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 III

EXAMINER HEARING

BEFORE: DAVID R. CATANACH, Hearing Examiner

July 30th, 1998

Santa Fe, New Mexico

This matter came on for hearing before the New Mexico Oil Conservation Division, DAVID R. CATANACH, Hearing Examiner, on Thursday, July 30th, 1998 (Vol. III), 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 30th, 1998 (Volume III)
Examiner Hearing
CASE NO. 11,996

(Continued...)

APPLICANT'S REBUTTAL WITNESSES:

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E X H I B I T S

(Cumulative index, Volumes I, II and III)

(Continued...)

E X H I B I T S (Continued)

(Cumulative index, Volumes I, II and III)

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E X H I B I T S (Continued)

(Cumulative index, Volumes I, II and III)

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E X H I B I T S (Continued)

(Cumulative index, Volumes I, II and III)

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E X H I B I T S (Continued)

(Cumulative index, Volumes I, II and III)

(Continued...)

E X H I B I T S (Continued)

(Cumulative index, Volumes I, II and III)

APPEARANCES

FOR THE DIVISION:

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FOR WHITING PETROLEUM, INC.,
and MARALEX RESOURCES, INC.:

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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 8:05 a.m.:

EXAMINER CATANACH: Okay, at this time we'll reconvene the hearing in this case, and I'll turn it over to Mr. Gallegos.

MR. CONDON: Okay, Mr. Catanach, I'm going to examine Mr. O'Hare.

A preliminary matter I'd like to just raise.

We, on our exhibit list -- And Scott, let me know if we have not provided you with copies.

Exhibits 1 through 7, I think we've given you all copies.

1 through 4 are Orders R-8768, 8768-A, 8769, 8769-A.

Exhibit 5 is a copy of the preliminary injunction that was entered in the court proceeding.

Exhibit 6 is the presentation and exhibits for the San Juan Basin coalbed methane spacing study that was admitted in Case Number 9420.

And Exhibit 7 is the hearing transcript and Exhibit 1 to Case 9420 and 9421. That's the hearing transcript from July 6th, I believe, 1988, and the Exhibit 1 to that hearing.

MR. HALL: Do you have extra copies?

MR. CONDON: I sure do. Yeah, I've got extra copies of all of them.

MR. HALL: I don't think I've got a set of the exhibits to 9420.

(Off the record)

MR. CONDON: So I'd like to move -- Right now, it might help speed things up through my presentation through Mr. O'Hare, if we could ask that those be admitted.

EXAMINER CATANACH: Okay, the numbers, again, Mr. Condon?

MR. CONDON: It's 1 through 7, Mr. Catanach. I'll read for the record again.

Exhibit 1 is Order R-8768.

Exhibit 2 is Order 8768-A.

3 is Order R-8769.

4 is Order R-8769-A.

Exhibit 5 is the preliminary injunction order that was issued in the court proceeding.

6 is the presentation and exhibits for the spacing study, and that was the reopened 9420, which was a February, 1991, hearing.

MR. CARROLL: Is that this?

MR. CONDON: No, that is the -- those are the exhibits that are part of the hearing transcript from the 1988. So these are --

MR. CARROLL: -- part of a set.

MR. CONDON: Yeah, part of a set that were rubber-banded together.

5 -- Or 6 is right there.

EXAMINER CATANACH: Okay, Exhibits -- Any objection to the admission of those exhibits?

MR. HALL: It's -- Clarify for what purpose they are being tendered.

You know, the order that issues from this case is supposed to be based on the record and evidence presented in this case.

I assume that the Exhibits 5, 6 and 7 are being tendered for the purpose to have you take administrative notice of them, simply.

They're not going to be tendered as evidence, *per se*; is that correct?

MR. CONDON: Well, 1 through 7, I'm asking that you take administrative notice of your orders and the hearing transcript and the exhibits that have been entered in prior administrative proceedings.

I think you're entitled -- You know, there was testimony that was given under oath in those proceedings, exhibits that were accepted in the prior proceedings that went into the establishment of the pools and recognition of the stratigraphic locations and the vertical boundaries of the formations that are at issue in this proceeding right here.

And so I think it's sworn testimony, it's exhibits that have been admitted and it's information and evidence that you can take into consideration in your ultimate ruling in this case.

MR. CARROLL: As well as the preliminary injunction?

MR. CONDON: Correct.

MR. HALL: The rules and statutes on taking notice provide that an adjudicatory body may take notice of fact.

And the problem is, in the transcript of the hearings, for example, there is evidence, there's countervailing evidence, there's argument of counsel, there's opposing materials presented that may or may not constitute fact.

So given that understanding, I think you can accord it the weight it deserves.

But to the extent that it is not fact you may not take notice of it, so --

MR. CARROLL: I think we understand that, Mr. Hall.

EXAMINER CATANACH: Okay. With that noted, I will admit Exhibits 1 through 7.

ALEXIS MICHAEL "MICKEY" O'HARE,

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

DIRECT EXAMINATION

BY MR. CONDON:

Q. Would you state your name for the record, please?
A. Yes, my full name is Alexis Michael O'Hare.
Q. And do you go by Mickey?
A. Yes, I do.
Q. All right. Mr. O'Hare, would you please give us a brief rundown on your educational and work experience background?
A. I received a bachelor of science degree in petroleum engineering from New Mexico Institute of Mining and Technology.
I went to work for Amoco full-time in 1981, in their Farmington District Office, where I became involved with their coalbed methane exploration and development program in both the San Juan Basin and also the Piceance and Raton Basins.
Q. When was that?
A. 1981.
Q. Okay.
A. I spent four years in the Farmington district office before I was transferred to the Denver office and

came to their reservoir engineering group. I've worked with the reservoir engineer, did the initial modeling on coalbed methane production in the Cedar Hill field.

From there I went to National Co-op Refinery Association as their district engineer for the Four Corners area and as their operations supervisor for the rest of the company. We developed the Fruitland formation on two large leases in Colorado.

And in 1990 I left NCRA to start Maralex Resources and have been the president of that company since that date.

Q. Okay. And Maralex is one of the parties in this proceeding?

A. Yes, it is.

Q. Is Maralex making contentions in connection with this proceeding that the Pictured Cliff wells operated by Pendragon are producing coal-seam gas?

A. Yes, it is.

Q. How many coal wells have you drilled?

A. I personally have been involved in the drilling and completion, recompletion or restimulation of literally hundreds of coal wells, possibly approaching 1000.

Q. And where have those coal wells been located?

A. They've been located in the San Juan, Piceance, Raton Basins, some in Alabama, the Black Warrior Basin, some as far away as Zimbabwe, Africa.

Q. Is there a particular tax issue that owners and operators of coal wells have with the development and production of coal-seam gas?

A. Coalbed methane wells that were drilled prior to the end of 1992 qualify for a Section 29 tax credit that continues with production through the end of the year 2002.

Q. And does coal gas that is produced out of a Pictured Cliff well qualify for the tax credits?

A. No, it does not.

Q. Would you just briefly discuss the difference between a typical Fruitland Coal well production profile and a typical conventional sandstone formation well production profile?

A. Generally speaking, a Fruitland, or any kind of coal well, will start producing with very low volumes of gas and very high volumes of water. As the water declines fairly steeply, the gas will begin an incline that will eventually peak and then start a decline to the end of the life of the well.

In a typical conventional sand, production will start off at its highest point immediately upon completion of the well. It will decline from that point until it reaches its economic limit and is abandoned.

Q. Okay. Has the analysis of coal wells in general progressed to the point where there's an industry standard where you're certain at any given point in time where you are on the incline or decline curve in coal-well production?

A. No, you cannot be certain. You can certainly make estimates as to where you are in the life of the well, just as you can with a conventional well. The closer you get to the end of the life of any type of well, the more accurate you can be as to where you are in the life of that well.

Q. Okay. Were you involved at all with the coalbed methane committee that was formed in the 1980s?

A. Yes, I was.

Q. What was your involvement there?

A. I was a member of that committee from late 1987 until I left NCRA in 1990.

Q. And what did your work with the coalbed methane committee consist of?

A. I was part of the spacing subcommittee, and we also had another member that was part of the -- another one of the subcommittees, and we sometimes alternated positions on those subcommittees, just to make sure we were up to date on the issues being discussed.

We also contributed to the full committee and had a voting voice on both subcommittees and the full committees.

Q. Okay. Did that committee have any involvement in the presentation of evidence in Case Number 9420, which I believe led to the issuance of Order R-8768?

A. Yes, it did.

Q. Okay. What involvement did the committee have in that?

A. The committee actually -- One of the subcommittees was a rules-writing committee, and it recommended the rules that were presented to the Division and most of which were adopted during that hearing.

Q. Okay. Are those the rules that are incorporated in Order R-8768?

A. Yes, they are.

Q. Okay. Do those rules include rules that identify specific factors that operators are to look at in order to determine whether they are producing from the appropriate common source of supply?

A. Yes, and they're not just rules for operators to look at but for the regulatory agencies to utilize in their assessment as to whether or not a coalbed methane well, or any well, is producing from the Fruitland Coal beds.

Q. Okay. Do you remember off the top of your head what those factors are?

A. I can't name all of them off the top of my head, but I can refer to an exhibit -- I believe that's Exhibit 7, that lists those on page 2 of the order.

Q. What are they?

A. Electric log data, drilling time, drill cutting or log cores, mud logs, completion data, gas analyses, water analysis, reservoir performance, other evidence that indicates the production is predominantly coalbed methane.

Q. Did the committee also have any involvement in presenting evidence in the 1988 proceeding on the pick of the boundary between the Fruitland formation and the Pictured Cliffs formation?

A. Yes, it did.

Q. All right. Were you involved in that at all?

A. As a voting member of the full committee, yes.

Q. Okay. Was there a specific well that was identified by the committee as a recommended type log for this formation?

A. Yes, the full committee decided to adopt the Schneider Gas Com B Number 1 well log as the type log for the Fruitland Coal Pool and recommended that to the Division as a type log that could be referred to in situations where there is uncertainty as to what coals constitute the Fruitland Coal pool.

Q. And where was that well located?

A. It's in the Cedar Hill area.

Q. Okay, and who operated that well?
A. Amoco Production.
Q. Do you recall whether there was testimony presented in the 1988 hearing on how to establish the pick or the boundary between the Fruitland formation and the Pictured Cliffs formation in this area?
A. Yes, there was.
Q. Have you relied on that testimony in connection with investigations and analyses that you've done in this proceeding?
A. Yes, I have.
Q. Would you please, for the Examiner -- And do you mind if I approach the witness?
I'd like for you to just take a moment, and you could use either this map that's up there, or we also have the map that is the first page here of Exhibit 9 that's been admitted, and just orient the Examiner on the project that you began in 26 North, 12 and 13 West of San Juan County.
A. This is a small portion of the project that we started in late 1991 and on into 1992. We actually drilled a total of 17 wells in what we refer to as the Gallegos Federal Project.
The first well that was drilled in that project is the Gallegos Federal 26-13-1 Number 2, located in the

southwest quarter of Section 1, Township 26 North, Range 13 West.

We also drilled wells --

Q. I'm sorry, Mr. O'Hare, if I could, what I'd like to do is, just so the Examiner has some point of reference for later on, as you're reading that if you would also give us an indication of the dates that those wells were drilled.

Just map this out. So the first well was what?

A. The 26-13 1 Number 2.

MR. GALLEGOS: Those don't show, Michael, here.

Q. (By Mr. Condon) Okay -- Okay, good. All right, so we've got the 26-13-1 Number 2, and that was drilled when?

A. In 1992.

Q. Okay. Next?

A. I believe the next well that we drilled was the 26-13-31 Number 1 -- I'm sorry, 26-12-31 Number 1.

Q. 12-31 Number 1?

A. Right.

Q. Okay.

A. And then we began a very aggressive drilling -- That was also in 1992. In fact, all of these wells were drilled prior to the end of the tax-credit period in 1992.

Q. All right.

A. At one point we had as many as five rigs running in this area and were spudding wells right up to the last day of the year to try to qualify for the tax credit for 1992.

Q. All right.

A. So the order of the rest of them is going to be a little jumbled.

Q. Okay. Well, just list them out. Is it safe to put 1992 --

A. Yes.

Q. -- as the completion --

A. Not the completion, the spud --

Q. -- or the spud date, it's the spud date for each of them? Okay.

Okay, next?

A. The 26-13-11 Number 1.

26-13-12 Number 1.

26-13-10 Number 1.

26-13-10 Number 2.

26-13-9 Number 1.

26-12-6 Number 2.

26-12-19 Number 1.

Q. 12-19 Number 1?

A. Right.

26-12-7 Number 1.

The 26-13-3 Number 2.

26-11-17 Number 1.

Q. Am I going to run out of room here?

A. I think there's one more.

Q. All right, 26- -- What was that one?

A. -- -11-17 Number 1.

Q. Okay.

A. And then 26-11-17 Number 2.

And I told you wrong, there's three more after that.

Q. Okay, let me ask you this: What are the wells that are in the immediate vicinity of the Chaco wells that are at issue in Pendragon's Application that we're dealing with and that we're most -- you're most concerned with, in terms of the development of the Chaco wells?

A. The 26-13-1 Number 1. You don't have it up there.

Q. I don't have that up there? All right. Well, let's -- Let's try this again.

26-13-1 Number 1. Okay.

A. 26-13-1 Number 2.

Q. Okay.

A. 26-13-12 Number 1.

Q. Okay.

A. 26-12-6 Number 2.

26-12-7 Number 1.

Q. 26-12- -- ?

A. -- -7 Number 1.

Q. Okay. And they were all spud in 1992?

A. Correct.

Q. Is that right?

A. Yes.

Q. Okay. And can you give us an idea of when they were completed?

A. They were all completed in 1993.

Q. Is there a month that we can put as kind of the end date of the completion process?

A. I'd say November of 1993 was the last one.

Q. Okay, 1993.

All right. Now, let me just back up for a minute. When did you pick up these interests?

A. We had been negotiating these interests in late 1991 and closed on them in mid- to late 1992.

Q. All right. And did you begin the spudding process as soon as you closed that deal?

A. As soon as we raised the funding to get the wells drilled, yes.

Q. All right. Let me just ask you, we've previously had admitted in this case Exhibit 9, which is a number of the assignments that affect the acreage that's at issue in this case. This is a display exhibit. I'll be happy to introduce it if Mr. Hall would like.

But I would just like you to look at the language here on the left side of this exhibit. Is that language the -- consistent throughout the assignments that you received in these conveyances?

A. Yes, it is.

Q. "From the surface to the base of the Fruitland (Coal-Gas) formation"?

A. Right.

Q. All right. And who did you purchase these interests from?

A. From Merrion and Bayless.

Q. At any point during this period, were the Pictured Cliff rights in the Chaco wells that are at issue in Pendragon's Application offered to you?

A. The Pictured Cliffs wellbores were offered to us subsequent to the completion of the Fruitland wells, yes.

Q. It would have been late 1993 or 1994?

A. Correct.

Q. All right. Did you analyze the possibility of taking assignments in those wellbores?

A. Yes, I did.

Q. What did you do?

A. I did a decline-curve analysis of the Pictured

Cliffs production on those wells and a very simplified gas-in-place volumetric determination.

Q. What did you determine, based on your analysis?

A. That the wells were at or below their economic limit, and that there was a very low chance of additional recovery from the Pictured Cliffs formation.

Q. Okay, you're talking about the PC wells?

A. Right.

Q. All right. Let me just, for a point of reference -- this is -- I believe it's Exhibit 16. That will be introduced through Mr. Ayers. It was admitted in the District Court proceeding. It's a cross-section. I'd just like to ask the witness a question using this as an example.

There was some discussion during Pendragon's case in chief of a lower Pictured Cliffs formation. Did you look at that formation in terms of your analysis of the economic potential of these leases, using the PC wellbores?

MR. HALL: Mr. Examiner, I will object. I think that mischaracterizes prior testimony to the extent it sounds like we said it was a separate formation. That was not the testimony.

Q. (By Mr. Condon) Okay, all right. All right, I'll stand corrected. I didn't mean to imply anything by that.

There's, as I understand the testimony, a couple of benches or different portions of the Pictured Cliffs massive sandstone, and the lower portion, as I understand, is an issue that's been used by some of Pendragon's witnesses in this case in order to calculate the reserves attributable to the Pictured Cliff formation in this area.

And my question is, Did you look at that portion of the Pictured Cliff formation in doing your economic calculation?

A. I can't say that I did. We looked at logs, and I did not see that there was any potential pay below the perforated interval in those wells, and so I didn't do any kind of reserve analysis on the lower portion of that Pictured Cliffs zone.

Q. All right. So as of -- What are we at? 19- -- Late 1993, early 1994, had you begun to operate these five wells full-time?

A. Yes, we had.

Q. All right. Was there a problem with any of those wells of putting them on production after you completed them?

A. Well, the initial problem was that they were making very large amounts of water and absolutely no gas.

At that time we had some partners who were very nervous about coalbed methane. They didn't really understand the dewatering process. We were sending them bills for purchasing propane to run pumping units, and we had them -- to the point that they wanted to even back out of the project.

Q. All right. Is that what's been described earlier as a dewatering process in coal wells?

A. Yes, that's the initiation of the dewatering process.

Q. All right. And at that point, is -- in the dewatering process, would you characterize these coal wells as having been on an incline curve or a decline curve?

A. At that point they were on neither. They were not making any gas at all. We were strictly pulling water out of the wells in very large quantities. Some of those wells, we went two or three months of producing nothing but water.

And then we finally started to see enough gas to run our pumping unit and were able to get rid of our propane bottles and eventually start selling gas from those wells.

Q. Okay. At about what point in time did that occur? I mean, what I'd like to get for the Examiner's reference is a couple of points in time in the 1993-1994 period, prior to the work that Pendragon did on the Chaco wells, so that they have a point in reference of what was going on with your wells as of that point in time.

A. My records show that in December of 1993 we started selling gas from the 1 Number 1 well.

The 1 Number 2 well started selling gas as early as July of 1993.

The 12 Number 1 well started selling gas in January of 1994.

The 6 Number 2 well started selling gas in December of 1993 --

Q. All right.

A. -- as did the 7-1 well.

Q. Okay, so three of the wells began selling gas in December of 1993, there was one that began in July of 1993, and one that didn't begin selling gas until January of 1994?

A. That's correct, for this area.

Q. For this area. And that's what I'd like to focus on here, in terms of the testimony.

All right. Since there's been some testimony during Pendragon's case-in-chief, I'd like for you to just discuss the -- briefly, the fracture-stimulation program that you used for your coal wells, how you designed it, what your intent was.

A. We recognized very early on in the life of our company that we were not going to be able to get the highpressured fairway-type of leases that the Meridians and Amocos had had tied up in the Basin for a significant amount of time, and we were going to have to make due with what most people considered substandard leases.

We didn't have a problem with that because we felt we could develop the technology that would enable us to properly stimulate those coals to give us some very commercial production rates.

At the time that we took this project from Merrion and Bayless, they had actually attempted at least one coalbed methane recompletion and had abandoned that well and were ready to sell the entire project to us.

We looked at it and decided it was a very attractive project that we though we could make some commercial coalbed methane from, provided that we could properly stimulate those wells.

One of the things that we recognized very early on is that the standard stimulations that were being attempted on coalbed methane wells in the San Juan Basin were very damaging to the coals, and so our approach was to design stimulations that would not damage the coals and would enable them to produce, desorb their methane in a classical manner.

Q. How did you do that?

A. Number 1, we looked at those components of the stimulations that had been damaging to the coals, and those consisted primarily of additives to the fracturing fluids, gels, some of the biocides, even some of the surfactants had damaging characteristics for the coals.

So we looked at either minimizing those components of the fracturing fluid or eliminating them altogether. And in the case -- By the time we got to this project, we had come to the conclusion that we had to totally eliminate all of those additives.

And so when we designed our stimulations, we did not have any kind of gel fluids in our base fluid. We did use foamed -- nitrogen-foamed fracturing fluids. But the fact that we had no viscosity to the base fluid had a big impact on both the viscosity of the total fluid being pumped and on the life of the foam and the stability of the foam that we were using.

So we looked at several ways to compensate for the lack of viscosity, and one of those was to increase the rate that we were pumping our fluids.

We had estimated at that time that we were reducing the viscosity by nearly an order of magnitude, and in order to compensate for that, theoretically, we would have to increase our rate by an order of magnitude. But we didn't think that was necessary, and we actually had some dismal failures on the first few wells that we were stimulating in this project.

And I think somebody pointed out in earlier testimony that there were some wells where we pumped for four or five minutes; as soon as we introduced sand to the formation we screened out.

So we adapted our procedures, we -- Actually, our engineering manager brought with him some patents that he had secured while he was working with ARCO. We went back to ARCO and secured some licensing agreements to utilize those patents, and combined those with some new techniques of our own, and were able to finally get some good stimulations on these coalbed methane wells.

Q. Okay. Were you concerned in designing and implementing your fracture-stimulation treatment for these wells to assure that your fractures stayed within zone and did not penetrate the Pictured Cliffs formation?

A. Yes, we were. We recognized that the Pictured Cliffs formation was a depleted zone at that time, and the last thing we wanted to do was have our frac migrate out of zone and basically prop open a depleted zone and keep us from being able to produce significant quantities of gas and water from the Fruitland.

So --

Q. That -- Okay, go ahead.

A. The primary technique that we utilized to prevent that from happening was to not perforate our lowermost coal, the thin coal that is at the base of -- I'm sorry, that is at the top of the massive marine sandstone that we defined as the Pictured Cliffs formation.

Q. Okay, and let me just -- For the record, using this Exhibit 16, would you just point out which of those coals you're referring to as the lower coal?

A. This thin, continuous coal across the area is the one that we call the basal Fruitland Coal, and that is consistent with the pick on the Schneider type log.

Q. At the time that you started your development program here, were the Chaco wells that are at issue in Pendragon's Application -- and I'll refer to Limited 2-J, 4, 5, 1 and 2-R -- were they operating in the area?

A. My impression was that they were on production, though they had very low producing rates, and it seemed to us that a good portion of the time there was no production due to log-off conditions of those wellbores.

Q. As of early January, 1995, can you just give us just a general description of the status of the production of the five wells that we've listed up here on this -- on my handwritten chart?

A. The 1 Number 1 at first part of January was producing about 140 to 150 MCF of gas a day and about 120 barrels of water per day.

The 1 Number 2 well at that time was producing in the neighborhood of 130 MCF of gas a day and about 30 to 40 barrels of water a day.

The 12 Number 1 well at that time was producing nearly 400 MCF of gas per day and just under 70 barrels of water a day.

The 6 Number 2 well was producing on the order of 430 to 440 MCF of gas a day and about 130 barrels a day.

The 7 Number 1 well was producing on the order of 500 MCF of gas per day -- almost 600 -- I'm sorry, 520 MCF of gas per day, and about 35 barrels of water per day.

Q. As of this point in time, where -- How would you characterize these wells in terms of where they were in the dewatering process?

A. They had gotten to the point where they had reached a stabilized incline in gas production and a stabilized decline in water production.

EXAMINER CATANACH: I'm sorry, what date was that, Mr. O'Hare?

THE WITNESS: January of 1995.

Q. (By Mr. Condon) What were the pressures looking like in your wells as of about this point in time?

A. That's a little difficult to say, because we had made a concerted effort to keep our wells from being shut down for any extended length of time, but a rough estimate would be in the 175- to 200-p.s.i. range.

Q. Now, what was -- And again, you can refer, if you would, to the top page of that Exhibit 9 with the map.

At some point in time, did you realize that someone was doing work on the Chaco wells? And I'll refer to the Chaco wells as being the wells that are at issue in Pendragon's Application.

A. It wasn't until August of 1996 that we realized additional work was going on in the area. At that time to the south of this project, we had actually drilled four new wells, Fruitland Coal wells, and were in the process of completing them, when we noticed that there was a drilling rig offsetting our 6 Number 2 well and our 7 Number 1 well at a relatively close distance.

At that point we started doing a little bit of investigating, but not a whole lot until the following month, when we realized that not only were those wells being completed and put on pump, which was unusual from the standpoint that they were listed as Pictured Cliffs wells, but that there had been restimulations of other Pictured Cliffs wells in this area, and that was in September of 1996.

At that point we did a very preliminary study, gathering additional production information on those offset Pictured Cliffs wells. We also pulled the most recent gas analysis from those wells and tried to gather any additional information we could that was available through public sources, primarily the NMOCD office in Aztec, and undertook a very thumbnail sketch type of study to determine exactly what had been done to improve the production from those wells and how it might be affecting our offsetting wells.

Q. Okay. What kind of production from the Chaco wells were you seeing that caused your suspicion to be aroused?

A. We had reports from the field that the production on those heretofore marginal or even shut-in wells were very close to the same producing rates we were seeing on our Fruitland wells in the area, rates on the order of 350 to 400 MCF per day.

Q. To digress for just a second, in terms of the development program and the completions of your wells, putting them on production and continuing to operate them, what kinds of notices did you file with the State on your wells?

A. We obviously filed APDs with both the State and the BLM. We did have some involvement with the Navajo Indian tribe, since all of the land out here is Navajo surface. We had to go through the BIA as well as the BLM.

We consistently submitted all the sundry notices reporting the work done on each of the wells, spud notices, casing and cementing notices, deviation surveys.

And then any workovers that were performed on the wells were noticed before and after, and obviously production reporting to both the federal government and the state government.

Q. Okay. Did you report your water production from these wells?

A. Yes, we did.

Q. How did you handle the water production at these wells?

A. We set tanks at each one of the locations, and we produced the water directly into those tanks. It was then trucked off to a disposal -- commercial disposal facility, and we paid for the disposal of that water, as well as the trucking of it.

Q. Okay. How did you measure the volume of water you were producing?

A. Through tank gauges, daily tank gauges by our pumpers.

Q. Okay, is that pretty standard in the industry in this area?

A. Yes, for Fruitland production that is standard.

Q. As of your first look at the Chaco wells, had you had an opportunity to look at any of the well files for the

Chaco wells?

A. Are you talking about when they were offered to us, the --

Q. No, no, I'm talking about when your suspicions were first aroused with the early reports of high production.

A. The only well files we saw were the ones available at the State Office in Aztec.

Q. All right. Did you reach any preliminary opinion, based upon your early investigation of what was going on out there?

A. Initially, our fears were that there was some Fruitland gas that could be produced from the newly restimulated Pictured Cliffs wells.

We did not at that time reach a conclusion, but we did reach a concern that we may, in fact, be impacted by the work that had been done on those wells.

At that point we contacted Ernie Busch at the State Office and presented our fears to him and asked him for some guidance as to how to proceed. And Ernie set up a meeting at San Juan college in Farmington in September and invited, not just Pendragon and Keith Edwards, but a number of other operators in the area.

At that meeting, I presented the evidence that we had to date for the fears or concerns that we had, and was fairly strong in expressing my fear that we may be seeing some production of Fruitland Coal gas through these restimulated Pictured Cliffs wells.

Rich Fromm was at that meeting, representing Whiting, and he tried to temper my presentation.

And the objective was to try to get some cooperation from the parties involved and see if we couldn't get additional information that it would either allay our fears or confirm them, and we think we were successful in that regard.

We had another meeting with Pendragon in -- I believe it was late October, at their offices in Denver. They did provide us with the gas-analysis information that was presented by Al Nicols at this hearing, and we also got some additional information from them, and we shared our information with them at that time.

Q. All right. To go back when you first saw evidence that these Chaco wells were producing at high volumes, did you in the course of your preliminary investigation take a look at the sundry notices that had been filed with those wells?

A. Yes, I did.

Q. Okay. And at that point in time, did you develop a concern or suspicion about the location of the perfs in the Chaco wells?

A. No, I cannot say that I developed that suspicion at that point in time.

Q. Okay.

A. Again, I was reading the sundry notices pretty much the same way that Pendragon presented. They were all shown to be Pictured Cliffs completions, and we did not question at that point in time that they were, in fact, Pictured Cliffs completions.

Q. All right. Were these sundry notices that were prepared and submitted and approved back in the 1970s during a period when there was typically common ownership from the surface of the earth to the base of the Pictured Cliffs formation?

A. The early completion reports were. The sundry notices regarding the restimulations of the PC were after, obviously, the change in ownership.

Q. All right. And to go back to the 1988 hearing again, was there testimony given at that hearing that involved concerns that some of the participants at that hearing had about a problem that might be caused if there was no longer common ownership from the surface of the earth to the base of the Pictured Cliffs formation, given the recognition of the Basin Fruitland Coal formation?

A. Yes, I remember specific presentations at that committee where individuals showed Pictured Cliffs wells that were completed in the 1950s with nitroglycerine, generally open-hole across not just the Pictured Cliffs but a portion of the Fruitland formation, and, you know, decline curves that had shown an incline in production over a 30-year period.

In fact, I believe that Mr. Paul Thompson, who was a member of that committee, also presented one of those at the time he was representing Northwest Pipeline, or the Williams companies, and he presented a specific well in one of the San Juan units -- I can't recall the name -- but, you know, was obviously concerned. And that was one of the reasons that we came up with this list of parameters to guide the Division in determining whether or not a well was producing from the Fruitland Coals.

Q. Was there any evidence presented to the committee about problems that were being experienced in the Basin with fracs or perfs or open-hole completions in the Pictured Cliffs causing communication with the coal?

A. Yes, again, I presented a case where, when I was with Amoco, we had a Pictured Cliffs well we ended up putting on pump, producing large quantities of water before we saw an incline in production on the gas side, and ultimately a decline in the water production, and we concluded that there was definitely communication between that -- or induced from the Pictured Cliffs zone, up into the Fruitland zone, through a fracture stimulation of that well.

We also recognized that some of the older Pictured Cliffs completions, open-hole completions, especially those that were shot with nitro, would have a very good chance of exhibiting communication between the two formations.

Q. Okay. Then going back to your -- the series of meetings that you had with Pendragon -- and as I understand it, at some point -- or I guess early on in the proceeding, the Aztec office of the NMOCD participated in some way in at least facilitating those meetings?

A. The very first meeting, yes. After that, we spent a little bit of time trying to get additional information out of Pendragon. We started a formal engineering study. Unfortunately, we had a very high level of activity at that time that kept us from getting that study completed in a timely fashion.

The study was completed in 1997, it was presented to Whiting and, I think, finally accepted by Whiting in October of 1997.

At that point Whiting decided to undertake -- or actually Whiting had been pursuing an independent study of their own once they received the results of our study.

My understanding is that they increased their attention to their own in-house study and then when the conclusions that we had reached in our study were verified by Whiting through their study, the decision was made to bring in an independent third party, namely Steve Holditch and his company, and have them make sure that our inherent bias in our studies had not led to any improper conclusions.

Q. Okay. And about what time frame are we talking about?

A. It's late 1997, early 1998.

Q. At that point in time, had you continued your investigation and analysis of the operation and production of your wells and the Chaco wells in order to determine whether there was communication?

A. Almost daily up till today.

Q. All right. Have you, on the basis of that investigation and analysis, reached any conclusions?

A. I have reached some very definite conclusions. I think it's been stated by our previous witness that there, in our minds, is definite communication between the Pictured Cliffs formation and the Fruitland formation.

My conclusion takes that one step further. I believe that that communication was induced from the Pictured Cliffs zones through the Chaco wells and that that induced communication was intentional.

Q. Have you also developed an opinion about the location of the perfs in the Chaco restimulations that were performed in 1995?

A. Yes, I have. Again, at the time that we started our study, we did not place any emphasis on the location of the perforations.

By the time that Holditch became involved in our study, we realized that those upper perforations were, in fact, within the Fruitland formation. And since our rights existed from the surface of the earth down to the base of the Fruitland Coal gas formation, we felt that in addition to a communication issue, there was a definite trespass issue.

Q. Okay, let me just pull this display exhibit up again, and you've already testified on the left side. Did you also have a chance to look at the conveyances by which Edwards received their interests from Merrion in the Pictured Cliff formation?

A. Very briefly, during discovery.

Q. Is it your understanding -- Is the language there that indicates that their interest is limited from the base of the Fruitland Coal formation to the base of the Pictured Cliffs formation, is that what you've discovered in your review?

A. It is, and that is specifically what I was looking for. I was concerned that Merrion may have inadvertently assigned overlapping rights, so I wanted to verify that our rights were indeed from -- or their rights started where ours ended, and that is the case.

Q. All right. Would you just point out to the Examiner which perfs are at issue in your claim that there's been a trespass?

A. We feel that the perforations in what we call the Fruitland sand, the WAW Fruitland sand formation, shown here in red, and this thin yellow sand, are the perforations that are trespassing on our rights.

Q. And what is the basis for your contention that that is a Fruitland sand, as opposed to the, quote, upper Pictured Cliffs sand, close quote, that was coined by Mr. Nicol in anticipation of this hearing?

MR. HALL: You know, I think I'll object at this point, Mr. Examiner. This witness is being asked to render opinion testimony in geology. He has not even been tendered as an expert for any purpose. I don't know that he's qualified to say.

MR. CONDON: I think he's an owner of the property, he's a petroleum engineer, he's been developing properties in this area for years, he's familiar with the area, he participated in the coalbed methane study committee in 1988 where this issue was specifically addressed. I think he's more than qualified, at least as an owner, to give you his opinion as to his understanding of why there's been a trespass.

EXAMINER CATANACH: I think we'll let him render his opinions.

THE WITNESS: Again, my opinion is based on the work beginning in 1988 on the coalbed methane committee where there was not just a consensus but nearly a unanimous consensus on the base of the Fruitland Coal formation.

In fact, the recommendation of the Committee was that all coals in both the Fruitland and the Pictured Cliff zones be included in this new pool.

And the reasoning behind that was that there is some intertonguing throughout the Basin, primarily in the northeastern part of the Basin where the Pictured Cliffs sandstone, the marine sand, actually transgresses back across the Fruitland, and you find a second Pictured Cliffs sandstone, marine sandstone, below the upper sandstone.

Those are both massive sandstones in that portion of the Basin, and by that I mean greater than 25 or 30 feet in thickness. They are obviously marine sandstones.

And so the committee's intent was to make sure that this pool included those coals that occurred even below the top of that first massive sandstone.

Q. (By Mr. Condon) Okay. And where do you pick the massive sandstone in this area, the top of it?

A. This is actually hung on the top of that massive sandstone as our datum. Each one of the wells is at that point. Sometimes immediately below that bottom coal, sometimes there is a small shale stringer between that bottom coal and the top of that first massive sandstone.

Q. Now, there are stringers, coal stringers, that are shown on that exhibit down below the top of the massive sandstone formation. Are you making any claim in this case as to ownership rights in those?

A. No, we are not. And the primary reason for that is that we believe our operating rights were granted to us based on a formation definition, not a pool definition. And that's what we are going by.

The formation definition, at least, that all of our expert witnesses and the literature refers to is, the base of the last coal above the first massive marine sandstone in the Pictured Cliffs formation.

Q. Now, I think there was one of the exhibits introduced through Mr. Nicol that had a log -- Do we need to break?

EXAMINER CATANACH: Go ahead.

Q. (By Mr. Condon) Okay. -- that included a log of the Schneider B well. Do you recall that?

A. Yes, I do.

Q. Okay. Do you remember which one it was?
A. I think it was C-C'.
Q. C-C'. I'm going to just hand you that. I think it's N11, if I'm not mistaken.
And over on the far right, I believe, of that exhibit is the Schneider B well; is that correct?
A. Yes, it is.
Q. All right. And had you seen this log back in 1988 when you participated in the coalbed methane committee?
A. Yes, I did, and numerous times before that too.
Q. All right. Is your pick of the boundary in our area between the Fruitland formation and the Pictured Cliffs sandstone, in your mind, consistent with the pick that was made on the Schneider B-1 well back in 1988?
A. It is.
Q. Why?
A. Number 1, we've taken a portion of this log and blown it up to the exact same scale that we have on this cross-section and placed it side by side on our picks there, and it matches up exactly.
Also, it is very consistent with the definition that had been issued in the orders establishing this pool, and --
Q. And what definition is that?

A. The last -- I'm sorry, the first massive marine sandstone below the last coal in the Fruitland formation.

And that Pictured Cliffs pick corresponds to that definition.

Q. Is there anything else which you utilized in your determination that these uppermost perfs in the Chaco wells are located in a formation in which you own the sole interest?

A. At one point we had discussed the ownership of this -- the conveyance of our ownership from the previous owner and were under the impression that they were in agreement with this.

Q. Is there anything else you did, analysiswise, to confirm your opinion about this?

A. No, not personally.

Q. All right. In 1995, did anybody from Pendragon or Edwards -- Do we need to break now?

EXAMINER CATANACH: No.

MR. CARROLL: Five minutes.

Q. (By Mr. Condon) All right. In 1995, did anyone from Pendragon or Edwards come to talk to you, to advise you that they were planning on doing restimulation work on the PC well and to solicit your input about how to -- how they could possibly do that work and minimize the possibility of there being any resulting communication between the Pictured Cliffs formation and the coal formation?

A. No, they did not.

Q. Okay. Is there a practice in the industry or a practice that you have seen operators undertake under these kinds of circumstances where there is communication with offset operators prior to starting work in a situation like this?

A. We have seen considerate prudent operators act in a manner that would notify other operators as to their intentions and even seek their cooperation in monitoring offset wells.

In fact, we had a very recent case in point that we can use to illustrate that point.

Q. And what kinds of things can an operator do in these situations where they're going to perform work where there's a possibility of a fracture stimulation causing communication between zones prior to starting the work? What types of things can an operator do?

A. If they're working with other operators, they can set it up to where those operators are helping to monitor the downhole pressures in the offsetting wells to see if there is any indication of communication.

In their own wellbores they can perform radioactive tracer surveys, radioactively tagging those stimulations and then running surveys after the stimulations to determine where the sand is placed.

They can run temperature surveys following the stimulation. They can even run spinner surveys following the stimulation.

Q. When you finally got copies of the Chaco well files in the course of your investigation, did you see any indication that Pendragon had done any of those sorts of tests?

A. No, we did not.

Q. As of the point in time when your suspicions were first aroused, had there been any noticeable effect that you could tell on the production from your wells?

A. Yes, we had been struggling -- I can't say that it was a year or longer than a year, but for a lengthy amount of time, trying to regain the incline in production that we had established on our -- especially our 7-1, 6-2 and 12 Number 1 wells, and we couldn't figure out why we weren't able to re-establish that.

The 6-2 and the 7-1 well were going through a common meter, a CDM, and we discovered that there was a pressure drop at that point, and so we took steps to minimize that pressure drop. We actually had El Paso remove a safety device that was restricting flow into the meter, and that did have some impact on our production, but it did not bring it up to the levels or the expectation that we had for the incline that we had seen prior to that point.

We also went so far as to eventually separate those two wells and put them on separate meters to minimize the backpressure on the wells. And ultimately, we put compressors on those wells to reduce the backpressure on them, and that has had the biggest impact in re-establishing that rate of increase.

Q. Okay. And then before we have the break here for a couple minutes, let me just go back to the handwritten -- When you went back and actually had a chance to look at the Chaco well files, what was the sequence of the work that was done on restimulating these Chaco wells that are at issue in Pendragon's Application?

A. There was some work done in early January of 1995 -- Actually, prior to January of 1995, there was some work done on the Lansdale Federal well, in December of 1994.

Q. All right. So let's just -- let's just put down -- If we put up here "Whiting/Maralex" and we go down here and we put "Pendragon Chaco" what you saw was the -- What was the Lansdale well?

A. Lansdale Federal.

Q. Lansdale Federal. And what did you discover in your review of that well file?

A. That showed that the well had been perforated into the Fruitland Coal in December of 1994.

Q. Okay, who performed that?

A. I believe it was done under Keith Edwards.

Q. Was there also a restimulation on the PC in December of 1994 in the Lansdale?

A. No, there was not.

Q. All right. Who actually -- Do you know who oversaw the work on the Lansdale Federal?

A. My understanding is, it was Paul Thompson.

Q. All right. And then what did you see next?

A. In addition to the perforating, the Lansdale Federal was acidized.

Q. I'm sorry, let me stop you for just a second, Mr. O'Hare. Just point out on the first page of this Exhibit 9 where the Lansdale well is.

A. It's located directly east of our 7 Number 1 well.

Q. All right, I'm sorry to interrupt you. What did you see next?

A. I just wanted to mention briefly the --

Q. Oh, sure.

Q. -- acid stimulation on the Lansdale Federal in the coal --

Q. Okay, and then --

A. -- immediately following the perforation.
Q. So perf and then acid stimulation?
A. Right.
Q. Okay.
A. The very next work that was done was in January of 1995. Work was done on the Chaco 1, the Chaco 2-R, the Chaco 4 and the Chaco 5.
Q. Okay, what kind of work?
A. The Chaco 1 and the Chaco 2-R were fracture-stimulated at that point in time.
The Chaco Number 4 was acidized.
There was attempt made to frac the Chaco Number 5 at that time, but a casing leak was discovered, and that casing repair was attempted and completed in February of 1995.
Q. Was there any indication in the well file for the Chaco Number 5 of when the casing leak actually started?
A. No, there is not.
MR. CONDON: Is this a good point?
EXAMINER CATANACH: Yeah, I think we need to go ahead and break for however long it takes.
(Thereupon, a recess was taken at 9:12 a.m.)
(The following proceedings had at 9:33 a.m.)
Q. (By Mr. Condon) Mr. O'Hare, before we broke we were discussing the Lansdale Federal well file, and as I

understand it, that's part of the information that you used to reach your conclusions in this case?

A. Yes, it is.

Q. All right. And that is -- Could you just point out on the front page of that what exhibit number that is?

A. Number 41.

Q. All right, and can you identify that particular document for me that's been marked as Exhibit 41?

A. This is the well file for the Lansdale Federal Number 1, located in Section 7, 26 North, 12 West.

MR. CONDON: Mr. Examiner, would there be a problem with me deviating from what I think is probably typical Division practice and moving the admission of these exhibits as we identify them?

For instance, this one I know we've discussed earlier, and you've been given copies, but I don't know if it's ever been admitted yet, so at this point I'd like to move the admission of Exhibit 41 if I could.

MR. CARROLL: What is 41?

MR. CONDON: It's the Lansdale Federal well file.

EXAMINER CATANACH: I don't have a problem with that. Mr. Hall, do you have any concerns about that?

MR. HALL: Take just a moment to look at it and see.

No objection.

EXAMINER CATANACH: Okay, Exhibit 41 will be admitted as evidence.

Q. (By Mr. Condon) Would you point out to the Examiner which portions of Exhibit 41 you've relied on in reaching your conclusion that there was a communication between the Pictured Cliffs formation and the Fruitland formation as a result of the Chaco well fractures?

A. Yes, the fourth page from the back has a summary of the work performed on January 22nd, 1980. And this basically is a relatively small frac of the Pictured Cliffs formation. It describes it as being pumped at a total rate of seven barrels per minute. There's something like 15,000 gallons of fluid and 20,000 pounds of sand that are pumped in this stimulation, which is substantially smaller than the stimulation designs presented on the Chaco wells by Mr. Blauer.

And then if you turn -- I think six pages, seven pages towards the front of that document, there's a report dated 3-12-80, and it shows that nearly two months after --

MR. CONDON: Hold on, just a second. Let the Examiner find that.

EXAMINER CATANACH: Okay.

Q. (By Mr. Condon) Okay.

A. It shows that nearly two months after that frac was pumped, the Lansdale was put on pump. They were recovering black water. The pump hung up, and the water shows heavy coal content.

Q. What does that indicate to you?

A. That indicates that they had communicated with the Fruitland Coals, with this fracture stimulation, even though it is a much smaller job than was pumped on the Chaco wells, at a much lower rate than was pumped on the Chaco wells.

Q. Anything else about Exhibit 41 that you want to call to the Examiner's attention?

A. There is the documentation within this document for the perforating and acid stimulization of the Fruitland coal. That information was never presented to the State, either before or after the fact, in the form of a Sundry notice. And indeed, we scoured the NMOCD files in Aztec and were unable to discover any information with regard to the work that was done in 1994 on the Fruitland formation.

Q. Now, when you say no information was provided in the notices that were filed with the OCD, what information are you specifically referring to?

A. To the completion report or a sundry notice. And I would like to point out that this is -- Even though J.K. Edwards and Pendragon did own the 160 acres that that well is completed on, that is an unorthodox location for the coalbed methane or the Fruitland Coal gas pool.

Q. Now, is this the well, as you understand it, that was squeezed off in the Fruitland formation last week?

A. Yes, it is.

Q. Okay. Let's move on, if we could.

Aside from the review of that Lansdale well file, what other information did you rely on in reaching your conclusions and opinions?

A. We also looked at all the well files on the Chaco wells. We reviewed production information, decline-curve information, we reviewed the available pressure information, the available gas and water analysis on all of these wells, including the Fruitland wells.

We reviewed reserve estimates, gas-in-place estimates, and we have also reviewed some simulation work that was performed by the Holditch group.

Q. Did you attempt to look at information regarding water production from the Chaco wells in performing your analysis and investigation?

A. Yes, we did.

Q. What luck did you have with that?

A. We had very little luck in the way of reported water production. We did have some indication that water was being produced through field inspections and by our field personnel.

Q. Okay. And did you attempt to check notices that were on file with the NMOCD on water production?

A. Yes, we did.

MR. CONDON: Okay. This, I believe, is an exhibit that's already been discussed. It's Exhibit 44. I think you all already have a copy --

MR. CARROLL: Can you give us another one?

MR. CONDON: -- but I'll give you that one.

MR. CARROLL: We've got it..

MR. CONDON: All right.

Q. (By Mr. Condon) Mr. O'Hare, can you identify that document that we've marked as Exhibit 44?

A. Yes, this is a summary of the reported water production for the Chaco 1, 2-R, 4, 5, 1-J and 2-J wells, and this summary includes both the pumper-reported water production and the C-115-reported water production.

MR. CONDON: At this point, Mr. Examiner, I'd like to move the admission of Exhibit 44. I know we've discussed it before, I'm just not sure that it's actually formally been admitted.

MR. HALL: No objection.

EXAMINER CATANACH: Exhibit Number 44 will be admitted as evidence.

Q. (By Mr. Condon) When you saw this information on the water production, was the reported information consistent with your field observations?

A. No, it was not.

Q. Why not?

A. We noticed in the field that there was earthen pits that were accepting substantial amounts of water from these wells, from our first discovery that they had been restimulated in August of 1996.

This is in an area where the soils are sandy loam, very high percolation rates. It's also a very arid climate, so there are high evaporation rates. The pits were basically 100- to 130-barrel capacity, and at every inspection that we made those pits were full of water.

Q. Okay. When you say unlined pits, does that have any consequence of being able to accurately determine how much water is being produced from a well, if it's producing into an unlined pit, as opposed to a lined pit or a tank?

A. Yes, as Mr. Thompson testified, it's very difficult to get an accurate gauge of the water being produced into an unlined earthen pit.

Q. Is water lost in an unlined earthen pit in ways in which water would not be lost if you were using a tank or a lined pit?

A. Yes, it is lost through the percolation of the water into the soils, especially high-permeability sandy soils like are evident in the Chaco area.

Q. And let me just ask you -- These are part of the packet I gave you this morning, and I'll hand you what I've marked as Exhibits 46-1, 46-2R, 46-2J, 46-4 and 46-5 and ask you if you can identify these exhibits.

A. The 46-1 exhibit is a picture of the Chaco Number 1 unlined earthen pit. These pictures were taken within the last week, after the wells had been shut in for not quite a month at the order of the District Court.

There are three pictures there, giving the perspective on the well and the pit itself.

Q. Hold on, let me help Scott in finding -- Okay.

A. The first picture on the front page shows what could be interpreted as a water line. Even though the pit is now dry, you can see that at one point it was evidently very full.

46-2R are pictures of the unlined pit on the Chaco Number 2-R well, and again you can see that at one time that had held substantial amounts of water. You can also get an idea as to the topography of the area and the arid climate from those pictures.

Exhibit Number 46-2J actually includes a picture of our Gallegos Federal 26-13-1 Number 1 well in the background, and the tank batter that we are producing our water into, in contrast with the open, unlined pit that sits immediately behind the compressor on the Chaco Limited 2-J well.

Exhibit 46-4 is a picture of the Chaco Number 4 unlined pit. And again, you can see that at one time that pit held substantial amounts of water. The picture on the back page includes the compressor that has been set on that well since February of this year.

Exhibit Number 46-5 is a picture of the unlined pit on the Chaco Number 5 well, and again you can see that there has been substantial amounts of water contained in that pit.

MR. CONDON: Mr. Examiner, I move the admission of this 46 series of Exhibits.

MR. HALL: No objection.

EXAMINER CATANACH: Exhibits -- Series 46 exhibits will be admitted as evidence.

MR. CONDON: Have we been involved in this litigation -- Let me just, so the record gets made and these things get over to the reporter -- Do you need to worry about that at this point?

COURT REPORTER: I think I have a copy.

MR. CONDON: Oh, great, okay. All right.

Q. (By Mr. Condon) Did you continue to try -- Did we continue to try to get documents that would reflect water production from these Chaco wells?

A. We did, and we were finally rewarded for our efforts last Friday in that --

Q. Last Friday or Monday? This is July 27, I believe, is the date on the letter.

A. I'm sorry, this Monday.

Q. Okay. And are the documents that were provided what we've marked as Exhibit 57?

A. Yes, they are.

Q. All right. Let me just have you go through your copy of Exhibit 57. Have you had a chance since those were first produced on Monday to look over them?

A. I did spend a little bit of time on these.

Q. All right. Did you find documents in there that reflect water production from the Chaco wells that are not noted in any of the notices that are filed with the State?

A. Yes, I did.

Q. All right, what documents are those?

A. These are pumper reports from Walsh Engineering and Production Company. I think they're labeled "well reports".

Q. Are also water-hauling records in here?

A. Yes, there are some water-hauling records in here.

Q. Okay. And are the -- Let's see, I believe that the water-hauling documents are the first couple of documents right before the second pink divider. Okay.

And would you just give the Examiner, and for the

record, the dates of those water-hauling tickets?
A. The ones that are presented for the Chaco Number 1 include two dates in June, several dates in March and several dates in May.
Q. What year?
A. 1998.
Q. Okay, that's for the Chaco 1?
A. Correct.
Q. All right. Let me just have you -- So those begin in March of 1998?
A. That's correct.
Q. All right. Let me just have you take a quick look at what we've already used for purposes of this proceeding as Exhibit 43 and ask if you can identify that.
A. This is a C-115 form that reports production to the State.
Q. Okay. Is that a Pendragon form for the -- including the Chaco wells?
A. Yes, it is.
Q. Does it include the Chaco 1?
A. It does.
Q. Okay. How much water was reported for the month and year February, 1998, for the Chaco 1 well?
A. Zero.
MR. CONDON: This is another one of those

exhibits that's previously been looked at and testified about. I don't know that it's been formally admitted, so I'd like to move the admission of Maralex/Whiting Exhibit 43 at this time.

MR. HALL: No objection.

EXAMINER CATANACH: Exhibit Number 43 will be admitted as evidence.

Q. (By Mr. Condon) Do you find it unusual -- Well, I'm sorry, let me go through it step by step.

What do the water-hauling tickets, beginning in March of 1998, indicate for that Chaco Number 1 well?

A. They indicate a total of 640 barrels was hauled for that month.

Q. Okay.

A. As much as 80 barrels was hauled every other day. In one case, between the 14th and the 15th, 160 barrels were hauled.

Q. Okay, how many total barrels for that month?

A. 640.

Q. Do you find it unusual that there would be 640 barrels of water produced in March of 1998 if the well actually produced no water in February of 1998?

A. Considering that they were hauling out of an unlined pit, yes.

Q. All right. If there were 640 barrels hauled out of an unlined pit for March of 1998, can you estimate the total volume of water that might have been produced by that well for the month of March, 1998?

A. We can make an estimate, but it would be speculating as to the percolation rate of that unlined pit and the evaporation rate in this area during that month.

Q. Okay, but you would expect some of the water to have been lost through percolation or evaporation?

A. Correct.

Q. All right. Now, are there other documents in that file that you have reviewed and feel are significant in terms of your analysis that's led to the opinions you've offered in this case?

A. Yes, there are.

Q. Okay, what other documents are there? Just -- If you could point them out to the Examiner, kind of a point-by-point fashion, without taking too much time, but just so he has an idea of what documents you're referring to and relying on in this exhibit.

A. Okay, before I get to that, I'd like to focus on the ones we're already discussing.

Q. Okay, all right.

A. Number one, Mr. Ancell testified yesterday that if there is a communication between the Pictured Cliffs formation and the Fruitland formation in the Chaco wells, that we would expect to see a higher ratio of water-to-gas production in their wells than we have in our Fruitland coalbed methane wells, because we should be farther along in the dewatering phase than what they would be in their wells.

Q. Do you agree with that?

A. I do agree with that. He is absolutely correct in making that statement.

Q. Okay. And based on these documents that were first produced on Monday, have you been able to do any kind of calculation or analysis of the water-to-gas ratio for the Chaco wells?

A. Yes, I very briefly have looked at a comparison between the water-gas ratio in the Chaco wells and the offsetting Whiting/Maralex wells.

Q. Okay, and what are the results of that calculation?

A. To give you an example, for the Chaco Number 1 in April of 1998, the ratio of water to gas produced is about .116 barrels per MCF. The offsetting -- The closest offset well that we operate is the Gallegos Federal 7-1, and for that same time period we are an order of magnitude less in our water-to-gas ratio.

Therefore, Mr. Ancell's statement holds true with regard to the water production on the Chaco wells coming from Fruitland gas -- I'm sorry, from the Fruitland zone, rather than the Pictured Cliffs zone.

Q. Okay. Now, your calculations that you did, are you factoring in any percolation or evaporation factor, or are you just taking the hauled volumes?

A. I'm only taking the volume reported by the pumper on the well report.

Q. All right. So if water was lost in those unlined pits, that -- you have not tried to account for that?

A. That's correct. The pumper may have attempted to account for that, but we don't know how accurate he could have been.

Q. All right. What else have you looked at in that packet of documents that we were furnished on Monday?

A. We did do a comparison, shown on Exhibit Number 44, again reporting the difference between the water reported by the pumper and the water reported on the C-115 reports. There is no consistency whatsoever in those reported rates.

Some of the other documents that we looked at -- And by the way, we could go through the same water-to-gas ratio on each one of the wells, if you would like to. I have calculated those, and it's a similar difference.

Q. Why don't you just -- if you could just -- You have looked at that and performed that calculation for each of the Chaco wells that are at issue?

A. Right.

Q. And for which we've been provided water production documents?

A. Correct.

Q. All right. If you would just give the Examiner the calculations for each well that you have.

A. On the Chaco Number 2-R, if you take the 7-96, there's actually production reported in here from July of 1996. The water-gas ratio at that time was 1.0.

The offsetting -- The closest offset, which is just a few hundred feet away, is our Gallegos Federal 7-1. In July of 1996 our ratio was .03 barrels per MCF.

On that same well in March of 1998, the water-to-gas ratio on the Chaco 2-R had fallen to 0.1. The corresponding ratio in the Gallegos Federal 7-1 was 0.018.

So again, an order of magnitude.

On the Chaco Number 4, in May of 1998, the ratio was .047, a very low ratio.

And the offsetting wells that I looked for us were the Gallegos Federal 6 Number 2 and the Gallegos Federal 12 Number 1, and our ratios were only slightly lower there, .042 and .046, respectively.

And that make sense from the standpoint that the Chaco Number 4 has produced a significant amount of water and gas from 1995 through 1998.

And so with the help of the 40-acre offsets, including the Chaco Number 5 and our Gallegos Federal 6 Number 2 and our 12 Number 1, that entire area is indicated to be very effectively dewatered at this point in time.

Q. Mr. O'Hare, was there -- Do you have the Number 5 in there? Did you do --

A. The Number 5 had only limited data. There was on report by the pumper that showed one barrel of water per day.

On three different occasions in March of 1998, that ratio is about the same as the ratio for our offsetting wells, the 6-2 and the 12-1.

Q. Okay. Are you comfortable that at this point in time we've seen all the water production data that might be available pertaining to the Chaco wells?

A. No, I don't believe so.

Q. Was there a point in time in 1998 when you started seeing water production from the Chaco wells being reported on the C-115?

A. In February of 1998.

Q. Okay. Was there an event that occurred in or around February of 1998 that involved a field inspection of the Chaco wells by Mr. Busch of the Aztec office?

A. Yes, we did have a field inspection following a meeting with the Pendragon folks, and the NMOCD, following our Application in front of the Division to shut in these wells.

Q. Okay. Do you recall when that meeting in the field, the inspection, occurred?

A. It was in February.

Q. All right. Would you expect -- Now, given the documents that we have, would you expect a Pictured Cliff well that was producing only Pictured Cliff sandstone gas to be producing these volumes of water?

A. No, sir.

Q. Why not?

A. Generally speaking, the operators in the Basin have shied away from anything that looks wet in the Pictured Cliffs zone, and they have attempted to produce only the upper parts of that zone that have traditionally produced very dry gas.

Even on those wells that produce water from the Pictured Cliffs, it is insignificant, one to two barrels of water a day.

Again, it's generally not enough to even wet the bottom of these kinds of unlined pits, let alone fill those pits.

Another thing I'd like to point out in this exhibit is that the Lansdale Federal, which was testified to, or about, yesterday, as never producing any water does show water production reported in 1998 on these same forms, pumper reports.

Q. Beginning when?

A. In March, again. We just have March, April and May down here. And there is water hauled off of that well in those months as well.

Q. Was there anything else about your analysis of the Chaco wells' water production that you want to tell the Examiner about that has formed the basis of the opinions you've offered in this case?

A. Just to reiterate that we recognized in the field very early after we discovered the stimulations had been performed on the Chaco wells that there were substantial volumes of water being produced into unlined pits.

We brought that to the attention of both Pendragon and the NMOCD as early as September of 1996, and it appeared that nothing was done about that, even up till our March -- or February meeting.

Q. Okay. What other factors -- Is that it for water production?

A. Yes, it is.

Q. Okay, let's move on then. What other factors have you looked at in order to reach the conclusion that you've offered to the Hearing Examiner in this case?

A. Again, we have reviewed reserve information from both the PC and the Fruitland formations. We have reviewed pressure information, production information.

A lot of the information has already been presented. I thought Mr. Williams did a very good job of presenting the majority of that information. We have two other witnesses that will present the remainder of it as soon as I'm finished.

Q. Okay. On the issue of pressures in the Chaco wells, did you see any indication of a significant recharge in the Pictured Cliffs formation prior to the time that Pendragon started its work on these wells in 1995 that would account for the pressure increases that have been discussed already?

A. No, I did not. There is absolutely no information available that indicated a recharge prior to the work initiated by Pendragon.

The only available pressure information that preceded the work performed by Pendragon was a shut-in wellhead pressure reported on the Chaco Number 4 well when the rig moved in to start the acid work on that well in January of 1995. That showed a recharge of 22 pounds over a 12-year period.

The last reported pressure information was in 1983. The value for that report was 97 p.s.i. The rig reported shut-in casing pressure on the Chaco Number 4 was 119 p.s.i. in January of 1995.

Two weeks after the acid job was performed on the Chaco Number 4, the pressure was reported as 170 pounds by the rig crew.

So we had a 50-p.s.i. increase in -- or recharge, in two weeks, when we only saw a 22-p.s.i. increase in 12 years.

Q. And what, in your opinion, was the cause of the pressure increase that you saw after the acid job?

A. I believe it was due solely to the fact that the acid communicated the Pictured Cliffs formation -- or perforations, with the Fruitland Coals.

Q. And how would that happen?

A. Acid is a very good destroyer of cement. Cement is very soluble in acid. The cement that was behind the pipe, between the wall of the pipe and the formation, was obviously eaten away by that acid. There's only a very short interval, two to three feet, between the top perf in the Pictured Cliffs zone or what we call the Fruitland sand and the base of our B coal zone.

Q. Okay, would you just point out to the Examiner where you're referring to there?

A. The Chaco Number 4 is located here. This top perforation, as you can see, is just maybe two feet away from the bottom of the Fruitland Coal. The B Coal is what we call that interval. And so with 500 gallons of acid, you could eat two feet of cement away in just a matter of seconds.

Q. All right. What about the Chaco Number 5 well? Did you see any evidence in that well of natural repressurization?

A. No. Again, we don't have any kind of pressures prior to the work done by Pendragon in January of 1995. And so it's impossible for us to say that there was recharge or there was not recharge at that time.

We do know for a fact that a casing leak existed in that well for some time before their attempt to frac it in January of 1995, and we also know for a fact that there was no cement behind the pipe above that casing leak and actually more than a hundred feet below the bottom of that casing leak.

Q. And what is the significance of that?

A. It is very possible and, based on the information from our gas analysis, that the Fruitland Coal was actually in communication with the wellbore through those casing leaks.

Q. Now, if there was communication between the Fruitland Coal formation and the Pictured Cliffs formation, would you expect as of, say, this point in time, for the pressures between the two formations to have stabilized?

A. Probably not. And the reason for that is, the Pictured Cliffs formation had been depleted to the point where pressures were on the order of 100 p.s.i. by 1983.

A substantial amount of gas had been removed from that formation. If there was direct communication between the two zones and the Fruitland formation had been shut in for a long period of time, there's a possibility that we would have reached equilibrium from the gas flowing out of the Fruitland formation into the PC and recharging the PC.

However, we have made every effort to keep our wells producing consistently at a low bottomhole pressure, and we believe that bottomhole pressure during producing time is much lower than the 100 pounds or less that the PC has been depleted to.

So while we are producing our gas from the Fruitland, there is no recharge going into the PC in those wellbores, in our wellbores, even if they are communication with the PC.

Now, at a distance away from our wellbores, it is possible that communication in the Chaco wellbores is occurring and some recharge is occurring of that formation, of the Pictured Cliffs formation, through migration of the gas from the Fruitland down into the Pictured Cliffs through the Chaco wellbore.

However, that rate -- the rate of recharge up until the shut-in was very low because the Chaco wells had been aggressively produced, and that gas was being pulled out of the Fruitland to the surface and sold, rather than being allowed to recharge the Pictured Cliffs formation.

Q. Is there any other explanation, aside from a recharge from the Fruitland Coal formation, that, in your opinion, explains the pressure increases that we've seen in the Chaco wells since the work that was done in 1995?

A. In my opinion, no.

Q. All right. There's been some discussion earlier about possible recharge from the -- what? The third bench of the Pictured Cliffs formation. Did you hear that testimony?

A. Yes, I did.

Q. Do you have an opinion about that?

A. Yes, I do. My opinion is that the water saturation of that zone is high enough that the relative permeability to gas is going to be very low. So if there is any kind of vertical communication through the reservoir, then it's going to be at a very low rate.

In fact, if you look at the core data on the Lansdale Federal, it gives permeability values both horizontally and vertically. The vertical permeability values are more than an order of magnitude lower than the horizontal permeability values, meaning that it's not likely that gas is going to be migrating in a vertical fashion anywhere in that reservoir, but especially in an area where the water saturation is much higher than the gas saturation.

Q. What about a possible recharge of the Pictured Cliffs formation, because these Pictured Cliff wells after the restimulation and because some formerly operating PC wells are no longer operating, and so they're essentially communicating with a larger volume of the formation?

A. That is not very likely from the standpoint if it were occurring, it should have been occurring all along in the history of that reservoir.

And if you look at the pressure data that was presented both by Pendragon and by Whiting at this hearing, you will recognize that the Chaco Number 1-J and the Chaco Number 2-J well pressures are much higher than the Chaco Number 4, Number 5, Number 1 and Number 2-R well pressures, meaning that even if that reservoir communication expands over a large horizontal distance, there is still some impediment to flow of the gas from great distances away to recharge of those pressure sinks on the existing wells.

But you also need to consider that those other wells are still producing. The Chaco Number 1-J and the Chaco Number 2-J, as well as several other wells operated by other operators in those offsetting locations, 160-acre locations, are still producing.

Q. You're talking about in the area of concern here for us?

A. Correct.

Q. Could you just point out on the first page there of Exhibit 9 what other Pictured Cliff wells are currently being operated?

A. We have the Chaco Limited 2-J. There's a Chaco 11, Chaco Limit- -- 1-J, Chaco Limited 3-J in the immediate area. There is a Chaco Number 9-R replacement well that I believe is also a Pictured Cliffs well in Section 6.

So basically the 160-acre well locations are filled in within the study area, with producing Pictured Cliffs wells.

Q. Now, did you look at the fracture-stimulation treatments that were given the Chaco wells?

A. Yes, I did.

Q. Okay, what did you learn from that information?

A. The first thing is that those well -- or those stimulations were performed at rates that were on the order of 22 to 30 barrels per minute. They were all nitrogen foam fracs. They ranged in size from about 30,000 pounds of sand up to about 42,000 pounds of sand. They were placed at pressures ranging from 1800 up to 2700 pounds, maximum treating pressures. One of those screened out at the end of the job.

I also looked at the Nolte plots on those. Mr. Blauer testified that in every case those plots showed a positive slope. If you look at the early time data, two or three of those exhibited negative slopes during the early time data.

But if you realize that acid jobs were performed on those wells prior to the frac jobs, you can understand that there is communication established before those frac jobs are performed.

And so even if there is a positive slope throughout the frac job, that's no guarantee that you are not extending a frac in the Fruitland Coal.

Another thing I'd like to point out is that we are so close, or those perforations that they were treating with those frac jobs, are so close to the bottomhole that it does not take any kind of extension of that fracture to break into the coals. Generally speaking, until you hit a barrier, you are extending your frac, for every foot that you go horizontally, one foot vertically up and one foot vertically down.

Now, if you are already in communication through the cement sheath being eroded away or eaten away by the acid, you have no barrier to get you into the Fruitland

Coal before you start extending a frac.

Q. There's been testimony about the coal acting as a kind of a natural safety blast barrier to a frac. Would you address that, please, based on your experience in this area?

A. Yes, my engineering manager gave a very apt analogy that I thought I could present here. He said Mr. Blauer's statement is akin to frac'ing through a concrete dam but not going through the mud cake on the other side of that dam and then not allowing the water to come back through that crack in the dam.

You know, it is not reasonable to assume that a very permeable formation that is made up primarily of cleats, basically fractures connecting one with another throughout the formation, both horizontally and vertically, would not allow the transmission of fluids and sands through that system.

So if the fracture can get up to the coal, there is no way to keep the fluids in the sand from entering into those cleats.

And yeah, the high leakoff due to that very permeable cleat system could prevent it from growing more, but it's already in the coal. You are already communicated with the coal at that point.

So there is communication established when the frac quits growing, even if it doesn't make it all the way through the top of the coal. Now, that communication that's been established is very effective in transmitting the fluids through the cleat system into that induced fracture and back through the perforations in the PC or the Fruitland sand and up the wellbore.

Q. In your opinion, did any of the fracture-stimulation jobs on any of the Chaco wells result in communication into the coal?

A. Yes, all of them did.

Q. All of them? Okay.

There was some discussion of skin damage on the Chaco wells in the direct evidence case, as explaining the higher production rates after the restimulation and perhaps -- I'm not sure that this was offered, but perhaps even explaining the higher pressures that we're seeing in the Chaco wells after the restimulation.

Would you explain what skin damage is?

A. Skin damage can be anything that reduces the ability of the formation to transmit its fluids through the formation immediately adjacent to the wellbore into the wellbore. That could also include restricted perforations. If you only have one perforation in a very permeable zone so that the gas can flow through the reservoir faster than it can get through that one perforation, that's skin damage.

Q. If a well has skin damage, is that going to affect a pressure reading and prevent a pressure reading from accurately reflecting the pressure of the formation?

A. Not in the least.

Q. Okay. Will it affect production rate?

A. Yes. Skin damage that occurs at the completion of the well, before the first production of a well, generally is masked. You cannot tell from production from that point forward whether or not you have skin damage unless you do some kind of analysis, a pressure-buildup analysis, a drawdown analysis or, as Mr. Gallegos mentioned, a Fetkovitch type-curve analysis or a simulation of the reservoir itself.

Q. So there are tests that you can run in order to try to determine whether there is skin damage on a particular well?

A. Yes, there are.

Q. All right. Did you see any evidence that any of those tests were run on any of the Chaco wells?

A. No, I did not.

Q. Okay. Now, there was -- I believe that a number of the exhibits that were introduced through Mr. Williams yesterday do indicate increased production in a number of the Chaco wells post-stimulation, post-acidization and post-frac'ing. I've pulled up MW 19 on the Chaco 4 well. Are you familiar with the fact that these wells did exhibit increases in production after this rework?

A. Very familiar.

Q. All right. In your opinion, is the increase in production explainable by eliminating skin damage?

A. No, it is not.

Q. Why not?

A. Generally speaking, if you are fracture-stimulating a well to overcome skin damage, you can project the folds of increase in production that could be realized through the placement of a particular size fracture in your formation. And in some of the best cases I've seen, that results in a five- to tenfold increase in production.

We don't have any idea, or at least Pendragon evidently didn't have any idea of what the magnitude of the skin damage was on these wells before these stimulations were performed, and so we never did get any testimony from them as to the projected increase or folds of increase in production that they expected following it.

But our Holditch folks have performed some analysis along those lines, and the indication based on those analyses was that, at best, it could have been a tenfold increase in production.

Q. Okay.

A. And we actually saw somewhere around, in this case, you know, maybe a 400- -- 200- to 400-fold increase in production.

Q. Is there anything in the production history of the Whiting wells, since the Chaco wells were stimulated in 1995, supports the opinions that you've offered?

A. In our view, yes.

Q. What is that?

A. Mr. Williams probably did a very good job of presenting that yesterday, but what we noticed initially was that our 12-1 well, in particular, was most impacted by the restimulations of the Chaco wells, and that was actually a reduction, a drop in production, following those restimulations.

Q. Was that during a period when you would have expected that, as a typical coal well, to still be on an incline curve?

A. No. In fact, the offsetting wells were still showing an incline, though that incline decreased following this stimulation. We actually saw a drop in production and a decrease -- a decline, I'm sorry, in the production on the Chaco -- I'm sorry, the Gallegos Federal 12 Number 1 well.

Q. Okay. Were there any factors that were affecting the operation of the well, any problems with the well, any mechanical problems or anything like that, that would explain the production change that you noted in your well?

A. Not that we could find, no. We actually went so far as to spend money to change downhole pumps, to increase our efficiency of those pumps, and they had no impact, our efforts had no impact on increasing the production.

Q. Okay. Did you look at the gas analyses in connection with forming your opinions in this case?

A. Yes, I did.

Q. Okay. What -- If you could just give us a brief statement of what, in your opinion, the gas analyses show?

A. In 1996, during our discussion before the State and the other operators at San Juan College in Farmington, we presented just some very basic data.

And essentially, it showed the BTU content of known Pictured Cliffs wells, which was on the order of 1100 to 1120 BTU, compared to our Fruitland gas analysis, which show BTUs in the 990 range to 1020.

And then we showed the Chaco wells had gone from those 1100-BTU numbers down to the 1020 range, following the fracture stimulation. That, to me, was a good indication that we were seeing Fruitland gas in those wellbores.

In conjunction with Whiting's work, we went so far as to try to analyze the percentage of Fruitland gas that was being produced through the Chaco wells and looked at different ways of determining whether significant portions of Fruitland gas were coming --

Q. Okay, is there --

A. -- from the Chaco --

Q. Is there any other natural phenomenon that would explain why the gas produced from the Chaco wells, if it was coming only from the PC consistently throughout this period, would have shown a change in the BTU content?

A. Not that dramatic a change, no.

Q. Was there -- There was some testimony by Mr. Blauer, I believe, about phase changes in the gas as explaining the BTU readings. Could you comment briefly on that?

A. Yeah. Again, I think Bruce touched on that yesterday. But if, in fact, Mr. Blauer's analogies were correct, it would result in an increase in his BTU content in the Pictured Cliffs gas, not a reduction in that BTU content.

Q. There was some testimony yesterday, I believe, by Mr. McCartney about some Dreyfus Pictured Cliff wells that he believed were analogous wells in terms of production history at this approximate point in time.

Let me hand you what I've hand-marked -- and I apologize for this, putting this together as we go -- what

I've marked as Maralex/Whiting Exhibit 62, and ask you if you can identify that?

A. Yes, this is a map showing the -- all of the wells located in the section that Mr. McCartney referred to yesterday, Section 1 of Township 27 North, Range 12 West.

Q. Are there, in fact, Pictured Cliffs wells up there?

A. There are four Pictured Cliffs wells in that section.

Q. Okay.

A. There are also two Fruitland wells in that section.

Q. What did you find when you looked at the well files for those wells?

A. We discovered that those Pictured Cliffs wells had been completed back in the early 1950s and that they were completed open hole and that they were stimulated with nitroglycerine.

Q. And what is the significance of that in terms of describing the production of those wells as coming only from the Pictured Cliffs formation?

A. Well, it's very likely that the completions on these wells resulted in the communication of the Fruitland formation, the Fruitland Coals, with the Pictured Cliffs sands in these wellbores. And in fact, there are proven coals exposed in the open-hole portion of these wellbores.

Q. Mr. O'Hare, is there any other evidence that you want to call to the Examiner's attention in support of the opinions that you've offered here this morning?

A. If I could, I would like to comment on a couple of the exhibits presented by the Pendragon folks.

Q. All right.

A. One in particular. It has to do with Mr. McCartney's creation of an adsorption isotherm curve from which he derived certain reserve information on our Fruitland Coal wells.

Q. Do you want the see the notebook with that --

A. Please.

Q. -- those exhibits? And just briefly point out to the Examiner which exhibit it is and what your opinion is regarding that.

A. This is Exhibit Number 6 in the -- I guess it's M Number 6, in the Pendragon book.

Mr. McCartney indicated yesterday that he took this information from a well that is greatly removed or at a great distance from our area and that he attempted to modify the curve by simply factoring in a reduction for each of the Langmuir constants and drove it down to the point where the gas content that he was using for the coals in question fell on that curve.

That's wrong for two reasons.

Number one, the Langmuir constants are specific to the coals, and they are determined through a destructive test on a coal core. And that test is performed in the laboratory, and it is going to vary depending on the *in situ* properties of the coal, and that has to do with the ash content, the maceral makeup of the matrix of the coal, and a number of other factors. And we know that these coals are much different in makeup than the coals that he was using or that this curve was derived from.

The other thing that Mr. McCartney failed to realize is that the gas content that is quoted here, 110 standard cubic feet per ton at 250 p.s.i., is an undersaturated gas content, meaning that it would not even fall on this curve.

In other words, it's going to be somewhere below this curve, and no gas will be released from these coals until the pressure is reduced to the point where that now falls on this line.

And that's exactly what we saw when we started producing our Fruitland Coals in this area. We had literally months of water production with no gas production, meaning we were reducing the pressure of the reservoirs from some point back to the adsorption isotherm curve, before gas was released from the coal, desorbed from the cola, and started flowing through the cleat system to the wellbores.

So any information or data that is derived from this curve, especially with regard to reserves, is going to be totally, indisputably related to our Fruitland Coals in this area.

Q. Okay, what else? What other exhibits did you want to address?

A. We talked briefly about Mr. McCartney's pressure information, and I would just like to reiterate the fact that when you're looking at communication between two zones in the same wellbore, and one of those zones is depleted, and you are comparing that to a pressure in an offset well, even if that well is relatively close -- I think a couple of thousand feet was referenced on a number of occasions -- the pressure in the formation of the producing well 2000 feet away, of the higher-pressured zone, is obvious- -- is always going to be higher than the pressure in the depleted zone, 2000 feet away, until that entire reservoir is recharged to the pressures seen in that offset producing well.

So the indication of communication is much greater, realizing that they are declining at the same rate, than it is if they overlaid one another.

Is that -- I may not have said that exactly intelligibly. But the point is, you are recharging a depleted zone 2000 feet away from the source of the recharge, even though that recharge is occurring in the same wellbore. Okay?

Q. Well, what is it about that that shows communication?

A. Again, it is the fact that those curves are parallel to one another. They are declining at the same rate, meaning that the gas is being removed from that zone, the producing zone, the gas-bearing zone, at the same rate that is exhibited in both wells.

Q. And what are the wells that are referenced in that exhibit?

A. This one is the Chaco Number 1, and the Gallegos Federal 7 Number 1.

Q. Okay, would you expect, absent communication, for those curves or lines, one representing a coal well and one representing a Pictured Cliffs sandstone well, to be tracking each other like that if there wasn't communication?

A. Absolutely not. The fact that the coals can contain so much more gas than a conventional sand, even over the same thickness, the same pressures, would mean that the decline of the conventional pressure would be much steeper than the decline of the Fruitland Coal pressure.

Okay? In essence, you are looking at a pressure-support system through the desorption process of a Fruitland Coal, whereas in a standard, conventional sandstone reservoir, it is simply a depletion process.

Q. Mr. O'Hare, let me ask you a couple of questions to wrap this up.

First of all, I'd ask you --

MR. CARROLL: Just a minute.

MR. CONDON: Okay.

MR. CARROLL: You can finish the direct.

MR. CONDON: Yeah, we're -- a couple more questions.

Q. (By Mr. Condon) Would there be any harm to Whiting and Maralex if the Pendragon Chaco wells which have been shut in by order of the District Court go back on production?

A. Most definitely.

Q. What would that harm be?

A. We would continue to lose reserves from our Fruitland Coal formation. We'd also continue to lose tax credits.

Q. Would an allocation of gas from the Pendragon Chaco wells that recognize the true contributions of production from those wells from the coal and from the Pictured Cliffs totally make Whiting and Maralex whole in terms of future production?

A. No, it would not.

Q. Why not?

A. Because of the difference in the Section 29 tax credits attributable to the Fruitland wells that are not attributable to the PC wells.

Q. And explain that to the Examiner, if you would.

A. Well, again, any production from the Fruitland Coals is eligible for a tax credit that amounts to somewhere around $1.05 to $1.08 per MCF up through the year 2002. So if the Chaco wells were shut in through that time period and then allocation of production was allowed from that point forward, then there would be a fair way to achieve the same kind of economic results that we would have, had they not communicated with our Fruitland zone.

Q. Okay. And if coal gas is produced through the Chaco wells, are you going to lose tax credits into the future?

A. Yes, we will.

Q. Have you already lost tax credits --

A. Substantially.

Q. -- from past production?

All right. If the Chaco wells continue to be shut in, is there any harm, in your opinion, to the Chaco wells?

A. No, there's not. The State of New Mexico practiced proration of conventional gas pools for years on end. Even during the low-gas-price periods of the 1980s, many of the conventional, including PC, wells were shut in due to the low prices. When those wells were brought back on production at the end of that period, they actually resulted in higher production rates and no loss of reserves.

MR. CONDON: I have no further questions.

EXAMINER CATANACH: Okay. We need to break again at this point, for the Commission.

(Thereupon, a recess was taken at 10:36 a.m.)

(The following proceedings had at 10:35 a.m.)

MR. CONDON: Mr. Examiner, before Mr. Hall starts his cross-examination we had Mr. O'Hare identify Exhibits 57 and 62, and I want to make sure that I move the admission of those two exhibits.

MR. HALL: No objection.

EXAMINER CATANACH: Exhibits 57 and 62 will be admitted as evidence.

Mr. Hall, your witness.

CROSS-EXAMINATION

BY MR. HALL:

Q. Mr. O'Hare, more recently you testified about recharge theories discussed here the past couple of days, and I believe you were referring to McCartney Exhibit M2, was it not, on the Chaco 1?

A. I believe that's correct. Yes.

Q. Mr. O'Hare, are you contending that the PC well, the PC formation, is being recharged by your coal well which is some 2000 feet away?

A. No, sir.

Q. What are you contending?

A. As far as recharge?

Q. Yes.

A. That as long as our Fruitland wells are producing there is no recharge.

Q. I see. How far away is the 12-7-1 -- 12-7 Number 1, from the Chaco 1? Any idea?

A. I believe it's about 3600 feet.

Q. Now, how about the Chaco 2-J? Did you consider that well?

A. As far as what?

Q. Whether there was any effective recharge of the PC between those two wells?

A. Again, as long as our wells are producing, there is no recharge.

Q. All right. Let's refer to Mr. Nicol's Exhibit N15. Do you have a copy of that here?

A. I don't believe --

Q. Let me just have you refer to this one here.
A. Okay.
Q. If you'll look at these pressure points for the Chaco 2-J --
EXAMINER CATANACH: Mr. Hall, is that N15?
MR. HALL: N15. It looks like this.
EXAMINER CATANACH: Got it.
MR. HALL: Let me see if I can find a blow-up, Mr. Examiner. I don't know where that blow-up went, Mr. Examiner.
If you don't mind me looking over your shoulder here --
THE WITNESS: No, that's fine.
Q. (By Mr. Hall) Let's look at some of the pressure points for the 2-J. Can you say, looking at this exhibit, what was the pressure for the 2-J in 1979?
A. It looks like it was about 220 p.s.i.
Q. And what is the next pressure point for the 2-J on here that you see?
A. Is that the one I just -- It looks like it's probably 160.
Q. All right. And if you look at that pressure for the 2-J in 1995, what is that pressure there?
A. It's probably 180 or 190.
Q. All right. And when you look at the most recent

pressure on that, what does that reflect?

A. That's probably 180.

Q. All right. Can you explain the increase in the pressure to 1998 from the 1984 pressure data?

A. Yes, sir. This well was also acidized in January of 1995, and again there's very little distance between the upper set of perforations in that well and the bottom of our coal.

The well that it offsets is the Gallegos Federal 1 Number 1, which is the well that we have had the longest dewatering of, meaning that it has produced more water than any of the other wells in the area. It's actually --

Q. How far away is that? Excuse me.

A. From the 2-J?

Q. Yes.

A. It's just a couple hundred feet.

Q. All right.

A. Okay? So we believe that that well is also in communication with the Fruitland Coal, as exhibited by that pressure increase.

Q. All right. Is it your contention that it was the acid job that may have breached the barrier between the formations?

A. Yes, it is.

Q. You were present yesterday for Mr. Williams' testimony, were you not?

A. Yes, I was.

Q. Do you agree with his conclusions that the 1-J and 2-J wells do not appear to be in communication with the Pictured Cliffs?

A. I believe his testimony was that they were in pressure communication but there was not an effective production communication between the two zones.

I disagree with that. I believe there is both a pressure communication and a channel for production of Fruitland gas through the Pictured Cliffs perforations in the 2-J well.

Q. All right. You spoke earlier about the acid job on the Chaco 4. Do you recall that?

A. Yes.

Q. What is your closest Fruitland location to that well? Is it the Whiting Fed 1 you have located here?

A. No, sir. The Chaco Number 4 is almost equidistant between the 6-2 and the 12-1.

Q. All right. Can you tell us about the volumes and rates for your frac jobs on those nearby coal wells to the Chaco 4 well?

A. I don't have those at my disposal here at the table. I can give you some general information on --

Q. Why don't you do that, generalizations?

A. The 12 Number 1 screened out during the job. I believe we got somewhere around 50,000 to 60,000 pounds of sand in the formation. My recollection of the 6-2 is that we got in excess of 80,000 pounds into that Fruitland formation.

Q. Okay. On the other well, was the frac pressure on the order of 110,000 pounds? Is that accurate to say?

A. The frac pressure?

MR. CONDON: 110,000?

Q. (By Mr. Hall) Oh, I'm sorry, 80,000 was the sand volumes.

A. Right.

Q. All right. In your opinion, Mr. O'Hare, which is more likely to have breached the barrier on the Chaco 4 if that occurred: the acid job or the frac jobs you performed on the coal wells?

A. The acid job.

Q. You testified that when you acquired these properties you were trying to beat the expiration of the Section 29 tax credit --

A. Correct.

Q. -- end of 1992.

You were drilling a number of Fruitland wells --

A. Yes, we --

Q. -- in this area and throughout the San Juan

Basin, correct?
A. Correct.
Q. How many wells did you have going at once when you were completing these particular Gallegos area --
A. During the completion phase?
Q. Yes.
A. One well at a time.
Q. Okay. How about the drilling phase?
A. During the drilling phase, we had as many as seven drilling rigs running at the end of 1992.
Q. How long did you wait after the drilling phase for these Gallegos-area wells until you did the completions on them?
A. The first one was just a couple of months following the end of the drilling of the well.
Q. And the next -- others directly following --
A. No --
Q. -- the --
A. -- no, the others were at monthly intervals, or even longer in some cases.
Q. Okay. And did you have other completion jobs ongoing about that same time for your other Fruitland wells outside of the Gallegos area?
A. Probably, yes.
MR. CONDON: Can I just -- I just want to make

sure the court reporter is picking up Mr. O'Hare as he turns. Okay.

COURT REPORTER: Yes, I am.

MR. CONDON: All right, thanks.

Q. (By Mr. Hall) For your subject coal wells here, and generally, again, how long did you wait from the time you completed your coal wells, frac jobs, until you first started reporting gas sales, generally again?

A. Could you restate the question, please?

Q. What was the length of time from the time you completed your coal wells till you first started reporting gas sales?

A. It depended on what the interval was between the time we completed them and we started producing gas, and that was not consistent from well to well.

Q. I see. Can you explain why no production data was available from public sources like *Dwight's* until 1996 for these wells? Do you know?

A. I wasn't aware of that.

Q. Did you report your produced water volumes from the coal wells before you commenced your gas sales?

A. I believe we did, yes. Let me qualify that by saying that any water that was produced back after the frac -- in other words, load water, was not reported, no.

Q. All right. Do you have any of that water-reporting information with you here today?

A. No, I don't.

Q. So that's not included on any of your exhibits that you or any of your other witnesses are presenting?

A. Are you talking about C-115 reports?

Q. Any form of water-production reporting data.

A. Regulatory reports?

Q. Any form.

A. I have water production reports, but not that -- not C-115 reports or 3160 reports or anything that went to regulatory bodies.

Q. All right.

A. What I have are tabulations of our production information.

Q. All right, in the form of an exhibit?

A. No, I don't think we introduced any of it.

Q. Would you make that available to us, please, sir?

A. I don't see a problem with doing that. In fact, I think we have done that.

MR. CONDON: You're talking about the production information, not asking us to prepare an exhibit, right?

MR. HALL: Correct.

MR. CONDON: Okay, sure.

Q. (By Mr. Hall) Mr. O'Hare, you stated you made some field observations on water production, and then you testified you prepared some water-gas-ratio calculations from that?

A. I'm sorry?

Q. You did some water-gas-ratio calculations from your field observations?

A. No, sir, I did not testify to that.

Q. Were those calculations done from the reported volumes?

A. Yes, they were.

Q. I see.

Did you attempt to track the rates of incline or decline for your water production from your coal wells before and after the Chaco wells came on line?

A. At the time, no, because we didn't know the Chaco wells were on-line or that they were potentially interfering with our wells.

Since then we have looked at the water information, water-production information, on our wells. And again, we don't have a complete set of water-production information on the Pendragon wells. So it's not very easy to make a comparison there.

But I would like you to ask me some more questions about that.

Q. I'll do that. Are you able to say whether there was a decline in your water-production rates corresponding in time with the Chaco wells coming on-stream?

A. No, I'm not able to say that, and there's a good reason for that.

If you look at Mr. Ancell's presentation yesterday, you cannot expect to see a decline in the water-production rate once the desorption process is far enough along to where the relative permeability to gas is much higher than the relative permeability to water.

And the reason for that is, for every barrel of water that you're removing from the formation, you're not necessarily transporting additional water to the wellbore; what you are doing is allowing desorption of gas to occur from the coal. And that's why you see the negative -- decline in gas production.

Q. Let's turn to your Exhibit 41. That's your file on the Lansdale Fed Number 1. Do you have that?

A. I don't see it here.

Q. It looks like this.

MR. CONDON: It's this one here; is that --

MR. HALL: Here, just use this one. Do you have that, Mr. Examiner?

EXAMINER CATANACH: Yes.

Q. (By Mr. Hall) Lansdale Fed Number 1 is a Pictured Cliffs completion, is it not?

A. Currently?

Q. As shown on that Exhibit 41?
A. Exhibit 41 shows that it is a Pictured Cliffs, a Farmington sand and a Fruitland completion --
Q. All right.
A. -- Fruitland Coal completion.
Q. By the way, who's the operator of that well?
A. At which point in time?
Q. As shown on your Exhibit 41, those completion reports in Exhibit 41.
A. At which point in time?
Q. At the very top, in 1980.
A. In 1980, Southern Union Exploration Company was the operator of this well.
Q. And that shows a perforated interval in the Pictured Cliffs, does it not?
A. I assume so, yes.
Q. And you testified that there were some coal fines that were recovered, some set of perfs, or at least from the well, anyway.
A. The record here shows that, yes.
Q. Yes. And you're aware -- the coals that appear in the body of the Pictured Cliffs sandstone itself, as shown by the core analysis, correct?
A. In the Lansdale Federal?
Q. Yes.

A. I would not say that -- You're talking about the coal below the perforations in the Pictured Cliffs?

Q. Coals within the Pictured Cliffs formation.

A. I'd say yes, there is a thin stringer of coal in the Pictured Cliffs formation, in the Lansdale Federal.

Q. And you also testified about coals in the casing for the Chaco Number 5. Did you see any evidence that there was a change in the BTU which you could attribute to those coals?

A. Yes, I believe that change occurred in January of 1994. An analysis showed that the BTU content went from approximately 1100 down to 1020 at that point in time.

Q. But you recognize there were no coals at the levels where those holes appeared in the casing, correct?

A. But there was also no cement behind the pipe more than a hundred feet below those holes.

Q. Okay.

A. The Chaco Number 5 also contains upper coals that are more than 150 feet above the top of the B coal.

Q. Mr. O'Hare, you made reference to this cross-section exhibit, and you identified this thin coal section here, which is just above what's been described as the middle bench of the PC, as what you contend is the base of the Fruitland formation; is that accurate?

A. Yes, it is.

Q. You call that the lower basal coal; is that right?

A. Correct.

Q. And you testified you had a blow-up of the well log from the Schneider B Com well, Cedar Hills area, that you compared to another log. What was that other well log that you did the comparison?

A. It was this cross-section.

Q. I see. Do you have a cross-section that ties what you call the lower basal coal section here to the well log in the Schneider B Com?

A. No, I don't, but Mr. Nicols presented one.

Q. Did you ever complete a well in this lower basal coal section?

A. In this area?

Q. Yes.

A. Not in the six-section area, or the five-section area that's the topic of this hearing, no.

Q. Why not?

A. Because I did not want to frac down into the Pictured Cliffs or risk that possibility.

Q. Do you believe that, had you frac'd above that lower basal coal, that that lower basal coal you identified would have stopped fracture growth?

A. If I had frac'd above it?

Q. Yes.

A. How far above it?

Q. You tell me. Do you think that lower basal coal would have been an effective barrier to stop fracture growth, had you frac'd above it?

A. It depends on how far above it. If I frac'd one foot above it, probably not. If I frac'd two feet above it, probably not. If I frac'd 200 feet above it, it would never see it.

Q. Mr. O'Hare, you earlier testified that you thought that there had been induced communication from the Chaco well fracs into the Fruitland Coal and that it was intentional?

A. Yes, sir, I did.

Q. What's the basis of that?

A. The basis has to do with the fact that the Lansdale Federal was intentionally perforated and stimulated in the Fruitland Coal in 12-94, without a pre- or post-report or sundry notice to any regulatory agency. Every effort was made to conceal that fact for more than four years -- I'm sorry, for almost four years.

And the fact that the water production was never reported on any of the Chaco wells until a state inspection was conducted, and then only for the month in which that inspection was conducted, indicates to me that there was a very determined effort to hide the fact that water was being produced from these wells.

Q. That's it?

A. No, there's a number of other --

Q. Well, let me ask you --

A. -- circumstances that I believe point to the fact that this was intentional.

Q. Let me ask you, isn't it true that J.K. Edwards owns the coal rights in 160 acres of the Lansdale Federal well?

A. Yes, that is true, as far as I know. That does not give him the right to perforate that Fruitland Coal, it does not give him the right to hide the fact that he did that work from the regulatory agencies, it does not give him the right to perforate in an unorthodox location in this pool without first notifying the regulatory bodies and the offsetting owners under the existing rules and regulations, it does not give him the right to hide the production of water from that well. Just because you own something doesn't mean that you can break every rule there is.

Q. What's the basis of your contention that says he has no right to perforate into the coal?

A. The State has very set rules on perforating --

Q. Yeah, can you tell me which rule you're referring to?

A. The rules that were formed for the Basin Fruitland Coal Pool in the San Juan Basin require, number one, that you notify the appropriate regulatory agency of your intention to complete in that zone prior to doing that work.

If it's an unorthodox location, it requires that you apply for an administrative approval of that unorthodox location and that you notify the offsetting owners of that formation prior to doing the work.

Q. Prior to producing it?

A. Prior to doing the work.

Q. What rule is that?

A. I can't tell you off the top of my head.

Q. Yeah. Back in time to when you first talked to Merrion about picking up this property and you said you had done an initial evaluation on the PC -- Correct?

A. When they offered the PC wellbores to us?

Q. Yeah.

A. Yes.

Q. You did a decline-curve analysis, you say?

A. Yes, I did.

Q. Do you still have that?

A. I believe I do.

Q. Could you provide that to us?

A. Not today. I believe it's in my office.

Q. All right. When you did that analysis, did you include that lower bench of the PC?

A. No, I did not. If you're talking about the water-bearing bench?

Q. Yes, I think we're in agreement which one we're talking about.

You also said that in the course of the meetings in Aztec you presented some volumetric calculations for your coal reserves?

A. I don't recall saying that.

Q. Did you do any volumetrics on your coal reserves?

A. Yes, we did.

Q. What were your assumptions about thickness?

A. We took the net coal thickness in each of our wellbores as determined from density logs.

Q. And did you include this lower coal, the lower basal coal?

A. I don't recall offhand.

Q. Isn't it your position that the gas content in the coal in this area is on the order of 110 standard cubic foot per ton?

A. I believe that's the minimum gas content in this area, yes.

Q. Do you still agree with that?

A. That it's the minimum gas content?
Q. Yes.
A. Yes.
Q. What are the averages, and -- What is the average, and what's the maximum?
A. The average gas content in this area? Number one, we don't have any kind of solid evidence to -- on a well-by-well basis, to derive an average for gas content in this area.
I believe the maximum that we might be looking at -- and this is again based on more intuition than actual data, is 130 to 140 standard cubic feet per ton. That's strictly my opinion.
Q. You testified that you believed that for every two feet horizontal fracture you achieve through a frac job, that you also gain one foot vertical growth, up and down; is that basically what you said?
A. No, not quite.
Q. Tell me what you said.
A. I think I said that generally speaking, in an unbounded formation, you will achieve one foot of frac-height growth upward and one foot of frac-height growth downward for each foot of horizontal frac-height growth.
Q. All right. Can you say how much vertical height growth you achieved on your coal-frac job, say, with your

80,000-pound volume?

Q. I can't say definitively what our frac height was, no.

Q. Can you estimate?

A. I can estimate that it stayed within our Fruitland Coal zone, which is on the order of 18 to 21 feet in thickness. A couple of the wells, we actually perforated some of the upper zones, and I would expect that some of those zones took some of the frac also.

Q. All right. In our District Court lawsuit you have maintained that it is possible for fracture treatment jobs on the coal wells to have escaped out of zone. Would you agree with that contention?

A. I personally didn't contend that, but I would have to say that there is a possibility, yes.

Q. Who contended that?

A. I believe that was presented by one of the Holditch witnesses.

Q. Did Holditch do a frac profile on any of your coal-gas wells?

A. I believe so. I'm -- That's probably a better question to ask Holditch than it is me.

Q. Okay. Do you know if they did that before the District Court hearing -- what? June 29th of this year?

A. I know there's been some ongoing work that

Holditch has done since January of this year --

Q. All right.

A. -- regarding frac work, for the fracs that were performed on both the Fruitland and the PC wells, but I can't tell you what was done when.

Q. All right. But you do acknowledge there was some work done on the coal fracs by Holditch?

A. I believe so, yes.

Q. Do you know if they used a simulator to do their work for the coal fracs?

A. That's my impression, yes.

Q. Do you know what simulator program they may have used?

A. I think they testified in the court hearing that it was FRACPRO.

Q. I think they established they used that for the Pictured Cliffs fracs, but do you know whether they used FRACPRO for their coal-frac profile?

A. I assumed it was both, but no, I don't.

Q. Now, you testified that in the course of your investigation of this situation you did an engineering study about October of 1997?

A. It was completed in October of 1997, yeah.

Q. And you shared that with Whiting at that time?

A. Right.

Q. And they followed up with their own engineering study?

A. I believe it was a simultaneous or ongoing study that they had undertaken while we were performing ours.

Q. And that was followed up with the Holditch study, I assume?

A. Correct.

Q. Were any of those studies presented to anyone outside of Whiting, Maralex or Holditch, with the exception of counsel, of course?

A. Not to my knowledge, no.

Q. Or presented to the OCD in Aztec?

A. The study?

Q. Yes.

A. No, sir.

Q. And did those studies include an evaluation of the coal formations as well, coal completions?

A. Yes, they did.

Q. When did you first take this deal on these properties to Whiting?

A. I never took this deal to Whiting.

Q. Oh, how did they acquire their interest in the property?

A. One of the original investors in our project sold their interest to Whiting.

Q. Who was that?
A. Gordy Gas Corporation.
Q. Do you know what data or other materials were disclosed to Whiting in the course of the due-diligence phase of Whiting's acquisition?
A. No, sir.
Q. When did you first tell Whiting that you thought there might be a problem with the perforations in what's been called the upper PC bench?
A. It was August of 1996, shortly after we discovered it.
Q. Did they call that to your attention, or did you bring that to their attention?
A. We brought it to their attention.
Q. After you performed the frac jobs on your coal wells, did you do any temperature surveys?
A. Not on these wells, no.
Q. Any tracer surveys?
A. No, sir.
Q. Do you believe that was prudent?
A. At the time, yes. Now, I wish I'd have done it.
Q. Mr. O'Hare, you were part of the San Juan Basin Coal Committee, and you said that some operators had expressed concern at -- possibility of fracs might reach out of zone. Was the concern expressed that the fracture-

treatment jobs that you typically see on coal wells might extend out of zone into the Pictured Cliffs formation?

A. I don't recall that being expressed as a concern.

Again, the purpose of the committee was to try to get together to recommend rules that the two State regulatory agencies could adopt for the development, the efficient development, of the Fruitland Coal Pool. So we were not as much concerned with the conventional pools, other than identifying them as a side note to the identification of the Fruitland Coal pool. Okay?

So the main consideration was, How are we going to be able to tell if a well is really producing from the Fruitland or if it is producing from a conventional pool?

And the committee agreed on nine different -- I believe it was nine different items that, in their words, a preponderance of data would indicate production from the Fruitland Coal Pool.

And that's what we are presenting here. It's more than just a preponderance of the data. Virtually everything that we have looked at indicates that the Chaco wells are producing Fruitland Coal gas.

Q. Well, set me straight. I thought I heard you testify that early on, that your involvement with the coal committee, that there was a concern expressed that fracs outside of the coalbody may reach into the coal and, as you say, there may be a problem determining where production is coming from. Is that accurate?

A. Pretty much.

Q. Wasn't it also discussed during those meetings that the same concern could apply with frac jobs in coal wells, because after all isn't it accepted that you can't have a coal well without a frac job?

A. The answer to the last part of your question is no, it's not accepted that you can't have a coal well without a frac job. There are parts of the Basin that coal wells have produced phenomenal amounts of gas without ever being frac'd. Most of those have to do with cavitation completions. That's a totally different subject, and we can go into that if you like.

But to answer the first part of your question, there wasn't the concern -- there was a mention, I'm sure, of frac'ing out of the coals, but the general consensus even to this day in the industry is that fracs initiated in the coal tend to stay within the coal, because it is such a soft rock that it is going to propagate through those high-permeability cleat systems much easier than it is going to propagate through the tighter, lower-permeability sandstone and shale interval surrounding the coals.

Q. Do you have a log available of the Schneider Gas B Com?

A. I believe Counsel does.

Q. Could you get that from them? I need to ask you about that.

A. Here's one right here. It's part of an exhibit.

MR. CONDON: Mr. Hall, we have this one also. Mr. Ayers is planning on -- when he's testifying.

Q. (By Mr. Hall) Can you show me -- Well, let's keep this up here. We've identified on Exhibit 16 what you call your lower basal coal.

A. Correct.

Q. Can you show me where that shows up on the log for the Schneider B Com?

A. I believe that is this coal right here.

Q. And you're referring to this blue?

A. Yes.

Q. Can you show me where on the Schneider B Com log that the upper Pictured Cliffs sand is reflected?

A. The upper Pictured Cliffs sand?

Q. Right.

A. Mr. Nicol's definition, or mine?

Q. You said that the Schneider Gas B Com well matched up perfectly with the well log that you utilized in the Gallegos Canyon area.

A. But I never said that there was an upper Pictured Cliffs sand in the Gallegos Canyon area.

Q. All right, what do you call that sand?
A. If you're referring to this sand here between the basal coal and the B coal?
Q. Uh-huh.
A. That is the WAW Fruitland sand.
Q. All right. Where does that show up in the Schneider Gas B Com log?
A. Again, this is not -- You understand that we're such a distance away from the Gallegos area that these are not equivalent -- I mean, say, in geologic terms, those are not the same coals, not the same sand sequence, but in general the formations are the same.
Q. I see.
A. Okay? What we're talking about here is this interval between the two coals, is comparable to this interval between these two coals.
Q. I see. Do you have any pressure data for your Gallegos 12 Number 1 well available to you?
A. I have a March, 1998, flowing pressure at the pipeline.
Q. Do you know what the initial shut-in pressure was for the well? Can you recall?
A. Off the top of my head, it was somewhere in the 200- to 250-pound range. I don't have an exact figure that I could give you.

Q. I thought I heard you testify earlier it was in the 180-pound range.

A. The initial pressure?

Q. Yes.

A. No, sir.

Q. Okay. What's the saturation pressure in the coals you're producing from?

A. The saturation pressure?

Q. (Nods)

A. Would you please define that term?

Q. Well, I thought I heard you testify that you believe the reservoir was undersaturated at 200, 250 pounds. What pressure do you consider to be saturation pressure?

A. We don't have what we can claim to be an accurate saturation pressure as you're defining it. We actually call that the desorption pressure. And the reason we don't have an accurate pressure is because we did not shut in the wells during the early dewatering phase, to try to determine what that pressure would be.

And the best way to do that would be -- In the field, anyway, the best way to do that would be to shut the wells in as soon as we saw gas, and let that -- with the bottomhole pressure gauge, let that pressure indicate what the desorption pressure of the coal is. We did not do that, though.

Q. You testified that you calculated volumetrics for the coal reservoir in the area. What are the volumetric reserves you assign to the perforated intervals in the coal?

A. I don't have that off the top of my head. If you'd like a general, ballpark number, I'll be happy to give that to you.

Q. If you could do that, please.

Go ahead, Mr. O'Hare.

A. A very quick off-the-calculator number for reserves in the perforated interval in our wells is going to be somewhere on the order of a BCF of gas, conservatively.

Q. How much of that do you think you're going to recover?

A. That is the recoverable. I didn't realize you were asking for gas in place. Do you want a gas-in-place number to go with that?

Q. Yes, please.

A. Gas in place is roughly 1.24 BCF.

Q. Some of the casing pressures that you all supplied to Pendragon from the coal wells, we discussed from the 200- to 220-pound range, then on the -- discussing the Gallegos 26-13-12 Number 1, showed a 180-pound pressure. Is that reflective of the Pictured Cliffs formation pressure, in your view?

A. In my view, no.

Q. And you've looked at the wellbore pressures for -- the wellhead pressures for Pictured Cliffs wells. Did you take into account the water in the wellbore at all?

A. We tried to take that into account by using only extended shut-in pressure readings from those wells.

Q. Well, assuming that they're one barrel of water in the wellbore, say, how would that affect wellhead pressure, PC wells?

A. It would reduce -- I'm sorry, maybe I -- Could you rephrase the question for me?

Q. Well, I want you to assume that there's a barrel of water in the wellbore for a PC well?

A. Okay.

Q. What effect would it have, wellhead pressure?

A. Compared to what?

Q. If there were no --

A. If there was no water in that same wellbore? Any amount of water in the wellbore is going to show a reduced wellhead casing pressure versus the case where there is no water in the wellbore.

Q. Okay, can you say by how much?

A. Depending on the mechanical configuration of the wellbore, yes.

Q. How about for -- say, for instance, the configuration for the Chaco Number 5?

A. Do you want me to calculate that now?

Q. Sure.

A. Can you give me that configuration?

Q. It's 2 7/8.

A. What weight is the casing, or the internal diameter?

Q. Two and a half.

A. Okay. And no tubing?

MR. McCARTNEY: No tubing.

THE WITNESS: Can you tell me the density of the water?

Q. (By Mr. Hall) It's fresh water.

A. That could reduce the wellhead pressure by as much as 71 pounds.

MR. HALL: That concludes my cross, Mr. Catanach.

Thank you, Mr. O'Hare.

EXAMINATION

BY MR. CHAVEZ:

Q. Mr. O'Hare, when you first were offered a chance to purchase those PC properties in the wells, you said, I guess, you did some, again, back-of-the-envelope type of calculations to see whether that was a worthwhile project?

A. Yes, I did.

Q. Did you include all the intervals that were perforated at that time in those wells in your calculations?

A. Yes, I did.

Q. Have you had experience designing Pictured Cliffs frac jobs also, along with the Fruitland Pictured Cliffs?

A. Yes, I have.

Q. Given your experience doing that, do you see a big difference in the way you design Pictured Cliff fracture programs, versus the way the Pendragon fracture programs were designed?

A. I can say that my designs were -- had different parameters for them.

Q. But given the parameters in the Pictured Cliffs that Pendragon was completing in, how would your frac jobs differ, just in general?

A. I would not have frac'd this.

Q. And why is that?

A. Because it was too close to the coal formation to be assured that we wouldn't frac into the coal. If I didn't own the coals, I would not have frac'd these wells.

Q. Okay, have you given -- Say, in your work with Amoco, had you made that type of recommendations there and in other positions, to not fracture the Pictured Cliffs because they were too close to the coal?

A. Yes, sir.

Q. Is the Fruitland Coal in your area in the -- what might be called well-cleated coal, as compared to how coals are generally thought of cleated in the Basin?

A. Yes, in our view it's very well cleated.

Q. How would you compare, say, the cleating in your coals to those in the Cedar Hill area?

A. If you're just looking at the coal itself, I'd say it's fairly comparable. You have to remember that the Cedar Hill is in a much higher overpressured area compared to this area. We're very underpressured here in the Chaco Gallegos area of the Basin. And so the information that you get to the surface from the two different areas is quite different if you're only looking at cuttings.

There were cores taken in the Cedar Hill area, even pressurized cores. We had one pressurized core down here in the -- what we call the west Bisti area, and that pressurized core barrel leaked, so there was no pressure on it by the time we got it to the surface and opened it. So we don't know what the *in situ* cleating looked like when we got that core to the surface.

But looking at what we had, versus what I have seen in the pressurized cores in the Cedar Hill area, it was very similar.

Q. Okay. Do your Fruitland Coal wells require fracturing in order to produce, or could they produce without fracturing?

A. We believe it's possible they would produce without fracturing, but not at the kind of rates we've been able to establish in this area.

Q. What type of production might you expect if you hadn't fractured the coals?

A. If we didn't fracture the coals?

Q. Yes.

A. Probably on the order of 100 MCF per day peak production.

Q. Earlier in your testimony, you said that your wells had developed -- and I think these were your words -- a stabilized incline for gas production and a stabilized decline in water production. Is that --

A. Pretty accurate, yeah.

Q. However at some time, that would have to change, wouldn't it? I mean, when you say "stabilized", is that something that you expect to continue, or do you expect that to change at some point?

A. We do expect that to change at some point, and I think Mr. Ancell presented a curve that showed a nice incline and then a rollover, even a flat point, on that curve at some time, and then it rolls over and starts declining over time.

And we expected a smooth transition like Mr. Ancell's curve exhibited. We did not see that in the offsetting wells to the Chaco wells.

Q. Okay. When you say "smooth transition" what do you mean by that?

A. Basically a constantly changing slope. Does that make sense? If you take the derivative of the derivative, that gives you the rate of change of that slope.

Q. Okay, I understand. So that was expected to change at some point in the life of the wells anyway?

A. Yes.

Q. What's -- Being that it changed at the same time that the Pendragon wells were put on production after frac'ing, is that an indication to you that their wells caused that change, or did you have any other way to anticipate when that change might occur in your wells?

A. The character of that change is really what triggered our suspicions with the Pendragon wells. If that character had been, as Mr. Ancell had illustrated yesterday, a smooth, constant rate of change, we wouldn't have had any kind of indication that the Pendragon wells were affecting our wells.

But as Mr. Williams pointed out yesterday, there was a very dramatic rate of change in the slope at the time that they performed their stimulations in the Pictured Cliffs wells.

Q. Do other coal wells in this area that may not have been affected by Fruitland/Pictured Cliffs wells, do you believe, show a smooth transition or smooth rate of change at that time?

A. Yeah, for the most part they do. If you look at -- I think it's Louis Dreyfus is to the north of us; he used to be DaKalb Production -- they had some Fruitland Coal wells that acted a lot like these wells are acting. They are a township away, but there is definitely a very nice, smooth change, in their production over time.

Q. How does the early water production in the Chaco wells frac'd by Pendragon compare to early water production after the frac'ing of other PC wells in that area?

A. It is much higher. And again, this is based on field observations, since we don't have any data reported to the regulatory agency showing what those volumes are. My observation is based on the fact that we went out and looked at their pits and saw those pits full of water.

And I can tell you from my own personal experience with Amoco in particular, when we frac'd a Pictured Cliffs well and put it on production, we never saw earthen pits full of water.

Q. Were your wells then, in your opinion, still in the dewatering phase at the time that the Pendragon wells were fractured?

A. Would you define "dewatering phase" for me?

Q. Well, do you know if there's a dewatering phase that's generally accepted by industry during the production of the wells?

A. Definitely, my --

Q. Okay, in you opinion for a dewatering phase, that's what you understand.

A. My definition of "dewatering phase" is, until there is no more water producing from that well. We are still in the dewatering phase of our wells --

Q. Okay, is that --

A. -- because we're still producing water from each one of our wells.

Q. Is that the general understanding you have of the use of the term "dewatering" as by other operators that --

A. Well, I think there are other people that say the dewatering phase is what you get until you start seeing gas production, and then it's no longer a dewatering phase. And I would challenge that because you are definitely removing water from the formation, it is having an impact on lowering the reservoir pressure below the desorption pressure of the coal. And as long as you are continuing to lower that reservoir pressure below the desorption pressure, you're desorbing gas and you're dewatering the formation.

Q. Okay. With the greater amount of water produced from the Pendragon wells, as you suspect, and if it was coming from the Fruitland Coal, wouldn't anticipate to see an effective increase in gas production in Fruitland Coal wells in that area, being that water is being withdrawn from lower in the reservoir?

A. Total gas production increased dramatically when the Chaco wells started producing following their stimulation. Our wells were producing around 400 -- slightly over 400 MCF of gas per day. With the combination of the Fruitland production from the Chaco wells, total production on the 320-acre spacing was well in excess of 800 and 900 MCF of gas a day, immediately following the restimulations.

Q. And that's again assuming that it was -- gas production in the Pendragon wells was from the coal zone?

A. That is relying on all the data that has been presented thus far, indicating that's where that gas is coming from.

Q. Would you have anticipated that the gas analyses of the gas being produced from the Pendragon wells would have shown that it was Fruitland Coal gas at the very near term to the time they started producing after their fracs?

A. With the size of volumes, the large rates that they were producing, yes.

Q. Did it bother you that it took more than a year, in some cases a little more than two years, before gas analyses indicated gas of a character more of Fruitland Coal than Pictured Cliffs?

A. Number one, that's not true, Frank. Some of those wells showed Fruitland gas analysis before they were even restimulated. The Chaco Number 5 comes to mind, where a year before the attempted frac on that well, we were seeing a BTU content reminiscent of Fruitland Coal gas, not PC gas.

The Chaco Number 4 we were seeing, immediately upon restimulation of that well, BTU contents that were indicative of Fruitland gas. The only well that did not show that was the Chaco Number 1, to my recollection.

And somebody asked me about that a long time ago, and I said the first thing that we do when we look at a scatter plot, any statistician will do when they look at a scatter plot like the one Mr. Williams put up yesterday was, you throw out the high and you throw out the low, and then you look at standard deviation on the remaining points.

If you get rid of the one point that is anomalous on the Chaco Number 1, there is no standard deviation.

They are in the same BTU-content range as our Fruitland wells, immediately following those fracs.

Q. Well, you mentioned using the scatter plot, throwing out the high, throwing out the low. Looking at the scatter plot of two months of production versus pressure, say for example, on the Chaco Number 1, if you did that from the Exhibit yesterday, wouldn't the lines again fall into line with the -- what's been the latest production since the fracturing of those wells?

A. If we are talking statistically, that is something that you might consider. But when you are evaluating pressures that are not based on anything other than what is measured at that wellbore, why would you throw out that pressure? There's no chance that that can be an erroneous pressure, is there? Whereas the BTU data that provided, there's lots of chances that it can be erroneous data.

Q. The cross-section that you were testifying to, I guess it was Number 8, that colored one, you were testifying that only for the purposes of ownership; is that right? Yes, that one.

A. I used that for two reasons. One was to point out exactly where we believe the base of the Fruitland Coal occurs for ownership purposes and, number two, to point out that it is my belief that the perforations above the base of the basal coal are trespassing on our rights.

Q. You used that in reference to Exhibit, I think, 7, that showed side by side a transfer of rights. You're familiar with filing the Form C-102 with the OCD where an operator has to declare what acreage they're dedicating to a well; is that right?

A. Yes, sir.

Q. On this exhibit -- Is that 8? I want to be sure I did it right.

A. 16.

MR. CONDON: 16 for purposes of this hearing.

Q. (By Mr. Chavez) I'm sorry, Exhibit 16. You indicated, while you're talking about that, that the committee that the OCD and Colorado established discussed the Fruitland Coals that existed in the Fruitland formation and in the Pictured Cliffs formation; is that right?

A. Correct.

Q. Does that exhibit show Fruitland coals in the Pictured Cliffs?

A. It shows coals in the Pictured Cliffs, yes. Stringers of coal, say. They're not continuous, but there's one here and one here.

Q. Okay. According the exhibit that showed the ownership of those rights, wouldn't you, in effect, actually have gas rights to the base of that coal?

A. Again, those rights refer to a formation and not a pool. Okay? A geologic definition is different from a regulatory definition.

The regulatory definition may include -- I don't believe it does, but it may include those coals in the Pictured Cliffs. But the geologic definition of the Fruitland formation will not.

Q. So you do not consider, for example, those two coals you pointed out earlier, as Fruitland Coals?

A. No, we do not.

Q. One thing that's interesting about -- I'm sorry, were you -- have any -- Did you have any say in putting together that cross-section?

A. No, I did not.

Q. That cross-section is hung on a certain datum, isn't it?

A. Yes, it is.

Q. Did you testify what that was? I don't remember.

A. I don't remember either. It appears to me to be hung on the top of the Pictured Cliffs formation.

Q. Okay. Given that top and the proximity of two wells on that exhibit, the -- get them right here -- the Gallegeos Federal Number 1 and the Chaco Number 2-R, do we see quite a bit of displacement between those two wells in the zones above the datum?

A. Yes, we do.

Q. How would you explain that, in your knowledge of the Fruitland Coal and the Fruitland formation?

A. Mr. Nicols actually had an exhibit yesterday that showed the structure in this area, and if you noticed on that exhibit, there was a very substantial nose in this area. And so it is very possible that there may even be a fault in this area that would explain the difference in the lithology above the top of the Pictured Cliffs formation.

I'm sure our expert geologist can answer your question much better than I can, but we did recognize very early on that there is some structural geology occurring in this area that we believe is actually responsible for the fact that we have much better wells in this area than we do in the rest of our project.

Q. If that cross-section was hung on sea level, rather than on that datum that was picked, would you see -- expect to see more difference in that displacement shown between those two wells?

A. Without drawing it out, I can't answer you, Frank.

Q. Okay.

A. It's possible, but I would actually have to do it to be able to answer your question.

MR. CHAVEZ: Okay. That's all the questions I have.

Thank you.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. O'Hare, you said that you do have some examples of some Fruitland Coal wells in this general area that show the classic smooth transition?

A. Yeah, in the township north of us there's actually -- there are a number of wells that produced much longer than our wells have and exhibit the classic Fruitland coalbed methane production decline curve.

Q. Can I ask you to submit maybe one or two examples of what you think are typical --

A. Sure.

Q. -- transitions?

In the BTU diagram that you guys presented yesterday afternoon, I noticed that there was some -- the BTU content of some of the PC wells was -- started to decrease in about 1993. Can you offer an explanation as to what you think was occurring at that time?

A. Number one, I was looking at it from a distance, but I only counted four points from 1993 through 1995 of Pictured Cliffs BTU analysis that were in the same range as the Fruitland analysis, the BTU.

Q. So you don't think it was a general trend, starting in 1993?

A. That's my personal opinion, but I'd be happy to investigate that further and see if there is truly a correlation there.

Q. Well, let's talk a little bit about the fracture stimulations that were performed by Maralex. Your fracture stimulations were designed to -- You were perforated in the basal coal section?

A. We were perforated in what we call the B coal section, this thicker --

Q. Okay, you're calling that the B coal?

A. Right.

Q. And the smaller one below it, you're calling that the basal coal?

A. Correct.

Q. Okay. Your wells are completed in the B section?

A. Yes.

Q. And you designed fracture treatments to penetrate that interval?

A. Yes, we did.

Q. How far would your fracture treatment have to extend vertically to penetrate the -- what the other party is calling the PC interval?

A. This zone here, or this zone?

Q. The upper zone there?

A. The yellow?

Q. Yes.

A. The distance between -- Let's look at one of our wells. The distance between the base of the B coal and the WAW Fruitland interval here is probably three feet.

Q. Three feet. Is it possible your fracs extended three feet downward?

A. Again, I think it's possible that I'll be President of the United States someday, but I don't think it's likely. I don't think it's likely that we extended down with our fracs. I believe, myself, that we stayed in zone and that we actually had very complex fractures in these coals with a horizontal component. But if we did break out of zone, it's much more likely that we broke out up than down.

Q. Why is that?

A. Number one, you don't have the same stresses. The shallower you are, the closer to the surface of the earth you are, the less the stresses are, because the overburden is lighter. And so if you're going to grow a frac, it's much more likely that it's going to grow up than it is that it's going to grow down, generally speaking.

Again, we had very strange pressure plots on these wells, as I'm sure you saw from the Pendragon exhibits. Those pressure plots are indicative of very complex fractures. And that, coupled with our actual treating pressures, indicates to us that we had a complex fracture system that probably stayed within zone.

Q. You've got nothing definitive to say that?

A. That's correct, we don't have a tracer survey, we don't have any kind of temperature survey or anything -- any post-frac analysis that would indicate that it stayed in zone. We do have some -- Well, I shouldn't say that. I believe we have some simulation work that the Holditch folks performed, but I don't know what that indicates.

Q. It's been testified that that -- what you're calling the lower Fruitland sand has very high permeability. If your frac even came down did penetrate that sand or just got to the top of that sand, could it have had the same effect since that formation was highly permeable?

A. Yes, it could.

Q. So you wouldn't even have to go into that sand to establish some communication?

A. With that lower sand? Again, we would have to contact that sand --

Q. Right.

A. -- just as they would have to only contact our coal for us to have communication there.

Q. Tell me --

A. One comment I -- I'm sorry --

Q. Go ahead.

A. One comment I'd like to address to that is, if we did, indeed contact that lower sand, it would have been very easy for the dewatering process to start instantaneously, because that zone was much lower pressure than our Fruitland zone at that -- at the point in time when we did our frac.

And so it would have acted like a big drain. The water in the Fruitland formation would have immediately started seeping into that WAW Fruitland sand that it contacted in May.

Q. How do you know it didn't? How do you know your dewatering process wasn't made easier by that?

A. Well, definitively again, I don't know. I can make some assumptions based on the reactions of the offsetting wells. The Pendragon wells, again, weren't reporting any production, but they did not show any increase in production or start reporting production immediately after or within months, even, after our fracs were performed.

There was, at least from the evidence that we are aware of, no indication that pressures changed in those zones until after either an acid job or a frac job was performed by Pendragon or Keith Edwards on the Chaco wells.

Q. So your opinion of what's happening out here is that your wells are not communicated with the sand and are, in fact, producing Fruitland Coal gas?

A. That is my opinion, and again, I recognize that there is a possibility that our fracs did not stay in zone.

Q. If your fracs did not stay in zone, is it still possible that you're only producing Fruitland Coal gas?

A. We believe so, yes.

Q. Even if your fracs extended into the sand?

A. Yes. If we are producing anything other than Fruitland Coal gas, it would be in minute quantities.

Q. Tell me what you think is happening in the Pendragon wells.

A. We believe the Pendragon wells are producing Fruitland Coal gas through the Pictured Cliffs perforations and that those perforations were actually connected to our Fruitland coal upon acidization of those perforations and that the communication was improved upon when they frac'd those same perforations, because now they had a direct channel to the acid washing away the cement, eating the cement behind the pipe into our Fruitland Coal.

Q. How many of those wells were acidized?

A. I believe there was five of them.

Q. All five of the Chaco wells were acidized?

A. I believe that's right.

Q. So you believe most of that gas is Fruitland Coal gas?

A. Yes, I do.

Q. Do you agree with your colleagues' interpretation that it might be 90 percent, 88 percent?

A. I believe it's going to be closer to 95 to 97 percent.

Q. That's based on what?

A. That's based on the analysis of the BTU content of the gas in trying to -- Basically what we did -- or Whiting actually did the work -- was to take a standard BTU content for a Fruitland Coal gas and then determine the percentage above that BTU value that the Chaco wells are exhibiting on their BTU contents.

EXAMINATION

BY MR. CARROLL:

Q. Mr. O'Hare, I have a few questions too regarding this sandstone that has been referred to by one party as, I guess, a lower Fruitland sand and the other party as an upper Pictured Cliff sand.

When you were offered the Fruitland Coal rights, did you assign any value to this sand?

A. No, we did not.

Q. Did you evaluate it all?

A. I don't believe we evaluated it at that time. It wasn't until we were offered the Pictured Cliffs wellbores that we evaluated it.

Q. And why did you evaluate it when you were offered the Pictured Cliffs?

A. At that time we were aware that there were perforations in those existing wellbores, and we assumed that if we owned all the rights, that we could produce any gas that might be contained within both those perforations and the lower Pictured -- or the proper Pictured Cliffs perforations from those wellbores.

Q. And then on this cross-section, you referred to everything above that coal stringer as a Fruitland sand, as part of the Fruitland formation?

A. Above this coal stringer, yes.

Q. Okay. And then will you put the cross-section on the floor up there?

Now, that stringer, from my understanding, ends there between the first well and the second well on this cross-section?

A. Are you talking about this stringer?

Q. No, I'm talking about the stringer that comes in from the left. No, on your left, the leftmost well.

A. Oh, I'm sorry.

Q. It's my understanding that's the stringer that was on the previous cross-section.

A. I'm sorry, I may be a little confused. Are you talking about --

Q. That one --

Q. -- this --

A. -- if that extends onto this cross-section, is it that stringer right there?

A. This one right here?

Q. Yeah.

A. Actually, this is a shale between two sandstones here. Where this is a coal, this is a sandstone between two coals. We didn't prepare this cross-section.

Q. Right, I understand.

A. This is a Pendragon cross-section. I think what they've done is shown the coals in blue. They've shown sands in yellow and shales in a brown color, I guess.

MR. CARROLL: Okay, I guess I'm just getting confused with all the cross-sections.

MR. CONDON: You might just tell Mr. Carroll where that well is located on the far left there.

THE WITNESS: This is in Section 6, 26 North, 12 West.

Q. (By Mr. Carroll) Where would that appear on the previous cross-section?

A. It would actually be in this -- probably in this area here.

Q. So that stringer would be the -- Where would that coal stringer be, then, on this cross-section?

A. This is -- The lowermost stringer here, what we call the basal coal.

Q. Yeah.

A. This is a poor well to try to pick that from, but I would say it's right in this area here, right at the top of that gray-colored -- In fact, they do have a blue line on that.

Q. But then this ends, right? The stringer ends?

A. Well, they take this a full township away, both to the north and to the east.

Q. Yeah, but the type log that defines the whole pool is way over -- is how many townships to the northeast?

A. It's about 35 miles to the northeast, or 38 miles to the northeast. And I think you'll have a better understanding once the Holditch geologist goes through and explains exactly the depositional environment and how to correlate those logs across great distances.

Q. Okay, I'll wait and ask further questions of him.

A. Okay.

Q. How many PC wells have you operated --

A. As Maralex?

Q. -- in the San Juan Basin? Or in this area?

A. As Maralex --

Q. With --

A. -- or with Amoco and NCRA and --

Q. Yeah.

A. -- NCRA and everybody? I would have to say it's several hundred. Amoco had --

Q. Have they all been perforated in this sandstone in question?

A. No, sir.

Q. How many of them have been?

A. Again, this sandstone is a local sandstone. Okay, so there are many places throughout the Basin where that sandstone is not present.

Q. Right. But if it is present, has it been perforated as a PC well?

A. In this area it's been perforated as a WAW Fruitland PC well. Okay?

Q. And again, whether it's a Fruitland or a PC sand?

A. Right.

MR. CARROLL: Okay. That's all the questions I have.

FURTHER EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. O'Hare, the reserve calculations that you did, have your wells -- Let me ask you. Is that on a per-well basis?

A. Yes.

Q. One BCF per well?

A. Right.

Q. Okay.

A. And that is assuming only that the B coal seam is contributing to those reserves.

Q. Have your wells started to decline?

A. Some of the wells have started to decline.

Q. Are you able to determine from those declines what your recoveries are going to be?

A. No, sir. Let me qualify that too. Some of the wells that have started to decline in this area, we have put compressors on. So we have reversed that decline, and we're actually seeing an incline on all the wells that have compression on them.

There is one well in particular that's showing a decline in production, but it appears to be tied to the line pressure changes that we've seen out in this area. Whenever those line pressures go down, our rates come back up to what they were prior to the increase in line pressures.

Q. At this point in time, you can't calculate what the end result or the net effect of the Pendragon wells producing the coal gas reserves -- what that might be on your wells?

A. We -- Through simulation efforts, we think we can get a pretty good idea. From decline-curve analysis, no, it's not possible.

Q. Have you done some simulation?

A. Holditch has.

Q. Is that going to be presented?

A. I believe so.

MR. CONDON: (Nods)

Q. (By Examiner Catanach) I'm sorry, what was the purpose of the introduction of this exhibit? And I don't know what it is.

MR. CONDON: I think it's sixty- --

THE WITNESS: -- sixty-two.

MR. CONDON: -- two.

EXAMINER CATANACH: Sixty-two.

THE WITNESS: Mr. McCartney yesterday introduced some evidence that there was an analogous area to this Chaco area where recoveries of reserves from the Pictured Cliffs would be even greater than what they're anticipating getting from their Pictured Cliffs wells following the restimulation of their wells.

What we were trying to point out is, yeah, it's probably very analogous from the standpoint that those are Fruitland reserves that are being produced up there, along with the Fruitland reserves that are being produced from our -- or from the Pendragon Chaco wells.

Q. (By Examiner Catanach) Due to the nature of the completions of the coal wells?

A. Correct.

Q. Okay. You've got no evidence with regards to the evidence -- or to the testimony about the water in the pits at the Pendragon wells? I mean, you've got no dates, you've got no volumes or anything else?

A. I beg to differ with you. Our Exhibit Number 57 is the exhibit from which I calculated the water-gas ratios. This is information that was provided by Pendragon just earlier this week, and that is pretty much the extent of the information we have available to us regarding water production from the Pendragon wells.

Q. But I believe your testimony was that you visually saw a lot of water in the pits at one time.

A. Yes, sir.

Q. That's -- You don't have anything else to support that, other than --

A. Other witnesses, other individuals that also witnessed that.

Q. But we really don't know what volume we're talking about?

A. True. Again, those -- We can figure the volumes that were in the pit. We -- It would be very difficult to figure exactly how much was being evaporated, how much was percolating into the soil, and then back into a production number from those volumes. But yes, you're exactly right.

Q. Well, I think you said that some of the pits were full at different times?

A. Yes.

Q. Do you know what the capacity of the pits are?

A. Yes, sir.

Q. You do?

A. Yeah, based on Mr. Thompson's testimony yesterday, it's very easy to calculate the volume of those pits. He claimed that they were 10 by 10, or 12 by 12, by four to five feet deep. If you take a 12-by-12 pit, five feet deep, that will contain 128 barrels.

Q. Those are their estimates on the dimensions of the pits?

A. Right.

Q. So those aren't -- You don't know if those are accurate?

A. Yeah, those aren't exact, just what he presented in testimony. And we can measure those if you like and give you an exact dimension.

Q. No, I don't want to know that.

Can you submit your -- the water-gas calculations, ratios, that you testified to --

A. Certainly.

Q. -- can you submit that as an exhibit?

A. Sure.

Q. So we have that data to look at.

A. Okay.

EXAMINER CATANACH: Okay, is there anything else? Mr. Chavez?

MR. CHAVEZ: Couple of questions.

FURTHER EXAMINATION

BY MR. CHAVEZ:

Q. Mr. O'Hare, when you purchased the properties you did in the Fruitland, were you aware of the perforations that existed in the Chaco wells at that time?

A. No, sir, I was not. I did not -- I knew that there were Pictured Cliffs wellbores in the vicinity, but I -- at that time I did not do any investigating of those wellbores.

We felt at that time that the Number 1 -- We knew those wellbores were older than the qualifying period, so that we would not be able to utilize those and still qualify for the tax credits. So we had intended from the start to drill new wellbores.

We also realized from a field inspection that those wellbores were slimhole, meaning that it would be very difficult for us to accelerate our dewatering program by lifting, artificial lifting, of the water from those slimhole wellbores.

So we didn't do any further investigating into those wellbores than that.

Q. Wouldn't it have been important to know that there had already been production from properties that you were purchasing, that might have come from those wells?

A. Well, we looked at the production information from those wells as part of our analysis of the Fruitland Coals, to determine whether or not Fruitland Coal gas had been produced from those wells prior to our taking of the project.

But I did not look at the perforations in those wellbores.

Q. But in a sense, you're claiming also that your property includes what you're calling the Fruitland sand, which is perforated in those wellbores, right?

A. Yes.

Q. So you did buy properties that had already been produced in those wellbores?

A. Yes.

Q. And in trying to understand what you were buying, did you look at the formation tops that had been called by Merrion previously, or accepted by Merrion, in the wellbores that --

A. No --

Q. -- produced?

A. -- I didn't. Actually, when we built our maps of this area, we mapped the coal thicknesses, we mapped the tops of the coals, and we mapped the top of the PC. And we did not look at, unfortunately, what the other operators had been calling the top of the PC.

I actually made those picks myself, based on the definitions that were provided by the State in the 1988 ruling.

Q. Wouldn't it have been important to understand exactly what you were buying from what the seller was calling -- what the seller was saying they were selling you and knowing where the PC and the Fruitland were?

A. Yeah, I felt very comfortable that I understood exactly what they were calling it. The base of the Fruitland Coal formation was the bottom of that basal coal, and that's what we had actually mapped.

Q. And the top of the Pictured Cliffs formation, was that important to you at all?

A. No, but if you look at this exhibit again, there are actually places here where the base of the Fruitland Coal is above the top of the Pictured Cliffs formation. And so we're only claiming that we own down to the base of the Fruitland Coal there. And then from that point down to the top of the PC is owned by Pendragon.

Q. No, what I was getting at, Merrion operated wells, and there were completion reports with geologic formation tops called. Wouldn't it have been important for you to know where those geologic formation tops were called in that area to understand what you had purchased?

A. Frank, none of those reports that were provided to the State ever named the base of the Fruitland Coal. They either showed the Fruitland top and the PC top -- some of them might show the Kirtland, the Ojo Alamo. But they never show the base of the Fruitland Coal.

So it wouldn't help me to know what those reports were showing as geologic tops, because that's not what I was buying. I was buying from the surface down to the base of the Fruitland Coal.

Q. And that doesn't give you any pause that there might be some ambiguity as far as the Fruitland and the Pictured Cliffs and where they're located and how that might affect what you're buying?

A. No, it still doesn't. The only thing I would do differently now is make sure I got the Pictured Cliffs right so nobody could come in and steal my gas through the PC perfs.

Q. In talking about fracturing, you had said that the early time in your fracture treatment reports showed a negative slope. By "early time" -- What do you mean by that?

A. On the Pendragon wells, the Nolte plots actually show a negative slope for, in some cases, up to the first ten minutes of the job. And in many cases, those were only 20- or 30-minute jobs. So it's -- A significant portion of those Nolte plots is showing a negative slope, even though Mr. Blauer indicated that the whole thing was positive.

Q. And how about the fracture treatments on your wells?

A. Again, if you look at the Nolte plots on our wells, we have a very complex Nolte plot, indicating a very complex fracture propagating in the coals, which is not uncommon.

If you think about the cleat system that you're trying to pump fracturing fluids through, those cleat systems -- You have both face and butt cleats, okay? And generally speaking, the face cleats are the preferential permeability tracks or channels in the coals. But occasionally you'll have a butt cleat that has greater permeability than the corresponding face cleat.

And so you may be pumping a stimulation fluid down a face cleat, and all of a sudden it wants to take a 90-degree turn down a butt cleat. Okay? That fluid is going at different directions, orthogonal directions, which increases your pressure and definitely has an effect on your Nolte plot.

And in this case, when we're so shallow that the overburden pressure is -- maybe and is more than likely, less than the horizontal pressures in the coals, there's a good possibility that in addition to that, we're actually raising the formation and creating a horizontal frac at the same time that that fluid is going through the face and butt cleats.

Q. Which formation would have a higher frac pressure in your area, the Pictured Cliffs or the Coal?

A. Again, define frac pressure for me.

Q. Well, as is generally considered in the industry. There are frac pressures that are used to determine at what point a formation starts parting so that you can start injecting fluids.

A. Then I'd have to say that the Pictured Cliffs has a higher frac pressure, because the Fruitland formation has already parted, the coal formation is parted in what we call cleats. And so when we are initiating a fracture in the Fruitland formation, we're not so much trying to break the rock as we are to expand an already-open crack in that rock.

Q. Which formations generally require higher pressures during fracture treatments, to initiate a continued frac? Pictured Cliffs or the Fruitland formation?

A. Generally speaking, it's the Fruitland formation.

MR. CHAVEZ: Thank you.

EXAMINER CATANACH: Is there anything of this witness?

MR. HALL: No.

EXAMINER CATANACH: This witness may be excused.

THE WITNESS: Thank you.

MR. CONDON: I couldn't anticipate that the cross would take longer than the direct.

MR. GALLEGOS: Our other witnesses talk faster too.

MR. CONDON: We have two more.

MR. GALLEGOS: We'll finish. We'll finish this afternoon.

(Off the record)

EXAMINER CATANACH: What do you think, an hour direct?

MR. CONDON: For Mr. Harris?

MR. GALLEGOS: Each of our witnesses, an hour direct.

MR. CONDON: Yeah, I would say an hour.

EXAMINER CATANACH: I think that's what you said about Mickey.

MR. CONDON: Well, take it with the same fine grain of sand we've been talking about here.

EXAMINER CATANACH: Okay, why don't we at least start the next witness, and we'll take a break about one o'clock. And I'm not sure how long. Maybe half an hour.

(Thereupon, a recess was taken at 12:40 p.m.)

(The following proceedings had at 12:45 p.m.)

WALTER B. AYERS,

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

DIRECT EXAMINATION

BY MR. CONDON:

Q. Would you state your name, please?

A. My name is Walter Ayers.

Q. Mr. Ayers, would you please give us your educational and professional background, please?

A. I have a bachelor's and master's degree in geology from West Virginia University, a PhD in sedimentary geology from the University of Texas at Austin.

Q. When did you finish your post-graduate education?

A. 1984.

Q. All right. What did you do after that?

A. After that, I worked at the University of Texas Bureau of Economic Geology. I worked there, actually, from 1979 through 1991.

And my responsibilities there were as a research scientist, I conducted research initially on coalbeds in the Texas Gulf Coast, I worked on depositional setting of the Wilcox lignites or brown coal beds, the Yegua, the Jackson coalbeds, all in different depositional settings, mapped those coals and the depositional settings of the coals. These were usually multi-year studies involving hundreds of well logs and outcrop studies, cores, et cetera.

From -- in the late -- Excuse me, in the mid-1980s I started working on some of the coals in the eastern shelf of the Midland Basin, carboniferous-age coals, mapped those, the depositional settings, controls on the coal cleats.

Also I should mention that, as part of my qualifications, my graduate for my dissertation was in coal depositional systems, and I've worked on, and I worked on coal in the Fort Union formation of the Powder River Basin in Wyoming and Montana.

To continue a little with my experience at the Texas Bureau of Economic Geology, I also moved into management roles and became project manager and then coordinator for all gas and coal research in that role, and as part of my project management role, I wrote proposals and obtained funding.

And one of the studies I had funded was by the Gas Research Institute. I had a project funded -- it was a multi-million-dollar project -- from 1987 through 1991, and in that study I was funded to conduct a study of the geologic controls on coalbed methane producibility in the San Juan, Black Warrior and Northern Appalachian coal basins.

The San Juan Basin study we did at the Texas Bureau of Economic Geology with cooperation from the New Mexico Bureau of Mines and Mineral Resources and the Colorado Geological Survey.

And we took a direct role in that project, mapping the coals, the depositional setting, controls on the coal occurrence, and I was project manager for the Warrior Basin and Appalachian Basin coal studies and coalbed methane studies.

Q. At what period of time are we talking about when you've done this work?

A. This was 1987 through 1991. In 1991 Taurus Exploration in Birmingham, Alabama, hired me to come to work for them. They are the largest operator of coalbed methane wells in the Warrior Basin, and I was hired as a senior geologist there to help lead them out of the Warrior Basin into other parts of the world.

And so I had the responsibility for reviewing prospects for investment in most U.S. basins, like the Raton, San Juan, Green River, Piceance, Powder River, Western Canada, Vancouver Island, Western Canada Sedimentary Basin, Foothills Basin, Nova Scotia, Cumberland Stellarton Basins.

We started looking internationally, and I headed projects in the U.K. where we evaluated basins, coal basins, and formed partnerships with companies to invest in coalbed methane and earned equity as part of our process of working up the geology and engineering features of those coal basins and the prospectability of the basins.

So we worked -- We had relationships with three companies in the U.K. based on that, plus we did consulting and coal -- coalbed methane for British coal.

In 1994, I believe it was, Taurus entered a strategic alliance with Conoco to help them with their international coalbed methane development, and I was part of the Conoco-Taurus team that managed that process. And in that process, we reviewed, gave a second opinion on Conoco's potential investments, and we worked up basin studies for them in places like the U.K., France, Germany, Indonesia, Australia -- three basins -- just around the world, international-type work, as well as western Canada and the U.S.

Q. How long were you with Taurus?

A. From 1991 to 1995.

Q. And what did you do after that?

A. In 1995 I joined Holditch and Associates in College Station as vice president of geosciences.

Q. Is that your position today?

A. Yes. And at Holditch I continued to consult in coalbed methane, as well as integrated reservoir studies and conventional reservoirs as well.

Q. I'm sorry, what did you say?

A. Conventional reservoirs, as well as coalbed --

Q. Okay --

A. -- methane reservoirs.

Q. -- thank you.

Have you published papers, articles in journals or in textbooks?

A. Yes, I have. I've published 80 or 100 different papers, abstracts, probably 20 or so proprietary reports for companies that I've written. Many of my papers have to do with coal depositional systems and controls on the coal occurrence, stratigraphy. Also coalbed methane, I think I have around two dozen publications on coalbed methane.

I'm also the editor for the *American Association of Petroleum Geologists Bulletin for Coalbed Methane*, associate editor. So I guess in some quarters, as Mr. Blauer said, I'm internationally recognized as a coalbed methane expert.

Q. Were you involved at all in the study that the New Mexico Oil Conservation Division conducted in the late 1980s, involving the recognition of the Basin Fruitland Coal Gas Pool?

A. I can't say I wasn't involved at all. I think one of the initial meetings, I was invited and as my role of the project director for the Bureau of Economic Geology to participate in a meeting when it was first getting kicked off. I don't remember the dates; I still have notes in my office on that.

But I attended the meeting, I presented the Bureau's work to that point, which had to do with identifying the different coalbed methane potential in different regions of the Basin and breaking it down into three areas, and that became the basis of part their report later on.

But after that initial meeting, I was not actively involved.

MR. CONDON: Okay. Mr. Examiner, at this point we would tender Mr. Ayers as an expert geologist.

EXAMINER CATANACH: Any objections?

MR. HALL: None.

EXAMINER CATANACH: Mr. Ayers is so qualified.

Q. (By Mr. Condon) Mr. Ayers, were you given an assignment in this case in order to conduct an investigation and come to some opinion?

A. Yes, I actually was given two assignments.

Q. What were you asked to do?

A. I was asked to look at the logs in this area, determine the contact between the Pictured Cliffs formation and the Fruitland formation -- Pictured Cliffs sandstone, excuse me, and the Fruitland formation -- and then to look at perforations in the Chaco wells and see whether those perforations were in -- whether any of those were in the Fruitland formation.

Q. And what did you do to answer those questions? What kind of information and data did you look at?

A. I gathered well logs by contacting one of the service company providers of well logs -- MJ Systems, in fact -- and ordered well logs for the region, received those logs, correlated the logs and drew cross-sections to see what the relationships were of the different rock strata and determined where that boundary was between the Pictured Cliffs sandstone and the Fruitland Coal.

I took one example cross-section, then, and placed the -- made a cross-section with the Chaco wells and a few other wells, and placed the perfs on there that I was provided by Whiting/Maralex.

Q. Okay. Was there anything else that you did in terms of a data or information or document review to prepare -- to come to a conclusion?

A. Well, I already -- I was already very familiar with the Basin. We -- In our previous work at the Bureau of Economic Geology we had mapped these units using about 2500 well logs. So we were very familiar with the stratigraphy and the layers involved.

So I used that as a starting point. But because of the dispute involved in that -- this boundary, I have reviewed other literature in the area, in fact, throughout the Basin, to get -- make sure I was fully aware of the different opinions or what I found to be a unique opinion of what that contact is between the Fruitland and the Pictured Cliffs, or at least I thought that until recently.

Q. All right. What articles? If you could give the Examiner an idea of the articles that you've relied on?

A. Yes, articles, Fassett's or Fassett and Hinds' 1971 U.S. Geological Survey Professional Paper 676 is a good starting point. Fassett published the same type log from that article in a later coalbed methane symposium volume in 1988. There are numerous Four Corners Geological Society publications and papers on different fields in the Basin, showing where the operators picked the tops of formations, there are GRI reports, there are reports from the coalbed methane committee that was put together to try to determine where this Basin coal Fruitland Coal boundary should be.

And so I reviewed all those types of data.

Q. Okay. Did you review any of the New Mexico Oil Conservation Division orders that have been entered that relate to the Basin Fruitland Coal?

A. Yes, I did.

Q. Have you reviewed the transcript from -- I believe it's Case 9420, that was a hearing in July of 1988?

A. Yes.

Q. Okay. Was there anything else that you looked at in forming your opinions in this case, as to the geologic boundary between the formations?

A. No, I think that pretty well concludes it.

Q. All right. Have you formed any opinions and conclusions based upon your investigation and analysis?

A. Yes, I have.

Q. All right. Can we use Exhibit 16 that's up there on the board right now to -- And could you highlight your conclusions for us?

A. I have concluded that the sand that was identified earlier by Mr. Nicols as being upper Pictured Cliffs is, in fact, a lower Fruitland sand. I've placed the boundary based upon my review of the literature and my knowledge of previous work in the Basin, as I show on this cross-section at the top of the orange line here. This is on Exhibit 16.

And what you can see is that this pick is placed at the top of a massive sand below the Fruitland Coal unit, which is consistent with the definition by Fassett and Hinds in 1971. It's consistent with the different coalbed methane committee reports to the Oil Conservation Division, et cetera. So it's a consistent pick that I've seen throughout the literature.

Q. Okay. Let me -- Mr. Examiner, if I could at this point, I just want to pass out a packet of the exhibits.

Now, you spoke of a massive sandstone Pictured Cliffs formation. What is the significance of the existence of a massive sandstone in this area, for purposes of your pick of the boundary between the Fruitland formation and the Pictured Cliffs formation?

A. Well, the significance is that that's the best way to define this boundary. There isn't a good way, an absolute way, to define this boundary, but that is the best pick, and that was identified by Fassett and Hinds in 1971, and it's been recognized and continued throughout the years as the best way to find this boundary between these two.

Q. Okay. Is there, in your opinion, any way to fairly characterize the sandstone interval between what you've designated as the basal coal and the B coal as a massive sandstone?

A. I'm sorry, what --

Q. In your opinion, is there any way to fairly characterize this sandstone layer that is between the basal coal and the B coal as a massive sandstone?

A. No. Massive sandstone is not a -- there isn't a formal definition for the -- or a term for massive sandstone, in the sense that it's being used by the stratigraphers.

It is a useful term, though, as you will notice if you look at the literature, U.S. Geological Survey, Fassett and Hinds used it, so -- The coalbed methane committee report to the Oil Conservation Division used it. Mr. McCartney used it twice in his testimony, retracted once, but he used it twice.

So it is a very common term used in the subsurface geologic community, because it allows you to distinguish between the character of the different sands, what -- The subsurface geology that would refer to this sand that you asked me about here between the top of the Pictured Cliffs and this B coal, as would be a ratty sand, "ratty" meaning it's discontinuous, it's thin, it's not a massive sand, it's not a significantly thick sand.

Q. Okay.

A. That would be a common term used in subsurface lingo.

Q. In your years of involvement in the Basin and publishing and reviewing the literature in this area, have you ever seen that sandstone layer between the basal and the B coal referred to as the upper Pictured Cliffs sands prior to the first day of the hearing in this case?

A. No, I haven't. That doesn't mean it hasn't been done, because geologists tend to use local terms sometimes.

There is a defined upper Pictured Cliffs in the northern part of the Basin, based upon our work for GRI that we did at the Texas Bureau of Economic Geology. We recognized three of the Pictured Cliffs sands in the northern part of the Basin.

You could refer to this as the upper Pictured Cliffs sand that I called Unit 1 here. You can have an upper Pictured Cliffs sand anywhere you have a series of two or more Pictured Cliffs sands. But this is not a common designation that I know of in this part of the Basin.

Q. Have you prepared some exhibits to illustrate your testimony and the conclusions that you've reached?

A. I have.

MR. CONDON: Do you want to break at this point --

EXAMINER CATANACH: Yeah, let's --

MR. CONDON: -- and we can --

EXAMINER CATANACH: Let's do that.

MR. CONDON: -- go grab lunch and come back.

EXAMINER CATANACH: Say about half an hour.

MR. CONDON: Okay.

(Thereupon, a recess was taken at 1:05 p.m.)

(The following proceedings had at 1:53 p.m.)

EXAMINER CATANACH: Okay, if we're all ready, let's reconvene the hearing at this time.

Mr. Condon?

Q. (By Mr. Condon) Dr. Ayers, we were talking before we broke. You said you had prepared a number of exhibits for use in support of your testimony in this proceeding, and do you want to -- I guess -- do you want to look at Exhibit 52 at this point, or -- What do you want to --

A. Yes, 52 would be a --

Q. Okay, that's 52 in the book. Would you identify Exhibit 52 for the record, please?

A. Yes, 52 is a geophysical well log from the San Juan Basin, from a publication by Jim Fassett, *1988, Rocky Mountain Association of Geologists Coalbed Methane Symposium and Guidebook*. It's also a repeat of the same figure that he had in his 1971 publication, Fassett and Hinds, U.S. Geological Survey Publication 676.

Q. Okay. And how did you utilize this exhibit in coming to or supporting the conclusions you've reached in this case?

A. This was probably the starting point, when I first started studying Fruitland-Pictured Cliffs in the San Juan Basin in 1987, and so I wanted to introduce that because it's the log that's often referred to when people describe the Fruitland-Pictured Cliff contact, which he described as being at the top of the massive sandstone underlying the Fruitland coalbed sequence.

Q. Okay. On page 27 of that exhibit, on the log that's reflected there --

A. Yes.

Q. -- what are those dark lines toward the bottom of the Fruitland formation?

A. Those dark lines are coalbeds, and you can see that they extend from 1800 feet down to 2100 -- or excuse me, just below 2100 feet, about 2120 or so, about 10 or 20 feet above the base of the Fruitland or top of the Pictured Cliffs. You can see that.

The coal is -- or rather, excuse me, the contact is placed at the top of the massive sand, and there is a shale and a coal above that, similar to what we see in our part of the Basin.

Q. All right.

A. This was important because I think a lot of people use that as a stepping-off point in studying the Pictured Cliffs-Fruitland throughout the Basin, and as I said earlier we built upon that by looking at logs throughout the Basin and used about 21 -- or excuse me, 2500 well logs to map both Pictured Cliffs and sandstone and Fruitland Coals throughout this Basin, which was much larger than any previous study in the public domain.

Fassett and Hinds used, I think, 325 well logs, and Kelso and others looking at coalbed methane for GRI in 1988 used about 550, thereabouts, well logs. So we did a much more extensive study throughout the Basin than anyone had done previously.

The other thing that we did in our study at the Bureau of Economic Geology was, we mapped the sandstones and the coalbeds to see the relationships between the two. That had not been done by previous workers. So we were trying to understand the stratigraphic relationships, where -- How does this pick look as you move across the Basin.

Q. Okay.

A. I think we've done a more extensive job of that than anyone that I know of in the public domain.

What --

Q. Go ahead.

A. What I concluded from seeing this described, this lower Fruitland WAW sand, the WAW sand described as upper Pictured Cliffs, was that there was a misunderstanding of that definition, and it had to be addressed on two different fronts.

One has to do with the stratigraphy, understanding the lateral relationships of these layers throughout the Basin. What's the relationship of this contact out in the field to the Schneider 1 B where this coal, Fruitland Coal unit is defined. So that's one thing that has to be understood.

The second is, how did Mr. Nicol justify calling this an upper Pictured Cliffs sand? What he did was, he said this is a marine sand. Well, the Fruitland formation, by definition, is primarily a coastal plain sediment, like inland from the beach. There may be a few thin marine or brackish formations embedded in it, but primarily it's a coastal-plain sediment. And the Pictured Cliffs is a beach -- a marine shoreline environment. And so in order for him to be able to say this is upper Pictured Cliffs, he had to be able to say this is a marine sand.

So we had to had to look at two things. We had to look at his stratigraphy from the type area, the Schneider 1 B, down to this area. And secondly, we need to look at the sedimentology. How did he decide that was a marine sand, and was he correct?

I want to start by evaluating that second part first. Is this a marine sandstone, or is it not?

Q. And have you prepared some exhibits to use in your presentation?

A. I have. I would like to start with Exhibit 12.

Q. I believe that's -- I think I've put them in order here.

A. Exhibit 12 is a spontaneous-potential map. What that is, is, on geophysical well logs one of the curves that's commonly run in track 1, the left-hand track of a well log, is a spontaneous potential curve.

And this was an unpublished map that I did back when we were doing the coalbed methane study for the Gas Research Institute, just to better understand the depositional systems in this region.

What this map shows is simply northwest-trending sand belts -- or I should say northwest-trending areas of high SP. I also mapped areas of sand thicknesses, percentages of sands. If you overlay this, you get -- this drops right on this trend.

What we're seeing is an negative SP deflection where we have the well-developed hydrocarbon-bearing sands. In some cases to the south, they're not hydrocarbon-bearing. But if you overload the -- overlay the production trends of the PC on here, you'll see that these are the producing sand trends in the PC.

So I had an understanding from this study what the depositional systems look like in this south part of the Basin. We're right here in Townships 26 North, 12 and 13 West, and what we see going right through this area of interest to us, which on this location map would be coming down through here, this is -- No exhibit number. It's a Pendragon leasehold ownership map, but that would be coming down through that area.

MR. GALLEGOS: It's N1, I believe.

THE WITNESS: We see a shoreline sand there. This is probably a river or fluvial system going to the northeast, another shoreline, and so on.

What we're seeing is the sands that were deposited as in the Cretaceous period, about 79 or so million years ago, we were on the western part of a broad seaway that went up through North America, and we had beaches here and they were building out, building in this old seaway out here.

And I'd like to use a depositional model to further show that.

Q. (By Mr. Condon) Okay. Just take them all.

A. This is Exhibit 10.

Q. Do you want me to move that cross-section off there?

A. No, that's fine, thank you.

Exhibit 10 is the simplified depositional model that we developed for this southern part of the Basin in our GRI study.

What it shows is northwest-trending beach in the Basin, seaway out in advance of that. These are rivers that are sourced in mountains to the southwest, and these rivers carry sediments out to the sea.

Longshore currents generated by waves out here in the sea take this sand that's in -- shale clay, rather, that's carried into the sea and spread it out to form a lot of beaches and barrier islands, which then create lagoons back behind them.

Now, it's important to understand this model to understand the coal and its occurrence and the depositional setting in which these coals form, because this is -- this takes us back to Mr. Nicol's interpretation of depositional systems.

And what we see -- And I'm going to talk a little about this regional picture, and then I will go to our geological or sedimentological study of this area and show you the maps that we made, and our interpretation of the area.

The first thing you have to understand a little bit about is the idea of depositional systems, in order to understand what's going on with the Fruitland Pictured Cliffs.

The shoreline sand here would be in this area, what's called a barrier depositional system. And that's because we have these islands of buildup, and they form a barrier to waves coming back inland, and shelter the lagoonal areas.

Now, when we talk about a barrier island depositional system, this would be a marine coastal unit, like the Pictured Cliffs sand, which -- That's what this is depicting. This can -- You can put a PC on there for Pictured Cliffs sand.

Out seaward of that, this tan on the figure shows the shales which are the Lewis shales, and that's because -- they're out here further because these rivers that are coming in here are carrying clays and sands, and the clays are fine grains, they get carried away offshore, settle out of the water, the coarse sand settles out first, so you get it along the shoreline. Over time this builds out seaward or, in this case through the northeast, and these sands build over the shale.

This depositional system, or the marine depositional system here, will consist of, for the Pictured Cliffs, this barrier core and flood- and ebbwater deltas that are associated with that. And these little deltas, they'll -- here under the water, when the tides go in and out of these lagoons carrying sand and build the little mounds of sediment on either side. This is the way you can get some sands back inland, in some lagoons, or you get these little mounds of sand out in the sea floor in front of one of these lagoons.

Notice on this cross-section where the coal is. You don't -- You see that we have not shown peat deposits in this first interval up here. We have some marsh there, but you don't have significant quantities of peat form. There's a reason for that. The reason is, in this area we're too young here to get significant peat at this stage. It takes a long time to accumulate that peat.

Peat forms when the organic material, either grasses, shrubs or trees, die, fall to the ground, and if it was a high water table, the peat gets preserved and later gets buried and compacted into coal.

Well, what happens in this area is, you don't get a coal in this area immediately behind the barrier, and that's -- or peat-forming coal. You get thin, discontinuous peat sometimes, but they're usually very localized in extent.

And the reason is, first of all, you don't get them in a lagoon, because this is an oxygenated environment. This is water moving in and out. You cannot preserve organics if you have oxygenated water; the organics decompose. So the peat rots or decomposes, it's gone. You can get some thin, discontinuous peats adjacent to that, but usually very localized.

So this is the primary core of a barrier or a Pictured Cliffs-type barrier, marine-sand deposition. It will be the forefront -- or the foreshore, ahead of the beach, some sand dunes, windblown sand dunes here, and some tidal deltas.

So when you talk about marine sands, you're going to be in this environment.

The coals that are the peat-forming coals are further back inland, and this is based on not just my studies but a lot of different studies that I've done, trying to understand coal for exploration, both for coal and for coalbed methane. And it's based on a lot of studies out of the literature.

You do not find coal from the peat; where find them is back further inland, behind the old abandoned shorelines that were left as this shoreline moved seaward.

What else do we find back there, interbedded with those coals? Well, we find some clays and shales, because at flood stage these streams overflow their banks. When they overflow their banks, it takes the sand, the clay, out into this floodplain, the area on either side of the river, and it gets spread out here as these types of features which we showed in this model that we did back in 1988.

These are the types of sands that we're seeing that Mr. Nicol was calling his upper Pictured Cliffs. These are not marine sands. Up here is the marine sands. We're back here. We're looking at these sands that spilled out of the rivers onto the floodplain, where we have that thin coal that -- this coal that we've been looking at. That's the type of setting we're looking at here, of this continuous lower Fruitland Coal and this Fruitland WAW sand.

So I think that -- This is my interpretation, based upon the best evidence that I have been able to collect.

Now, this is based upon some mapping that I did in this Whiting/Maralex area, and what I'd like to do next is to describe that mapping.

This is a base map --

Q. Which exhibit number is that?

A. This is, excuse me, Exhibit 53.

Exhibit 53 shows -- Generally, I call the six sections of interest is the area where we were focused on and where I purchased or obtained most of the well logs. I used about -- a little over 50 well logs in this area to map the coals and Pictured Cliffs sand.

Now, the thing to notice is the way I oriented these cross-sections, because I had done regional mapping here, I knew the trends of the depositional systems.

In depositional systems you talk about strike and dip, and strike is -- Well, let's say what dip is first.

Dip is the way everything is sloping. You're standing on the beach, everything is sloping offshore. So that's dip.

If you're talking about strike, you're talking about the direction along the beach. That's the strike of the beach.

The reason that's important is because this is a strike-elongated depositional system. You can see that these sands are spread out in that direction. And you always orient your cross-sections, when you're trying to do sedimentology and stratigraphy, you orient your cross-sections along strike and along dip, because you want to see what happens at right angles to these depositional systems and along their strike to better understand the geometry of it.

So I made a series of sections here, and you can see there are three northeast sections, which would be like this, and one northwest section, tying those all together, going like so.

What I did was put these cross-sections together with geophysical well logs, and I correlated the well logs using my picks for top of the PC or the Pictured Cliffs-Fruitland boundary. I didn't make any special cross-sections to demonstrate that, but this demonstrates it very well, this being Exhibit 16, which we referred to earlier.

Exhibit 16, as you can see, is oriented along the strike.

This is Exhibit 15, which is the base map, and it shows the location of Exhibit 16, and you can see there's -- pretty much parallel to the strike section shown on Exhibit 53. So it pretty much shows the relationship in that direction.

Now, what did we see when we correlated this? And I'll say that I focused my efforts on the lower part of this, the boundary area, even though I showed some upper coals and sandstones here, for completeness I focused on this boundary area between the lower Fruitland and the PC.

Well, I mapped two different sands. I mapped this upper Pictured Cliffs -- excuse me, my upper Pictured Cliffs sand. I mapped what I call Unit 1 in the Pictured Cliffs. I broke the Pictured Cliffs down into as many as four units in this area. And I mapped Unit 1, and I mapped Mr. Nicol's upper Pictured Cliffs sand, which is lower Fruitland WAW sand, looked at the relationships to them to try to see where we were in terms of the depositional systems.

Exhibit 14 is a map of Unit 1, and as I'm focusing on the area in issue here, it is -- the area in issue is slightly smaller than what I have emphasized in the six sections here with the dark border. We're really focusing on this area right in here. I had to map a little bit larger area to show the relations, to have data points around the region of interest.

And you can see that this map very well clarifies or supports our previous map in here in a regional sense. our regional map of the SP had shown this trend coming through here in this upper Pictured Cliffs. We had a high SP -- or, excuse me, a very strong negative SP in the area. That is this sand, right through this part of the area of interest.

So we're effectively mapping an old beach that's down in Unit 1 here. Then you notice these northeast-trending sands going out the map, and way up here a mile and a half or so, we start seeing another thickening, and we have another beach, then, up here somewhere.

The other sand that we mapped was this lower Fruitland WAW sand, and this is a map of that sand. This is Exhibit 11.

Notice we see the same trends, parallel to this trend that we saw in Exhibit 14, northwest-trending, but there's offset. These trends are not on top of one another.

I'd like to take just a minute to show you that relationship, because I think it's important, in understanding the depositional systems, that you understand what I'm saying when I say this is not, in my opinion, marine sandstone, but rather it is a coastal-plain sandstone, and therefore it's not part of the Pictured Cliffs.

May I trouble you for some of your tape, please?

What I'm going to do is just trace the outline of some of these thicker sands on this lower Fruitland WAW interval and then overlay it on this older shoreline sand and show you the relationship between the two. I'm going to highlight -- And I might say that my thicknesses for the lower Fruitland WAW sand here are about the same as Mr. Nicol's. We didn't disagree much on the thicknesses.

I'm just going to outline, for example, a couple of the contours here showing thickness from six feet there, eight feet there, and we'll do eight feet in here. So this is an area here of local thickening of sand, area of local thickening of sand in here, and we have local thickening of sand here, and it's coming down through here, off the map there.

Now, what's that relationship of that sand to the underlying sand? These would be local depo centers. And what I contend is that what we're seeing in this lower Fruitland WAW sand is cases like this where the rivers overflow their banks, spread out these thin sheets of sand onto the floodplain in between old, abandoned beach ridges. And let's overlay this and see how it looks.

That wasn't too smart. I forgot to put my tickmarks, identify the...

Now, when we do this, we overlaid the depo centers or the thick pods for the lower Fruitland WAW sand, we see that for the most part we have a thickness here behind another region starting to form there, we have a thickness here in between two thicks here, and back behind this one.

So these things are filling in the space. It's up above it, and it's filling in the thick space where we have little swales between old abandoned beach ridges.

So where I've placed this depositional setting is back here, we've got a beach -- old beach ridge up here. We're not in the active beach area. We've got -- We're sitting back here behind that beach ridge, and then even behind the second one.

Now, the reason that's important, we see that we have coal in this interval. We can't have coal when you're down here this close to the sea, because it gets oxidized by waters if you're in the lagoon, or it doesn't have enough time to develop thick peats here until the shoreline has moved on up that way.

So what this suggests, this relationship shows, that we're back inland at least one beach, and probably -- Here we're at least two beaches back, and probably more, from the active shoreline. We don't have active marine sediments back this far landward.

Now, is there any other evidence for that?

Unfortunately, we don't have a lot of evidence, we don't have a lot of core data. The core data that we have are not very good quality. Mr. Nicol introduced a core from the Lansdale Federal Number 1. Let's see what that tells us about this lower Fruitland WAW sand.

If we look at --

Q. Is that Exhibit N6?

A. That is N8.

Q. N8?

A. N8. If we look at the core analysis, N8, and look at the log to the left of it, it looks like on the log to the left of it this lower Fruitland WAW sand goes from about 162 to about one-sixty- -- my eyes are bad? Eight? Is that right? About 162 -- Yeah, about 162 to 168.

And if you look --

Q. You're saying 162, and I'm --

A. I'm sorry --

Q. -- having a hard time orienting.

A. -- 1062.

Q. Oh, okay.

A. Depth ten sixty-two.

Q. Okay.

A. Excuse me. That log trace is not very good. Let me show you where the sand is on the map. This is -- I marked these depths earlier. It's this blip on the gamma ray here.

MR. CARROLL: This one here?

THE WITNESS: That's correct, down to there. So it's about 1062 to 1068.

Q. (By Mr. Condon) So about six feet?

A. It's about six feet. I think I mapped it as five, and I think Mr. Nicol may have also. It's around five or six feet.

Now, if we look at this core description, first of all you recognize that it's a very poor geologic description of a core, as Mr. Nicol pointed out yesterday. You're luck if you get good core descriptions or mudlog descriptions. I guess that was Tuesday when he pointed that out.

But when you look at this core description on the right and they describe as sand, gray, fine-grained sand, gray, fine -- fine-grained -- they keep going down repetitive like that, then you know it's not a real good-quality core description for the most part, especially when you look at the left at some of the analyses and you see a lot of change in those analyses that aren't accounted for by any difference in the core description to speak of.

And so we see that in this description in the interval which was covered by samples 3 through 6 there, cover this interval, we find that there's not a good description. So we don't have a lot to go on. It's all the same. It's fine-grained, gray sands here with some clays, et cetera.

But what you notice is, there is a good permeability unit in and toward the bottom at about 1064 to 1065, and -- so that's sort of the middle or the lower half of it. Permeabilities -- Horizontal permeability 142 millidarcies, and vertical permeability 92 millidarcies.

Q. What does that tell you?

A. What that tells me is that this is not a lagoonal type of sand as Mr. Nicol described it, because this lagoonal environment is an area of high bioturbation. In other words, there are a lot of critters living in this area, a lot of clams, marine brackish worms, and they burrow in this environment. And when they burrow, they burrow through the sands and the clays alike and they mix them up. It's called bioturbation, life formed or -- turbating or stirring up the bottom sediments there.

As a result, sediments that formed back in this environment usually have pretty poor reservoir quality. You've mixed the shales in with the clays. So this is not consistent with having a high-permeability reservoir-type rock as we have seen described here.

We have very little other evidence, I have to say. But the evidence that we have, the geometry of these sandbodies, their position relative to the shoreline as we determine from mapping some of the other sands below it, suggests -- the fact that we have coal here, all suggests that we're back in them. We're not looking at a marine setting.

The only way we could be sure about this is if we had some cores -- and it might take several cores -- to examine this and see if there are marine fossils in there, are there trace fossils, are there any types of sedimentary structure, different features that would tell us something about the environment.

But from my analysis and having looked at similar depositional systems in many different area, this is more an inland coastal plain than a marine setting. You just do not get coals out here in this proximal marine setting.

So on that basis, I could not include that sand as a marine sand, even if I was not going on the definition of a massive sand. I cannot call it a marine sand either.

Q. Okay, and is that -- Is your opinion consistent across the course of this area and applying to all of the Pendragon wells?

A. Yes, it applies to this area that's in question here, which would be where I've mapped it within this six-section area. I didn't map it down here where I ran out of logs and it was pinching out, anyway, as Mr. Nicol showed. That applies throughout this area with the Pendragon-Whiting/Maralex wells.

Q. Okay.

A. It does not apply to this area to the northeast. It doesn't apply to the area to the north or to the south. It applies only to this one area.

And this is part of the problem that you have if you try to use a definition of just saying a marine sand, nothing about saying massive, if you're going to try to establish this boundary on the basis of any sand and just say it's a marine sand, how are you going to prove it? Every time you're going to have to go in there and fight this battle.

And that's why these earlier workers, in their wisdom, said the top of the massive sandstone unit below the Fruitland Coal beds. Otherwise, every time you run into one of these stringers, you're going to fight that battle.

And you can't take a five- or four-township area in the Basin without running into this problem because, as I'll show you here in a little while, this is not layer-cake geology. These layers, same layers, don't run from this part of the Basin to the Schneider well in the Cedar Hill field. It's not like that. You can't say this layer here or this coal here is the thick producing coal in the Cedar Hill field. It's not. And we need to go into that and discuss that next, when we discuss the stratigraphy.

Q. Okay.

A. So in my opinion, this is not a marine sandstone. I could be wrong, but I've looked at similar depositional settings, and based on the evidence I have, that's my best interpretation, that this is not marine. It's inland coastal plain, and this is a lower Fruitland WAW sandstone on that basis.

The second basis we need to look at this is the definition of the Fruitland sand, and we'll include some of the -- also the definition of the Fruitland Coal Pool by looking at the Schneider well and comparing it to this area.

Q. Now, is this the -- Go ahead, do you have something else to add on the depositional --

A. I did have -- I wanted to say -- I wanted to make a comment or two about Mr. Nicol's map on this sand, that he has an exhibit which covered this area. This lower Fruitland WAW sand, which he's mapped as the upper Pictured Cliffs, and the exhibit number is not on here.

MR. HALL: I think it's N6, I believe.

THE WITNESS: N6? Mr. Nicol mapped this same area, a little different scale here, a little different scale. But you can see we have the same basic trends, our thickness picks for the logs you would see are about the same if you were to check them. But there are some differences, and some of those have been masked over by using only two colors here on the map. What you see is the basic general northeast trend.

I took the liberty on his Exhibit Number 4 -- which is the same map as his Exhibit N6, because N4 is the same as N6 except, I think, he has cross-sections located on there -- I colored this up using a lot more color range on this.

And what you see when you when you do it like this, with more color range, that -- sedimentologically, it does not make sense. As a sedimentary geologist, I see problems in the interpretation here.

And to put it just very briefly, pick areas like this where you have a thick sand and then suddenly you've got a trough, something missing, well, in sedimentary geology you look for everything -- all of the distribution of the sand is process-controlled. If a river is flowing in that direction, you're going to have sand pods going in that direction. And you don't find areas where thick trends snake around the low -- or a low trough like that. It doesn't make sedimentological sense.

And there are several little problems in here that shows that this map was not contoured, probably, with a good understanding of sedimentary processes in this setting or in sedimentary processes in general.

Q. (By Mr. Condon) Does that conclude your testimony on the depositional basis for your conclusions?

A. It does.

Q. All right. And time, now, to move to the stratigraphic basis --

A. Yes.

Q. -- for your conclusions?

A. Yes, it is.

Q. All right. And again, you've prepared some exhibits, haven't you?

A. I have.

Q. All right, and do you want to turn to Exhibit 52 first?

A. Exhibit 52 we've already looked at, and that's --

So I think that was sufficient. That was --
Q. Okay.
A. -- the type log from Fassett --
Q. From Fassett?
A. Yes.
Q. Okay, so we don't need to pull that out again?
A. Correct.
Q. All right. So Exhibit 54?
A. Exhibit 54 would be next. It's stuck in with 53, I think.
MR. HALL: I go from 53 to 55.
THE WITNESS: It's stuck in with 53. It's in the back. They left a pocket out, so I put two of them together there.
In their wisdom, the coalbed methane committee, as they described -- followed the conventions of previous workers in the Basin in defining the boundary between the Pictured Cliffs and the Fruitland Coal, and they defined it on the basis of the Schneider -- the Amoco Schneider B-1 well in the Cedar Hill field in San Juan County, New Mexico. And their definition in the coalbed methane committee was -- they said -- if I can remember, not quote exactly, but they said that they were using the established contacts and that their contact was at the top of the massive Pictured Cliffs sandstone, and I can find that if

you'd like in these hearing notes, but --

Q. (By Mr. Condon) Well, why don't you just go ahead and explain what the exhibit represents?

A. What I'm going to show you is the Schneider 1-B well on the same scale as our cross-section here vertically. And you can see that we have a sand that -- unfortunately, with this log you can't tell the top of it, but it is a massive sand. You can see it a little better on one of the Pendragon exhibits, that this sand is a massive sand as it continues several tens of feet down below this contact.

This is the contact shown for the Pictured Cliffs-Fruitland -- Excuse me, this is the contact shown for the Fruitland Coal Gas Pool. And I have it a little bit higher here. I have it at -- I'm showing it at 2878, and they formally define it, I think, as 2880, finally. But the early reports said 2880 in the Commission testimony, and that was because they were taking this gamma-ray pick there, and that was probably a little better pick, but it got rounded off to 2880.

But the point is, what we see above the massive sand is a shaly interval, as identified from log analysis, a coal, and then an upward-coarsening thin interval with a very thin sand, identified in this Exhibit 54 as a yellow streak, and then above that a thicker coal. Very similar to what we have down here in the southern part of the Basin for that interval.

So there's no difference in the definition of this boundary down here. This little thin sand would be equivalent to this sand, which gets very thin or is -- even pinches out in this area, as Mr. Nicol showed to the west here.

There is no difference in the definition on this contact as described in the earlier OCD reports.

Now, what Mr. O'Hare was asked to do earlier today was something which he recognized could not be done and should not be done. He was shown Pendragon Exhibit C-C' and asked to evaluate this correlation from the Township 26 North, Range 12 West, up to the Schneider well in the north here, and -- can't read township or range, but we have it on the Schneider log here. In Section 28, Township 32 North, 10 West.

Q. Now, why is it not possible to correlate that accurately?

A. Well, if Mr. Clinton had drawn this cross-section, he would have been impeached. As a geologist, that's an impeachable offense.

Correlation is defined as showing the age equivalency or the lateral equivalency of rocks, and this is not correct. These layers are not layer-caked like this. They don't go -- This thick coal doesn't go from the Schneider well all the way to this well down here. It's not like that.

The way it really goes, Fassett and Hinds showed -- I think that was Exhibit 52 again. Yes, Exhibit 52.

Q. Is that the second page of the attachment?

A. It is. It's the second page of the attachment titled "Figure 10, Northeast-Trending Stratigraphic Cross-Section".

Q. What does that show you?

A. What that shows you is what happened as this beach moved through this area. As the beach built to the northeast through this region, from southwest to northeast, it deposited a series of shorelines.

And if I can just sort of sketch what happens -- And I'm going to do something Fassett and Hinds did, which is not correct. We since do this a little differently. But they did it for a good reason, because it illustrates the point that needs to be made here.

They showed this thing building up in time.

What really happens is, for this shoreline to deposit thick masses of sediments, the bottom has to drop out of the Basin, because sea level doesn't change that much. It fluctuates some, like when ice sheets expand, et cetera.

But we have thousands of feet of sediments in the San Juan Basin, and the only way you can do that is to drop the bottom out of the Basin, in which case I would have to show this basin filling like that. And we can do that, show these coals behind shoreline sands. These would be shorelines building out, where we have ocean here, Pictured Cliffs sands here, coastal-plain sediments with coal back here.

But it's harder for you to see the stratigraphic problem here unless you do it the way Fassett and Hinds did it.

So what they did was, they took the bottom of the Basin and pushed it up and made everything level with the way it was when the Basin started filling. And that shows you, then, what happened to these layers.

So what happens is, the shoreline builds northward, maybe the Basin starts subsiding more rapidly or you get a greater sediment supply here or something. It builds up the shoreline, and then maybe the Basin subsides and the shoreline moves back this way, sediment supply outstrips Basin subsurface, it moves out like that, and it just keeps doing that and moves itself slowly to the north.

Now, that's the shoreline, that's the top of the beach. Then here's the bottom of the beach interval, like so.

So this would be Pictured Cliffs sand, as they depicted it.

But where are the coals forming? If this is the beach, the coals are forming back inland here. So the coals are back behind this. And at the time when the beach was right here, we had coals forming back here like so. Not up real close here, because that's not a bad -- good environment. You may get a little stringer here and there, but not much there. Mostly back here.

Then the shoreline shifted back and you get a few coals up here, the shoreline built on out that way, coals are like this. And over time it works its way out to the northeast. So finally it ended up in the Raton Basin and not into the -- off the continent.

Now, the question is, how do you identify this layer and this contact stratigraphically? Because when we talk about stratigraphy we're talking about the layers of strata, the layers of rock in the earth's crust.

Well, these layers don't do this, they don't go whatever number of miles this is here, 60 miles or so. They don't go that far unbroken. These things break. You look at this, this beach isn't unbroken. We have a pass through it here. Here we have a delta building out. We have rivers here interrupting these sediments in this direction. This is very complex, a lot of interfingering going on, and I was trying to give you a feeling for some of that with interpreting some of the sands in this cross-section on Exhibit 12.

It's very complex. But first we have to remember that this is incorrect. You cannot show this lateral equivalent, because, as we just saw, this coal that's produced -- or deposited in the south part of the Basin down here where we are, is not the same layers that are up here in the Schneider 1-B.

These coals, when they were deposited, were way up here, and they ended right here. They don't exist down here. All this is other inland coastal plain sediments behind these.

So you can't draw a line there and connect that coal with that coal and say this is that. There may be 15, 10 million years' difference in the age of this coal and that coal up there. It's not the same rock.

So why did they define it this way? Well, it's because -- These are what we call rock-stratigraphic units. I'm not going to worry you with all this, but we have time stratigraphic units and rock-stratigraphic units.

Time stratigraphic units are like this. What was deposited in a given unit of time? This is time one, time two, time three, et cetera. At any given time, this rock has equivalents. So this coal here is the same age as this beach out here in front of it. But it's a lot younger than this coal and this beach down below it.

Well, in studying a basin like this, we find there are some similar reservoir characteristics to rock units, these units here. They cut across time. Pictured Cliffs sand down here is a little bit like Pictured Cliffs sands up here, not like up here in the north part of the Basin because some things happened to them after they got buried. But generally, it's good to be able to compare these rock units.

So this would be a rock unit, Pictured Cliffs rock unit, Fruitland rock units, sands, shales and coals. Lewis Shale out here, rock units. And we define these rock units and work with them.

And I can work this rock unit here, Lewis shale, the Pictured Cliffs sand that overlie Fruitland Coal, and I can come down here and say, Well, I've got Lewis Shale down here, Pictured Cliffs and Fruitland Coal above that, and I know something about them. It tells me something -- what to expect in that reservoir. So I study it in terms of rock units -- sandstone, shale, coal -- rather than time rock units, which cut across that.

The important point to all of this is, Mr. O'Hare had not looked at this log here and say it's going to be exactly like that log because they're not the same; they're deposited in different times.

There's another factor as well, is, anytime you move more than a few hundred feet, a few thousand feet, in any area, the rock layers change, because, as I showed you earlier on -- a few minutes ago, these environments are not extensive. Fly over a modern coastline or a coastal plain, and what do you see? A variety of different environments. And they shift with time.

This longshore current carries sand down this beach, it builds out on this side of this spit here and builds it in that direction and it erodes that side. Everything shifts and just moves along.

So what happens is, you get all these very complexly interfingered coal beds, sands, in this particular lower Fruitland environment. And we are in the -- One part of this field that we're looking at, or one part of this Basin, you won't find the same exact layers. You may have two coals in this lower Fruitland WAW interval in some places, you may have one, you may have none. It's because of these subtle changes that occur.

Q. Dr. Ayers, notwithstanding that, is there nevertheless a way to reach a conclusion about whether a formation is the stratigraphic equivalent of a formation in another location in the Basin?

A. Okay, that's -- My point is, it's not -- this is not the stratigraphic equivalent of this; it's a rock-stratigraphic equivalent. In other words, if it's stratigraphic equivalent, you have to say this is equivalent to this, which is equivalent to this way back here and up above that. But it's a rock-stratigraphic equivalent, and that's what they defined, and that's why they did it that way.

This makes it a useful practice, because now you can come over here and say this is the massive Pictured Cliffs sand and this is the lower Fruitland shale. Anywhere I have that I'm -- I have a definition of where to find that boundary. And that's the way it's been defined, and it's a workable but not ideal -- I mean, there isn't an ideal answer. We have intertonguing formations like this.

And that's why I said, if you start straying away from this and going with these little thin, stray sands that come and go, some of them may be marine -- This particular one I don't think is, in this lower Fruitland WAW. Some of them may be, but how are you going to prove it?

You're going to go to all kinds of arguments and studies and trying to collect cores and do core analysis and description to try to figure it out, whereas if you stick with this accepted definition as the top of the massive sand below the Fruitland Coal, it works most of the time as -- in a very good fashion.

Q. Okay. And does that bring us back, then, to your stratigraphic analysis and the support for that conclusion?

A. It does. And what I would like to do is document a little of what I did after this issue arose, because I had already -- I had no questions about this pick when I first did this evaluation. I felt very comfortable with it, having looked at so many logs in the Basin before.

But I went back and put together some examples of type logs, and I think Mr. Nicol had introduced a log from the NIPP PC well, a paper by Jim Jacobs. I was trying to see if I had jotted down the -- it was -- I don't know if I have the exhibit number. Oh, it's N9 --

Q. Okay.

A. -- Exhibit N9 from Mr. Nicol.

I would say that Mr. Nicol's selection of a well log supports his position very well. It looks considerably like this pick. Yes. I don't think Mr. Jacobs got it right, because I've looked at a lot of this -- Here's the one that I'm talking about. It is the one that's starting on page 429 of the Four Corners Geological Society publication on the NIPP Pictured Cliffs.

Mr. Jacobs got it wrong, and I think of all the -- I've looked through a lot of different publications, and a few of them were wrong, but few of them were more incorrect, I think, than that one.

And so I -- just to make that point, I compiled several of these. And Exhibit 51 is a map that shows some of the well logs that I looked at. And I've forgotten how many I put in here, but something like a couple dozen logs, or 18 or a couple dozen logs, just from throughout the Basin.

And most of these locations -- I wouldn't say they're all in there, but I looked at all those, but I put several of those locations, logs from those locations, in Exhibits 47 and 49 for you to look through. Some of those are from the federal wells like the Federal -- Mesa Federal 12 to the east, which was a GRI research project from the GRI study of the Cedar Hill area, where the Snyder B -- 1-B well is.

And I'd like to take this just one step further to make my point about the similarity --

Q. Which similarity are you referring to?

A. In the rock-stratigraphic definition between this area in this other part of the Basin where we're working and the area to the north.

And what I'd like to do is just use the examples here of Exhibit 50, which is a plate from the subcommittee, coalbed methane subcommittee. It was their Plate 3; it's

Exhibit 50 here. This was prepared by ICF Resources, Incorporated, for the coalbed methane subcommittee.

And I shrunk this Schneider 1-B log down to about the same size. Unfortunately, their cross-section didn't include the Schneider 1-B. This cross-section was just south of it.

But what you can see, again, is, on the Schneider 1-B, it compares with their pick throughout that Cedar Hill field study area, and they have here -- In some cases they don't have a thin sand in the lower unit. There, I think there's one I started to highlight and I didn't bother. Over here, there's no question there are some thin sands.

They come and go. This kind of lensing, thinning, thickening, pitching, swelling is very common as these sands and coals come and go in an environment like this.

And notice the way they define this coal here. They have a basal coal unit, which they describe as two coals, upper Basin coal, lower Basin coal, separated from the top of the Pictured Cliffs -- This is their definition, which I've highlighted here in orange, this shale-sand interval.

Very similar rock-stratigraphic definition. You can take this and walk over to our cross-section over here. The rock-stratigraphic definition holds up 100 percent. No question that it meets the intention both of the coalbed methane committee and the earlier accepted descriptions of the boundary between the Pictured Cliffs sandstone and the Fruitland Coal unit.

I would suggest that if you look through several of these exhibits that I have included in 47 and 49, that you will conclude -- for example, in the WAW 1, which is -- WAW 1 is in -- oh, probably about 10 or 15 pages in. But you see right exact -- for example, the WAW 1 definition is very like the definition that we are taking here. It's the top of the massive sand.

These are all published field examples.

Q. Do you know, Dr. Ayers, if the WAW 1 is a type log for this area?

A. I don't know. I don't know if it is or not.

Here's another good example. This is the Piñon North-Fruitland field. Notice here, top of the massive sand, there's a Pictured Cliffs, there's a shaly interval, there's a thin little coal there, another coal there, up there. It's a very similar definition to the one that we've been looking at in -- as I said, I have samples from throughout the Basin here.

If you're going to be consistent and not run into a definition problem like this everywhere, you're going to have to have some kind of a consistent definition. I know people are going to find it a struggle, and the problem will be -- There will be a problem with it, but it's held up for decades, it's worked very successfully for decades, but there will be a problem if this issue continues.

And the problem will be, what happens in the case where one of these Fruitland sandstones -- or excuse me, one of these Pictured Cliffs sandstones thins and pinches out to the southwest and you make the interpretation that Mr. Nicol did? It's a common -- I mean, it's a natural thing to do. But, as we saw upon further sedimentologic analysis, it probably wasn't the right decision.

But unless we stick with a simple definition like a massive sand -- top of a massive sand, this is going to be a much greater and recurring problem, in my opinion.

Q. Okay. Dr. Ayers, were Exhibits 10 through 16 and 47 through 55 prepared by you or under your supervision and control?

A. They were.

MR. CONDON: Okay. I pass the witness and move the admission of Maralex/Whiting Exhibits 10 through 16 and 47 through 55.

MR. HALL: Mr. Examiner, can I ask a question? With respect to Exhibit 47, Dr. Ayers was showing you an article and type log on the WAW 1. It's not contained in our copy. Do you have that in yours? Are they all like that?

THE WITNESS: I don't know.

MR. CONDON: You're looking for the WAW 1?

MR. HALL: Yes, there's the article, Michael, but no log that I can --

MR. CONDON: Okay. Do you want -- I mean, I can give you -- We've got an extra volume here with a copy of the log.

MR. HALL: What do you have?

EXAMINER CATANACH: Is this what you're talking about, this one right here?

MR. CONDON: Right, the WAW --

EXAMINER CATANACH: Yeah.

MR. CONDON: -- Number 1. Yeah. Do you want us to just pull this out? Or just trade volumes?

MR. HALL: No objection to the exhibits.

EXAMINER CATANACH: Exhibits 10 through 16 and 47 through 55 will be admitted as evidence.

Mr. Hall?

CROSS-EXAMINATION

BY MR. HALL:

Q. Dr. Ayers, while we're on the WAW 1, let me ask you about that. I hand you what's been marked as Exhibit A1. Some of these aren't stapled. Is that the completion report for the WAW 1?

A. Yes.
Q. And can you identify for the Hearing Examiner perforation record shown on A1?
A. Completion interval, producing interval, completion type?
Q. Perforation.
A. Okay. 1325 to -- It's fuzzy, I can't make it out. It's 1325 to -29.
Q. All right. On page 2 of that, it shows the log tops. Can you refer to that and read that into the record, please, sir?
A. Pictured Cliffs, 1317. Doesn't match their -- This publication, does it?
Q. All right. Saying that that operator, Mr. Dugan, got it wrong when he was picking the PC top?
A. Well, let's see who he disagreed with here. I mean, we obviously have two opinions right here. Kurt Fagrelius at Dugan. So I guess they need to get together and talk about that.
Q. All right. Do you agree with Mr. Fagrelius's --
A. I do.
Q. -- opinion?
A. I agree with the pick on this figure, yes.
Q. And is --
MR. CONDON: Just for the record, which figure

are you talking about?

THE WITNESS: The figure is in Exhibit 47, the 14-by-17 page called "WAW Fruitland-Pictured Cliffs", geology by K. Fagrelius, in the lower left corner.

MR. HALL: Let me go ahead and move the admission of Exhibit A1.

MR. CONDON: No objection.

EXAMINER CATANACH: Exhibit A1 will be admitted as evidence.

MR. CONDON: That's A1?

MR. HALL: A1.

Q. (By Mr. Hall) Dr. Ayers, you recognize that there is intertonguing in the Fruitland formation, do you not?

A. That's what I was describing here a few minutes ago, Mr. Hall, yes.

Q. All right. And you referred to an exhibit you had that's marked Exhibit 52?

A. Yes.

Q. Okay. Generalized cross-section.

A. Exactly.

Q. If I may approach you --

A. Sure.

Q. -- point out some of the features on this. I have circled some areas here --

A. Uh-huh.

Q. -- and this is some of the intertonguing you were describing?

A. Yes.

Q. And that would include -- our situation -- it's analogous to our situation here where we have Pictured Cliffs sandstone intertonguing the Fruitland?

A. It is -- Throughout the Basin that's true, Mr. Hall, yes.

Q. And similar to our situation here, you have a thinner sand here that coalesces into a larger sand as you go, in this case, to the northeast?

A. This -- I'm not sure what you're saying. If you're talking about this area here, yes, because the north part of the Basin, there's a hinge line that's subsiding more rapidly. You've got these bigger shoreline buildups and therefore thicker coals behind them. So it's a little different story in the north than it is in the south.

Q. All right, I understand.

Dr. Ayers, what's the stratigraphic equivalent of the definition point on your Amoco Schneider Gas Com B log when you take that to the well in Section 1, in 27-12 on C-C'? Can you explain that?

A. Now, what was the question?

Q. What is the stratigraphic -- Let me ask you to define that term as geologists use it. What does "stratigraphic equivalent" mean?

A. Well, it would be something of equal age. Strata are the layers of the rock. A stratum is an individual layer. It's a layer in the earth's crust.

And so if you're talking about the stratigraphic equivalent of the Pictured Cliffs in the north -- in the south part of the Basin to the north part, it wouldn't be on this cross-section. We don't have enough log there. Because we're talking about -- Where's Mr. Fassett and Hinds' exhibit here, 52? And I think they had a vertical scale on there that gives you an idea how much we're talking about here.

I thought they had -- Yeah, they have a vertical scale there, that you can see we're going 800 -- we're going 1200, 1000 feet, as you go from the south to the north, you have that much more sediment built up. So it wouldn't even be on here. This would be stuck way up here in the air relative to this thick coal down here.

Q. All right, so do you see one on the well in Section --

A. None of these wells down here have anything stratigraphically equivalent to the north end of the Basin.

Now, we have rock-stratigraphic equivalents. In other words, Pictured Cliffs, Fruitland Coal, Lewis Shale when you get down in here. But you don't have the stratigraphic equivalent, the same layer just going from one type of rock into another type of rock at the same age correlation like this. Implying that's the same age is not right. Like I said, this may be five million, ten million years younger than that.

Q. Well, would that make the Lewis shale the same age as the PC, then?

A. In parts of it, it is, yes. In fact, let me show you, since you ask the question, a cross-section that might explain this a little better. This is out of GRI Topical Report 91-0072, which was a report that I was the principal author on and -- for this GRI study of the coalbed methane in the Fruitland of the San Juan Basin.

And, if I may --

MR. CONDON: If we could, if you could approach the Examiner so that he can get the benefit of the testimony also, and Mr. Hall and I can come up? I mean, I just -- I don't want the Examiner to be left out of your explanation to Mr. Hall.

THE WITNESS: What this is doing is showing these relationships the way I started to show you, which was more correct, showing that the Basin bottom is dropping out instead of pushing everything up.

And what you see is -- Mr. Hall asked me if the

Lewis shale was the same age as the Pictured Cliffs across here. And we have time lines on here, and these are based upon gamma-ray hot spots that we correlated throughout the Lewis shale, which you can see is this interval in here.

And we can take these time lines, like I showed time one and two upon the board there, follow them back up into the Pictured Cliffs from the Lewis shale, and then you lose them up in the beach environment. This shoreline was building out like this, sort of like shingles on a roof, building to the northeast.

Here we are at time 35 up above, 20 here. This is the Huerfanito bentonite, which is often described in the Lewis shale as a good correlation point. We move up younger to, say, 42, follow that time line up, and it comes up in here like that, and time would cut across.

So these layers are all getting younger as you go in this direction, and these coals down here are not the same as these coals up here.

And it's very complex like this, with all that intertonguing which Mr. Hall is referring to. If you don't stick with the massive -- top of the massive sand or some easily boundary like that, then you find a very great difficulty to pick any boundary when you get back in this setting, because these thin sands could have several different origins.

Q. (By Mr. Hall) Well, as I have posited the question to you, stratigraphic equivalent means a function of age or time. Does that mean some PCs and some coals are stratigraphic equivalents?

A. Yes, sir.

Q. How about the rock-stratigraphic equivalent in the Schneider B Com log?

A. Okay, that's what I showed you a little earlier here with the rock-stratigraphic unit, and you take the well log in the Schneider 1-B, which I had here a few minutes ago.

MR. GALLEGOS: I think you left it over here, didn't you?

THE WITNESS: Oh, I think I did, yes.

MR. CONDON: It's Exhibit 54?

THE WITNESS: Yes, thank you.

Now, I can take this and say in terms of rock-stratigraphic units, this is similar enough to the Schneider 1 -- the Schneider 1-B is similar enough to this to say that this is a rock-stratigraphic equivalent down here.

But it's not the same age rocks, and you don't expect all these layers to look the same. They're going to change, markedly.

Q. (By Mr. Hall) Dr. Ayers, you referred to what we're calling the PC sand. You call it the WAW Fruitland sand. What's WAW mean? Never mind.

Can you demonstrate another Fruitland sand of the same continuous area and consistency as the WAW Fruitland sand?

A. Well, this is a very small area in terms of geologic maps, and I've done detailed mapping in, oh, the Navajo Lake area, the Cedar Hill area, the western margin of the Basin. I mean, you could demonstrate that. I don't know if I have any maps handy to do that. I mean, that's a common occurrence, Mr. Hall, but I'd have to go through some of the publications here to pick out a figure that shows that.

Q. Well, can you -- Is there a contemporary analogy to an area of deposition where you'll see a six- to eight-foot sand being deposited over a ten-mile wide area by a three- or four-mile-wide area in a fluvial-type environment?

A. Well, this is not a ten-by -- How big did you say? We're looking at something here, two by three. The area that we're focusing on here is two miles wide and three miles long.

Q. I see. This looks up the shoreline, does it not?

A. The shoreline would be like this. At this time this was forming, the shoreline would have been out here somewhere.

Q. And so you've -- For the record, you're indicating from northwest to southeast?

A. Northwest to southeast, yes, and to the northeast of this mapped area.

One thing that I did also to help me identify these -- this setting here, Mr. Hall, is, I looked at log patterns. As Mr. Nicol kept describing on Tuesday, he said log patterns are indicative of environment, and sometimes they are. So sedimentologists often map the well log patterns as upper-coarsening, upper-fining, spiky, blocky, and that helps you, along with the thickness and other data, to interpret the environment.

In this area, we're talking about a very thin sand here, as you can see from pinching out down to the southeast here, to a maximum of ten feet in this area of interest here.

And log responses are such that well-log patterns aren't real good in this thin interval, but usually what you can see is a spike. But I recorded them and used them along with my mapping. And what I saw was that out of the 27 logs in that section, this six-section area here, they were all -- Let's see, out of the 27 logs I had, 15 were just spikes, 11 were upward coarsening, and both of that indicates pretty low-energy environment, and that could be a crevasse splay, flood stage of the river when it spills over its bank and you get this stuff spilling out in here. That's consistent with that kind of setting on the scale and the log patterns.

Q. Did you call that the crevasse splay?

A. Crevasse splay, yes. Crevasse is a break in the channel or the bank of the levee of the stream, and this material splays out or spreads out, fans out, from that break as the water pours through that crevasse.

Q. Can you show me here on your thickness map where this river depositional mechanism was at play? Is it a river channel?

A. There is not in this area. And there's nothing to suggest -- We don't have any sand in -- In this lower Fruitland WAW interval, we don't have any sands either thick enough or the right log pattern character to suggest that we have a stream moving through here. We're off on the flank, we would be either south or north of the stream, or southwest or northeast of the stream, off on the flank, not in active fluvial or river sedimentation. That's why we're getting such thin discontinuous nature to the sand there.

Q. But in that type of environment, as I understand it, to fit in with your thickness map there would have been a river channel running generally to northeast, perpendicular to your shoreline?

A. What's happening is, the river's running like this. These are the old beach ridges, and they are -- they may be at various stages of burial, as I'm suggesting here by younger sediments, but they're still exerting enough influence so that you have sags between them and sediments splay out between them at flood stage.

Q. All right.

A. So it's similar to this. That would be a crevasse splay.

Q. But the depositional mechanism I understand you contend was at play here was river deposits out into a lagoonal-type environment?

A. Not necessarily lagoonal, no. No, lagoon is way down here. We're too far inland for a lagoon. We wouldn't have the coal stringers that we have in there if we were out in the lagoon. This would be an old inner beach ridge area. And it's just a coastal plain setting, what's called lower coastal plain setting.

Q. Well, I'm having a problem correlating that explanation with what you show on your thickness map there.

A. Here we are. Let's put it up here to help you.

Q. Let me finish my point --

A. Okay.

Q. -- before you begin yours.

It would seem that in this case there is some thickening to the north and east, and you're saying, in this anyway, that's not happening?

A. No. No, I'm not saying that at all.

What I am describing on Exhibit Number 11 in this field of interest here, in these sections of interest in the Whiting/Maralex-Pendragon area of interest, I'm describing this as being equivalent on Exhibit 10 to this -- these intervals like this, back inland.

As you go more Basinward, you could come up to -- you could have thicker or thinner or splay deposits. You could even get up here where you actually do get into a lagoonal area, and you could get flood-tidal deltas into a lagoonal area. It could be the next one up, it could be this one. I don't know. I didn't map that far. It wasn't our area of interest. We're looking back here.

But we can see we've got this one, we've got this, we've got another one here. So we know we're not at the active shoreline. We're back behind it.

Q. Let me ask you about this exhibit again.

The coal you all have been describing is the basal coal --

A. Yes.

Q. -- the thin coal down here?

What happens to it as you go towards the northeast?

A. It would pinch out behind a sand, most likely, and disappear, or it could have been erosionally truncated. A lot of different things could happen.

Q. It's discontinuous that way, anyway?

A. All coals are.

Q. All right. Is it possible to have PC sands forming above PC shales and coals?

A. PC sands can form -- They all form at the same time. You can find them stratigraphically above one another today because of the intertonguing relationship that I showed on that cross-section -- well, both of them, the one that I showed from the GRI publication, and the one Fassett and Hinds showed, Exhibit 52.

Q. Where is the northeastern marsh boundary of the WAW sand?

A. I have no idea.

Q. Okay.

A. We didn't map that extensively.

Q. Are there other circumstances where previous deposition controls subsequent thickness deposition?

A. Oh, yes, very common.

Q. Can you give us an example?

A. Sure. Gulf Coast of the United States. You look at all the modern rivers, they're stacked above ancient rivers in the subsurface.

I've worked the coastal plain a lot, and like the Brazos River, if you look in the subsurface -- it's a common thing to do -- and what you'll find is stacking, and you'll find offset because of compaction differences.

What we're seeing in this case is probably offset due to compaction differences, or actually existing at the same time, these remnants here that we're focusing the sedimentation around these.

But that's a very common feature, very common feature in sediments.

MR. HALL: That concludes my cross, Mr. Examiner.

EXAMINER CATANACH: Let's take a short break before we start.

(Thereupon, a recess was taken at 3:24 p.m.)

(The following proceedings had at 3:48 p.m.)

EXAMINER CATANACH: Okay, we will reconvene the hearing, and I'm going to turn it over to Mr. Chavez.

EXAMINATION

BY MR. CHAVEZ:

Q. Dr. Ayers, in the area that you reviewed, did you attempt at all to extend your study even a little bit further to verify that what you were looking at was interpreted well enough, or could you have been more sure of your interpretation had you looked at a little larger area?

A. I've been told that geologists never have enough data, so the answer is, the more data you have, the more sure you are of your answer. But I think we carry far enough beyond this area to feel confident of what we are seeing here in this area of interest.

Q. Okay. Are there places in the San Juan Basin where a log would show a thin Pictured Cliffs sandstone above a much thicker Pictured Cliffs sandstone, what might be, in your terminology, called massive?

A. Oh, yes, indeed.

Q. And how is it interpreted then that those are thinner Pictured Cliffs sandstones?

A. You would have to -- To be definitive about it, you would have to look at the -- a lot of detail, like core samples, probably, and you'd have to map the features.

That's what I was saying earlier is, you would have to look to see if you see certain fossils that are indicative of an environment, a more marine environment, a lagoonal environment, right behind this strand layerular barrier.

You would have to look for things like certain types of burrows that certain critters that lived in this environment made. You could look at -- if you had -- oh, let's see, sedimentary structures, geometry.

The other thing you could do would be to map it both ways or in all directions and try to get a good feel, as I said, for the geometry, and that's about it.

There's no question that there are occurrences just as you've described. The problem is, you have too many of them. You have those everywhere you have this relationship at the end of this landward side of this, you have those intertonguing relations, and you can't easily define whether those little thin sands are the little thin sands that may have been deposited in here or may -- and these little thin sands deposited back here, because as you can see, this is all time-equivalent. These are all being deposited at the same time.

So if I draw a cross-section or make a cross-section with logs, I could see equivalent-age sands right along her, but they're not going to be in the same environment. That's what makes it really tough. It's not an easy issue, and that's why you're better off, I think, sticking with what you know is the Pictured Cliffs, the more massive sands.

And even that is not a straightforward issue, because what's massive sand is somewhat of an arbitrary decision, and it may be a thinner sand in this part of the Basin than in this part of the Basin. So you have to look at this part of the Basin as one area.

And then as Mr. Hall asked me about before, why do we have these thick rises up here? We have a different setting there, it's thicker sands because of more accommodation space in the Basin. So it's a tough issue.

Q. Okay. Before you did the hand drawing that's up there, or as you were doing it, you said you were going to do something, or Fassett made a mistake --

A. No -- Okay.

Q. Okay, and I didn't understand what you were getting at and how you interpreted that was a problem.

A. It's not a problem, it's just not a correct geometry to the present-day sediments. This is the way it really looks, because the -- We talk about basins like the San Juan Basin, the Raton Basin, et cetera.

If we look at the sedimentary fill of the Basin today, you know, it might -- At some level, this might be top of Fruitland, this might be the Lewis shale. If we look at this, what we see is a lens of sediment that's thicker in the Basin than up here.

And sediments are always being deposited at basin level, which is sea level. That's where they're piling up. So what happens is, the basin drops to create more accommodation space, to let those sediments be deposited.

So it's like in the cafeteria, one of these loaded spring things with plates. You put more plates on there and it's dropping down and accepts more. So you're always at that same level here.

And so what he's doing here is showing it as taking the bottom of the basin and pushing it back up so you can see these layers as being flattened out, when in fact what happens is, it's more lens shaped like that. So this is thicker back here than it is up here where it sort of thins out. And that's why the Fruitland formation is much thicker as you go from the south part of the Basin to the north part of the Basin. It's all expanding.

So what he's doing is making it simplistic and easier to understand why these relations exist like that. But it's not the physical relation that actually exists in the Basin today; it's more like this, where we have Lewis shale, PC sand, and Fruitland back behind it.

And the intertonguing relations, then, are here between the Lewis shale and the PC, and between the PC and the coals back to the left of that. This would be back here.

Q. One of the things that's interesting -- I had asked Mr. O'Hare about it, but I guess you were the person to ask, is, on the Exhibit 16, these cross-sections that you used there, that is -- for the datum on that -- By the way, did you construct this?

A. I did.

Q. Okay. For the datum, you used the top of what you're calling the massive Pictured Cliffs?

A. Yes.

Q. What type of rendition does that give us, different than if we had used, say, a point like the Huerfanito bentonite marker below the Pictured Cliffs or some point above the Fruitland, or even sea-level data? What differences should we look for when we're trying to understand what you're telling us in the cross-sections, depending on what data you used?

A. Well, that's exactly what Mr. Fassett did. He used the Lewis bentonite and said that you have to flatten on something down below to understand the relationship. But that's not true. That was 1960s and 1970s mentality on sedimentology, and we now understand more about how these basins fill.

What this does -- There are two types of cross-sections that are commonly made, stratigraphic and structural cross-sections, and you make a structural cross-section to look at structural relations, faults, folds, et cetera.

Stratigraphic cross-sections are made to show the relationships of the strata or the layers, and so you flatten them on the layer, one of your primary areas, the layers of interest, or one that has a good continuity. You can use the Huerfanito bentonite as a datum for a stratigraphic cross-section.

Here, we didn't have -- This was the area of interest, the top of this massive sand as it's defined, and so that's the logical thing to flatten on, to evaluate the relation of the other sediments to it, or the other layers to that layer.

Q. Would we have gotten -- What might be different in the interpretation if that was hung on sea level?

A. On present-day sea level, you would see the structure. There would be a slight rise across here, a little more than you're seeing here.

You asked Mr. O'Hare about this, and I noticed it, and that's why I put in there, so we could call attention to it. I didn't interpret all the coals in here, because this is a poor-quality log, the Chaco 2-R, and some of these coals come down through here.

What we're seeing here, you don't want to interpret as structural. This is sedimentologic. This is a fluvial or river sand in here. And notice how this is wedging and pitching and swelling. So you don't want to misunder- -- mistake that for structure. That's actually compactional folding over these old river-channel-filled sands.

If we would put this on structure, all you would see is some arching where you go across that little structural nose that Mr. Nicol showed.

This is -- There's not a lot of structural relief, and this is almost on -- I think this is almost on structural strike, as well as depositional strike, so you'd be going sort of parallel to the strike lines or the structural lines, with the exception of this little structural nose which I think is faulted, and that's why I put some of this question mark in here, poor-quality log. But I think there is probably a fault here.

And what this suggests to me, this difference in thickness across here, is, that fault may have been active actually during sedimentation, and it was allowing -- This side was probably downdropping, allowing more sediment to accumulate during this interval of time, because I've flattened on that layer and pushed this up. If I had flattened on the coals, it would have pushed this contact down, if I had flattened, say, on the bottom of that coal.

So you get a different look, and it depends on what your objective is. Our objective being to evaluate this contact, that was the logical datum to use.

MR. CHAVEZ: Okay. At this time I'd like to ask the Examiner to take administrative notice of a document called *Coalbed methane in the Upper Cretaceous Fruitland Formation, San Juan Basin, New Mexico and Colorado*. It is published by the New Mexico Bureau of Mines and Mineral Resources, which is a division of the New Mexico Institute of Mining and Technology, educational institution of the State of New Mexico. And this document is used by both our agency and other professionals to better understand the coalbed resources, and it's been edited -- or one of the editors of this is the witness.

So if you would take notice of it, I'd like to ask the witness some questions about this document.

MR. GALLEGOS: This is not part of the records of the Division of which you can take notice.

I don't think -- You know, if Dr. Ayers is one of the authors, then that could be a proper source of cross-examination, but I don't think the proper procedure is taking administrative notice.

MR. CARROLL: You're objecting to it?

MR. GALLEGOS: I'm objecting to the way it's attempted to be put into the record on the basis of administrative notice. What I'm saying is, it's always appropriate to cross-examine somebody on their own work. He can certainly ask him some questions about what's in the -- what he's written.

MR. CARROLL: Mr. Chavez, are you going to -- Are there pages that you want --

MR. CHAVEZ: Yes, there's specific pages I'd like to ask the witness about, and --

MR. CONDON: Do we have copies for the witness and for --

MR. CHAVEZ: Yes.

MR. CONDON: -- the parties?

MR. CHAVEZ: Yes. I withdraw, then, my request for administrative notice, if I could just go ahead and --

MR. CARROLL: Yeah, just cross-examine him based upon the book. He's the editor, right?

MR. CHAVEZ: He's one of the editors, he along with W.R. Kaiser.

MR. CARROLL: Yeah, you can ask him if he's aware of it, which I'm sure he is.

MR. CHAVEZ: There are three sheets there. One -- The copy machine didn't get all the page numbers. There's an 82, an 83, and a page -- I don't think we got the page number.

THE WITNESS: 205?

MR. CONDON: 205.

MR. CHAVEZ: 205, yes, it has been --

MR. CONDON: It's handwritten on there.

MR. CHAVEZ: Okay, that is page 205.

MR. CONDON: And just so the record reflects, this is from that --

MR. CHAVEZ: Yes, I'll -- it's a --

MR. CONDON: Can we just introduce the volume at the end of this?

MR. CHAVEZ: It's Bulletin Number 146, published in 1994.

MR. CARROLL: Yeah, let's maybe mark it as OCD Exhibit Number 1 and just put the whole thing in the record. Is there any objection to that?

THE WITNESS: Yes.

MR. GALLEGOS: No objection.

MR. CARROLL: That way it will be in the record, and people can --

MR. HALL: OCD 1?

MR. CARROLL: Yeah.

Q. (By Mr. Chavez) Dr. Ayers, on page 82 there's a cross-section that's part of a paper that you co-authored with S.D. Zellers as part of this publication, or Bulletin 146, and on there you show two cross-sections, basically the same information with two different renderings --

A. Uh-huh.

Q. -- as we discussed earlier, using two different data points. Now, under the explanation there, at the bottom of that figure -- I guess it's Figure 4.18, Cross-section B-B', it says that the cross-section, (a), "suggests that coal seams terminate abruptly against Pictured Cliffs shoreline sandstones."

Now, that's what you were suggesting that was the old way of thinking, that Jim Fassett had used.

A. That's correct.

Q. All right.

A. Yes.

Q. And then for cross-section, (b), it says that, "suggests that swamp facies (coal seams) migrated over abandoned, foundered Pictured Cliffs shoreline sandstones" --

A. Correct.

Q. -- is that correct?

A. Yes.

Q. Then on page 83, the left-hand column, under "Structural controls on producibility of coalbed methane", the second sentence there says, "However, as we have demonstrated, some Fruitland coal seams may be regionally continuous, overriding and thinning over upper Pictured Cliffs tongues..."

A. Uh-huh.

Q. Does that give more credibility to a -- say, a more distant-type of correlation that's drawn with the Fruitland Coal sands?

A. Coalbeds?

Q. I'm sorry, yes, coalbeds.

A. Yes, that was the whole purpose for this. And that's why I said our thinking has changed some since the Sixties and Seventies, and that's exactly what this is based on. I didn't think it was an issue we wanted to get into here today.

But what it's saying is, Mr. Fassett in doing this assumed that -- he actually thought that these coalbeds were terminating, in all cases, right behind the shoreline.

And what we showed is, when actually you can't get -- you don't have buildup of sea level like this that amounts to 1800 feet. Sea level doesn't change like that. Sea level fluctuates with the ice ages, ice caps expanding and contracting, maybe 150 to 300 feet maximum. So this is not a valid picture.

And what we were saying is, this is the more correct model. And what that hap- -- what causes -- or what that allows to happen is, in some cases the coals that are back here do not terminate against these tongues but, in fact, because this area is building up and the Basin is dropping down, some of these coals back here will split and migrate over the top of these abandoned -- And this coal here might have a split that terminates here, and the top of it may ride across here and terminate against this next shoreline further to the north.

And so they have more continuity than Mr. Fassett was suggesting with having them all stop right behind the immediate shoreline, which they were forced to do with the way -- What happened is, he took the Huerfanito bentonite bed, which could be this bed here, and pushed everything up relative to that.

So in his picture, the Huerfanito bentonite is flat. And it's not the way basins develop. we've learned since then that basins don't -- You don't deposit sediments like this with all this building. You have the outbuilding, but it's like this, filling in a pot that the bottom's dropping out on.

Q. Okay. So actually when you're looking at the Fruitland, without drawing it, you could actually -- Correct me if I'm wrong here. You could start a coalbed, say, for example, about where F is on "Fruit" and actually continue it maybe in more of a diagonal upward. That would -- might give a better rendition of this overlying --

A. Well --

Q. I mean, if we were to interpret that, going up to the little sketch --

A. See, what's wrong with this is, we're starting to get real complex now, because what's happening in this direction? See, we've got these boundaries in this direction, and what happens to these coals here is, they're intertonguing in this direction.

So you'll lose some against this shoreline, some will override this, because these rivers change position. They don't cross the coastal plain always in exactly this spot. They'll shift a half a mile, shift back, and back and forth.

And as a result, you can look at other pages in that same book that you're quoting from, or look at -- this is -- That's actually a condensed form of this GRI publication.

And what you see going on in this direction that we see on Exhibit 10, like so, is, we get intertonguing in this direction with these fluvial sands, we get intertonguing directions in this direction with these beach sands and termination behind them.

So it's very difficult to correlate these pods and determine what's happening. This is from the Navajo Lake area, and what you see here is a thick coal deposit splitting in the northwest direction as it interacts with this fluvial complex, very like the one that we're showing right here, like this, except in this case we're -- it's splitting some coal seams. But see how this complex is thickening? That's exactly what's happening here.

Coal is much more compactable than shale and sand. There are different compaction ratios put forth, but for peat compacting to coal, you see compaction of six to one, to 22, 23 to one.

So if you decompact all this, you see that this all comes back up. The shale will compact two to one, sand will compact much, much less. And so you decompact all that, and you can understand these relations better.

But these -- what you don't -- What you have trouble doing, sometimes, is following these pods in this direction and in that direction at right angles at the same time. And what usually is happening is, they're switching -- these streams are switching positions. As this all builds up, they're switching this way, the shorelines are moving that way, pods will be forming in here for a while, then they'll forming over here as the stream slips over here, and it gets very complex.

But I don't think you'll ever see a case where you'll have, say, one coal down here that you can follow all the way up through there like that. It just doesn't happen that way.

Q. Okay, thank you.

A. Uh-huh.

Q. On the next page, I guess it would be the third page of our handout there, page 205 of this document, on the right-hand column -- Let's see, this paper is Paper Number 10 which you co-authored with W.R. Kaiser.

A. Okay.

Q. You talk specifically about the WAW Gallegos area. And, you know, part of the -- some of the evidence presented here has to do with gas analyses in determining whether a well is producing from Fruitland or Pictured Cliffs.

And I think it's the fifth line from the bottom, in that WAW-Gallegos area section, you say, "Gas may in part come from the underlying Pictured Cliffs Sandstone. Thus, the presence of significant free gas and enhanced permeability are thought to combine to explain relatively high gas productivities in the WAW-Gallegos area."

Now, when you're talking about gas, in part, coming from the Pictured Cliffs sandstone, are you talking about the gas of coal?

A. Yes.

Q. And when you're talking about the Pictured Cliffs sandstone, you're talking about -- let's say -- you bring up your Exhibit 16 again. You're talking about from that orange-brownish colored area, going up into the Fruitland Coal; is that right?

A. That's correct.

Q. It would have to go through what you've called the Fruitland sandstone in order to do that, is that right, in this area?

A. This sandstone may not be present through all the area. In some cases you may find this interval much thinner and this coal sitting directly on the sand. Or it be, again in reference to this coal, closer to sand there.

Dr. Kaiser wrote that particular part of that section, and I'm sure he had a reason for doing it. And it was probably based upon our regional gas analysis that Andrew Scott was very instrumental in. It's further described in that report.

And I don't know the details. We don't have enough information here to know exactly what he was thinking on that.

Q. So although you're co-author, you didn't author this portion of that paper?

A. I was -- I edited, probably, this portion of the basin -- of the paper. I think he was probably first off on this, wasn't he?

Q. Beg pardon? Yes, his name is mentioned --

A. Yeah, he's first author on this particular section.

But I think what we're referring to here, in part, is the fact that some of these fields produce water-free in this area. Isn't that correct, in this area? And somebody --

Q. I think that's mentioned in that section.

A. And I think that's what he's referring to, is, he's saying here that significant free gas and enhanced permeability can explain the high productivity in this region.

And if you have enhanced permeability, that's implying that there's -- something happened to enhance that permeability, like possibly some vaulting or fracturing, which may mean that you have a conduit through some of this interval, like in a case like this, and there may be some gas migrating upward from the PC.

Now, I'd have to say that I've looked over the gas analysis in this particular area that I'm looking at, and I don't know what it was in the exact area that we're referring to here, but I would have to say that in this area, the gas data that I looked at suggests that the coalbed and the PC gases are different. I feel very comfortable in saying that.

And I think I was misquoted, in one of the papers that I co-authored with Andrew Scott and Bill Kaiser, Tuesday, by Mr. Nicol when he selectively quoted from our paper.

That paper that we wrote was based upon 5500 PC gas analyses -- or 5500 wells, analysis from 5500 PC wells and the 447 or so Fruitland wells, and it was a look at the whole Basin, a regional view.

And we specifically said in there -- What we said is, statistically you cannot use the differences in gas composition to separate coalbed from PC gases in a statistical sense looking basinwide or looking regionalwide sometimes. But in some areas -- and we specifically say this -- locally it can be used, especially in conjunction with other types of information.

So I think we were misquoted on that. And when I look at this area, I feel very comfortable in saying that looking at the early time data on gas compositions, the folks at Whiting/Maralex are correct in saying that these PC and Fruitland gases are different initially.

Q. In the work that you've done in the past, have regulatory agencies in the past used your work as part of the bases for perhaps pool rules or otherwise regulating these pools, that you know of?

A. I don't know whether they have or not.

Q. Have you ever directly advised any regulatory agencies?

A. No, I haven't. Mr. -- Dr. Whitehead extensively referenced this work in the gas atlas that was done by the New Mexico Survey in his discussion of the PC and the Fruitland. Most sections, if you will read that -- In fact, I saw one right across the hallway in someone's office the other day. But it's been exclusive- -- or extensively referenced by his -- in his publications, the gas atlas.

I don't know about regulatory agencies.

Q. Did you hear Mr. O'Hare state that regulatory definitions and geologic definitions can be different?

A. I think that seems consistent with what I've read, yes.

Q. Okay. In a sense I'm asking you -- Well, I'll ask you directly: Is there some other basis, or what kind of basis can be used by regulatory agencies, in your opinion, to be helpful in area where there might be confusion as to where perhaps a formation or a pool could have tops and bottoms, especially in areas like this where you do have intertonguing, you do have confusion sometimes?

A. Yes, as I said earlier, I think it's a difficult issue, and I don't -- I wish I had a good answer for it.

I think in this particular case we have an ownership issue, somebody owning the surface to the base of a certain formation, and so that's a little different than talking about a case where somebody has ownership of both of these. And that's where the problem really comes in, is in this case both parties own -- or if one party owned both of these, obviously, it wouldn't be a problem. And I don't have an easy answer for that. I don't know how we handle it.

I understand why some of the rules were written, but I think maybe they need to be re-evaluated in view of this particular case and what's, possibly, likely to follow.

Q. In Exhibit 16, there are two places where there is a thin coal shown in that brown area you call the Pictured Cliffs.

A. Yes.

Q. Would that be a Fruitland Coal?

A. I don't know. There are two possibilities. That could be a Fruitland Coal, if we were to map -- This is a strike section, so it's parallel to the old shoreline. If we were to map back this way, we might find that it was.

And that has -- Whether or not it is a Fruitland Coal has nothing to do with whether it was deposited in a marine sediment, or setting, or not, because this an old shoreline.

Just make hypothetical, but a true case, because we've got a good sand with a little break there in the coal. If you have this shoreline -- and say the shoreline migrated on out this way and we deposited a coal across the top of it, and then sea level rose so we're back in the coastal plain now, the shoreline is way out here, we migrated across here and built coals across here.

Now, if sea level rises enough so that this beach comes way back across here, now we've got another beach sand coming back over the top of what was an old coastal plain sediment.

So you can have that kind of an intertonguing, and it doesn't -- It's very common, in fact. It doesn't create any problems with interpreting this as a PC sand. You just have to recognize that this is a very common feature in sedimentary strata.

And I think that realistically it shouldn't be an issue. I don't think -- Maybe the definition of this, the pool -- I've read so many of those definitions, it's hard to keep them all straight. The one that I like the best is the most simplistic one, which says simply on the Schneider well from -- whatever it was, 2580 or whatever, up to 2450. That is very clear, it's a good rock -- You can look how that ties in with the massive sand; it's a good rock-stratigraphic unit pick.

But when you start tonguing about the intertonguing equivalence in the Fruitland Coal, then you get into a messy situation.

Q. This is kind of what we have now, is a messy situation?

A. Well, I think this one is a little more clear-cut than that, but it has a tendency to keep recurring so that it might have to be dealt with on a case-by-case basis, unless it's better defined.

I think if we stick with this top of the massive sand, it's probably the best thing going. It may not be ideal, but I think it's the best solution that I can think of.

I think the earlier workers and the coalbed methane committee had the right answer. That was their recommendation.

Q. The sandstone that you're calling Fruitland sand that's at issue, the log character on that, some people have described as a grading-upward character, more indicative of marine sandstone than a continental type of deposit. How would you explain that?

A. That's not a problem at all. In fact, as I mentioned, I did log-pattern analysis. That's standard practice in sedimentary basins, in evaluation. So I mapped the thickness and the log pattern.

And this is my overlay map on a small scale here, and you can see that -- This is the way it lays on there. And I mapped the log character, and in this area that we are focusing on, right in here, this area right here, I had 27 well logs.

And of those 27, I had 15 what I call spiky. You don't see any character definition. That, in part, is because, as I said earlier, this unit is so thin you don't get good resolution in this particular area.

But what we try to do is look at this, and you have spiky which -- that's not a very -- I used four different log patterns.

Spiky would be like that, or ratty, some people call thin interbedded sands, like this little Fruitland WAW sand.

And then we have upward coarsening. On log it looks something like that.

I had an upward fining, just use the same -- which would be more like this.

And a blocky pattern.

And these are usually indicative of energy changes in the system. What you're looking at here is your distal sedimentary input. And so you're seeing quiet-water shale.

This is a gamma-ray response with lower values to the left. You're looking at thin shots of sand, out into some kind of a quiet shale environment. That could be a floodplain, it could be a -- if you were in a lagoonal area it could be something, washover into that area.

This is upward-coarsening; that's increasing energy. We're going from shales up into sand, which take higher energy of transport.

Decreased energies at top, that's common in a fluvial system where you have the deep channels with the coarser sediments, and finer sediments deposited on a point log.

And the blocky can be fluvial or distributory, common -- In this setting, these are common log patterns you would find.

What I found was, in this area I had 27 logs, I found only one that I could characterize as blocky, and I had 11 that were upward coarsening, and I had 15 that were just spiky. So this is the dominance, it tells you this is a low-energy environment.

Now, how do you resolve this with a fluvial environment? This is a very common pattern to find in a fluvial environment. This is what happens in this setting shown on Exhibit 10.

When you get this where at flood stage a stream breaks through the channel, crevasse splay, and spills sediment out onto the floodplain, what happens is, when it breaks through the bank the water spreads out and loses energy.

And so this is at flood stage, so we probably -- we might have some water out here in the floodplain. The shales will be carried way out here, this coarse sand will fall out of the water closer to the channel that they broke out of.

Well, what happens, then, as time -- as this flood continues, this coarse part is going to build out over this, the fine builds out further, coarse comes out over the top of that. And what you end up with is upward coarsening. That's a very common feature called a crevasse splay. I've mapped dozens of them, hundreds of them.

And very commonly you'll find coal splits by these -- split by these splays. So you'll find a coal that is forming in a floodplain.

And say out here we have a thick coal forming. What it will do is, you'll find that the lower bench of that coal goes under this, and the upper bench goes over the top of it, because with time this heals or the stream switches position, this, when cross the swamp -- kill the swamp off, the coal comes -- or the plants come back and go over the top of it, and we find a coal split by a crevasse splay.

It's a very common feature in fluvial sediments.

Q. And do you believe from what you have mapped, those types of log characteristics, that is what has occurred there?

A. Yes, I do.

MR. CHAVEZ: That's all I have.

EXAMINER CATANACH: Are there any other questions of this witness?

MR. HALL: Briefly, Mr. Catanach.

FURTHER EXAMINATION

BY MR. HALL:

Q. Ever seen a crevasse splay that deposit material six feet thick over several township?

A. Several townships. Probably larger than that. The Cubit's Pass splay on the Gulf of Mexico, but that's splaying out into the ocean. Not usually on a fluvial system, no.

Q. You're talking quite a sizeable river to do something like that?

A. Yeah, not usually -- You wouldn't usually see it that big. It would usually be on the scale that we're seeing here. It wouldn't be much bigger than that.

Q. I see. Would you take OCD Exhibit 1 before you there, the literature excerpt --

A. Okay.

Q. -- page 82 of that? If you look at the section on the right side, there's several portions of the sandstone, the PC sandstone --

A. Yes.

Q. -- and upper PC 1, upper PC 2. If you look at -- UP2, it's marked, that upper PC sandstone 2 --

A. Uh-huh.

Q. -- it pinches out to the southwest there.

A. Yes.

Q. At what point does that stop being Pictured Cliff sandstone, becoming something else?

A. It's a definition based upon the sediment. Like -- As I was saying before, Mr. Hall, it's tough because you can drill logs, go around through here today and core this. You've got a fluvial system here, and you could follow this right out into a lagoon here and have sand in that lagoon.

So you have to look at more than just having a layer of sand there. You have to do is, look at its proximity to the shoreline, look at its geometry, look, as I did here, how many shorelines back is it, you know? You have to look at a combination of features.

Another thing you have to keep in mind, when we correlate these logs, we tend to connect some of these things when probably they aren't really connected. It would get real thin like this.

And you notice the way I nested these channels like that? That's because these sands don't have to be exactly equivalent. They -- You get down in the Pictured Cliffs, you'll see the same thing. Just because we correlate them like that doesn't mean they go there. There could be a break right between these two wells, we don't have the data for this.

So I think I probably strayed off your question there a little bit, but I think the point you were trying to make is, it's hard to tell exactly where you are in there, and that's why I was looking for a preponderance of data. How many different lines of data can I find that would make me feel comfortable with where we are here? And I think I sifted through all the types that I have, and I feel comfortable with saying that we're back on the coastal plain in this setting

Q. When you're an operator out in the field trying to complete a well, determining where your completion is, and you get into a situation like this, you -- to use your judgement, don't you? It gets beyond the realm of academic geology, and you're getting into operator's judgment?

A. Well, in a basin like this, a mature oil basin, there's a lot of existing data to work from, and there shouldn't be a problem with looking at the logs and interpreting the stratigraphy in your local area.

Now, if you try to correlate it out of the area, it becomes harder. It's like I say, I'm testifying to what's going on right here. I'm not testifying to what's going on a mile or two miles outside of the area I mapped. I don't know.

Q. Well, would you tend to accept or reject an operator's judgment in determining what formation he's completing?

A. I don't know -- I couldn't just answer that flat. It would depend on the operator and how well I knew him and the quality of the work that his staff does.

MR. HALL: Nothing further.

MR. CHAVEZ: Follow-up here.

FURTHER EXAMINATION

BY MR. CHAVEZ:

Q. On that OCD Exhibit 1, on the right-hand side there, what's labeled the UP2, I guess for the Pictured Cliffs 2, where that's encountered in Well Number 213, would you consider that massive?

A. It's hard to say with this -- with this log. What we did for this study was to use a definition of a cutoff or sands for the Pictured Cliffs. And the upper Pictured Cliffs tongues, I think if you look in that article, in the article that addresses this in that publication, you'll see that we used the cutoff, because as I said, this is not a clearcut issue.

And we used a cutoff of -- I'm trying to remember what it was, but we used something like a 30- or a 40-foot cutoff for what we call the major sand and didn't map it if it was less than that. And that was the way we handled it.

Q. Okay. In your studies of the Fruitland, have you mapped Fruitland sands?

A. Yes, I have.

Q. What is the nature of the Fruitland sand, as far as its character when you're looking at, especially, those that might be above the Fruitland Coal sections?

A. The Fruitland sands -- I haven't mapped these in this area, but this would be a good example of a fairly significant Fruitland sand here. Well, these are 12 or -- 10 or 12 feet thick; they're not real significant. But those are some sort of little channels running across the coastal plain.

Now, we don't see anything down in this interval of that magnitude or with this log pattern, which in some cases is blocky or upward-fining, suggestive of some kind of a small fluvial channel.

But if we map these little channel sands here, or this complex, which is where this little channel system jumped back and forth from one place to another, coming in or out of the board here, if we were to map these, either the complex or individual bodies, if we could have enough logs to do that, they would be sinuous sands that are oriented to the northeast.

Q. So they'd be in a north- -- We'd find those sands in a northeast-northwest direction --

A. Northeast- --

Q. Or northeast-southwest?

A. Yes, yes.

Q. All right. And what type of width would we find for those sands, about?

A. That's hard to say, but you can look at this and see bad log quality there. But you see that we have a little channel there that's one log wide and could be two logs wide there. I think this correlation is probably pretty real. I had more wells, I think, than -- But I didn't have real good data here.

You'd have to look at the area. And generally, the width of the individual sandbodies is somewhat related to the thickness of the sandbodies, because think of the size of a stream. The bigger the river, the wider it is. In some cases, the deeper it is. There are exceptions to that, of course, depending upon what kind of sediments are being transported by the stream.

But it's hard to say offhand here that you could map this as a complex and see how wide the complex is or some of the individual sand and get a feel for that.

Q. So Fruitland sandbodies above main coal, then, are generally northeast-southwest-trending, perhaps as wide as the river was at that time, type of sandstone?

A. Well, unfortunately, they often -- streams are just straight to the river -- I mean, straight to the coastline, and you can have -- It depends upon the sinuosity of the stream.

But if you get real sinuous streams like this, versus streams that are more like this, you get different sand packages deposited, because a stream like this is always eroding on the outside of the channel, the cutbank, and depositing on the inside. So it's always migrating. And so what it will be doing is something like this, always migrating.

And so it reworks its own sediments, and you can get sand pods formed -- Like this can work back over into that, and you end up with a complex sandbody the width of this meander path, whereas in this situation you'll get a much narrower sand deposit, and you might get some sand building in here on these point bar deposits in -- eroding out there, and it will be different.

But you don't just fill up the channel. Most of these streams will -- are reworking their own sediments and making complex deposits.

Q. Did you find any of that type of character in that sand that Pendragon calls Pictured Cliffs and you're calling Fruitland?

A. No, I didn't. It's really too thin. If you look at the thickness on this sand, it's not a fluvial sand. I think, at least in the most part, it could be some kind of a distal little sand out on the splay like I drew before, some of those little distal fingers.

But for the most part, this is a very thin sand that's moving out into a -- being deposited in a quiet-water environment. And you can see that we're going from something that's a little thick and upward-coarsening over here, to a spike here, to just a little blip on the log there. It's not a very impressive sandbody in terms of thickness or -- at least from what appears here.

MR. CHAVEZ: Okay, thank you.

EXAMINER CATANACH: Mr. Condon?

MR. CONDON: I just have one question. Could the witness be excused?

EXAMINER CATANACH: The witness can be excused.

MR. CONDON: Thank you.

(Thereupon, a recess was taken at 4:40 p.m.)

(The following proceedings had at 4:50 p.m.)

EXAMINER CATANACH: Okay, Mr. Gallegos?

MR. GALLEGOS: Yes, we call to the stand Bradley Robinson.

BRADLEY M. ROBINSON,

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

DIRECT EXAMINATION

BY MR. GALLEGOS:

Q. Will you state your name, please?

A. Bradley M. Robinson.

Q. Where do you live, Mr. Robinson?
A. I live in College Station, Texas.
Q. Who are you employed by?
A. By S.A. Holditch and Associates.
Q. Okay. I'm going to ask you about your qualifications, but do you have a booklet of Exhibits, and we can include the Exhibits 32 through 36 and 58 through 65 --
A. Yes, I do.
Q. -- that you're going to sponsor? All right.
And Mr. Examiner, I just want to point out to you and everybody else, it's kind of hard to find some of these -- under Tab 36, then, 58 follows. So we get around there, we watch for that, because it's just the way the tabs overlay each other.
A. Okay.
Q. All right. Tell the Examiner, if you would, about your -- both your professional education and your professional experience, up to the present time.
A. Okay, I graduated in 1977 from Texas A&M University with a bachelor's of science degree in petroleum engineering.
I went to work for a couple years for Marathon Oil Company out in west Texas. At that time, in 1979, latter part of 1979, I went to work for S.A. Holditch and

Associates, Inc.

While I was employed by Holditch and Associates, I went back to school on a part-time basis and got my master's of science degree in petroleum engineering.

Since I've been employed by Holditch and Associates I've dealt with primarily the completion, evaluation and stimulation of unconventional reservoirs, tight-gas sands, Devonian shales, fractured shales, coalbed methane reservoirs. I've been involved in numerous projects for the Gas Research Institute over the past 10 to 12 years regarding unconventional gas reservoirs.

Q. Do you teach courses in hydraulic fracture stimulation of wells and reservoir engineering?

A. Yes, I do.

Q. All right. Just by way of a few brief examples, who are the attendees, typically, of the courses that you present?

A. Some of the major service companies, Dow Well, we've taught well completions for them, stimulation to PDVSA, which is the national oil company of Venezuela, some of the major oil companies. I've taught schools, Texaco, Maxis, independents, virtually all sizes and types of companies, either myself or my company I have taught schools for.

Q. Have you testified as an expert witness on well-stimulation, well-completion techniques, prior to appearing here today?

A. Yes, I have.

Q. Okay, before what jurisdictions?

A. Both for the Texas Railroad Commission and the New Mexico Oil and Gas Commission.

MR. GALLEGOS: Okay. We ask that Mr. Robinson be admitted to testify as a qualified petroleum engineer in the field that he's described.

EXAMINER CATANACH: Any objection?

MR. HALL: No objection.

EXAMINER CATANACH: Mr. Robinson is so qualified.

Q. (By Mr. Gallegos) Mr. Robinson, did you have three assignments that you -- principal assignments that you were asked to address in connection with this case?

A. Yes.

Q. Okay, was one of those assignments the evaluation of the fracture treatments applied to the Chaco wells by Pendragon and Edwards in 1995?

A. Yes, it was.

Q. Okay. Was the second of those assignments an analysis of the production of gas and the history of gas performance by the Defendants' Pictured Cliff wells?

A. Yes.

Q. All right. And thirdly, were you asked to calculate an allocation of the production from the Fruitland Coal formation and from the Pictured Cliff formation that has been produced from the Pendragon Wells Number 1, 2-R, 4 and 5?

A. Yes, I was.

Q. All right, let's go to the first of your assignments, which is the evaluation of the stimulations applied to the Chaco wells in 1995, and describe first of all for the Examiner how you went about your investigation.

A. Okay. First of all, let me point out, I didn't get a chance to analyze the fracture treatment on the 2-R. None of that data was made available to me. So my analysis was limited to the Chacos 1, 4 and 5.

What we did is, we took the actual fracture-treatment data on those wells, and we analyzed that data in an effort to estimate the fracture geometry, in other words, how tall it got, how wide it is, and how long it was, both the created and the propped dimensions.

Q. What was the source of your data?

A. It was the actual recorded data during the treatments. It was supplied by Pendragon, I guess, through Whiting to me.

Q. In order to accomplish your investigation, did you need to learn something about the formation properties surrounding these wells?

A. Yes.

Q. And what did you do in that regard?

A. We took -- We started with the open-hole log data, which is the place where you start to try and identify the different layers, the different types of lithologies that are involved in the fracturing process, both the layers that you're fracturing and the ones above and below.

We then used our experience in the Pictured Cliffs and the Fruitland Coal, as well as published literature, to build a layer profile of properties for each of those different formations, because all of that information is required when you're analyzing fracturing data. You can't just assume that it's one big, thick zone, or three zones. If you've got 15 different layers that you're involved in, you need to get properties for all those different layers. And so the more complex the system, the more complex the model has to be, to analyze it.

Q. At a later point do you have an exhibit in here that helps illustrate the importance of having the formation properties?

A. Yes, I do.

Q. All right. And once you had the necessary data and made the investigation, how did you go about making an analysis of those stimulation performances?

A. What you do is, you use -- we used a simulator called FRACPRO, and you use that simulator -- you input all the data, formation properties, thicknesses, all that sort of thing. And you generate, based on actual volumes that are pumped, sand concentrations, injection rates -- you use that model to calculate what was referred to earlier as the net pressure, because the net pressure dictates how the fracture grows.

So you -- Then you take the actual data and you calculate that net pressure. So you've got a real net pressure that's measured in the field, and you've got a net pressure that your model's calculating.

And you compare those two. It's called history-matching. You're trying to generate pressures with a model that match what's actually observed in the field.

And this technique is being used commonly today by all the major service companies, all the consulting companies, all of the major oil companies, as a way -- the way, to analyze our hydraulic-fracture treatments, because it's generally accepted that if you can match the actual net pressures observed in the field, then the fracture geometry that your model is calculating is going to be pretty good, pretty reliable.

Q. Even beyond the broad acceptance of this methodology by the various segments of the industry that you mentioned, do you and your firm take steps to determine to your own satisfaction the reliability of this kind of analysis?

A. Yes. In fact, part of the project for the Gas Research Institute that I was involved in for close to ten years was the development of the FRACPRO model. And we went in four or five basins around the United States and collected the raw data needed to calibrate, verify that that model was giving us good answers.

Now, it's not always right, as evidenced by the single examples Mr. Blauer showed, but -- and I'll testify to that later. But all the data we could collect to help calibrate that model was part of an extensive research project.

Okay, so I'm satisfied that it was developed properly.

Q. Is it common practice for the service companies who do stimulations to run a Nolte plot when they perform the stimulation?

A. Yes, it is.

Q. Do you place any reliance on the Nolte plots in your analysis of the Chaco 1, 4 and 5 stimulations?

A. Not the Nolte plot as described earlier, and there are some very good reasons for that. I mean, when

Dr. Nolte developed that theory back in 1978 and 1979 with Michael Smith, that was a tremendous breakthrough for the industry. And I still teach that method in my courses today, because it is so significant in helping us to understand how fractures grow.

What little we've learned since then is that real fractures don't really behave like that. It's very obvious after doing ten years' worth of research and measuring these things in the field that you can get an increase in slope -- It might be helpful if I put these examples up here, of Mr. Blauer's Exhibit M -- No, B- -- I think it was --

Q. B9, maybe?

A. B9? Yeah.

By the way, I want to add one thing to this exhibit to make it correct, or more correct. The mode of growth labeled 4 here as unstable height growth, that can also be caused by excessive leakoff, by the way.

You can get an increase in slope even with height growth. We've -- Not only have we used models to prove it, we've seen it, we've taken pictures of it in the field. I've seen cameras taken in open-hole wellbores where, you know, fracture height is tremendous even though we see an increase in slope.

Q. Send cameras where you actually look at the fracture?

A. You see the fracture right there in the wall, yeah, of the wellbore.

And so, you know, we know that the fractures don't behave -- especially complex fractures in multi-layered systems, they don't really behave like that. If you had -- This theory was based on a model developed by Perkins and Kern and modified by Norgreen.

If you have a simple three-layer system, then this comes pretty close to being true. But when you have multi-layer systems, you really can't rely on this to interpret any net pressure plots or Nolte plots that are generated by the service companies.

And even if you do, you want to make sure that they do it right, because if this data isn't calculated properly, if the net pressure isn't right, then the interpretation is going to be wrong.

Q. But what's the difference, for example, between a fracture-height growth based on, you know, one cause and in, the other case, the curve being affected by excessive leakoff?

A. I'm not sure I understand your question.

Q. Well, what I'm asking is, when you put the addition on there about excessive -- What was the words? Excessive leakoff?

A. Excessive leakoff, yes.

Q. Well, what would that -- What could that phenomenon be reflected, or what would it reflect on the Nolte plot that might be misinterpreted?

A. Oh, well, a great example is the decreasing slope in Mode 4, as defined by Nolte.

All this means is -- Okay, you've got a pressure inside the fracture and you've got the net pressure which was defined by Mr. Blauer earlier. All it means is that the pressure at the tip is decreasing faster than the net pressure is increasing. That's what that means.

Now, there are two things that can cause that: height growth or excessive leakoff, the fluids leaking off faster than the net pressure is increasing. It's as simple as that, in that context.

It's really a lot more complicated because there's a lot of physical things going on at that fracture tip. If you don't model them right, you don't get the right net pressures, then you misinterpret the shapes and slopes of these curves.

Q. Would a coal formation be a good candidate for having that kind of loss of your fluids, leakoff?

A. Oh, sure. I mean, that's exactly what happens, either a coal form- -- any type of naturally fractured formation. A real high permeability streak anywhere, maybe fracturing into a fault where you had -- of leakage down the fault or something, and you see that decrease in pressure when you get there.

I was looking for a different exhibit, but this one will do.

Q. What's that one? It's not very stable.

A. This is, I believe, B- -- B11, which is all the Nolte plots from the Whiting wells.

And what you see is decreases in slope, increases in slope, which are very common when you're fracturing a complex formation like a coal seam. And this decreasing slope simply could be due to excessive leakoff as that fracture is propagating, interconnecting, more natural fractures, more cleats.

And Nolte described in his paper where you typically see an increase in slope due to screenout after a period of excessive leakoff. And I think in my mind, you know, just accepting that, realizing it's more complex, that's what you see in a lot of these cases.

The other point I want to make is that all of these are wrong anyway, so it's very difficult for me to stand up here and really draw those kinds of conclusions. The plots are miscalculated, they're wrong, the numbers are wrong, all the slopes are wrong.

And the reason is, these are all calculated bottomhole pressures. They had to be calculated from surface conditions. And the service company either put the wrong friction in there, the wrong fluid properties, they didn't take into account perforation friction or something, because every one of these pressures drop when they shut down and they quit pumping.

Net pressures don't do that. Net pressures slowly decline after you shut down. They don't drop. That's friction in the wellbore, that's perf friction, that's near-wellbore tortuosity, that's something, some other physical phenomenon occurring in the wellbore that they're not modeling correctly when they're calculating bottomhole pressures.

And so all this data is wrong.

Q. Unreliable?

A. Unreliable, totally.

Q. Okay. Let's turn to your analysis made in the way you've already described of the hydraulic fracturing on the three Chaco wells. Do you have exhibits that demonstrate the results of that analysis?

A. Yes, I do.

Q. Okay, is the first one Exhibit 32?

A. Yes.

Q. And does that relate to the Chaco Number 1 well?

A. Yes, it does.

Q. All right, would you explain to the Examiner what Exhibit 32 shows?

A. What it shows is, the left-hand side with the green line and the different shades of layers and so forth represent the different layers that we've selected -- the sands, the shales, the silts, the coals, all the different layers -- and the green is the estimate for the -- to put it simply, the frac pressure of each of those layers.

The picture on the right with the two semicircles, the one black one and the one with the different contours, represent -- if you were -- if you could go down in the formation and look at the fracture from the side -- if you were sitting here and there was a fracture over there and it was growing, the left-hand side, represents half of the propped length, realizing there's another half on the other side, because fractures generally grow in two wings, in a simplistic point of view.

What's on the right-hand side is the created length. That's what -- The fluid that's pumped creates the fracture, and then you pump the proppant in, and that's what's represented on the left-hand side.

Does your stress profile over here on the left clearly show where the coal -- the lower and the upper coal formations are?

A. Yes.

Q. Could you help -- Maybe if you just step up here and show it on this one, then we'd be clear on it.

A. Sure. These little thin darker streaks right here at a depth of about 11,000 --

Q. 1100, I think.

A. Oh, excuse me, 1125 feet, those were the thinner coals. And then this zone here at about 1100 feet is the main Fruitland B coal that we've been talking about.

And then this lighter-shaded area down here is the upper part of the Pictured Cliffs.

Q. All right. Now, if you took Exhibit 16 -- That's that cross-section display over there, Mr. Robinson.

A. Yes.

Q. Yeah, the one that Walter Ayers was referencing. It's kind of a -- Why don't you just step up here a little closer so...

A. Okay.

Q. Can you show what the height growth of the fractures applied to the Chaco Number 1 by Pendragon were, as shown by your analysis?

A. Okay. I've already marked on this where I believe the top of the fracture grew, based on my analysis, in the Chaco Number 1. That's this red line here at a depth of about 10,050 feet.

Q. One thousand, maybe?

A. One thousand. Hard to see upside down. 1050 feet.

Q. Okay. So that fracture would have grown not only into but through the lower coal and through the upper coal and somewhere on above that?

A. Yes.

Q. All right, if you'd go ahead and place that back up. Let me just ask you what the second page is of Exhibit 32 and how that plays a role in the analysis.

A. This is just a copy of the log section on the Chaco Number 1, and it shows where the perforations are, it has a gamma-ray log on the left, and obviously we didn't get the resistivity curve on there. We've got a density curve and some lithology descriptions over on the right-hand side.

This is something our petrophysical group generates when they take log data, put it into their programs. This is just called a log playback. And so that just helps the engineer look at the different formations and help pick layers and describe lithologies and so forth.

There are some areas on here where there are some gaps, you can see. Those were areas that our petrophysical group didn't analyze, because they were either bad data or coals. We didn't analyze petrophysical properties in the coals themselves.

And so on the right-hand side there's a little misnomer. Anything that's black was not analyzed. In most cases it's coal, but in some cases it could be just that it was bad data or there was another formation where there was a hole washout or some bad data. So anything that's black is possibly a coal, but it definitely means we didn't analyze that part of the curve.

Q. Okay, do you conclude as a matter of engineering probability that the fracture treatment applied to the Chaco Number 1 by Pendragon fractured up into and opened communication through both the lower and upper coal owned by Whiting and Maralex?

A. Yes, I do.

Q. Okay. Let me just ask you to go ahead with Exhibit 33 and 34 and just go right through those and explain what that shows, and also use Exhibit 16 as you did in the case of the Chaco 1.

A. Okay. Same two types of displays are presented for both Chaco 4 and Chaco 5. The first one is a side view of the fracture. The different layers.

On Chaco 4 we show here that the fracture grew up to approximately 1140 feet, which is represented by this red line right here, and on Chaco 5 the fracture grew up to about 1150 feet, which is represented by this red line here.

Q. And so you formed the same conclusion as to the Chaco 4 and 5 as you did as to Chaco Number 1?

A. That's correct.

Q. Okay. Let me ask you to refer now to Exhibit 59.

A. Okay.

Q. Okay, does that exhibit explain or help sort of illustrate the principles you were talking about concerning the information it's necessary to have about the formation in order to evaluate the fracture performance?

A. Yes. This is an example out of one of the lessons in my frac school where I try to illustrate to students just how complex the fracture geometry can be when you have multiple layers involved.

And what that figure illustrates is that the stress, or, in simple terms, the fracture pressure in each of the layers defines how tall the fracture gets and how wide the fracture gets. It's a function of the stress in the layers and the pressure inside the fracture. And if you have a pressure inside the fracture that's greater than the stress of the layer, that fracture will grow through it. When the stress in the layer is greater than the fracture, then it becomes a barrier to fracture growth.

What we see in the Chaco wells is various layers in the Fruitland -- here's the B coal -- and we have some thin shales and some sands and some other little coals in here, and then we have the main Pictured Cliff right here. So we've got all these different layers.

Now, for these layers here to be barriers, they have to have a stress and a toughness greater than the pressure inside the fracture.

And you can just -- let me -- Can I correct myself? There's one place on any of this data that's right.

Q. Okay, now you're back referring to that -- I think it's B11, the Nolte --

A. B11. There's one place where this data is correct, and that's right there after you shut down. Because there's no friction in the system, there's no flow to no injection. So it's nothing but hydrostatic plus the net pressure, the frac pressure. That point is the only place in this whole plot that's right.

All of the --

Q. But then when you see a dramatic, just falling-off-the-cliff on the curve after that, that is not --

A. That's leakoff. When you see this decline afterwards, that's leakoff into all of the different formations that the fracture has encountered. That's nothing but leakoff.

And that's why it's important to model these wells with a simulator, because the simulator can take into account leakoff at the same time as height growth. If you try to go to a simple 2-D model or to a Nolte-type analysis, you can only vary one parameter at a time. When you have multiple things going on, you have to model all those things.

And we don't always model them right. I'm not perfect and I'm not a hundred percent right all the time, because it's very complex. But you do the best you can, and that's all you can do.

So this data is leakoff. So if we match with our simulator that falloff and we know we've got the leakoff right, we've taken that out of the equation. So any other change in pressure is due to lithology. Leakoff is no longer a factor because we've matched it, we've got the right number.

But if you take these shut-in pressures here -- And these values are net pressures. You go through the calculations and you find out that all the final frac pressure on all the Chaco wells was about 1200 p.s.i., at 1100 feet. That's a frac gradient over 100 p.s.i. per foot, which is classical frac gradient for coal seems.

And you go to the Whiting wells and measure their frac gradients at the end of shutdown, 1 p.s.i. per foot. Some of them are higher. And you get them for coal seams because it's more complex.

But that's not the frac gradient from a depleted Pictured Cliff formation. You don't have to have a model or a PhD to calculate that number.

Q. All right, let's go to the second study you made concerning the gas production potential and performance for the Pendragon Pictured Cliff wells, and let me start your testimony by reference to Exhibit 35. And I think there's a demonstrative version of 35 there.

A. Yes.

Q. Explain that exhibit, if you would.

A. This exhibit represents the size of the drainage area that we calculated for each of the four Chaco wells, this -- and I hate to say it, being an Aggie -- this burnt orange color represents a circular-shaped drainage area that we calculated for each well.

Q. All right. And how did you calculate that?

A. We took the production data and analyzed it with a program that we have called PROMAT, and that program will analyze production data and estimate the permeability and the drainage area for the reservoir -- you know, for the reservoir, based on production data.

Q. And did you use data from other Pictured Cliff wells in the area?

A. Production data?

Q. Or information on the Pictured Cliff formation in the area, from other than just these specific wells?

A. I don't -- No, I don't guess I understand your -- These were the only four wells we analyzed production data on.

Q. Did you compare their pre-frac and post-frac performance?

A. Yes, we did.

Q. All right. And in doing this, did you also look at the performance of the Fruitland Coal wells that are in this area?

A. Yes.

Q. All right.

A. Let me make one point about this, just to make sure it's clear.

This is pre-fracture production analysis. This is the data up until the time the fracs were performed. So it's the drainage area that we estimate for each well under primary completion conditions, if you will.

And what we've shown is that the wells are draining -- for example, Chaco 1, 107 acres; Chaco 2-R, 130; Chaco 4, 147 acres; and Chaco 5, 109 acres. So it's somewhere between 100 and 150 acres, is the average drainage area for those wells, based on their actual performance.

Q. Did you use what you'd call reservoir-modeling approach to do this, or what was your --

A. Yes, we used a simulator called PROMAT, and it takes -- it's a combination material-balance program, so it takes into account the change in pressure as a function of flow rate and does internal material balance; it also goes and uses the flow equations for both transient flow and steady-state flow.

Q. Why is that important? Explain what that is.

A. The reason that's important is -- Well, let me see, I can't find a good example.

Transient flow occurs before the boundaries are felt. You plot flow rate versus time, you get a natural decline in production and/or pressure -- most of the time it's simultaneous -- during the transient portion. And those equations are built into our program.

Now, once you start reaching pseudo-steady state, right in here, you're starting to feel the boundaries of the reservoir. And the --

Q. The distance out into the reservoir?

A. Distance out into the reservoir, you know, 1000 feet or 1500 feet, however far it is to a fault or another producing well or something, you've got multiple wells draining the same reservoir.

So the shape of the curve defines the reservoir properties of permeability and how long it takes and how far it is to those boundaries. So you can get permeability and drainage area from a production-decline analysis. And as I said, it also has an internal materials-balance check to make sure, you know, the pressures are reasonable and nothing's out of whack.

So we use this program, real simple program. And there are other type-curve methods to do the same sort of thing, but this is computerized and, you know, you can make a run in 30 minutes or so. So it's real simple.

Q. And do you reflect the results of that study in Exhibit -- it's -- or a group of exhibits?

A. Yes, in Exhibit 36 there's a couple of tables that reflect the drainage area size and the original gas in place for both the PC, the upper Pictured Cliff sand, and in some cases when the WAW was completed as we're defining it, we included that also. It shows the original gas in place and the corresponding drainage area for those wells.

Q. Okay. Now, this is gas in place in this right-hand column, not necessarily recoverable reserves?

A. Right, that's total gas in the ground; you'll obviously produce less than that.

Q. Okay. And what's the second page of Exhibit 36?

A. Well, what I wanted to show on the second page -- and I apologize for this being not up to date. We started this when we had production data through June of 1997, and this has been -- it was prepared based on that data.

Q. So there's, let's see, almost 12 -- 13 months of production. If this were up to date, it would be added into this right-hand column.

A. Right, I think Mr. Williams had an exhibit that shows the more recent updated production data, and we can refer to that if we need to, Exhibit -- the exhibit out here in front.

But what I wanted to illustrate with this is that with the exception of the Chaco 2-R at the time the study was done, all the other wells have produced more gas than there is in the ground for these wells.

And if you look at the current production level on the Chaco 2-R, which is now approximately 99 million cubic feet of gas, it also has produced more than its original gas in place.

Q. Now, before we make some additional comparisons there, do Exhibits 60 and 61 -- Were those studies that you made to confirm or support what you've just found, considering the fact that these Pictured Cliff wells have already produced more gas -- in fact, a year ago had produced more gas than even gas in place in the Pictured Cliffs reservoir that they were draining?

A. Right, one of the -- I think the second thing we were asked to do was compare the production before and after fracturing, which we did in the previous table.

And also, as a separate evaluation, we went and we looked at all of the Pictured Cliff wells within this general area, and I think there was around 130-some-odd wells that we picked within a two-, three-mile radius around the six sections that are the subject of this study.

And we averaged the production for all those Pictured Cliffs wells. And then we plotted on that same graph -- and that's the green curve, by the way, on Exhibit 60 -- we plotted the average production for the four Chaco wells in the red curve. And these are zero time plot, so any time a well came on production it was started at time zero. So this is the average production of the Pictured Cliff wells. One group excludes the Chaco wells.

Q. Okay. And what does this show?

A. Well, what it shows is, initially, before the fracture treatment -- and that's the period of time starting at zero till about year 17 -- that the Chaco wells started out about average for Pictured Cliff wells. They declined more rapidly than a typical Pictured Cliff well. I don't know if that means they were poor quality or maybe weren't draining quite the full proration unit. You saw some of the drainage areas were slightly less than the standard 160-acre proration unit.

But they declined faster up until the time that they were fracture-stimulated. And you'll notice that the average production on the Chaco wells, after fracture stimulation, increased -- And I'm going to make a point here. This is a logarithmic scale over here, so each one of these heavy black lines is a factor of ten. So you started here, and you went tenfold increase, hundredfold increase, somewhere between a 500-fold increase after fracture stimulation. And so...

Q. Okay, that supports the conclusion that you arrived at from your prior studies that the Pictured Cliffs reservoir simply does not hold -- did not hold enough gas to account for the production from these wells?

A. Exactly. And the increase in production is far greater than you would ever expect to get simply from fracture-stimulating a well. That's just phenomenal. I've never seen increases that high.

Q. Well, you've heard about the -- I'm sure you've heard the testimony that Pendragon believed that there was some damage to the wells, sometimes referred to as skin damage. In your experience, if that's the case, what results would be expected on an optimum basis in terms of reworking or stimulating the well that was in that condition, if these were in that condition?

A. We've got a lot of examples. I've looked at hundreds of wells that have skin damage before fracturing, some of them pretty severe, skin factors as high as plus 50 to a plus 100, which is -- Some people will laugh and say that's impossible, you can't damage a well that much.

But, you know, typically 25- to 50-fold increases, something like that, maybe. That's a tremendous increase, and that's kind of the order of magnitude you see when you have severe skin damage before frac versus after frac.

If you don't have any damage, then about a five- to tenfold increase is typical.

Q. Have you heard anything in this entire proceeding that indicated that Pendragon used any kind of recognized methodology to quantify the skin damage in these wells, if there were such damage?

A. I haven't heard anything that anybody's done to define that skin damage, and it's such an easy thing to do. I mean, you can take a type curve and plot the data and estimate if that well has skin damage or not.

Q. Are there three or four common approaches by which an operator, before deciding to apply fracture treatment, can satisfy itself that, in fact, there is skin damage?

A. Yes, there's -- I mean, we have computer programs that will do it in a matter of a few minutes, you know. They cost a couple of thousand dollars. There's type curves, there's hand calculations --

Q. Drawdown tests?

A. Drawdown tests, which is really the production analysis I was referring to. You know, there's any number of economical ways to review these data and determine, a), if there's skin damage and, b), if there's enough reserves left to justify the cost of the fracture-stimulation treatment.

Q. Okay. But from what you've heard, that was not done in the case of the Pendragon wells?

A. No.

Q. What's the purpose of Exhibit 61?

A. Sixty-one -- Well, if you refer back to 60, you see that the average flow rate for the Chaco wells after fracture stimulation is about 10,000 MCF a month.

What I did is, I plotted the average production for a Whiting Fruitland Coal well in the area, and I saw that it was also about 10,000 MCF per month. So almost identical average flow rates for the Chaco wells as the typical Fruitland Coal well in the area.

Q. Okay. Now, does this study and the information that's illustrated in these exhibits lead you to the conclusion that the only scientific explanation for the production rates achieved by the Pendragon Chaco wells after the fracture treatment is that those wells are producing from the Fruitland Coal formation?

A. Yes, that's correct.

Q. Now, were you requested in your third assignment to do a study to attempt to quantify on a relative basis if one were to look at the situation back in 1995, how much gas was available for these Chaco wells from the Pictured Cliff formation, how much from the Fruitland Coal formation, so that an allocation might be made as to the relative percentages or quantities of production from those wells, from those two formations?

A. Yes, I was.

Q. All right, and does Exhibit 58 reflect the results of that effort?

A. Yes, it does.

Q. All right, would you explain the method, the data and the results of that study?

A. What I did, the first column in the page 1 of Exhibit 58 is, of course, the well.

The next column is labeled "Pictured Cliffs remaining gas in place", and that was the remaining gas in place as of 1995 that I estimated based on my production analysis.

Q. Okay, even though this is not dated, this does not address the current situation. If we took the time in 1995 when the reworks were being done on these wells, that's what we'd be looking at?

A. That's right.

Q. Okay, all right.

A. That's my original gas in place, minus the production up to that time of fracture stimulation. So it's what's left in the ground. Okay? Not going to get all that out, because there's some recovery factor you've got to apply to it. That's how much remaining gas was down there, based on the production analysis.

The next column is an estimate for the Fruitland Coal thickness in those wells. We looked at the logs, I looked at them with Dr. Ayers, and we estimated a coal thickness for each of those wells.

And then applying the standard factors for calculation of coal reserves, which the assumptions are on the bottom of the page, we calculated in the fourth column the original gas in place in the Fruitland B coal. Again, not recoverables, not reserves, just how much gas is calculated to be in place for the Fruitland B Coal, based on, in this first case, 320-acre drainage areas.

And then we -- Just as a first shot at this, I took the totals and added them up and figured out of the original gas in place what percent was Pictured Cliffs and what percent was Fruitland Coal, and that's the last two columns.

Q. All right. And does this approach give the -- adopt the assumption that these Chaco wells would drain as much as 320 acres, and even though your studies have shown that -- not drain half of that, but that they would drain 320 acres?

A. In the Fruitland B Coal?

Q. As to the Fruitland Coal?

A. Yes.

Q. All right. And what is the second study of Exhibit 58, and how does it differ?

A. Well, I tried to pick -- I did it with several different assumptions, and I wanted to try to pick a high case and a low case. So the second page is sort of my low-case scenario, where I've dropped my drainage area down to 160 acres and said, Okay, they'll only drain 160 acres --

Q. Of the coal?

A. -- of the coal, excuse me, you're right.

Q. All right.

A. I've said, Okay, we'll lower the gas content down. Most people -- I've heard values from 85 to 110 standard cubic feet per ton. I've assumed a little bit less than that to be ultraconservative, and have gone through the same calculation of gas in place for the Fruitland Coal and then again calculated the percentages.

So this, in my mind, is kind of a high- and low-end case of the allocation of gas in place in these wells.

Q. Okay. So in 1995, if one were attempting to fairly allocation the production from these wells to the two relative formations, the Fruitland Coal and the Pictured Cliffs, would this represent the -- probably the, as you as say, the high and the low, five to 95 percent, or 11.6 to 88.4 percent?

A. Did you say gas in place, or the production?

Q. This would just be gas in place.

A. This just the allocation of the gas in place?

Q. Well, just even assuming -- Just for purposes of this question, just to make it simple, we'll assume that you could produce 100 percent of this gas. This would still -- This would reflect the relative allocation and production? That would be your opinion?

A. It's not that simple, I wish it was. But, you know, given a simplistic approach, look, this is probably as fair a way to do it as anything.

You know, that would let Pendragon produce every drop of gas out of their wells, even though it's impossible. That would allow them to produce all that gas, which they already have, by the way.

And so, you know, somewhere between five and ten percent of what they produced is probably Fruitland -- I mean, Pictured Cliffs gas. And the rest is Fruitland Coal.

Q. Okay, and explain to the Examiner your statement when you say allow them to produce every drop of gas they have in the reservoir, even though that's not possible, but they've already produced that.

A. Well, you see the remaining reserves, and what Mr. Williams did was calculate how much gas they produced since the frac jobs. And in the case of Chaco 1, it's 275 million; they only had 83 million left of the total gas in place.

And it's the same for each one.

The Chaco 2-R, approximately 50 million been produced; they only had about 33 million left.

Chaco 4, 389 million produced; they only had about 66 million left.

And in the Chaco 5, almost 363 million; and about 54 million were left at that point in time.

Q. Now, even if you didn't believe in the numbers, did I ask you to just do an exercise, just sort of a let's see what happens, if you take either one of the theories that's been presented by Pendragon to account for all this gas production, one theory being, well, we've got more pay than we had before because we're getting gas from that second unit of the Pictured Cliffs formation, or the theory that we're getting more recovery because we have less wells competing, so instead of just draining them with our proration unit, we're reaching out and draining wider areas?

A. Yes, you did.

Q. All right. And I didn't ask you to believe that was the case, but I just said, if you accept their theories, run some calculations and see what that would show. And did you do that?

A. I did that, and that's the final four exhibits.

Q. All right. And before you go into showing what the exhibits are -- we can just use one for an example, maybe -- what did that tell you?

A. Well, it's -- The short and the sweet of it is, you cannot produce the rates they're producing, given twice as much net pay or two or three times more drainage area. And the reason is -- I mean, you can put a reservoir as big as New Mexico in these wells if you want to, and you can show all day long that there's enough gas in place.

But there's a little-known theory called Darcy's law, and it defines how much gas you can flow out of that zone in that wellbore. It's got a thickness and a permeability. And any reservoir engineer who says they don't believe in Darcy's law gets struck by lightning.

And you can't flow as much gas, even with a fracture. Because the first calculations we made -- They fractured the wells, can they get the flow rate? And they couldn't. Then Mr. Gallegos asked me --

Q. Explain that about the flow rate. Maybe you ought to stop a second. Why is that important?

A. Well, the flow rate over this period of time creates the amount of gas they produced. Now, you can say that -- if I've got a BCF in place and my reservoir is as big as New Mexico, yeah, I might get 275 million out of it, but it will take 20 years, because I've got a limited KH, even if I put a frac on. It's still limited by Darcy's law.

So that's exactly what we did. We said, All right, what if we double KH, increase the net pay? Or what if we increase the drainage area two or three times over and above what we calculated. And what these calculations show is, you still can't produce the rate. You can get the gas in place, but you can get it out in a two-year period because you don't have enough KH, even after fracturing.

Q. And you can just take one of these. I mean, they're all the same for each well.

But just briefly explain what you did to make that calculation when I asked that you just give them, you know, their theory, and then see what happens.

A. Okay. The first part of the table is the reservoir properties that we calculated or measured from -- estimated from logs, whatever, that went into the basic reservoir model and into the flow-rate calculation.

Now, if we put a fracture in that reservoir, then the average gas rate -- and this is Chaco 1 I'm looking at, I'm sorry, it's Exhibit 62 -- the average flow rate for the first year is about 99 MCF per day for those reservoir conditions.

After two years, it's down --

Q. Are you aware of these wells after fracturing, this Chaco 1 was making 300, 350, something like this?

A. Yes, yes, I've looked at that data.

After two years, that well is down to 13 MCF per day. And in that first two-year period it produced a total of 47 million.

The next short table is labeled "With 30 feet of Net Pay". It's almost twice as much net pay as what was in the well, based on our log analysis.

And as you can see, the average flow rate goes up because you've got twice as much net pay. It's about 180 MCF per day, still less than half of what it's actually producing. The average rate after two years is down to 25. Fracturing accelerates reserves. It gives you more flow rate so you get it out faster, and you deplete the reserves faster. After two years with twice as much net pay, that reservoir is basically depleted.

Q. In other words, unless you go into somebody else's formation, fracturing doesn't add reserves?

A. Right. Oh, exactly, unless you fracture into something different.

And that's what this was to illustrate: What if you did fracture and double your net pay in the Pictured Cliffs? Cumulative production after two years was 85 million. Cumulative production after two years in the Chaco 1, which was illustrated in my table, was several hundred million. And Mr. Williams -- That's almost a three-year period there, but you can see the incremental production was about 275 million.

Now, if I triple the drainage and do those calculations, I get 140 MCF per day average flow rate during the first year, with 66 MCF per day after two years, a total production of 87 million. And I did the same thing for every well, I got the same results.

MR. GALLEGOS: Okay, thank you, Mr. Robinson.

That concludes my direct, and we move the admission of Exhibits 32 through 36 and 58 through 65.

Pass the witness.

MR. HALL: No objection.

EXAMINER CATANACH: I'm sorry, the numbers were 32 through 36 --

MR. GALLEGOS: Thirty-two through 36, and 58 through 65.

EXAMINER CATANACH: Okay, Exhibits 32 through 36 and 58 through 65 will be admitted as evidence.

Mr. Hall, your witness.

CROSS-EXAMINATION

BY MR. HALL:

Q. Mr. Robinson, you're aware that FRACPRO simulators come under criticism in the professional literature lately?

A. No, I'm not.

Q. You've not read this article, SPER?

A. Sure.

Q. You don't believe that's critical of FRACPRO?

A. That's one article that says FRACPRO didn't agree with the microseismic activity in that well.

Q. In fact, aren't there hundreds of additional articles that also similarly criticize the use of FRACPRO?

A. No.

Q. How many other articles are there that criticize FRACPRO?

A. I don't know. I haven't read very many, if -- except maybe this one.

Q. How about fracture simulators in general? Aren't they largely being criticized in the literature lately?

A. No.

Q. You're familiar with the M site in the Piceance

Basin where they use FRACPRO?

A. Yes, I am.

Q. Now, did the FRACPRO history match with the Nolte plot for the well that was profiled in the Piceance Basin?

A. Yes, they -- Were you finished? I'm sorry. They attempted a history match of the treatment on that well, they sure did.

Q. But FRACPRO didn't yield a correct fracture-geometry result, did it?

A. I don't know if it did or not.

Q. Well, assume that this is the FRACPRO geometry, and these are the tracer heights, shown by independent means. It looks like it did not model correctly, wouldn't you say?

A. Well, two things about this analysis. Number one, they didn't get a very good match of the net pressures. If you read the article, it says that they had a tough time matching the data because they had a very complex geometry, and they had to take into account all sorts of near-wellbore tortuosity and tip effects and fluid-flow effect to match it off good.

What this shows me is that FRACPRO calculated a height very similar to microseismic events that were recorded in this well, the top part, that it calculated a bottom height that did not correspond. It was about 75 to

100 feet below recorded microseismic events in this well.

That does not mean that's the fracture height. That means those -- That's where the microseismic events occurred. And if you talk to Norm or Mike Sorrels or Jim Fix or anybody who analyses this data -- Mike Sorrels told me ten years ago when we started this project, you can't see microseismic events through every formation because some formations are more elastic than others.

So just because you don't see a microseismic event does not mean it's the bottom of the fracture.

Q. And likewise, it didn't correctly model the geometry of the fracture length, did it?

A. On the left-hand side, it calculated a length that was longer than the recording microseismic events. On the right-hand side it calculated a length that was very close to the recorded microseismic events.

Q. So it calls into question, at least, accuracy of FRACPRO simulators?

A. I'll give you my honest answer. In this example, this single example, it calls into question.

Q. Well, if you could straighten me out on something, the other day in court I believe you testified that you didn't run FRACPRO simulator on the Whiting/Maralex coal wells. Then this morning Mr. O'Hare indicated that perhaps you did. Which is correct?

A. I did not.

Q. Okay. Why not?

A. Because I was not asked to analyze the Whiting/Maralex coal wells. Those wells are not the subject of this dispute.

Q. What happens when fracs are high with increasing slope in layered reservoirs, in the Nolte plot?

A. I don't understand your question, I'm sorry.

Q. Well, I'm speaking about big fracture heights in layered reservoirs. What does that mean when you see an increasing slope on a Nolte plot, a condition like that?

A. What does it mean when you see an increasing slope on a Nolte plot?

Q. Uh-huh.

A. And I'm assuming you're talking about one that's been calculated correctly.

Q. Let's assume that.

A. It could mean the fracture is either growing in height or length or width, any of those three, and probably all three at the same time.

Q. The pressures on the Nolte plot are showing excessive leakoff. What happens when pumping stops? Can you illustrate that?

A. The pressure declines.

Q. Well, does it fall off immediately or gradually?

What type of decline is it?

A. It varies depending upon what happens at the end of the job. Now, tell me -- Describe the fracture that's there and the permeability of the rocks that it's encountered, and then I'll give you an estimate of what I think the falloff looks like.

Q. Why don't you tell me about that one, those conditions? What happens there when the pumping has stopped?

A. Right here at this peak?

Q. Yes.

A. Pressure falls very rapidly and then turns and becomes not flat but decreasing ever so slightly.

Q. All right. For the record, you're referring to the Gallegos Federal 26-13-1 Number 2; is that correct?

A. That's correct.

Q. If the correct pressure were calculated, would the slope direction change at all? If the bottomhole treating pressure were calculated correctly, would the slope change? You need to answer verbally for the record.

A. Okay, yes. I'm sorry, I didn't think you were finished with your question. That's why I didn't say anything, because you didn't ask a question.

Q. I asked you if the slope direction would change. I thought you answered yes.

A. I was waiting for you -- You made a statement. You said if the bottomhole pressure calculated correctly and the slope changed, and I was waiting for you to finish your statement.

Q. I said if it were calculated correctly, would the slope direction change? That was the question.

A. I'm sorry, I misunderstood your question. I totally misunderstood. Under what conditions?

Q. Well, you indicated earlier that all of the numbers on these Nolte plots were calculated wrong. If they were calculated correctly, how would those slopes look? And you can refer to the same well again.

A. Okay, I believe I did say that anything after shut-in, it's right, because all friction, everything is taken out of the picture.

So I believe, assuming the service company calculated the right hydrostatic pressure of the fluid in the wellbore, I believe that is the only correct portion of this Nolte plot.

Now, if you ask me -- I haven't studied this well, because in my opinion -- I'll give it to you -- it appears to me that this well screened out. That's why you get this rapid increase in pressure when they shut down.

And when a well screens out, it's usually due to the proppant getting packed in the formation, and the pressure builds very rapidly. And when you shut down, that pressure dissipates very quickly into the formation, and the fluid plates off into the formation, the gel plates off the proppants in there, and all sorts of crazy things are happening. And so you get this real rapid decrease in pressure.

And then at some point the pressure slope changes, once that rapid leakoff into the fractures and the reservoir decreases. Then the slope changes and the rate of pressure decline is less.

Q. All right. You're saying this is the pumping stoppage point right here; is that correct?

A. I'm assuming it is, yes.

Q. What you call a shut-in point?

A. Shut-in point, yes.

Q. Now, did you recalculate the bottomhole pressures when you analyzed the fractures from these Nolte plots?

A. These are the Whiting wells, and I did not analyze these wells.

Q. How about for the Pictured Cliffs wells?

A. Yes, we did.

Q. And can you give those to us, tell us what those are?

A. Yes, I can.

Q. What are they?

A. What are the Nolte plots?

Q. Your calculations?

A. They vary as a function of time, just as demonstrated by these plots, and I'll be glad to give you copies of them.

Q. Okay, we'd like to have those.

A. Okay.

Q. By the way, what's the source of the data for your calculations?

A. The source of the data were the treating reports from the service companies that were provided to us, either from Whiting or the Gallegos law firm, but from Pendragon.

Do you want them to keep, or do you just want to look at them?

Q. We want to look at them.

A. Okay. They're generally the second or third graph. The green curve is the model net pressure, and the red curve is the calculated net pressure on that graph.

Q. Let's look back at Exhibit 34, if you could, please, sir.

A. Okay.

Q. Why did you show so much downward growth on that profile?

A. I didn't.

Q. I'm sorry?

A. I didn't show it. I didn't make it grow downward.

Q. Why does this exhibit reflect so much downward growth?

A. Because the stress contrast going down is not sufficient to stop the fracture from growing downward.

Q. Is there a low pore pressure condition in that well?

A. In the main Pictured Cliffs sandstone, yes.

Q. What was the fracture gradient on fracture pressure in the Fruitland wells?

A. About 1 p.s.i. per foot.

Q. And Pictured Cliffs?

A. About .4, .5 -- .5 p.s.i. per foot.

Q. Okay. So what are the fracture gradients for the coal pressures?

A. Would you repeat the question, please?

Q. Now, you said the fracture gradients for the PC wells were fairly high, around 1. Is that --

A. I thought you asked me the frac gradients for the Fruitland Coal.

Q. Well, let's talk about the Pictured Cliffs.

A. Okay.

Q. You said earlier that the fracture gradients for the PC frac jobs were on the order of 1, and that's why in your opinion they penetrated into the coal?

A. Yes, that's correct.

Q. Let's look at the Chaco 1 frac profile, your Exhibit 32.

A. Okay.

Q. Were the pressures for that simulation calculated correctly?

A. Which pressures?

Q. Well, your Nolte plot and your traditional plot aren't showing any displacement, are they? They match, or is there an error?

A. Are you talking about net pressures or surface treating pressures or what?

Q. I'll move on to another question, Mr. Robinson.

A. Okay.

Q. I want to talk to you about your PROMAT simulator now, your materials-balance programs. Does PROMAT use type curves?

A. No.

Q. You mentioned some type curves in your testimony. What was that?

A. What types of type curves?

Q. Yes.

A. There was -- There's Fetkovitch, there's Greengarden, for hydraulically fractured wells, there's

Cinco type curves, Ramey type curves.

Q. Which of those did you use, if any?

A. We didn't use type curves, we used PROMAT.

Q. Did you consider any reservoir recharge in your materials-balance calculations?

A. No.

Q. And why not?

A. Well, number one, PROMAT can't account for recharge conditions.

And number two, I didn't see any reason to. I saw a natural depletion drive reservoir.

Q. Did you -- Your materials-balance, did you -- for the PC, did you include any water-production data?

A. No, I did not.

Q. Turn to Exhibit 61.

A. Okay.

Q. It appears that the water line was redacted there; is that correct? Is that what that --

A. What word did you use?

Q. Redacted.

A. Redacted?

Q. Whited out --

A. Oh.

Q. -- eliminated.

A. No, it was not eliminated. That was -- There were white Xs on there, and somebody picked a really horrible color choice for that graph, but there were white Xs there representing the water production from the Fruitland Coal wells. Sorry about that.

MR. GALLEGOS: White on white doesn't show up too good.

THE WITNESS: No, white doesn't show up too good. Maybe I'll start out with a black background. Have to talk to my technician about that.

Actually, these were light blue originally, and I think when we had them reproduced -- I apologize.

Q. (By Mr. Hall) That's all right.

In your material-balance calculations, did you -- what assumptions were made with respect to thickness on the PC?

A. I didn't make materials-balance calculations as -- if I understand your question, say, by hand? Like has been discussed here?

PROMAT does an internal materials balance analysis, pressure-volume relationship, standard materials balance. Net pay that I used in the PROMAT analysis, was the same values that I list in my Exhibits 62 through 65. In fact, I had the values typed exactly that we used in our PROMAT analysis and provided on this exhibit. You had asked me about these numbers last time, and I didn't have them. I wanted to make sure I gave them to you this time.

Q. Okay, that's what I was leading to.

Can we get those from you right now?

A. There they are.

Q. All right.

A. The net pays.

Q. All right, for each of -- Okay.

For -- Let's look at the Chaco 5, if you can tell us which intervals went into determining net pay.

A. The short answer is, the perforated intervals. That net pay of 16 feet represents the calculated net pay within the perforated intervals of the Chaco Number 5.

Q. So you didn't consider the lower zone at all; is that correct?

A. Not in the original analysis.

Q. Okay. Can you expand on your answer? Perforated intervals for the Chaco Number 5, it seems to show more than 16 feet of net pay on the log.

A. Can I look at the log --

Q. Sure.

A. -- you're looking at?

Okay, perforated -- Perforations aren't marked here. Do you want me to mark the perforations on this log?

Q. Go ahead.

MR. GALLEGOS: I think maybe they're on 16, aren't they? Aren't the perforations on there?

THE WITNESS: Is that your cross-section?

MR. GALLEGOS: Yes. I think the perforations --

MR. CONDON: Yeah, it's on the cross-section --

MR. GALLEGOS: I think the perforations are in plastic --

MR. CONDON: -- little blocks.

MR. GALLEGOS: -- little red --

MR. CONDON: -- squares.

THE WITNESS: Okay, Chaco Number 5. It looks like the zone's perforated 1150, -60 -- I can't really tell. Can we get a --

MR. CONDON: Do you want a well file?

THE WITNESS: -- a well file, or does somebody have the actual --

MR. GALLEGOS: We've got the well file. It's Exhibit 40.

Q. (By Mr. Hall) Let me ask you while you're looking for that information, why are you limiting net pay to just the perforated intervals?

A. Because that was the original completion intervals.

Q. Well, why do you even need to know where the perforations are to calculate that pay?

A. Well, you don't. But what's going to flow is going to be what's perforated, right?

Q. Yeah. We're still asking you to calculate net pay. You've only shown 16 feet on your exhibit. I think you'll agree that there appears to be more than 16 feet of pay in that well log.

A. I see three, 10 --

MR. GALLEGOS: Here's the original completion report on that.

THE WITNESS: Okay. No, I see 15 or 16 feet of what appears to be gas-saturated sand on this log.

Q. (By Mr. Hall) In what intervals? I mean, identify those for us, please, sir.

A. Sure, 11- -- maybe 1164 to -68 appears to have maybe two, three feet; 11- -- Well, it's hard to read the divisions on this log. It looks like it's about 1160, -70, at the top of the next sand, to about 1170 -- 1170 to -80, maybe, has about ten feet. And if I was real generous I would give two, three feet to 1185 to -88, something like that.

Q. Okay.

A. And those depths could be off a foot or two, because it's real hard to read this log.

Q. Okay, thank you.

Mr. Robinson, on your volumetric calculations, can you tell me what your formation volume factor was for your calculations?

A. For which volume calculations?

Q. Well, your Exhibit 58, let's look at the first one. Your hundred -- for the -- yeah, for your Pictured Cliffs formation volume calculation, what was your formation volume factor for that Pictured Cliffs?

A. I don't know, but I can get you that number.

Q. Quickly?

A. It's in my computer. It would be four or five minutes to pull it up. It's calculated by the PROMAT program, automatically, based on gas properties of the fluids.

Q. What initial pressure did you use?

A. For the Pictured Cliffs?

Q. Pictured Cliffs.

A. 240 p.s.i.

Q. Okay. Will you give me that formation volume factor later?

A. Sure.

Q. Back on PROMAT, can you tell us what the line pressure data used for that was?

A. No, I didn't -- the only -- With PROMAT, you input bottomhole pressure because it doesn't calculate -- it wouldn't take surface pressures. You have to input a bottomhole pressure.

Q. Then what bottomhole pressures did you use?
A. Would you let me get you that number when I get you the formation volume factor?
Q. Sure, and that's a flowing pressure, I assume?
A. Yes.
Q. Did those pressures come from the data that was supplied to you by Pendragon, or supplied to your counsel?
A. The flowing bottomhole pressure?
Q. Yes.
A. We had no flowing bottomhole pressure available to us, from anybody.
Q. Let's look at Exhibit 62, Mr. Robinson.
A. Okay.
Q. For Chaco Number 1, you're showing a permeability of 31 millidarcies?
A. That's correct.
Q. Drainage area of about 107 acres?
A. That's correct.
Q. Then let's look at Exhibit 65, flow rate calculation for the Chaco Number 5. You show a drainage area there of 109 acres, pretty close to the Chaco Number 1, right?
A. Very close.
Q. But the permeability is three times as great, correct?

A. That's correct.

Q. Can you explain why the drainage radii for those two wells are so close? Higher permeability in the Chaco Number 5?

A. Because the calculated time to steady-state flow was about the same for both wells, according to PROMAT.

Q. But wouldn't you expect a larger drainage area with a higher permeability?

A. No.

MR. HALL: Okay, that concludes my cross, Mr. Robinson.

EXAMINER CATANACH: Frank?

EXAMINATION

BY MR. CHAVEZ:

Q. Mr. Robinson, you said that the -- I guess it was the Nolte plots on the Whiting well fracs and treatments were not usable except for the pressures achieved after shut-in; is that right?

A. That's correct.

Q. Did you try to -- Let me ask you this: Could those Nolte plots be recalculated if the correct figures were put in, correct parameters of fluid volumes and -- well, those issues you said that were wrong?

A. They could be easily recalculated properly.

Q. Okay, what led you to believe that they were inaccurate?

A. It's real simple. When you see -- Let me state one thing real quickly. The net pressure, that's the pressure inside the fracture. If we took this floor and cracked it open with hydraulic pressure, the pressure inside the fracture is -- minus the closure, which is what Mr. Blauer described the other day, that's the net pressure. That's not the pressure it take to pump through the carpet or through the two-by-fours, or whatever we're standing on. It's the pressure inside the crack.

Anything happening there at a wellbore has to be zeroed out, because if you think about it, you've got a well here, a fracture here, a very simplistic model. Your measuring pressure -- or calculating pressure right here, typically, you've got things going on in the perforations, you've got some near wellbore tortuosity occurring around the wellbore, and what you're after, net pressure inside the fracture, minus all this garbage that's going on in the wellbore.

When you see a pressure drop -- When you shut down, net pressure slowly decreases, as the fluid leaks off into the formation. When you shut down, you shouldn't see an 800-pound pressure drop in net pressure. That's all friction.

So everything from this point back to time zero was calculated with an incorrect friction somewhere. It was either incorrect fluid properties, perforation problems, near-wellbore tortuosity, any number of things. So that point right there is wrong, because it didn't account for 800 pounds of friction somewhere.

Q. Okay, what type of a pressure dropoff would you see that would give you confidence that the other factors were done correctly?

A. That's the key. They way you calibrate these -- It's almost kind of putting the cart before the horse. You've got to shut down and measure the friction before you can calibrate the Nolte plot.

That's why people are pumping almost exclusively to these little data fracs before the frac jobs. They pump, create a fracture and shut down. They can measure it. It doesn't make any difference, you know, whose program you use to calculate a bottomhole pressure when you can measure it after pumping 100 barrels.

So you pump in, you shut down, you measure all that friction and you zero it out. You've now calibrated the Nolte plot, accounting for all friction.

Even if you don't do it before, you do it at the end of the job and you go back and recalculate it and correct it.

Q. Were the frac treatments on the Chaco wells --

were those Nolte plots calculated correctly, as best you can remember?

A. No, they weren't. And that's the exhibit I was looking for but I couldn't find it, because they're wrong too.

Q. Okay. The pressure falloff at the end of the pumping sequence, can that be used to calculate KH?

A. Pressure falloff?

Q. Yes.

A. Not really.

Q. Does that slope of that curve tell you very much about KH or get you within some type of reasonable intimation of KH?

A. Yes.

Q. Did you use those pressure falloffs on the Chaco frac jobs to verify the KH that you came up with, say, and used with your PROMAT?

A. We didn't make those calculations, no. What you do is, you adjust the leakoff coefficient in the model to match that falloff.

Now, if you had a water-saturated reservoir and you were frac'ing the water, then you could take that falloff data and, like any pressure decline, simple -- do a simple simulog analysis and get permeability, P*, skin, the whole nine yards.

But because you have, most times, two or three phases saturating the formation and you're injecting -- in this case it's foam, which is a different two-phase fluid, I mean, you'd be kidding yourself thinking you could calculate the right permeability from the falloff data.

Q. Have you verified your computer model, the PROMAT, against other Pictured Cliffs production in this area or the San Juan Basin?

A. No, not in this area.

Q. Is the PROMAT model the only one that's available to you?

A. No, we have four different computer programs that are available to us that we can use.

Q. Okay. Why was the PROMAT chosen for at least this particular model?

A. It's the one that's easiest to use when you're trying to history-match actual data and when you're trying to analyze data. It's just the easiest to use for me.

Q. So the only history matching that you've done with PROMAT is for these wells?

A. No, no.

Q. I'm sorry, in the San Juan Basin?

A. No. No, no. Maybe I misunderstood your earlier question. No.

I've analyzed other wells in the San Juan Basin and the Piceance Basin and all over the place using FRACPRO.

Are you talking about FRACPRO or PROMAT?

Q. PROMAT.

A. Ah, I'm sorry. No, I've analyzed other Pictured Cliff wells in the Piceance Basin with PROMAT.

Q. But not in the San Juan Basin?

A. Not in the San Juan Basin, no.

Q. Might there be some variations and factors that would perhaps allow you to choose a different model to use to make this analysis?

A. No, not really.

Q. Did you hear Mr. Williams' testimony about his wellhead shut-in pressure versus cumulative-production curves?

A. Yes.

Q. Did you compare your data against his curves?

A. My -- What data?

Q. Well, first of all, I'm referring to your Exhibit 58.

A. Okay.

Q. And you're showing Pictured Cliffs remaining gas -- Is that remaining gas in place?

A. Yes.

Q. -- at 83 MMCF.

A. Yes.

Q. Did you try to match that against the -- for example, Exhibit 25 of Mr. Williams? Do you recall those exhibits? Maybe I should bring this up to you.

A. No, I remember it. I just didn't understand your question.

Did we honor those pressures in the PROMAT analysis? Is that kind of what you're asking me?

Q. Well, what I'm saying is, it looks to me like the figures are different, and I'm wondering if you noticed that and what you might -- think might be the differences.

A. This is what's remaining after they produced the 50 to 100 million prefrac. So if you take those two and add them together, you really get my numbers back here on Exhibit 36, which -- 186 million, 84 million for the Chaco but nobody's got any pressures for that, 268 for Chaco 4, 199 million for Chaco 5.

And those numbers I compared to Mr. Williams' plots, and they were right in line with the pressure-versus-cumulative plots that he had.

Q. You said that the data on the Nolte plots -- or the Nolte plots for the stimulation of the Chaco well, or the Pendragon wells, were also correct. Did you redo those Nolte plots using the parameters you thought would be more appropriate?

A. Yes, that's what Mr. Blauer and Mr. Hall had asked for that's in my book that they looked at, and still have, by the way.

MR. CHAVEZ: Thank you, very much.

THE WITNESS: You're welcome.

EXAMINATION

BY EXAMINER CATANACH:

Q. Can you submit those Nolte plots as evidence in this case?

A. Yes.

Q. Did you see a change in slope on those plots from what the -- Pendragon reported?

A. Several changes. Would you like me to show you one of my Nolte plots?

Q. Sure.

A. The red line is what we call observed net pressure. This is the Nolte plot. It's not really a Nolte plot, because we didn't plot it versus log log -- on a log log graph paper. So it's not really a Nolte plot; it's what we refer to as a net pressure plot. It's the same principle.

We're plotting the net pressure, because that defines how the fracture grows. You can see when we first start out -- By the way, the green line is the model-predicted pressure for that growth. You can see the green line models -- matches the calibrated and corrected Nolte net pressure, if you will, almost perfectly, with the exception of a few spikes.

We have some rate changes, and it's very difficult to accurately calculate the bottomhole pressure. But for the most part, the match is excellent.

So you've got a decrease for the initial -- first 12 minutes. If you believe Nolte's theory, that's hyper or excessive leakoff, one of the two.

Then you've got an increase. If you believe Nolte's theory, that's confined height, or height restriction. It's not really, though, because if you run this simulation in time, what happens is, the proppant gets out here pretty close to the edge of the fracture. Now you're trying to create a crack with this sand-gel mixture, and the pressure starts increasing. That's what causes a screenout, when you try to get that proppant out to the tip and you can't go any further because it gets wedged in.

So the pressure can actually increase. That's Nolte's mode 3, where the pressure turns and goes like that. So if you start getting proppant out at the top, it can turn and start going up.

But it can still grow even without that. Even with an increasing slope, if you were to run this in real time, you'll see this thing slowly growing in height, because it's more complicated than a simple 2-D model depicts.

There's Chaco Number 4, net pressure plot. We see a relatively flat period, then an increase, then another flat period, the a gentle -- we modeled it with a gentle increase for about the last ten minutes. The first 16 to 18 minutes, it's relatively flat or slightly increasing in places.

So you see slope changes. And it's all a function of the layers that you're frac'ing through, because each little layer has different pressures and different mechanical properties. So you'll see pressure fluctuations.

Q. So you're going to have different slopes on this line; is that what you're saying?

A. You can, sure. One minute you can have a decreasing slope and the next minute it can be increasing, then it will be decreasing again. So...

Q. Can you generally plot the slope of this line to determine where that should fall?

A. Can --

Q. As Pendragon did. They plotted the slope on this line as a positive slope. Can you do that on these curves?

A. Yes. If you would like me to, I can reproduce this curve on a log log plot, and we can see how the slopes change.

But even if I plot on a log log plot, you can see, in the case of the Chaco 4, for the first eight minutes that pressure, the net pressure, decreases. So it doesn't make any difference whether I'm plotting on a log log plot or semi-log or linear coordinate paper. You'll see a drop in the slop, decline in the slope, because that pressure declines. Right here, it increases for the next four or five minutes, and you'll see an increase in slope on the Nolte plot, and then it goes flat.

So it doesn't really matter how you plot it; you can still look at that data and see those slope changes that Nolte represented in his original work.

So I can put this on the log log plots, if you'd like me to, sure. But you can see the same slope changes here.

Q. Uh-huh.

A. Decrease, increase, flat, increase, flat, and then things get really squirrely at the end when they cut proppant and try and flush.

Q. Okay.

A. Do you want me to do that for you?

Q. No, if we could just have the --

A. Copies of these?

Q. Yeah.

A. Okay.

Q. Do you know what the recovery factor for the PC wells is, or should be?

A. I didn't calculate it. It looks like -- I did, I'm sorry. It ranged from about, I think, 50 to 60 percent in the Chaco 1 and 2-R to 70 percent or so, 75 percent in the Chaco 4 and 5, if my memory serves me.

Q. Do you have that someplace?

A. Yes, I do.

MR. GALLEGOS: You might want to --

THE WITNESS: Do you want me to verify those numbers?

MR. GALLEGOS: It might be better --

THE WITNESS: That was the range, 60 to 75-percent recovery factor.

Q. (By Examiner Catanach) But it was different for different wells?

A. Yes.

Q. Is that typical of a PC well?

A. If all I had to look at was permeability, I would say no. But these wells were produced under slightly different conditions. Some of them were pulled to lower pressure than others.

So given the flowing bottomhole pressures, then, that affects the recovery factor, obviously.

Q. How did you guys estimate the fracture pressure on those formations when you ran your frac models? Did you calculate or estimate those, or how did you --

A. It was a combination of calculation and looking in the literature and just knowing in general what the value should be, based on our experience in other Fruitland Coal and Pictured Cliffs wells, not in this area but other areas. So it was a combination of those three things.

Q. Did you actually take some of those values, say, from logs or something?

A. No, I don't think we -- We used log-calculated values, but I think on a few wells we made those calculations but we didn't use them.

Q. And do you think they accurately depict the formations in this area?

A. Yes.

EXAMINER CATANACH: Any other questions of this witness?

MR. GALLEGOS: We have no further questions.

EXAMINER CATANACH: Okay, this witness may be excused.

Let's take a short break, and I suppose you're going to call some -- How many do you have? Rebuttal witnesses, Mr. Hall?

MR. HALL: We'll have a short rebuttal.

MR. GALLEGOS: May we have some idea of the nature of this? We've been here for three days, and they've seen our case before in the District Court.

EXAMINER CATANACH: Who are you going to call, Mr. Hall?

MR. HALL: I'll call Mr. Blauer, Mr. McCartney and Mr. Nicol.

MR. CARROLL: And what are you going to rebut?

MR. HALL: A lot of things. Give you an idea of the time it will take, I think I can do all three of them in 30 minutes on direct.

MR. GALLEGOS: I have a commitment at eight o'clock.

EXAMINER CATANACH: Well, let's not take a break; let's get right into it, then.

EXAMINER CATANACH: Are you ready, Mr. Hall?

MR. CARROLL: Are you going to ask for closing statements too?

MR. CONDON: Can we submit something?

EXAMINER CATANACH: Yes, I would suggest that.

MR. GALLEGOS: I've got my notes all ready here. I think we'd better do it in writing.

MR. CONDON: I think George decided he was going to do it in writing, didn't he?

EXAMINER CATANACH: He was going to do what?

MR. CONDON: Submit a statement in writing.

EXAMINER CATANACH: Is that what he decided?

MR. CONDON: I think that's what he -- That was my best recollection when we were up there talking to you the first day, because we've given him a set of our exhibits, so...

MR. HALL: We're ready.

EXAMINER CATANACH: Go ahead, Mr. Hall.

<u>JACK A. McCARTNEY</u>,

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

DIRECT EXAMINATION

BY MR. HALL:

Q. Mr. McCartney, there's been some testimony with respect to line pressures the last two days. Do you have anything additional to add on that subject?

A. Well, I believe it was Mr. Williams put up an exhibit showing daily -- monitoring daily pressures on the PC wells and then the flow rates on the coal gas wells, and I believe also on that tabulation was -- Well, I'm not sure if it was on there. But anyway, the data had line-pressure data on that also.

He didn't show the line pressure on his exhibit, but the raw data behind the exhibit had line pressures indicated for the various wells also.

We took a look at that, and it appears -- Number one, it appears the pressures on -- plotted on his graph are similar to -- except in maybe two or three cases, they had a little more data than we did at the time, but -- and we had no data -- No, I think we had all this data. Anyway, it's irrelevant.

Our data showed a little bit of discrepancy in the pressures, not a whole lot. And it appeared that these pressures agreed with the Pendragon pumper's reports that were given to Walsh Engineering and then forwarded on to Pendragon.

And then it was discovered that the pumper then calibrated his gauge -- and my information is, using a 300-pound gauge -- he calibrated his gauge and found his gauge was reading off about 7.5 pounds.

So one problem is, is, you know, with the small degree of accuracy making an inference with one pound pressure or two pounds' pressure, several things could affect that.

One, it could just be the physical measurements. You've got a pumper out there. And I don't know whether this data came from the single source or whether Whiting independently measured the wells.

Q. Mr. McCartney, you're referring to Williams Exhibit 31; is that correct?

A. Yes. That's one thing.

The other thing that should be noted, that when the line pressures -- if you plot the production, which is shown on some of -- he did plot his production, that -- I believe he had a production plot in his Exhibit Number 30, daily plots there of production. If you plot the line pressure as opposed to the production, you'll find that when the -- for the most part, line pressure goes down and production goes up.

When the line pressure goes up out there, the entire PC production pretty much comes to a standstill. Otherwise, not only these wells are shut in, but when the line pressure goes up the other PC wells in the whole area basically can't buck that pressure, and they go down too.

So there may be some -- there very well could be some minor interference, if that's what they're trying to show, from the PC sand itself, by virtue of the PC production.

Then the performance of the coal wells, it appears to me, are very erratic, and I don't know what inference you can gather from that. It appears that after a period of shut-in, then they get some flush production, the production drops back off. And then they have another period of shut-in, they get flush production, and then we -- production comes back off, which is very typical of most any well.

So I'm not -- You know, I'm not satisfied, necessarily, with the quality of that data and the inference that might have as far as being a poor-boy pulse-test type of information.

Then there was a reference -- if I might just go through -- Okay. There's a reference to the desorption isotherm that I put on there, or I should say sorption isotherm -- looked like this. And Mickey correctly pointed out that, as I know now, that this is undersaturated reservoir and it takes some dewatering.

The reason I didn't assume an undersaturated reservoir was State production reports show like first production for some of the wells, December, 1993, that was the first production, produced a bunch of gas and a bunch of water, first month. So I was unaware of the water production prior to the first reported production to the State.

But with that, what happens -- On this well, you can pretty well see this one. If I would adjust this to say there's 25 pounds in this case, saturation pressure is 25 pounds less than what -- original reservoir pressure, which means that we'd have to drop to like 225 pounds pressure in order to liberate gas, we know that that production or that pressure plot we had, we knew that we were up there in the 220-some-pound pressure, that reading in 1995. Well, they were producing a lot of gas at that time, so we know that's below saturation pressure.

What that would do is merely raise this curve up a little bit in this outer portion. It also intersect at zero, and what that actually do is, at a given pressure down here, an abandonment pressure, it would actually leave a little more gas in the ground.

So my abandonment here at -- with -- if you assume an undersaturated reservoir, or slightly undersaturated, instead of 42 cubic feet at economic limits, you're leaving 45 cubic feet in there.

But the difference, the material balance and whatnot, is virtually unaffected. I'm starting at 100, I'm going to some other pressure here, and at -- and terminal conditions on down in here, it doesn't make much difference. Mickey indicated he thinks he's going to get 80-percent recovery, which would put him right down in here.

It would almost have to be a straight-line relationship between the -- what I use, the 110. And I see that Robinson used 100 standard cubic feet per ton in his analysis. But it almost have to be a straight-line relationship in order to get anywheres near that 80-percent recovery.

One thing that we did not see, we did not see any performance curves or any reserve -- remaining reserve analysis or estimated ultimate reserves from Whiting or their experts on their coal wells, and I'm a little distressed at that.

We did have two sets of volumetrics. Robinson gave a set of volumetrics. His volumetrics showed about 1 BCF per 320 acres. I think he gave some -- Mr. O'Hare gave some verbal testimony it's about 1.25 BCF per 320. Mine is about 1.3. So a pretty close agreement on that.

But I didn't see any material-balance estimates of remaining reserves, any modeling, any type of estimate what they would do.

So the only thing I heard was that if you --

MR. GALLEGOS: Well, Mr. Examiner, it's one thing for a witness to give some evidence. It's something else for him to sort of make an argument about the evidence. I don't think this is proper. I object.

MR. HALL: Mr. Examiner, he's presenting rebuttal evidence. Right now, he's allowed to do so.

MR. GALLEGOS: He's commenting on and arguing the evidence presented. If we're going to have argument, I think there's a proper way to do that. Counsel can do that.

THE WITNESS: I'll refrain from doing that.

MR. HALL: Please refrain from arguing, Mr. McCartney. Go ahead and present your evidence.

EXAMINER CATANACH: Yeah, I would tend to agree with Mr. Gallegos on this point.

MR. HALL: May he be allowed to offer his rebuttal evidence?

EXAMINER CATANACH: Yes.

THE WITNESS: Okay, I apologize for whatever it is I did there. But anyway, what -- It is late in the day, and I don't have much left in me, so...

What points out, the volumetrics of -- Say we have 1.2 BCF, 1.3, and say we use -- Well, say we use 80-percent recovery, use Mickey's number, and use 1.25. That's -- Well, I think he said a BCF per well.

Okay, and he says that if we would add in the PC reserves with the coal gas reserves, well, then, that's where all the gas is. Well, so I did that.

I took the 320-acre patterns. There's a coal well here. This is the 6-2, the 7-1 is here, there's a 12-1 here, the 1-1 here. Those are coal wells.

And there's the PC wells sitting in here. There's -- Actually, that 7-1 is down here, and there's a PC well there, and there's actually a PC well up here pretty close. So we've got one, two, three -- Here's the 2-J. Well, it's over here, I won't worry about it.

Anyway, we've got -- If we add them up, we've got four hundred -- the 1-1 is 435,00, and a cum production, these are cum production. The 12-1 is 611, the 6-2 is 675, the 7-1 is 822. That's coal wells.

Then if we add the PC to that, the Number 4 PC well -- the 4 PC well is 596, the Number 5 is 500, and the Number 2-J up there is 41. No, I had the 2-R. I think -- Yeah, there's the 2-R right down there. 41. The 2-R is 118.

Add all that together, and you come up with three hundred and seventy-nine, nine, zero, zero and zero MCF, just about exactly 1 BCF per 320 acres, already produced. Okay?

So where is that gas coming from? Well, dang sure, in their calculations, I don't think they can show that it's coming from the Fruitland Coal. The PC has to have a significant contribution in order to justify that kind of production.

Then with respect to volumetrics, we have two, we have my version, we have Mr. Robinson's version. The staff, Commission, can make their own judgments on that. I don't think he picked the pay -- as much pay as there really is in there, but we had significant differences there.

On one other main thing, it's got this PROMAT model, and I'm not familiar with PROMAT model, but I am familiar with the Darcy equation. And I don't want to get struck by lightning, so I'll use the Darcy equation.

Okay, Darcy equation would indicate -- And what I did is, I took Chaco Number 5 -- I don't know if it's very handy -- and what I did is, Chaco Number 5, I said, Okay, initially I looked at the pressure we had on Chaco Number 5, and it was about 227 pounds, initially, back in November of 1977. That's where we start there. Initial production.

Now, this is a bad example. You might want to look at my graph, my exhibit in here, if you want to look at what the performance is.

As I understand, these are six-month-average numbers of some kind, which makes it look like it didn't produce near as much at the front end because it averages in the peak production up here.

But that well really came in -- produced a little over 11,000 MCF in the first month or two, in the first -- one of the first several months there. So the average rate was like 350 MCF a day.

So what I did is, I took Darcy equation and says, Okay, I've got a couple givens. I've got initial pressure. I've got initial flow rate. I've got, you know, typical thickness, say 25 feet. And I assume 25 millidarcies and 40 pounds flowing pressure -- Actually, that's 40 pounds, p.s.i., so 25-pound line pressure, could be a little different than that because I don't have that data, but assume 25.

We've got a 2-1/2-inch casing in there -- Well, we've got 2 3/8 tubing for casing, so I've got 2-1/2-inch i.d., and I used 2 7/8 for the R_w on this calculation. And I came out through the calculation, if you use 25 millidarcies, pressures I talked about, you calculate 352-MCF-a-day production. And that would get you 25 millidarcies, 25 feet.

Okay, then I came down to July, 1980, right down in here someplace, because I had a couple pressures there, and those pressures were like 121 pounds, I believe they were. Okay.

So I said, Okay, if it's 121-pound pressure, using the same parameters, what's my effective permeability? Well, my effective permeability went from 25 to 9. And my flow rate was 38 MCF a day. Okay, which matches up what it's producing.

Well, what's the skin factor? You divide that, one by the other, and come up with skin, or what I refer to skin, or impediment or whatever you want to call it, 2.78. That's less than Robinson's typical five, whatnot.

Then -- And then I did another thing. I said, Okay, what if we frac this well and -- If I remember what I did. Okay, what if we frac this well, and what if we create in the Darcy equation you have to use an effective wellbore radius?

So I played with that a little bit, and I came out, if you use 160-acre drainage, you could use a 50-foot wellbore radius, and you would calculate at 150 pounds pressure against a 45-pound line, you would calculate 375 MCF a day, and that's what it did after frac.

If you had a hundred and -- If you had 320-acre spacing it would match it if you had a 70-foot effective radius.

Then I came to current time, which I think was June, and I said, Well, June, I've got about 95 pounds pressure, I've got a line pressure of probably 60 pounds, and using all the same other things I calculated through Darcy's equation I should produce 103 MCF a day, and that's what it was producing.

So I have a hard time getting to the hundred and -- Well, number one, I can't get to the hundred-and-some millidarcies or whatever -- however it got in here.

But I can match up through Darcy's equation these various points in time that seem to fit. And what happens is, we had this skin factor building up there. Not only do we get our skin factor removed -- Well, finally, you get down with -- you know, you get down to 60, 70 pounds pressure, you get 60-, 70-pound line pressure, of course there's no flow. So your recovery factor is not very good unless you put it on compression, which some of these wells now are.

But the point is that I think we can justify the reserves in the PC and we can justify the flow rates that we're seeing, and the volumetrics plus the flow-rate calculations, I believe, demonstrates that.

Q. (By Mr. Hall) Quickly, Mr. McCartney, about your .7, 3.8 million volume figure there, that includes pre-frac, does it not?

A. Yes, that's cumulative production to date from pre-frac, post-frac for the PC wells.

Q. All right. Do you have a -- Can you extrapolate post-frac production from that?

A. Well, it's pretty close to Bruce Williams' exhibit -- well, the Chaco Number -- pre-frac, Chaco Number 1, pre-frac, was -- well, I ought to use Bruce's exhibit. I think he had that on there. It's probably correct. It's not very much.

My numbers are the same, I think, for this, except for the -- I may have one more month of production. I probably had in there -- This is through May; I had through June, 1998, probably, but I think if you -- There's 1 BCF, and that's pretty close, anyway, to what I had for the -- It should be, anyway. It should be these top numbers, added together on the 4, 5 and 2-R and a little bit for the 2-J.

Q. All right.

A. Most of that production is post-frac.

Q. How about line pressures, Mr. McCartney?

A. Well --

MR. CARROLL: Well, what about line --

THE WITNESS: Yeah, with respect to what?

MR. CARROLL: Mr. Hall, your rebuttal witness doesn't even know --

THE WITNESS: Oh, I think -- I'm sorry, the Commission had -- Somebody, maybe it was opposing counsel, had asked for the line pressure data for the last few years. There's some question that the line pressures were not lower in the earlier times than they are now, and that was provided to us October, 1996, a 36-pound pressure; July, 19- --

MR. CARROLL: Can you mark that as an exhibit?

THE WITNESS: -- -98, 68 pounds --

MR. GALLEGOS: Yeah, can we see that as an exhibit --

THE WITNESS: -- and --

MR. GALLEGOS: -- if it's got any authenticity to it?

THE WITNESS: McCartney 12, if you want to.

MR. HALL: We'll mark this M12.

MR. GALLEGOS: From Walsh Engineering, the Leslie Number 1 -- I object to this.

EXAMINER CATANACH: Can we see it?

MR. GALLEGOS: No foundation.

EXAMINER CATANACH: Can you explain this exhibit, Mr. McCartney?

THE WITNESS: Well, what that is, it appears to me to be the line pressures for the Leslie Number 1 well, which is located in the northeast quarter of Section 7, which is a Pictured Cliffs well which is offset -- the east offset to the Chaco Number 4. And it's on the same system with these other wells, I do believe, and obviously that line pressure would vary a little bit from well to well, depending on --

MR. CARROLL: You didn't take these line pressures?

THE WITNESS: No, those are supplied by Paul Thompson with Walsh Engineering.

MR. CARROLL: And Mr. Thompson's already left.

THE WITNESS: Well, somebody requested it, and so we -- you know, provided it. It's not necessarily my exhibit, you might say, but I'm they one that they said ought to hand it to you.

MR. GALLEGOS: Rank hearsay, no foundation. For a number of reasons, it's not admissible. We object.

MR. HALL: Well, I think Mr. Williams testified with respect to line pressures, and it's certainly relevant in that context, and I think you can give it the appropriate weight.

MR. CARROLL: Line pressures of what?

THE WITNESS: This is the discharge pressure of the gathering system that goes through the Chaco plant, all of the wells --

MR. CARROLL: Who operates the gathering system?

THE WITNESS: I think it's El Paso. El Paso.

EXAMINER CATANACH: I'm not sure how you can take it for what it's worth, Mr. Hall. You can either use these pressures or you can't. There's no in between.

I don't think I'm going to allow that into evidence.

Q. (By Mr. Hall) Anything further, Mr. McCartney?

A. No.

CROSS-EXAMINATION

BY MR. GALLEGOS:

Q. Mr. McCartney, just real quickly, on this calculation you did here of the 3.799 million, you've got a half a BCF in there that was produced by these Chaco wells before their fracture treatments in 1995, don't you?

A. That's pretty close, it appears.

Q. All right. So that would -- down to 3.29, and one could as easily conclude from your calculations --

A. Pardon me? 3.29?

Q. 3.29. If you take away half a BCF, it's 3.29 instead of 3.79. That's simple math, isn't it?

A. I don't know for what purpose, but okay.

Q. Well, do you think there's a contention here that -- a claim that the gas before these wells were fractured was coming from the Fruitland Coal formation?

A. Well, okay, I see what you're doing now. Okay.

Q. Do you understand?

A. Yeah, three -- three-point --

Q. You take off a half BCF --

A. -- three-point-three.

Q. -- then your calculation would be 3.29.

A. Yeah.

Q. I'm sorry if I confused you.

A. Okay.

Q. Do you understand now?

A. (Nods)

Q. All right. So one can conclude that the reason that number comes up is that Mickey O'Hare's estimate of what can be recovered from these Fruitland wells is way too conservative? You can conclude that as easily as you can conclude it's coming from the Pictured Cliffs, can't you?

A. Oh, I don't know as you could reasonably conclude that, given the data.

Q. On your -- This calculation over here on the skin damage, what Darcy equation did you use?

A. The one for gas, assuming gas flow.

Q. Then your --

A. Radial --

Q. -- flow --

A. No --

Q. -- is radial flow?

A. -- radial flow.

Q. Radial flow?

A. Yes.

Q. In a -- for a depleting reservoir?

A. Of course, it's depleting reservoir.

Q. All right.

A. Yeah, it's -- well --

Q. But it --

A. In the PC -- In the PC reservoir.

Q. But it was a radial flow?

A. Radial flow.

MR. GALLEGOS: Okay. No further questions. That's 25 minutes of the 30 minutes.

EXAMINER CATANACH: This witness may be excused.

MR. HALL: Call Mr. Blauer.

ROLAND BLAUER,

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

DIRECT EXAMINATION

BY MR. HALL:

Q. Mr. Blauer, you heard Mr. Williams testify about his BTU data yesterday, did you not?

A. Yes, I did.

Q. Did you prepare certain exhibits addressing that?

A. Yes, I did.

Q. I hand you what's been marked as Exhibit B14 [*sic*], ask you to identify that and explain it, please, sir.

A. Exhibit B14 is a little different plot of BTU versus time and also BTU versus cumulative production for the wells.

During Mr. O'Hare's testimony, he made a couple statements about BTU which I do agree with. He said that in this reservoir system if pressures were decreased due to production, we would probably expect the BTU to actually increase with time. He also made some comments about equation of state being needed to be used, and I would agree with that also.

But the bottom line is, even if you use an equation of state, in this reservoir with these fluids that we would anticipate to be in the reservoir -- and I'm talking about the Pictured Cliffs reservoir -- a drop in pressure caused by production would probably be associated with some kind of an increase in BTU.

Well, the converse of that is also true. A decline in BTU is consistent with an increase in production.

And looking at the first page of this exhibit, you notice that starting in roughly -- Oh, and what this exhibit is, it's the BTU data that's been presented in this room for the Chacos 1, 4 and 5.

Starting in August of 1988, you notice that, for example, the Chaco Number 4, which is the circles, there is a decidedly negative slope to that. If we used Mr. Williams' computer program and did a least-squares fit, we would get a negative slope to that data.

My interpretation of that data is, this is an indication of recharge, because if you look at the production data for the wells -- and Chaco 5 is here and just convenient; it doesn't matter which one we use -- you notice that in this time period the wells are producing very low, very low production rates.

So if we're seeing a reduction of the BTU rate, we're withdrawing a very small amount of gas from this reservoir, my interpretation is we're withdrawing less gas than is recharging the reservoir.

Now, the other part of this that is interesting is that if we have depleted the reservoir during the early production of the well and we have dropped the pressure down through that production, and then through recharging -- which we have seen through the exhibits of Mr. Nicol and the pressure increases and so on, we have seen a major pressure increase -- whether the recharge is coming from the Fruitland Coal or possibly from our concept of a larger reservoir down below that has higher water saturations, which would mean lower permeability to gas, the probable fluid that would then fill that reservoir would be methane.

So when you go in and fracture the wells, open them back up and you have recharged the reservoir with gas, you'd have a probability of having a lower BTU come out of that well because of the recharge.

The other three graphs are -- I have the Chaco 5 in front of me; it doesn't matter which one we look at. This is the BTU measurement versus cumulative gas production. That vertical line of data points that, on this well, is about 140 million cubic feet is that long, sustained period of very low production rates. I mean, it makes sense. The data isn't necessarily consecutive from top to bottom, but just during that period we're seeing the BTU as showing a decided drop.

Notice that there was a -- the next BTU reading after the frac job -- which would have been right about 150 million cubic feet, because this is when our well was completed -- the next BTU measurement was not made until almost an equal amount of gas had been recovered from that well.

So that drop was not an instantaneous drop, as has been purported. We took out almost as much of a pore volume of gas between the next BTU rating -- between the next two readings, as we had produced before.

That's it.

Q. Mr. Blauer, when you say lower pressure would result in higher BTU, you mean for the area in the phase diagram, after the liquids pass through the phase envelope; is that correct?

A. Yes, sir, and that would also be true if you did an equation of state with all the combination of liquids in that reservoir.

MR. HALL: All right, nothing further.

MR. GALLEGOS: No questions.

EXAMINER CATANACH: I have no questions.

Is that it, Mr. Hall?

MR. HALL: Yes, sir.

EXAMINER CATANACH: Okay.

MR. GALLEGOS: So we -- Rather than summing up at this time, given it's 7:20, Mr. Examiner, maybe you would permit us an opportunity to submit statements or briefs in whatever time you'd like to have them.

EXAMINER CATANACH: Yes, let's do that. Closing statements or -- Well, what briefs are you talking about, Mr. Gallegos?

MR. GALLEGOS: Well, just a brief that would be what -- the equivalent of final argument or final closing argument. Just --

EXAMINER CATANACH: Okay.

MR. GALLEGOS: -- our arguments --

MR. CARROLL: Closing statements.

EXAMINER CATANACH: That would be fine, closing statements. And I think we're leaving the record open for, I believe, a statement from Merrion. Is that our understanding?

MR. GALLEGOS: I guess.

MR. CARROLL: Yeah. Any objection to that?

MR. GALLEGOS: I think Merrion wanted to submit a statement, but Mr. Sharpe wanted an opportunity for his attorney to participate in that, and we don't have any problem with that.

EXAMINER CATANACH: Any problem with that, Mr.

Hall?

MR. HALL: No. We'll pass on the brief. We'll submit to you a proposed order, if you want to give us -- and again, you have a lot -- a volume of evidence to work with. Ten days, two weeks, sound all right for that?

EXAMINER CATANACH: Two weeks is fine with me. I don't know that you can reasonably expect an order soon after that.

MR. HALL: I understand.

MR. CONDON: Are we talking two weeks for submission, or is he asking for an order?

EXAMINER CATANACH: Well, you're going to waive -- You're not going to submit a closing statement in this case?

MR. HALL: We'll probably pass on that.

With respect to statements from other parties, such as Merrion, I'd like for us to be able to put a deadline on that. I don't want Tommy Roberts to ask for the transcript, I don't want to wait around for that.

EXAMINER CATANACH: I agree. We can put a deadline on that of two weeks for the closing statements, and if you want to submit an order within that time period, you may.

I'm not going to put a limit on the draft -- Well, I may put a limit on the draft orders. What do you think you guys --

MR. CONDON: We could get an order to you at the same time we get our closing written statement.

EXAMINER CATANACH: You think within two weeks?

MR. CONDON: Well, I would think that --

EXAMINER CATANACH: All right, well, let's -- If you guys are agreement with that, let's do that. Two weeks for everything, and we'll close the record at that time.

MR. HALL: Thank you very much.

EXAMINER CATANACH: Thank you.

MR. CARROLL: All the exhibits in?

EXAMINER CATANACH: I think -- I'm not sure we admitted OCD Exhibit Number 1. If we did not --

MR. HALL: No objection.

EXAMINER CATANACH: -- we'll do that at this time.

MR. CONDON: Do we need to clear out tonight, or would it be possible for us to come back first thing in the morning and haul everything out?

MR. CARROLL: You can do the same thing I am, come back tomorrow.

MR. CONDON: Okay, if that's all right with you.

EXAMINER CATANACH: Yeah, that's fine.

MR. CONDON: All right, great. Thanks.

EXAMINER CATANACH: There being nothing further, this case, Case Number 11996 will be --

MR. HALL: I'd move Roland Blauer's M14, I so move.

EXAMINER CATANACH: Which ones, Mr. Hall?

MR. HALL: M14, Roland Blauer's last one -- B14.

EXAMINER CATANACH: B14?

MR. BLAUER: M16.

MR. HALL: B14.

MR. BLAUER: B16.

MR. HALL: B16.

MR. CARROLL: Bingo.

EXAMINER CATANACH: What's the number? What are the numbers?

MR. HALL: It should be B16.

EXAMINER CATANACH: B14 through B16 --

MR. GALLEGOS: I object in that the testimony was incomprehensible. No objection.

EXAMINER CATANACH: Exhibit B16 will be admitted as evidence.

And there being nothing further, Case 11,996 will be taken under advisement.

(Thereupon, these proceedings were concluded at 7:23 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 31st, 1998.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 1998