CASE 11122

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J. Espinoza	Bennie Garcia	Harding Co.
Johnny A. Garcia	Self	Clayton, NM
Tobias Sanchez, Jr.	Self	Clayton, NM
Fannie Lee Bray Pittard	Leo Bray Estate	Union Co.
Louis Miera	Self	Harding Co.
Benjamin M. Ulibarri	Self	Harding Co.
Teresina Sanchez	Self	Union Co.
Elmer Sanchez	Self	Union Co.
Loretta Boardman	Nellie C. Johnston Carl Cooper Family Clark Cooper Family	Union Co.
Beatrice V. Lopez	Louisa Vigil	Union/Harding Counties

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Name	Representing	Location
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~~Johnny A. Garcia~~	GD Cattle Co. ~~Myself~~	Logan, NM
John A. Garcia	Myself	Union Clayton N.M.
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Louis F. Mirabal	Myself	Harding County
Benigna M. Ulibarri	Myself	Harding County
Eugenio Sandoval	Myself	Union County
Elmer Sanchez Jr.	Myself	Union Co. NM
Loretta Boardman	Nellie C Johnston	
	Carl Cooper family	
	Clark Cooper family in	
Beatrice V López	Louisa G. Vigil	W. Harding Co.

STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION COMMISSION

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

CASE NO. 11,122

HEARING CALLED TO CONSIDER THE RECOMMENDATIONS OF THE BRAVO DOME CARBON DIOXIDE GAS UNIT WORKING INTEREST OWNERS TO CONTRACT THE BRAVO DOME CARBON DIOXIDE GAS UNIT AREA

REPORTER'S TRANSCRIPT OF PROCEEDINGS

COMMISSION HEARING

BEFORE: WILLIAM J. LEMAY, CHAIRMAN
WILLIAM WEISS, COMMISSIONER
JAMI BAILEY, COMMISSIONER

October 20th, 1994

Santa Fe, New Mexico

This matter came on for hearing before the Oil Conservation Commission on Thursday, October 20th, 1994, at Morgan Hall, State Land Office Building, 310 Old Santa Fe Trail, Santa Fe, New Mexico, before Steven T. Brenner, Certified Court Reporter No. 7 for the State of New Mexico.

* * *

I N D E X

October 20th, 1994
Commission Hearing
CASE NO. 11,122

(Continued...)

I N D E X (Continued)

* * *

E X H I B I T S

(Continued...)

Q. And what is your current position with Amoco?

A. I'm a geological associate with Amoco.

Q. Will you tell the Commission what a geological associate does?

A. Yes, a geological associate is a senior position in Amoco. I'm available to work in any part of Amoco. I've consulted throughout the United States, the eastern United States, on geological exploration, and also particularly in the Permian Basin on production.

I've worked here for 22 years with Amoco.

Q. What's your educational background?

A. I have a bachelor's in geology from Texas Christian University; I got that in 1970. And I have a master's in geology from the University of Texas at El Paso that I got in 1972.

Q. You indicated that since graduation you have worked at all times for Amoco Production Company?

A. Yes, I have.

Q. And has all of your work over the last 22 years been in various geological positions?

A. I have worked in geological positions, yes.

Q. Could you tell the Commission what was your first involvement in the Bravo Dome unit?

A. I'd been hired in 1972, in September, to work with Amoco, and I started working Bravo Dome in 1973.

evidence, you will see that to meet our duties and to meet the duties of all the working interest owners under this unit contract, contraction must occur. And with the data we have, it must occur now.

And the evidence will also show that what we are proposing is consistent with what your statutory duty is, for it will assure that we continue to operate this unit so as to prevent waste, protect correlative rights, and otherwise conduct that project in the best interests of conservation.

We're ready to call Mr. Wacker.

CHAIRMAN LEMAY: Thank you, Mr. Carr. You may proceed.

MR. CARR: At this time we call Herb Wacker.

HERBERT J. WACKER,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Will you state your name for the record, please?

A. My name is Herbert J. Wacker.

Q. And where do you reside?

A. Houston, Texas.

Q. By whom are you employed?

A. Amoco Production Company.

geologic portion of the effort to define the zero net pay isopach line.

Next we will call Terrence Cosban. Mr. Cosban is a geophysicist. He will explain how seismic data on this reservoir was integrated into the determination of the productive limits of the Tubb formation. He will particularly focus on the determination of the structural top of the Tubb interval and also on how the gas-water contact in the reservoir was picked.

Following that, Jim Collier, a petroleum engineer, will testify about the engineering and petrophysical aspects of the study. He will show you how we determined what the appropriate porosity cutoff was in the reservoir. He will talk about how we determined the appropriate water saturation limits and how these were utilized to define the limits of the reservoir and, in particular, pick the actual gas-water contact in the unit area.

Finally, James W. Allison will be called. He is a landman. He will review the unit boundary as it stands today. He will show what it will look like following contraction and give you generally a picture of what the unit boundary looks like today and what it will be once contraction is accomplished.

At the conclusion of the presentation of operate the unit so as to protect correlative rights and to prevent waste.

This order also provided that all contractions, and I quote, all contractions of the unit area shall be submitted to the Commission for approval. You told us then when we contracted the unit, we would come here and seek your approval, and that's why we're here today. We're here to show you what evidence has been obtained on the productive Tubb interval in the unit area.

We will review with you the new technology which is available to us now to analyze that data, and we will show you that using this data and this technology we have accurately determined in accordance with industry standards the limits of the productive interval in the Tubb formation. We will show that we have used all data available on the unit and that we have applied state-of-the art technology to complete our work.

We will call four witnesses.

We will call Herb Wacker. Mr. Wacker is a geologist. He will explain to you the processes used to define the productive limits of this reservoir. He will summarize for you the data that has been accumulated on the reservoir, he will review the technology we have used, he will explain the general geologic environment of this reservoir and then in detail will explain to you the

What we are doing is determining what is productive, so that those who have CO_2 under their tract will receive the royalty that is coming from the unit area.

The unit agreement then goes on and explains exactly how the tract participations will be determined, and it is on one very simple factor: productive acres. Royalty will be based on the number of productive acres under any tract compared as a percent of the total productive acres in the unit area.

Now, I explained that and went into that for one reason, and that is to show you that the determination of the zero net pay isopach line absolutely governs under this contract how contraction will occur, what the new unit boundary will be and how the new tract participations will be determined, and that is the reason we believe that this hearing has been limited by the call of the case to evidence concerning the productive limits of the Tubb formation in the unit area.

Now, why are we here? Well, in 1981 when the Commission approved the unit, it assumed for itself a role, a continuing role, as the unit area was actually developed.

Order R-6446 provides for four-year reviews of unit operation, and we have come back periodically, three occasions, to review our operations. And on three occasions this Commission has found we are continuing to and propose the contraction and redetermination of tract participation in the Bravo Dome unit.

This contract also provides exactly how the mechanics of this process will work, and it provides that as to contraction and the redetermination of tract participation, that these shall be determined, and I quote, by establishing a zero net pay isopachous line, based on the extrapolated net pay intervals in all wells in the unit area, in accordance with industry-wide acceptable practices for interpreting underground geologic features on maps.

That's the phrase in the contract which brings us here today.

So what that says is simply this: The working-interest owners are required to determine what the productive limits of the Tubb formation are in the Bravo Dome unit area, and this must be done in a fashion consistent with industry standards.

What this means is that tracts -- and the agreement also provides this expressly -- that once that line is determined, tracts having no productive acres are eliminated from the unit area. And once that occurs, the owners of those tracts no longer receive royalty.

It's not that the working interest owners are here to -- attempting to receive from you an authorization that will let them pay less.

the Oil Conservation Division and that you also approve it, determining that the unit plan would prevent waste and would protect correlative rights.

There were two hearings in 1990 before this Commission, and twice the Commission approved the unit agreement, finding it did prevent waste and it would protect correlative rights.

Having received approval from the Commissioner of Public Lands, the Oil Conservation Commission and also the Bureau of Land Management, this unit agreement became effective November 1st, 1980.

It is a voluntary unit agreement -- no one has been forced in -- and it is the contract which governs and controls the operation of the Bravo Dome unit.

Contraction of the unit and the related tract participation redetermination are addressed by this agreement, and the unit agreement specifies exactly how contraction and tract redetermination must occur.

In Section 5 of the unit agreement, it provides that within 15 years of first sales of unitized substances, the working interest owners shall redetermine the tract participation of each tract in the unit area. It must occur within 15 years of first sales.

Those occurred in April of 1984. And using that time frame, we would have until April of 1999 to come back

MR. CARR: May it please the Commission, I have a brief opening statement.

Amoco Production Company, on behalf of itself and the other working interest owners in the Bravo Dome unit, are here today seeking your approval of contraction of the unit.

As you're aware, in the late 1970s, Amoco and other working interest owners in northeastern New Mexico proposed the development of a large source of carbon dioxide gas in an area just north of Clayton. They proposed to develop this resource under a unit plan, and this unit was to be, and is, one of the largest, if not the largest, gas units in the United States.

The unit area is distant from the fields in southeast New Mexico and west Texas where carbon dioxide is used in enhanced oil recovery projects.

The unit agreement was developed by the working interest owners.

In obtaining approval of the agreement, they brought it to the Commissioner of Public Lands. There were negotiations. The unit agreement was amended to accommodate the concerns of the Commissioner, and he gave his approval to the unit agreement.

The agreement itself also required as a condition precedent to it becoming effective that it be brought to

What we're looking at is the scientific validity of that zero pay line as presented and defended by Amoco, and we'll take -- That's the issue we're here to decide.

I also might state, as the hearing goes on, those of you that will want to make statements will be allowed that opportunity after Amoco makes their presentation.

We will have a period of time when we'll accept statements for the record. Any of you that would like to make a statement for the record, you can stand, identify yourself and make the statement, and the court reporter will take that statement in.

You can write a letter. We'll leave the case -- the files open for ten days following the hearing to receive written comments from all of you if you wish to make written comments. Those will all be part of the record.

Statements and written comments are not subject to cross-examination; they are part of the record and taken at that value. Just so you can kind of understand our process, and when questions come up concerning that process during the hearing I'll try and explain it further, what we're here to do and what we're here not to do.

So with that, we'll begin with the Amoco presentation.

Mr. Carr?

So I need to keep emphasizing that because I'm a geologist, Commissioner Weiss is an engineer, Commissioner Bailey is a geologist.

We are not lawyers, we're not practicing the legal profession; we're rendering a professional judgment based on scientific fact in that narrow area.

So with that, I think we'll call about a ten-minute recess to allow those of you that would like to be a party of record in this hearing to sign up in the back of the room.

We'll be in recess for ten minutes.

(Thereupon, a recess was taken at 9:10 a.m.)

(The following proceedings had at 9:21 a.m.)

CHAIRMAN LEMAY: That list will be back there during the entire hearing, so feel free to go back there and sign to be a party of record anytime you wish.

I'd like just to reiterate again, for those of you that might have just arrived or come in a little late, what we're considering here, this Commission -- which is a scientific commission, I'm a geologist, Commissioner Weiss is an engineer, Commissioner Bailey is a geologist -- we're not looking at equity interest, we're not looking at whether your lease should or should not be paid royalties or should be paid higher or lower or lease terms. That's beyond our jurisdiction.

that I know a lot of you are very much interested in. We're a scientific commission; we are not a court of law in terms of dealing with equity interests.

So there is a procedure the Oil Conservation Division and Commission have. It's an administrative law body whereby cases are presented before the Examiner, which are part of the Division, which can be appealed to the Commission, the three of us; we're the Oil Conservation Commission.

We issue an order, that order generally goes directly to the district courts. It can be heard by the Secretary of Energy under very unusual circumstances if it involves the general welfare of the State. But generally our decisions, when they're appealed, would go to the court.

I have to emphasize again, we are only receiving testimony and only issuing a decision based on the scientific merits of that zero-pay line that was advertised in the Application.

We are not receiving testimony or not hearing evidence on whether the leases should or should not be paid royalties, whether it's fair or unfair to have lease terms that some of you might have engaged in, whether there is -- it's right or wrong, what Amoco is doing in terms of equity interests.

to please stand.

Mr. Carr?

MR. CARR: May it please the Examiner, my name is William F. Carr with the Santa Fe law firm Campbell, Carr, Berge and Sheridan.

I'm appearing here today in association with A. Andrew Gallo, attorney from Houston, Texas.

We represent Amoco Production Company, and we will call four witnesses.

CHAIRMAN LEMAY: Are there any other people in the audience that will be presenting direct testimony in this case before the Commission?

Okay, will those witnesses that will be giving testimony please stand and raise your right hand?

(Thereupon, the witnesses were sworn.)

CHAIRMAN LEMAY: Okay. Now, before we begin, we'll take about a five- to ten-minute recess.

And there are some tablets in the back of the room. Those of you that wish to be a party of record in the case, which will mean that you will have rights to appeal any decision by the Commission, that you will be involved -- that doesn't --

I might state that we are only going to be looking at the scientific evidence; we're not looking at equity interests, we're not looking at those legal issues

WHEREUPON, the following proceedings were had at 9:05 a.m.:

CHAIRMAN LEMAY: We shall now call Case 11,122.

MR. CARROLL: In the matter of the hearing called to consider the recommendation of the Bravo Dome Carbon Dioxide Gas Unit Working Interest owners to contract the Bravo Dome Carbon Dioxide Gas Unit area.

CHAIRMAN LEMAY: Normally, it's our procedure to call for appearances in this case.

Recognizing the interest that we have, rather than relate the appearances up here, what I plan to do is call for those appearances which will be presenting direct testimony.

I'll list those, we'll swear in the witnesses, and then take a five- to ten-minute recess for all those of you in the audience that wish to be a party of record to the case, and you can do so by signing up in the back of the room at the recess.

I know there was some concern concerning being able to be a party of record in the case but not necessarily wanting to put on testimony, and for that reason we're going to do it in that fashion.

So I'd like at this point to ask for those companies, individuals, entities that will be a party of record but will be presenting direct testimony in the case

A P P E A R A N C E S

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* * *

E X H I B I T S (Continued)

* * *

At that time, there were three isolated wells near what is now the plant area of the Bravo Dome unit. My job was to expand three isolated wildcats into -- and understand what the field type was for those wells.

Q. What did your effort entail at that time?

A. What I did was, understand first that we were looking at all of northeastern New Mexico, which carries a large amount of carbon dioxide. And my job was to drill -- I decided the thing to do was to drill wells from what's now the plant area of Bravo dome, towards Des Moines. I drilled seven wells.

And I drilled another seven wells due west, towards Wagon Mound. And by doing that, essentially on township spacing, I was able to define the general area, trap configuration, and an upper boundary of Bravo Dome.

But we couldn't tell how far it would go. It was just a guess at that point.

A. Is it fair to say that your work in the early 1970s was in the nature of data gathering to be utilized in just generally evaluating the potential for CO_2?

A. Yes, the first cross-sections that we drilled helped define the field, and then I followed that with a drilling and coring program which added on perhaps another 20 wells or 30 wells that gave us more insight into the interior of the Tubb and Granite Wash reservoirs.

Q. And all of this occurred in the early 1970s?

A. That's right.

Q. When was your next involvement with Bravo Dome?

A. Once the unit was formed, the unitized interval was declared to be from the base of the Cimarron anhydrite to the top of granite.

The seismic that we had shot in 1983 suggested that lower paleozoic Mississippian and Ellenburger carbonates might be present in the Bravo Dome area.

I was called to evaluate the best location, the most structurally advantageous location to drill a well, to determine whether carbon dioxide was present in those lower horizons.

Q. Did you find carbon dioxide in the lower horizons?

A. No, unfortunately those horizons were tight and non-productive.

Q. Was there any show of any other kind of gas in those tests?

A. No, there were not.

Q. And that was in 1984?

A. That's right.

Q. When were you next involved with this unit?

A. Amoco went through a stage where I was working largely with the producing department as an adjunct from the exploration department, and we had a change in 1981 -- or 1991, that brought me to the north Permian Basin business unit as an integral part of the Bravo Dome team, and this was a real special thing because we began working together in a unified fashion, the geologists, the engineer and the geophysicists.

So I was called there in 1991.

Q. And how much of your time since 1991 has been devoted to the Bravo Dome unit?

A. All of it.

Q. How much of that time has been devoted to attempting to determine the productive limits of the reservoir?

A. About 70 percent has been dedicated to determining where that zero net pay isopach line lies, whether it's inside or outside the unit, just to try and find where it is.

Q. Are you the person that is primarily responsible for the geologic portion of this effort to determine a zero net pay isopach line?

A. I am.

Q. Could you explain to the Commission generally what your assignment has been?

A. My assignment has been to understand the structure and stratigraphy and internal geology of the

Bravo Dome unit, the full unitized interval. It's been to coordinate with the geophysicist and the engineer in a concerted effort to try and define the zero net pay isopach line.

Q. Are you a member of any professional associations?

A. Yes, I'm a member of AAPG, the American Association of Petroleum Geologists; SEPM, which is now called the Society of Sedimentary Geology; the Houston Geological Society; the West Texas Geological Society; and I'm a member of the Society of Petroleum Engineers.

Q. Have you written articles on the Bravo Dome?

A. I've been involved in two publications on Bravo Dome. One was in the New Mexico Geological Guidebook for 1972, and another one was this year where we presented a poster on the petrology of Bravo Dome at an AAPG convention in Denver.

Q. Have you previously testified before this Commission on the geology of the unit area?

A. Yes, I have. I was here in 1992 with the four-year review.

MR. CARR: May it please the Commission, we tender Mr. Wacker as an expert witness in petroleum geology.

CHAIRMAN LEMAY: Mr. Wacker's credentials are acceptable to the Commission.

Q. (By Mr. Carr) Mr. Wacker, could you refer to the exhibit book and identify what has been marked as Amoco Exhibit Number 1?

A. Exhibit Number 1 shows the outline in white of the Bravo Dome unit in Union, Harding and Quay Counties.

The unit itself is about eight miles south of Clayton, New Mexico, and about two miles north of the City of Nara Visa.

Q. Why is this matter, the approval of the zero net pay line, before the Commission today?

A. What we have done is been able to pull together all of the geologic and engineering and geophysical data that we've acquired through the years and tie with it the technology, and developed the line. So because we have the line, we're prepared to present.

Q. All right, let's go to Exhibit Number 2 in the exhibit book. Would you identify and just explain what that's designed to show, or intended to show?

A. The real challenge and real thing that we've been able to do lately is use a synergy between the geologists, the engineers and the geophysicists, a group of people that generally don't come together on a routine basis, and work together side by side, shoulder to shoulder, to organize and present the data that we have at Bravo Dome.

We've done that through computing systems and pulled it together in a fashion that is as precise as technology can make it today.

Q. Let's go on to Exhibit Number 3. Would you identify that?

A. Exhibit Number 3 -- and it's one that we'll be looking at from time to time today -- helps lay out the program for the day. It shows the geological, geophysical, petrophysical aspects that we've used in developing the zero net pay isopach line.

Q. Now, you were the person responsible for the geological portion of this study?

A. Yes, I am.

Q. And could you just summarize the particular things you have been attempting to identify?

A. I've looked at the regional paleogeography and come to understand what the Bravo Dome reservoir is in a regional sense.

I've looked at the depositional model to understand what it is, and it is a unique reservoir, it's one of a type that has never been described worldwide.

We've used core descriptions, core-to-log calibration, which means taking the rocks and comparing the rocks to the core data and making sure that everything fits and we have good calibration, and also to work with the geophysicists to develop a unified model for the structure of Bravo Dome.

Q. Now, Amoco will be also calling geophysical and engineering witnesses to review the other portions of the study as depicted on Exhibit Number 3?

A. Yes.

MR. CARR: May it please the Commission, we're going to refer back to this exhibit on a number of occasions. We're going to use it to try and keep the presentation in some sort of a framework, and we think it's easier to understand when we do that.

Q. (By Mr. Carr) Mr. Wacker, could you summarize for the Commission the data that has been utilized to determine this reservoir limit?

A. I've used a total of 557 data points, many of them outside the unit, many of them going on into Texas. It's important for us to begin to -- continue to look outside so that we can get a real good feel for what makes the zero net pay isopach line work.

I've used 506 data points that actually map the top of the unitized interval, and within the Bravo Dome itself we have 429 penetrations which carry that top unitized interval.

Q. And when you talk about data points, you mean you're actually looking at wells that have been drilled in this area?

A. That's right.

Q. All right. In addition to the data from the 557 wells, what other information has been available to you?

A. From continuing coring programs from time to time, we've acquired rock data from 45 wells. We've analyzed that and tied it back to the well data. We've also acquired seismic and that type of thing.

Let me go back to the cores for just a second, because it's really important to get a feel for how much core we actually have.

We have over 6000 feet of core, and we have data points on each of those. It helps us to describe the lithologic types, the porosity types, the cement and what we call diagenesis, which means the changes that take place in the rock, and gives us a clue for what makes the reservoir what it is.

Q. As to the seismic information, how much seismic data is available?

A. We've shot enough seismic to go from here in Santa Fe to the Pacific coast. We've shot 1100 miles of seismic. With that, we're able to shape out the topographic surface of the unitized interval.

Q. Approximately how many shot points are we talking about? Do you know?

A. There are 60,000 shot points, actually.

Q. In your opinion as a geologist, do you have sufficient data available to you to make a determination of the zero net pay line in this reservoir?

A. Yes, we do.

Q. Can you explain to this Commission why we're making this determination now instead of two years ago or, say, in 1999?

A. Yes, I'd like to refer to a diagram just behind the Bravo Dome reservoir description, and it shows --

Q. Behind Tab 3?

A. Yes, behind Tab 3, it shows to be Exhibit 3A. And it's a visual way of expressing the kinds of changes that have taken place in the industry over the last few years.

If you look at the early times Amoco was looking at the Bravo Dome area, we were interested in the mid-1960s. We recognized what might happen with oil. We had an interest in making sure that we could get the most out and that CO_2 might be a possible resource.

We collected data from the mid-1960s through 1991 in the traditional fashions. We used slide rules and perhaps calculators to evaluate it. We used pencils and erasers to make the maps and traditional seismic and mapping to help us build a good interpretation.

But we still needed something more, something that would give us a more precise evaluation of where that zero net line might be.

Between 1991 and 1992, there was a revolutionary change in the oil industry that involves the use of workstations in interpretation. The workstation assists the geologist, the engineer and the geophysicist to build a more reliable, more accurate, more precise interpretation, so that we can deliver to the royalty owners and to the working interest owners an accurate line.

Q. If we look at this exhibit, you've indicated in just graphic format the revolutionary change that occurred between 1991 and 1994?

A. Yes.

Q. Have the procedures, in your opinion, that evolved during that period of time achieved a position where you can now say these are industrywide, acceptable practices for mapping underground features?

A. Yes, they are.

Q. If we had acted earlier, what impact would that have had on the effort to try to determine the zero net pay line in this reservoir?

A. We would not have placed the line in the right -- in a place that was the right place.

Q. Have these technological changes increased the accuracy that you can bring to the project?

A. Yes.

Q. And all of this, again, is in an industry-now-accepted fashion?

A. It is.

Q. What if we had waited until 1999? Why didn't we do that?

A. We have the line now, Mr. Carr.

Q. And that's the reason we're here today?

A. That's why we're here today.

Q. Now, Mr. Wacker, we're talking about revolutionary changes and technological advances. Could you briefly summarize what those are for the Commission?

A. Yes. I'd like to refer to notes here.

The computer technology allows us to orchestrate the huge amounts of data that come out of the 500 wells and seismic that we've got at Bravo Dome, and it allows us to make a holistic interpretation. It ties it together and helps us resolve complex problems quickly, in ways that we can understand, because they're difficult even for us.

Q. What hardware are you utilizing?

A. We've used the computer hardware that's called the Sun workstation. It's a Sparc Station-2. It was developed by Sun in 1990.

Amoco purchased the Sparc workstation

specifically for Bravo Dome in February of 1991, recognizing that it would be the cutting edge, and it would be the industry-accepted standard in the near future.

At that time, there were only 3000 in use in the petroleum industry. Now we have 27,000 in use in the petroleum industry, and it's part of the accepted hardware.

Q. And you utilized this in your effort to determine the productive limits of the Tubb formation?

A. Yes, I used it.

Q. And who else in your group also used the Sparc workstation?

A. The engineer and the geophysicist both used that. We have -- The geophysicist had his own; it had 2.5 gigabytes, plus a 5-gigabyte tape drive. And mine was a little smaller because I didn't require it; it was 2.5, and it did not have the tape drives.

Q. What software have you used?

A. We've used some key software. One is by Landmark Zycor. It's called Z-Map Plus.

Z-Map Plus was issued in July of 1991. The Z-Map program was the first program to allow surface-to-surface computations. Surface to surface means it can take the bottom of something, take the bottom of something and the top of something, and intersect them by simple subtraction and come up with an answer that's reliable over a large area. With that, we were able to evaluate all of the geophysical and geologic points.

We also used a process -- a program called Geolog by Mincom USA, and it's a geological interpretation and petrophysical interpretation package. It helps us understand where the gas is present and where the porosity is. It helps us do mapping and helps me pick points.

The geophysicist used a program called Geoquest, and it's an interactive geophysical mapping program that lets us pick the seismic points exactly in the same place, on the line that -- every single time, as opposed to having a geophysicist go through and draw a pencil line and measure down to see how many seconds or how many microseconds it takes to get to a point. It's a much more precise way to summarize it.

And we also used some proprietary techniques. One is called the sequence -- the Seismic Sequence Attribute Mapping, and it allows us to make a better evaluation of the seismic.

And we used an older program developed by the French government called Bleupack. Bleupack has been in use for over 15 years, and it helps us tie the information that I get from the wells with the information the geophysicist gets from his seismic.

Q. Is it fair to say that we now have technology which enables us to take the data we have on Bravo Dome, use all of it, and accurately determine the productive limits of the Tubb formation in the unit area?

A. Yes, it is.

Q. Were the other working interest owners in the unit involved in this effort to determine the zero net pay line?

A. Yes, they were. One of the things that we felt was important was to invite all of the working interest owners to come and involve themselves with the work as we laid it out, and we had the participation of 89 percent of the working interest ownership.

Q. And were -- Was it 89 or 98 percent?

A. I'm sorry, it was 98 percent.

Q. And were the owners of that percentage of the working interest in full agreement with the line that was developed by the committee?

A. Yes, they were.

Q. All right. Let's go to the part of the case and start really looking at how we got the line.

Let's go to what has been marked Amoco Exhibit Number 4. We have an enlargement of it.

I want to check first, Andy, to be sure the Commission can see it. The witness stand may be in the way. Can you see that, Mr. Weiss?

COMMISSIONER WEISS: Could you move it out a little more? Yeah, maybe right up adjacent to the -- There, that way we can all see it.

MR. CARR: And I would note that we have copies of these exhibits in the exhibit book. Several of them are very large composite exhibits, and we have broken them down into subparts. But they're all there with the exception of a couple of photographs, and we'll identify those when we get there.

THE WITNESS: Is it okay if we -- when we're through with these we post them along the wall, so that the --

CHAIRMAN LEMAY: Yeah.

Q. (By Mr. Carr) All right, let's go to Exhibit Number 4, Mr. Wacker, and I'd like you to just initially tell us what is depicted on the exhibit overall.

A. This is the regional paleogeography of Bravo Dome. It takes us from far away and brings us up close.

I start off on the far left-hand side of the diagram with a regional map that goes from Texas to Wyoming and from Arizona to Kansas. In it, shows the major geologic features and provinces that were important to the Tubb deposition during the Permian. Bravo Dome is the box in the middle of the diagram.

The structures, the positive structures, are shown in brown; those would be hills, mountains and that type of thing. The negative structures, or basins where the water was, are located in dark blue.

Bravo Dome, as I said before, is a unique reservoir. It's the first reservoir worldwide to be recognized in a loessite facies. Loessite is very fine dust. It's the dust that's moved around by the dust storms that are not uncommon in west Texas.

It blows -- I'm familiar with it because I lived in El Paso and saw the dust come in my window, and the stuff is so fine it seeps through small cracks. It's this kind of dust that makes the bulk of the Bravo Dome pay.

That dust was generated up in northwestern Colorado, in the sand dune fields that were present there in Maroon Basin. It came down a chute between the ancestral Front Range of the Rockies and the Uncompahgre Uplift.

When it came through that chute, the wind blew across the Bravo Dome uplift and deposited the dust on the lee side, or the protected side of Bravo Dome.

Q. Would you indicate the uplift?

A. The Uncompahgre Uplift is here. The Sierra -- I'm sorry, it crosses New Mexico from a northwest-to-southeast direction. The Bravo Dome uplift is in northeastern New Mexico and shows as a rather small spot by comparison, but it was topographically high enough to create a change in the wind patterns.

The prevailing wind direction was from northwest to southeast because of the placement of the equator at the time.

Q. And so the Bravo Dome is actually, if we go back in geologic time, the result of a dust deposit that blew from northwestern Colorado?

A. Yes, it is. It's been reworked with water and deposited in lakes and streams. But primarily the reason why it's so fine and the reason why it's as productive as it is has to do with the fact that it's dust.

Q. And what is that called?

A. It's called loessite when it's lithified, loess when it's not, and we have deposits of those here in the United States and in China today.

Q. All right, Mr. Wacker, let's go to the map in the central portion of this exhibit.

First, would you explain to us what kind of a map this is?

A. Yes, this is an isopach map, and it's a blow-up, if you will, of the Bravo Dome that's shown on the larger regional map. It's an isopach specifically of the Tubb formation, because it constitutes the primary pay of Bravo Dome, almost the exclusive pay but not entirely.

The brown colors represent -- the brown colors in the northwest area represent the thinner section, and the yellow colors in the southeast area represent the thicker Tubb.

The Tubb formation goes from less than 100 feet to more than 400 feet from the northwest to the southeast.

The blue outline here is the outline of the current Bravo Dome unit, and there's a cross-section line on here that I'll refer to later.

The reason why it's thin to the northwest is that it's relatively close to the Sierra Grande uplift, and as the dust blew across the top, it just filled the area that was low, and the highs stayed -- were mantled and did carry sediment, but they were a little more bare.

Q. All right. Let's go on to the stratigraphic column, if you would, on the right-hand side of this exhibit.

A. On the right-hand side, I take us to what geologists do to help explain and understand the geologic formations in different places. We give names to the formations, and I compare the stratigraphy of Bravo Dome with that of the Delaware Basin.

The Bravo Dome units that we will talk about today are called the upper Tubb, the middle Tubb, which is the main pay, the lower Tubb, and Granite Wash section.

These correspond in this way. The Tubb ties well with the upper Tubb in the Bravo Dome unit. On the diagram, the traditional Tubb is shown in blue and the upper Tubb, which is the way we describe it today, is shown in red.

The Abo formation that has been described well by Ron Broadhead of the New Mexico Bureau of Mines and Mineral Resources, seems to tie with the middle Tubb main pay and also the lower Tubb, as well as parts of the Granite Wash.

The larger part of our Granite Wash ties with the Sangre de Cristo formation, so in this way we can describe it. We call it all the Tubb to make our conversations simpler and so that people have a feel for what's above and what's below without getting confused.

Q. Let's go now to the cross-section on the bottom of the exhibit. Would you first explain what the colors mean and then what is shown on each of the logs?

A. Yes. These are, in blue, the logs, the electric logs and subsurface data that we've acquired from wells across Bravo Dome.

On the left-hand side is the gamma ray.

In the central area is a listing of the depth, along with the perforations, which are shown in red with small dots. And in magenta are the cored intervals that we show.

And that will be a key that we'll use through the day. It will show on some, won't show on others. But if you'll remember that the red is the perforations and the magenta is the cored interval, it will help us.

Down the center is a lithology log that is developed by looking at the subsurface data that we've acquired from the wells and by calibrating that to the cores.

So we've calibrated the rock that we get from the cores to the data that we get from the wells and made models that we can tie, and it helps us in interpretation.

It's a whole lot easier to look at these and say the yellow, which represents clean sand and porous sand, is the heart of the reservoir, and the browns and reds represent poorer reservoir or nonreservoir rock. The blues and purples represent the anhydrites, which are also Tubb.

So in this way, we're able to calibrate. It's one of the tools that we've been able to use in our computing systems.

One of the more -- One of the important parts of this display is the porosity log, which is marked as DPHI on the well to the furthest left, and that DPHI line, which means porosity of holes in the rock, is a blue line that wiggles down the section.

We've developed what we call a porosity cutoff.

The porosity cutoff is the least porous rock that effectively carries carbon dioxide gas.

I've shaded to the left of the line -- and that line represents 12 percent porosity -- I've shaded that in deep purple so that we can see where the porous rock is and what it looks like.

There's a small red line also in that curve, and it shows the core-shifted porosity. What that means is, we've been able to measure the porosity in the core, compare it with the log and make sure they're right, make sure that the log's reading right, make sure that they do compare.

Further to the right is a permeability log. That's based on the core itself. These are permeability measurements made on the core. It's shown in deep red, and it lets us know how porous -- how permeable the rock is. That says how fast the rock can carry the gas.

The purple line that goes all the way across the top is the Cimarron anhydrite. It's important to us because it marks the top of the unitized interval.

The salmon color is the main pay of the Tubb formation, and the cinnamon color is granite Wash and basement.

What's important to show here is that as -- and I'm going to refer first to the central picture in the diagram and then go back to the cross-section. As you can see, the cross-section goes from the northwest area to the southeast area. It goes from near the Sierra Grande Uplift to further away.

In doing that, the reservoir expands from less than 100 feet to more than 350 feet. So the formation of the Tubb loess, the dust, is a large wedge, and it pinches out somewhere beyond the limits of the unit to the northwest side.

What these graphs also show is that the porosity and permeability in the unit also carries to beyond the reservoir limits -- I'm sorry, to beyond the current unit limits. And that will become important later on.

Q. All right, Mr. Wacker, let's now go to Amoco Exhibit 5, the photomicrographs.

As we're putting this exhibit up -- still -- and as we put it up, with the top up, could you make one more comment on the exhibit --

A. Oh, yes.

Q. -- that we've just put on the side of the auditorium?

Do you have any estimates of the flow rates of the wells --

A. Oh --

Q. -- that you've indicated on the bottom of the exhibit?

A. -- yes. Yes, sir, thank you.

In the same way that the porosity and isopach thickness changes from the northwest to the southeast, the flow rates change. And we have deliverability from the far northwestern corner of only 32 MCF of gas, but the well did make gas. It was very -- The pay is thin there, but the porosity is present. I'll show you that in the next display, but the porosity is present.

As we move down to the south, the thickness increases and the flow rate increases to 340 MCF of gas per day.

As we move further towards Texas, the porosity increases -- the thickness increases again, and the flow rates increase to 1229 MCF gas per day.

And then further still to the east the flow rate increases to 3800 MCF per day.

So we have a gradual increase from one side to the other in the thickness of the formation and the continuity of the -- and the productivity of the wells there.

Q. All right. Now, let's go to Exhibit Number 5, and let's first identify what this is.

A. This diagram shows also a large blow-up of the Bravo Dome unit area. The Bravo Dome unit is shown in black inside the map, and on it I've located the same kinds of logs we saw on the first cross-section. They have the same pattern that we've seen in the past.

Underneath them, I've posted photomicrographs of the siltstone and the graphs that we use to show the grain size on the thin sections that we've taken a picture of.

In the thin section in the far northwest corner, which is Well 2431-271K, we see white spots, and the white spots are the grains of sand. We see some brown through here, which is hematite staining and/or clay. And we show blue, which represents the porosity in the rocks.

So here on the northwest corner, we can identify the porosity in the rocks by the cores that we took. We can actually see it and verify by looking at that, the fact that we do have porosity up that way and that the pay extends further out towards the northwest by extrapolation.

Q. Mr. Wacker, what we have on this exhibit are photographs of cores?

A. We have graphs of thin sections, yes.

Q. And those have been magnified?

A. Yes, they have.

Q. And on this exhibit has the magnification on each of these been identical?

A. The magnification is always the same, yes.

Q. All right. Let's go ahead and review the rest of the exhibit.

A. Each of the photographs that's shown on here carries blue. In your diagrams that you have before you, the small books, I've only used one picture. It's hard to post all that stuff on the smaller books that you've got.

What I've shown is the porosity in 1834-161A. It's the best example of the good porosity at Bravo Dome. Again, the blue is a coloring that we add to the thin section so that we can see where porosity goes.

This is some of the most amazing porosity I have ever seen in paleozoic rocks. It ranges from 12 percent to over 30 percent porosity, and it is unique.

The arrows that are shown on this diagram point to the wells, and the well symbols identify where they come from.

Mostly what I want you to understand from this cross-section, or these -- I'm sorry, this display, is that the porosity is extensive throughout the Bravo Dome area in the Tubb unit.

Q. It's extensive. How uniform is it?

A. It's very uniform. From the -- As long as the porosity is over 12 percent, the porosity carries gas.

That grain size distribution is uniform. There is some change, perhaps a little. As we go towards the Bravo Dome uplift, we get some sand coming in and there are a few coarser grains there. But as we move away and to the southeast, it becomes increasingly uniform, but it's all generally the same kind of rock.

Q. In your opinion, is this what you would characterizes as a complex reservoir?

A. No, it's a very simple reservoir. It's rather basic, as reservoirs go, and it's quite continuous throughout the area.

Q. All right. Let's go to Exhibit Number 6 in the exhibit book, and I would ask you to refer to Exhibit 6 and use this to review the basic parts of this undertaking.

A. One of the challenges of Bravo Dome is to understand the container, and we're taught to -- if you can describe the container that the gas is held in, you're going to be able to do everything you need to know as far as that reservoir is concerned.

Most importantly for me as a geologist is the top of that feature of the container and the internal characteristics of that container. What I've showed you here, up until now, is entirely internal to the container. The challenge is understanding -- for me, is understanding the top. And that comes in two parts.

On Exhibit 6 we show the Cimarron anhydrite as a formation, a wedge, a pie-shaped wedge called the tight Tubb, as a formation. There's a polygon that's colored,

CO_2, which is the container. And then there's a line that separates the tight Tubb from the remainder of the unitized interval, which is porous Tubb to basement.

My job was to define the boundary between the gas-filled Tubb in the Cimarron and the Cimarron anhydrite throughout most of its part, and then the boundary between the gas and the tight Tubb in the remainder of that part.

So if you will, the tight Tubb is as good a seal as the Cimarron anhydrite. And in that sense, the reservoir is sealed in two parts, by the Cimarron and by the tight Tubb, particularly in the south, and I'll show you that.

Q. Now, if I understand this exhibit, the assignment was to determine the productive limits of the reservoir?

A. Yes.

Q. To do that, you had to determine the shape of the container?

A. (Nods)

Q. To get the shape of the container at the top, you had to determine what was the base of the Cimarron anhydrite?

A. That's right.

Q. You also had to refine that by determining where the bottom of the tight Tubb was actually located in the southern portion of the reservoir?

A. That's right.
Q. With those two you have the top of the reservoir?
A. Yes, I do.
Q. Then other individuals were assigned and had primary responsibility for defining the bottom of the reservoir?
A. That's right.
Q. And they were looking at the gas-water contact which is shown on this exhibit?
A. Yes.
Q. They were also looking at where the Basement becomes the bottom of the productive interval --
A. Yes.
Q. -- is that right?
And then when you have all of those surfaces and you can put them together and have the computer with all of that input define where those planes or surfaces meet, that's how you get the zero net pay line?
A. That's exactly right.
Q. All right. Let's now go on to what has been marked as Amoco Exhibit Number 7, and I'd ask Mr. Wacker again to go to the large copy of the exhibit and first explain what it is and then review the information on this exhibit for the Commission.
A. This map is a structure map on the top of the

unitized interval, base of the Cimarron anhydrite. It covers Bravo Dome from south to north and east to west.

The coloration is that the darker colors here are structurally low. Those would be browns and greens. And the yellows are structurally high. Those occur primarily in the northwest area.

The magenta lines are seismic coverage. They're part of that 1100 miles of seismic that we've shot; they're all of that 1100 miles of seismic that we've shot.

The location of wells drilled in the Bravo Dome area are spotted on this map. The wells that I've used -- The wells that carry Tubb values are present and marked with the well name above and the structural elevation of the Tubb underneath. There's an explanation in the lower left-hand corner that describes all these pieces.

On the right-hand corner, we show the type log for the unit. This is the same well that was used to originally describe the Bravo Dome unit. It shows the base of the Cimarron anhydrite and the top of the granite, which represents the base of the Bravo Dome unit.

Again, in yellow it shows the rock that is representative of pay for that.

This particular map represents the merging of both the geologic data and some very carefully processed and -- some carefully processed seismic data as well, and

Terry will talk about that later.

Q. And this map actually shows the base of the Cimarron anhydrite?

A. Yes.

Q. And that is one of the elements that defines the top of the productive interval in the Tubb formation in Bravo Dome?

A. That's exactly right.

Q. All right. Now, let's go to the next exhibit, Exhibit Number 8, and I'd ask you to identify that for us.

A. The second part of the seal to Bravo Dome is that wedge that is the tight Tubb formation. The coloration on this map -- and this is the same geologic area, the same area that we looked at in the other one -- shows white as an area where that wedge is not present, it shows a purplish blue where it's relatively thin and a dark green where it's thicker.

As you can see, it thickens as you move to the south. This is in response to the Tucumcari Basin and the subsidence that took place there, and it's related to the fact that the base of the Cimarron is an erosional contact. That's why it's a wedge. This is what we have to show for this exhibit.

Q. And this was developed from what data?

A. This is an isopach based on a measurement from the base of the Cimarron anhydrite to the first occurrence of 12-percent porosity as it's seen on the electric logs. So it's a tight wedge.

Q. And it involves both geological input and engineering input?

A. It does.

Q. And this is the -- an isopach of what we have identified on Exhibit 6 as the tight Tubb?

A. That's right.

Q. And the bottom of this wedge becomes part of the top of the container from which CO_2 is produced in Bravo Dome?

A. That's true.

Q. All right. Now, let's go on at this time to Exhibit Number 9.

A. Exhibit Number 9 is the base of the container, if you will. It comes in two surfaces as we describe it on that exhibit, the model.

Q. Exhibit 6?

A. Exhibit 6. The two parts are shown here. The first in green, which is the gas-water contact; and the second in shades of brown, which is the basement. There's no water, as a water table as we think of it, as a gas-water contact, north or west of this line, of the line that we've shown here in black that separates that contoured on basement from that contoured on the gas-water contact.

What's unique in this reservoir is that the gas-water contact is not a flat surface. Most of us are familiar with reservoirs where the gas-water contact is a single contour and it does not change. The work that we've been able to do, the engineers have been able to do, has determined that that does indeed change, and we've carefully mapped that through the field so that we can make an accurate representation of that surface.

Examples of the mapping horizons are shown on the right-hand side of the display for both the part mapped on basement and the part mapped on the gas-water contact.

Q. This exhibit was prepared with geological data?

A. It was prepared with geological data through the basement, where the basement surface is important, and it used engineering data where the gas-water contact is important.

Q. And it was confirmed with geophysical information, was it not?

A. Yes, it was. In an area to the northwest we were able to add some important points using geophysical data to identify where the gas-water contact was. This has to do with other things, and Terry will talk about that.

Q. All right. Let's go now to Amoco Exhibit Number 10, the structure map on top of the productive reservoir.

A. With the pieces or the elements that we have for the top of the Bravo Dome reservoir and the base of the Bravo Dome reservoir, we're able to build an intersection which is the zero net pay isopach line.

That zero net pay isopach line is shown on this map in blue, where the gas-water contact is that surface, and in red where features called granite -- we call granite knobs are present.

At the place where the granite knobs are, the unitized interval is not present. So because it's not present, we've cut it out of the unit.

This map, like the others, shows a dark green where the structure is low and a yellow where the structure is high. It's very familiar to the first surface map that we saw, because the bulk of it carries the same structure as the Cimarron anhydrite that we defined before.

It shows an example of what the unit pay zone looks like on the far right-hand side, and it shows an explanation of the well codes and the two different characteristics of the zero net pay isopach line. That's shown in the lower left-hand corner.

Q. Now, this exhibit differs from the structure map that we presented as Exhibit 7 in that this shows and is a map of the top of the container?

A. That's right.

Q. And so in the northern portion of the unit it does look just like Exhibit Number 7, or very similar to it?

A. Right.

Q. But as we get to the southern portion of the exhibit, we have also taken into account and taken out the wedge that sits on top, the nonporous zone that sits on top of the productive interval in the southern portion of the unit?

A. That's exactly right.

Q. Now, the zero net pay line, you indicated basically where it goes across the southern portion of the unit. Could you show where it also goes along the eastern boundary, just generally?

A. Yes, it follows fairly close -- well, it follows along the eastern side, through -- Do I need to describe it by township --

Q. No, I think just for the Commission, if you'll show where it is.

A. It's very near the dark green edge and follows through the brown features here.

And then there is a deep low in Township 21 North, Range 34 East, that we call the graben. It's a deep structural low that we'll talk about later. That zero net pay isopach does exclude that area called the graben.

Also there's a deep structural low, which in research by Muehlberger has been called Mapes Basin. It lies in Township 22 North, 32 East, and it is a structural low that's defined by seismic and by surface geology.

Q. And all of these are indicated by the blue or the purple line on Exhibit 10?

A. By the blue or red line, yes.

Q. Mr. Wacker, let's now go back to Amoco Exhibit Number 3, and could --

A. Excuse me, what you said was true. It is a -- It looks like a blue or purple line. Those are the gas-water contacts. The red is not.

Q. All right. And the red are areas that are excluded because of the granite knobs and other irregularities in the formation?

A. That's right.

Q. All right. Let's return to Exhibit Number 3, and using Exhibit Number 3, could you just summarize the geological portion of the study to determine the zero net pay isopachous line?

A. My job as a geologist was to understand what made Bravo Dome the field that it is. I started in 1973, and at that time we were trying to pull it all together.

We've done that, we've concluded that, we've developed the regional paleogeographic setting, the depositional model. I've done core descriptions, we've made core-to-log calibrations and have completed our study by understanding the upper surface of the Bravo Dome reservoir as it contains gas and the internal geometry and characteristics of porosity within that zone.

Q. So you've completed the first portion of the study that's set forth on Exhibit 3?

A. Yes.

Q. Who actually drew the zero net isopachous line on Exhibit Number 10?

A. The zero net pay isopachous line was physically drawn by the computer. It represents the intersection of two surfaces, the top interpreted by me, the geologist, and the other interpreted by the engineer.

The subtraction of those two topographic surfaces develops a line with no dimensions, and that line was used to mark the placement of the zero net pay isopach of Bravo Dome.

Q. How accurate do you believe this determination is of the top of the reservoir?

A. It's very accurate.

Q. How often do you have the volume of data available to you to work with that you've had in trying to address this question?

A. It's rare that we're able to incorporate this volume of data together.

Q. Even on a unit the size of the Bravo Dome?

A. Yes.

Q. Will Amoco also call geophysical and engineering witnesses to review those portions of this study?

A. They will.

Q. Were Amoco Exhibits 1 through 10 prepared by you?

A. They were.

MR. CARR: At this time, may it please the Commission, we would move the admission into evidence of Amoco Exhibits 1 through 10.

CHAIRMAN LEMAY: Without objection, Exhibits 1 through 10 will be admitted into the record.

MR. CARR: And that concludes my direct examination of Mr. Wacker.

CHAIRMAN LEMAY: Thank you, Mr. Carr.

Are there any questions of Mr. Wacker?

Commissioner Weiss?

EXAMINATION

BY COMMISSIONER WEISS:

Q. On the contours, what method was used to draw the contours themselves? Do you know?

A. In Z-Map what we do is use a gridding process. The grid size that I used was 1320 feet, so we have a data point every 1320 feet, or about a quarter section.

And I -- The processes in Z-Map allow me to choose the algorithm to do the mapping. The algorithm that I used was a weighted average algorithm, along with a biharmonic fit. Those are the most acceptable and most familiar to evaluation of geologic data.

Q. Thank you. A couple more.

Did you include krieging or variograms in your analysis of the edge?

A. I thought about using krieging. I don't feel that krieging is as accepted an industry standard as normal contouring, and I feel that I have a better understanding and the industry has a better understanding of what normal contouring does, as opposed to krieging as a method.

Q. Do you think you identified all the granite knobs?

A. We have identified four, three which have no Tubb over them. There may be some more. I don't think so. They seem to be fairly few and far between.

Q. Do you have engineering support later to support your statement that it's not a complex reservoir?

A. The engineering -- Yes.

Q. Thank you.

A. Yes.

Q. And then have you considered 3-D seismic as a means of identifying the edge?

A. 3-D seismic is helpful in relatively smaller areas than Bravo Dome. It's something that we had considered, and what we understand of the reservoir, because it's relatively -- because it's so continuous, because it's a relatively simple wedge, 3-D seismic would not be a great advantage over what we have now.

COMMISSIONER WEISS: That's all the questions I have. Thank you.

CHAIRMAN LEMAY: Commissioner Bailey?

EXAMINATION

BY COMMISSIONER BAILEY:

Q. The software you used was 1991 software, which is the best currently available technology?

A. Yes.

Q. Have you actually tested -- Since the zero line was drawn using a computer, have you actually tested that zero line by drilling a well out in the field?

A. We have not tested it actually by drilling a well in the field.

What we have done is, once the line was drawn, we've gone back and looked at both sides of the line with selective test information and seen where -- which wells made gas and which ones were dry. And for every well that we can see on the inside of the line, it made some gas or had a log show of gas. And every one outside the line tested water or calculated water on the logs.

So we have not drilled wells to identify the line itself.

CHAIRMAN LEMAY: Thank you.

Just a couple questions, Mr. Wacker.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. You talked about the number of working interest owners that were involved, I think, that okay'd it, 98 percent?

A. 98 percent of the interests.

Q. Was that by number or by percentage in the unit?

A. It's by the working interest itself, not by the numbers.

Q. By the percentage of working interest in the unit?

A. That's right.

Q. Okay. Your porosity in the loess deposit, is that primary or is that secondary porosity?

A. I was surprised, as I began to evaluate it, to find that most of it was primary porosity. There is some secondary porosity in the leaching of the feldspars that does actually increase the porosity in that fine-grain rock.

Feldspars in the Granite Wash are also altered and make for a vuggy -- not quite vuggy but corroded feldspar grains. That tends not to be connected and for the most part doesn't make pay. There are some places where there is pay in the Granite Wash, and we've included that as well.

Q. But generally there's not much post-depositional change within this reservoir then?

A. There's not a lot of change. We have seen some feldspar overgrowths, but they're not extensive. We have seen some quartz overgrowths. But in studying the loess in China, they also see that in Plio-/Pleistocene deposits, so it's a fairly recent effect, it's an early diagenetic effect.

Q. Your wedge of tight Tubb, I'd like to kind of get into that a little bit.

Do you have a gradational porosity change from the 12-percent grain to tighter rock as you get above that -- what you call, I guess, the seal? Or is it rather abrupt?

A. It seems to be rather abrupt. The unit -- There's a plugging that seems to take place, and I don't know exactly why it selected that rock to do it, but there's a dolomitic and anhydritic cement that occurs quite often in the upper Tubb, and I think that plays a role in making it tight.

In other words, there were more diagenetic, later diagenetic, if you will, effects that occurred to that part of Tubb that didn't happen to the rest of the -- to the remainder of the Tubb. So it's a diagenetic change that seems to have taken place.

Q. Just two more questions. One of the granite knobs, you have the -- the size of those, are they defined by seismic, or did you use just a radius around wells that have penetrated those granite knobs? How do you define the size and the extent of them?

A. Okay, the two in the south were drilled and penetrated by wells only. We don't have seismic over those specifically.

But I do have gravity, and the gravity work shows the general size and dimension of them. They seem to occur in an area that's about -- that's less than a quarter section, and they have fairly steep sides.

Geologically, we call these either bornhardts or yardangs. Yardangs is a desert feature, and I suspect that that would be more accurate for this.

But they're fairly small geologic features that have very steep sides and rather high relief. These look like they're about 300 to 400 feet high and actually penetrate the Cimarron.

The other one, farther to the northwest, is defined both on seismic and by well control. We do have seismic across one in the southwest, and over it we have pay. So they're not all very, very high.

We have -- And I've forgotten exactly how many feet of pay we have over the top, but the loess mantles the -- whatever is underneath it. It drapes and fits over it like a sheet. And where there are topographic highs, it's not at all unusual to have that mantling of the loess on top. So we do see those changes.

And we've -- In a couple of places we've got it with seismic, and -- In one place we've got it with seismic, and in a couple places we don't. And it's defined by well control and gravity.

Q. Just one final question so we're all understanding what line you're drawing. You're actually defining the zero net pay isopach line of the Tubb. This has nothing to do with the commercial well versus a noncommercial well versus a dry hole? Is it true to say that noncommercial wells would be included in the productive acreage?

A. Let me -- I need to take that in pieces.

Q. Okay.

A. The zero net pay isopach line is a line that is for the unitized interval. That includes the base of the Tubb, all the way to basement. So it includes the Granite

Wash, and it includes any other formation that might occur there, not just the Tubb.

The -- What was the other part to your question?

Q. Well, I'm trying -- You're defining this line. What is it?

A. Yes.

Q. And just for the Commission, we'd like to know truly what it is. If it's a zero net pay isopach --

A. That's right, it's --

Q. Define that a little further, I guess, in terms of commercial and noncommercial --

A. Zero was a large challenge for us; scientifically it's a tough feature to define. What we did was look at industry-accepted standards, at what they consider zero to be. Zero is where you won't find any gas, where you won't find any movable resource. It's not what's productive.

So the zero net pay line is outside what one might consider capable of producing economic quantities of gas, whatever that is, because we don't know, there might be a time when we could drill all the way out and produce an MCF of CO_2.

Our challenge was to make sure that we got all of the CO_2 that's present in the carbon dioxide reservoir in the unit, and we've got it.

Q. So a productive-limits line and a zero isopach line could be different, probably would be different lines?

A. They would be different lines.

CHAIRMAN LEMAY: All right. That's all the questions I had.

Commissioner Weiss?

FURTHER EXAMINATION

BY COMMISSIONER WEISS:

Q. Make that real clear. The value of CO_2 does not impact your zero net pay?

A. No.

CHAIRMAN LEMAY: Anything else?

COMMISSIONER WEISS: No more questions. Thank you.

CHAIRMAN LEMAY: Mr. Carr?

FURTHER EXAMINATION

BY MR. CARR:

Q. The answer to your last question was that the value of CO_2 did not impact your study; is that correct?

A. It does not impact my study.

MR. CARR: Just wanted to be sure that was clear. I thought we had a yes to a no, and it might not read like it sounded.

That's all we have with Mr. Wacker.

CHAIRMAN LEMAY: Are there any additional questions of the witness?

Yes? Could you identify yourself for the court reporter?

MR. ROMERO: Chairman LeMay, members of the Commission, my name is Dave Romero, Jr. I represent the entities of the GD Cattle Company, the Estate of Herbert Garcia, and Bennie Garcia.

We stand in opposition to the Application, and we are primarily interested in the southwest section of the Bravo Dome carbon dioxide unit, in particular, Township 17 North, Range 30E, Range 31E, 32E, 29E, 28E, 33E, 34E, 27E, and 26E.

And I would just ask a limited number of questions with your permission.

CHAIRMAN LEMAY: Fine, fine, please do.

CROSS-EXAMINATION

BY MR. ROMERO:

Q. What is your margin of error in your calculations in general, to date?

A. We have made careful geologic interpretations of the well tops, the formation tops, and the geophysical tops. They are a geological interpretation and a geophysical interpretation. They are the best that technology can deliver today.

We don't normally set a margin of error on the work that we do. What I know is that we have made surfaces that are defined and are accurate. The accuracy of our line is a null point. It shows on a map with no dimensions, and it cuts the lease lines with no dimensions.

In other words, it is a true line. The measurements inside and outside the lease line are accurate and precise.

Q. You used the term "very accurate". On a scale from zero to a hundred percent with a hundred percent being exactly accurate and zero percent being not accurate, how accurate is "very accurate"?

A. It is accurate, and it is the best that a man can do. I have been working at this for 20 years and have had the pleasure of working with excellent data and excellent surfaces.

In the geologic arena, this is an easy top to pick, the top of the reservoir and the base of the reservoir, and on a scale of one to ten, it's a ten as a way of picking it and as a method.

Q. Then are you saying that your analysis is a hundred percent accurate?

A. As far as the data that we have and the way that we've presented it and the way that we've collected it, it is accurate.

Q. In reality, though, you don't know what's under the ground? You're making certain assumptions that come into your conclusions?

A. We've used all of the geologic data that we have available, which is what we're required to do. The assumptions are industry-accepted assumptions, and it's important to us to stick by those. We have honored those and performed in an industry-accepted fashion.

Q. Could you please list what assumptions you used in making your conclusions?

A. We assumed a 12-percent cutoff for the porosity and a 65-percent saltwater cutoff for the water saturation in the rock.

The formation tops were based on a gamma-ray curve, along with a density curve on the wells, and the base of the Cimarron is defined as the top of the unitized interval simply because it is a very sharp pick. It makes for a very convenient pick geologically, so I'm pleased with that.

Q. Did you use any other -- Were those the total number of assumptions you used in your calculations?

A. Those are all the assumptions that I personally used, yes.

Q. How about the others whose information you based some of your decisions on? Do you know what assumptions they used?

A. I'm not familiar with theirs, no.

Q. But yet you did use other data for coming to your conclusions?

A. We used the industry-accepted standards throughout, yes.

Q. You didn't use 3-D seismic?

A. We did not.

Q. That's not an industry-accepted form of analysis for this type of -- the size of Bravo Dome unit?

A. We -- what I -- Let me think. It would not change the answer that we have. And what's important is that we deliver what's just right in a way that represents the geologic data that we have.

Today, this is what we have, the geologic and geophysical data. So the 3-D seismic is just not something that would be valuable to our interpretation, and it would not change it, I don't feel.

Q. But you don't know for sure?

A. That's right.

Q. In particular, with the township and ranges that I mentioned earlier, can you tell me specifically if on Township 17 North, Ranges 26 to 32 -- or 30 -- Ranges 30 -- 26 to 34, were wells drilled outside that boundary, which in general is the southwestern corner of the Bravo Dome area?

A. Southwest. Okay, will you please repeat those for me so I can mark them?

Q. Okay, I'm talking about Township 17 North, and I'm talking about in particular Ranges 26 through 34, which on your map is primarily the southwestern corner of the Bravo Dome carbon dioxide gas unit.

A. We have well control and extensive seismic through that, to help us define it. We have more well control than -- We have more seismic control than most companies would normally use to define the structure of this province.

It's a very low-slope area, and it's easy to interpret, because the slope is relatively low there.

I feel we have sufficient data. We've looked at the wells and determined where the -- which wells made water and which ones make gas, and we've carefully selected a line that does lie between wells that made gas and wells that made water, and we've used a method that is an industry-accepted standard to do that.

Q. Do you have particular wells just outside the particular township and range?

A. We -- I would need to look at a map to do that, and the engineer has a map that shows specifically in that area which wells we used to show productive and gas-filled porosity.

Q. So you don't know --

A. I can't tell you without getting up close, no.

Q. Let me also ask you, in looking at the entire unit, I see that it is only decreased in size instead of increased in size. Why is that?

A. That's a good question. From the way I understand it -- and I'm a geologist, I'm not a lawyer -- when the unit was set up we had an opportunity to change it, and that change would be to reduce the size and make it more accurately fit.

From what I understand, we're not at liberty to increase the size of the unit. That's not the way the contract was written.

Q. Although at the time the contract was written, the techniques and scientific methods used were not as good as they were today?

A. I only know what the -- There are people who understand the contract better than I. But what I know is, we are not at liberty today to increase the size of the unit.

Q. So if there was someone who -- From your analysis and the increasing technology, if the production area went outside those boundaries, you wouldn't be here asking to pay those individuals any greater amount or to bring them into the unit?

A. I'm not in a position to talk about that. I'm a geologist. I don't know. I'm limited that way.

Q. And I would also assume that if you look at the entire boundary of the Bravo Dome unit, there are some areas where you would feel more assured in making your prediction as compared to other areas?

A. In the interpretation of geologic data, it is an interpretation, and we're required to take all of the data that we've had. We've used that data and very carefully placed the lines.

Geology is an inexact science, and there are certainly some places that are more risky to drill than others, I would agree with that.

Q. Now, you said today was the best day to make one's decision and to bring this to the Board. But I would also assume that as technology improves, that your conclusions today could be modified tomorrow or next year or the year after with the improvement of technology?

A. I've thought about that question a little, and the best way for me to explain it is to look back at the diagram -- what is it, 3B or 3A?

And it's rather like the space program. First they learned -- And I remember seeing the Vanguard rockets go up and fall over, and finally they got a guy to the moon. And then it became -- The process of getting to the moon moved the industry of space exploration to a plateau, and now it's trivial for us to see people go around, and it's not a big deal to go up in space. That was a revolutionary change, to be able to do that.

This is the same kind of change that we've had in the oil and gas industry, where we've gone -- and if you'll look on that 3A -- from a slide-rule-and-eraser type engineering and geology, we've gone through a revolutionary change that uses space-age technology and computing to help us do a better job.

We've reached a point in 1994 where, okay, we've put a guy on the moon, we're able to do this kind of thing fairly routinely now, and I think in the future we'll see what we call evolutionary changes in the type of things that we have. We'll be able to use the computer on a more routine basis.

Right now we're at a stage where we can evaluate the data that we've got in an exceedingly accurate and precise way. And that's the best way that I can explain it to you. I don't feel that we will see changes in the line, based on the work that I've done.

Q. But there were changes from when the original line was drawn, from that point on to this point; is that correct? Otherwise you wouldn't be here changing it?

A. That's true.

Q. And also there may be an assumption that with any reservoir, that the more you pump out of it, the smaller it will get?

A. Those are engineering questions, and I'm not prepared to talk about that.

Q. You described synergy, the ability of different entities who worked separately in the past now working together to come up with what is hoped for, a better understanding or a better product, as compared with each one taken alone; is that correct?

A. Yes, sir.

Q. In that synergy, could you discuss some of the differences in opinion as far as the outside boundaries of the carbon dioxide gas unit, in particular, the township and ranges which I discussed earlier?

A. I remember maps that Amoco made that show the structure of the top of the Tubb as an engineer would draw them. And to explain certain engineering phenomena in the field, they put faults in there. Those faults were part of the Amoco's mapping, as far as the engineer cared.

But it didn't incorporate the geophysics, which shows that everything through there is very flat. By reconciling the early interpretation that the engineers had of faulting with the new data that the geophysicists acquired, we've come up with a better understanding of the province that you're talking about, and that understanding is a synergetic understanding that helps us explain the pressure changes that we see from one side of the unit to the other. And we do see some gas pressure changes.

Q. Let me understand this. In reconciling the differences of this synergistic evaluation, are you saying that when you did have differences in the end, that all parties thus agreed to one final conclusion, or were there still some of the parties sticking by their differences?

A. What we've done is looked at it together, and we have together developed a holistic understanding that we all agree on.

Q. As to all the differences?

A. Yes.

Q. I assume within the industry you have industry standards, and then you have, say, for example, new technology or approaches that are not yet accepted by the industry, but say a significant portion of the industry is using; is that correct?

A. Uh-huh, uh-huh.

Q. Part of that being maybe 3-D seismic. Could you discuss those techniques that you would not consider industry standard, that you didn't use here, but that a significant part of the industry is using, at least in a shortened fashion, because I realize we're short on time?

A. The only thing that I can think of is the gravity data, and it's a guide to the geologist and the geophysicist. But there are so many variances that can create -- to create a high and a low in gravity data that it's generally not an accepted practice to use it as definitive data for this type of a hearing. So we would use it as a guide, but not as something to prove a specific point.

Q. My last question: I didn't feel comfortable in your definition "very accurate" because I could not get from you a definition from zero to a hundred percent of how much of a percentage is "very accurate". Are you willing to give that at this time?

A. We've mapped --

MR. ROMERO: Your Honor, I would just object to --

CHAIRMAN LEMAY: Just -- I'm not "your Honor".

MR. ROMERO: I'm sorry.

CHAIRMAN LEMAY: That's all right, Mr. Romero, we're a little bit more informal here.

MR. ROMERO: Chairman LeMay --

CHAIRMAN LEMAY: Yes.

MR. ROMERO: -- I would just object to some of the signaling by Counsel to the witness, either by a nod of the head or a --

MR. CARR: I would like to --

MR. ROMERO: Let me finish my objection, please, for the record.

I would just like to object to some of the signaling by Counsel to the witness, either of the nod of the head or the nodding of the head in a negative fashion, since the witness is the only one testifying.

CHAIRMAN LEMAY: Mr. Carr?

MR. CARR: And I take issue with that. I have not signaled this witness at all. I have never done it in 20 years before the Commission, and I resent somebody coming in here and suggesting I'm doing that today.

This witness has stood and said on a scale of one to ten the accuracy is a ten. If that's going to be converted into one to a hundred, he can say that. But I'm not testifying and I have not signalled anyone on any issue and never have and do not intend to start today.

CHAIRMAN LEMAY: Thank you, Mr. Carr.

I do not recall any signalling of the witness, Counselor.

MR. ROMERO: Thank you.

CHAIRMAN LEMAY: If I did, I would be the first to object to something like that.

Q. (By Mr. Romero) Would you please answer my last question, which is, on a scale of one to a hundred how accurate is "very accurate"?

A. This is the data that we have to present. It is an interpretation, and I'm -- I cannot give you a percentage in accuracy. I gave you one to ten. It's as accurate as I can make it.

MR. ROMERO: No further questions.

CHAIRMAN LEMAY: Thank you.

Additional questions of the witness?

MR. CARR: Yes, I have one.

CHAIRMAN LEMAY: Mr. Carr?

REDIRECT EXAMINATION

BY MR. CARR:

Q. Mr. Wacker, you testified about the original boundary of the unit being determined, and now it has been moved.

A. Yes.

Q. When that original boundary was determined, it was back in the era shown on Exhibit 3 as the era you describe as the slide-rule-and-eraser era; is that not correct?

A. That's right.

Q. Do you have more technology available today?

A. Tremendously so.

Q. Do you have more data available today?

A. Tremendously so.

MR. CARR: That's all I have.

CHAIRMAN LEMAY: Thank you.

Any other questions of the witness? He may be excused.

We'll take about a 15-minute recess, and I think we can start your other witness if that's all right, Mr. Carr.

MR. CARR: That would be fine.

(Thereupon, a recess was taken at 11:00 a.m.)

(The following proceedings had at 11:20 a.m.)

CHAIRMAN LEMAY: We're ready to reconvene.

Mr. Carr, you may call your second witness.

MR. CARR: At this time, Mr. LeMay, we call Terrence J. Cosban.

TERRENCE J. COSBAN,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Will you state your name for the record, please?
A. Terrence John Cosban.
Q. And where do you reside?
A. Katy, Texas.
Q. By whom are you employed?
A. Amoco Production Company.
Q. And what is your position with Amoco?

A. I'm a geophysicist.

Q. Have you previously testified before the New Mexico Oil Conservation Commission?

A. No, I have not.

Q. Would you briefly summarize your educational background for the Commission?

A. I have a bachelor of science degree in geology from Louisiana State University, have a bachelor of science degree in petroleum engineering from Louisiana State University.

I attended a one-year Amoco in-house training course pertaining to petrophysics. That involves understanding all the cutting-edge, multi-discipline technologies available to our research center and our production company, including engineering, geological and geophysical training.

Q. Could you review your work experience since graduation for the Commission?

A. I started in 1982 with Amoco and worked as a production engineer in the Lafayette offshore district for two years, from 1982 through 1984.

I then transferred into the exploration department and worked as a geophysicist from 1984 through 1988.

I held various assignments on this, involving processing of seismic data, interpreting of data, rock-property data, bright-spot technology.

From 1988 through 1989 I was transferred into the logging group and served as a log analyst for Amoco Production Company.

From 1989 through 1990 I attended Amoco Petrophysical School in Tulsa.

From 1990 through 1991 I was transferred back to the Houston office and served in a technological group analyzing shear wave estimates.

From 1991 through 1994 I served as a single geophysicist representing the north Permian Basin business unit for Amoco Production Company.

Q. And it was during this time period from 1991 through 1994 that you actually worked on the Bravo Dome unit?

A. That is correct.

Q. Was this your first involvement with the Bravo Dome?

A. That is correct.

Q. And during this period of time, from 1991 through 1994, how much of your time has actually been devoted to this particular assignment, that is, defining the reservoir limits of Bravo Dome?

A. Approximately one-third of my time.

MR. CARR: We tender Mr. Cosban as an expert witness in geophysics.

CHAIRMAN LEMAY: His qualifications are acceptable.

Q. (By Mr. Carr) Mr. Cosban, what were you initially asked to do when you started this project?

A. The initial objective was to determine if the gas-water contact would be visible on the seismic data we had over the Bravo Dome area.

Q. And were you able to do this?

A. Yes, I was.

Q. And how did you go about that?

A. We took some key seismic lines, I handed those up to the exploration processing group, they processed them for amplitude and returned the seismic sections to me. I then interpreted them, looking for gas-water contacts. I found what I felt were some gas-water contacts on these particular lines.

I then went to the engineering and the geological representatives and asked them to coordinate their understanding with me and see if this actually was the gas-water contact. It appeared to be so.

Q. And so you were able, using seismic data, to observe the gas-water contact in this reservoir?

A. On these key lines, I was.

Q. And were you using what they call bright-spot technology?

A. Yes, I was.

Q. Once you confirmed the value of this seismic work, how did you apply it on a reservoir-wide basis?

A. First thing we did was made a recommendation to our management to go out and purchase a Sparc-2 workstation, a dual-monitor Spark-2 geophysical interpreting workstation.

I then made an additional recommendation to my management to purchase the Geoquest software package to go along to interpret the seismic.

I then loaded up the 1100 miles of seismic data, approximately 60,000 points, onto the workstation and began my interpretation.

Q. And in doing that, in putting all of this information into the workstation, are you able to maintain the integrity of the amplitude of these various lines?

A. Yes, the nice thing about utilizing a workstation is, every data point is honored. The amplitude is honored and the location is honored. And so it allowed me to manipulate my data in a much more efficient manner than I would have been able to do using anything prior.

Q. And did you load all the seismic information that Amoco had on this unit into this process?

A. All the quality seismic data we had. We had two lines that were spec lines, which meant we went out and used those as test lines to come up with better acquisition parameters to obtain our additional data. Two lines were not used, but they're not referenced in the 1100 miles I continue to reference.

Q. So all 1100 miles were utilized?

A. Yes, they were.

Q. And all 60,000 data points were utilized?

A. Approximately 60,000 data points.

Q. Is this 2-D or 3-D seismic?

A. This is 2-D seismic.

Q. Is not using 3-D seismic industry standard?

A. Being the only geophysicist in the north Permian Basin unit, I've been given the opportunity to be involved in many 3-D projects, I've recommended numerous 3-D projects. And for this particular problem that we were addressing, 3-D seismic would not have been of any significant benefit, would not have been industry-accepted for this particular problem.

Q. Let's go to Amoco Exhibit Number 3. That's the sort of process map, roadmap for the hearing.

If you refer to that and then just identify for the Commission the portions of this overall study that were entrusted to you.

A. I handled the geophysical portion. That involved picking the seismic horizons, primarily the Tubb, making a depth map of this seismic information, and utilizing bright-spot technology to attempt to determine the gas-water contact.

Q. Did you also look at the top of the structure?

A. Yes, I did. I also mapped the top of the structure of the Tubb.

Q. On the easels is Amoco Exhibit Number 7, which has previously been admitted. Could you refer to that exhibit and then summarize for the Commission your involvement in actually preparing this map?

A. Mr. Wacker has previously described this particular exhibit. I won't go into great detail on it.

I utilized the seismic data -- again, the maroon lines -- incorporated it with the geological information to come up with a top-of-the-Tubb structure map. I did this in the following manner.

Approximately 20 wells had velocity information in them, velocity electric logs. I used that well control with the velocity information to correlate the electric log information to my seismic data.

Upon having this correlation, I then utilized this prior data set, and expanded from those 20 points and interpreted the entire seismic data set.

Now, I ended up with a top-of-the-structure map. However, it's in time, which all geophysical data is measured in time. Our challenge now is to convert from time to depth.

This is done by utilizing velocity functions converting your time to depth. Typically, you'll have a few sporadic velocity functions obtained from your data, and you utilize those, you have your entire data set to convert from time to depth.

That's a good method. However, if you utilize the velocity function here in the top left area of the map, over here, the top right area of the map, and there's been some lithology change, near-surface lithology change, that also affects the velocity change over there, you in effect have used the wrong velocity function and your map is totally invalid over in this area.

To overcome that, we utilized the geostatistical method which Mr. Wacker referenced in Bleupack. What we did is, we utilized all the well control from the entire data set. We generated time and depth velocity functions at every wellbore.

Now, what this does is, it makes us honor every geologic pick. It also gives us a significant amount of velocity functions throughout the entire study area, to convert from our time to depth domain.

As you can see, the well control is spread throughout this entire area in a pretty good fashion, which gave us the optimum depth map of seismic data.

Q. Did you have sufficient data to, in your opinion, tie the seismic in an accurate way to the geological information that was available on this reservoir?

A. Yes.

Q. How is this map actually different, or how could it differ from the maps that would have been generated prior to the utilization of your workstation?

A. Prior to utilization of a workstation, you typically have a large seismic line such as this one up in the northern area. You go in there and on that seismic section you would look for major changes in the slope. You pick key points along that to give you changes in slope, changes of continuity of slope, things of that nature.

But you might end up with 20, 30, 40 points on that seismic line. You're looking for significant changes.

The workstation gave us the ability to use every single data point. Every 100 feet on that seismic line we had a data point. I wasn't skipping data points, I wasn't looking for inflections. I was honoring everything.

Previously, I would have had to go in and look for major inflection points, gone in with a ruler, measured off of a ruler, measured my time.

My workstation doesn't require me to pull rulers out. It's digitized and it gives me an exact time measurement for that pick.

So I used every data point, and there's much more accuracy in my time pick and I'm able to load that into the workstation and allow it to honor all my data.

Q. What was your role in identifying the gas-water contact in the reservoir?

A. As geophysicist, I incorporated bright-spot technology to assist me in identifying the gas-water contact.

Q. All right. Is the effort that you made reflected on Amoco Exhibit Number 11?

A. Yes, it is.

Q. "Reflected" may have been a bad choice of words. It's shown on Exhibit 11.

Initially, Mr. Cosban, go through the exhibit and explain what each of the component parts are, and then I'll ask you to go back through and review in detail what this shows.

A. This exhibit shows some seismic characteristics, the northeast quadrant of the Bravo Dome area.

The top left-hand portion, we have a top-of-Tubb structure map which Mr. Wacker referenced. Again, the seismic in the maroon.

Indicated here is the graben. Also indicated is some white circles. These white circles indicate wells that were utilized in the geologic cross-section in the lower right-hand corner.

Next to those circles is a solid dot with a number on it. That simply indicates what the number of that well was in this geologic cross-section, again, down here on the right-hand. For example, 1, 2, 3, 4, 5; 1, 2, 3, 4 and 5. The dashed line just indicates that the geologic cross-section was done in that fashion.

Over here we have a red box in the left-hand area of this map. That goes around the Mapes Basin.

Below this top left-hand area, in the lower left-hand corner, we have a blow up of that red box, the insert, again showing the detail over Mapes Basin.

To the right of that is an explanation, and below that is a seismic section and amplitude showing the structure, seismic structure associated with the Mapes Basin.

The right-hand portion of this exhibit deals with bright-spot technology. The top line is a key seismic line, my PCW 30. On that seismic line we have three black boxes, A, B and C. These are shown below line PCW 30 as blow-ups.

Additionally, on this top seismic cross-section we have the wells annotated that correspond to the geologic cross-section below, and we have the arrows pointing to where the boxes correspond.

The center portion of the right-hand area are the three key blow-ups of the seismic line, PCW 30. They correspond to the box annotated A, B and C. They're an amplitude, displays of amplitude.

Briefly, to discuss the amplitude, the amplitudes on this, the strong color indicates a higher amplitude, a stronger reflection coefficient. The lower color -- oranges, yellows -- indicate a lower amplitude, lower reflection coefficient. I'll talk more about this in a few minutes.

Also indicated are where I picked the gas-water contact off the seismic.

Below that is a geologic cross-section, tying the geologic and production information to the seismic interpretation.

Q. Now, the geologic cross-section is just to confirm the seismic. You just tied to the geology, and those are the wells you used?

A. That is correct.

Q. All right. Let's go to the lower left-hand portion of the exhibit, and would you explain to the Commission how seismic was used to define Mapes Basin?

A. Very simply, seismic sections cross the Mapes Basin. As I discussed earlier, we generate a map horizon and we follow that reflector, in this case the top of the Tubb.

As you can see, there's a significant decrease or lowering of the top of the Tubb in the central portion of the seismic section, in the lower portion. This is indicative of a low. This corresponds to the Mapes Basin, which corresponds to the topographic area, features in the area.

This simply shows that there's a change in the regional dip, and there certainly is below in this area, based on the seismic data.

Q. So seismic information was used to define the boundary, the non-productive area in Mapes Basin?

A. It was used with the engineering and geologic understanding also to define the non-productive area.

Q. All right. Let's go to the right-hand side of this exhibit. Would you review how the seismic was used to define the graben area in the northeastern portion of the unit?

A. This seismic line, PCW 30, crosses the horst and the graben. It's a key line in utilizing bright-spot technology.

As you can see, the horst is indicated on the seismic in the graben. These blow-ups, which we'll talk about in a few minutes, are just showing you what the seismic so you can visually see what I went through in interpreting amplitude strength.

Before that, let me briefly just talk about bright-spot technology and what it is.

Velocity is an integral part in seismic. First let me talk about velocity variations and what causes those.

A velocity variation is going to be a result of changes in your mineral constituents, mineralogy, changes in the way these mineral constituents are placed upon each other, a building-block fashion, and the fluid within the pore throats.

If you have a reservoir where the mineral constituents in the blocking, building blocks of this, stay the same, you can indicate changes in the reflection coefficient or velocity are going to result in an amplitude change.

So in this situation, going from a brine sand to a gas sand was what was causing my velocity change.

My velocity change shows up on my seismic sections as an amplitude change. My brine sands are these low orange-to-yellow pores in the Tubb. And my gas sands, because the velocity has changed, I have a higher reflection, end up being these strong amplitudes as we come up onto the structure.

These three lines here all show examples of picking the gas-water contact. They've all been annotated with these purple arrows pointing to where the reflection coefficient changes and where I chose to pick the gas-water contact off of the...

Below that we have the geological data, which substantiates and says that this was indeed a gas well. These were the lower amplitudes, corresponding to a brine sand.

Q. Mr. Cosban, if you go to this exhibit, between the blocks that have been blow-up and identified as A and B, you have printed in purple, "Bright reflector shows gas". And there's an arrow that goes from that into both of the blocks, but I'd like you to point where the one in Exhibit A extends into exhibit -- At the bottom of that there is a red spot. What is that?

A. That is where the amplitude has increased and where I have picked the gas-water contact.

Q. All right. From that point, if we move on the seismic data to the right, we see the color moving into yellow and orange. What does that tell you is in that portion of the reservoir?

A. When the amplitudes diminish, that indicates to me that you're in a wet sand.

Q. So that would be water?

A. That would be water.

Q. If you go then to the left on that seismic line, the amplitude increases and it becomes much brighter. What does that tell you you have?

A. It indicates to me that's where your gas is.

Q. And then where those -- where you have picked those two to meet, you have drawn a red line across these blocks, have you not?

A. Yes, I have.

Q. And is that your pick of the gas-water contact?

A. That is my pick.

Q. Let's go now to the next exhibit, which is Amoco Exhibit 12.

Okay, let's again just explain what we've got on this exhibit, and then we'll go back to the data.

A. The seismic characteristics in the northwest quadrant of the Bravo Dome area.

In the center portion of this we have an indicator map showing what I'm going to be discussing here, primarily over the granite uplift in the northern area.

Off to the left of that, the top left-hand corner, there's a blow-up showing a granite uplift in this red color, the seismic lines in the maroon, and again a geologic cross-section corresponding to the white line, the wells circled in white and the corresponding number to that well below it in the solid dot, again corresponding to the geologic cross-section in the lower left corner.

On the right, lower-right half of this exhibit, are three seismic lines, PCW 16, PCW 13X and 81. These are three seismic lines that cross this granite uplift in this area, PCW 81, 16 and 13. We utilized these to pick the granite extent under this area.

Q. All right. Now, let's go to the seismic cross-sections, and if you would run through those and relate them back to the diagram in the upper left and show just exactly how this information was utilized to identify that non-productive area in the unit.

A. Again, once mapping the top of the Tubb horizon throughout the area, it became obvious to us that there were some areas where this Tubb came up onto a structure, appeared to diminish, and we were able to see these granite uplifts, granite knobs, on the side in this area.

This hatched line is indicative of what I have interpreted as a granite knob.

The Tubb has come up, diminished on one side, and picked up again on the other side. This is line PCW 16, a dip line.

Another dip line, PCW 81, indicated in the lower right-hand portion, is again the same thing. Amplitude, seismic cross-section shown on the Tubb, an indication of the granite uplift in that fashion, the red line, and the termination up against...

The strike line, PCW 13, is shown in the center, and again the red hatched on the granite uplift and the additional picks for the Tubb, the green throughout the site.

To confirm this, we have a geologic cross-section in the lower left-hand corner. These numbers correspond to the numbers in the middle seismic.

Based on the geological information in the area, it was shown that indeed the Tubb did come up onto the structure, thinned and in essence wasn't there.

Q. So your exhibits, 11 and 12, show how seismic has been utilized, tied to geology, to define the reservoir in the Bravo Dome unit area?

A. That is correct.

Q. Have you completed your work in the -- done those items identified on Exhibit 3, the process chart?

A. Yes, I've completed my work, and I did a geophysical data, picking the horizons, making a depth map, applying bright-spot technology in an effort to identify the gas-water contact and to generate a top-of-depth structure map for the Tubb.

Q. Have the seismic methods and the interpretation that you've made, in your opinion, been consistent with industry practice and standard for evaluating a reservoir of this nature?

A. Yes, they have.

Q. Were Exhibits 11 and 12 prepared by you?

A. Yes, they were.

Q. Will Amoco also be calling engineering and land witnesses to review those portions of the presentation?

A. Yes, they will.

MR. CARR: At this time, Mr. LeMay, I would move the admission into evidence of Amoco Exhibits 11 and 12.

CHAIRMAN LEMAY: Without objection, Exhibits 11 and 12 will be admitted into the record.

MR. CARR: And that concludes my direct examination of Mr. Cosban.

CHAIRMAN LEMAY: Additional questions of the witness? Commissioner Weiss?

COMMISSIONER WEISS: I have no questions.

CHAIRMAN LEMAY: Commissioner Bailey?

EXAMINATION

BY COMMISSIONER BAILEY:

Q. Would you expect the gas-water contact line to move over time according to the production of CO_2 from the reservoir?

A. I have an engineering background, but we have much more qualified individuals here to address that question.

Q. Okay. But you did all of your work during one time period, and you did not see any differences in where you would put that gas-water contact from one year to the next over the same line?

A. The line was shot at one point in time. I'm not sure I understand your question.

COMMISSIONER BAILEY: That answers it right there.

That's all.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. Follow-up on Commissioner Bailey's question. When were these lines shot?

A. They were acquired in 1983, half of them approximately, and then again in 1985, the second portion of them.

Q. Okay. In trying to define the reservoir, does seismic aid you at all in delineating that convergent line that we just heard about where the tight Tubb goes into porous Tubb?

A. There was some indications on seismic, but that was pretty much a geological call.

Q. That's a geological pick, no seismic confirmation on that pick?
A. No, sir.
Q. Seismic confirmation pick on structure?
A. Yes, sir.
Q. Oil-water contact?
A. Yes, sir.
Q. Anything else?
A. No, sir.

CHAIRMAN LEMAY: That's the only -- all the questions I have.

Additional questions? Yes?

MS. BELL: My name is Diane Bell, and I was wondering if there is some information that's available for us to have, the same that the Commission has.

CHAIRMAN LEMAY: It's a matter of public record. I mean, I might address that. The exhibits are a matter of public record and available for review.

Mr. Carr, do you want to comment on what is available, Mr. Carr?

MR. CARR: Yes, and I will tell you that -- I will put a pad down here. We brought exhibit books in this morning and had a box of them. We came back and there were two left, and we don't know where they went. I'm not suggesting any -- I will tell you that -- I'll put a pad here, and if you will put your name and address on that, I will see to it that we mail you a copy of all of the exhibits, the small ones, so you can have those to work from.

MS. BELL: Thank you very much.

CHAIRMAN LEMAY: Additional questions?

Is Mr. Romero still here? Does he want to --

FROM THE FLOOR: He had to leave.

CHAIRMAN LEMAY: He had to leave? Okay.

MR. CARR: Maybe just to --

CHAIRMAN LEMAY: Yes, follow-up, Mr. Carr?

MR. CARR: -- on redirect.

FURTHER EXAMINATION

BY MR. CARR:

Q. The seismic lines, you testified, were acquired in 1984 and 1985; is that right?

A. 1983 and 1985.

Q. All right. Is that the only data that you utilized to evaluate the reservoir?

A. We utilized the seismic data in conjunction with the electric log data.

Q. And how recently have you acquired electric log data?

A. Electric log data has been coming in as recent as last year with the infill package.

Q. And so some of the information you used was acquired in 1993?

A. Yes, sir, it was.

MR. CARR: That's all I have.

And Mr. LeMay, I've got a pad and I will put it here, and I could give you my set of exhibits after the hearing, and if there are others I'll see to it they're mailed.

CHAIRMAN LEMAY: Are there additional questions of the witness?

If not, he may be excused.

It's a good time to break. Let's resume at one o'clock.

(Thereupon, a recess was taken at 11:46 a.m.)

(The following proceedings had at 1:00 p.m.)

CHAIRMAN LEMAY: We shall resume. And Mr. Carr, you may call your next witness.

MR. CARR: At this time we call Mr. Collier.

<u>JAMES W. COLLIER</u>,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Will you state your name for the record, please?

A. My name is James W. Collier.

Q. And where do you reside?
A. Houston, Texas.
Q. By whom are you employed?
A. Amoco Production Company.
Q. And what is your current position with Amoco?
A. I'm a senior petroleum engineering associate with Amoco.
Q. Would you briefly review your educational background?
A. I obtained a bachelor of science degree in petroleum engineering from Texas A&M University in 1972.
Q. And since that time, for whom have you worked?
A. I've spent my entire career with Amoco Production Company.
Q. And has all of that experience been basically in engineering-related assignments?
A. Yes, sir, that's correct, it has.
Q. What has been your involvement with the Bravo Dome carbon dioxide gas unit?
A. For the last eight years, I provided engineering support from the regulatory affairs group in Houston.
I have testified -- presented the engineering testimony at the spacing hearing in 1987, which resulted in the Commission issuing an order making the temporary 640-acre spacing rules permanent.

Also, I've testified at two of the three four-year reviews that Mr. Carr has reviewed to earlier today, from the engineering standpoint.

Q. At the time of that prior testimony, were your credentials as a petroleum engineer accepted and made a matter of record?

A. Yes, they were.

Q. Are you familiar with the engineering portion of the effort made by Amoco to determine the productive limits of the Tubb formation in the Bravo Dome unit?

A. Yes, sir, I am.

MR. CARR: Are the witness's qualifications acceptable?

CHAIRMAN LEMAY: His qualifications are acceptable.

Q. (By Mr. Carr) Mr. Collier, let's go back to Exhibit 3, and I'd like you to refer to that exhibit and then just identify the portions of the overall study that you will be reviewing here this afternoon.

A. I'll be reviewing, if you look at Exhibit 3, the petrophysical and reservoir engineering aspects of this study.

Q. And specifically, what were you attempting to determine, or what were you attempting to define?

A. The role of the petrophysical and reservoir efforts was to fine-tune the gas-water contact, as has been testified to here this morning, by going through the steps shown on this exhibit.

Q. What particular specific things were you looking for?

A. I was looking to define minimum porosity or porosity pay cutoffs, permeability cutoffs, and maximum saturation of the water that we could consider productive, below that level which was productive of CO_2, so establishing pay cutoffs.

Q. Were the porosity cutoffs utilized to define and eliminate the acreage which was shown on the non-productive wedge in the Tubb in the southern portion of the reservoir?

A. Yes, sir, it was.

Q. Was that information also utilized to calculate appropriate water saturation figures for this unit?

A. Yes, sir.

Q. When you developed water saturation information, was that information then utilized in refining and further picking the gas-water contact throughout this formation?

A. Yes, sir, it was.

Q. And why did you need to refine the data on the gas-water contact?

A. The gas-water contact is -- First of all, it's not a flat surface. It is tilted, we know this. But beyond being tilted it's also -- for lack of a better term, has undulations in it.

The role of the petrophysics and engineering was to fine-tune that pick based on core and log calculations, to refine the line and make it as accurate as we possibly could, and that's the role of the engineer in this study.

Q. Now, Mr. Collier, would you identify what has been marked Amoco Exhibit 13, the large exhibit on the easel, and then go to that exhibit and generally review the information set forth on the exhibit?

A. Yes, Exhibit 13 is a section showing log core, capillary pressure, and photographs of cores and thin sections. I'll just move down to the exhibit. I've shown a lot of information on this. What I'll try to do is tell you what's on here.

The far left-hand side is a gamma-ray log, and this is a typical well, and the reason we've chosen it is, it has core information on it.

It was drilled into the granite, through the Granite Wash into the granite, about 60 feet of penetration into the granite. So it's a whole log section through the Cimarron anhydrite and all the way through the granite.

The color track here is a lithofacies log with different, as you can see, different colors on it, the yellow being our productive sandstone pay. This is the well sorted sandstone that you heard talked about this morning.

The brown color is shale.

The Cimarron anhydrite is shown here in a purplish color.

We also have salt sections shown in green.

The granite is in red.

And the Granite Wash, just above that, is an orange color.

Moving over to the right is a track where you can see the purple color. That is the log density porosity, bulk density log, as measured on the well. And then there's a red curve overlying that, and that is our core measured porosity on the same well.

This red here is -- it shows measured core permeability, laboratory measured. These plots are calculated pressure data from samples taken --

Q. When you're talking about the red here, you're talking about the red area directly below the core permeability legend on the top of the log?

A. That's correct.

Q. And then we're moving now to the right on the exhibit, and we're looking at four graphs.

A. The four graphs are mercury injection capillary pressure data from samples, core plug samples, taken from each of the different lithologies or zonations.

And then to the right we have core photographs again from the different zones and lithologies.

And then on the very far right are thin sections showing the details of the grains of the rock.

Q. And these thin sections, again, are magnified sections from the core?

A. That's right.

Q. Has the magnification on each of these been identical?

A. Yes, it has.

Q. Let's go back and let's work through the log section and review what each portion of the log -- the information that it provides?

A. Okay, on the left is a gamma-ray log, of course measuring naturally occurring radioactivity.

Some of the features I want to point out is the fact that the tight streaks or shale streaks are easily identifiable here. You have a pay that can be characterized as consisting of packages or bodies of sandstones. You can see that the intervals of shaliness or dirtiness show up quite well on the gamma ray.

You can also see by looking at just the general trend of this gamma ray that there's a curvature to it, there's a definite character. Call it a hook if you will.

This is indicative -- It indicates to us a general increase in dirtiness, consisting of shales, cements, and we have confirmed this through cores and lithology testing or petrophysical testing.

Okay, moving over to the right, the cored interval is shown in the stippled red track. This well was cored from the upper Tubb, about halfway into the upper Tubb, down into the middle Tubb, and this encompasses quite a few of what I've referred to as these porosity packages.

You can see that the middle Tubb is not only the thickest identified lithological zone, but it has the best pay, it has the best porosity. These porosity bodies consist of packages of maybe 20, 30 feet of good porous thick pay. These are the well sorted sandstones.

As you move into the lower Tubb you see a definite degradation or deterioration in that porosity. We neither have the absolute porosity that you have in the middle Tubb, nor do you have the thickness that was developed in the middle Tubb. You do have pay, we've identified pay in the lower Tubb, just as we have uphole. But the quality generally does deteriorate.

The core porosity which we used to calibrate our density logs is also shown here, and if you can see that from the bench I'm not sure. We do have a very good match between core porosity and bulk density log porosity.

The red bodies here are the core measured permeability, next to the lab. And what's important to note is that our core's basic permeability directly relates to the size and thickness of these porous bodies. So we have a good relationship between porosity and permeability; it's pretty much a direct relationship. Not a straight line, but it is a direct relationship.

Q. All right. Let's go now to the capillary pressure graphs in the central portion of the exhibit.

A. The four graphs here are mercury injection capillary pressure. There were 88 core plug samples analyzed in the lab to generate this information.

Now, about 59 of these samples are from the middle Tubb. Of course, that's the thickest identified lithological zone. There were several from the upper Tubb, about 19 from the lower Tubb, and five or six from the Granite Wash.

If you look just in general at these four curves, now what we've plotted here is mercury injection pressure on the left, versus mercury saturation. This is the non-wetting phase, of course.

This simulates the introduction of CO_2 into the reservoir, when the CO_2 formed in Bravo Dome field. So what we're trying to do is simulate the movement into the pores of that non-wetting phase, and that's what this laboratory data measures.

If you look just in general at the data, you can see that for each zone there's a wide range of permeability, as you can see in the spread of the plots, and each curve is one individual core plug sample. This tells us that we have a range in permeabilities all through this Tubb pay, the upper Tubb, middle Tubb, lower Tubb, and even Granite Wash can show a range of permeabilities.

What we're looking for is -- Of course, we use this data to measure pore-throat radii. The better sorted the sandstone grains are, the better distribution of pore throats you have, and the more permeability and potential for pay you would have.

You can see, I think probably, that the bulk of our samples in the middle Tubb indicate a very small pressure increase necessary to increase mercury saturation or non-wetting phase saturation. This tells us we do have a very well sorted sandstone.

Some of the samples in the upper Tubb show that too. You can see that the sample to the far right actually is indicative of pore plugging, either salt or anhydrite, maybe a dolomitic cement. That's this curve here. It actually took a high pressure to introduce any mercury into the pore system for that sample.

Moving down to the lower Tubb, again we see some samples showing the same well sorted characteristics but many more samples showing poor sorting, evidenced by the fact that it took much more of a pressure differential to flood the core with mercury.

Even in the Granite Wash, we see evidence of some positive grain sorting and some spread in permeability differentiation in that model.

Q. Now, on the far right we have some photographs. Could you review those and relate them to the capillary pressure graph to which they are related?

A. Everything I've described to you so far supports the fact that the best pay is -- the better sorted the grains are, the better the pay is. This is pretty simple petroleum engineering.

You can see that visually. In the upper Tubb we have two samples. One core sample shows a lot of secondary plugging of pores. This is not good rock, this wouldn't be considered good pay rock.

However, right below that, again from the upper Tubb, you can see a light there, and this is because we have a fairly uniform grain size, it's well sorted, the capillary pressure curve from a rock that looked like that would be to the left on this graph.

The petrolized thin section, you can see some porosity. The porosity is shown by the blue on these thin sections. What we're looking for is a continuous phase of that, an even distribution of that blue phase.

Moving down into the middle Tubb, this is what we've identified as the best pay. You can see on this photograph of the core a very evenly sized grain sample. You can even see some reworking of the grains probably from a -- maybe a stream environment or an eolian environment.

And again on the thin section you can see this is definitely the best pay. The grain sizes are very uniform. You've got a continuous phase of the blue phase, which is the porosity, and it's very effective porosity. The pores are well connected.

The lower Tubb, the pay does start to deteriorate, and you can see that both on the core and the thin sections.

I think you can see on the core the nature of the porosity. Some of it has been filled. It's been overgrown with intercrystalline growth, some feldspars and dolomitic cements. You can actually almost see with the naked eye different grain sizes. You can see that it's not the continuous well sorted sandstone that we saw updip, uphole.

And that's shown on the thin sections. You can see a poorly sorted or bimobile sorting where we've got two or three different sizes of grains. There is some porosity, but it's not what you would consider as effective porosity as it is from the middle Tubb, but it does have pay characteristics to it.

And then moving down to the Granite Wash, we have included this as part of our pay definition, but you can see that the rock really is not as conducive to good reservoir quality as it is uphole. We've got a lot of feldspar, crystalline growth, a lot of moldic porosity, a lot of secondary plug porosity too.

Q. Now, Mr. Collier, if I look at this exhibit, this exhibit actually supports the zonation within the Tubb that Mr. Wacker testified to?

A. Yes, sir, it does.

Q. The capillary pressure curves also go to that, but they provide you with information that you can then use later on in estimating porosity cutoffs, things of that nature?

A. Yes, sir.

Q. And basically what this also shows is that we do have reservoir-quality rock throughout the interval we're talking about? Is there anything that --

A. Yeah, that's the point I want to make, is that from the base of the Cimarron anhydrite through the Granite Wash there is a reservoir-quality rock. It's the nature of the rock to have some sandstones in it. It's what has happened to the sandstone as it was worked and reworked when it was deposited, as well as what has happened to it diagenetically, after it was laid down. We do have sandstone that are conductive throughout the entire Tubb.

Q. All right. Would you return to the witness stand, and I would next like you to refer to Exhibits 14, 15 and 16. These are three graphs, they're interrelated, and if you would first identify them and then take us through them and explain what they show.

A. 14, 15 and 16 are cumulative plots from over 4000 individual core points, co-analyzed points. They're, if you will, percentile curves; they're cumulative percentile curves.

14 plots on the left-hand side cumulative permeability feet, or KH, versus permeability. This is a tool the reservoir engineer uses to estimate a permeability cutoff for poor reservoir, and what he's looking for is a point of inflection.

This is, I will point out right now, a subjective tool; it is by no means the final say in what the cutoff would be. But it does target, in looking at this, about a one-millidarcy permeability cutoff for this sandstone, below which there is no effective flow in the reservoir.

Moving on to 15, entering that -- This is a plot of cumulative core porosity feet, or ϕh, versus permeability. And entering that plot with the one-millidarcy pay cutoff, you can see that we would eliminate somewhere above 15 percent of the total ϕh from this reservoir, using this technique. I think the actual number is about 18.6 percent.

And entering the next graph, which is a plot of cumulative ϕh, porosity feet, versus porosity, using that 18.6 cutoff we have generated a porosity limit of about 12 percent.

This allows us from a reservoir standpoint to, if you will, zero in on what we think is the limits of the effective pay in this reservoir, effective porosity.

Q. So using these three graphs and the method you've just shown, you're able to at least establish initially that an appropriate porosity cutoff in this reservoir would be in the neighborhood of 12.1 percent?

A. Yes, sir.

Q. Okay. Let's go to the next exhibit, and could you explain what that is and how you used that to address the question of porosity cutoff?

A. All right, Exhibit -- This is labeled 17A, which is a plot of percent porosity versus percent water saturation from core analysis.

This is a -- represents a wide range of data points through all the different -- the four different lithological zones that I've talked about. Again, we're trying to reach some point of concurrence or corroborate what we believe is the minimum net-pay parameters for this reservoir.

You can see that this data falls mainly in two families of plots -- of points, one being to the upper left-hand side of the graph and the other family of points being down to the lower right-hand side.

I've drawn a curve through this. By no means is that a mathematically best fit; it's just visually to show you the relationship of core porosity versus measured water saturation. And this would indicate to me that at about a 12 percent core measured porosity that correlates to about a 65-percent water saturation.

Q. And the information on this exhibit was actually derived from the capillary pressure graphs that were shown earlier?

A. That's correct.

Q. All right. Let's go to now Exhibit 17B. What is this?

A. Okay, 17B, again, is the third method we've used to try to identify a minimum net pay porosity for this reservoir.

Using the capillary pressure information, that is, injection pressure versus non-wetting phase saturation, we can convert that data to a height above free water, because at free water we define capillary pressure -- it is defined as zero. So with increasing capillary pressure you can calculate height above free water mathematically for different porosity values.

If you look at this graph, it tells us that at a porosity of eight percent we never, in essence, escape the hundred-percent water saturation. It always calculates -- At any footage above that free water, it calculates 100 percent water saturation. And there's a reason for that.

The reason is that this is a strongly water-wet rock. This is a typical sandstone, very water-wet. The porosity at eight percent does not contain enough interconnected pore-throat radii of a size big enough for the CO_2, which is non-wetting, to have pushed the water, initial water, out. So anything that's eight percent porosity, this data shows us, remains saturated with water. The CO_2 never did drain that water out.

If you look -- move over to the left at 12 percent porosity, we see a departure from that. What that says -- and this is from capillary pressure data -- is that at 12 percent you start to see enough pore throat -- connected pore throats, big enough size for that wetting phase, the water, to be forced out of the pores by the CO_2, which is the non-wetting phase, so that you calculate a departure from a 100-percent water saturation.

This, in conjunction with what I've showed you, gives us a lot of confidence that at 12 percent porosity and above, you will have CO_2 in some distribution. Below 12 percent porosity, you'll have only water; there won't be CO_2.

Q. Mr. Collier, you've identified that 12 percent porosity cutoff using three independent methods?

A. That's correct.

Q. All right. Now, let's turn to the part of your study that focused on the calculation of water saturation. Would you go to Exhibit 18 and identify that for the Commission and then review it?

A. We have -- Yeah, this is a relative permeability curve, expressed as a percent to -- of permeability of each phase to its specific permeability. In other words, it's a plot of the relative permeability of both gas and water, versus the saturation of water, again water being the wetting phase.

So what's the curve labeled Krg is the relative permeability expressed as a percent, plotted, versus water saturation. The Krw is the relative permeability to water, which is the wetting phase, again expressed versus its saturation.

You can see that we measure nominal or practically negligible relative permeability to gas at a wetting-phase saturation of roughly 65 percent. That's shown at the bottom of the chart here.

The wetting-phase saturation, or saturation to water, really, even at 65 percent saturation, is one percent of its specific permeability.

If the core -- Or if the rock were 100 percent saturated with water, it would have some specific permeability. If it's 65 percent saturated with water, it has only one percent of the permeability at 65 percent saturation.

What this tells us is several things. It tells us this is a very strongly water-wet system. It's extremely water-wet. The water holds very tightly to the rock grains. The CO_2 occupies the pore space between the rock grains.

One other thing it shows us, if you look at the shape of the relative permeability curve, from the literature this tells us that it is a very well consolidated sandstone.

Q. So if I understand what you covered so far, is that if we're going to have a CO_2-productive reservoir, we've got to have porosity greater than 12 percent, and we've got to have water saturation below 65 percent; is that right?

A. Yes, sir, that's correct.

Q. All right. Let's go now to Exhibit Number 19. Could you identify this for the Commission, please?

A. Yes, Exhibit 19 is -- Of course, in order to analyze both density logs, we have to know what matrix density is, we have to know what our fluid density is, to be able to calibrate the log.

This is a sample of -- I wish I could tell you. This comes from 41 different wells. I don't know how many individual core plug samples this is, but it's in the hundreds, to generate a relationship between core-measured porosity and measured bulk density.

If you look at the equation for porosity by using bulk density, it's simply the matrix density minus the bulk density, divided by the bulk density -- matrix density minus fluid density.

So in other words, where, if you look at the left-hand side of the chart, this is a zero-percent porosity, this is where matrix density equals bulk density. You have a container, the container contains some rock and some void space.

So far to the left, we're looking at zero percent porosity. To the extreme right is 100 percent porosity, where whatever is occupying the pores or fluid density is the same as bulk density.

And that relationship, that best-fit line where it intersects those points of zero porosity on the left and a hundred percent porosity on the right, gives us our fluid densities and our matrix densities.

These are the values: the 2.68, which is a grain density or matrix density for sandstone, which is what we have, and the fluid density of 1.04 -- this is grams per cc -- is our fluid density in this reservoir.

These are the calibration parameters we've used for our density logs.

Q. What you've done here is, you've established a relationship with this graph between the density and the porosity; is that right?

A. That's right.

Q. And once you know that relationship, you can then from a density log calculate or calibrate the porosity?

A. That's true.

Q. Okay. Let's go now to Exhibit Number 20. Could you identify that?

A. Exhibit 20 I think the Commissioners are familiar with, probably. This is a simple Archie's equation.

This is the relationship that we have used to calculate water saturation in this reservoir. We feel we can do this because, of course, this is an industry standard, this is a well-sorted sandstone. We feel that the relationship of Archie's equation applies very well to this rock.

We've identified the parameters here in Archie's equation, where F is the formation factor, which is simply a, which is a constant, over porosity to the m.

a normally is found to be 1. It can vary slightly from that; that's not a critical part of this formula. But we've assumed that a is equal to 1.0 for purposes of calculating water saturation.

R_w, which is a very critical parameter, formation water resistivity, this is typically measured in the field.

m, a laboratory-determined cementation exponent.

n, a laboratory-determined saturation exponent.

a, the constant I mentioned.

And then the Archie's equation, through substituting, can be expressed as the nth root of $a \cdot R_w$ over porosity to the m times R_t, where R_t is the true resistivity.

Q. Let's go now to Exhibit 21, and if you could use that exhibit and show how the cementation factor was determined.

A. Yes. This, as I mentioned, is an experimentally derived value. At each porosity we measure this relationship of F versus porosity, and what we've plotted is that relationship with F, formation factor, being described as 1 over ϕ to the n, versus porosity on the bottom of the chart.

Through arranging the terms of these parameters, you can develop a straight-line relationship. That's what's shown on this plot. This is a logarithmic relationship with the slope of that line, shown here on this plot, being our m value.

This is a consistent number. This is the number we've used for our log analysis in Bravo Dome, that being 1.776, and this was generated from 61 plotted points.

Q. And you do not anticipate this figure to change across the reservoir?

A. No.

Q. All right. Let's go to Exhibit Number 22, and I'd ask you to refer to that and explain how the n exponent was derived.

A. All right. The n exponent is the saturation exponent. Again, this was measured in the lab. This was measured both by Amoco's Research Center Core Analysis lab, as well as Core Laboratories.

We've made these measurements that simulated net confining pressures, so it is indicative of what's in the reservoir, and also controlled salinity conditions.

This is simply measured off a core sample. It's a prepared core sample measured at a number of different water saturations. And for each water saturation we measure the ratio of R_o, which is resistivity of the rock a hundred percent saturated with water, over R_t, which is the true resistivity.

And we can arrange the terms in Archie's equation to get a logarithmic relationship again of this resistivity index, which is R over R_t, shown on the left, versus the log of saturation on the bottom of the chart.

And again, this best-fit relationship, the slope of that line, is our n exponent. For Bravo Dome, that's found to be 1.286. This is what we used in Archie's equation, and again this is consistent across the field. That is a rock property versus saturation, so it doesn't change.

Q. All right. Let's now go to Exhibit 23. We have a large copy of that to put on the easel, and I'd ask you to, when we get it up, identify it and review it for the Commission. What does it show?

A. This is a contour map of Bravo Dome, contoured on R_w. These are measured R_w's from numerous samples from selected tests, formation waters.

I've testified already that the m exponent doesn't change in Bravo Dome.

The n exponent doesn't change.

But to complete Archie's equation, we have to know R_w. And I think you can see from this map that our measured R_w's do change. There is a definite gradation of R_w's from our measured analyzed water samples.

And that brings up the question, were these samples valid samples? Were they contaminated? There's all sorts of means that a sample cannot be representative of the true formation water. It can be a filtrate sample, which would be completion fluids, kill fluids. Maybe the rock itself had some dissolution as the pressures and temperatures changed. That could affect your formation water resistivity.

So not having seen -- Let me just tell you what we've got here, is, we've got lower R_w's indicating more salinity down in the southeast. But coming up the east side of the unit and across the north we see much higher R_w's, indicating brackish or much less saline waters. And then there seems to be, if you will a horseshoe-shaped trend of R_w's, indicating less saline or higher R_w's coming through here. And this is something we wanted to confirm, you know, we -- Not being able to explain why this happens, we wanted to check these values before we made calculations of water saturation.

Q. Okay. Let's move to your next exhibit and explain to the Commission how you went about confirming the information shown on Exhibit 23.

A. We use a technique that's been around for 25 years, maybe, called Pickett plots. This is just a sample of one; we have many of these.

A Pickett plot -- what we have, I'll show -- I'll tell you, on the left-hand side is the log of porosity, and on the bottom part of the graph, on the bottom scale, is log of R_t. This is our deep resistivity. This is a log-measured value.

Again, this is strictly a derivation from Archie's equation, which I've already showed you. You can arrange the terms and substitute into Archie's equation, and by plotting these points you can determine what R_w is.

Knowing your m exponent, which we already know, knowing the points that line up that are a hundred percent water-saturated zones, you can draw a line to those points. And on this graph those points are the ones farthest to the left. So the line, the angled line farthest to the left, represents a line of 100 percent water saturation.

Where that line intersects a porosity of a hundred percent -- and in this case, the very top of this chart, you can directly read -- this is a visual solution to this equation; you can directly read R_w.

In this case, if you take that 100 percent water saturation line up to the 100 percent log of porosity line, I would read about a .04 R_w, and that's what this shows us, is a .04 R_w.

We now have all the factors that we need to calculate water saturation.

You can scale off on this logarithmic curve and draw lines parallel to the hundred percent line for 90, 80, 70, and so on, percent water saturations. So the points lying further to the right are points of lower water saturation; the points to the left are the hundred percent water saturation lines.

And in doing these charts, we honored the 12 percent porosity cutoff. We honored what was pay. In other words, there is nothing in here that is not pay. There is no non-pay rock lithology in this plot.

On the right-hand side is a log.

The green log is simply our R_t, deep resistivity or induction log measure.

The red curve is our porosity from our bulk density log.

The scale on the -- of R_t curve goes from about .2 to 2000 ohms.

And the porosity scale here is roughly .1 up to about 30 percent porosity.

And you can see we -- Again, we see packages of porosity, as I've showed you earlier.

Q. Now, Mr. Collier, you have used these Pickett plots across the unit area to confirm the R_w values that are shown on Exhibit 23?

A. I've used these to confirm that we have a change in R_w that we've seen from our samples.

Q. And using this, can you tell us if you have confidence in the log-derived water saturations that we have shown?

A. Yes, sir, I do.

Q. Let's go now to the next exhibit. It's Exhibit 25.

Could you first tell us what this is and then review it for the Commission?

A. Exhibit 25 is just a histogram or distribution of the R_w's from the Pickett plots that I've just showed you.

And you can see we do have a range of R_w's on this graph. It shows anywhere from .07 all the way up to 5.

You can see the distribution is much heavier on the end of the chart where R_w is lower, indicating a more conductive water, more saline water. But we do see a freshening of the water, and geologically we haven't defined what has caused that yet. That's the subject of more study. We haven't defined why that happens; we just know that it does happen.

And the reason this is important -- and I'm trying to make sure that we understand that we didn't use some average R_w, some assumed R_w; we used specifically calculated R_w's from Pickett plots on every well to calculated water saturation.

But they do show to be on this end of this histogram.

Q. Okay. Using Archie's equation, with the data that you have just reviewed, what you've shown us is that you've been able to determine water saturation in the Bravo Dome on a well-by-well basis?

A. Yes, sir.

Q. All right. Let's go now to Exhibit 25 [*sic*], the log section, and I'd ask you to go to this and show us how you go about picking a gas-water contact.

A. If you look at the center part -- Now, this is a digitized log, computer-generated/analyzed log -- or a computer-analyzed log.

In the center you see there's two tracks. The one to the left, again speaking of the center of this exhibit, simply shows our resistivity curves. It shows the microspherically focused curve, which reads resistivity and what we would consider to be near wellbore or a flush zone.

It reads a deep resistivity curve, which we would consider to be R_t, beyond that flush zone.

And then it shows what R_o is. That is resistivity at a hundred percent water saturation.

Where those three curves would overlie each other or come together, we would say that would be a very high water saturation zone.

If you look down -- let's see, on the footage -- You can see the footage tracks over to the tracks over to the left. But if you look at about 2480, I would say, these curves almost track each other. I would say that is a zone of a hundred -- That is the free water level. That is 100 percent water saturation from that point.

Moving up from that, you see a divergence, and the reason you see a divergence is the pores are partially flushed with filtrate, and what we've flushed is indicative on the saturation curves.

If you move over to the next track to the right, we've shown what we call S_{xo}, which is the saturation of the flush zone. And we show S_w, which is our calculated water saturation from the deep resistivity curve and our known R_w.

Where you see separation in those two curves is indicative of permeable zones that have been flushed, that contain movable saturations.

And if I were to analyze this for you right now, and I haven't marked it on here but I would say a gas-water contact -- and this would be a point where the water saturation is 65 percent -- would be at about 2467, right where you don't have the separation in those two curves.

And this is the analysis technique we've used from well to well in this reservoir, to pick a gas-water contact.

Q. You've testified as how you determined the 12 percent porosity cutoff.

You've now shown us how you went about determining the gas-water contact on a well-by-well basis.

Was this information integrated into the overall study to refine the pick of the zero net isopach line in this reservoir?

A. Yes, sir, it was.

Q. All right. I'd like to go to Exhibit 27 now. This is a larger map.

Mr. Collier, could you first tell the Commission what this map is designed to show?

A. This is a map of the units that we've shown around the perimeter, the periphery of this unit, all the data we have from a selected test nature, where we have selectively tested zones in the Tubb.

Q. And the information on this exhibit is independent of the methodology that was used by Amoco to determine the zero net pay isopach line shown on the map?

A. Yes, sir, this exhibit was really, I guess, put together for purposes of this hearing. This was not a study exhibit, if you will.

This is a check of the methodology that Mr. Wacker, Mr. Cosban and myself have tried to define for you today.

We feel like if selective test information proves either positive or negative production results, then we probably have a pretty good methodology for saying what's pay and what's not pay.

And if you go around all these selected tests, it does, 100 percent of the time, prove that the methodology is correct.

Q. And just show us what you mean by that.

A. What I mean by that is, any wells that are located such that they would be indicated to be on the inside of what we defined as zero net pay have produced gas, not necessarily commercial quantities of gas, but they've produced gas or had a log show of gas.

Wells from the outside of this line, without exception, have shown to not contain gas. They've shown -- produced only water, they've shown no show of gas. And this is true all the way around the unit.

Q. And this exhibit was prepared after the zero net pay isopach line --

A. Yes, sir.

Q. -- was determined?

A. Yes, sir, it was.

Q. And do you find any dry holes within what has been defined as the productive limits of the reservoir?

A. No, sir.

Q. Do you find any producing wells outside what has been defined as the zero net isopach line in this reservoir?

A. No, sir.

Q. Let's go back to Exhibit Number 3, and I ask you to refer to this exhibit and just generally summarize your portion of the study that was employed to define the zero net pay isopach line in this reservoir.

A. The portion -- The study that I've testified to this morning is the petrophysical part of the study and the reservoir engineering part of the study. Those two things are really intertwined.

I feel that the reservoir engineering has supported the methodology of the geologists and the geophysicists. We feel that we have, through this multi-discipline study, a very accurate pick of where this zero net pay isopach line is.

Q. If the unit is contracted to this line, then what will remain inside is productive acreage; is that right?

A. Correct.

Q. And what is outside is non-productive?

A. Yes, sir.

Q. Were Exhibits 1 [*sic*] through 27, including subparts A and B of 17, were they prepared by you or can you testify as to their accuracy?

A. Yes, sir, I can.

MR. CARR: At this time, Mr. LeMay, I would move Amoco Exhibits 13 through 27 and all subparts.

CHAIRMAN LEMAY: Without objection, those exhibits will be admitted into the record.

MR. CARR: And that concludes my direct examination of Mr. Collier.

CHAIRMAN LEMAY: Thank you, Mr. Carr.

Questions of the witness?

Yes?

MS. ZIMMERMAN: Yes, my name is Sandra Zimmerman, and I'm here as a personal consultant to Ms. Bell.

I need to ask you some very basic questions, because a lot of people don't know what you're talking about.

CROSS-EXAMINATION

BY MS. ZIMMERMAN:

Q. CO_2 is heavier than air, right?

A. Yes.

Q. CO_2 also dissolves in water?

A. Right.

Q. Right? Now, I don't want to make a bad pun, but you've spent a lot of money determining the size and shape and depth of the Tubb, and it only takes one good hole to drain the whole Tubb, right?

A. Over time, I would say that it would, a very long time, yes.

MS. ZIMMERMAN: That's what I needed to know. Thank you.

CHAIRMAN LEMAY: Are there additional questions of the witness?

Yes?

CROSS-EXAMINATION

BY MS. BELL:

Q. I'm curious about the mercury induction [*sic*] process. How much mercury, and how much is left as residue in the ground?

A. I can't hear you.

Q. How much mercury is used in the mercury induction process --

A. Well --

Q. -- and how much mercury residue is left when you remove the core or whatever you do?

A. Well, what you do is, you drill what's called a core-plug sample. It's roughly an inch long and about three-quarters of an inch in diameter. And these -- There were 88 of these from the different zones taken.

You clean this core, you remove all the fluids. It's totally clean, because you want to measure a rock property. And you're measuring interfacial -- You're measuring capillary pressure, which is a function of the interfacial tension between that mercury and those pore grains.

So -- There's some mathematics involved, but you're actually measuring a preserved core sample that's been cleaned. It's a small plug sample. You inject mercury into one end of it. Knowing how much mercury you've injected and knowing the porosity of this sample, then you know what the saturation of the mercury is.

Q. Okay. So in other words, you remove the core and then induce the mercury into that core?

A. Right, and the purpose of injecting mercury is, it coats the rock -- or actually, it does not coat the rock, much as CO_2 does not coat the rock; it's the water that coats the rock. And by measuring this data, you can generate those curves that I showed.

CHAIRMAN LEMAY: Other questions?

Yes?

CROSS-EXAMINATION

BY MR. CULBERTSON:

Q. Yes, when you say that wells outside of the zero pay line are non-producing, do you mean commercially non-producing or just simply do not have any CO_2?

A. They have no CO_2 in them.

CHAIRMAN LEMAY: I'm sorry, could you identify yourself for the court reporter?

MR. CULBERTSON: Oh, excuse me, Joe Culbertson. I'm with Harding County.

CHAIRMAN LEMAY: Thank you.

MR. WEST: Charles West --

CHAIRMAN LEMAY: Yes.

MR. WEST: -- Clayton, New Mexico.

CROSS-EXAMINATION

BY MR. WEST:

Q. Is the Tubb formation the only formation that you found the CO_2 gas within the unit, or is there other formations that are carrying the gas?

A. Well, the unit defined as from the base of the Cimarron anhydrite to the basement rock, so that's all Tubb.

So the unit is only the Tubb --

Q. There's no formations above that that are carrying CO_2 gas?

A. I've read studies where there have been maybe shows in the Glorieta, but that's not part of the unitized interval.

MR. WEST: Thank you.

CHAIRMAN LEMAY: Other questions?

Commissioner Weiss?

COMMISSIONER WEISS: I have no questions.

Nice piece of work.

CHAIRMAN LEMAY: Commissioner Bailey?

EXAMINATION

BY COMMISSIONER BAILEY:

Q. I'll ask you the question that was deferred by the geophysicist.

How much has the unit produced in the last 15 years?

A. We hit the 1 TCF mark in 1992.

Now, I don't know what we've produced since then; I would be speculating. But it's between 1 and 2 TCF.

Q. Would the removal of that volume of gas affect the gas-water contact?

A. Not at all.

Q. Okay. So there would not be any movement --

A. No.

Q. -- through water drive in the reservoir, or --

A. It's not a water-drive reservoir; it's a volumetric reservoir --

Q. Great.

A. -- so there's no movement in that context.

COMMISSIONER BAILEY: Thank you.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. Mr. Collier, I'm not sure if we're ever going to get to the point of the variation in oil-water *[sic]* contacts that have been noted through the field, but since you're an engineer I'll try you out on this one.

Is it -- The first question would be, where is the recharge area, do you think, for the water for this reservoir?

A. I can't -- Mr. LeMay, I can't answer that. I don't know.

Q. Assuming that -- Do you think there's any hydrodynamic component to the tilted water table that's noticed in the field?

A. That's probably part of it, yes.

Q. But pretty much beyond resolving as far as either factors go or predictability on how that oil -- gas-water contact will migrate across dip?

A. One thing --

Q. Is there a tilt to it? I mean, is there a dip on the gas-water contact, I guess, is my question?

A. There is a tilt to it.

Now, one thing that -- And again, I'm not really in my area of expertise, but there is a major fault that runs basically northwest to southeast.

We don't know the conductivity along that fault plane.

That could have a great bearing on the dynamic effects of this tilted water contact, gas-water contact. That's an area that needs some study.

We do know that it's tilted, we do know that there are variations, localized variations in the gas-water contact, and it's basically a pay effect, it's a wetability effect, a capillary-pressure effect.

But I -- Other than sort of reaching for an answer about that fault, I don't know all the other factors that cause that to be a tilted contact.

That's about the only explanation I can give.

Q. But generally, where it does affect -- and it does, I assume, affect the zero net isopach pay line that you're drawing through there, because that follows the gas-water contact?

A. Yes, in that part of the reservoir, that is the zero net pay line, that gas-water contact.

Q. So as that migrates, is it fair to say that's really an empirical -- you've resolved how that migrates in an empirical fashion and not in a predictable fashion, but by defining the tilt and then the relationship of the tilt to the dip on the formation?

A. I think the parameters of tilt were defined in the geological part of this study.

The localized effects on that gas-water contact, whether they're hydrodynamic or pay-related, is what's been defined in the petrophysics and reservoir engineering part of this study.

I think the tilt, the empirical rejection of that contact, was the first part that's been presented to you, and what I've presented represents the refinement in where that gas-water contact is on a localized basis, all the way around the edge of that reservoir.

Q. Which would be a function of the permeability or the capillary action --

A. That's right.

Q. -- of the reservoir?

A. That's correct.

CHAIRMAN LEMAY: Okay. That's all I have. Thank you very much.

Additional questions?

MR. CARR: No additional questions.

CHAIRMAN LEMAY: Okay. If not, the witness may be excused.

You might as well continue, Mr. Carr.

MR. CARR: Thank you, Mr. LeMay.

At this time we call James Allison.

JAMES H. ALLISON, JR.,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Will you state your name for the record, please?

A. James Haywood Allison, Jr.

Q. Where do you reside?

A. Katy, Texas.

Q. By whom are you employed?

A. Amoco Production Company.

Q. What is your current position with Amoco?

A. I'm a senior land negotiator.

Q. Could you briefly summarize your educational background for the Commission?

A. Yes, I earned a bachelor of business administration in petroleum land management from Texas Tech University in 1982.

Q. Since 1982, by whom have you been employed?

A. Amoco.

Q. And have you been working all that time as a landman in a land capacity?

A. Yes, I have.

Q. Are you a certified professional landman?

A. Yes, I am.

Q. How long have you actually worked on the Bravo Dome unit?

A. Three and one half years.

Q. Are you familiar with the contraction of the unit and the impact of this contraction on the various types of lands included within the unit area?

A. Yes, I am.

Q. And have you prepared certain exhibits for presentation here today concerning the changes in the unit area that will result from this contraction?

A. Yes, I have.

MR. CARR: We tender Mr. Allison as an expert witness in petroleum land matters.

CHAIRMAN LEMAY: His qualifications are acceptable.

Q. (By Mr. Carr) Mr. Allison, would you identify what has been marked as Amoco Exhibit Number 28?

A. Yes. This exhibit pictorially displays the Bravo Dome unit as it exists today. What I've tried to represent here in four basic colors -- white, pink, blue and yellow -- is the different types of land or whether or not it's in the unit.

Specifically, the areas that are white around the map or white inside the map are areas that are outside the unit, or windows within the unit.

The pink acreage is state acreage, and there is 295,128.54 State of New Mexico acres in the unit. That's roughly -- or it is 28.7 percent of the unit. Again, that is shown in the pink.

In the blue is United States of America or federal acreage, of which there's 81,430.97 acres. That's 7.92 percent of the unit.

And then in yellow is the private or fee acreage, of which there's 651,741.04 acres. That's 63.38 percent of the unit.

Q. Are the tract numbers shown on this exhibit?

A. Yes, they are, and the outlines of each of the tracts with the tract number inside, or for very small tracts the tracts are designated with an arrow.

Q. Let's go now to what has been marked Amoco 29, and I would ask you to review that for the Commission.

A. Again, this map represents the unit as it exists today. The colors have been pulled off so you don't see the distribution of the acreage within the unit.

But what's significant is the line that our scientists have established is applied to this map so that we see where that lies in relation to the various land tracts.

And in this regard what we've got is, we can see that any tract lies south of this line or each -- of this line here, totally, or within the other areas, would be excluded from the unit.

What we tried to capture here, in the inset up to the northwest, shows the amounts of acreage and the type and the percentage of that acreage that will be excluded.

Specifically, we'll work through the state acreage. There's 29,294.59 acres that falls completely outside of that zero pay line. There's 7,829.26 federal acres that falls outside the productive area, and there are 80,980.33 private or fee acres that fall outside the productive area.

Q. So what we're talking about with those numbers is the acreage in the tracts that are outside the zero net pay isopach line?

A. That's correct.

Q. All right. Let's go now to Exhibit Number 28 [*sic*]. Would you identify it and review this, please?

A. Yes, again, using the same colors as we did on the first map, the yellow representing fee lands, the blue federal and the pink state, just for the distribution purposes, this map represents the unit as it will exist once the redetermination has been approved.

The inset shows up the make-up of the unit by type of acreage once that exclusion is done. And what it shows is that the state will have a 29.2 percent representation or 265,833.95 acres in the unit, the federal government will have 73,601.71 acres or 8.09 percent of the unit, and the fee owners 570,760.71 or 62.71 percent of the unit.

That's a total unit acreage of 910,196.37 acres.

Q. Now, Mr. Allison, how was this particular boundary determined?

A. This particular unit boundary, Section 5.2 of the unit agreement requires the deed tract that is shown to be outside the productive limits -- in other words, outside of that line -- that if it is totally outside that line, that it will be excluded. And as a result of pulling off those tracts that are totally outside the productive area, it creates the new boundary line.

Q. Now, if we look at the new boundary line there's some tracts that are going to cross over the zero net pay line, that is, they're going to be partially productive, partially not. How has that happened?

A. Well, again, what we relied on there is Section 5.2.2 of the unit agreement, which told us that -- or required us to keep those tracts totally in the unit, but only that portion which is productive is allowed to have a participation in the unit.

Q. So if there's a tract that straddles the zero net pay line and 40 acres are productive and 40 acres are not, royalty will be paid to the 40 acres that are productive and no royalties paid to the portion that is not?

A. That is correct.

Q. And the result is that only productive acres share in royalty on it, forward from the time the contraction is approved and becomes effective?

A. That's correct.

Q. Could you identify for me what has been marked -- and we're going out of order here, I think -- Exhibit Number 31?

A. That is an affidavit prepared by Mark Randolph, or signed by Mark Randolph.

Q. And does that affidavit confirm how notice was provided of this particular hearing today?

A. Yes.

Q. And how was that done? Do you know?

A. The working interest owners arranged for Amoco as operator to notify all of the working interest owners, or the -- excuse me, royalty or overriding royalty interest owners in the unit.

And the way that was accomplished was, each of the working interest owners provided Amoco with a list of all of their royalty or overriding royalty interest owners and their addresses, and those -- that list was consulted and notice was made, actual notice was made to all of those owners through the mail.

Q. And attached to the affidavit are the addresses of all the individuals to whom notice was given?

A. That's correct.

Q. And also attached is a copy of the notice letter and the plat showing the unit boundary following contraction?

A. Yes.

Q. Now, let's get back and go back in order, and I'd ask you to refer to Exhibit 32 in the book, and I'd ask you to identify what that is.

A. Okay, Exhibit 32 shows how the royalty participation will be once the zero pay or the unit is redetermined.

And what that does is, it takes into account those acres which are productive in the unit only. And it shows there that the State of New Mexico will share in the royalty at 29.72 percent, the United States of America at 7.97 percent, and the fee or private owners at 62.31 percent.

Q. And this table shows just the number of productive acres that participate following approval of contraction?

A. That's right.

Q. All right. Has notice of this hearing been provided to the Bureau of Land Management?

A. Yes, it has.

Q. And do you know what the nature of that contact was?

A. Yes, the -- One thing, they received the same notification letter as all other royalty or overriding royalty interests in the unit, provided -- Also, a follow-up call was made inquiring as to whether they would prefer to have a pre-hearing meeting. They declined on that, and they said that they would probably have a representative here today.

Q. Has an application for approval of the contraction been made to the Commissioner of Public Lands?

A. Yes, it has.

Q. And at this time are the schedules that would go with that application being revised by Amoco to be submitted upon completion?

A. Yes, they are.

Q. Could you identify what is included in the exhibit book behind Tab 33?

A. Yes, these are letters from working interest owners who participated as a part of the technical subcommittee that worked hand in hand with our engineer, geophysicist and geologist to basically have their input in determining this line, and just verifying and confirming the work they have done.

We have letters from Amerada Hess, Markland Corporation, Shell Western E&P, and I guess that's it.

Q. Were Exhibits 28 through 33 either prepared by you or compiled under your direction?

A. Yes, they were.

Q. Can you testify to their accuracy?

A. I can.

MR. CARR: Mr. LeMay, at this time we move the admission of Amoco Exhibits 28 through 33.

CHAIRMAN LEMAY: Without objection, Exhibits 28 through 33 will be admitted into the record.

MR. CARR: And that concludes my direct examination of Mr. Allison.

CHAIRMAN LEMAY: Thank you, Mr. Carr.

Questions of Mr. Allison?

Yes?

CROSS-EXAMINATION

BY MR. CULBERTSON:

Q. Yeah, Joe Culbertson, Harding County.

What do you -- Maybe you'll have to shoot that by me again.

Now, I understand that if the tract, if the iso- -- the zero pay line goes through a tract, the tract, the whole tract, will stay in the unit. You're only going to pay on the productive acres.

What if the line runs through a 40 acres? How do you determine that? How do you add that in? I mean, is there a way to do that? I mean --

A. Are you asking --

Q. Forty acres are usually the -- normally the smallest acre --

A. If the tract, the 40-acre tract, is split, the area is measured, and those acres that fall inside the line will receive credit for production and those acres outside will receive no credit for production.

MR. CULBERTSON: Thank you.

CHAIRMAN LEMAY: Yes?

CROSS-EXAMINATION

BY MS. PITTORD:

Q. I'm Fannie Pittord, representing the Leo Bray estate.

Now, they have one well, I know, that's producing on the land in Range 34, and in 36 and 37 you're letting that go. But what I need to know, if you let Range 36 and 37 go, can they -- will you let the others go too where you're producing?

A. No, ma'am --

Q. You're --

A. -- if I understand your question correctly --

Q. -- that contract, but you're canceling the other lease; is that right?

You're canceling the lease on the non-productive, letting that land free. But you're not -- But you'll keep all that that's under production?

A. The acreage that falls into the -- if I understand your question correctly, and I think I do, the acreage that is held by the wells and is proven to be productive, yes, will still be included in the unit.

Q. And you can't get it released? It will not be released, you cannot have it released, is what I'm asking. I know they'll ask me this.

Since you're releasing that that's by the Texas line, near up below Amistad, you know, right in the corner, the lots and so on, then on the Hutcherson ranch where you have acreage, LS, if you're going to leave it, can't we get it out of the other? That's no, isn't it? It's no, you're going to not release the contracts?

See, we have leases, a lease contract for 34, Range 34, and then we have a contract for 36, 37 Range.

A. Right. Now, and what you're saying is, part of your acreage is going to be inside the productive area and part of it's not, but it's covered by one lease.

Those portions that are inside will still be in the unit. They will still be paid. The only thing you need to do is, acreage that is outside, that falls outside the unit, request a release.

MS. PITTORD: Thank you, sir.

CHAIRMAN LEMAY: Yes?

CROSS-EXAMINATION

BY MS. ZIMMERMAN:

Q. Yes, Mr. Allison, you characterized the royalties in terms of percentages, so that after the lines are drawn the State will get 27 percent, the United States government will get 7 percent, and then private is 60-plus; is that right?

A. Those numbers are close.

Q. Okay. I need -- I didn't note down, what were the percentages before that?

A. Yeah, it's on the very first map, and those numbers are presently, the State is 28.7 percent, the United States is 7.92 percent, and the fee is 63.38 percent.

Now, let me give you those other numbers so you can get them.

Q. So basically the percentages are remaining pretty much the same?

A. They're pretty close. Yes, you'll see that the State has 29.72 percent after elimination of tracts, the federal government 7.97 percent, and the fee 62.31 percent.

MS. ZIMMERMAN: Thank you.

CHAIRMAN LEMAY: Yes?

CROSS-EXAMINATION

BY MR. WEST:

Q. Yes, Charles West, Clayton. Mr. Allison, how are you?

I need to know about what you're going to do about your unknowns and unable-to-locates that you have out in the unit presently.

How are you going to treat those people if they get out of the unit, if they're there, for the unit? You're just not going to recognize them or -- ?

I mean, they have a participation assigned to them that that money has been in suspense. How are you going to go about -- I mean, I don't understand the economics of that from a landman's standpoint.

A. The unleased, unknown, we continue to try and clean that up. I think, as you know, unknown is unknown. Maybe those parties are parties that died years ago and they're difficult to locate, or heirs are difficult to locate.

They're -- You referred to suspense, and Amoco or -- I can only speak for Amoco, but Amoco is going to honor -- If those parties do come forward and make a claim on that, we're going to honor our royalty obligations from the day of the unit, since its establishment, until that acreage is excluded from the unit.

Q. Okay, what about your windows that you have in the unit that you're leaving within the unit that are unleased? Are you still going to provide those people the opportunity to come in as working interest owners of the five options that they have?

A. Those parties have to come forward and basically negotiate with the working interest owners to be included in the unit, and then any enlargement would have to be approved by this Commission.

Q. Okay, you said "enlargement". I think I heard testimony this morning that there is no enlargement of the unit, but in fact at 12.1 of the unit agreement there is specific language that states that the unit can be enlarged, not made smaller.

A. That is correct, and what I would say is that the testimony this morning, he was probably referring to this hearing today, that we didn't come here to enlarge the unit, we came here to show cause for the reduction of the unit.

Q. Okay. Then basically what you're saying is, sometime in the future, then, you do still have the right to come before the Commission and request an enlargement of the unit?

A. That's what the unit agreement language says, as I recall. And again, it would require the working interest owners to approve that, as well as the Commission.

Q. Okay, now I'd like to ask, on the leases that totally fall outside the revised line of the unit, are you saying Amoco will release those in total if the royalty owner contacts it?

A. What I was referring to was leases that are split, and if they ask for a release of those lands that are outside the unit, yes, they will be released.

But --

Q. Okay, is the plats that you're providing, are they precise enough that we can determine what parts of those leases are in and what parts are out?

A. Would you --

Q. I say, are your maps precise enough that we will be able to determine what portion of the lease is within the unit and what portion of the lease is falling out of the unit?

A. Those tracts that are totally excluded, yes. Those tracts that are split, no.

Q. How would myself as a royalty owner know what to request from Amoco, then, to release that portion of the lease that falls outside the unit?

A. These maps are of public record, and you can determine what tracts have been eliminated, tie those specifically to an acreage description and request that.

Q. Are you aware of a class-action suit being brought on this unit?

A. Yes, I am.

MR. WEST: Thank you, sir.

CHAIRMAN LEMAY: Additional questions of the witness?

Yes.

CROSS-EXAMINATION

BY MS. BELL:

Q. For the record, my name is initial C. Diane Bell, and I'm here representing myself and my mother, Elsie E. Bell.

I would like to go on record as being in opposition to this request.

And I was wondering when this will go into effect, when would this affect our royalty checks?

A. I do not know.

MR. CARR: I can answer that, I think. It is the intention of the working interest owners to make contraction effective at 7:00 a.m. on the first day of the month following receipt of both approval from the Oil Conservation Commission and from the Commissioner of Public Lands. Once both of those are in, and for accounting reasons, the change will be effective 7:00 a.m. the first day of the month following.

MS. BELL: Thank you.

CHAIRMAN LEMAY: Additional questions?

Yes.

CROSS-EXAMINATION

BY MR. SANCHEZ:

Q. I'm a bit confused -- Elmer Sanchez from Clayton, interested.

I'm a bit confused as to what you mean by a working interest within a perimeter or outside of a perimeter. Are we saying...

And in the 40-acre deal, if I have 80 acres and 40 acres have a producing well, then that producing well starts to dwindle, are they saying we're going to eliminate that 40 acres and possibly move over to this other 40 acres and maybe find a producing well there? Am I on track here, am I out in left field or where am I?

A. If your acreage contains a producing well, it will not be eliminated from the unit.

Q. You didn't hear me. I said, if it starts to dwindle like I understand oil -- Let's see if I understand this correct.

We take this gas to an oil field to frac the earth to extract more oil from a dwindling well. Am I right there?

A. That's engineering, and -- I don't understand how the CO_2 flood works so I can't specifically answer that question, I'm sorry.

Q. If you have a dwindling CO_2 well, do you -- can you frac the earth to cause it to produce more like you do oil? If it's water-soluble, can you do that?

A. Well, again, that's an engineering question. I'm not trained in that area.

Q. Is there any engineers here that can answer that?

What I'm having a problem with, here's an imaginary boundary line. This guy has no producing CO_2. This guy does. But if I frac this well here on producing acreage and it causes CO_2 to come into that well, with water solubility, how do we know where it's coming from?

A. Well --

Q. Do I make sense? Is there anybody --

A. Well --

Q. -- who can answer it? Am I not making sense?

A. I -- The line that is drawn, that you referred to with the producing well on one side and the non-producing on the other side, this acreage is excluded and there is no CO_2 over there, the side that is non-productive.

Q. And you know that, you have gone all the way to China to know that?

A. Well, first we don't have to go to China because our unitized interval doesn't go to China.

But I understand what you're saying, yes, and the testimony that the engineer, geophysicist and geologist put on today, they demonstrated what they know. And as far as gas from other areas, I do not know.

Q. If we had 600,000 acres and there is a pool of CO_2 somewhere in there or whatever, in that boundary, supposedly, very supposedly, 13 people own, but the biggest pool is in one person's land boundary. But some of that may reach over into someone else's. We don't know, it's in the ground.

Can one well be dug here and extract that CO_2 from this other person's --

A. Well --

Q. -- and never have to drill a well over there?

A. Again, I don't know because I'm not an engineer and I don't understand rock, you know, mechanics or flow of fluids underground.

MR. SANCHEZ: I fail to see how you can make imaginary boundary lines and say there's CO_2 here but there isn't over here, so I would like to join Ms. Bell in opposing this.

CHAIRMAN LEMAY: Additional questions of the witness?

Commissioner Weiss?

MS. ESPINOSA: I --

CHAIRMAN LEMAY: I'm sorry, I didn't see you.

MS. ESPINOSA: I'm Josephine Espinosa for GD Cattle Company and Harding County --

CHAIRMAN LEMAY: Uh-huh.

MS. ESPINOSA: -- and I'm very much opposed to this, and I want to go on record.

CHAIRMAN LEMAY: Yeah, you know, what we can do, as I mentioned, we'll have statements at the end. And those of you that want to identify yourselves and make that statement, it will be part of the record. So there will be room for that.

MS. ESPINOSA: All right, thank you.

CHAIRMAN LEMAY: Okay. Yes?

MR. SANCHEZ: I have a question. Is there any engineer that can answer some of these questions? The gentleman says he's not an engineer.

CHAIRMAN LEMAY: Well, we had an engineer on before that was --

MR. SANCHEZ: I still have the questions and I'm still confused --

CHAIRMAN LEMAY: Yeah.

MR. SANCHEZ: -- and I certainly don't like confusion.

CHAIRMAN LEMAY: Well, I don't blame you.

MR. SANCHEZ: And as I look around, I'm beginning to see that maybe there's some other confused people around here.

Before -- I would like to see some of these questions answered before a decision can be made to this. And in fact, we fall within the boundaries. That has no -- I don't think it matters, other than how can any individual say there is and there isn't? I don't think you can, sir, and I don't think an engin- -- They're going to have to prove to me. I don't understand that, and apparently there's no engineers here that can say that.

CHAIRMAN LEMAY: Thank you.

MR. SANCHEZ: So how can we make a decision today, based on today's testimony, we are going to exclude so-and-so and we're going to include or keep so-and-so, if there's no engineer to say why they can't extract this oil or this gas from some other area. And I think I'm pretty clear in this, in this question.

CHAIRMAN LEMAY: I think in the way of clarification, most of the testimony here to date has been how they do make that delineation. It's --

MR. SANCHEZ: It hasn't got through to me, and --

CHAIRMAN LEMAY: Well, it's pretty complicated. I would agree with that, it truly is.

MS. SANCHEZ: I see some other questions and faces that they haven't -- You haven't cleared it up in my mind.

CHAIRMAN LEMAY: Yeah, I can appreciate your position.

MR. SANCHEZ: I don't understand what you're doing.

CHAIRMAN LEMAY: Well --

MR. SANCHEZ: I know we've got wells dug, water wells on our place, but we really don't know -- Hell, I might be taking water from the neighbor. I don't understand it.

CHAIRMAN LEMAY: Well, thank you. I don't know where to go with that either.

Additional questions?

Commissioner Weiss?

EXAMINATION

BY COMMISSIONER WEISS:

Q. Yes. Are the current -- the owners of the leases in the current windows, have they contacted you to get in the unit?

A. No, they have not.

Q. Now, the land that's released, that goes outside the -- that's outside the unit, that you guys are going to cut out, now what happens to those leases?

For instance, if I thought your zero line was wrong, can I go get a lease there outside the unit and drill a well and suck all your gas out?

A. Yes.

COMMISSIONER WEISS: Thank you.

CHAIRMAN LEMAY: Commissioner Bailey?

COMMISSIONER BAILEY: I have no questions.

EXAMINATION

BY CHAIRMAN LEMAY:

Q. As I understood you that -- speaking for Amoco, I'm assuming, that if you have a lease that's partially -- or tract -- partially in and partially out, that the land owner can request a release of that portion of that tract that's outside the zero line?

A. Maybe I didn't make myself clear. Those tracts that are totally outside --

Q. Yes.

A. -- Mr. LeMay? We will release that acreage if requested.

Those that are split, it would be difficult but I'm sure we could work to release some of that acreage.

But it is -- As you know, that line is not a straight line, as landmen like to work with, so that is extremely difficult to do.

Q. I guess that was my question. If you did release it, would you release it on the basis of 40-acre releases, whereby the majority was -- outside that 40 acres and would be released or not, or --

A. I think what we were trying to do is get as close to the line as possible.

We have not discussed this, so I can't tell you, yes, that's exactly how we would do it. But I think if we were requested, we would try and get as close to that line as possible.

Q. You understand the reason for the question --

A. Absolutely.

Q. -- because of correlative rights?

A. Absolutely.

Q. An operator who had acreage outside the zero line that might disagree with your zero line could protect his acreage by drilling a well?

A. Yes.

CHAIRMAN LEMAY: That's the only -- Yes?

FURTHER EXAMINATION

BY MS. ZIMMERMAN:

Q. Yeah, I'd like that clarified. My name is Sandra Zimmerman.

You made a very good point that I haven't thought of. So if my east well -- or say my west well is producing but not my east well, and it's all on the same piece of land, you're not going to pay me for the east well, but you will pay me for the west well, but I still can't use the east well or dig another one?

A. Let me get one clarification here. Is your east well and your west well all within the unitized area?

Q. Let's put it this way: They are right now, but one of them is going to be excluded. One of those wells is considered to be on the other side of the non-productive line, so since it's all part of the same tract, does that mean you're not going to release that other well?

A. I would have to look at it specifically.

Q. Okay, because that raises the a bunch of questions again then. You only need one well to drain the whole Tubb. One hole at the deepest part will take the CO_2 out.

So if you find the deepest part of my land and dig one well and don't pay me for the five others that you've used to study my land with, I'm sort of -- I'm only getting one-fifth of my royalties, even though you're taking all of my gas. I can't take the oxygen [*sic*] from just that corner over there, can I?

A. I don't know --

Q. Well, why --

A. -- and I'd like to answer your question but I didn't know if it was a question.

Q. Well, the question is this: Can I use the well that you don't want to use? Can I put another well next to that well that you don't want to use? Just because it's in the same unitized piece --

A. If --

Q. -- you don't want to pay me for it --

A. If there's --

Q. -- but you don't want to --

A. If there's no gas to be made from that well, then it's to be excluded --

Q. You're saying that there's no gas to be made, but we all know that aluminum was very expensive to get out of the ground until a college student made an easier way to do it.

A. I don't understand your question.

Q. That well, according to your scientific evidence and your business sense, has no value to you, in the same way that certain oil wells had no value before new techniques were found. So you're not paying royalties on the well that you're not using.

However, if a year from now you find that you can extract CO_2, will you come back and re-use the well because you haven't released it?

I mean, if you're not going to pay for a well, you should release it, period. That seems logical to me.

If you say it's non-productive, then I can take my own chances and sink a well, right? Because I might think it is productive.

CHAIRMAN LEMAY: Mr. Carr?

MR. CARR: May it please the Commission, I understand the concern and the questions. They really are getting into the nature of legal opinions and questions which I think Mr. Allison probably cannot -- is not the proper person to respond to.

To try and address the question, I think what we've tried to show today is where there is CO_2 and where there is not.

And if we have, because of this line, determined that there is not CO_2 under another well on a tract that might straddle the zero net pay line, the situation is, a royalty isn't paid because of the well, it's paid because of the acreage we deem productive.

And that line is established here and now, and if there is an appropriate request made to us to release acreage and the boundary can be defined by a normal description, since what we're dealing with is land descriptions that are basically rectangles and squares and a line that curves, we will attempt to accommodate an interest owner to release that acreage.

As to the question of releasing a well, that raises a number of questions in terms of liability and ongoing exposure. Those have to be dealt with on a well-by-well basis, and we would be willing to talk to anyone about how that could be handled so that the responsibility for the well could be not only passing the wellbore individual to individual, but responsibility for that wellbore could be addressed consistent with normal regulatory precautions and requirements.

And I've just been advised that as of this time, it is our understanding that all wells outside the line have been plugged as of today.

CHAIRMAN LEMAY: Okay, hopefully that has some degree of clarification --

MR. CARR: I'm not trying to argue, I'm just trying to --

CHAIRMAN LEMAY: Yeah, we really don't want to get in an argument. What we're trying to do is clarify --

MS. ZIMMERMAN: I understand that --

CHAIRMAN LEMAY: Yeah.

MS. ZIMMERMAN: -- but geology is one of my specialties, and the Bravo Dome is enormous. It's like what I understand that they're doing is, they're going to this far corner, and this whole thing is the Bravo Dome, and they're going to that far corner where all the gas sinks to get all of the well [*sic*] from the entire Bravo

Dome.

CHAIRMAN LEMAY: Those -- Commissioner Weiss?

COMMISSIONER WEISS: I have a comment.

I think that all the acreage outside that line can be leased and drilled on. Go ahead and drill it.

CHAIRMAN LEMAY: I think that's the point I'm trying to make. I think Amoco's policy statement, if I understand it correctly, that in the event you feel differently -- the zero line, you don't believe it, and you request a release and you get your acreage, you can put your money where your mouth is, you can go drill that thing.

MS. ZIMMERMAN: Right.

CHAIRMAN LEMAY: And I think that protects you. I think that's what we're concerned when we're talking about correlative rights, the fact that you have the opportunity to protect yourself, and that's where we come from when we talk about correlative rights.

MS. ZIMMERMAN: Well, it was your question --

CHAIRMAN LEMAY: Yes.

MS. ZIMMERMAN: -- a fine point. Are they going to release this well?

CHAIRMAN LEMAY: Well, I think that's why I raised it. I mean, I was -- We were concerned about correlative rights; that's part of our obligation.

And the fact that if you do have disagreements with Amoco -- and we all have disagreements with each other. As you're a geologist, I'm a geologist. You and I will have disagreements most of the time if we're trying to describe a field.

If you have acreage and you feel like drilling it, you can do that, if it's outside the unit and released. You're not dependent upon Amoco telling you that you can or cannot drill it.

So that's -- I think that's a critical element in --

MS. ZIMMERMAN: Yes.

CHAIRMAN LEMAY: -- our correlative rights discussion here.

MS. ZIMMERMAN: Thank you.

CHAIRMAN LEMAY: Thank you.

Anything else?

MR. CARR: Mr. LeMay, I'd like to make one statement --

CHAIRMAN LEMAY: Please do.

MR. CARR: -- in response to a question, and that was that as to unknown owners those funds are held in suspense, those funds remain available to be claimed. They don't remain there for the history of time; there are certain statute of limitations -- or statutory requirements for the funds to escheat to the State and otherwise, and those will be honored. And after those time periods, then of course the claims cannot be made.

Other than that, I am prepared to make a closing whenever you're ready for a closing statement.

CHAIRMAN LEMAY: Fine, I think we're ready. We'll have the closing statements, then your statements after that.

Please do.

MR. CARR: May it please the Commission, by Order Number R-6446-B this Commission ordered the noncontraction of the Bravo Dome unit. We would come here, show you our work and seek your approval, and we're here today as a result of that order.

We've presented to you the results of the technical committee, the committee that worked on this contraction. And admittedly it is complicated, it is confusing for those who do not fully understand it.

But it has to be understood in terms of the kind of technical expertise that exists today to make these kinds of technical calls. And it comes to you, a board of scientists, of technical people, to review and to determine whether or not it has been done consistent with industry standards and whether or not what we've presented to you is the known zero net isopach line to date, and that's paraphrasing the unit agreement.

We come here to show you today, with the best technology we have and with the well information we have, what we know today, and what as experts we have been able to determine, applying industry standards, and that's what we have presented.

The testimony has been limited here today, and it's limited because the only thing that isn't absolutely defined by the contract unit agreement is the call on the zero net pay isopach line. You're the appropriate board to bring this issue before, and that's why we've come here today and presented testimony on just this one particular issue.

We've shown you the geology, we've shown you the geophysics, we've shown you the engineering, and we think you're qualified to determine whether or not the job has been done well and whether or not what we have done is consistent with what is expected in this industry.

And we have defined the limit, we submit, consistent with industry standards, we've used the best technology available, and the line we have shown you today, we believe, is the zero net isopach line. On a scale of one to ten we think it's a ten, and we stand on that.

The line isn't just developed by methodology. Exhibit -- I believe it was 25, the map with all the selected test data around the edge, was done afterwards, and it confirms the methodology because there is no producing well outside that line, there are no dry holes within that line. And we believe this independent test data confirms that we have correctly placed the line where it is in this reservoir.

Now, when we come before you, your jurisdiction is rooted in waste considerations and questions involving correlative rights, and by statute you're directed to protect those. Clearly waste is not the issue here.

Today the issue is, is the line technically correct and are we, because of that line, going to be protecting the interests of those owners in this area, those individuals who own carbon dioxide?

Correlative rights is defined in the New Mexico Statues as the opportunity to produce your fair share of the reserves.

The people in this room and the other people in Bravo Dome have availed themselves of that opportunity in a number of ways, or at least could have.

They could have drilled wells, they could have farmed out their interests, perhaps, to someone who was prepared to drill a well, or they could have committed that interest to a voluntary unit.

And once that is done, their opportunity to produce these reserves is merged into effective operation of the unit, and they entrust the operation to one party, and in this case it was Amoco.

And then our role is defined by the contract and by our obligation to act in good faith in carrying out our duty. And that's what we've done. And we have a duty to the person inside the line today as well as to those who are outside. And the day we determined that this is the zero net isopach line, that's the day we knew we had to come to you.

We have to contract so that those people who own the resources are the people who in fact will be compensated for the production of that resource, and that is what we've done.

On the evidence before you today, showing the data we have, the technology employed, we have shown you what the zero net isopach line is.

And based on the record today, I submit that you have but one decision and that is to approve the work that has been presented to you here today, approve the contraction. And in so doing, you will act to protect correlative rights, because contraction will occur, and those who own CO_2 will be paid for it, those who do not will no longer share.

CHAIRMAN LEMAY: Thank you, Mr. Carr.

At this time we'll be taking statements. So if you would, those that want to make a statement, please stand, identify yourself, make your statement, and it will be part of the record. The court reporter will record your statement.

Yes, please?

MR. BLAKELY: I'm Herbert Blakely, representing both myself and my mother, Winifred Blakely, and I just want to go on the record as opposing it.

CHAIRMAN LEMAY: Thank you.

Additional -- Yes, please?

MS. ESPINOSA: I'm Josephine Espinosa for GD Cattle Company, and I also am here to go on record as opposing it.

CHAIRMAN LEMAY: Thank you.

Yes?

MR. CULBERTSON: Joe Culbertson, Harding County.

I'm not necessarily opposed to reducing this, but I have problems with the -- not their line. That's all based on geology, and I'm not a geologist and I take their word for it. I have a little bit of doubt about whether they can say almost absolutely for sure there's no CO_2 on the other side of that line.

But they could have drawn the line for pay purposes, for royalty purposes, by not following a crooked line down through dividing 40s and all this stuff, by dropping down, as this friend here suggested, dropping down using geological survey lines and staying right below that zero pay line, just below it. It wouldn't have cost them that much more to do that and simplify it.

There's no way that we can go down to Houston or get with -- and look and see how they took a 40-acre tract and divided it all up. I mean, it just complicated the whole situation.

I mean, I don't know how willing they are to sit down and check all that, but I would guess that there's going to be a lot of people challenging the acreage that they have in their individual tract participation in this unit, just because of that. And it would have simplified it if they had just dropped down, and it would have probably given them a little bit more margin to be able to say they were a hundred percent sure, which they couldn't say that there was no CO_2 below that line. But that's their geology and that's their business.

But they could have simplified this very complicated tract participation thing. If you've ever looked at one of those books, it's about this thick and about who owns what, and it's just going to complicate it a whole lot more.

Thank you.

CHAIRMAN LEMAY: Thank you.

Yes?

MS. BOARDMAN: I'm Loretta Boardman. I'm representing the Cooper family from Harding County, and I just want to say I object to this because the land that we have represented out there shows no testing ever having been done on it, according to your maps.

And also, I want to say that I feel so sorry for the geologists since they have no future after this year. They said that they had gone as far as they could, and most professions continue to climb. I know engineering does.

CHAIRMAN LEMAY: Thank you.

Yes?

MS. BELL: I'm Diane Bell, and I want to go on record representing myself and my mother, Elsie E. Bell.

I'm in opposition of this, mainly because this line cuts one tract of ours right -- kind of meanders across the middle of it. So I'll be real interested to see how this is going to be worked out.

CHAIRMAN LEMAY: Thank you.

Additional statements?

Well, we thank you all, and what we will do is leave the record open two weeks for written comments.

Those of you that would like to supply a letter are certainly welcome to do so. It will be part of the record.

I'd like to have a draft order, Counsel, within a two-week period of time. We will leave that record open, then we will take the case under advisement.

Is there anything else further in the case?

If not, thank you.

We'll take the case under advisement.

(Thereupon, these proceedings were concluded at 2:43 p.m.)

* * *

CERTIFICATE OF REPORTER

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

I, Steven T. Brenner, Certified Court Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Commission was reported by me; that I transcribed my notes; and that the foregoing is a true and accurate record of the proceedings.

I FURTHER CERTIFY that I am not a relative or employee of any of the parties or attorneys involved in this matter and that I have no personal interest in the final disposition of this matter.

WITNESS MY HAND AND SEAL October 24th, 1994.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 1998