboratory-observed methods that cause the coals to be fracture barriers is, when the fracture tip encounters a coal, that's growing through a low leakoff sand or shale, encounters a high-permeability coal, the leakoff is so high that instead of building a fluid pressure in the coals enough to fracture it, the coals just let the thing leak off.

And when you look at the fracture growth, you have a relatively small treatment rate, the fracture widths are very small so you have higher fluid frictional losses at the tip of the fracture where the tip is encountering the coal. It's a very plausible explanation.

In fact, the GOHFER simulator, which is Marathon's simulator, now includes that ability to model in their simulator.

The other model, which Bob Barree is presenting at the fall meeting, is one of the differences in the Poisson's ratio. It has nothing to do with the permeability of the coal.

My personal professional opinion from the work I've done is that the reason coals are such good barriers is the combination of their high Poisson's ratio and the cleat system and the ability of that cleat system to take the fluid.

So it's a combination of both.

Q. So that thesis would lead one to the conclusion that you really can't fracture the coal when you're trying to apply, intentionally, a fracture stimulation to it, because your fracture fluids just leak off in this cleat matrix?

A. That's entirely wrong. If you perforate in the coal and if you're trying to fracture in coal and perforate in the coal, you've hopefully designed your fracture fluid that -- and your fracture-treating rate, sufficiently high that you'll overcome the leakoff. And that's the whole purpose of designing a fracture fluid.

Now, there's a large discrepancy of -- We'll say there's a large body of disagreement between the fracturing experts and how you go about figuring out what that leakoff rate is. But as I showed in the Raton Basin and other coals that I've fractured, you certainly do take into consideration the permeability of the cleat system or the fluid efficiency that you'd have in a reservoir with second permeability. When you design your fracture fluid you make damn sure that you get enough rate in there to overcome that.

Q. Okay. And on that note could we ask that you supply us -- I don't want to elongate the process here; I'd like to finish up. Could we ask that you supply us with the data concerning the fracture treatments on these Raton Basin wells that you used where you say the fracture stayed within the target zone? Could you give us that information so our people could have that?

MR. HALL: Well, Mr. Examiner, it's sort of a late request. I don't know that we're able to comply for this hearing, frankly.

MR. GALLEGOS: Well, we've never heard about this before. How can we make an earlier request until we've heard the well information and we have a witness who's now --

Q. (By Mr. Gallegos) You've got it right there?

A. On Exhibit B13 I have a -- It's a very basic presentation, just rate, treating volume and proppant concentration probably.

Q. Well, if we could have pressures, pressures and volumes.

MR. HALL: We'll see if we can get them. We can't promise. We will try.

Q. (By Mr. Gallegos) Well, do you have that available?

A. I have it in my office, but I'm going to certainly do the courtesy of checking with Evergreen, see if they have any reason that they wouldn't want that released.

MR. GALLEGOS: That completes my cross-examination.

EXAMINATION

BY MR. CHAVEZ:

Q. Mr. Blauer, on your phase-change graph you talked about an analogy of a pop bottle.

A. It's a poor analogy, but...

Q. All right, because there really isn't a phase change that goes on in there, isn't it? It's just dissolved carbon dioxide coming out of solution?

A. That is correct, but if you were sitting in a laboratory with an absolutely pure bottle of methane and you unscrewed it, as soon as the pressure in the bottle dropped you'd see the methane bubble, and it would be the same process.

That was a poor analogy in realty, but a very common analogy of what happens when you cross the phase envelope from a constant temperature.

Q. Okay, in example that you used of increasing BTU, it was mostly theoretical. Have you seen this happen in other pools that reach low pressures, where there's increasing BTU?

A. Yes, I have. I'm working in a reservoir in Australia right now where that's a major concern, because they're trying to figure out how to optimize the recovery of their heavier hydrocarbons, and the best way to do that is draw the pressure down. So it's beginning to look more like a coal gas reservoir by drilling more wells and getting the pressure down faster.

Q. Do the gas analyses from the Pendragon wells bear out what you've stated about increasing butanes, propanes and other heavier hydrocarbon gases?

A. Well, again, that's a very difficult analysis to do, because the BTU analysis is related to the pressure history and production history of the reservoir. What we see -- I think Mr. Nicol introduced in his testimony on the -- I'm sorry, Lucky Strike, what's the name of the well?

MR. NICOL: Designated Hitter 2.

THE WITNESS: Designated Hitter 2. The BTUs started high, reduced with time, stabilized, the well was fractured -- Designated Hitter, yes -- was fractured, and there was an increase in BTU after the well was fractured, indicating that you were connected to additional new reservoir that was above the gaseous -- the bubble point of the heavier hydrocarbons.

That whole issue is very difficult because you have a multi-phase reservoir -- You have a two-phase reservoir with a multi-component system, with very small quantities of the heavier hydrocarbons. It's very difficult to simulate. We've tried to do that and we can't.

Q. (By Mr. Chavez) But wouldn't the gas analyses bear out that you've got increasing propanes and butanes and got heavier hydrocarbon gases?

A. For a period of time, yes. Yes, you would expect that.

Q. Were there any measurements attempted of skin damage that might have been occurring in these wells, that you know of?

A. Not that I know of, no, sir.

Q. Wouldn't that have been important in trying to design the fracture job, to get beyond the skin?

A. If I were a scientist, absolutely. In this case I was an engineer/owner, and the cost of doing that kind of analysis was -- Again, it was like the radioactive tracing. It was almost cheaper to step up the line, do an acid cleanup and a frac job than it would have been to go out and do a lot of study to try to figure out the answers before we did it.

We're playing super poor boy here at this point.

Q. Do you agree with Mr. Nicol's characterization of a soft shale between the PC and the coal?

A. I would probably be uncomfortable with that, but "soft" and "brittle" are kind of nebulous words. It's kind of like his reaction to "massive". The shale, relative to a sand, is probably a little softer, it has a little higher Poisson's ratio and probably a lower Young's modulus, so you could call it softer. Certainly when you get it in the rock -- on the ground, and look at it and -- probably fissile, and beat it and it's brittle and everything.

But I don't know that I would characterize that shale as "soft", no.

That's a hard one. I mean --

Q. Well, isn't it -- When you talked about the change, or lithologic change, causing a fracture to stop growing, does it matter what type of change it is, if it's to a softer or harder rock?

A. Well, what we've found in stating a little more technically than "soft" or "hard" is that if we have initiated a fracture in a low-Poisson's-ratio rock and it encounters a higher-Poisson's-ratio rock, and if there is some permeability in that rock, that rock becomes a potential barrier to growth.

Q. What about the other direction?

A. If you initiate your fracture in the lower -- I'm sorry, the higher-Poisson's-ratio rock -- and in this case we're talking about a shale -- and if you do something to grow out of that zone, the tendency will be to very rapidly grow out of that zone.

If you look at the extremes, like the 300-foot-thick coals in Germany, it's very hard to fracture out of that with one fracture treatment. You can, but it's hard to get enough height to fracture out of it. So you stay contained within the coal.

But if you look at thinner coals, like I was looking at the Raton Basin, where you are able to achieve enough rate and viscosity to breach those coals, you get very rapid growth out of those through the sands until you get to the next lithology change.

And if that lithology change is appropriate for fracture growth, usually -- This almost sounds too simple. If you look at the gamma-ray log and you see a kick to the left, that's a strong, wide kick from the sand side to the shale side, that may be sufficient to cause a growth barrier.

Q. Okay, so in a sense you're saying it's easier to frac out of the coal than it is to frac out of the sandstone?

A. Absolutely, absolutely. It's almost automatic if you're in thin coal that you get a fracture out of it.

Q. Do your analyses of the Pendragon fracture treatments indicate any fracture growth into what Mr. Nicols indicated as the third bench or lower PC?

A. Well, there we're going to have some professional disagreement.

I see fracture barrier down underneath the -- above the third bench. But I think in most of the wells -- I'm looking here at the Chaco 4, for example -- I would be surprised if the fracture grew into the third bench because of the barriers above it. And the treatments that we used -- it wasn't a major part, because no one seems to care if we fractured into the water -- but at the time I was doing these fracture designs I was also concerned that we'd fracture into the water in the third bench, and it was an undesirable thing to do. So I chose low rates particularly to stay within what we're now calling the upper and second bench.

But I don't think many of -- Looking at the logs, I would say none of the Pendragon wells grew into that third bench.

Q. If there had been natural communication, say through natural fractures between the Fruitland Coal and the Pictured Cliffs, would you have been able to see that on your fracture treatments?

A. No, sir.

Q. If a fracture of the PC got into one of those connecting fractures, would you have been able to see it then?

A. Absolutely. In other words, if during the fracturing treatment we had encountered an *in situ* fracture, *in situ* fault, in the Pictured Cliffs, would we have seen that?

Q. Yes.

A. Absolutely.

Q. What would you have seen on your fracture treatment?

A. Well, probably the most notable thing we would have seen would be a very, very sudden drop in pressure, because when we encountered that fault, all of a sudden we encounter a feature with, one, a lot of permeability, and two, some amount of storage. If a fault is present, there's a storage there. And if we were to cross that during a treatment we'd see a huge drop in pressure.

It would look somewhat similar to breaching the coal, actually. I mean, if we breached the coal and got into the coal, we'd grow very rapidly through the coal to the next -- and the next sand, if there were one, to the next coal barrier. We would see the same thing if we did that.

There would be some subtle differences in the leakoff characteristics between encountering a fault and encountering a coal. You'd see a very rapid leakoff if we encountered a fault.

Q. You'd also see the same thing if you encountered a frac that had been induced, say, by a treatment of Whiting on the Fruitland Coal?

A. Absolutely.

Q. What's the likelihood of encountering a fracture that was produced by another well in a fracture in your well?

A. I think -- Well, tiny. The two wells would have had to have been on strike with the maximum principal stress, and -- It's unlikely. I mean, I've seen it happen sometimes.

But I think that if we had done that we would have heard from Whiting, because they would have frac fluid in their well, they might have had some very high pressures at their well, there might have been a shutdown. I don't know how their wellhead configuration is set up. But I think Whiting would have been aware that we had fractured into their well if we had done that.

Q. Do you have fracturing calculations for the Whiting and Maralex -- I'm sorry, the Whiting and Pendragon wells, that might indicate, say, in the worst possible scenario the fracs approached each other, how close they might be?

A. No, sir, I don't.

Q. Well, given the information you have now about pressures and lithology, would you change what the fracture treatment -- would you change what you have done if you were to design it now, knowing the information you have?

A. Not in terms of the fracture design, no. I would have probably done a little bit more instrumenting the fracture, collect a little bit more data. But in terms of rates, volumes, quantities of proppant, no, sir.

MR. CHAVEZ: Thank you. That's all I have.

EXAMINATION

BY EXAMINER CATANACH:

Q. Okay. Let me go over -- I wanted to make sure I understand how that -- the plots that you prepared on the Maralex and Whiting wells, how exactly those were prepared.

A. Well, I didn't prepare them. Are you talking about Figures B11?

Q. Yes.

A. Okay. I actually did not prepare these. These were sheets taken from the fracture-treating reports of the service companies that did the job.

What these plots are is, the service company calculated the bottomhole pressure. They also had, either supplied to them or possibly determined by a mini-frac or experience in the area, an estimate of the closure pressure.

Q. Now, the closure pressure is the pressure it takes to initiate the fracture; is that correct?

A. Well, yes and no. But actually, the closure pressure is measured by creating a fracture and then letting it close and determining the first point of contact. If the world were perfect and that's how fractures worked, that's the closure pressure.

And so for -- Now we'll leave it that that's what it is. What that, though, is, says that that pressure -- you have to pump a pressure higher than that to get the pressure to part, the first parting pressure. Any pressure above that will cause additional parting, length growth, provide a place to pump your proppant.

So they calculate the closure pressure and they calculate -- or they determine the closure pressure somehow. They then calculate the bottomhole pressure from the surface pressures of the treatment. And this pressure on the Y axis is bottomhole treating pressure minus closure pressure. So it's essentially trying to represent the frictional pressure loss, plus the stress-induced pressure at the fracture.

And then the X axis is logarithm of time. And this first plot, which is the first one on the first page, they didn't quite get the time axis right, but it doesn't affect the analysis of the data.

Q. Okay, you're looking at the Well Number 2?

A. The Gallegos Federal Number 2, yes, sir.

Q. Okay.

A. Now, the fact that there's two plots on this, or two figures -- And you look in a number of these diagrams, there's multiple plots. Often, if you look in the upper left-hand corner it says, "Calculated net pressure -- " I'm sorry, right in the center of the heading. S1, calculated net pressure, is 200 p.s.i. And the second one is calculated net pressure is minus 1300 p.s.i. I guess there's three of them on there, there's one for 800.

They either weren't sure or they wanted to look at a statistical sampling of closure stresses, so they plotted three different closure stresses to see how that would affect the Nolte plot. So they have an 800, a 200 and a 1200 closure-pressure curve on here.

For some reason, I can't see one of them, so I don't know what happened to it, unless it disappeared when we copied it.

Q. Okay. So the initial pressure is actually when the treatment began.

A. The initial pressure --

Q. Or --

A. This pressure which starts up here, that's probably when the treatment began, yes, sir.

Q. Okay.

A. That's when they started pumping.

Q. Typically, what length of time are we looking at in these graphs?

A. Well, for the Maralex wells -- And let me just look through here. Well, probably look at it faster this way; these are all together.

It looks like about 70 minutes, 40 minutes, 20 minutes, 30 minutes, less than five minutes, 20 minutes, and about four minutes.

Q. And that's from start to end --

A. Yes, sir.

Q. -- through the whole treatment?

A. Yes, sir.

Q. So when you -- once you plot those graphs, you determine the slope of that line just by visual inspection?

A. Yes, sir.

Q. Okay. And you compare it to the -- I'm sorry, what was that graph? It's under Exhibit 9; is that right?

A. B9, yes, sir.

Q. Okay. You just compare it to that in a qualitative sense, and that tells you in effect what that fracture did?

A. Essentially, yes. It's that simple.

It's also one of the reasons all of the service companies calculate these and supply them, because it's useful information and it's easy to calculate.

Q. Okay. You've shown a negative slope on all of the Maralex wells?

A. Well, on this -- Well, in the early times, yes. They show positive slopes later, which is when they were screening out.

On the Gallegos Federal 26-12 31 Number 1, which is this last well, I'm not sure what happened here. They only pumped for, it looks like, 12 or 13 minutes, and they had a pressure-out or screenout. I don't know what happened. They shut down, they tried again, and they got a high pressure.

That one -- It is indeed a negative slope, but it's very close to zero. They could have been pumping at too low a rate and they didn't have enough viscosity rate. I don't know what happened on that one.

That one, you could build a case that it's not negative. But the rest of them all have negative slopes of the right amount, or of -- enough negative slope to indicate out-of-zone growth, unrestrained high growth.

Q. Okay, the chart you're looking at for a negative-slope-type line says "unstable height growth". How do you know that that's out of zone?

A. The unstable height growth means that the fracture is growing vertically --

Q. Right.

A. -- instead of laterally. And if you pump on a reservoir for 15, 20, 30 minutes at a high rate, you put a lot of volume in. Even if you -- I mean, we can do simulations and do all this.

But if you assume that the fracture width is, let's say, as much as an inch, which is a very wide created fracture width, and pick a volume that's reasonable, 150, 200 foot, and you start calculating what heights you need to handle that volume of fluid, assuming that the height is growing, you can get 200- and 300-foot fracture heights.

In fact, the Fracture Pro models and the work that was done at the GRI multi-well site, a lot of the fracture models around now typically say that fractures are going to have 400, 500, 600 foot of height growth. And I've seen designs where people try to grow those kinds of fractures. That is a material balance. You're creating a volume by your fracture, by the amount of fluid and proppant you're putting in there, and you have to honor that.

If you assume out-of-zone growth and the rate and the volume that Maralex/Whiting treated, which was on that other exhibit -- they put fairly large volumes in some of these wells -- you have to be able to do something with that volume. If you've got unrestricted height growth, which means you have a limit to your length growth, you're going to create big fracture heights, and that's why I say it's out of zone.

I'm trying not making this a battle of simulators. If we did that, we could come up with all sorts of weird stuff.

Q. Do you feel like they got any horizontal frac in these wells?

A. They probably did. Again, just an experience call. They're probably looking at 50 or 100 feet. They got some horizontal fracture growth, sure.

Q. But at some point during the treatment it just -- it was preferentially vertical?

A. It is more vertical than lateral. The vertical fracture growths can get all sorts of weird kinds of geometry. But -- You have to have some lateral growth as well as vertical growth, but if you're getting vertical growth, your effective hydraulic diameter of your fracture is growing. That's why you have the negative slopes.

Q. And from this data you can't quantify the lengths of those vertical fractures?

A. Well, if I wanted to get into all sorts of very controversial simulation, I'd put my estimate forward, and there's probably five fracture experts in here that, if they were locked in closets where they couldn't talk to each other you'd have five different estimates. We could certainly do that.

I think the importance here is, if we compare the Pendragon and the Maralex wells we see two very different looks to the fractures, which indicates two very different fractures and two very different fracture growth patterns. I think that's the significance here, without getting into quantifying how high and how far.

Q. You can't definitively say from this evidence that Maralex frac'd into the Pictured Cliffs zone?

A. Not with just this evidence, no sir. That is correct, I cannot do that with this evidence.

Q. Okay. Do you have any additional evidence that might help you in that regard?

A. I think with the last package of information that was delivered, it might be possible for me to sit down and do simulations.

But if you read between the lines, I'm not a believer of simulations, and I'm not sure that the simulators that we have, including my favorite simulator, are solid enough to give us a good handle on what actually happens underground.

I would feel a lot more comfortable if we instrumented some wells with some bottomhole pressures and went out and fractured wells, put temperature logs, radioactive tracers and went about this thing the proper way.

Q. Can you, in fact, do that after the fact?

A. No, sir.

Q. You can't?

A. That has to be done while you're fracturing.

And if my Buddy Chris Wright is right and Paul Branagan is right -- and there is a service now where you could do the microseismic study that GRI did, you can call Branagan and Associates and install the geophone. That's probably actually the better way to do it, but that has to be done while you're fracturing.

Q. Now, I guess you've also stated that you believe that the Chaco wells were nor frac'd out of zone?

A. Yes, sir.

Q. And that, again, is based upon these logs that you have and these diagrams?

A. In 1995 and 1994 when we got this data and I saw what the Nolte plots were, I was done. I had made a contained fracture that hadn't breached the coals, probably hadn't breached some barrier down below somewhere. I was content that we had achieved our goal of a contained fracture.

In reflection, for preparation for this, there's other pieces of data that give me even more confidence in that.

Q. Okay, you have no other evidence to indicate that you -- to support this?

A. No, sir.

Q. Okay.

A. No hard -- No tracer surveys, temperature surveys, nothing like that.

Q. In going about designing your frac treatments for these wells, did you rely on -- was it your prior experience in the Raton Basin?

A. Not just the Raton Basin. I've been doing contained fracture probably for about ten years all over the world and had very strong -- Well, I have a large database but also a very strong experience level with this.

And I had a pretty -- Because of the Raton Basin and some work that we were doing, we were very early on in our studies of Raton Basin, and also some work we've done in the Rosa Unit in the San Juan Basin -- for Evergreen, incidentally -- we had a pretty strong body of knowledge of what kind of pressures, we had depths and reservoir types. We were in pretty good shape in terms of data, even though we didn't have the hard data on these wells.

We're using analogy reservoirs, yes, sir.

Q. Okay. Can you again go over the major differences between the Whiting frac treatments and your frac treatments, in terms of -- Is that significant in terms of rates, volumes, that type of thing?

A. Yes, sir. Assuming that -- I won't get into the issue of the gel or the non-gel, because with foams, when you make a foam the viscosity of the base fluid isn't as important as it is in a non-foam treatment. So we'll assume that the viscosities of both fluids were essentially the same. That's not true, but we'll assume it, because they're not -- It's not that big of a difference.

When you look at all the fracture mathematics, you find that the pressure -- we're talking now about the net treating pressure, the change in the treating pressure -- is always a function of viscosity and rate. There's other things there also. But it's always proportional in some fashion to viscosity and rate.

So if you increase either your viscosity or your rate, you're going to increase your net treating pressure. And the higher you increase your net treating pressure, the more likely you are to break across zones, across barriers. And if you treat at very high rates, you can probably breach about anything. I think that's what they found at the GRI M-site, or at least that's what they thought; it didn't quite work that way.

But the key for the Whiting/Maralex wells is that they treated these wells at 40 to 45 -- I'm sorry, 40 to 60 barrels per minute from the data we have, very high rates -- compared to our 20 to 30 barrels a minute, and actually it was probably 20 to 25 barrels a minute.

The volume of the treatment is significant, because as I was saying before, you have a material-balance question. If you break out of zone and you've fixed the length of your fracture and you're getting height growth, the more volume you pump, the more height you're going to get.

Now, when I look at the Whiting/Maralex wells, on three of the wells they screened out and they pumped the last 15 minutes of their job in a screenout. That's where the pressures were going up very sharply. At that point their height growth had probably been arrested and they were just filling their fracture. That would be my interpretation of the data.

But the fact they were treating with large volumes, large pads, I mean, they had a lot of height growth before they started putting proppant in here and possibly arresting their height growth.

And so the Pendragon wells were designed with low rates.

We won't talk about viscosity right now, because that would be a whole day of trying to figure out what the viscosity of foam in a fracture is. But low rates and low volumes specifically to not risk breaching the coal.

Q. Is it possible for you to estimate what the half-length of your fractures were?

A. I could do that.

Q. Have you done that?

A. No. Again, we're back into the question of the battle of the simulators, and that's ugly stuff.

EXAMINER CATANACH: Okay, I think that's all I have of this witness.

Mr. Hall?

MR. HALL: A quick clean-up.

FURTHER EXAMINATION

BY MR. HALL:

Q. Mr. Blauer, refer back to Exhibits 39 and 40 Mr. Gallegos handed you, which include the BJ Services post-frac treatment summaries on the Chaco 4 and Chaco 5, I believe --

A. Yes, sir.

Q. -- the point was made that these are labeled as treatment summaries for Fruitland Coal formation.

A. Yes, sir.

Q. Just so the record is absolutely clear on this, do these frac-treatment summaries identify the perforated intervals?

A. I believe they do, but let me check.

I'm looking at Exhibit Number 39, the tab "Post-

Frac Treatment Study", and it looks like it's about page -- It's the page that says "Well Data". It's about the fourth page back, looks like this.

Q. Does the perforation correspond to perforations -- Pictured Cliffs formation reflected on the well logs?

A. Let's see, you have a number --

Q. A-A' cross-section.

A. Well, let's see. The table says "Perforated Interval: 1,163' - 1,189'".

The gross interval is correctly identified. This table does not indicate -- There's actually two perforated intervals with a little break between them, but the top and bottom perforation are identified on the log correctly in this table.

Q. Is it correct to conclude that the post-frac treatment summary exhibits you were shown by Mr. Gallegos are simply mislabeled?

A. Yes, sir.

MR. HALL: Nothing further.

EXAMINER CATANACH: Mr. Chavez?

FURTHER EXAMINATION

BY MR. CHAVEZ:

Q. A couple of things, Mr. Blauer. Did the bottomhole treating pressures that were used on the Pendragon wells, the bottomhole treating pressures and the rates -- were those relative to pressures and rates that are needed to fracture the Pictured Cliffs in this area?

A. Obviously they were, yes. We had some offset data, other wells, other frac jobs. I think, as Mr. Nicol said, there were a number of Pictured Cliffs wells, and we had a limited amount of that data to discuss. The service companies had that. We had a pretty good idea what our fracture pressures would be, yes, sir.

Q. Were they sufficient to fracture the -- Were those rates and pressures sufficient to fracture the Fruitland Coal?

A. If you had perforated the coal -- if you put your perforations in the coal, yes, sir.

Q. In order for a fracture of the Pictured Cliffs to go into the coal, it would have to cross this shale sequence below the coal; isn't that right?

A. If there was a shale sequence there, yes, sir.

Q. Would that be reflected on your plots in some way?

A. As thin as that interval is -- I recall Mr. Nicol's testimony is, it was between zero and four foot thick. You might not see it in the pressure-treating responses. It's possible. There are some people who will look at a net treating response, the pressure, and try to follow the growth across every gamma-ray kick. I haven't done that, I don't know if it's possible. You might be able to, but I haven't done that.

MR. CHAVEZ: Okay, thank you.

THE WITNESS: Uh-huh.

EXAMINER CATANACH: Anything further?

MR. GALLEGOS: I've got to ask a question too now.

FURTHER EXAMINATION

BY MR. GALLEGOS:

Q. I want to read to you, Mr. Blauer, from the July 6th, 1988, Examiner Hearing in Case 9420 and 9421. Those are the cases involving the creation of the Fruitland Coal formation Pool. And Mr. Chavez, Frank Chavez, was testifying at page 104 [*sic*] as follows. I quote:

> A problem that's developed in developing the coal resources is that due to the nature of the shales that separate the coals and the sandstone, it is not uncommon for a hydraulic fracture initiated in the Fruitland Sand or the Pictured Cliffs sandstone, to break through the shale into a coal.

Are you aware of that?

A. I wasn't aware of that statement, no, sir.

Q. Okay. Were you aware of that being a fact that -- experienced by --

A. I don't think that --

Q. -- those who --

A. I don't think that's a fact. My data would say that that's uncommon.

MR. GALLEGOS: Okay. That's all.

EXAMINER CATANACH: Okay, anything further of this witness?

MR. HALL: Not from this witness. I can do one more by six, by ten till six.

EXAMINER CATANACH: Who do you have in mind, Mr. Hall?

MR. HALL: Paul Thompson. I have a very brief direct of him.

MR. CONDON: Well, we're not necessarily going to be brief on cross.

EXAMINER CATANACH: Yeah, that's the problem. Why don't -- I think it would be a good place to stop.

MR. GALLEGOS: Before we close the record for today, we have identified and referenced our Exhibits 9, 37, 39 and 40, and I'd like to move their admission?

MR. HALL: You know, I am going to object. They weren't authenticated through any of the witnesses we've presented today. I'm sure Mr. Gallegos can authenticate them among his own witness.

EXAMINER CATANACH: Will you have somebody to testify to these, Mr. Gallegos?

MR. GALLEGOS: Well, 37, 39 and 40 are documents, the well costs, produced to us by Mr. Hall's clients. So are you saying they're not authentic?

MR. HALL: To tell you the truth, I cannot respond to that. I haven't had a chance to even look at them, so I don't know.

MR. CARROLL: Why don't you look at them right after we adjourn here, and then tomorrow morning we'll move them into the record?

MR. HALL: Okay.

MR. GALLEGOS: And is there an objection to 9, which is simply the map and the conveyancing documents by which the parties obtained their ownership?

MR. HALL: I don't object to that now.

EXAMINER CATANACH: Okay, Exhibit Number 9 will be admitted as evidence.

MR. GALLEGOS: Okay.

EXAMINER CATANACH: And with that, we'll adjourn until tomorrow morning at 8:15.

(Thereupon, evening recess was taken at 5:47 p.m.)

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. ____, heard by me on ____ 19__.

____, Examiner
Oil Conservation Division

CERTIFICATE OF REPORTER

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

I, Steven T. Brenner, Certified Court Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Division was reported by me; that I transcribed my notes; and that the foregoing is a true and accurate record of the proceedings.

I FURTHER CERTIFY that I am not a relative or employee of any of the parties or attorneys involved in this matter and that I have no personal interest in the final disposition of this matter.

WITNESS MY HAND AND SEAL August 10th, 1998.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 1998