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:

Case No. 10425
Order No. R-9643

APPLICATION OF CONOCO, INC. FOR DESIGNATION OF A TIGHT FORMATION, SAN JUAN COUNTY, NEW MEXICO.

ORDER OF THE DIVISION

BY THE DIVISION:

This cause came on for hearing at 9:00 a.m. on December 20, 1991, at Albuquerque, New Mexico, before Examiner Michael E. Stogner.

NOW, on this 9th day of March, 1992, the Division Director, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS THAT:

(1) Due public notice having been given as required by law, the Division has jurisdiction of this cause and the subject matter thereof.

(2) The applicant, Conoco, Inc., initially requested that the Division, in accordance with Section 107 of the Natural Gas Policy Act of 1978 and 18 C.F.R. Section 271.701-703, recommend to the Federal Energy Regulatory Commission (FERC) that the Pictured Cliffs formation underlying 71,192.87 acres, more or less, of lands in San Juan County, New Mexico, as described in Exhibit"A" attached to this order, hereinafter referred to as the Pictured Cliffs formation, be designated as a "tight formation."

(3) The area described in said Exhibit "A" can best be described as a rectangle measuring approximately 10 miles longitudinal and 11 1/2 miles latitudinal. Approximately one-third of the proposed area has experienced extensive development within the Pictured Cliffs formation while the remaining geographical area has almost no production and only a nominal number of bore-holes in which to obtain data. This

producing area is entirely within the Blanco-Pictured Cliffs Pool and can best be described as a right triangle extending approximately 6 1/2 miles east and 8 miles north from the southwest corner of the entire area. The resulting hypotenuse, which extends 10 1/2 miles in a northwesterly/southeasterly direction is the boundary line within the original proposed area where development of the Pictured Cliffs formation occurs.

(4) At the time of the hearing, the applicant presented extensive geological data of the surrounding area utilizing subsurface data from the producing Blanco-Pictured Cliffs Pool, data from the "tight formation area" designated as "NM-7", a small Pictured Cliffs gas producing structure just north of this area in Colorado, and data available from several wellbores in the expansive "barren area."

(5) The applicant presented evidence showing that the Pictured Cliffs formation within the proposed tight formation area has been penetrated by approximately 148 wells, most of which are situated within said developed triangular area. At the time of the hearing, the applicant concentrated its engineering support data from information obtained on wells located along the periphery of the developed and barren regions of the proposed tight formation area.

(6) At the conclusion of the hearing proceedings, Conoco, Inc. was requested to submit additional engineering data from wells within the developed area to supplement its application. The record in this case was to remain open until this additional information was submitted for review.

(7) On January 22, 1992, by letter from general counsel, Conoco, Inc. requested the Division consider an amendment to its application ("the amended area") reducing the proposed tight formation area to that portion of the Pictured Cliffs formation underlying 48,155.07 acres, more or less, of lands in San Juan County, New Mexico as described in Exhibit "B" attached hereto and made a part hereof, which comprises the barren northeastern two-thirds of the original area.

(8) The Pictured Cliffs formation underlies all of the lands described in the amended area; the formation consists of fine to very fine grain sands classified as litharenite with significant amounts of digenetic minerals formed in the intergranular pore spaces resulting in porosity which has been significantly reduced due to compaction and mineralization of the intergranular spaces. The top of the formation is found at an average depth of 3500 feet below the surface and the gross thickness of productive sand is approximately 150 feet.

(9) The deposition of the Pictured Cliffs formation in the immediate area consists of near shore bars which are lenticular, ribbon-like deposits oriented northwest to southeast; that better production is encountered on the crests of these near shore bars where the sands appear to be better developed than the areas off the bar crests where the sands become siltier and more mineral-filled and the amended area is off the northeast side of a bar crest in largely undeveloped exploratory area.

(10) The Division and the U.S. Bureau of Land Management have previously recommended to and the Federal Energy Regulatory Commission has previously approved other portions of the Pictured Cliffs formation in this general area as "tight formation designation."

(11) The type section for the Pictured Cliffs formation is found at a depth of approximately 3500 feet, with the productive portion being the upper 70 feet of a 150-foot section as described by the State of New Mexico on the Dual Induction-SFL log from the Amoco Production Company's San Juan 32-9 Unit Well No. 102 located in the SW/4 NW/4 of Section 17, Township 31 North, Range 9 West, NMPM, San Juan County, New Mexico.

(12) The original area of application, as described in Exhibit "A", included some 133 wells which produce from the Pictured Cliffs formation, all located in the southwestern third of the area, and all required fracture stimulation to achieve commercial rates of production.

(13) According to the applicant, the amended area contains a total of fifteen wells, six of which are non-commercial Pictured Cliffs attempts.

(14) The amended area is to the northeast of the Pictured Cliffs trend and is expected to be a lower productivity area. The northern boundary of this area is correlative to Pictured Cliffs wells in Colorado with calculated in-situ gas permeability of 0.083md, 0.051md and 0.069md. The eastern boundary of this area is correlative to the previously approved "NM-7" tight formation designation recommended by Division Order R-6594 and subsequently approved by the FERC. The western boundary is defined by off trend non-commercial Pictured Cliff well attempts. The southern boundary is the Picture Cliff trend running generally northwest to southeast.

(15) Within the amended area, there are three core analysis which measured in-situ permeability of 0.014md, 0.028md and 0.007md.

(16) Within the amended area, a pressure buildup analysis on the San Juan 32-9 Unit Well No. 106 located in the SE/4 of Section 17, Township 31 North, Range 9 West, San Juan County, results in a calculated in-situ permeability of 0.007md.

(17) The typical Pictured Cliffs well in the San Juan Basin produces dry methane gas with little or no well head condensate and no water. No Pictured Cliffs well in the area is known to produce volumes of oil or condensate greater than one barrel per day.

(18) The evidence presented in the Case demonstrated that no well formerly or currently completed in the Pictured Cliffs formation within the amended proposed area exhibited permeability, gas productivity, or crude oil productivity in excess of the following parameters:

(a) average in-situ gas permeability throughout the pay section of 0.1 millidarcy; and

(b) stabilized gas production rate, without stimulation, against atmospheric pressure, of 91 MCFPD, the FERC maximum allowable production gas rate for an average formation depth of 3500 feet; and

(c) crude oil production rate of 5 barrels per day.

(19) Based on analysis of available data from existing wells within the proposed area and utilizing generally and customarily accepted petroleum engineering techniques and measurements:

(a) the estimated average in-situ gas permeability, throughout the pay section of the Pictured Cliffs formation, is expected to be 0.1 millidarcy or less; and

(b) the stabilized production rate, against atmospheric pressure, of wells completed for production in the Pictured Cliffs formation, without stimulation, is not expected to exceed 91 MCFPD, the FERC maximum allowable production rate for an average formation depth of 3500 feet; and

(c) no wells drilled into the Pictured Cliffs formation is expected to produce, without stimulation, more that 5 barrels of crude oil per day.

(20) Within the amended area the deepest fresh water aquifer that is expected to be used as a domestic or agricultural water supply is the Ojo Alamo which is found at an average depth of 1900 feet; and existing State of New Mexico and Federal regulations relating to casing and cementing of wells will assure that development of the Pictured Cliffs formation will not adversely affect the fresh water zones.

(21) The Pictured Cliffs formation within the amended area is governed by statewide rules which require 160-acres spacing for gas wells. Currently, no special rules authorizing infill drilling exist in the area.

(22) Based on evidence and testimony submitted by the applicant, the Pictured Cliffs formation within the vertical intervals described in Finding Paragraph No. (6), underlying the area described in Exhibit "B", meets the criteria set forth in the FERC Regulations in Title 18 CFR, Section 271.703 and should therefore be recommended for designation as a "tight formation".

IT IS THEREFORE ORDERED THAT:

(1) It be and hereby is recommended to the Federal Energy Regulatory Commission pursuant to Section 107 of the Natural Gas Policy Act of 1978 and FERC Regulations in Title 18 C.F.R. Section 271.703 that the Pictured Cliffs formation within the vertical limits described in Finding Paragraph Nos. (8), (9), and (11) of this order, underlying certain lands in San Juan County, New Mexico, as shown on Exhibit "B" attached to this order, be designated a tight formation.

(2) That jurisdiction is hereby retained for entry of such further orders as the Division may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

WILLIAM J. LeMAY
DIRECTOR

SEAL

Exhibit "A"
Case No. 10425
Order No. R-9643

Original area requested by Conoco, Inc. for the designation of the Pictured Cliffs formation as a Tight Formation.

SAN JUAN COUNTY, NEW MEXICO

TOWNSHIP 30 NORTH, RANGE 9 WEST, NMPM
Sections 1 through 6: All

TOWNSHIP 30 NORTH, RANGE 10 WEST, NMPM
Sections 1 through 4: All

TOWNSHIP 31 NORTH, RANGE 9 WEST, NMPM
Sections 1 through 36: All

TOWNSHIP 31 NORTH, RANGE 10 WEST, NMPM
Sections 1 through 4: All
Sections 9 through 16: All
Sections 21 through 28: All
Sections 33 through 36: All

TOWNSHIP 32 NORTH, RANGE 9 WEST, NMPM
Sections 7 through 36: All

TOWNSHIP 32 NORTH, RANGE 10 WEST, NMPM
Sections 9 through 16: All
Sections 21 through 28: All
Sections 33 through 36: All

The proposed "tight formation" as described above includes portions of the Blanco Pictured Cliffs Pool. Said area comprises a total of 71,192.87 acres, more or less, and consists of the following (more or less):

Federal:	56,322.97 acres
State:	8,769.76 acres
Fee:	6,100.14 acres

Exhibit "B"
Case No. 10425
Order No. R-9643

Amended area requested by Conoco, Inc. for the designation of the Pictured Cliffs formation as a Tight Formation.

SAN JUAN COUNTY, NEW MEXICO

TOWNSHIP 30 NORTH, RANGE 9 WEST. NMPM
Sections 1 through 3: All
Section 4: Lots 1 and 2, S/2 NE/4 and SE/4 (E/2 equivalent)

TOWNSHIP 31 NORTH, RANGE 9 WEST. NMPM
Sections 1 through 6: All
Sections 8 through 17: All
Sections 21 through 27: All
Section 28: Lots 1, 3, and 4, N/2 N/2, S/2 NE/4, SE/4 NW/4 and N/2 SE/4 (N/2 and SE/4 equivalent)
Section 33: Lots 1, 2, 7 through 10, 15, and 16 (E/2 equivalent)
Section 34 through 36: All

TOWNSHIP 31 NORTH, RANGE 10 WEST. NMPM
Sections 1: All

TOWNSHIP 32 NORTH, RANGE 9 WEST. NMPM
Sections 7 through 36: All

TOWNSHIP 32 NORTH, RANGE 10 WEST. NMPM
Sections 9 through 16: All
Sections 21 through 28: All
Sections 33 through 36: All

The amended proposed "tight formation" as described above includes portions of the Blanco Pictured Cliffs Pool. Said area comprises a total of 48,155.07 acres, more or less, and consists of the following (more or less):

Federal:	38,089.09 acres
State:	5,766.48 acres
Fee:	4,299.50 acres

NEW MEXICO OIL CONSERVATION DIVISION

STATE OF NEW MEXICO

CASE NO. No. 10425

IN THE MATTER OF:

The Application of Conoco, Inc., for designation of a tight formation, San Juan County, New Mexico.

BEFORE:

MICHAEL E. STOGNER

Hearing Examiner

Bureau of Land Management Building
435 Montano Road, Northeast
Albuquerque, New Mexico
December 20, 1991

REPORTED BY:

DEBBIE VESTAL
Certified Shorthand Reporter

NMOCD Exhibit "B"
Case 10425 Order No. R-9643
Conoco Inc. - Tank Mountain TF Area

A P P E A R A N C E S

FOR THE NEW MEXICO OIL CONSERVATION DIVISION:

ROBERT G. STOVALL, ESQ.
General Counsel
State Land Office Building
Santa Fe, New Mexico 87504

UNITED STATES DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
ALBUQUERQUE DISTRICT OFFICE:

ALLEN F. BUCKINGHAM, MINERALS DIVISION
ROBERT KENT, PETROLEUM ENGINEER
JANE CLANCY, GEOLOGIST

FOR THE APPLICANT:

KELLAHIN, KELLAHIN & AUBREY
Post Office Box 2265
Santa Fe, New Mexico 87504-2265
BY: W. THOMAS KELLAHIN, ESQ.

I N D E X

E X H I B I T S

EXAMINER STOGNER: This hearing will come to order for a continuation of Docket No. 3691. We're meeting here in Albuquerque at the BLM Office, Albuquerque District, on 435 Montano Road. Note the date, December 20th. We took a recess until 9:00 o'clock this morning from yesterday's hearing.

Before we get started, I'd like to have a short introduction, and then I want to have Bob say a few words about why we've come here to Albuquerque -- this is a little out of our norm -- and why we're changed up.

At the end of the table to my right, Jane Clancy, geologist with the BLM here in Albuquerque. Robert Kent, engineer here in Albuquerque with the BLM. Debbie Vestal, our court reporter. Bob Stovall. Allen Buckingham, who is the NGPA Coordinator with the BLM here in Albuqeruque. And Arlene Salazar, and you're an assistant to Mr. Buckingham?

MS. SALAZAR: Sure.

EXAMINER STOGNER: Sorry. I didn't know your title there, Arlene.

Bob, do you have a few words at this point?

MR. STOVALL: Well, I think you probably all know the reason we are down here is because the tight formation designation process is a joint jurisdictional BLM-state approval. The state has some authority, the BLM has some, and I guess the FERC has kind of the final stamp on it.

Because of that process, we've determined that it is more convenient, more effective, and hopefully more efficient for those of you who are constituents to do this jointly to get all the information on the table at one time and go through both administrative processes in a one-time situation.

One thing I will say as far as the ground rules in this thing, because this is more of almost an information-gathering, you certainly have to present your cases, and the attorneys are prepared to do that, but the one thing we are going to do is permit the BLM representatives, because they have their own approval process, although they are not represented by the solicitor or any counsel, we'll permit them to ask witnesses questions to clarify information which they need in order to make their determination and recommendation.

Again the purpose of that is to get all the information out at one time and in one place. So I assume counsel has no objections to that approach for any of the parties; is that a safe assumption, Mr. Kellahin?

MR. KELLAHIN: Safe assumption, Mr. Stovall.

MR. STOVALL: Mr. Carr?

MR. CARR: Safe assumption.

MR. STOVALL: Ms. Smith, I guess you don't have any witnesses, so you're not quite as concerned.

MS. SMITH: That's fine.

MR. STOVALL: With that in mind I guess we're ready to -- any questions as far as the procedure and how we'll handle it?

EXAMINER STOGNER: Or any other comments? Okay. In that case we'll call our first case for today, which is Case No. 10425.

MR. STOVALL: Application of Conoco, Inc., for designation of a tight formation, San Juan County, New Mexico.

EXAMINER STOGNER: Call for appearances.

MR. KELLAHIN: Mr. Examiner, I'm Tom Kellahin of the Santa Fe law firm of Kellahin, Kellahin & Aubrey appearing on behalf of Conoco, Inc., the applicant. I have three witnesses to be sworn.

EXAMINER STOGNER: Any other appearances?

Mr. Kellahin.

MR. STOVALL: Will the three witnesses raise your right hand.

(The witnesses were duly sworn.)

MR. KELLAHIN: Mr. Examiner, we have exhibit packages we have prepared. Within the exhibit package are Exhibits 1-A through 16. There is a summary index page to the exhibits, and then each package contains a full set of those exhibits. I'll distribute those now, if I may.

EXAMINER STOGNER: Please.

MR. STOVALL: Off the record before we begin.

(A discussion was held off the record.)

EXAMINER STOGNER: Mr. Kellahin.

MR. KELLAHIN: Thank you, Mr. Examiner. The exhibit package is arranged so that the geologic presentation is first. The petroleum engineering presentation is second. Mr. Reed Meek is the petroleum geologist for Conoco that has prepared, studied, and will make the geologic presentation.

Mr. Ben Sargent is the petroleum engineer who will talk about the reservoir engineering, his tests and conclusions concerning permeability. In addition, I have sworn Mr. Steve Kline. Mr. Kline is a landman with Conoco, Inc.

We have available, and I must apologize for having only one detailed set of land displays, but we have the oil and gas plats for each of the townships within the area of the application. They're here for review, and they'll detail each of the sections involved.

Mr. Kline has also prepared a colored summary as an index so that you could have a quick reference as to where the federal base oil and gas lease tracts are in the area as opposed to the fee tracts and the State of New Mexico tracts. I don't propose to call Mr. Kline as a witness other than to say that he has been sworn and he's available to talk about those questions.

The application shows a request for 76,800 acres. That in fact needs to be reduced because on subsequent check, it's my understanding that it is 71,134?

UNIDENTIFIED SPEARKER: 192.

MR. KELLAHIN: I'm sorry. 71,192 is within an acre of being the right number. I have passed out the exhibit package. And let me also circulate the color-coded index for the base leases so that if you have any questions about the acreage it will give you a way to see how that's organized.

At this time, Mr. Examiner, I'd like to call Mr. Reed Meek.

MR. STOVALL: This the first time we've had a hearing around poinsettias. I must say that.

MR. KELLAHIN: Mr. Meek spells his name R-e-e-d H. M-e-e-k.

REED H. MEEK

Having been duly sworn upon his oath, was examined and testified as follows:

EXAMINATION

BY MR. KELLAHIN:

Q. Mr. Meek, for the record would you, please, state your name and occupation.

A. My name is Reed Meek. I am a petroleum geologist. I work for Conoco, Incorporated, in Oklahoma City, Oklahoma.

Q. On prior occasions, Mr. Meek, have you testified as a petroleum geologist before the Oil Conservation Division?

A. No. This will be the first time that I've testified.

Q. Summarize for us your education.

A. I have a bachelor's degree in geology from Brigham Young University in Provo, Utah.

Q. In what year?

A. Graduated in 1980. I have a master's degree from the University of Wisconsin in Madison, Wisconsin. Finished that in 1983.

Q. Subsequent to attaining your degrees, would you summarize for us your employment experience as a petroleum geologist.

A. I went to work for Conoco, Incorporated, in Houston, Texas in 1984, and worked in Houston for three years. I was located in Hobbs, New Mexico, for three years subsequent to that. And have been located in Oklahoma City for about the past year-and-a-half.

Q. Summarize for us, Mr. Meek, what your responsibilities have been with regards to reviewing, analyzing, and reaching conclusions about the petroleum geology available in the area of application for the tight formation designation that your company has applied for.

A. Well, for about the last three years, it's been my responsibility to study the geology of the San Juan Basin area. And I've been involved in studying both the Fruitland, Mesaverde, Pictured Cliffs, and some work in the Dakota sands.

And I have developed all of the displays and all of the mapping that is presented in the geologic context of this application.

Q. In determining an area to apply for, did you examine and review the available log information, the production information, and other geologic components by which you could accurately map and interpret the Pictured Cliffs formation within this area of application?

A. Yes. I've looked at the Pictured Cliffs in quite a bit of detail using data from many sources, including well logs that are available from all these wells, production history data. I've read much of the published literature that regards the Pictured Cliffs formation.

And virtually every type of information that I know is available regarding the geological aspects of the Pictured Cliffs has been the type of data that I've been concerned with learning about and understanding.

Q. Have you satisfied yourself as a petroleum geologist that that data is sufficient upon which you may apply your expertise and reach certain geologic conclusions about the rock characteristics, the depositions, and other geologic conclusions about the Pictured Cliffs formation?

A. Yes. I believe that the data base that's available is very adequate for being able to make the determinations that we've made regarding the Pictured Cliffs. There really is a large amount of data available relative to many other types of projects or studies that I've worked, so this is not a problem in this area -- is availability of data. There's a lot of data available.

MR. KELLAHIN: We tender Mr. Meek as an expert petroleum geologist.

EXAMINER STOGNER: Are there any objections or questions of this witness?

His credentials are accepted.

Q. (BY MR. KELLAHIN) Mr. Meek, let me have you turn to the exhibit package. Let's set aside as a reference the list of exhibits in the tabulation and also if you'll set aside the written geologic description and have you unfold for me what is the first display. The plat is marked in the lower right-hand corner, it says Exhibit 1-A, if you'll unfold that.

Before I ask you specific questions, let's have you explain to us how to understand the display. First of all, what's the base map upon which you have identified certain specific areas?

A. Well, the base map is simply a township and range grid that represents the US Geological Survey's township and range grid for the area. The map base covers most of the productive area of the San Juan Basin.

Q. When we look at the display and see the dots on the display, what do those dots signify?

A. Each one of the dots represents a well that has been completed in the Pictured Cliffs horizon. There are approximately 3,000 wells that have been completed in the Pictured Cliffs throughout the San Juan Basin.

And one thing to note in particular is that these wells are in a -- are oriented in a northwest trending band, and that represents the trend of the current producing area in the Pictured Cliffs.

Q. We'll come back in a minute to your geologic explanation of the reason for that trend and how it was deposited and developed. Let me have you identify what is signified the "Proposed Area." What does that mean?

A. Okay. The proposed area includes portions of the Townships 30, 31, and 32 North, Ranges 9 and 10 West. And that is the area that we are proposing in this application designate -- or naming it the Tank Mountain Area because there's a prominent topographic feature located in about the center of that area called Tank Mountain. And this is the area that we would like to get a tight gas designation for the Pictured Cliffs formation.

Q. Identify for us what are the other areas shown on the display with the dark outlines.

A. There are several areas. There are actually five areas in the San Juan Basin in New Mexico that have previously been designated as tight gas areas. And those are outlined with the bold outline. And these areas include New Mexico No. 25, New Mexico 11-A, 11-B, and the New Mexico-7.

And then another area where I've been made aware that there is a pending application, that has been titled the Cabresto Tight Gas Area.

Q. The identification numbers NM and then a number refers to what?

A. I believe that refers to the state of New Mexico's number or designation of that particular area in state records.

Q. Let's set that aside again for a moment and turn now to what is identified as Exhibit 1-B. Identify the display for us.

A. This is a map that is simply an enlargement of the area surrounding our proposed Tank Mountain-Pictured Cliffs gas area. It shows more detail of the area.

The items I would like to draw your attention to: In the southwestern portion of the area, the map is populated by a number of Pictured Cliffs producing wells. And next to each one of the gas well symbols is a number which represents the cumulative gas production for each of those wells up until January of 1990.

I've also put some contours on the map, which represent -- which associate wells that have that have produced certain cumulative production, threshold. The contours are 250 million cubic feet and 500 million cubic feet.

Q. You're contouring cumulative production?

A. That's right. And it's a very important thing to notice that when you contour the cumulative production, it demonstrates a strong northwest trend to this production, which I believe is also representative of certain conditions that existed during the deposition and formation of the Pictured Cliffs rock horizon.

The other things that I would like to draw your attention to is that in the northwestern -- or the northeastern portion of the proposed Tank Mountain Area, there are very few producing Pictured Cliffs wells. And in fact the area essentially straddles the northeastern boundary of the field.

There is production in the southwestern portion of the area. Then you cross the edge of the current producing area, and then you move into an area where the Pictured Cliffs is relatively undeveloped or not producing at this time.

And part of the reasoning for that is that several wells have been drilled out in that portion of the area but have not encountered commercial rates of production from the Pictured Cliffs. We believe that that is mainly due to a lower permeability nature of the Pictured Cliffs horizon in that area.

Q. When we're looking at Exhibit 1-B and comparing back this specific area to the basin map, Exhibit 1-A --

A. Uh-huh.

Q. -- describe for us geologically how they fit together.

A. Referring to the map 1-A, again this

represents the entire extent of the Pictured Cliffs producing area in New Mexico. I want to make the point that the Pictured Cliffs sandstone is present throughout the entire mapped area; that the formation exists but it is not found to be productive beyond the limits of where the wells are located.

I would like to discuss the nature of the sand horizon, the Pictured Cliffs, if that would be appropriate at this time.

Q. Well, let's do it in reference to Exhibit 1-B so that we can see how the area of application fits into the geologic description of the Pictured Cliffs.

And if you'll start with giving us your geologic opinions and conclusions about the age of the rock. Let's talk about that first.

A. Well, the age of the Pictured Cliffs formation is well established in literature. Many people have studied and documented that all of the producing horizons in the San Juan Basin or the main producing horizons from the Dakota up through the Pictured Cliffs and Fruitland are cretaceous in age.

And the Pictured Cliffs itself is upper

cretaceous in age, and in more detail would be assigned to the Campanian period of the upper cretaceous.

Q. When you as a geologist investigate the rock properties known to be associated with Pictured Cliffs production, what are you looking for? What are the components by which you would characterize a particular data as rock properties?

A. Well, there are three main things that we look for when we're studying sandstones. The first -- such as the Pictured Cliffs. The first being what is the texture of the rock or, in other words, what is the grain size, the predominant grain size that composes the sand in the Pictured Cliffs.

Q. If you're trying to make an interpretation as a geologist about the permeability of the Pictured Cliffs, how does the texture of the grain size help you determine what the possible permeability will be?

A. Well, the coarser the grain size, generally the higher the amount of porosity in a rock and also the higher you would expect the permeability to be.

So in a very coarse grain sandstone, you would normally anticipate that you would have a relatively high permeability relative to a finer grain sandstone where there is much more tortuosity in the flow path that fluids have to move through the rock so that finer grain sands are generally regarded as lower permeability.

Q. What is your opinion of the texture of the Pictured Cliffs rock, if you will, within the area of application?

A. The Pictured Cliffs in the area of application and throughout the San Juan Basin is described as fine to very fine grain so that it is the permeability in the sandstone is low relative to many other sandstones in other areas of the country where you would find a coarser grain size. But in this area it's fine to very fine grain.

Q. Would that texture of rock be consistent with an engineer who, based upon core information or pressure buildup tests, was able to determine that the permeability of the Pictured Cliffs was .1 millidarcies or less?

Would that geologic opinion about the texture of the rock that you see in the Pictured

Cliffs be consistent with what the engineer is seeing for permeability in certain wells within this area?

A. Yes, it certainly would. You would expect finer grain sands to have low permeability and probably in the range of the less than .1 millidarcy.

Q. You mentioned that there were other items of rock properties that you as a geologist considered significant in examining the Pictured Cliffs. Is the composition of the grain --

A. Right.

Q. -- is that one of of the items?

A. Texture, composition, and then also a term we call diagenesis, which is the process of alteration that the sand goes through after it's deposited. So the second thing to discuss is the composition of the grains that make up the sand. Some sands are composed of relatively pure quartz, which is a very stable mineral and doesn't alter very much after deposition.

In the case of the Pictured Cliffs, many of the -- most of the sand grains are composed of rock fragments, volcanic rock fragments, which are very unstable in their composition and tend to alter subsequent to their deposition and form different minerals and to break down.

Q. How does the composition of the grain affect permeability?

A. Well, during the process of diagenesis, which includes the compaction as a result of burial that the rock goes through, and then fluids moving through the rock after the deposition, tend to alter these unstable rock fragment grains and to create different -- new minerals in the rock.

And these minerals often fill up the matrix or the porosity that might be present at the time of deposition such that when you actually deposit a sandstone in a marine shoreline environment, similar to what we had in the Pictured Cliffs, you may have a porosity of, say, 20 to 25 percent at the time of deposition.

Well, as the sand is buried by other sediments on top of it and compacted and then this process of diagenesis, much of that original porosity becomes occluded, or filled up with -- well, both closed by the compaction and filled up by these diagenetic minerals that form in the porous base that existed at the time of deposition.

So as a result, generally the porosity that we find in the Pictured Cliffs today is in the range of 8 to 12 percent. The highest porosity that I've ever seen reported for the Pictured Cliffs is, I believe, 13 or 14 percent. So much of the original porosity is destroyed during this process that we call diagenesis.

Q. Is your reservoir description of the rock properties consistent with the low permeabilities that are characterized to be associated with the Pictured Cliffs formation?

A. Yes. It's very consistent with the permeabilities that we observe in the Pictured Cliffs. And we attribute the low permeability nature in large part to the fine grain nature and then the presence of all these diagenetic minerals, the clays that have filled the porosity.

Q. Describe for us as a geologist the depositional environment in which the Pictured Cliffs sands have been distributed on a regional basis and then on a site-specific basis as it applies to your area of application.

A. Okay. The Pictured Cliffs is a marine sandstone, and it was deposited during the cretaceous. The cretaceous period was an interesting time in the geologic history of the San Juan area because there was a seaway that came through most of the central United States and across the San Juan Basin area.

There was a shoreline that trended in a northwesterly direction. And during the cretaceous the sea level fluctuated several times. It moved up and down and laid down, beginning with the Dakota and moving up through the Mesaverde, which includes the Point Lookout and the Cliff House sandstones.

And then finally the last regression, or moving out of the seaway, in this area resulted in the deposit of the Pictured Cliffs. And what you see is that during this regression, or moving out of the shoreline, that the sea level would drop and then stand still for a period of time and create benches of higher quality reservoir rock.

And then the sea level would drop a little bit, the shoreline would move out several miles and then stabilize, and you would deposit a subsequent bench of fairly high quality reservoir rock. And this happened several times.

When you look at the Pictured Cliffs several times on a regional basis and look at the cumulative production trends, similar to what I've contoured on the Exhibit 1-B map, you see these benches of higher quality reservoir rock being represented by higher cumulative production from wells that were in the higher quality trends.

Q. On a regional basis then you can determine that orientation of deposition to be northwest to southeast?

A. That's right. And that's an important point when we draw your attention to the measured permeabilities that we've been able to acquire that pertain to our Tank Mountain Area.

Q. When we look at Exhibit 1-B, have you displayed that northwest-southeast depositional trend and have identified it?

A. Yes. I've identified it with some lettering and some arrows. And these are -- the lettering and the arrows are written in some of the higher quality productive areas of this detailed map area.

Q. As you move perpendicular to that trend in a northeast direction, what happens to the Pictured Cliffs reservoir as you move away from the trend?

A. Well, what's happened is that -- I think you need to understand a little bit about the development history of the Pictured Cliffs horizon. The first Pictured Cliffs wells were drilled in the 1920s down in the Farmington area. And then throughout the 40s and 50s and up through the 1970s, the limits of the Pictured Cliffs field moved progressively to the north.

And the limit that we see, the limit of the productive area that we see represented on map 1-B is representative of where, essentially, drilling stopped at the end of the 1970s. There's been very little activity in the Pictured Cliffs formation since about 1979.

Q. Do you have an explanation for the lack of activity?

A. Well, I believe that the operators tried several times to step out from the productive area and found that they were drilling noncommercial wells.

And in general, the industry has

recognized that as you move further north, further to the northeast, that the permeability in the Pictured Cliffs deteriorates, so that the general view is that you have a little higher permeability to the south and as you move north, your permeability decreases so that many people feel like it's uneconomic to develop anything north of the current producing area.

Q. Let's turn to Exhibit 2, which is the tabulation of well data. Identify that for me, please.

A. All right. This is simply a list of all of the producing wells within the boundaries of our Tank Mountain, our proposed Tank Mountain tight gas area. There are 144 wells on the list.

And associated with each well is a legal description of the location, including the township, range, section, footage from the section line, then a well name, operator, total depth of the well, the date that the well was spud and the date that the well was completed. And then cumulative gas production and cumulative well production up until January of 1991.

Q. In reviewing this data, have you found any well that was able to attain commercial production without being stimulated prior to that production?

A. No. It's customary practice to drill a Pictured Cliffs well. And to achieve commercial production, it's always required stimulation. Even back as far as the early wells that were drilled in the 1930s and 40s, these wells were stimulated in an open-hole condition with nitroglycerin fracturing techniques.

Our fracture techniques have become a little more sophisticated over the years so that now generally the wells are cased, perforated, and then frac'd through the perforation rather than in an open-hole situation.

But I'm not aware of any well in the entire San Juan Basin that produces from the Pictured Cliffs that hasn't been stimulated in some method.

Q. Why do the operators have to stimulate the Pictured Cliffs in order to attain production?

A. Because it is a low permeability. Sandstone.

Q. When you as a geologist are

assimilating data and developing maps from which to make interpretations and conclusions, one of the tools you often use is a structure map. I know you haven't presented one here, but can you describe whether or not there is a structural significance to the Pictured Cliffs, particularly as it affects the area of application?

A. Right. I have done structure mapping of the Pictured Cliffs. And there's relatively little structure in the area. There is a regional dip essentially to the northeast that results in about a 25-foot-per-mile dip to the horizon, which is very flat. It's essentially undetectable. It's like as flat as a tabletop. So there's really not any structural deformation. There's no faulting of any significance that affects the Pictured Cliffs horizon.

It's essentially a blanket of sand that covers the entire San Juan Basin and is fairly uniform in thickness and is not disrupted until you get to the very edge of the basin where it can turn abruptly upward and outcrop at the surface.

Q. Let's turn now, Mr. Meek, to the type log, have you identify for us the location from which you've taken the type log example, and then describe for us the vertical limits of the Pictured Cliffs as they apply to your area of application.

A. Yes. The location of the type log is indicated on Exhibit 1-B. It's located in Township 31 North, Range 9 West, Section 17 in the northwest quarter of that section. And this is a well that's titled the San Juan 32-9 Unit No. 102 and was operated by the Amoco Production Company.

Q. For reference, give us the commonly utilized description of the Pictured Cliffs so that a geologist with that description would know how to pick the top and the bottom of the Pictured Cliffs formation.

A. Well, the Pictured Cliffs is overlain by the Fruitland formation, which contains coal deposits, sandstones, and shales. And typically the top of the Pictured Cliffs is picked at the base of the lowest coal in the Fruitland formation.

Although there is sometimes some transition to it in the sense that occasionally there is a stray coal stringer that might appear somewhere lower in the -- down into what would be the Pictured Cliffs.

But it's a fairly easy correlation to make on most of the well logs that are available once one becomes familiar with that transition from the Fruitland coals into the marine sandstones below it.

Q. What is your opinion of the average depth of the top of the Pictured Cliffs within the area of application?

A. The average depth is about 3500 feet, but it varies quite a bit because there is a significant topographic relief in the area. But 3500 feet, I believe, is a fairly accurate number to estimate an average depth for the top of the Pictured Cliffs.

Q. What is the average gross thickness of the Pictured Cliffs that you're dealing with?

A. The way that I define the Pictured Cliffs, it's about 100 to 150 feet, sometimes as much as 200 feet thick. But it's a very transitional boundary at the base of the Pictured Cliffs.

The Pictured Cliffs overlies the unit

that is known as the Lewis shale, which represents the more distal marine deposits, the shales that were being deposited far away from the shoreline. And as the ocean moved out over these marine shales, then the sandstones were deposited over the top of the shales.

So it's what we refer to as a coarsening-upward sequence in the sense that if you're starting somewhere down in the Lewis shale, you're coming through these black marine shales, and then you might see a thin bed of sandstone appear.

And as you go a little bit further up, the thickness of the sandstone beds increases, the grain size might increase slightly, become a little bit coarser grain, until when you get up into the upper part of the Pictured Cliffs, you've made a transition from shale into a pure, massive, or thick-bedded sandstone beds.

Q. Within that gross vertical limit of the Pictured Cliffs, where is the best production found?

A. The productive interval is always found in the very upper part of the Pictured Cliffs, usually within the upper 100 feet, and probably in most cases in the upper 50 to 70 feet of the Pictured Cliffs.

Q. When you look at the average depth of the top of the Pictured Cliffs and compare that to the maximum allowed gas producing rate on a daily basis under the Oil Conservation Division rule contained in Order R-6388, I believe the limit that corresponds to the 3500-foot interval is 91 Mcf a day; am I correct in understanding that?

A. Yes, I believe so.

Q. Do you find any of the wells within the area of review for this application that are capable of producing at that type of rate?

A. That's at an unstimulated rate. I'm not aware of any wells that have produced at that kind of a rate in an unstimulated condition. But most wells are not tested in an unstimulated condition, so it's a little bit hard to make that determination.

Q. For the wells on your list on Exhibit 2, do you find any of them that will produce five barrels of oil a day or more?

A. No. The Pictured Cliffs produces fairly dry methane, very little liquids associated with it, no water. And in no case in any of the 144 wells that are on the list is a well capable of producing more than maybe a barrel of condensate a day.

Q. Is there water production associated with producing the Pictured Cliffs wells in the area of application?

A. No, there's not.

Q. Let's turn to your cross-sections now, Mr. Meek, and let me ask you to look at Exhibit 4-A. The Exhibit 4-A is your A-A prime cross-section that runs north-south?

A. That's right. On my cross-section I'm showing an index just in the lower portion of the map. It shows the outline of our proposed Tank Mountain Tight Gas Area and then the orientation of the two cross-sections, which are Exhibits 4-A and 4-B.

The first cross-section is A-to-A prime, and it runs from the north to the south through the area. The main things that I would like to point out on the cross-section, first of all, I've selected six wells that are spaced about -- well, about two to three miles apart.

These wells are very representative of

the typical type of log response that you see in the Pictured Cliffs. The cross-section shows the overlying Fruitland formation with a fairly thick coal seam just right on top of the Pictured Cliffs. That coal seam is represented on the logs by a high resistivity development.

The resistivity curve, which is on the right side of the depth track on each of the logs, as the curve moves off to the right, it represents a higher resistivity. So it's fairly easy to recognize the thick coal seam that overlies the Pictured Cliffs in this area.

Q. When you look at the display and see the dark black line running horizontally across the cross-section, what does that depict?

A. That represents the top of the Pictured Cliffs sandstone as I have interpreted it from these well logs.

The other thing that I would like to point out on this cross-section is that the first three wells, the northern wells are wells that produce from the Mesaverde horizon, which is a deeper horizon. They've penetrated the Pictured Cliffs but have not been completed in it.

And then the three wells in the

southern portion of the cross-section are actually producing Pictured Cliffs wells.

And in the depth track of these three wells I have annotated the zone that's been perforated in the well so that you can see that the producing interval in the Pictured Cliffs is found in the upper 50 to 70 feet of the formation.

Q. Am I correct in understanding that you're not able to take the logs and quantify specifically permeability of the reservoir from the log analysis, but you can use it as a device or a tool to give you a qualitative indication of permeability?

A. That's true in a sense. The gamma ray curve and the SP curve, which are represented in the -- on the left side of the depth track on each of the logs, give us an indication of the lithology, the rock type.

And when these curves deflect to the left, it indicates a cleaner sandstone. And as the shale content of the rock formation increases, then these curves tend to move to the right so that there is sort of a qualitative feel that you can get for the type of rock and maybe whether there is possibly permeability in that particular formation at that point.

Q. If we have a determination of a cleaner rock property within the Pictured Cliffs as displayed by the log curve character, the cleaner the rock, what happens correspondingly to the permeability?

A. You would anticipate that the permeability would increase as the shale content and the rock decreases. Or the cleaner the sandstone, you would anticipate that permeability would be somewhat better.

Q. Let's explore that for a moment by going back and referencing Exhibit 1-B, which is our area map that gives the details of your data control points, if you will.

A. Uh-huh.

Q. And looking at the north-south cross-section, do you have a core analysis with established average permeability that is close to any of the logs shown on your A-A prime cross-section?

A. The well that's labeled on the cross-section San Juan 32-9 Unit No. 102 is located in Section 17. It's also indicated on the map as the type log, and therefore it's located just less than a mile away from one of the wells that we do have some measured core permeability analysis on.

Q. We'll talk about the specifics of the core analysis later for Well 106, but it is in the same section, if you will, as the type log?

A. Right. It's within a mile of the type log.

Q. In comparing the log curve character on the 102 well, which is on the cross-section, explain to us what you see about the log curve character that would support the indication of low permeability as established by the core analysis in the 106 well.

A. Well, the log curve character on the 106 is very similar to what we see on the 102. There is a -- one of our other exhibits, which presents the actual core analysis data on the 106, there is a Xerox copy of the logs that are associated with that well. So a comparison could be made to the curves shown on the 102 here on the cross-section and in that presentation in a further exhibit.

But they are very similar, and in fact

I don't really detect any difference looking at logs to the quality of one well versus another. I expect that both wells are going to produce in a similar fashion and they have very similar rock characteristics.

Q. As we move south on this line of cross-section, do you see the quality of the rock improving so that you would anticipate a greater permeability as you move to the south?

A. Well, we're moving into a productive area. I don't really believe that the permeability is going to improve tremendously, although there probably is some improvement.

But I guess the point that I would like to make is that the cores that we're presenting, several of them are from wells that offset very closely some of the higher productive wells in the Pictured Cliffs.

If I might back up just a little, the average Pictured Cliffs well in the basin produces about 600 million cubic feet. And some of the wells produce up to as high as 4 billion cubic feet. So that would be about eight times the average. There are a few wells that have anomalously high cumulative production.

Q. That's on a daily-producing basis?
A. No. That's on a total cum.
Q. I'm sorry. As you move to the north on your cross-section, do you see the character and quality of the rock changing significantly so that you would anticipate the permeability would be getting better, staying the same, getting worse as you move north?
A. I would anticipate it's going to stay the same or decrease in quality. The decrease is mainly an inference from this, from a regional view of the basin and the idea that in general the industry regards the permeability to decrease as you move north.
I don't really expect that it's going to be significantly different than any of the cores that we've measured. I feel like the depositional environment that created the Pictured Cliffs is fairly uniform throughout the basin so that you wouldn't expect significant changes in the magnitude of the permeability measurements, particularly when you're looking at areas that are on trend on this northwest oriented trend.
Q. Let me ask you about the continuity.

We haven't looked at the east-west cross-section, but let me cover that with you now. When you take all the cross-sections together, plus the rest of your data, are we looking at the same continuous Pictured Cliffs reservoir within the area of application?

A. Yes. It's a very continuous formation.

Q. Is this the same common source of supply for the area in the Pictured Cliffs?

A. Right. The source of the sediment is the same. The marine environment that deposited it is the same and was very stable and very consistent throughout the entire time of deposition.

Q. You don't see any geologic indication that you're dealing with reservoirs that are somehow separated?

A. No. I think it's very -- quite continuous.

Q. No structural displacement, no faulting that would separate the reservoir from the southwest to the northeast?

A. No.

Q. Okay. Let's let's look at the east-west cross-section. That will be Exhibit

4-B, Mr. Meek.

A. All right. This cross-section is again oriented from east to west across our area. As shown on the index on the lower part of the cross-section, I've selected five wells that are again spaced approximately two to three miles apart.

And there is a log on this cross-section that's common with the cross-section that we just looked at. It's the El Paso San Juan 32-9 Unit No. 9 well, which is the second one from the left on this display.

But this cross-section is very similar to the one that we just looked at. It shows the top of the Pictured Cliffs horizon represented by the heavy line separating it from the overlying Fruitland formation.

The log response is very similar to what we looked at on the previous cross-section. I think the main point that this demonstrates is that the formation is continuous in an east-west direction across the entire area while the previous cross-section made the point that it's continuous in a north-south direction across the entire area.

Q. When we look at the reference map 1-B, the engineering witness will discuss engineering details that are also included on this display, but as an introduction, would you go through the rest of the information and explain to us what's indicated by the yellow outlined data points that are identified on that display.

A. Well, in trying to characterize the Pictured Cliffs reservoir and support the contention that the permeability is less than .1 millidarcy, we did quite a bit of research to determine where we could get any core data that might be available.

This type of data is not commonly acquired in the drilling of an oil and gas well, mainly because it's very expensive. It takes quite a bit of time to cut core. It's expensive in terms of rig time. And then the core analysis itself is time-consuming and expensive. And so it's rare to find cores. And we've had to do quite a bit of research in order to find what data that we have to present here.

But we have located four cores which we feel are pertinent to the Tank Mountain Area. Three of them are actually located within the boundaries of the area. If we began in the upper left of our area, the Ealum No. 1 is a well that was drilled by Amoco Production Company who, by the way, is an interest -- is a party that we share an interest in some of the acreage within the area. And they've been cooperative and supportive in preparing this application.

So we're presenting some core analysis from the Ealum well. I believe there are some greater than 40 core measurements or plugs that have been taken from that core and permeabilities that have been measured on those and represented the average of all of those calculations, those measurements as being .02 millidarcies.

Q. Before we leave that core information, adjacent to that core is another box that arrows to, I guess, five more wells that are shown to be noncommercial?

A. That's right. These are wells that were drilled and completed in the Pictured Cliffs formation. One of the exhibits that we are presenting includes scout tickets documenting the completion of these wells in the Pictured Cliffs. The wells were stimulated, but there is no production data available from these wells.

Several of the scout tickets indicate that the wells were drilled and abandoned following the completion, indicating that they were not commercial.

Q. Moving to the south and east, then, identify for us the two additional cores within the area of application.

A. All right. These are the San Juan 32-9 Unit No. 108 and the 32-9 No. 106. And these are two wells that again were drilled by Amoco Production Company. They have supplied us the confidential core information that was acquired.

These are side-well cores, which is a little different than the type of core that was taken in the Ealum. The Ealum was a full-diameter core where they actually went in with a special drill bit and acquired a three-inch cylinder of the rock.

The side-well core is an instrument that's run in a well by the logging company on a cable or a wire line. And they shoot a projectile out into the side of the wellbore and retrieve a small piece of the rock formation using a little core barrel.

So that's the type of data that we have

available on those two wells is the side-well cores. And I believe there are ten measurements available on those two wells. And the average perm on the 108 was .008 millidarcies, and on the 106 was .007. So both very comparable in the permeabilities that were measured.

Q. Were you able to confirm the permeability range with cores outside of the area of application?

A. Yes. One other core that's located in the southeastern portion of the Exhibit 1-B may have indicated with the yellow box is the Vandewart B-3. This is a well that was drilled by Tenneco Oil Company back in the early 70s.

And they acquired a full-diameter cylinder of rock or a conventional core. And we've been able to get the core analysis on that. And that indicates that the average permeability from some 75 separate plugs that were measured was .014 millidarcies.

I guess I want to make the point that we have core data from four wells. And from those four wells there's been well over 100 different measurements taken on different pieces of rock material to determine the permeability.

And these are -- the average of these is well below the .1 millidarcy threshold that's required for a tight sand designation.

Q. When you look at the southeast corner of the area of application, just outside of that area there's a label that says "Noncommercial Wells." What have you discovered there?

A. There again, there are several wells that have been drilled and completed in the Pictured Cliffs and are indicated on their scout tickets as being drilled and abandoned or there is no production data available from the wells, indicating that they were noncommercial and haven't produced in paying quantities.

Q. Identify for us, then, the three data points in the Colorado side of the state boundary that is just outside your northern boundary of the application area.

A. All right. These are -- to the north of our area there is some Pictured Cliffs production in Colorado. I believe it's of a very similar nature to the producing area that we see in the New Mexico side in that these are marine sandstones deposited in a very similar depositional environment to what we see in New

Mexico.

And we have selected the three wells, the three closest wells to the Colorado border, which is also the boundary of our proposed tight gas area, and done some calculations. And I'll let our reservoir engineer discuss more the nature of those calculations.

But our determination from the best reservoir engineering analysis that we can make is that the permeability on these wells is of a similar nature to what we see in the core data that we have in New Mexico in that it's well below the .10 millidarcy threshold.

Q. Mr. Meek, have you made a literature search of published reliable treatises or papers that have been widely known within the industry and experts such as yours to confirm whether or not the general belief among geologists about the Pictured Cliffs geology would be consistent with your own conclusions?

A. Yes. In fact, most of my conclusions have been arrived at from a study of the literature. I have seen some of the rock and outcrop and in core samples, but most of my understanding of the Pictured Cliffs comes from published sources.

Q. With that background of understanding then, looking at the individual logs and the data that you've assimilated for this application, do you find any information that you've examined that's inconsistent with the published literature about the geology of the Pictured Cliffs?

A. No. I think everything that I've presented is consistent with general -- the general body of scientific knowledge that's been published.

Q. Have you given us one example of that type of published literature with Exhibit No. 5?

A. Right. Exhibit No. 5 is a figure that I've taken from a master's thesis that was published at the University of Texas at Austin in 1981 by a Mr. Cumella.

And the reason that I've presented this figure is to show that in published sources the Pictured Cliffs is regarded as having low permeability north and east of the current producing area.

The figure -- if I could just describe the figure -- it shows an outline of the San Juan Basin with the Pictured Cliffs outcrop forming a roughly circular feature that straddles the New Mexico-Colorado border.

And then within the center of this circle is the Pictured Cliffs producing area, which is the same area that I represented on Exhibit 1-A, and this area is shaded. It shows the gas producing area where the Pictured Cliffs is productive.

It also -- I've drawn onto this figure an outline approximately locating our Tank Mountain proposed tight gas area, which is north and east of the current producing Pictured Cliffs field.

And then the annotation that was put on there by the author indicates that to the south the Pictured Cliffs has somewhat higher permeability but is water saturated. Then you move into the producing portion of the field. And then as you move to the northeast, you go into a low-permeability but gas-saturated area in the formation.

But the fact that there is outcrop around the entire San Juan Basin of the Pictured Cliffs is further evidence that the formation is continuous across the entire area.

And as one studies the outcrops that surround the basin, it becomes apparent that the depositional environment for the entire Pictured Cliffs horizon or sandstone formation was a relatively consistent shallow marine depositional setting, so that the nature of the Pictured Cliffs that you find out-cropping in Colorado is very similar to what you find down in the southern part of the basin in New Mexico.

Q. Do you have an opinion, Mr. Meek, as to whether or not you can reach a conclusion that this application should be approved as a qualifying tight formation designated area?

A. I believe that it should. I think that all of the evidence that I've been able to assimilate through reading literature and from studying the core analysis that we've been able to locate indicates that the Pictured Cliffs is a very tight formation.

Most of the measured permeabilities are nearly in order of magnitude lower than the .1 millidarcy threshold that we're required to meet. So you would have to improve permeability by ten-fold in order to surpass that threshold requirement.

So I feel very comfortable that throughout the San Juan Basin, and particularly in the Tank Mountain Area, that the permeability of the Pictured Cliffs is less than .1 millidarcy.

MR. KELLAHIN: Thank you, Mr. Examiner. That concludes my examination of Mr. Meek.

We move the introduction of Exhibits 1 through 5 at this time.

EXAMINER STOGNER: Are there any objections?

Exhibits 1 through 5 will be admitted into evidence at this time.

Couple of somewhat specific questions.

EXAMINATION

BY EXAMINER STOGNER:

Q. What is the origin of the natural gas in the Pictured Cliffs in this area, and how was the transgression or the -- how was the gas transmitted? How did it get there?

A. The general view is that the gas that's produced from the Pictured Cliffs has an origin in the marine shales that underlie it, the Lewis shale in particular, and that this is the source of the organic material that through the process of metamorphism became natural gas and migrated into the porous sandstone reservoir of the Pictured Cliffs.

Q. And that Lewis shale is more commonly the base of the Pictured Cliffs; is that correct?

A. That's right. Uh-huh.

Q. Now, in looking at the type log, your Exhibit No. 3, this well is presently a Pictured Cliffs producer, is it not?

A. Yes. This well has been completed in the Pictured Cliffs. It's a recently drilled well. It was drilled in 1989. And it's represented on the Exhibit 2 list. Let's see, yes, I'm showing that it has produced up until the beginning of 1991, 300 -- or let's see.

334 -- let's see -- thousand cubic units. Would that be the right units? I get confused on the units sometimes.

Q. I don't have it in front of me. MM. One M or two M's?

A. That would be Mmcf, yeah.

Q. Okay. My point is, this well or this cross-section -- I'm sorry. This log also appears on your cross-section; correct?

A. That's right.
Q. Your north-south?
A. That's right.
Q. I got the perforated interval, and it appeared that the perforations extend down from the -- right at the base or the base of the coal, or top of the Pictured Cliffs down to 3390. And then there's another set of perforations from about 3415 to 3440; is that correct, or 3430?
A. 3430. About 3415 to 3430.
Q. Okay.
A. That's right.
Q. Is this normally the productive interval in the Pictured Cliffs at the top of the upper portion of the Pictured Cliffs sandstone, or do we see wells perforated throughout the Pictured Cliffs interval?
A. In most cases the perforated interval is located in the upper 50 to 70 feet of the Pictured Cliffs, just below the Fruitland formation.
And the way that that productive interval is typically identified is that the resistivity logs, which is what I've represented on the type log in the right side of the depth

tract, would read greater than 20 ohms of resistivity.

And then also normally there is a porosity log that is run, which I haven't represented here. But these generally read a little greater than 10 percent porosity through the productive interval.

So that's the way that a company would determine which interval to complete is whether it met the 20-ohm resistivity and greater than 10 percent porosity threshold.

Q. Now, the zone immediately above the Pictured Cliffs is the infamous Fruitland coal, is it not?

A. That's right. Uh-huh.

Q. On these upper-perforated intervals, is that gas that is produced from this area, is it the same Lewis shale origin gas, or does it have some other origin?

A. From the Fruitland coal?

Q. You probably want to extend it up to there. What is the origin of Fruitland coal gas?

A. Well, the gas that is in the Fruitland coal is generally regarded to be a source from the coal itself.

During the process of coalification, one of the main by-products is the production of methane and other gases.

Q. Okay.

A. So that the gas that's associated with the coal seams has been self-source from the coal seams.

Q. Now, does this gas from the coal seam, does it migrate down into the Pictured Cliffs?

A. Well, there's been considerable debate as to whether the Fruitland has been a significant source to the Pictured Cliffs. And generally in composition of the gases is quite similar in the sense that they're both fairly dry, pure methane with very little liquids associated with them.

Some of the studies that I've read where they try to determine that the source, whether it be marine or whether it be a coal source to produce gases, they look at particular isotopes that are found associated with the methane molecules.

And generally the conclusions have been that most of the Pictured Cliffs gas is sourced by marine shales where the gas produced from the coal seams is actually source from the coal seams.

I'm not really an expert in this type of analysis to determine the origin of produced gases, but I have read quite a bit of the literature. And some of it indicates that there is possibly some sourcing of the Pictured Cliffs from the coals, but it's a minor component.

Q. I guess what I'm leading up to, do we find, since most of the perforated interval is up at the top portion of the Pictured Cliffs and in some instances, like this particular type log, just right under the coal bed, do we find the permeabilities in that upper region different throughout the whole Pictured Cliffs? Is it less permeable, more permeable in this upper portion, or is it pretty homogeneous throughout?

A. Well, the best permeability in the Pictured Cliffs is in that upper portion that we find productive. That's where most of the core analysis that we've presented is taken from, that upper portion of the Pictured Cliffs.

So I think the data that we're presenting is representative of the productive interval in the Pictured Cliffs. It's not representative of the lower permeability rock in the lower portion of the Pictured Cliffs simply because we would never acquire permeability data down there. We're not concerned about it since we never complete that portion of the formation.

Q. Now, you were giving an overall discussion about the trends, the shoreline trend in this cretaceous --

MR. STOVALL: Easy for you to say.

Q. -- the seaway that was in here in that particular time that I can't pronounce. And obviously, or it appears somewhat to me, that all of a sudden you've got a clear line what's productive here and I guess what you're trying to show, that this quality of rock is deposited in the shallow waters. And then when you get north of that or north and east of it, it's deeper, more a deeper marine sediment; correct?

A. In a sense that's the case, although what's happened is that the shoreline has moved out, remained stable for a period of time, formed the more productive benches, and then the sea levels dropped, the shorelines moved out a couple of miles. You develop another series of shoreline higher quality reservoirs.

And I think what we're seeing is that the development of the Pictured Cliffs horizon has reached the edge of one of these higher quality reservoir benches and they haven't found one beyond that.

It's possible that there is another bench that exists to the northwest between what is currently the New Mexico producing area and the bench that appears to be developing up into the Colorado side.

Q. That's what I was leading up to. Maybe a little more detail of this phenomenon that appears in Colorado which looks very localized. It looks more like a pod. And then you've got that -- I'm referring to Exhibit 1-B, up on the Colorado-New Mexico state line, on the upper right-hand side of the exhibit --

A. Uh-huh.

Q. -- where there appears to be, what, about six or seven producing wells?

A. Well, I think the reason that it looks like a pod up in Colorado is mainly because there hasn't been lateral development of that particular trend as you move northwest or southeast; that a similar bench probably exists;

it just hasn't been fully developed.

If you look at a more regional view of a productive area and do a -- and contour the cumulative production, there are trends in New Mexico that would line up in a north or a southeasterly direction with this Colorado production.

So that I think it's a very similar type of feature to what we're looking at in Colorado. Rather than being a pod, it really is a long, linear trend. It just hasn't been fully developed.

EXAMINER STOGNER: Okay. I have no other questions of Mr. Meek.

Are there -- Ms. Clancy.

MS. CLANCY: I've got a couple here.

EXAMINATION

BY MS. CLANCY:

Q. You've given a very detailed description of this finer reservoir deteriorating basically to the northeast. Your perm data that you've shown is in this -- is on the fringe of the production and then up in what we would consider the core area.

I've noticed that in your southwestern

area you do have a lot of production there, and that's supposed to be your higher quality reservoir. Did you do any work as far as what your permeabilities would be in this area? And why did you include this higher quality area in your tight formation designation?

A. Well, the reason that we've drawn the boundary that we have to our area that we're requesting for tight formation designation is based primarily on where we hold an interest in the oil and gas leases.

What our intent is, there are several open locations still within that producing area that has been developed that we would like to drill additional development wells in, so that it's our intention to develop some of those areas. And we would like those wells to also qualify for the tight gas designation.

Q. Okay. On your core analysis, I assume that this -- that you verified the average was taken from the upper zones, or was it taken from the entire PC formation?

A. Well, the cores are typically only taken from the upper portion, which is the productive interval. A typical core is about 30 feet of the rock formation.

Q. So that this permeability data would represent the higher permeability zones of the PC?

A. That's right. Uh-huh.

MS. CLANCY: That's all for me.

EXAMINER STOGNER: Mr. Kent.

MR. KENT: No questions.

EXAMINER STOGNER: Mr. Buckingham.

MR. BUCKINGHAM: No questions.

EXAMINER STOGNER: Ms. Salazar.

MS. SALAZAR: No.

EXAMINER STOGNER: Does anybody else have any questions of Mr. Meek? If not, he may be excused at this time.

Mr. Kellahin.

MR. KELLAHIN: Do you need a break, Debbie?

THE REPORTER: No, thank you. I'm fine.

MR. KELLAHIN: I'd like to call at this time Mr. Ben L. Sargent. Mr. Sargent is a petroleum engineer.

BEN L. SARGENT

Having been duly sworn upon his oath, was examined and testified as follows:

EXAMINATION

BY MR. KELLAHIN:

Q. For the record, Mr. Sargent, please state your name and occupation.

A. My name is Ben Sargent, and I work for Conoco, Incorporated, in Oklahoma City.

Q. In what capacity are you employed, sir?

A. I work as a petroleum engineer over the San Juan Unit area.

Q. Summarize for us your educational background.

A. I graduated from Texas A & M University in 1980 with a bachelor of science degree in chemical engineering. And subsequent to that I was employed by Sun Oil Company/Works Energy for eleven years. And I've been working for Conoco, Incorporated, since that period of time.

Q. Describe in general the kinds of things that you did as a petroleum engineer in reviewing and analyzing the engineering details concerning the application of your company for a tight sand designation for this area.

A. Okay. I looked at the core analysis of the Pictured Cliffs area for these four cores that we've got presented in exhibits. Also, did a detailed engineering study on the pressure buildup work that we did on the 106 well located within the tight gas area.

Q. After that I looked at some after-frac post-treatment work that was done on three wells on the Colorado side, just north of our Tank Mountain Area?

MR. KELLAHIN: Okay. Mr. Examiner, we tender Mr. Sargent as an expert petroleum engineer.

EXAMINER STOGNER: Are there any objections or questions?

Mr. Sargent is so qualified.

Q. (BY MR. KELLAHIN) Mr. Sargent, let me jump right in to the next exhibit and have you direct your attention to Exhibit No. 6. Does this represent your work product?

A. Yes, sir, it does.

Q. First of all, tell us the well involved. Where is it? If you'll look at Exhibit 1-B, we'll keep 1-B out as a reference map to help us all stay oriented as to where you're focusing your attention. All right. First of all, tell us the well involved in the test.

A. Exhibit 6 represents a pre-treatment flow test of the San Juan Unit 32-9 No. 106 well. It's located in the southeast quarter of 17 of 31 North, 9 West.

In 1991 the well was perforated in an unbalanced condition from the upper portion of the Pictured Cliffs, 3398 to 4420, also 3434 to 3450.

After shooting the well in an unbalanced condition, the well was shut in for 27 days to allow the pressure to build up. The well was then flow-tested. And in a period of four hours, the well bled down to a rate of less than 1 Mcf a day at an initial rate of 130 Mcf a day, representing a pre-treatment flow test of less than the 91 Mcf a day. In actuality the rate came in at less than 1 Mcf a day.

Q. In looking at the pre-treatment flow test, are you satisfied as a reservoir engineer that that flow test was accurately and reliably conducted in the field?

A. Yes, sir, it was.

Q. Do you see any problems with the data gathered or the information compiled from that test?

A. No, sir. The data was gathered in a consistent manner over the four-hour period. Every five minutes flow pressures were taken, and then the flow test was conducted through an orifice meter.

Q. Is that flow test one that's relied upon by you and other engineers that practice your profession in making engineering calculations?

A. Yes, it is.

Q. For what purpose did you apply this test in making an analysis of the permeability in that well?

A. In a normal case, if you had a higher permeability reservoir in a pre-treatment test, you would see substantially higher flow rates on a pre-treatment test. And this well essentially bled down to zero, which indicates a very low permeability reservoir.

Q. When you look at page 2 that's attached to the Exhibit 6 summary, what have you shown on page 2?

A. Page 2 is a documentation of the gas flow rate over time and also the casing pressure over time as the well was produced in this four-hour period. As you can see, they both converged to zero.

The casing pressure bled down to zero, which indicates you're flowing against atmosphere, and the gas flow rate dropped essentially to less than 1 Mcf a day.

Q. Applying Mr. Meek's averaged maximum depth of the top of the Pictured Cliffs at 3500 feet, have you found any production information that shows that prior to stimulation the flow rate of gas on a daily basis for any gas well in the area of application would exceed 91 Mcf of gas a day?

A. No, sir, I've not found any wells that would indicate that they would do that.

Q. Can you give us an estimate based upon your search of what the average unstimulated flow rate is for a Pictured Cliffs well in the area?

A. Once again, and Reed referred to this earlier, the typical well completion is to perforate and go ahead and stimulate the well without doing any pre-treatment stimulation.

As you can see, just to obtain a four-hour test here, you had to shut the well in for 30 days, and that's expensive for producers to do. The permeability is such that you know you're going to have to fracture-stimulate the well.

And, typically speaking, producers don't go to the expense of obtaining pre-treatment tests that are going to show less than 5- or 1-Mcf-a-day flow rate.

Q. It's beyond dispute that the unstimulated well is simply not going to flow regardless of what the standard is that you apply to that formation?

A. That's right.

Q. Let's look at Exhibit 7. Would you identify for us on Exhibit 1-B the well that's involved in that test.

A. Exhibit 7 is once again discussing the pressure buildup and follow-up test on the San Juan Unit 106. And it is located in 17, 31 North, 9 West.

Q. What is the data that you are analyzing?

A. Okay. We were looking at the flow test after buildup trying to calculate a relative permeability of the reservoir. And our conclusions, based on the 1-Mcf-a-day rate, was that a permeability of .0035 millidarcies would give a rate of approximately 1 -- less than 1 Mcf a day.

A normal pressure fall-off test for a reservoir that's got higher permeabilities than this would generally produce at a longer period of time. However, due to the fact of the very low nature of permeability, we obtained rates essentially unmeasurable.

And, therefore, we applied an equation of the infinite-acting radial flow equation to this very tight reservoir to come up with the magnitude of permeability.

Q. Describe for us -- or have you presented the radial flow calculation on the display?

A. Yes, I have.

Q. Describe for us the methodology utilized to make the calculation and show us what the end result of that calculation is in determining the permeability value.

A. The methodology of the equation is to take the height of the reservoir that you've got perforated and then apply reservoir characteristics that are known for that rock and look at the delta pressure that you are flowing against, your initial shut-in pressure and your final flowing pressure, and then from that and then applying that to this equation with a known rate that we measured, we came up with a permeability of .035 millidarcies applying that equation.

Q. And that is the permeability shown on Exhibit 15 for this well?

A. The permeability showed on the Exhibit 15 for this well is actually the measured core permeability and not this calculated permeability from this equation.

Q. The measured core permeability for that well is what shown on this well?

A. It came in at .007 millidarcies.

Q. Okay. Let's turn to the core analysis then for this well, the 106 well, and that's summarized on Exhibit 8?

A. Yes, sir, it is.

Q. Describe for us what it shows.

A. Exhibit 8 is the core analysis on the San Juan 32-9 Unit 106 well and also the San Juan 32-9 Unit 108 well, which is located in Section 10 of 31 North, 9 West.

There were ten core measurements taken over these two wells and then the average permeability of these ten core measurements at in situ conditions came in at .007 millidarcies permeability.

Q. Where within the Pictured Cliffs were the core plugs taken?

A. Core plugs were taken over the perforated interval in the upper part of the Pictured Cliffs in the 106 well and the 108 well.

Q. Based upon your review of the core reports, were the cores taken from that portion of the Pictured Cliffs in that wellbore that was the most likely portion to be productive?

A. Yes, sir, they were. They were taken over a large area, top to bottom, over that Pictured Cliffs interval, which is generally the productive interval of the Pictured Cliffs.

Q. So you're looking in the log on the well for the best possible place to complete the well. You've perforated at those points. You take your cores from those points. And despite your best effort, the core analysis shows a permeability on an average in situ basis of .007?

A. That's correct.

Q. Anything else about the core report or the analysis?
A. No, sir.
Q. All right. Let's turn now to Exhibit 9. First of all, find us the well.
A. Exhibit 9 is another core analysis of the Ealum Gas Unit B No. 1, which is located in Section 33 of Township 32 North, 10 West, located on the western side of the Tank Mountain Unit area.
Q. In reviewing the core information, what did you specifically review?
A. I reviewed the average permeability over the 44 measurements that were taken of the core.
Q. Again, what portion of the Pictured Cliffs was the core data derived from?
A. It was derived from the upper portion of the Pictured Cliffs.
Q. And in that well that was the portion of the Pictured Cliffs that was most likely to contribute production?
A. That is correct.
Q. What does the core analysis show for the average in situ permeability of the Pictured

Cliffs in that well?

A. This particular well came in at .028 millidarcies perm over the average of the 44 permeabilities taken from the core.

Q. As a reservoir engineer, do you find any defects in the data or the report that you've analyzed for the core of this well?

A. No, sir, I do not.

Q. Turn now to Exhibit 10. Locate for us on Exhibit 1-B the well from which this core analysis was derived.

A. Exhibit 10 is a core analysis of the Vandewart B No. 3, which is in Section 11 of 29 North, 8 West, which is southeast of the Tank Mountain Area.

Q. Okay. Describe for us what the core analysis demonstrates.

A. Okay. This core analysis was taken over 72 measured permeabilities, and the average permeability for this came in at .014 millidarcies perm for the interval cored.

Q. When you gathered together all the data points from all the cores that you've analyzed in the area of application, how many data core points are you dealing with?

But the actual 30 foot gives you a much better idea of what the average permeability at that reservoir is going to be versus just a one-point observation.

Q. That wouldn't affect your judgment and is not significant data upon which to change your conclusion about the permeability within the area of concern?

A. No, sir.

Q. Let's go now to Exhibit 11. And would you identify that for me, please.

A. Exhibit 11 is a summary of the nine commercial wells that were drilled within the northern Tank Mountain Area.

Q. Again, take us back to Exhibit 1-B and orient us as to the location of the wells that are summarized on Exhibit 11.

A. Okay. The seven wells that I'm referring to are located in Sections 23 of 32-10, 33 of 32-10, 28 of 32-10, 39 of 32-10, 33 of 32-10, 27 of 32-10, and 34 of 32-10. They are located in the northwest portion of the Tank Mountain Area.

Q. Why is this information significant to you as an engineer when you're trying to reach a conclusion about the average in situ permeability in the area of application?

A. When you look at the completion techniques that were used on these seven wells, the wells were perforated over the correct portion of the Pictured Cliffs. They were given reasonable fracture stimulation treatments over the Pictured Cliffs formation. And yet in some -- four of the cases they were dry and abandoned, and in the other three cases they were shut-in with no production reported.

And since the Pictured Cliffs in this area is known to be gas-saturated and contains gas, the conclusion you must arrive at is the wells do not have sufficient permeability to flow at commercial rates.

Q. In making your investigation for supporting your conclusions about the permeability, did you explore the available data that exists in Colorado's side of the boundary to look at the Pictured Cliffs well in that area?

A. Yes, sir. In trying to firm up the possibility of core or permeability data to the north, the only data I had available was normal production data from the well on a monthly basis for the wells in Colorado to the north.

There's no known pressure buildup data on these wells, just post-fracture normal production reported to the state.

Q. What did you do with the available data for those wells from which to establish a method and a calculation by which you could reach a conclusion concerning the permeability for those wells?

A. Okay. Since the well is known to be -- or the Pictured Cliffs is predominantly a tight reservoir, you can make the assumptions that just after a post-fracture treatment and you know the initial reservoir conditions that the well was drilled in, because you know the original reservoir pressure and you know the average flowing pressure that the wells have been flowing against at line pressure, you can again apply the infinite-acting radial flow equation with some corrections for the fracture treatments that were applied to the well to estimate some of the reservoir characteristics that you must apply to the questions to give a magnitude of permeability that would be exhibited by these wells.

Q. That's the same infinite-acting radial flow equation subject to adjustment of the parameters that you applied in Exhibit 7 for the San Juan Unit Well 106?

A. That's correct.

Q. And you validated that calculation with the core permeability for the 106 well?

A. That's correct. The core permeability and the permeability calculated were within a magnitude of very low permeability.

Q. So having become comfortable that you can use this infinite-acting radial flow equation, you've taken that equation and applied it to the well information you had in Colorado for those three wells?

A. That's correct.

Q. Show us what the end result of the calculation is for each of those wells.

A. For each of those three wells, which is the Southern Ute 13-1, located northeast of 13; 32 North, 9 West of La Plata County, Colorado, the calculated permeability based on the first month's average production rate on the state report was .069 millidarcies perm.

Q. Okay. And then we turn to Exhibit 13 and pick up another of the Colorado wells?

A. Exhibit 13 is the Southern Ute 24-2, located in the northwest of 24 of 32-9, La Plata County, Colorado. And that permeability calculation resulted in a permeability of .083 millidarcies perm.

Q. Okay. Then Exhibit 14.

A. Exhibit 14 is the third well I looked at, which is in the southeast of Section 15 of 32 North, 9 West, La Plata County. And that magnitude of permeability came in at .051 millidarcies of permeability.

Q. You've attached to each of those last three exhibits the supporting documentation that supports the calculation and shows how you developed the analysis of that permeability?

A. Right. I attached a log analysis which I used for net height of the reservoir. I attached the scout ticket which I used for determining approximate frac link of the reservoir, or the fracture treatment, and then the equation I used to calculate the effective wellbore rate as used in the flow equation.

Q. So if Mr. Stogner or Mr. Kent want to reverify the calculation, there is enough reference material here that they can

double-check the calculation?
A. That is correct.
Q. Let's turn now to Blackwood & Nichols Blanco, northeast Blanco unit area that was the subject of the Commission's approval of a tight sand designation, which I think is shown on Exhibit 1-B as area NM-7.
A. That's correct.
Q. Within that particular area have you reviewed the transcript and the exhibits presented by Blackwood & Nichols in their application in that case in which they identified two pressure buildups for two of their unit wells?
A. That is correct. I did review the testimony given by Mr. Blackwood, or the representative of Blackwood & Nichols for the application.
Q. And you looked at the pressure buildup, Exhibit 19 and Exhibit 20 in that transcript, that applied to two of their unit wells?
A. That is correct.
Q. What is the end result of the data tests in applying the calculation in terms of determining a permeability in each of those wells

in that unit?

A. In each case so the equation applied or the permeability derived from the pressure buildup, the permeability came in at less than .01 millidarcies permeability in both those exhibits that he presented to the case.

Q. As you look in your area of application and looked to the east, have you established data points outside of your boundary that are consistent with the permeability derived for your area of application?

A. Blackwood & Nichols is a good indication to the east that's below .01 millidarcies perm. In our application our average of our four core-measured data points come in at .014 millidarcies perm, which is in the same magnitude as the Blackwood & Nichols reservoir.

Q. As we go to the north, then, you have validated for yourself the permeability range as you look at the Colorado wells north of your boundary?

A. That is correct. I looked at the magnitude of permeability with the known production data that I had to calculate permeability.

Q. On the western boundary of your application area, you've got the core analysis, plus the seven noncommercial dry holes that were in that immediate vicinity?

A. That's correct.

Q. As we move to the southwest corner in the south portion of the application area, address Ms. Clancy's question about the data available from which you can conclude that an area of better production should also meet the criteria of the .1 millidarcy or less threshold?

A. If you look at the core that we obtained to the southeast, which is approximately 12 miles away, that permeability came in at less than .1 millidarcies perm on the Vandewart B No. 3, .014 millidarcies, so it's to the south.

And also if you look at the cores that we obtained within our area there on the border of the known productive trend, and they're coming in in the magnitude of .01 millidarcies permeability, so they're within a reasonable distance of the southwestern portion of the area.

Q. When you look specifically at the southwestern corner of your application area down on Exhibit 1-B and you move southwest of your core in the 106 well, what's your opinion of the permeability down in the area where you have a greater number of Pictured Cliffs wells?

A. If you look at the cumulative production on these wells in this southwestern portion of the trend, their actual cumulative production is in the magnitude of 250 million, which is in some of the lower -- it's lower than the average Pictured Cliffs.

Once you get into the southwest corner, the average is coming in at 600 million for a typical Pictured Cliffs well, which indicates tighter than an average Pictured Cliffs well for permeability.

Q. Turn now to Exhibit No. 15 with me, Mr. Sargent. What have you summarized on Exhibit 15?

A. Exhibit 15 is a summary of all the measured and calculated reservoir permeabilities that were presented in this application, four of which are within the area that we're requesting and three of which are just outside the area. Actually, three are within the area, and then four are outside the area.

Q. Would you describe for me and identify the analysis or approach that you've taken as a basis for the proposed boundary of the tight formation designated area in your application.

A. For the area for the application, I looked at the 106 and the 108 wells within approximately the center of the application, and then we took the Ealum No. 1, which was on the northwestern border of the application, and that's approximately six to six-and-a-half miles. And then our area of application is an approximate even radius around the center reference points, and our outside reference point to close in the area that we're asking for reference.

In addition to that, we have the Blackwood & Nichols to the east that's beyond our area that closes in to the east. And we have the Colorado measured -- calculated permeabilities to close in our northern boundaries.

Q. Let's address Exhibit 16 and talk about the requirements to assure that there is no potential risk to known freshwater aquifers. What have you done to determine the deepest known depth of potable freshwater in the area of the application?

A. Okay. The general state and federal requirements require that casing be set below the Ojo Alamo, which is found at 1900 feet, and encased in cement above that point to adequately protect all freshwaters that are above 1900 feet. And Conoco believes that compliance with these existing state regulations will adequately protect any freshwater aquifers that are found in the area.

Q. Do you find in reviewing the information of existing wells that it is a common practice and procedure of your company and other companies operating in this area to set casing and cementing strengths in such a fashion that they have isolated out the aquifers from any exposure of contamination from production from the Pictured Cliffs formation?

A. Yes, sir.

Q. Are the methods utilized by you in demonstrating the average in situ permeability within the area of the application acceptable methods used by the oil and gas industry and engineers applying those disciplines to determining permeability?

A. Yes, sir, they are.

MR. KELLAHIN: That concludes my examination of Mr. Sargent, Mr. Examiner.

We move the introduction of Exhibits 6 through 16.

EXAMINER STOGNER: Are there any objections?

Exhibits 6 through 16 will be admitted into evidence at this time.

EXAMINATION

BY EXAMINER STOGNER:

Q. Mr. Sargent, on the Colorado wells, let me make sure I get this straight. Those wells were stimulated; correct?

A. Yes, sir, they were all fracture-stimulated.

Q. And then this data that you submitted on Exhibits 12, 13, and 14 were after the wells were stimulated to come up with a permeability measurement?

A. That's a post-stimulation rate that I used to apply the infinite-acting fluid equation to determine a magnitude of permeability.

Q. Can this equation be utilized for any of these wells out there?

A. The equation itself is an indication of permeability, kind of a range of whether or not the permeability is high or low. The equation itself should be backed up with actual pressure buildup and core analysis if it's available.

If you look at the equation and you apply it to the 106 well, we came within a magnitude of similar permeabilities there, below .1, .01 millidarcies.

Once again, this is just a magnitude of permeability to try to estimate the actual rate that you're paying from the post-fracture stimulated case.

Q. Oh, I bet you can probably guess my next question. How come this calculation wasn't done to any of the wells in the southwestern portion?

A. I didn't feel it was necessary to apply that equation in the southwestern part of the area that we're requesting because we've got good core analysis, actual measured permeabilities within a reasonable six-mile radius when you look at the Ealum No. 1 and the 106 and 108 wells.

Q. Now, is that core analysis, are you saying that that's going to be representative to that southwestern corner, those core analyses are?

A. Yes, sir, I think it would be representative of that area down there also.

Q. Then why are those producing down there and the No. 108 and 106 and the Ealum aren't?

A. In terms of -- well, the 106 and the 108 we haven't even post-fracture stimulated, so we haven't determined whether or not they're going to be commercial wells or not. So that is an unknown yet.

Q. It looks like to me you've got a real sweet area down there but no information on it. Then you come out here to the outer fringes and get some core analyses. Are there any cores -- I'm going to ask this to Mr. Meek too -- are there any core data representing the southwestern corner down there?

MR. MEEK: I have done extensive research to find any cores available in the entire area that I'm representing on that map 1-B, and I've represented every core that's available.

EXAMINER STOGNER: I guess we have to go back to this kind of analysis then.

MR. STOVALL: Let me ask another

question, if I might. You have made an analysis that you did the 106 and the 108, looked at those cores, found them to be tight. Went up to the Ealum; that's six miles away; that had to be tight. Said okay, the 106 and the 108 are kind of in the middle so I'll draw a circle around it.

Yet it appears to me that based upon Mr. Meek's testimony that the line from the 106, 108, up to the Ealum is a long trend. And that would indicate that there might be -- and I'm not a geologist, so I'm giving you your chance to refute it there -- but it would appear to me that that would be -- it would be consistent that they would be similar in their geologic makeup.

What basis do you have for other than saying I want to do it for going southwest and making the same conclusion, because you're going across this trend of the deposition now. So how do you -- Mr. Meek, do you want to step in on that one?

MR. MEEK: Yeah. I think the best estimate of permeability in the southwestern portion of our area is probably to make reference to the Vandewart B-3 well, the one that's furthest to the south.

MR. STOVALL: Let me stop you right there. If I draw the line, I'm going to stay right on that same line right down the trend, and you haven't answered my question yet.

MR. MEEK: Well, the reason that I would make reference to that particular well is that it is immediately adjacent to a Pictured Cliffs well that has produced over 1 Bcf of gas, which is relative -- which is comparable to the amount of production that you see in the southwestern portion of our area.

So I think that the Vandewart B-3 well has sampled the Pictured Cliffs in one of the higher productivity areas comparable to the high productivity area that you see in the southwest portion of our proposed area. And, therefore, I think that that well represents the magnitude of permeability that you're going to see in the more productive areas.

MR. STOVALL: But yet you didn't go across trend, as you've defined it, to make any supporting calculations of any sort such as you did up in the north; is that right?

MR. MEEK: Well, if I was to draw the

trend line directly from the Vandewart well, it would cut right -- if I followed the same trend that I'm seeing in the trends to the south, it would cut right through the heart of the area that's in question.

I wouldn't say that it's exactly on trend with the other cores that we've represented as actually in a trend slightly to the south of there so that actually, you know, represents the trend that cuts right through the core of the area that you're asking me about.

MR. STOVALL: In other words, the answer to your question is no, you haven't done any analysis down the southwest corner of the area to determine if that assumption can be supported by any sort of technical analysis? Have you done an analysis or not? Just I want an answer yes or no.

MR. MEEK: I've looked at the cumulative production data --

MR. STOVALL: Okay.

MR. MEEK: -- which is the same. You see the same type of production profiles as is represented from the wells that he's done calculations on up in Colorado. We have looked at the data. We haven't gone through the exercise of calculating the permeability with this infinite-acting radial flow equation.

But I have studied that area in terms of looking for any available core data, and there is none available in that area. There were never any cores taken, so there's no core analysis done that could be had by anybody.

Does that answer your question?

MR. STOVALL: I think so, yeah.

MS. CLANCY: If I can jump in here. Is there any reason if we were to go back or you were to go back and look at any of these wells and run a perm on this infinite-radial flow equation -- I mean, is there a problem with doing that and just eliminating this difference of opinion here on the adequacy of this data in proving this southwestern area?

MR. KELLAHIN: No. We'd be happy to do that. We just hadn't done it up to now and didn't recognize that you might have a different perception about the southwest quarter than we had, and we'll be happy to run through the calculation, and if you'll allow us to submit that type of analysis for wells in the southwest quarter.

But I'd like to come back and ask Mr. Meek some other questions after we finish the panel's questions. I'm not sure that I heard his statements exactly like Mr. Stovall's statements, so I want to take the time to make sure I've understood what he said to you.

MR. STOVALL: Sounds fair to me.

MR. KELLAHIN: Mr. Examiner, we would request permission to submit post-hearing today an additional similar calculation that was applied in Colorado to wells that Mr. Sargent and Mr. Meek would select in that southwest corner to answer the questions that have been posed by the panel.

EXAMINER STOGNER: And I'm probably going to request that you include a few wells also, but I will let you know which ones before the end of the day here.

MR. KELLAHIN: We need to see if we've got the data in which to make the calculation. Perhaps not all the same data is available for these wells, and we need to find out.

MR. STOVALL: One thing I need to say now, and I'll just mention it now just to preserve the dignity of it so it's of comparable, if you will, legal dignity of these -- to put a supporting affidavit so it becomes a sworn item if you're going to put it in the record.

MR. KELLAHIN: Certainly.

MR. STOVALL: Perhaps what we can do after you finish here, I think what we're going to recommend as the procedure is that we're going to break and we and the BLM staff will meet and see if there's any additional items and then go back on the record and make the specific -- you know, any specific requests we might have and accept any recommendations you would have for additional information.

EXAMINER STOGNER: I tell you what, I have no other questions of Mr. Sargent at this time.

Mr. Kent.

MR. KENT: Yes, I have a few.

EXAMINATION

BY MR. KENT:

Q. We'll start with the easy ones. I think it's basically lack of access to information on my part. But the well, the Ealum B No. 1, which is used in Exhibit 9, has that well been renamed? I could not find a record of a well by that name, and I could not find it on your computer printout that you left with us after the meeting.

Do you know if that well has been renamed?

A. To my knowledge it hasn't. Reed might --

MR. MEEK: I can answer that question. There is a discrepancy in some of the public records on that well. The scout ticket that's available from the petroleum information -- is the main source we get scout ticket data from -- calls that well the Com. -- Gas Com. No. 2.

MR. KENT: Okay.

MR. MEEK: It has the exact same legal location as the well where we have a well log. And the log header names the well the Ealum Gas Com. No. 1.

And when we contacted Amoco regarding the core to that well, they located the core in their warehouse. They hadn't done any core analysis on it. And subsequently sent that core out to be analyzed. And their reference on the core analysis sheet was to the Ealum No. 1. So that's the way we've referred to it in all of our documents here.

Q. (BY MR. KENT, DIRECTED TO THE WITNESS) Okay. Also in Exhibit 13, the Southern Ute 24-2 well, again my records show that as being a Mesaverde completion. Are my records just incomplete? Has it been completed in the Pictured Cliffs?

I'm wondering where the data in Exhibit 13 came from, since my records show only a Mesaverde completion on that well.

A. If you look at the scout ticket on the well, the well was supposedly tested, and I'm looking here. And I may have made a mistake here, but I don't think so. The perforations that we're showing for the Pictured Cliffs are from 3772 to 3820. And the Mesaverde is 5927 to 6254.

So the scout ticket is showing Pictured Cliffs completion and then Mesaverde completion. And then production data from the state, which I've attached in the last sheet, shows the production data from the Pictured Cliffs as reported by the state.

Q. My records were just incomplete on

that. On Exhibit 8, your core analysis exhibit, in the middle where the actual analysis is, there's samples, 1 through 8 and then 9 through 14, for the two different wells?

A. That's correct.

Q. When I looked at the back pages that actually had the analysis there, I noticed that a couple of them were missing. When I did my cut and paste, I came up with sample 4 on the 106 well was missing and samples 9 and 12 and 14 on the 108 well. Do you know what happened, why they're not included or weren't analyzed?

A. No, sir. I saw the same thing as far as they were missing. This data was obtained from Amoco via core lab, and I don't know why those are not included in the report.

MR. MEEK: If I might comment on that, it's not uncommon that when you submit a set of cores or a core to a core lab that for one reason or another, several of the cores are in such poor condition that they don't feel like they they can get a valid measurement on that particular sample.

I know in the case of the Ealum B No. 1, maybe you didn't notice, but there are several samples that were taken but there is no measurement reported with those. And that's because they were of such low permeability that in the time period that we had, which was a period of about a week-and-a-half, they weren't able to obtain complete measurements on those particular samples so they're not included in the core.

So I would guess that the reason that these particular samples aren't reported is one of those two reasons: that they didn't feel that the core was in good enough condition to actually get a valid measurement or that the measurements that they made because of the nature of the rock were invalid so they didn't report them.

But there has been -- certainly been no attempt to conceal any kind of data or anything, you know, in our documents.

Q. One more question. On Exhibit 7 on your calculation, on your calculation I notice that when you did this, you used a skin factor of zero on there.

Did you look at using any other values or an attempt -- I was wondering because of the difference in your calculated value and your measured core value since you happen to have a core on this well of, you know, it's about half -- your calculated value appears to be about half of what you measured. Did you do anything other than assuming zero damage there on the skin factor?

A. The well was completed in a fashion that would normally give you a zero value. The fact that it was perforated in an under-balanced condition generally removes most of your skin damage that you see from initial perforation. Therefore, that skin was assumed to be zero.

Once again, I want to refer to the fact that this equation just kind of gives you a magnitude of permeability. And its actual number is based on several assumptions that you're making here, such as, the flow rate of less than 1 Mcf a day; the time factor, you've got your flow test of four hours when you compute your time in there.

The actual measured core data is going to be -- is much better and that's why we referred to that in our actual application in terms of the result that we're reporting.

Q. So you feel fairly comfortable with the completion technique that was used will give you close to a --

A. Close to a zero skin.

MR. KENT: Okay. That's it. No more questions for me.

EXAMINER STOGNER: Any more questions for Mr. Sargent? Mr. Kellahin, any redirect?

MR. KELLAHIN: No, sir.

EXAMINER STOGNER: Anybody else have any further questions of this witness?

MR. STOVALL: Put Mr. Meek back on I believe; is that correct?

MR. KELLAHIN: Let's take a short break, if I might.

EXAMINER STOGNER: We'll take about a five-minute recess at this time.

(A recess was taken.)

EXAMINER STOGNER: Mr. Stovall, I believe you have a statement at this time.

MR. STOVALL: During the break, we had some discussions with the BLM and with counsel for the applicant. Let me first state to the witnesses for the applicant, Mr. Meek and Mr. Sargent, that I have been advised during the break that the -- I understand that the BLM in your previous discussions expressed some real concerns about the undeveloped area which focused your intention in that area as far as developing information.

And given that information, I'm a little less critical of you perhaps for not having developed the information to the southwest where we have now all of a sudden expressed concern to you.

Having said that as sort of a form of apology to you for getting a little hard on you, let me say that what we have discussed is that in fact that is a problem, there is not a scientific basis that satisfies either the BLM or OCD with respect to the conclusions; that what you find along the trend line is applicable to what we'll call the heart of production, or the sweet spot of the proposed area.

What we have discussed and what Mr. Kellahin has agreed to, I think in principle although we need to define the details, is that we need some data, some analysis that says that that presumption is supported by the best information available, allow that information to be -- tests or analysis to be done post-hearing and submitted, as I say, and supported by an affidavit to give it the appropriate dignity with the testimony that's on the record.

I think what the Examiner and the BLM have agreed is that representative wells from each of the production contour areas be analyzed. We'll let the applicant select the well within those contour areas.

What we recommend is that you identify the wells on which you can do the analysis to say yes, this works, no, these are the better wells to do what -- we've got the right information, they meet the criteria for analysis purposes -- recommend you submit those to both agencies for this preliminary approval so you don't test wells that they would later come back and say those aren't the right wells, go test a different one, so you do all the work on things that we're going to accept as being meaningful and representative, and then do the analysis and submit the results and conclusions.

As I say, pick the areas within the production contours. If you don't mind, Mr. Kellahin, I'll ask your witnesses since they're the ones who are actually going to do the work, do you understand what we mean by that and what we're looking for in that area?

MR. SARGENT: Yes, I do.

MR. MEEK: Yes.

MR. STOVALL: Okay. Good.

Mr. Kellahin, do you want to go into the question of leaving it open to adjust the application if you find it's not possible to submit data in a timely manner? Is that something you want to just --

MR. KELLAHIN: I think we'll leave that for further discussion. In the event we are unable to provide the data in the fashion that satisfies your concerns about the permeability, then we want to preserve the right to amend the application to delete acreage that may not satisfy the criteria at this time simply because we don't have enough information. But we leave that to later discussions.

MR. STOVALL: My recommendation to the Examiner will be that this record be left open for a period of -- how long do we need initially would you say?

MR. KELLAHIN: Let's say not more than 15 days.

MR. STOVALL: To identify the wells? What about getting the data in? It's actually going to be part of the record getting the data in as well.

MR. KELLAHIN: It may take us longer to do that, but let's talk about not less than 15 days.

MR. STOVALL: I was thinking more in terms of 30; is that acceptable?

MR. MEEK: Thirty days.

MR. KELLAHIN: Thirty days.

MR. STOVALL: Or the next hearing within approximately the 30-day time frame --

MR. KELLAHIN: Yes, sir.

MR. STOVALL: -- which, I believe, would be January 25th approximately.

EXAMINER STOGNER: 23rd, I believe.

MR. STOVALL: Okay. That's my recommendation, Mr. Examiner.

Mr. Buckingham, do you concur in what we've --

MR. BUCKINGHAM: I concur.

MR. STOVALL: I want to recognize that this is a different sort of beast, and we're not going to adhere to a formal procedure, and this more fluid process would be better to accomplish the result for everybody. That's important.

EXAMINER STOGNER: In this particular area, I have one more comment. There is a thumb that sticks up just to the north and east of the word "trend" at points. I would like a representative well in there. That appears to be one of the more sweet spots.

I believe you can identify that, Mr. Kellahin.

MR. KELLAHIN: Yes, sir.

EXAMINER STOGNER: I would like that area included. That's the only particulars I would have.

MR. KELLAHIN: We'll analyze the areas of contour and submit the preliminary list of wells to do the calculations on and obtain your approval to go forward then.

MR. STOVALL: I think we'll give our commitment to you to respond quickly when we get that list.

Allen, can you do the same? When they tell you which wells they'd like to look at, you can look at it fairly quickly and say those are okay, do it, or we're missing some wells?

MR. BUCKINGHAM: Yes, I think we'd be able to do that.

EXAMINER STOGNER: Mr. Kellahin, one further thing. I believe you were going to submit me a breakdown of the number of acres in the federal, state, and private sector in this area.

MR. KELLAHIN: Yes, Mr. Examiner. In order to expedite the process today, we would like to waive calling Mr. Kline, the landman, and submit his verification of the acreage quantities within the area of application by affidavit.

EXAMINER STOGNER: That would be fine.

MR. KELLAHIN: That concludes our presentation today, Mr. Examiner.

EXAMINER STOGNER: Does anybody else have anything further in this case at this time?

If not, then that concludes what we're going to do on this particular case today. And the record will be left open pending the additional information. Thank you.

MR. KELLAHIN: Thank you very much.

EXAMINER STOGNER: Let's take a ten-minute recess before our next case, ENRON.

(The proceedings were concluded.)

CERTIFICATE OF REPORTER

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

I, Debbie Vestal, Certified Shorthand Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Division was reported by me; that I caused my notes to be transcribed under my personal supervision; 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 DECEMBER 21, 1991.

Debbie Vestal

DEBBIE VESTAL, RPR
NEW MEXICO CSR NO. 3

APPLICATION OF
CONOCO INC.
FOR DESIGNATION OF THE
TANK MOUNTAIN AREA OF THE
PICTURED CLIFFS SANDSTONE
AS A TIGHT FORMATION

SAN JUAN AND RIO ARRIBA COUNTIES
NEW MEXICO

BEFORE EXAMINER STOGNER
OIL CONSERVATION DIVISION
Conoco EXHIBIT NO. ____
CASE NO. 10425

NMOCD Case No. 10425 December 20, 1991

TANK MOUNTAIN TIGHT GAS AREA

LIST OF EXHIBITS

Exhibit Number	Exhibit Name	Exhibit Purpose
1A	Pictured Cliffs Field Map	Show the location of the Tank Mountain tight gas area relative to area of established Pictured Cliffs production.
1B	Tank Mountain area Detail Map	Show the location, cumulative production, and permeability data from wells in and around the Tank Mountain Area.
2	Tank Mountain Tight Gas Area Wells	List Pictured Cliffs gas wells and cumulative production data in the Tank Mountain Area.
3	Type Log Amoco Prod. Co. San Juan 32-9 Unit #102 NW 17 T31N R9W	Show log character of the Pictured Cliffs Formation in the Tank Mountan Area.
4-A	North-South Cross Section	Show the continuity of the Pictured Cliffs Sandstone from north to south across the Tank Mountain area.
4-B	West-East Cross Section	Show the continuity of the Pictured Cliffs Sandstone from west to east across the Tank Mountain area.
5	Map of Pictured Cliffs gas production and permeability trends	Show that published studies regard the Pictured Cliffs to be a low permeability formation in the Tank Mountain Area.

6	Pre-treatment test of San Juan 32-9 Unit #106	Show that the Pictured Cliffs production rate before stimulation does not exceed 105 MCFD.
7	Plot of pressure buildup on San Juan 32-9 #106	Show that the average in situ permeability through the Pictured Cliffs pay section is expected to be 0.1 millidarcy or less.
8	Core analysis from the San Juan 32-9 Unit #106 & #108	Show that the average in situ permeability through the Pictured Cliffs pay section is expected to be less than 0.1 millidarcy in the center of the Tank Mountain area.
9	Core analysis from the Ealum Gas Com B #1	Show that the average in situ permeability through the Pictured Cliffs pay section is expected to be less than 0.1 millidarcy on the west side of the Tank Mountain Area
10	Core analysis from the Vandewart B #3	Show that the average in situ permeability through the Pictured Cliffs pay section is less than 0.1 millidarcy on trend to the southeast of the Tank Mountain area.
11	Scout tickets from non-commercial wells in the northern part of the Area	Show that the Pictured Cliffs did not produce at commercial rates in the undeveloped portion of the Tank Mountain area, due to low permeability.
12	Post stimulation permeability calculations on the S. Ute 13-1	Show that the permeability is less than 0.1 millidarcy immediately north of the Tank Mountain area implying that permeability is low across the entire area.
13	Post stimulation permeability calculations on the S. Ute 24-2	Show that the permeability is less than 0.1 millidarcy immediately north of the Tank Mountain area implying that permeability is low across the entire area.
14	Post stimulation permeability calculations on the S. Ute 15-4	Show that the permeability is less than 0.1 millidarcy immediately north of the Tank Mountain area implying that permeability is low across the entire area.
15	Summary sheet of all permeability measurements and calculations	Summarize all permeability data presented in this application.
16	Fresh Water Remarks	Show that Conoco believes that development drilling for the Pictured Cliffs in the Tank Mountain area will not adversely affect fresh water aquifers.

PICTURED CLIFFS SANDSTONE
GEOGRAPHICAL AND GEOLOGICAL DESCRIPTION OF THE FORMATION

Geographic Description

The Tank Mountain area is located in San Juan County, New Mexico adjacent to the Colorado boarder. The area includes the following sections: T30N R9W sections 1-6; T30N R10W sections 1-6; T31N R9W all sections; T31N R10W sections 1-4, 9-16, 21-28, 33-36; T32N R9W all sections; and T32N R10W sections 9-16, 21-28, 33-36. Tank Mountain is the name of a prominent topographic feature located near the center of the area. The area includes the San Juan 32-9 Unit which is a Federal Unit operated by Meridian Oil Inc.

Geologic Description

Location

The Tank Mountain Area is located in the north central San Juan Basin, a major gas and oil producing region which covers over 6000 square miles in Northwest New Mexico and Southwest Colorado. Hydrocarbon production in San Juan Basin is primarily from four Cretaceous age formations including the Dakota, Mesaverde and Pictured Cliffs Sandstones, and coal seams in the Fruitland Formation. The Tank Mountain area includes several hundred wells which produce gas primarily from either the Mesaverde, Fruitland, or Pictured Cliffs horizons.

Stratigraphic and Structural Description

In the Tank Mountain Area the top of the Pictured Cliffs Sandstone is found at an average measured depth (depending on topography) of 3,500 feet (3,160 feet above sea level). The average thickness is 150 feet. Structural dip is negligible at less than 25 feet per mile. The geologic age of the Pictured Cliffs is Campanian (Upper Cretaceous). It is the youngest in a series of Upper Cretaceous marine sandstone deposits found in the San Juan Basin. The Pictured Cliffs was deposited in marginal marine (shoreface) environments and can be described as a coarsening upward sequence. A gradual transition from the underlying Lewis Shale begins with 30-60 feet of thin beds of very fine sandstone interbedded with gray marine shale. The beds gradually become thicker and coarser grained and the upper part of the Pictured Cliffs is characterized by 40-100 feet of medium to thick bedded, fine grained sandstones interbedded with siltstones and shales. Common sedimentary structures found in the thick sandstone beds in the upper part include cross-bedding and burrows characteristic of the marine environment.

The Pictured Cliffs is overlain by the Fruitland Formation which is composed of coal seams, silty shales and sandstones of terrestrial origin. The top of the Pictured Cliffs is generally defined as the base of the first coal seam or shale in the Fruitland Formation. The contact between the Pictured Cliffs and Fruitland however is somewhat transitional. Thin coal seams occasionally appear below the thick bedded marine sandstones and marine sandstones occasionally interfinger above the thick coal seams of the basal Fruitland.

Texture and Composition

The texture or grain size of the Pictured Cliffs Sandstone is best described as fine to very fine grained. The average composition of framework grain types is 50% rock fragments, 40% quartz, and 10% feldspar. The sand composition is classified as a litharenite or feldspathic litharenite. The sandstone also contains significant amounts of diagenetic minerals which have formed in the intergranular pore spaces. The formation of these minerals following the deposition of the sandstone has contributed greatly to the low permeability nature of the rock. These minerals include clays such as illite-smectite, dolomite, siderite, calcite, quartz overgrowths, and minor amounts of kaolinite. The existing porosity in the Pictured Cliffs is largely the result of dissolution of unstable framework grains. Most of the original porosity present at the time of deposition has been destroyed by compaction and the formation of diagenetic minerals in the intergranular spaces.

Gas Production and Reservoir Characterization

The Tank Mountain Area includes 133 wells which produce from the Pictured Cliffs, all of these are located in the southwestern third of the area. The northern portion of the area does not currently produce from the Pictured Cliffs but completions have been attempted on only a limited number of wells. The Pictured Cliffs throughout the area is considered a low permeability reservoir and all wells require fracture stimulation to achieve commercial rates of production.

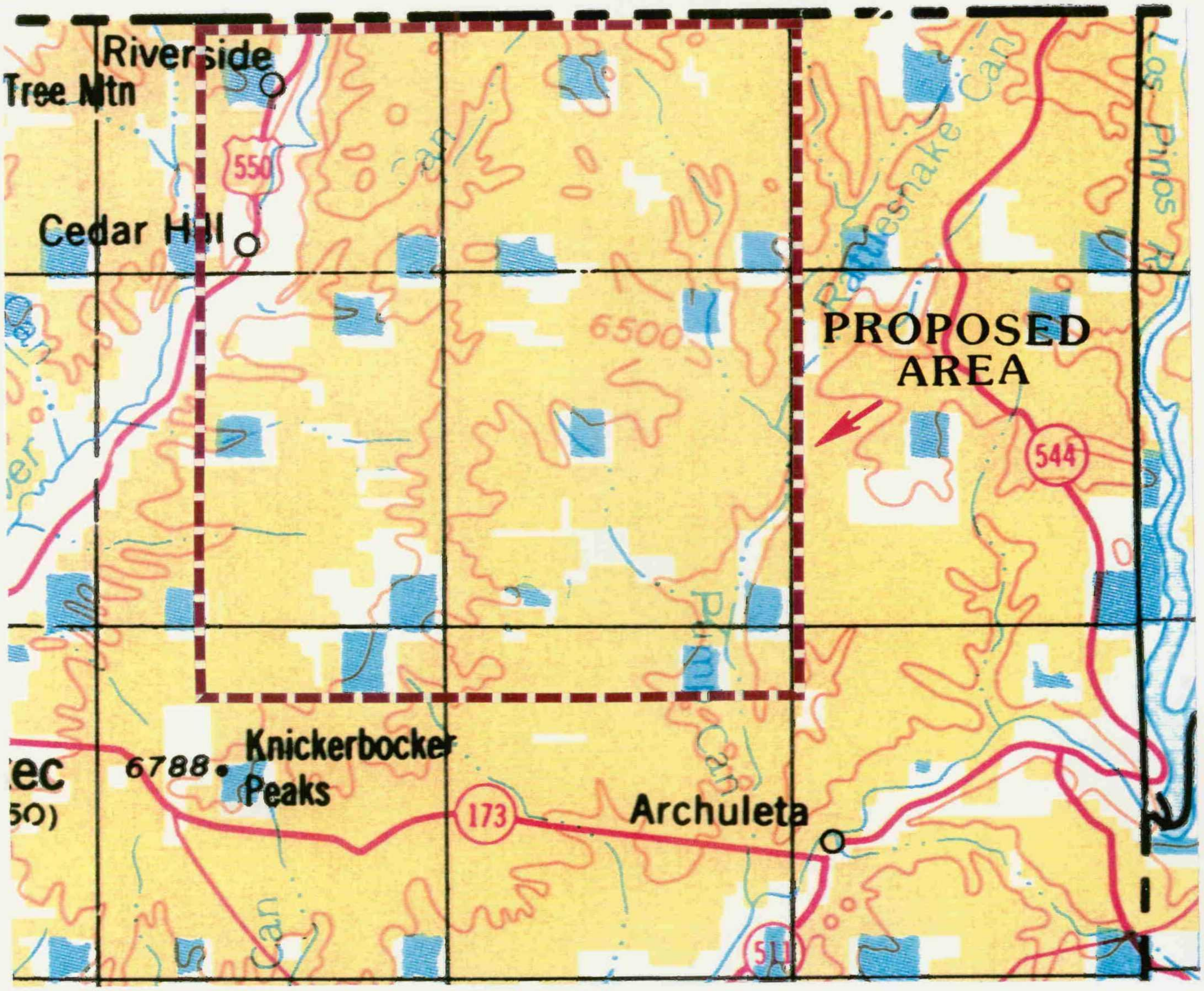
There is a strong northwest oriented trend to the Pictured Cliffs Production. This trend is illustrated in Exhibit 1B by contouring the cumulative production from existing Pictured Cliffs wells. There are several "benches" of higher productivity separated by areas of lower productivity. The northwest orientation to these trends was created at the time of deposition when the shore line of the Cretaceous Seaway crossed this area in a northwest direction. Each bench represents a sea level stillstand as the sea regressed out of the area in a stepwise fashion. The best quality reservoir rock was deposited in the shallow water near the shoreline. The production in the southwestern portion of the proposed tight gas area is from one of the higher productive trends. The undeveloped area to the northeast of this trend is expected to be a lower productivity area. Several non-commercial wells have been drilled north of the current producing area and are indicated by the dry hole symbols on Exhibit 1B

The most common type of data available in the Tank Mountain Area for studying the Pictured Cliffs is from induction resistivity, electric, gamma-ray, spontaneous potential and density well logs which are run on most wells. The productive zone in the Pictured Cliffs is typically found in the upper 150 feet and may range from 0 to 70 feet in net thickness. It is typically identified on logs by density porosity greater than 8% and resistivity greater than 20 ohm meters. Average porosity of this productive zone is 12-14%. Saturation calculations indicate gas to be present in the formation along with average water saturations of 50%. The typical Pictured Cliffs well produces dry methane gas with little or no well head condensate and no water. No Pictured Cliffs well in the area is known to produce volumes of oil or condensate greater than one barrel per day.

Permeability Measurements and Engineering Calculations

Permeability in the Pictured Cliffs is considered to be tight (less than 0.1 millidarcy). Permeability measurements however are available on a limited number of wells due to the high cost of obtaining cores and the knowledge that all wells will require stimulation to produce. The low permeability nature of the Pictured Cliffs in the Tank Mountain Area is established with core data from four (4) wells, a pre-stimulation pressure buildup and flow test on one well, and a non-commercial well all located within or on trend with the area. Permeability calculations were made on the three closest Pictured Cliffs wells north of the area in La Plata County, Colorado to demonstrate that the permeability is less than 0.1 millidarcies. The average permeability calculation for these wells is 0.068 millidarcies. The location of the data is presented on Exhibit 1B and the data are presented in Exhibits 12-14. All available core data within the area is presented. This core data includes 126 measurements on cores from four wells. The average measured permeability is 0.016 millidarcies for the 126 core measurements.

Calculations of reservoir permeability were made on three wells between one and three miles north of the Tank Mountain Area. To estimate a reservoir permeability from a new well where several reservoir characteristics are known the normal Darcy equation is not applicable. The well has not reached pseudosteady state and is still producing in a transient condition. During the transient period, the transient equation is recommended to predict the inflow performance for a well. The pressure behavior of a reservoir during the transient period is essentially the same as that of an infinite acting reservoir. The transient equation used is the infinite acting radial flow equation that is presented in Exhibits 12 through 14.



PROPOSED PICTURED CLIFFS FM TIGHT SANDS AREA

(FROM U.S.G.S. BASE MAP PREPARED FOR B.L.M., SANTA FE, NEW MEXICO, ENTITLED - STATE OF NEW MEXICO LAND STATUS MAP 1990)

LEGEND

- PUBLIC LANDS
- STATE LANDS
- PRIVATE LANDS

BEFORE EXAMINER STOGNER
OIL CONSERVATION DIVISION
Conoco EXHIBIT NO. ____
CASE NO. 10425