CASE NO.

7489

APPLICATION,
TRANSCRIPTS,
SMALL EXHIBITS,

ETC.

CASE NO.

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APPLICATION,
TRANSCRIPTS,
SMALL EXHIBITS,

ETC.

United States Department of the Interior
OFFICE OF THE SECRETARY
Minerals Management Service
South Central Region
P. O. Box 26124
Albuquerque, New Mexico 87125

APR 21 1982

Mr. W. Perry Pearce
Oil Conservation Division
State of New Mexico
P. O. Box 2088
Santa Fe, New Mexico 87501

Dear Mr. Pearce:

This jurisdictional agency concurs in the recommendation of the State of New Mexico, Case No. 7489, Order No. R-6939, dated April 14, 1982, that the Chacra Formation underlying the described lands in subject order in Rio Arriba County, New Mexico, be designated as a Section 107 tight formation.

It is requested that this concurrence be included with the recommendation submitted to the Federal Energy Regulatory Commission.

Sincerely yours,

James W Shelton

FOR Gene F. Daniel
Deputy Minerals Manager
Oil and Gas

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION
STATE LAND OFFICE BLDG.
SANTA FE, NEW MEXICO
17 February 1982

EXAMINER HEARING

IN THE MATTER OF:

Application of Curtis J. Little for designation of a tight formation, Rio Arriba County, New Mexico. CASE 7489

BEFORE: Richard L. Stamets

TRANSCRIPT OF HEARING

A P P E A R A N C E S

For the Oil Conservation Division: W. Perry Pearce, Esq.
Legal Counsel to the Division
State Land Office Bldg.
Santa Fe, New Mexico 87501

For the Applicant: William F. Carr, Esq.
CAMPBELL, BYRD, & BLACK P.A.
Jefferson Place
Santa Fe, New Mexico 87501

I N D E X

E X H I B I T S

MR. STAMETS: We will call now Case 7489.

MR. PEARCE: Application of Curtis J. Little for designation of a tight formation, Rio Arriba County, New Mexico.

MR. CARR: May it please the Examiner, my name is William F. Carr, with the law firm Campbell, Byrd, and Black, P. A., of Santa Fe, appearing on behalf of the applicant.

I have two witnesses who need to be sworn.

(Witnesses sworn.)

MR. CARR: We'll first call Mr. Little.

CURTIS J. LITTLE

being called as a witness and being duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. CARR:

Q. Will you state your full name and place of residence?

A. My name is Curtis Little and I reside in Farmington, New Mexico.

Q. By whom are you employed?

A. I'm self employed.

Q. And in what capacity?

A. I'm an independent oil and gas operator.

Q. Have you previously testified before this commission or one of its examiners and had your credentials as an independent oil and gas operator accepted and made a matter of record?

A. Yes, sir.

Q. Are you the applicant in this case?

A. I am.

Q. Are you familiar with the application filed on your behalf?

A. Yes, sir.

Q. And are you familiar with the subject acreage?

A. Yes, sir.

MR. CARR: Are the witness' qualifications acceptable?

MR. STAMETS: They are.

Q. Mr. Little, will you state what you are seeking in this case?

A. I'm applying for an area adjacent to and southwest of the Otero Chacra Gas Pool to be designated as a tight formation under Section 107 of the Natural Gas Policy Act of 1978.

Q. And where is this area located?

A. The proposed Gallegos Canyon Tight Gas Area is located in the southeastern portion of the San Juan Basin in Rio Arriba County, approximately thirty miles southeast of the Town of Bloomfield in northwestern New Mexico.

Q. And this area is called the Gonzales Canyon Tight Gas Area?

A. Yes, sir.

Q. Have you prepared certain exhibits for introduction in this case?

A. Yes, I have.

Q. Were each of these exhibits submitted to the United States Geological Survey and the Oil Conservation Division fifteen days prior to hearing, as required by Oil Conservation Division rules?

A. Yes, they were.

Q. Will you please refer to what has been marked as Little Exhibit Number One, identify this and explain what it shows?

A. Exhibit Number One displays the proposed

Gallegos Canyon Tight Gas Area, a map showing all the Chacra Wells in the San Juan Basin.

The area includes approximately 6720 acres, described as 25 North, 6 West, Section 16, 21, 22, south half of 23, 25, 26, 27, 28, 34, 35, and 36.

Q Does the Chacra formation in the Gonzales Canyon area meet the criteria established in Section 107?

A Yes, sir.

Q Generally would you summarize what these criteria are?

A The criteria being the estimated in situ gas permeability throughout the pay section is expected to be 0.1 millidarcy or less; the stabilized gas production rates without stimulation at atmospheric pressure of these gas wells are not expected to exceed a maximum allowable production rate of 91 Mcf GPD for an average depth of 3390 feet to the top of the Chacra formation in this area; and lastly, no well drilled into the Chacra formation in the area is expected to produce more than 5 barrels of crude oil per day prior to stimulation.

Q Will you now refer to what has been marked for identification as Exhibit Number Two and review this for the Examiner?

A Exhibit Number Two is a Chacra formation

completion and production map of the Gonzales Canyon Tight Gas Area. The production figures presented for each well, producing well, are number one, the initial potential, the date of initial potential, the average daily natural gas production rate for 1980, and the January 1, 1981, cumulative production of gas for the well.

It also presents completion and production data for some of the wells surrounding the proposed tight gas area for comparison purposes.

This morning we found that in searching the State records there was one well omitted, and that should be added, and it is located inside the requested area, Gonzales Canyon Tight Gas Area. The well is located in the southwest northeast of Section 16, in the upper portion of the area, 25 North, 6 West. It was drilled by Bowlin Oil Company. The name of it was State No. 1. It was drilled, cased, perforated, fracd, and plugged and abandoned, in September, 1966.

And we regret that this was left out of the original exhibit.

Q Mr. Little, how many Chacra wells are there in the proposed area?

A Of these tests, there are now, adding the one I just referred to there, five wells in the -- in the

area. Three have been abandoned, one producing, and one drilled, completed, but not yet on the line.

Q. And what is the average depth to the top of the Chacra in the area?

A. The average depth in the tight area is 3390 feet.

Q. Where does the proposed area lie in regard to other Chacra production in this general vicinity?

A. It's on the southwestern fringe of the main Otero Chacra gas producing field.

Q. How would you characterize the Chacra in this general area?

A. The examination of the Chacra in the area indicates the poor quality Chacra reservoir in the applied for area.

A list of the operators, well names, and production figures for Chacra Wells is presented in Exhibit Number Three.

Q. Okay, Mr. Little, will you now refer to Exhibit Numbers Four and Five and identify these for Mr. Stamets and explain what they show?

A. Exhibits Numbers Four and Five are January 1, 1981, cumulative gas production, and 1980 annual gas production, maps of the Chacra formation, both in and

outside the area of this application.

The maps are color coded to distinguish natural gas production thins in the area. The red color in Exhibit Four is used to distinguish which -- cumulative gas production greater than a quarter BCF cumulative, while the white is less than one quarter.

Exhibit Number Five, on the next page, the red is to distinguish areas which have more than 12-million cubic feet of gas last year, in 1980. The white areas are less than 12-million gas production in 1980.

Examination of these two exhibits shows that the great majority of the Gonzales Canyon Tight Gas Area is white, indicating little or no gas production in the Chacra.

Q. Why do you suspect there has been so little development in the area?

A. The small cumulative production and sparse well location is due to the tight nature of the reservoir rock and several dry holes drilled within the area.

Q. Now where does the proposed area lie in regard to the main portion of the Otero Chacra Field?

A. It's on the southwest flank.

Q. And I believe Exhibits Four and Five show the drilling in the Chacra in that area.

A. That is correct.

Q. Now I have a couple of questions I want to ask you about the general geology, and I ask you first, generally just to characterize the -- the Chacra formation in the subject area from a geological point of view.

A. The Chacra interval is a marine siltstone and sandstone. The source was from the southwest. The lithologic unit was deposited in relatively deep water with the strike of sedimentation being northwest/southeast.

Q. How would you characterize the form of gas entrapment in the Gonzales Canyon area?

A. The form of gas entrapment is stratigraphic. The interval outcrops approximately 30 miles south/southwest of the area and dips to the northeast at 90 feet per mile.

Exhibit Number Six is a structure map of the Pictured Cliffs formation lying 1000 feet above the Chacra interval and show this regional dip.

Sample examination of the Chacra interval indicates that the 130-foot zone is to be a light gray, very fine grained siltstone. The siltstone has varying amounts of shale and carbonaceous with clay infilling, all contributing to the low permeability of the interval.

Q. Will you now refer to Exhibit Number

Seven?

A. Exhibit Number Seven is a type log of the Chacra interval. The well is the Curtis Little No. 3 Salazar, recently drilled and located in the northwest quarter of Section 26, Township 25 North, Range 6 West.

Q. Is that Section 25 or 26?

A. 26.

Q. So it would be --

A. The type of the Chacra on the log is 3425 feet, with the base of the Chacra being 3553 feet, and this log is representative of the Chacra formation characteristics outside the main Chacra Gas Pool, and is in the center of the tight area.

Q. Will you now review Exhibit Number Eight for Mr. Stamets?

A. Exhibit Number Eight is a cross section across the area. The trace of the cross section was portrayed earlier in Exhibit Number --

Q. Two.

A. -- Two.

MR. STAMETS: While we're discussing that, you show two wells in Section 34 on the cross section, and yet you don't identify those as -- as Chacra wells.

What's the -- you said that there were

five wells in there, and I count seven wells, if I count those wells in Section 34.

A. Well, Mr. Stamets, those are Dakota wells and they penetrated and logged the Chacra, but they're Dakota producing wells.

MR. STAMETS: Are there other wells in this area that have penetrated the Dakota, or --

A. Yes, sir.

MR. STAMETS: -- there are other wells here, then, but we are talking about Chacra wells, either as a completion or attempted completion.

A. That is correct.

MR. STAMETS: Okay.

A. You might note that on the cross section the four wells on the righthand side of the cross section are productive.

The three wells on the left part of the cross section are not producing. The first two are Dakota wells; the third one is the Kimbell dry hole, in the Chacra.

The cross section portrays the character of the Chacra formation. It is hung on the datum, reference datum of the Huerfanito marker bed, which is a bentonite. It illustrates that the Chacra interval to be continuous across the area, throughout the applied for area. It also

indicates that the better sand development in the main portion of the Otero Chacra Gas Field, to be better than the outside the gas field.

The poor sand development on the left and in the applied for area is responsible for the low natural gas production characteristics exhibited by the area.

Q. Would you just generally summarize the conclusions you can reach about the Chacra in this area?

A. Well, the Chacra interval in the area is -- is readily identified. It -- as you move away from the Otero Chacra Field it becomes tighter, less permeability.

Q. Is it continuous throughout the proposed area?

A. It is continuous.

Q. Were Exhibits One through Eight prepared by you or under your direction and supervision?

A. Yes, they were.

MR. CARR: At this time, Mr. Stamets, we would offer Applicant's Exhibits One through Eight.

MR. STAMETS: These exhibits will be admitted.

MR. CARR: I have nothing further on direct of Mr. Little.

MR. STAMETS: Any questions of this

witness?

MR. CHAVEZ: I will later.

MR. STOGNER: Yeah, I will later.

MR. STAMETS: None at this time but perhaps later.

MR. CARR: At this time we'd call Kevin McCord.

KEVIN H. McCORD

being called as a witness and being duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. CARR:

Q. Will you state your name and place of residence?

A. My name is Kevin McCord, and I reside in Farmington, New Mexico.

Q. By whom are you employed?

A. I am a self employed petroleum engineer, and I'm working as a consultant for Mr. Little.

Q. Have you had your credentials as a petroleum engineer accepted and made a matter of record for this Commission?

A. Yes, I have.

Q. Are you familiar with the application filed in this case on behalf of Mr. Little?

A. I am.

Q. Are you familiar with the proposed Gonzales Canyon Tight Gas Area?

A. I am.

MR. CARR: Are the witness' qualifications acceptable?

MR. STAMETS: They are.

Q. Mr. McCord, have you obtained stabilized, unstimulated gas production rates for the Chacra in this area?

A. Yes, we have. Obtaining stabilized, unstimulated gas production rates for the Chacra formation is not a standard procedure used in the San Juan Basin by companies completing Chacra wells.

Past experience has shown that these low permeability Chacra wells must be stimulated to obtain commercial production.

However, in preparation for this tight gas study Mr. Little prepared a 3-hour unstimulated gas production test on the Salazar No. 3 Well, located in Section 26 of 25 North, 6 West.

Exhibit Two shows that this well is located in the center of the tight gas area.

The results of this unstimulated natural gas production test was a rate of 3.89 Mcf of gas per day. This rate is well below the 91 Mcf of gas per day allotted for a tight formation with an average depth of 3390 feet.

Q. Are these truly unstimulated production rates?

A. They really aren't. These natural, unstimulated production rates were taken after the perforations were acidized with 250 gallons of 7-1/2 percent hydrochloric acid, and this was used as a production aid to induce a flow channel from the wellbore to the formation.

This acidizing, of course, cleans up the flow path so the gas can move more freely to the wellbore. True unstimulated natural production could be assumed to be even lower than this rate.

Q. How would the actual rates compare?

A. Well, they'd be expected to be lower than this 3.89 Mcf of gas per day; therefor, you could consider that to be the maximum obtainable from this area.

Q. And what conclusions can you reach concerning this natural gas production rate?

A. I feel that the average unstimulated

natural production, gas production rate from the Chacra formation in this area cannot expect -- cannot be expected to exceed the 91 Mcf of gas per day allotted.

Q Have you obtained stabilized, unstimulated oil production rates?

A Not in a true sense. Most of the gas produced from the Chacra formation is virtually dry gas. There has been no oil and condensate production reported for any of the wells now producing from the Chacra formation in the area. Therefor, it can be expected that no well would produce without stimulation more than 5 barrels of crude oil per day.

Q Now I'd like to ask you several permeability questions.

First, is stimulation generally required to obtain commercial production from Chacra wells in the subject area?

A Yes. I believe that, as has been proved many times in the past, that without a fracture stimulation treatment these wells will not produce, due to the low permeability of the reservoir rock.

Q Will you now refer to Exhibits Nine through Thirteen and review these for Mr. Stamets?

A Exhibits Numbers Nine through Thirteen

present core analysis data used to determine the average laboratory permeability to air for Chacra formation pay zones in this area.

The exhibits contain the actual core analysis reports, plus summary tables, showing the analysis of cores taken from only the productive portion of the Chacra formation for each well.

The cored intervals chosen for permeability averaging were determined by log examination of the interval cored through each well. Only cored intervals of sand that were perforated by the operator of the well were considered pay intervals and were used in the permeability averaging.

The average laboratory permeability to air determined in this manner was 1.06 millidarcy.

The Chacra formation core data presented for this area was taken from wells in the main sand trend of the Otero Chacra interval. There were no cored intervals in our actual area. The location of these cored wells is shown on Exhibit Number Two, the area map, and it would be logical to assume that the average Chacra formation laboratory permeability in the Gonzales Canyon Tight Gas Area would be lower than this 1.06 millidarcy average permeability found for the main Otero Chacra trend because of reservoir rock on

these outer areas is poorer.

The actual in situ permeability of the Chacra formation in this area is even less than this laboratory determined value due to water saturations and net confining pressures found under reservoir conditions.

Q. Will you now review Exhibit Number Fourteen for Mr. Stamets?

A. Exhibit Number Fourteen is a technical paper presented, entitled The Effect of Overburden Pressure and Water Saturation on Gas Permeability of Tight Sandstone Cores. This was written by Rex Thomas and Don Ward of the U. S. Bureau of Mines.

This paper presents relationships between laboratory determined permeability in cores and actual in situ permeability found in reservoirs.

Exhibit Number Fifteen goes along with this Fourteen, and it explains how in situ permeability is calculated from the core analysis using this technical paper.

Q. Will you now refer to Exhibit Number Sixteen and review this for Mr. Stamets?

A. Exhibit Number Sixteen is a summary of all the laboratory core analysis results for this tight gas area.

An average in situ permeability value

of 0.038 millidarcy was calculated from the average laboratory permeability value of 1.06 millidarcy for this tight gas area.

This is 0.038 millidarcy in situ permeability value is well below the 0.10 millidarcy cutoff for tight gas determination.

Q. What other methods did you employ to determine permeability in the subject area?

A. Well, I made use of the natural unstimulated production tests taken in the area, which was a gas flow rate of 3.89 Mcf of gas per day, and I used it along with other Chacra reservoir data and I used it in Darcy's Law of fluid flow through a porous medium to calculate a reservoir permeability. This is presented as Exhibit Seventeen.

Darcy's Law calculations report the average reservoir permeability value of 0.015 millidarcy for this tight gas area. This permeability value compares to the 0.030 millidarcy permeability value determined by core analysis methods. Both of these values are well below the 0.10 millidarcy tight gas cutoff.

Q. Are either of these methods of calculating permeability preferable to the other?

A. I believe that Darcy's Law calculation

of 0.015 millidarcy is the best estimate of reservoir permeability because it involved an actual -- the actual formation flow characteristics along with this natural production test taken for the area.

Either method, though, establishes that throughout the Chacra area the permeability is not expected to be 0.1 millidarcy. It's expected to be less than the 0.1 millidarcy.

Q. Mr. McCord, have you reviewed existing State and Federal regulations concerning fresh water protection.

A. Yes, I have. The existing State and Federal regulations will assure that development of the Chacra formation will not adversely affect or impair any fresh water aquifers that are being used or are expected to be used in the foreseeable future for domestic or agricultural water supplies.

These regulations require that casing programs be designed to seal off potential water-bearing formations from oil and gas producing formations. These fresh water zones exhibit -- exist from the surface to the base of the Ojo Alamo formations. This Ojo Alamo depth averages approximately 2200 feet in the proposed tight gas area. Most Chacra wells drilled in the vicinity of the tight gas area are drilled with natural mud that will not contaminate

fresh water zones. The normal casing design consists of 7-inch OD surface casing being set from the surface to a depth of 120 feet.

Production casing used is usually 2-7/8 inch OD pipe and is set from surface to TD.

The surface casing is cemented in place by circulating cement to the surface, which protects the near surface formations from downhole contamination.

The production casing is cemented from TD to the surface, or to a depth sufficient to cover the Ojo Alamo formation.

This whole process protects the Chacra, Pictured Cliffs, and other shallow formations from contaminating this Ojo Alamo aquifer. Therefor, all productive and fresh water zones are protected by both casing and cement.

Q Do you anticipate that fracture treatments could pose a threat to fresh water in the area?

A I don't believe they would. The Chacra formation stimulation uses varied fracture treatments depending on the operator.

They usually consist of one or two percent potassium chloride water base fluid with sand, or a nitrogen water foam base fluid with sand. Either treatment will not harm a fresh water aquifer. Fresh water pro-

tection is assured during these fracture stimulation treatments due to zone isolation caused by the cementation.

Also, the large distance of approximately 1200 feet between the Chacra formation and the Ojo Alamo fresh water zone is further assurance that no existing fresh water zone will be contaminated by stimulation of Chacra wells in this area.

Therefor, New Mexico and Federal regulations will protect any fresh water supply that may be affected by drilling, completing, and producing the Chacra formation in the Gonzales Tight Gas Area.

Q. Would you summarize for the Examiner the general conclusions that you can reach based on your study concerning the subject area and how it qualifies under Section 107?

A. For the Gonzales Canyon Tight -- Chacra Formation Tight Gas Area the average Chacra well depth is 3390 feet and the stabilized production rate at atmospheric pressure of wells completed in the Chacra formation without stimulation is not expected to exceed a aximum allowable rate of 91 Mcf of gas per day.

No well drilled in the Chacra formation in the Gonzales Canyon area is expected to produce without stimulation more than 5 barrels of crude oil per day, and

the estimated average in situ gas permeability throughout the Chacra pay section is expected to be 0.1 millidarcy, or less.

Q. Mr. McCord, is a copy of the geological and engineering report marked for identification as Exhibit Number Eighteen?

A. Yes.

Q. In your opinion will granting this application be in the best interest of conservation, the prevention of waste and the protection of correlative rights?

A. Yes.

Q. Were Exhibits Nine through Eighteen prepared by you or under your direction and supervision?

A. They were.

MR. CARR: At this time, Mr. Stamets, we would offer into evidence Little Exhibits Nine through Eighteen.

MR. STAMETS: These exhibits will be admitted.

MR. CARR: That concludes our direct case.

MR. STAMETS: I'm not certain who is the appropriate party to answer this, but whoever feels like he should, speak up.

Is the nature of the Chacra formation in here such, and the nature deriving from such things as the depositional environment, such that we would expect the Chacra to be the same both northwest and southeast of the line of cross section which is shown on these exhibits?

MR. LITTLE: Yes, very definitely.

MR. STAMETS: Are there questions of any of the witnesses?

MR. CHAVEZ: Yes.

QUESTIONS BY MR. CHAVEZ:

Q. Mr. McCord, was a shut-in bottom hole pressure test, or shut-in build-up -- pressure build-up test done on the Salazar No. 3?

A. No, sir, they weren't. Where we got the shut-in bottom hole pressure for Darcy's Law, we took an average of the Otero Chacra wells in the main trend and got an average of what their build-ups would be, and applied it to our area. That's the only data available that I could find.

Q. Has the Salazar No. 3 been fractured at this time?

A. Yes, it is fractured and awaiting on pipeline hookup.

Q. Was it flow tested after fracture?

A. Yes, it was. The AOF on this well was 274 Mcf of gas per day, for the Chacra. It was a dual well. It was completed in the PC also.

Q. The water saturations that you used from the -- or that you got from the cores that were done out of this area, are they the type of water saturations you expect in this area?

A. That's correct, yes. And those were taken directly out of core analysis reports.

MR. CHAVEZ: I have no further questions.

MR. STOGNER: I have one question.

QUESTIONS BY MR. STOGNER:

Q. You gave us an average well depth of the Chacra in this area as 3390?

A. Yes, sir.

Q. What kind of thickness do you expect over the area?

A. Let me see what the thickness was. I believe it's -- the type log will show the top and the bottom, I believe. I believe it's 130 feet gross thickness.

Is that right with you, Curtis?

Okay, top of the Chacra -- excuse me,

top of the Chacra is 3425; base at 3553.

MR. STOGNER: I have no more questions.

MR. CHAVEZ: May I ask one more question?

QUESTIONS BY MR. CHAVEZ:

Q. The overburden pressure that you used in correcting the laboratory permeabilities to in situ, how was that derived?

A. Okay. The overburden is figured by taking an average porosity for the overburden, and that was assumed to be the same as the Chacra formation. By using the porosity, the grain density of the sand, multiplied by the depth, you get a pressure due to the rock face, and that's offset by the bouyancy of the fluid in the formation.

So a combination of those two results in an overburden pressure of approximately 3600 psi, and the net confining pressure used in the paper was an overburden pressure minus the reservoir pressure and that resulted in 2733 psi.

MR. CHAVEZ: I have no further questions.

MR. STAMETS: Any other questions of this witness? He may be excused.

Anything further in this case?

MR. CARR: Nothing further, Mr. Stamets.

MR. STAMETS: Are there any statements in this case?

The case will be taken under advisement.

(Hearing concluded.)

C E R T I F I C A T E

I, SALLY W. BOYD, C.S.R., DO HEREBY CERTIFY that the foregoing Transcript of Hearing before the Oil Conservation Division was reported by me; that the said transcript is a full, true, and correct record of the hearing, prepared by me to the best of my ability.

Sally W. Boyd CSR

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 7489 heard by me on 2-17 19 82

Richard L. Stamets, Examiner
Oil Conservation Division

SALLY W. BOYD, C.S.R.
Rt. 1 Box 193-B
Santa Fe, New Mexico 87501
Phone (505) 455-7409

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

BRUCE KING
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POST OFFICE BOX 2088
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SANTA FE, NEW MEXICO 87501
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April 15, 1982

Mr. William F. Carr
Campbell, Byrd & Black
Attorneys at Law
Post Office Box 2208
Santa Fe, New Mexico

Re: CASE NO. 7489
ORDER NO. R-6939

Applicant:

Curtis J. Little

Dear Sir:

Enclosed herewith are two copies of the above-referenced Division order recently entered in the subject case.

Yours very truly,

JOE D. RAMEY
Director

JDR/fd

Copy of order also sent to:

Hobbs OCD x
Artesia OCD x
Aztec OCD x

Other

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

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

CASE NO. 7409
Order No. R-6939

APPLICATION OF CURTIS J. LITTLE
FOR DESIGNATION OF A TIGHT
FORMATION, RIO ARRIBA COUNTY,
NEW MEXICO.

ORDER OF THE DIVISION

BY THE DIVISION:

This cause came on for hearing at 9 a.m. on February 17, 1982, at Santa Fe, New Mexico, before Examiner Richard L. Stamets.

NOW, on this 14th day of April, 1982, the Division Director, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

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

(2) That the applicant, Curtis J. Little, requests that the Division in accordance with Section 107 of the Natural Gas Policy Act, and 18 C.F.R. §271.703 recommend to the Federal Energy Regulatory Commission that the Chacra formation underlying the following lands situated in Rio Arriba County, New Mexico, hereinafter referred to as the Chacra formation, be designated as a tight formation in said Federal Energy Regulatory Commission's regulations:

TOWNSHIP 25 NORTH, RANGE 6 WEST, NMPM
Section 16: All
Section 21: All
Section 22: All
Section 23: S/2
Sections 25 through 28: All
Sections 34 through 36: All

Containing a total of 6,720 acres, more or less.

(3) That the Chacra formation underlies all of the above-described lands; that the formation consists of marine deposits about 130 feet thick, composed of very fine grained siltstone having varying amounts of shale with carbonaceous and clay infilling; and that the top of such formation is found at an average depth of 3390 feet below the surface of the area set forth in Finding No. (2) above.

(4) That the type section for the Chacra formation for the proposed tight formation designation is found at a depth of approximately 3425 feet to 3553 feet on the Dresser Atlas Induction Electrolog dated December 19, 1981, from the Curtis J. Little Salazar Well No. 3, located in Unit C of Section 26, Township 25 North, Range 6 West, Rio Arriba County, New Mexico.

(5) That one well produces natural gas from the Chacra formation within the proposed area being the Kimbell Oil Co. Salazar Federal Well No. 1 located 1450 feet from the South line and 1450 feet from the East line of Section 22, Township 25 North, Range 6 West, NMPM, Rio Arriba County, New Mexico.

(6) That the Chacra formation underlying the above-described lands has been penetrated by several other wells, none of which produced natural gas in commercial quantities from the Chacra formation.

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

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

(b) the stabilized production rate, against atmospheric, of wells completed for production in the Chacra formation, without stimulation, is not expected to exceed production levels determined by reference to well depth, as found in the table set out in 18 C.F.R. §271.703(c)(2)(B) of the regulations; and

(c) no well drilled into the Chacra formation is expected to produce, without stimulation, more than five barrels of crude oil per day.

(8) That the Chacra formation underlying the area described in Paragraph 2 hereof is not being developed by infill drilling.

(9) That the evidence presented in this case demonstrated that the application of incentive pricing is reasonably necessary to stimulate further development of the proposed tight formation underlying the area described in Paragraph 2 hereof.

(10) That within the proposed area there is a recognized aquifer being the Ojo Alamo, found at an average depth of 2200 feet or approximately 1200 feet above the Chacra formation.

(11) That existing State of New Mexico and Federal Regulations relating to casing and cementing of wells will assure that development of the Chacra formation will not adversely affect the said aquifer.

(12) That the Chacra formation should be recommended to the Federal Energy Regulatory Commission for designation as a tight formation.

IT IS THEREFORE ORDERED:

(1) That it be and hereby is recommended to the Federal Energy Regulatory Commission pursuant to Section 107 of the Natural Gas Policy Act of 1978, and 18 C.F.R. §271.703 of the regulations that the Chacra formation underlying the following described lands in Rio Arriba County, New Mexico, be designated as a tight formation:

TOWNSHIP 25 NORTH, RANGE 6 WEST, NMPM
Section 16: All
Section 21: All
Section 22: All
Section 23: S/2
Sections 25 through 28: All
Sections 34 through 36: All

Containing a total of 6,720 acres, more or less.

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

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

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

JOE D. RAMEY
Director

SEAL

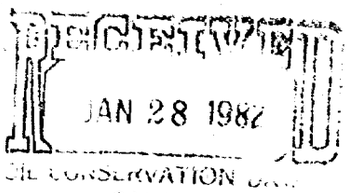
fd/

CAMPBELL, BYRD & BLACK, P.A.
LAWYERS

JACK M. CAMPBELL
HARL D. BYRD
BRUCE D. BLACK
MICHAEL B. CAMPBELL
WILLIAM F. CARR
BRADFORD C. BERGE
WILLIAM G. WARDLE
KEMP W. GORTHEY

JEFFERSON PLACE
SUITE 1 - 110 NORTH GUADALUPE
POST OFFICE BOX 2208
SANTA FE, NEW MEXICO 87501
TELEPHONE: (505) 988-4421
TELECOPIER: (505) 983-6043

January 28, 1982



Mr. Joe D. Ramey
Director
Oil Conservation Division
New Mexico Department of
Energy and Minerals
Post Office Box 2088
Santa Fe, New Mexico 87501

Case 7484

Re: Application of Curtis J. Little for Designation of Tight Formation, Rio Arriba County, New Mexico (Gonzales Canyon Area)

Dear Mr. Ramey:

Enclosed is a complete set of all exhibits which applicant proposes to offer into evidence at the hearing on the above-referenced application, together with a statement of the meaning and purpose of each exhibit as is required by Section D of the Oil Conservation Division's Special Rules and Procedures for Tight Formation Designation. Also enclosed is a Certificate of Filing, which certifies that all exhibits have been filed with the United States Geological Survey.

Very truly yours,

William F. Carr

WFC:lr

Enclosures

cc: Curtis J. Little
Kevin McCord

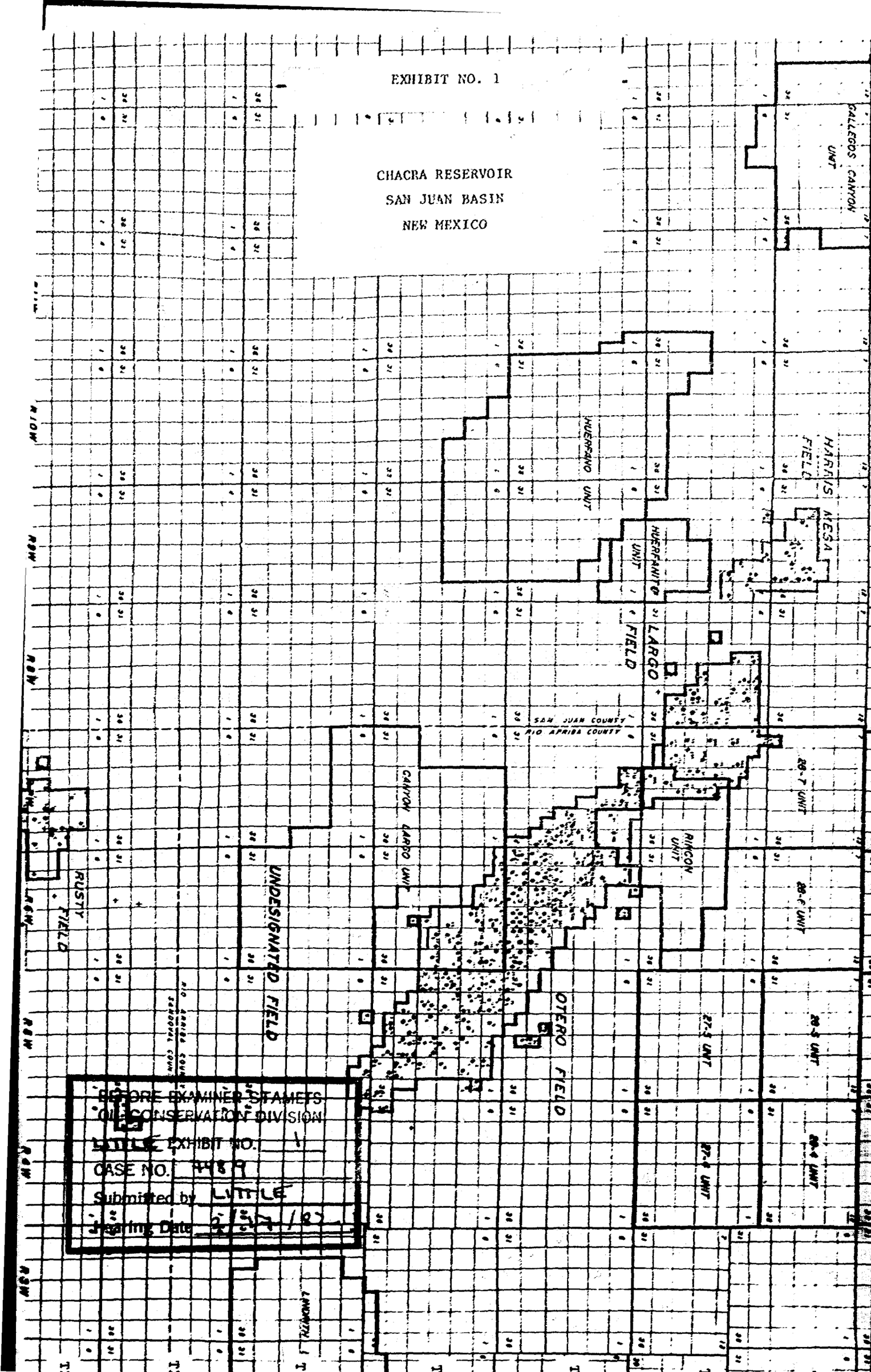
LIST OF EXHIBITS

Exhibit Number	Exhibit Name	Purpose of Exhibit
1	Chacra Reservoir Map	Show location of Gonzales Canyon Tight Gas Area with respect to Chacra production.
2	Chacra Formation Completion and Production Map	Show production figures of completed and dry Chacra wells in and around the tight formation area.
3	Gonzales Canyon Tight Gas Area Wells	List production figures of completed and dry Chacra wells in the tight formation area.
4	January 1981 Cumulative Gas Production Map of Wells Completed in the Chacra Formation	Present, by color codes, the production trends in the vicinity of the Gonzales Canyon Tight Gas Area.
5	1980 Annual Gas Production Map of Wells Completed in The Chacra Formation	Present, by color codes, the production trends in the vicinity of the Gonzales Canyon Tight Gas Area.
6	Structure Contour Map	Show regional dip in the vicinity of the Gonzales Canyon Tight Gas Area.
7	Type Log	Show log characteristics and depth of Chacra formation in the Gonzales Canyon Tight Gas Area.
8	Cross Section A-A'	Show Chacra formation development in the Gonzales Canyon Tight Gas Area.
9	Core Analysis Amoco Production Company Jicarilla 146 No. 11	Show average laboratory core permeability.
10	Core Analysis Exxon Jicarilla J No. 9	Show average laboratory core permeability.
11	Core Analysis Amerada Petroleum Corp. Jicarilla F No. 5	Show average laboratory core permeability.
12	Core Analysis Amerada Petroleum Corp. Jicarilla F No. 4	Show average laboratory core permeability.
13	Core Analysis El Paso Natural Gas Co. Klein No. 12	Show average laboratory core permeability.
14	Technical Paper	Present relationship between laboratory and in situ permeability.
15	Determination of In Situ Permeability	Show method of determining in situ permeability from laboratory core analysis.

Exhibit Number	Exhibit Name	Purpose of Exhibit
16	Summary of Core Permeability Data	Show summary of permeability data, average laboratory permeability and in situ permeability.
17	Darcy's Law Calculation	Show determination of permeability from unstimulated gas production test.

EXHIBIT NO. 1

CHACRA RESERVOIR
SAN JUAN BASIN
NEW MEXICO



BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
EXHIBIT NO. 1
CASE NO. 7489
Submitted by LYELL
Hearing Date 2/14/80

EXHIBIT NO. 3

GONZALES CANYON TIGHT GAS AREA

LIST OF WELLS

	COMPANY	WELL NAME	LOCATION	CHACRA DEPTH	IP DATE	IP MCFGPD	1980 AVERAGE DAILY PRODUCTION MCFGPD	CUMULATIVE PRODUCTION 01-01-81 BCFG
1.	Kimbell Oil Co.	Salazar Federal 1-22	NWSE 22 25-6	3398	05/58	1803	45	0.565
2.	Kimbell Oil Co.	Salazar 4-26	NWNW 26 25-6	3508	05/80	D&A	--	---
3.	Curtis J. Little	Salazar No. 3	NENW 26 25-6	3425	12/81	New Well	--	---
4.	Kimbell Oil Co.	Federal 1-27	SENE 27 25-6	3484	02/58	570	P&A, 04/60 - well never produced.	

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 3
CASE NO. 7489
Submitted by LITTLE
Hearing Date 2/17/82

R-7-W R-6-W R-5-W

T 26 N

T 25 N

T 24 N

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 4
CASE NO. 7489
Submitted by LITTLE
Hearing Date 2/17/82

CHACRA

GAS PRODUCTION ONLY

12 = ANNUAL PRODUCTION (MMCF), 1980.

345 = CUMULATIVE PRODUCTION (MMCF) TO 1-1-81

CUMULATIVE GAS PRODUCTION GREATER THAN 1/4 BCF

EXHIBIT NO. 4

R-7-W R-6-W R-5-W

T 26 N

T 25 N

T 24 N

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 5
CASE NO. 7489
Submitted by LITTLE
Hearing Date 2/17/82

CHACRA

GAS PRODUCTION ONLY

12 = ANNUAL PRODUCTION (MMCF), 1980

345 = CUMULATIVE PRODUCTION (MMCF) TO 1-1-81

= 1980 PRODUCTION GREATER THAN 12 MMCF

R-7-W R-6-W R-5-W

T 26 N

T 25 N

T 24 N

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 5
CASE NO. 7489
Submitted by LITTLE
Hearing Date 2/17/82

CHACRA

GAS PRODUCTION ONLY

12 = ANNUAL PRODUCTION (MMCF), 1980

345 = CUMULATIVE PRODUCTION (MMCF) TO 1-1-81

= 1980 PRODUCTION GREATER THAN 12 MMCF

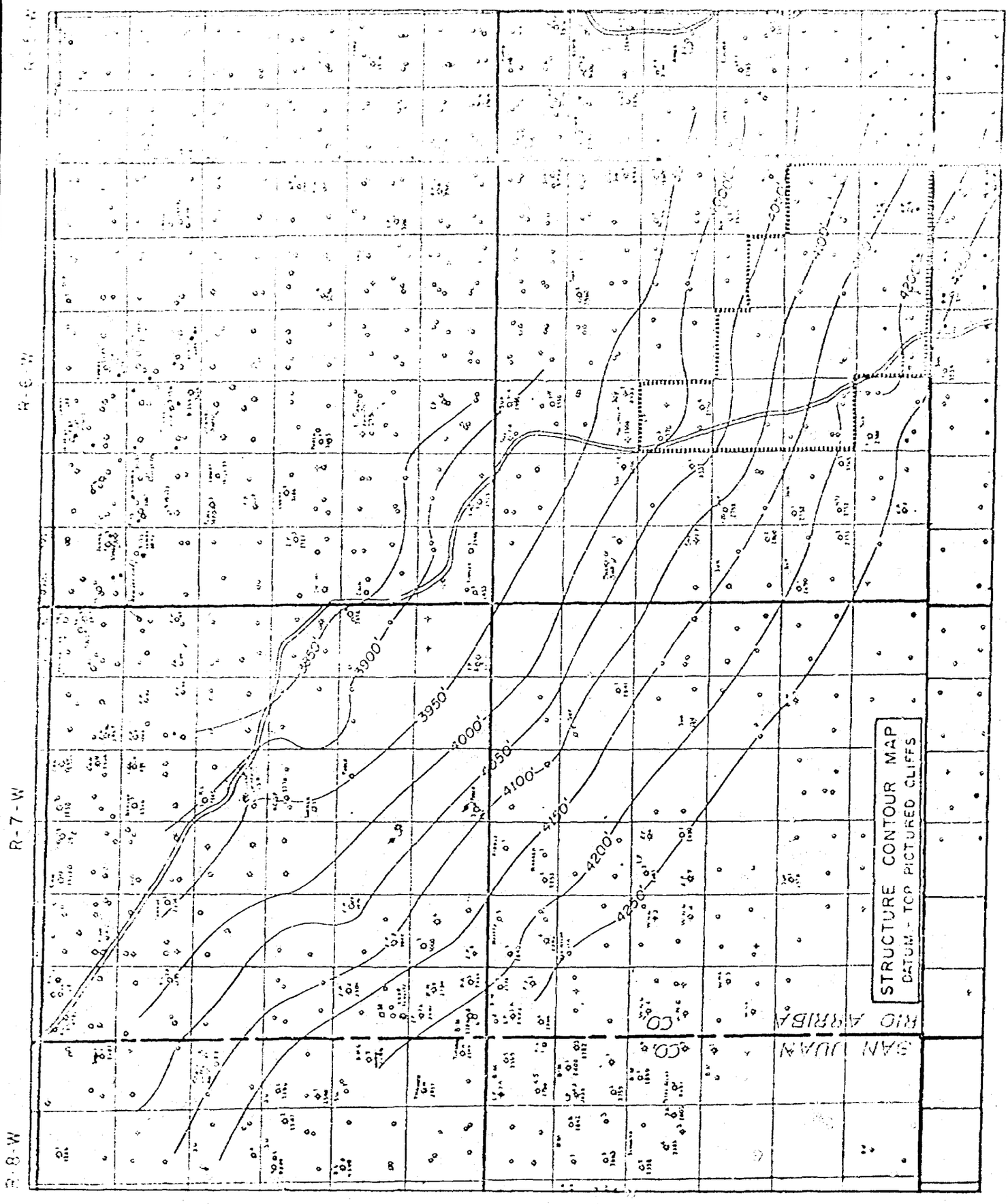


EXHIBIT NO. 6

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 6
CASE NO. 7489
Submitted by LITTLE
Hearing Date 2/17/82

EXHIBIT NO. 9

Company: Amoco Production Company
Well: Jicarilla Contract 146 No. 11

Otero Chacra Field

NESW, Section 4, Township 25 North, Range 5 West
Rio Arriba County, New Mexico

CHACRA FORMATION CORE DATA
(Only Perforated Intervals Shown)

Depth (ft)	Sample Footage (ft)	Permeability (md)
3772-3773	1	0.07
3773-3774	1	0.34
3774-3775	1	0.08
3775-3776	1	0.32
3776-3777	1	2.50
3777-3778	1	6.30
3778-3779	1	0.52
3779-3780	1	1.10
3780-3781	1	0.33
3781-3782	1	0.10
3782-3783	1	0.38
3783-3784	1	0.10
3784-3785	1	0.07
3785-3786	1	0.01
3786-3787	1	17.00
3787-3788	1	5.80
3788-3789	1	0.20
3789-3790	1	6.60
3790-3791	1	7.30
3791-3792	1	0.30
3792-3793	1	0.23
3793-3794	1	0.20
3794-3795	1	0.14
3795-3796	1	5.40
3796-3797	1	0.08
3797-3798	1	2.60
3798-3799	1	0.03
3799-3800	1	0.19
3800-3801	1	0.10
3801-3802	1	0.08
3802-3803	1	0.41
3803-3804	1	0.07
3804-3805	1	0.18
3805-3806	1	0.13
3806-3807	1	0.02
3807-3808	1	0.13
3808-3809	1	0.04
3809-3810	1	0.19
TOTAL:	38	59.64

Average Laboratory Permeability = $\frac{59.64}{38}$ = 1.57 md

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 9
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

OTERO CHACRA FIELD

	CHACRA		RF-3-1440
SIGNILLA CONTRACT 146 #11		DIAMOND CONV.	
BA. IN DAKOTA		WATER BASE MUD	McCOMAS
RIO ARRIBA NEW MEX	6660 KB	SEC 4 T25N R5W	

Lithologic Abbreviations

SAMPLE NUMBER					
1	377--73	0.07	7.0	10.0	77.1
2	73-74	0.34	8.3	2.4	80.8
3	74-75	0.08	10.6	6.6	77.4
4	75-76	0.32	13.8	5.1	55.9
5	76-77	2.5	17.5	1.1	48.5 ✓
6	77-78	6.3	15.8	0.0	46.9 ✓
7	78-79	0.52	15.2	3.3	52.0
8	79-80	1.1	10.9	0.0	30.2 ✓
9	80-81	0.33	18.1	1.1	45.3 ✓
10	81-82	0.10	6.3	11.1	79.5
11	82-83	0.38	14.6	0.0	47.2 ✓
12	83-84	0.10	10.1	2.0	64.4
13	84-85	0.07	7.5	1.9	70.6
14	85-86	0.01	10.0	25.0	64.0
15	86-87	17	18.5	0.0	31.9 ✓
16	87-88	5.8	15.0	0.0	31.2 ✓
17	88-89	0.20	10.0	0.0	27.0
18	89-90	6.6	15.7	0.0	30.0 ✓
19	90-91	7.3	15.0	0.0	31.3 ✓
20	91-92	0.30	12.2	0.0	34.4
21	92-93	0.23	12.3	4.1	48.0
22	93-94	0.20	12.6	1.6	50.0
23	94-95	0.14	16.5	4.2	44.1
24	95-96	5.4	15.8	5.7	43.5 ✓
25	96-97	0.08	17.1	4.1	41.0
26	97-98	2.6	14.7	8.8	42.2 ✓
27	98-99	0.03	6.6	10.6	75.8
28	99-3800	0.19	6.9	7.2	73.9
29	3800-01	0.10	10.5	6.7	68.5
30	01-02	0.08	10.5	4.8	69.4
31	02-03	0.41	7.7	9.1	85.6
32	03-04	0.07	8.2	8.1	80.6
33	04-05	0.18	6.2	8.1	87.0
34	05-06	0.13	7.7	9.1	83.2
35	06-07	0.02	8.1	8.7	81.5
36	07-08	0.13	9.7	7.2	76.4
37	08-09	0.04	9.5	7.4	74.6
38	09-10	0.19	8.1	11.1	79.0

CORE ANALYSIS RESULTS

Company	PAN AMERICAN PETROLEUM CORP.	Formation	CHACRA	File	RP-3-1440
Well	JICARILLA CONTRACT 146	Core Type	DIAMOND CONV.	Date Report	5/25/61
Field	LAC IN DAKOTA	Drilling Fluid	WATER BASE MUD	Analysts	McCOMAS
County	RIO ARRIBA NEW MEX	Elev. 6660 KB	Loc. SEC 4 T25N R5W		

Lithological Abbreviations

SAMPLE NUMBER				RESIDUAL SATURATION		
				OIL	WATER	
39	3812-14	0.04	5.5	12.7	81.7	
40	14-15	0.17	5.9	11.9	83.1	
41	15-16	0.02	5.4	9.3	89.0	
42	16-17	0.08	6.0	11.7	85.0	
43	17-18	0.11	5.3	13.2	84.9	

Service No. 8 No interpretation of results

EXHIBIT NO. 10

Company: Exxon
Well: Jicarilla J No. 9

Otero Chacra Field

NESE, Section 6, Township 25 North, Range 5 West
Rio Arriba County, New Mexico

CHACRA FORMATION CORE DATA
(Only Perforated Intervals Shown)

Depth (ft)	Sample Footage (ft)	Permeability (md)
3714-3715	1	0.18
3715-3716	1	0.10
3716-3717	1	0.03
3717-3718	1	0.45
3718-3719	1	0.26
3719-3720	1	0.67
3720-3721	1	0.10
3721-3722	1	2.00
3722-3723	1	0.24
3723-3724	1	0.41
3724-3725	1	0.08
3725-3726	1	0.23
3726-3727	1	0.26
3727-3728	1	0.06
3728-3729	1	0.19
3729-3730	1	0.12
3730-3731	1	0.05
3731-3732	1	0.09
3732-3733	1	0.05
3810-3811	1	0.01
3811-3812	1	0.04
3812-3813	1	0.02
3813-3814	1	0.04
3814-3815	1	0.03
3815-3816	1	0.04
3816-3817	1	0.02
3817-3818	1	0.02
3818-3819	1	0.04
3819-3820	1	0.01
3820-3821	1	0.03
3821-3822	1	0.02
3822-3823	1	0.02
3823-3824	1	0.02
3824-3825	1	0.02
TOTAL:	34	5.95

Average Laboratory Permeability = $\frac{5.95}{34}$ = 0.18 md

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 10
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

CORE LABORATORIES, Inc.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company The Humble Oil & Refining Co. Formation Chacra Page 1 of 2
Well Jicarilla "J" 9 Cores Diamond Conv. File RP-3-516
Field So. Blanco Pictured Cliffs & Chacra Drilling Fluid Date Report 7/9/57
County Rio Arriba State New Mexico Elevation 6662 DF Analysts DI; JS
Location Sec. 6 - 25N. - 5W. Remarks Service # 4 (Preliminary Report)

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS	POROSITY PERCENT	RESIDUAL SATURATION		PINPOINT PRODUCTION	REMARKS
				OIL % VOLUME % PORE	TOTAL WATER % PORE		
1	3697-98	0.03	7.4	9.4	79.5		
2	98-99	0.03	5.7	12.2	77.2		
3	99-3700	*	5.8	8.6	77.5		
4	3700-01	0.02	6.5	7.7	80.0		
5	01-02	0.28	7.3	13.7	60.7		
6	02-03	0.07	7.7	9.1	75.3		
7	03-04	0.10	11.7	4.3	60.7		
8	04-05	0.11	13.7	3.7	50.4		
9	05-06	0.20	15.7	1.3	50.3		
10	06-07	0.08	8.2	0.0	12.2		
11	07-08	0.19	18.5	3.2	33.5		
12	08-09	*	19.1	1.0	33.5		
13	09-10	1.3	16.4	3.7	34.1		
14	10-11	3.3	10.2	0.0	14.7		
15	11-12	0.55	13.6	1.5	30.9		
16	12-13	0.11	9.5	0.0	26.3		
17	13-14	0.12	12.6	4.0	31.7		
18	14-15	0.18	13.7	5.1	30.6		
19	15-16	0.10	10.0	0.0	19.0		
20	16-17	0.03	6.2	0.0	87.0		
21	17-18	0.45	10.5	4.8	56.1		
22	18-19	0.26	15.4	3.2	40.3		
23	19-20	0.67	17.4	2.9	38.4		
24	20-21	0.10	16.0	6.3	57.3		
25	3721-22	2.0	16.1	0.0	31.1		

*Unsuitable permeability measurements.

3697-3704-

High total water saturations (76.0% average) show this zone to be of no commercial value. Other properties of the zone are: permeability (0.09 md/ft average) porosity (7.5% average) and residual oil saturation (9.3% average).

NOTE.
(*) REFER TO ATTACHED LETTER (2) OFF LOCATION ANALYSES—NO INTERPRETATION OF RESULTS.
(†) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company The Humble Oil & Refining Company | Formation Chacra | Page 1 of 2
Well Jicarilla "J" #9 | Cores - | Diamond Conv. | File RP-3-516
Field So. Blanco Pictured Cliffs & Chacra | Drilling Fluid Oil Emulsion Mud | Date Report 7/9/57
County Rio Arriba | State New Mexico | Elevation 6662 DF | Analysts JW:JS:DI:RY
Location Sec. 6 - 29N. - 5W. | Remarks Service #5 (Preliminary Report)

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS	POROSITY PERCENT	RESIDUAL SATURATION		PRODUCTIVITY CONCLUSION	REMARKS
				OIL % VOLUME	TOTAL WATER % VOLUME		
26	3722-23	0.24	12.5	4.0	52.0		
27	3723-24	0.41	13.6	3.7	36.3		
28	24-25	0.08	6.4	8.3	78.7		
29	25-26	0.23	14.9	3.4	45.0		
30	26-27	0.26	14.6	4.1	46.6		
31	27-28	0.06	8.4	21.4	69.1		
32	28-29	0.19	6.3	6.4	84.4		
33	29-30	0.12	11.6	8.6	63.0		
34	30-31	0.05	6.5	14.1	81.1		
35	31-32	0.09	10.1	6.9	76.2		
36	32-33	0.05	9.8	7.1	83.6		
37	33-34	0.06	10.7	6.5	77.5		
38	34-35	0.06	6.3	11.1	61.9		
39	35-36	0.07	13.2	3.8	66.9		
40	36-37	0.07	12.1	4.1	77.7		
41	37-38	0.08	12.8	5.5	68.0		
42	38-39	0.13	13.0	7.7	56.2		
43	39-40	0.03	8.6	13.9	83.7		
44	40-41	0.03	7.6	15.4	80.7		
45	41-42	0.07	7.5	13.4	81.6		
46	42-43	0.02	7.1	14.1	83.1		
47	43-44	0.02	6.7	14.9	82.0		
48	44-45	0.02	7.9	12.7	82.2		
49	45-46	0.03	8.5	11.8	82.4		
50	46-47	0.01	7.3	9.6	89.0		
51	47-48	0.02	1.6	12.5	75.0		
52	48-49	0.03	7.6	9.2	88.0		
53	49-50	0.05	7.8	6.4	89.8		
54	50-51	0.06	8.8	8.0	91.0		
55	51-52	0.04	8.5	8.2	87.0		
56	52-53	0.02	8.4	6.2	91.8		
57	3753-54	0.02	7.2	2.8	91.7		

NOTE
(*1) REFER TO ATTACHED LETTER
(1) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED

(2) OFF LOCATION ANALYSES—NO INTERPRETATION OF RESULTS

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company	The Humble Oil & Refining Company	Formation	Chacra	Page	2 of 2
Well	Jicarilla "J" #9	Core	Diamond Conv.	File	RP-3-516
Field	So. Blanco Pictured Cliffs & Chacra	Drilling Fluid	Oil Emulsion Mud	Date Report	7/9/57
County	Rio Arriba State New Mexico	Elevation	6662 DF	Analysts	JW:JS:DI:RY
Location	Sec. 6- 25N.- 5W.	Remarks	Service # 5 (Preliminary Report)		

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

Sample Number	Depth Feet	Permeability Millidarcys	Porosity Percent	Residual Saturation		Probable Production	Remarks
				Oil % Volume Pore	Total Water % Pore		
58	3754-55	0.12	7.1	7.0	87.3		
59	55-56	0.04	6.6	5.8	90.9		
60	56-57	0.05	5.5	1.9	91.4		
61	57-58	0.02	9.4	2.1	91.5		
62	58-59	0.02	7.9	2.5	91.2		
63	59-60	0.01	8.0	6.3	88.8		
64	60-61	0.02	7.2	2.3	95.8		
65	61-62	0.04	7.7	2.6	96.1		
66	62-63	0.01	6.7	3.0	95.5		
67	63-64	0.09	6.7	7.5	91.0		
68	64-65	0.04	8.3	6.0	92.8		
69	65-66	0.01	6.9	2.9	95.6		
70	66-67	0.01	7.3	2.7	95.9		
71	67-68	0.03	7.6	6.6	89.5		
72	68-69	0.02	7.5	2.7	90.5		
73	69-70	0.02	7.0	0.0	92.8		
74	70-71	0.02	6.9	2.9	92.9		
75	71-72	0.04	6.5	3.0	96.7		
76	3772-73	0.01	7.4	2.7	94.5		

3722-3727-

The total water saturations (52.1% average) are higher than the zone above this one and contain a very high total water saturation . This zone should be excluded from any completion attempt. Other properties of this zone are: permeability (0.24 md/ft average), porosity (12.8% average) and residual oil saturations (1.7% average).

3727-3773-

High total water saturations (85.0% average) show this zone to be of no commercial value. Other properties are: permeability (0.05 md/ft average) porosity (8.3% average) and residual oil saturations (0.0% to 21.1%).

NOTE
(*) REFER TO ATTACHED LETTER (**) SEE EVALUATION ANALYSES - NO INTERPRETATION OF RESULTS
(+) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company	The Humble Oil & Refining Co.	Formation	Chacra	Page	1 of 3
Well	Jicarilla "J" #9	Cores	Diamond Conv.	File	RP-3-516
Field	So. Blanco Pictured cliffs & Chacra	Drilling Fluid	Oil Emulsion Mud	Date Report	7/10/57
County	Rio Arriba State New Mexico	Elevation	6662 DF	Analysts	JW:JS
Location	Sec.6- 25N.- 5W.	Remarks	Service # 4 (Preliminary Report)		

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS	POROSITY PERCENT	RESIDUAL SATURATION		PROBABLE PRODUCTION	REMARKS
				OIL % VOLUME % PORE	TOTAL WATER % PORE		
77	3773-74	0.02	8.3	6.0	85.6		
78	74-75	0.12	7.2	6.9	90.4		
79	75-76	0.05	6.7	5.7	87.5		
80	76-77	0.04	7.4	6.9	86.5		
81	77-78	0.07	7.5	6.7	85.3		
82	78-79	0.04	7.4	6.3	86.5		
83	79-80	0.12	6.9	7.2	86.9		
84	80-81	0.06	7.5	6.7	86.8		
85	81-82	*	7.6	6.6	84.2		
86	82-83	0.03	7.1	2.8	90.2		
87	83-84	0.05	7.6	2.6	89.6		
88	84-85	0.04	7.8	6.4	84.5		
89	85-86	0.04	7.4	6.8	90.6		
90	86-87	0.02	8.0	6.3	78.7		
91	87-88	0.02	8.3	8.4	87.8		
92	88-89	0.02	6.7	10.4	85.0		
93	89-90	0.04	8.3	2.4	45.8		
94	90-91	0.03	6.8	2.7	51.5		
95	91-92	0.01	6.6	8.1	86.0		
96	92-93	0.04	7.6	9.2	83.0		
97	93-94	0.04	9.3	10.8	83.8		
98	94-95	0.02	7.3	9.5	91.8		
99	95-96	0.02	7.1	2.3	92.2		
100	96-97	0.06	7.7	9.1	84.3		
101	97-98	0.02	10.7	6.5	89.6		
102	98-99	0.02	7.4	6.8	83.9		
103	99-3800	0.03	8.0	15.0	75.0		
104	3800-01	0.01	7.3	6.9	87.7		
105	01-02	0.03	8.6	11.6	85.0		
106	02-03	0.04	8.3	8.4	87.9		
107	03-04	0.02	7.7	9.1	86.5		
108	3804-05	0.02	8.6	5.8	93.2		

NOTE
(*) REFER TO ATTACHED LETTER
(1) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED.
(2) OFF LOCATION ANALYSES--NO INTERPRETATION OF RESULTS

CORE LABORATORIES, Inc.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company The Humble Oil & Refining Company	Formation	Chacra	Page 2 of 3
Well Jicarilla "J" #9	Cores	Diamond Conv.	File RF-3-516
Field So. Blanco Pictured Cliffs & Chacra	Drilling Fluid	Oil Emulsion Mud	Date Report 7/10/57
County Rio Arriba State New Mexico	Elevation	6652 DF	Analysts JW:JS
Location Sec.6- 25N.- 5W.	Remarks	Service # 4 (Preliminary Report)	

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

Sample Number	Depth Feet	Permeability Millidarcys	Porosity Percent	Residual Saturation		Probable Production	Remarks
				Oil % Volume	Total Water % Pore		
109	3805-06	0.02	7.8	9.0	88.5		
110	06-07	0.03	7.8	9.0	82.1		
111	07-08	*	9.2	7.6	84.9		
112	08-09	0.02	10.9	7.0	75.0		
113	09-10	0.02	9.1	5.5	25.3		
114	10-11	0.01	7.9	8.9	65.9		
115	11-12	0.04	11.8	5.9	28.8		
116	12-13	0.02	11.4	6.1	43.6		
117	13-14	0.04	8.5	7.1	31.8		
118	14-15	0.03	11.7	4.3	39.3		
119	15-16	0.04	8.0	15.0	15.0		
120	16-17	0.02	5.3	13.2	61.0		
121	17-18	0.02	6.2	11.3	77.5		
122	18-19	0.04	10.9	6.4	28.4		
123	19-20	0.01	7.2	6.9	83.3		
124	20-21	0.03	12.5	5.6	29.6		
125	21-22	0.02	9.8	5.1	46.9		
126	22-23	0.02	13.3	5.3	38.3		
127	23-24	0.02	3.5	14.3	62.9		
128	3824-25	0.02	6.3	7.9	85.6		

3772-3809-

High total water saturations (84.1% average) show this zone to be of no commercial value. Other properties are: permeability (0.04 md/ft average), porosity (7.9% average) and residual oil saturations (7.0% average).

3809-3810-

This foot has gas productive characteristics, but very low permeability.

3810-3811-

High total water saturations show this foot to be of no commercial value.

NOTE
(*) REFER TO ATTACHED LETTER (2) OFF LOCATION ANALYSES—NO INTERPRETATION OF RESULTS
(1) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED

EXHIBIT NO. 11

Company: Amerada Petroleum Corporation
Well: Jicarilla Apache F-5

Otero Chacra Field

NWSE, Section 16, Township 25 North, Range 5 West
Rio Arriba County, New Mexico

CHACRA FORMATION CORE DATA
(Only Perforated Intervals Shown)

Depth (ft)	Sample Footage (ft)	Permeability (md)
3782-3783	1	0.04
3783-3784	1	fractured
3784-3785	1	fractured
3785-3786	1	0.12
3786-3787	1	0.19
3787-3788	1	0.03
3788-3789	1	fractured
3789-3790	1	0.46
3790-3791	1	fractured
3791-3792	1	0.16
3792-3793	1	0.01
3793-3794	1	0.11
3794-3795	1	0.11
3795-3796	1	0.01
3796-3797	1	0.25
3797-3798	1	fractured
3798-3799	1	fractured
3799-3800	1	0.02
TOTAL:	12 (nonfractured)	1.51

Average Laboratory Permeability = $\frac{1.51}{12}$ = 0.13 md

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 11
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

CORE LABORATORIES, INC. *Petroleum Reservoir Engineering*

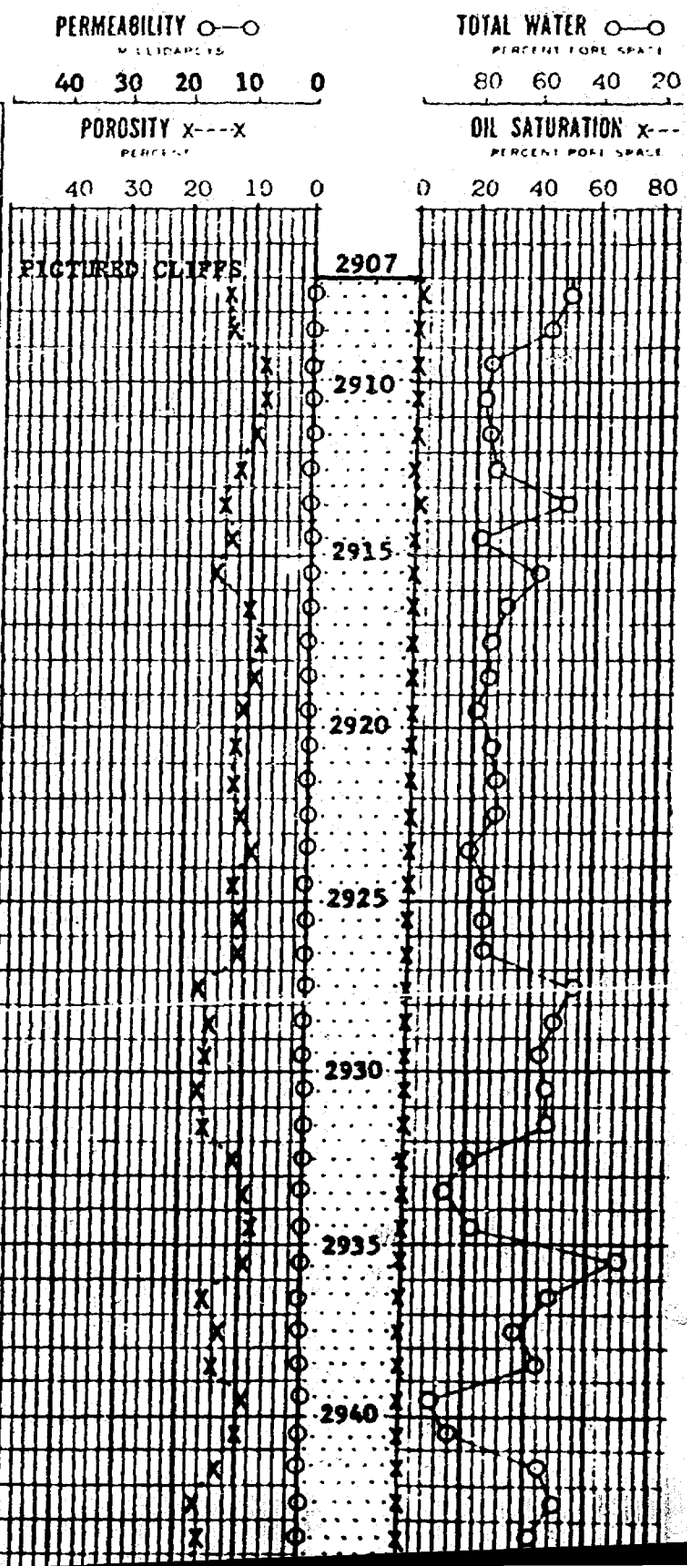
COMPANY AMERADA PETROLEUM CORPORATION — DATE ON 7/24/57 — FILE NO. RP-3-534 FC
WELL JICARILLA APACHE F-5 — DATE OFF 7/27/57 — ENGRS. JE
FIELD JICARILLA — FORMATION AS NOTED — ELEV. 6761' KB
COUNTY RIO ARRIBA — STATE NEW MEX. — DRLG. FLD. OIL EMULSION — CORES DIAMOND
LOCATION SE NW SE SEC 16-T25N-R5W — REMARKS SAMPLED BY CLI ENGINEER

SAND · LIMESTONE · CONGLOMERATE · CHERT
SHALE · DOLOMITE · FRACTURES

TABULAR DATA and INTERPRETATION

SAMPLE NUMBER	DEPTH FEET	PERM MD	POROSITY %	RESIDUAL SATURATION % PORE SPACE OIL	RESIDUAL SATURATION % PORE SPACE TOTAL WATER	REMARKS
	f - DENOTES FRACTURED PERMEABILITY PLUG.					
1	2907-08	0.07	14.5	1.4	49.7	
2	08-09	0.09	13.6	0.0	55.6	
3	09-10	0.01	8.8	0.0	75.0	
4	10-11	<0.01	8.2	0.0	77.0	
5	11-12	0.02	9.6	0.0	75.0	
6	12-13	0.06	12.3	0.0	73.0	
7	13-14	0.02	14.0	1.4	49.3	
8	14-15	0.04	12.6	0.0	77.7	
9	15-16	0.05	15.0	0.0	58.8	
10	16-17	0.02	10.1	0.0	70.3	
11	17-18	0.02	7.9	0.0	74.8	
12	18-19	0.21	8.8	0.0	75.1	
13	19-20	0.13	11.4	0.0	79.0	
14	20-21	0.05	12.1	0.0	74.3	
15	21-22	0.03	12.4	0.0	72.5	
16	22-23	0.02	11.5	0.0	71.3	
17	23-24	0.01	9.5	0.0	80.0	
18	24-25	0.02	12.4	0.0	75.7	
19	25-26	0.02	11.0	0.0	75.3	
20	26-27	0.01	11.3	0.0	76.1	
21	27-28	0.06	16.9	0.0	44.9	
22	28-29	0.07	15.0	0.0	51.3	
23	29-30	0.28	15.7	0.0	55.4	
24	30-31	0.01	16.9	0.0	53.3	
25	31-32	0.08	15.9	0.0	53.4	
26	32-33	<0.01	10.9	0.0	80.6	
27	33-34	<0.01	9.3	0.0	85.0	
28	34-35	<0.01	8.3	0.0	78.4	
29	35-36	0.04	8.9	0.0	30.4	
30	36-37	0.05	16.3	0.0	52.3	
31	37-38	0.03	12.8	0.0	64.9	
32	38-39	0.06	16.2	0.0	56.6	
33	39-40	0.01	9.2	0.0	89.0	
34	40-41	0.01	10.3	0.0	83.5	
35	41-42	0.05	13.5	0.0	56.3	
36	42-43	0.05	17.9	0.0	49.7	
37	43-44	0.03	16.0	0.0	57.5	

COMPLETION COREGRAPH



38	44-45	0.04	17.3	0.0	51.4
39	45-46	0.03	15.4	0.0	53.9
40	46-47	0.02	9.5	0..	.3
41	47-48	0.02	13.3	0.0	75.2
42	48-49	0.03	14.4	0.0	71.0
43	49-50	0.08	14.7	0.0	73.6
44	50-51	0.05	16.5	0.0	69.9
45	51-52	0.04	14.3	0.0	79.9
46	52-53	0.05	15.7	0.0	72.6
47	53-54	0.04	13.4	0.0	83.6
48	54-55	0.02	14.1	0.0	78.0
49	55-56	0.03	13.4	0.0	83.7
50	56-57	0.05	13.6	0.0	83.8
51	2957-58	0.07	17.2	0.0	55.7
52	3782-83	0.04	14.2	7.7	66.1
53	83-84	f	11.5	7.8	67.9
54	84-85	f	10.1	14.9	82.2
55	85-86	0.12	17.5	2.9	52.6
56	86-87	0.19	10.8	1.9	38.0
57	87-88	0.03	13.2	3.8	68.1
58	88-89	f	6.3	11.1	55.6
59	89-90	0.46	13.8	0.0	37.7
60	90-91	f	9.0	7.8	76.8
61	91-92	0.16	10.8	0.0	53.7
62	92-93	<0.01	7.6	9.2	80.2
63	93-94	0.11	19.6	2.5	52.1
64	94-95	0.11	15.7	3.2	37.6
65	95-96	0.01	11.4	6.1	72.0
66	96-97	0.25	14.0	3.6	41.4
67	97-98	f	13.0	10.8	54.6
68	98-99	f	11.1	6.3	84.7
69	99-00	0.02	14.0	3.6	55.0
70	3800-01	f	9.9	18.2	70.9
71	01-02	<0.01	7.8	20.5	68.1
72	02-03	0.01	9.7	5.2	79.4
73	03-04	0.01	9.1	7.7	79.1
74	04-05	<0.01	7.5	12.0	81.3
75	05-06	0.17	8.4	10.7	76.1
76	06-07	0.01	10.2	11.7	70.6
77	07-08	0.01	11.0	8.2	70.8
78	08-09	<0.01	12.0	4.2	75.0
79	3809-10	0.02	10.7	6.5	74.7
80	3810-15	0.01	9.5	12.7	73.8
81	3815-20	0.01	6.7	10.5	79.1
82	3820-25	<0.01	7.4	12.2	77.0
83	3825-26	<0.01	8.3	8.4	78.2
84	3826-27	<0.01	7.6	11.8	79.1

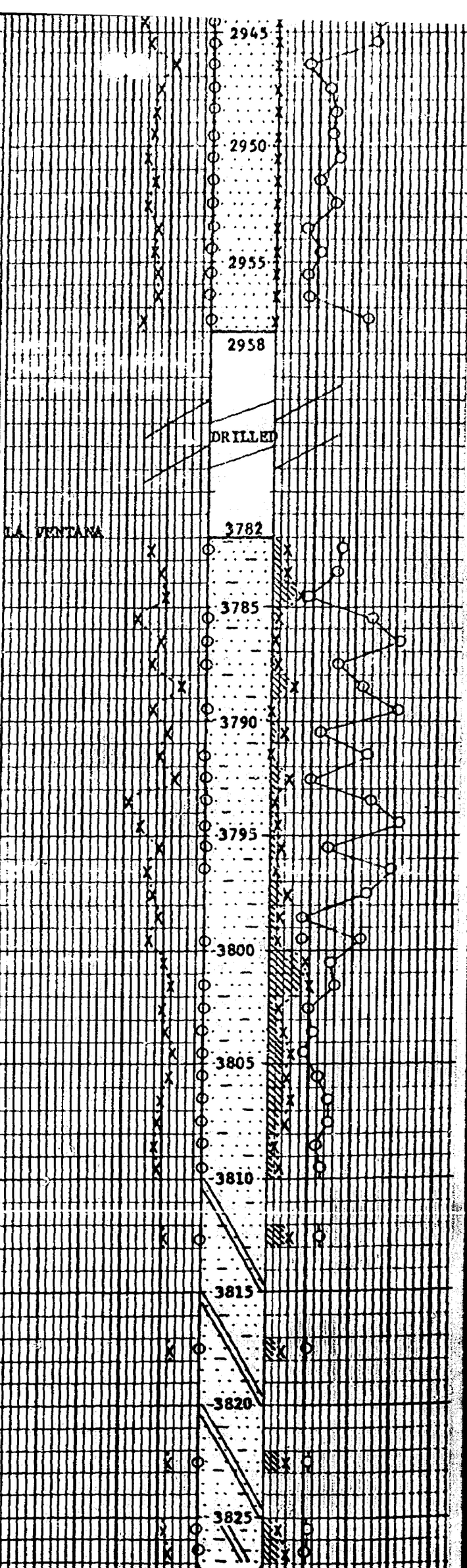


EXHIBIT NO. 12

Company: Amerada Petroleum Corporation
Well: Jicarilla Apache F-4

Otero Chacra Field

NWSE, Section 18, Township 25 North, Range 5 West
Rio Arriba County, New Mexico

CHACRA FORMATION CORE DATA
(Only Perforated Intervals Shown)

Depth (ft)	Sample Footage (ft)	Permeability (md)
3477-3478	1	5.60
3478-3479	1	6.40
3479-3480	1	4.00
3480-3481	1	0.90
3481-3482	1	4.40
3482-3483	1	8.40
3483-3484	1	1.00
3484-3485	1	0.08
3485-3486	1	2.50
3486-3487	1	0.07
3487-3488	1	0.47
3488-3489	1	1.00
3489-3490	1	3.80
3490-3491	1	3.10
3491-3492	1	3.50
3492-3493	1	4.20
3493-3494	1	fracture
3494-3495	1	0.22
3495-3496	1	0.58
TOTAL:	18 (nonfractured)	50.22

Average Laboratory Permeability = $\frac{50.22}{18}$ = 2.79 md

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 12
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

CORE LABORATORIES, INC. [WAITED] *Petroleum Reservoir Engineering*

COMPANY	AMERADA PETROLEUM CORPORATION	DATE ON	7/14/57
WELL	J APACHE F-4	DATE OFF	7/15/57
FIELD	SOUTH BLANCO	FORMATION	LA VENTANA
COUNTY	RIO ARRIBA STATE NEW MEX.	DRLG FLD	WATER BASE MUD W/OIL ADDED
LOCATION	NW SE SEC 18-T25N-R5W	REMARKS	SAMPLED BY CLI ENGINEER

FILE NO. RP-3-524
ENGRS WJC, LAM
ELEV 6542' KB
CORES DIAMOND

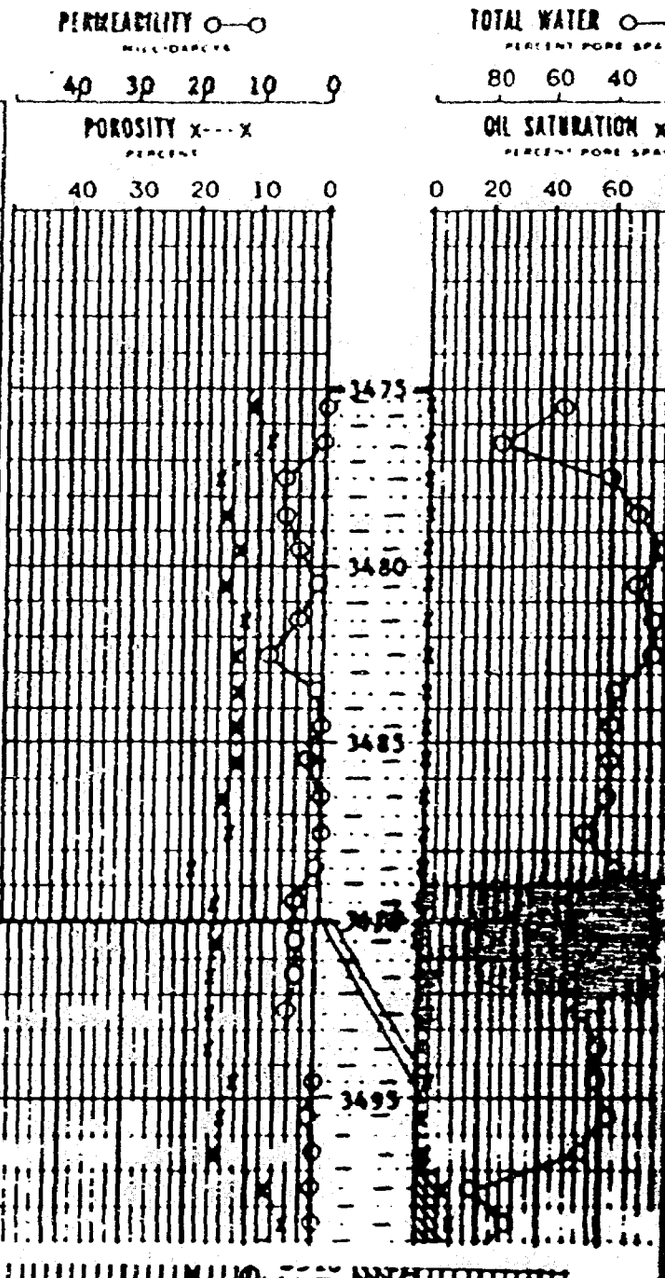
SAND · LIMESTONE · CONGLOMERATE · CHERT
SHALE · DOLOMITE · FRACTURES

TABULAR DATA and INTERPRETATION

f DENOTES FRACTURED PERMEABILITY PLUGS

	DEPTH FEET	PERM MD	POR %	RESIDUAL SATURATION % PORE SPACE: OIL	RESIDUAL SATURATION % PORE SPACE: TOTAL WATER	PROD
1	3475-76	0.21	10.7	0.0	56.1	
2	76-77	0.08	8.0	0.0	77.5	
3	77-78	5.6	15.9	0.0	40.8	
4	78-79	6.4	15.4	0.0	32.5	
5	79-80	4.0	13.5	0.0	23.7	
6	80-81	0.9	14.8	0.0	32.4	
7	81-82	4.4	11.7	0.0	27.4	
8	82-83	8.4	13.5	0.0	26.6	
9	83-84	1.0	12.9	0.0	38.8	
10	84-85	0.08	12.7	0.0	40.1	
11	85-86	2.5	13.4	0.0	40.3	
12	86-87	0.07	15.2	0.0	40.8	
13	87-88	0.47	14.5	8.0	48.2	
14	88-89	1.0	20.1	0.0	38.3	
15	89-90	3.8	15.6	0.0	27.6	
16	90-91	3.1	15.4	0.0	35.7	
17	91-92	3.5	16.0	4.4	41.9	
18	92-93	4.2	18.6	4.5	47.4	
19	93-94	f	18.4	1.2	40.8	
20	94-95	0.22	11.8	4.2	41.5	
21	95-96	0.38	14.1	1.4	37.6	
22	96-97	0.08	14.7	3.4	46.9	
23	97-98	0.05	7.3	9.6	82.3	
24	98-99	0.02	4.3	11.6	69.9	

COMPLETION CORELGRAPH



SHALE DOLOMITE

TABULAR DATA and INTERPRETATION

	DEPTH FEET	PERM MD	POR %	RESIDUAL SATURATION % PORE SPACE: OIL	RESIDUAL SATURATION % PORE SPACE: TOTAL WATER	PROD
	f DENOTES FRACTURED PERMEABILITY PLUGS					
1	3475-76	0.21	10.7	0.0	56.1	
2	76-77	0.08	8.0	0.0	77.5	
3	77-78	5.6	15.9	0.0	40.8	
4	78-79	6.4	15.4	0.0	32.5	
5	79-80	4.0	13.5	0.0	23.7	
6	80-81	0.9	14.8	0.0	32.4	
7	81-82	4.4	11.7	0.0	27.4	
8	82-83	8.4	13.5	0.0	26.9	
9	83-84	1.0	12.9	0.0	38.8	
10	84-85	0.08	12.7	0.0	40.1	
11	85-86	2.5	13.4	0.0	40.3	
12	86-87	0.07	15.2	0.0	40.8	
13	87-88	0.47	14.5	8.0	48.2	
14	88-89	1.0	20.1	0.0	38.3	
15	[illegible]-90	3.8	13.6	0.0	27.6	
16	90-91	3.1	15.4	0.0	33.7	
17	91-92	3.5	16.0	4.4	41.9	
18	92-93	4.2	18.6	4.5	47.4	
19	93-94	f	16.4	1.2	40.8	
20	94-95	0.22	11.8	4.2	41.5	
21	95-96	0.58	14.1	1.4	37.6	
22	96-97	0.08	14.7	3.4	46.9	
23	97-98	0.05	7.3	9.6	82.3	
24	98-99	0.02	4.3	11.6	69.9	
25	99-00	0.02	8.9	11.3	80.9	
26	3500-01	0.02	8.7	8.0	87.3	
27	01-02	0.02	9.5	5.3	84.2	
28	02-03	0.04	9.6	5.2	81.3	
29	03-04	0.03	10.7	6.5	79.4	
30	04-05	0.03	11.0	8.2	70.0	
31	05-06	0.03	11.8	4.2	65.6	
32	06-07	0.03	10.6	8.5	81.0	
33	07-08	0.04	9.8	7.1	80.6	
34	08-09	0.02	9.2	13.1	77.3	
35	09-10	0.01	10.0	12.0	86.0	
36	10-11	0.02	8.8	13.6	81.8	
37	11-12	0.02	7.0	14.3	81.3	
38	12-13	0.01	6.6	15.2	80.4	
39	13-14	0.02	8.0	8.8	79.9	
40	14-15	0.02	7.2	9.7	82.0	
41	15-16	0.05	9.1	5.5	85.8	
42	16-17	0.05	4.7	4.3	76.7	
43	17-18	0.04	7.5	2.7	86.8	
44	18-19	0.03	8.9	5.6	90.0	
45	19-20	0.06	9.2	5.4	84.8	
46	20-21	0.01	7.8	2.6	91.0	
47	21-22	0.02	7.9	6.3	81.0	
48	22-23	0.04	5.3	3.8	81.2	
49	23-24	0.04	8.0	2.5	87.5	
50	3524-25	0.03	8.1	8.7	84.0	

COMPLETION CORELOGRAPH

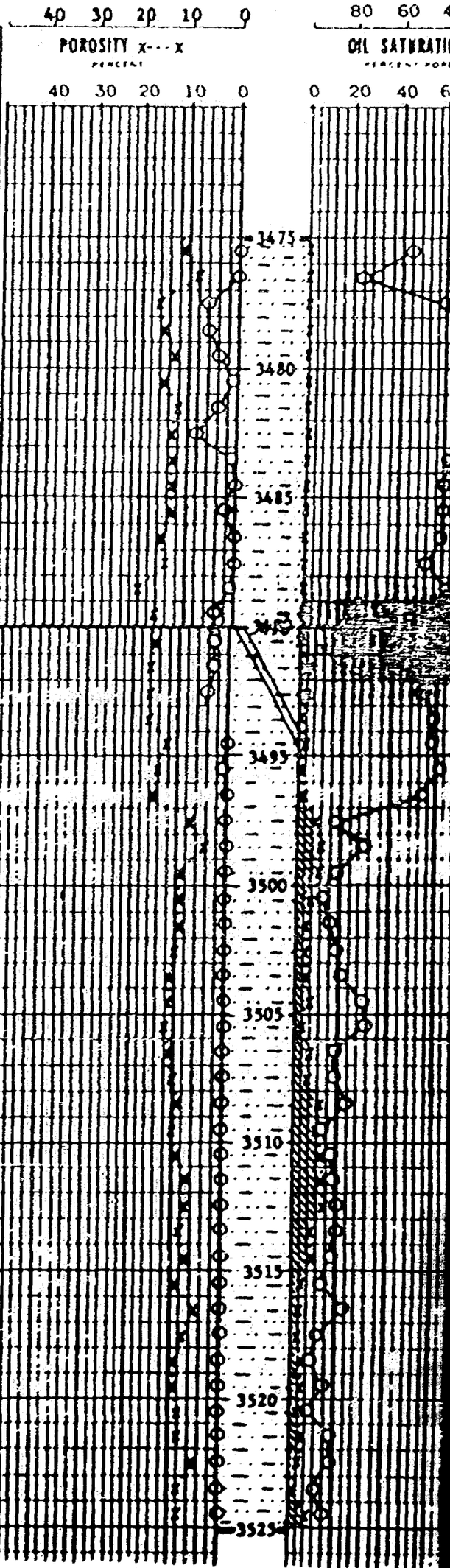


EXHIBIT NO. 13

Company: El Paso Natural Gas Company
Well: Klein No. 12

Otero Chacra Field

NESW, Section 34, Township 26 North, Range 6 West
Rio Arriba County, New Mexico

CHACRA FORMATION CORE DATA
(Only Perforated Intervals Shown)

Depth (ft)	Sample Footage (ft)	Permeability (md)
3780-3781	1	0.83
3783-3784	1	0.41
3784-3785	1	0.01
3785-3786	1	0.10
3788-3789	1	0.19
3789-3790	1	0.05
3872-3783	1	0.05
3873-3874	1	0.02
3875-3876	1	0.02
3877-3878	1	0.23
TOTAL:	10	1.91

Average Laboratory Permeability = $\frac{1.91}{10}$ = 0.19 md

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITLE EXHIBIT NO. 13
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

CORE ANALYSIS RESULTS

Company El Paso Natural Gas Company Formation Chacra File RP-3-2383
Well Klein # 12 Core Type Dia. Conv. 2 5/8" Date Report 9-24-69
Field Otero-Chacra Drilling Fluid Water Base Mud Analysts Mohl
County Rio Arriba State N. Mex. Elev. 6731 GL Location NE SW Sec 34 - T 26N - R 6W

Lithological Abbreviations

ANH-ANHYDRITE SHALE-SH LIME-LM	DOL-DOLOMITE CHERT-CH GYP-GYPSUM	ANHY-ARGILLACEOUS CONG-CONGLOMERATE FOSS-FOSSILIFEROUS	SANDY-SDY SHALY-SHY LIMY-LMY	FINE-FN MEDIUM-MED COARSE-CSE	CRYSTALLINE-XLN GRAIN-GRN GRANULAR-GRNL	BROWN-BRN GRAY-GY VUGGY-VGY	FRACTURED-FRAC LAMINATION-LAM STYLOLITIC-STY	SLIGHTLY-SL/ VERY-V/ WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS K_a	POROSITY PER CENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
1	3764-65	0.10	10.9	6.4	65.1	SS, gry, vfn, shly, slty
2	3765-66	0.83	13.9	5.0	63.3	Ss, gry, vfn, shly, slty
3	3766-67	0.08	13.0	9.2	44.6	Ss, gry, vfn, v/shly, slty
4	3767-68	0.60	16.1	3.1	36.0	Ss, gry, vfn, v/shly, slty
5	3768-69	1.4	20.3	2.0	42.3	Ss, gry, vfn, shly, slty
6	3769-70	0.41	17.9	2.8	51.4	Ss, gry, vfn, shly, slty
7	3770-71	0.83	15.5	3.8	52.1	Ss, gry, vfn, w/shly, slty
8	3771-72	0.04	10.6	6.6	47.1	Ss, gry, vfn, v/shly, slty
9	3772-73	1.0	13.5	0.0	31.1	Ss, gry, vfn, shly
10	3773-74	0.62	12.1	0.0	19.0	Ss, gry, vfn, shly, vf
11	3774-75	0.21	10.4	0.0	38.4	Ss, gry, vfn, shly,
12	3776-77	0.02	3.8	0.0	63.1	Ss, gry, vfn, v/calc
13	3778-79	0.01	5.2	0.0	80.8	Ss, gry, vfn, v/calc
14	3779-80	1.2	11.7	0.0	26.4	Ss, gry, vfn, v/calc
15	3780-81	0.83	19.4	22.6	34.5	Ss, gry, vfn
16	3783-84	0.41	14.1	0.0	36.2	Ss, gry, vfn
17	3784-85	0.01	12.7	8.7	40.1	Ss, gry, vfn, shly
18	3785-86	0.10	16.7	3.6	32.2	Ss, gry, vfn, shly
19	3788-89	0.19	10.3	0.0	23.2	Ss, gry, vfn, shly
20	3789-90	0.05	9.5	0.0	25.2	Ss, gry, vfn, shly
21	3792-93	0.04	6.8	10.3	36.8	Ss, gry, vfn, v/shly
22	3795-96	0.02	12.2	4.1	75.3	Ss, gry, vfn, shly
23	3811-13	< 0.01	6.7	0.0	86.5	Ss, gry, vfn, shly
24	3814-15	0.05	8.2	0.0	58.5	Ss, gry, vfn, vf
25	3820-21	< 0.01	3.0	0.0	83.3	Ss, gry, vfn, v/calc
26	3841-42	0.01	4.5	0.0	69.0	Ss, gryp vfn
27	3849-50	0.01	5.4	0.0	75.9	Ss, gry, vfn, vf
28	3866-67	1.4	14.4	0.0	29.2	Ss, gry, vfn, vf

VF denotes vertical fracture

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Lithological Abbreviations

SAND-SD SHALE-SH LIME-LM | DOLOM-DOL CHERT-CH GYPSUM-GYP | ANHYDRITE-ANHY CONGLOMERATE-CONG FOSSILIFEROUS-FOSS | GRAIN-GRN SPAR-SPAR FINE-FN | FINE-FN MEDIUM-MED COARSE-CSE | CRYSTALLINE-XLN DARK-DK GRAIN-GRN | BROWN-BRN GRAY-GY MUDDY-MDY | FRACTURE-FRAC LAMINATION-LAM STYLOLITIC-STY | SLIGHTLY-SL/ VERY-V/ WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS K_A	POROSITY PERCENT	RESIDUAL SATURATION PER CENT PORE OIL	RESIDUAL SATURATION PER CENT PORE TOTAL WATER	SAMPLE DESCRIPTION AND REMARKS
29	3867-68	1.4	15.1	0.0	29.2	Ss, gry, vfn, vf
30	3868-69	1.7	15.9	0.0	28.2	Ss, gry, vfn, vf
31	3869-70	0.07	8.8	0.0	37.5	Ss, gry, vfn
32	3872-73	0.05	9.4	0.0	25.6	Ss, gry, vfn, shly
33	3873-74	0.02	9.5	0.0	44.2	Ss, gry, vfn
34	3875-76	0.02	11.7	0.0	42.7	Ss, gry, vfn
35	3877-78	0.23	12.3	0.0	35.8	Ss, gry, vfn
36	3881-82	0.01	7.0	0.0	61.5	Ss, gry, vfn, v/calc

EXHIBIT NO. 14

Effect of Overburden Pressure and Water Saturation on Gas Permeability of Tight Sandstone Cores

Rex D. Thomas, SPE-AIME, U. S. Bureau of Mines
Don C. Ward, SPE-AIME, U. S. Bureau of Mines

Introduction

Research on the potential of nuclear explosions to stimulate gas production from low-permeability (tight) sandstone reservoirs is being conducted by the U. S. Bureau of Mines in cooperation with the Atomic Energy Commission. This report describes the part of that research that was conducted to establish correlation between permeability measured on dry cores at low external pressure (routine analysis) and permeability at reservoir conditions.

Cores used in this research were obtained from two Plowshare gas-stimulation projects. Project Gasbuggy cores from the Pictured Cliffs formation, Choza Mesa field, Rio Arriba County, N. M., can be described as very fine grained, slightly calcareous, well indurated sandstone. Project Wagon Wheel cores from the Fort Union formation, Pinedale field, Sublette County, Wyo., can be described as very fine grained, slightly calcareous, very well indurated sandstone.

Underground reservoirs are under considerable compressive stress as a result of the weight of overlying rocks (offset somewhat by internal-fluid pressure). The resultant net confining pressure or effective overburden pressure is referred to in this report simply as overburden pressure. The resulting effects on the physical properties of the reservoir rock have been studied.[1-3] Overburden pressure causes only a small decrease in porosity, which can usually be ignored.[3] This was confirmed for Project Gasbuggy and Project Wagon Wheel cores. A commercial laboratory found that the porosity of these cores is reduced by about 5 percent of the original porosity. The effect of overburden pressure on permeability, however, is appreciable and varies considerably for different reservoir rocks,[1-3] causing greater reductions in permeability for low-permeability rocks.[2,3] The effect of overburden pressure on relative permeability has been found to be small[4] or nonexistent.[5]

This report presents material that confirms and extends previous research findings on the effect that overburden pressure has upon the permeability of dry cores. Also presented are the results of research on the relative gas permeability of low-permeability cores under overburden pressure.

Apparatus and Procedure

Cylindrical cores 2.0 to 7.5 cm long and 2.5 cm in diameter were cut parallel to the bedding plane. After the cores were dried overnight in a vacuum oven (4.5 psia, 70°C), the gas (N_2) permeability of each core was measured in a Hassler cell. An external pressure of 100 psi over the inlet pressure was used to maintain a good seal between the rubber sleeve and the core.[6] Permeability was measured at inlet pressures of 45, 60, and 100 psia, with atmospheric pressure at the outlet. A bubble tube and timer were used to measure gas flow rate. Initial permeability (k_i) then was calculated by the Klinkenberg technique to correct for the effect of gas slippage. All other permeabilities reported here were calculated by this method.

In the same manner, permeability was measured at

Research conducted to determine the potential of nuclear explosions to stimulate gas production verifies that the gas permeability of tight sandstone cores is markedly decreased with increasing overburden pressure. Water saturation also reduces the gas permeability by a large amount. The relative permeability, however, does not change significantly with overburden pressure.

increasing external pressures of about 500, 1,000, 2,000, 3,000, 4,000, 5,000, and 6,000 psi. External pressures actually were somewhat higher to compensate for internal pressure. The core and staniless steel end pieces were placed in a rubber sleeve (piece of bicycle innertube) 0.1 cm thick. Rubber cement was used to seal the stainless steel end pieces to the rubber sleeve. Shrinkable plastic tubing proved unsatisfactory because high pressure was required to seal the core. The jacketed core was mounted in a high-pressure cell with distilled water as the external fluid.

Cores used in relative permeability studies were first subjected to high external pressure and then allowed to recover their initial permeability. Bulk volume, dry weight, and porosity were measured by conventional gas-expansion techniques. Cores then were subjected to a vacuum (0.3 psia) for 2 hours, immersed in water, and allowed to stand under a vacuum overnight. The cores were weighed and again subjected to vacuum overnight and weighed again to assure complete saturation. Most of the cores were completely saturated after one night. Porosity values calculated on the basis of water saturation are in good agreement with those measured by conventional gas-expansion techniques.

Water in the core was allowed to evaporate at atmospheric conditions to a saturation of about 70 percent and the core was placed in the holder for 2 hours under external pressure (100 psi above inlet) only so the water saturation was uniform. Gas permeability then was measured at three inlet pressures between 30 and 100 psia with atmospheric pressure at the outlet. This procedure was repeated for decreasing water saturations at the same external pressure. After the permeability was measured the core was weighed to determine if any water was lost. In all cases the amount lost was negligible. After the core was dried in a vacuum oven, the gas permeability at this external pressure was measured. The procedure was repeated for external pressures of 3,000 and 6,000 psi.

Results and Discussion

Effect of Overburden Pressure on Permeability

Core number, length, porosity, and initial permeability of the cores used in this research are shown in Table 1. The core number refers to the depth in feet at which the core was obtained. Typical plots of the effect of simulated overburden pressure on Gasbuggy cores are shown in Fig. 1. The permeability is decreased by about 75 percent at an overburden pressure of 3,000 psi and by 90 percent at 6,000 psi. The hydrostatic loading used in these experiments does not reproduce subsurface conditions exactly; in an actual reservoir the horizontal component of stress is usually less than the vertical component. Since the actual loading is not known, this method probably is as realtistic as any other. Cores that contain microfractures are affected to a greater extent, as shown in Fig. 2. In these cores the permeability is decreased by about 95 percent at a simulated overburden pressure of 3,000 psi, with most of the reduction occurring below 2,000 psi.

The data shown in Table 1 and Figs. 1 and 2 were obtained by subjecting the core to successive incre-

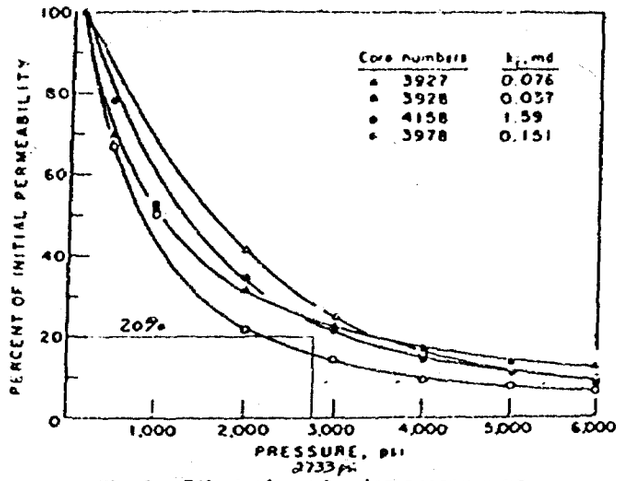

Fig. 1—Effect of overburden pressure on gas permeability of Gasbuggy cores.

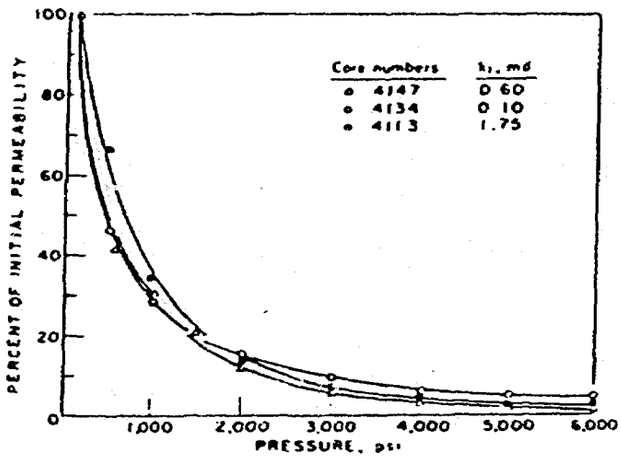

Fig. 2—Effect of overburden pressure on gas permeability of fractured Gasbuggy cores.

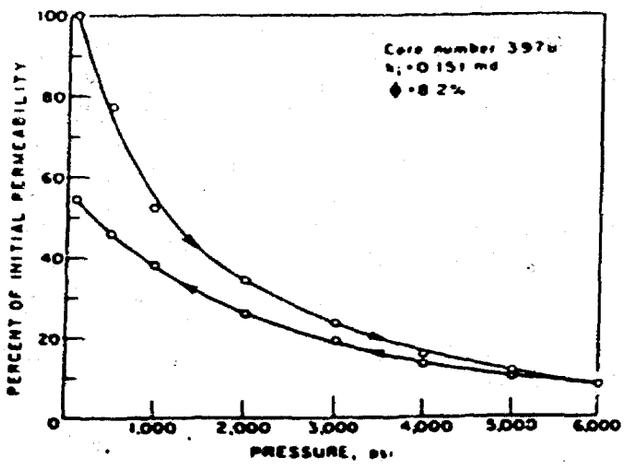

Fig. 3—Hysteresis effect at decreasing confining pressures.

TABLE 1—EFFECT OF OVERBURDEN PRESSURE ON GAS PERMEABILITY

Effective Overburden Pressure (psi):				500	1,000	2,000	3,000	4,000	5,000	6,000
Core Number*	Length (cm)	Porosity (percent)	k_i†	Permeability (md)						
Gasbuggy										
3927	2.1	8.1	0.076	0.053	0.040	0.024	0.0175	0.0132	0.0105	0.0095
3928	7.5	8.3	0.037	0.031	0.024	0.015	0.0093	0.0059	0.0046	0.0035
3978	2.1	8.2	0.151	0.118	0.078	0.052	0.036	0.024	0.0175	0.0132
4113**	2.1	10.1	1.75	1.16	0.602	0.252	0.113	0.068	0.042	0.029
4134**	2.1	11.6	0.10	0.046	0.029	0.0153	0.0095	0.0065	0.0055	0.0047
4146**	7.5	11.6	2.40	1.73	1.32	0.31	0.14	0.069	0.052	0.022
4147**	7.5	11.3	0.60	0.247	0.181	0.071	0.034	0.0186	0.0118	0.0082
4158	2.1	13.6	1.59	1.06	0.80	0.35	0.225	0.152	0.116	0.100
Wagon Wheel										
8084	3.8	7.7	0.028	0.022	0.020	0.010	0.0070	0.0047	0.0035	0.0030
8122	3.8	11.4	0.071	0.055	0.048	0.034	0.027	0.024	0.021	0.019
8975**	3.8	8.7	0.039	0.029	0.024	0.0114	0.0073	0.0048	0.0032	0.0025
10156	3.8	8.5	0.088	0.067	0.051	0.032	0.025	0.022	0.018	0.016
10990**	3.8	9.0	0.048	0.020	0.0175	0.0080	0.0050	0.0040	0.0025	0.0019

*Number denotes depth in feet.
**Slightly fractured.
†Initial permeability.

mental increases in external pressure. The core was assumed to be in equilibrium at each pressure when permeability measurements remained constant for 15 minutes, which required between 1 and 2 hours. A period of 30 minutes to an hour was required to attain equilibrium when the inlet pressure was changed. Consequently, each external pressure was maintained for a minimum of 2 hours.

The effect of decreasing external pressure was determined on a few cores, and typical results are shown in Fig. 3. Other researchers[2,3] have observed and shown that this hysteresis is mainly dependent on the stress history of the core. Cores generally recover their original permeability after 3 to 6 weeks at atmospheric conditions. This time could be shortened by storing the core in an oven at 70°C.

The effect of overburden pressure on the permeability of cores from Project Wagon Wheel is similar to that on cores from Project Gasbuggy, and typical results are shown in Fig. 6. The permeability is decreased to about 30 percent of initial permeability at an overburden pressure of 3,000 psi and to 20 percent at 6,000.

A study of the data in Table 1 indicates that the original porosity of the core and the reduction in permeability caused by overburden pressure are not related. Pore structure (fractures to uniform pores) is probably the governing factor.

Water Saturation Effects

The data in Table 2 show that the permeability decreased with increasing water saturation. The values at 20-, 40-, and 60-percent water saturation were obtained from individual relative-permeability curves for Gasbuggy and Wagon Wheel cores. Relative-permeability curves for three cores from Project Gasbuggy are shown in Fig. 4 with the data points for Core 3978. Data points were omitted for the other cores to avoid confusion. This figure shows that although gas permeability is reduced, the relative gas permeability of Gasbuggy cores is not significantly affected by increased overburden pressure. This conclusion is in agreement with the results of others.[4,5]

Extremely low values of permeability that resulted from water saturation and overburden pressure required that either long flow times or high inlet pressures (high differential across the core) be used. Since a high inlet pressure increases the end effects by changing the distribution of water in the core, long flow times were required. Although end-effect problems were encountered with the short cores (Cores 3978 and 4158), the permeability of these cores was

TABLE 2—EFFECT OF OVERBURDEN PRESSURE AND WATER SATURATION ON GAS PERMEABILITY

Water Saturation (percent):		0	20	40	60
Core Number	Pressure (psi)	Permeability (md)			
Gasbuggy					
3927	100	0.115	0.099	0.041	0.0023
3927	3,000	0.026	0.023	0.009	0.0005
3927	6,000	0.012	0.010	0.003	0.0002
3978	100	0.112	0.080	0.034	0.011
3978	3,000	0.036	0.026	0.011	0.004
3978	6,000	0.013	0.009	0.004	0.0013
4158	100	0.447	0.335	0.156	0.045
4158	3,000	0.075	0.056	0.026	0.0074
4158	6,000	0.027	0.020	0.010	0.0026
Wagon Wheel					
8084	100	0.038	0.030	0.014	0.0042
8084	3,000	0.012	0.0096	0.0043	0.0013
8084	6,000	0.0070	0.0056	0.0025	0.0008
8122	100	0.074	0.054	0.017	0.006
8122	3,000	0.027	0.020	0.008	0.002
8122	6,000	0.020	0.015	0.006	0.002
10156	100	0.100	0.074	0.029	0.003
10156	3,000	0.028	0.020	0.008	0.0008
10156	6,000	0.017	0.013	0.005	0.0005

high enough to yield reasonable results. Permeability measurements for Core 4161 (7.5 cm long, 0.053 md) required more than 2 hours per reading. These extremely long flow times can cause errors.

End effects, long flow times, and changes in permeability due to water saturation tend to decrease the accuracy of permeability measurements, especially at the higher water saturations.

The initial permeability of many of the dry cores used in this research was not reproducible following saturation and drying. The changes probably were caused by solution of material in the pores and by particle movement. These caused both increases and decreases in permeability. The variation, although sometimes large, usually was less than 5 percent; however, we feel that the relative permeability curves are essentially correct. To eliminate the effects of solution and particle movement, the permeability of the dry core following saturation, rather than the permeability initially measured, was used in calculating relative permeability.

A composite of the relative permeability curves for Gasbuggy cores is shown in Fig. 5. These curves are representative of permeabilities encountered in this formation. At a water saturation of 50 percent, the relative permeability of the cores ranges from 15 to 20 percent and is not affected by overburden pressure.

Similar results were obtained on cores from Project Wagon Wheel, as shown in Table 2 and Fig. 6 with data points for Core 8122. These cores were cut to a length of 3.8 cm to alleviate some of the long flow time and end-effect difficulties encountered with Gasbuggy cores. These curves are representative of the permeabilities encountered in the formation. At a water saturation of 50 percent, the relative permeability of these cores ranges from 12 to 21 percent. The data in these figures show, as do the data from Gasbuggy cores, that relative gas permeability is not significantly affected by increased overburden pressure.

Correlation with Nuclear Stimulation Projects

Many of the basin areas of the Rocky Mountain region consist of thick, low-permeability sandstones containing large quantities of natural gas. This type of reservoir has been the object of the AEC's Plowshare Program experiments, Projects Gasbuggy and Rulison, and proposed Projects Wagon Wheel, WASP, and Rio Blanco. Because most wells in these reservoirs have not been commercial, only limited reservoir-analysis and production-test data are available. Reservoir analysis is most difficult because low permeability requires long-term testing. Also, it is difficult to determine permeability and net pay from these tests. Knowledge of the gas permeability is necessary in predicting gas recovery, and because it is not economical to define the characteristics of different strata by well test, it is desirable to be able to relate laboratory-measured permeability to the true in-situ permeability.

Conventional analysis by a commercial laboratory (confirmed in our laboratory) of about 200 Gasbuggy cores gave an average initial gas permeability of 0.16 md on dry cores and an average water saturation of 48 percent. The effective overburden pressure of this

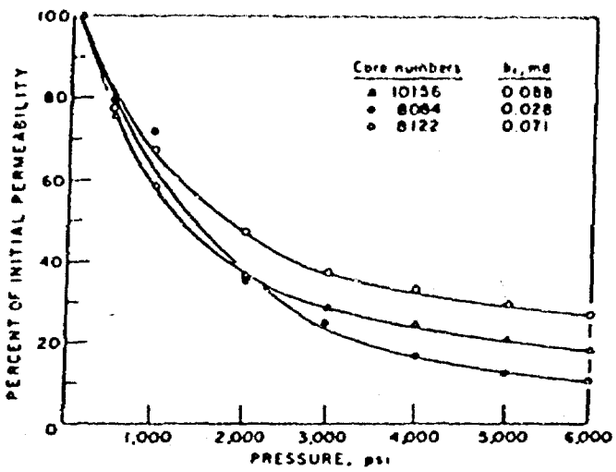

Fig. 4—Effect of overburden pressure on gas permeability of Wagon Wheel cores.

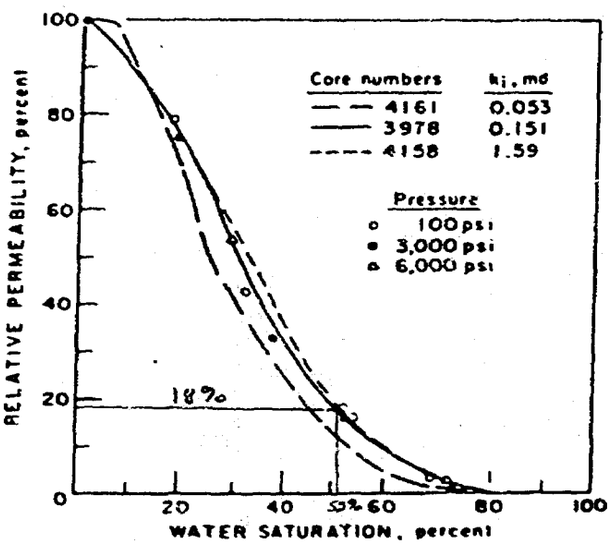

Fig. 5—Relative gas permeability of Gasbuggy cores.

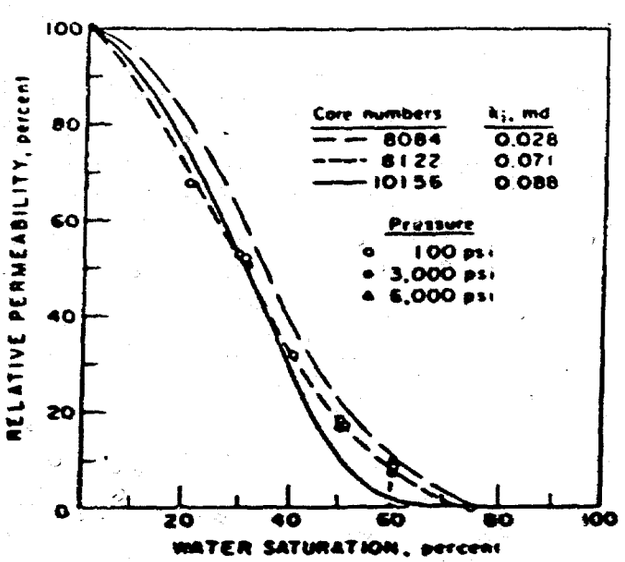

Fig. 6—Relative gas permeability of Wagon Wheel cores.

reservoir is about 3,000 psi. From Fig. 1, the reduction factor resulting from the overburden pressure is 0.25, and the reduction factor for a water saturation of 48 percent (Fig. 5) is 0.20; thus the total reduction is 5 percent of the initial permeability, or 0.008 md. This value compares favorably with permeability determinations of about 0.01 md from both preshot and postshot flow testing at Gasbuggy. The gas reservoir at Project Rulison is similar to that at Gasbuggy, having an average initial dry permeability of 0.11 md and an average water saturation of 45 percent. Simulated in-situ permeability has not yet been measured in the laboratory on Rulison cores; however, using an effective overburden pressure of 5,000 psi and curves of Gasbuggy core data (Figs. 1 and 5), the reduction factor because of overburden pressure would be 0.12 and that for water saturation 0.24. This results in a combined reduction to 3 percent of the initial permeability, or 0.003 md. Postshot production testing at Rulison is not complete, and the only preshot determination of permeability was made from tests of a 32-ft isolated zone that gave an average value of 0.008 md. No cores are available from this zone. Rulison reservoir rock is said to be less compressible than that of Gasbuggy; therefore Gasbuggy pressure-effect data would be expected to indicate a greater reduction for Rulison than actually exists.

The average initial permeability of dry Wagon Wheel cores is 0.068 md, with an average water saturation of 50 percent. An estimated effective overburden pressure of 3,000 psi gives a reduction factor of 0.28 (Fig. 4). Water saturation further reduces permeability by a factor of 0.18 (Fig. 6). Therefore, the total reduction in permeability is to approximately 5 percent of the initial permeability, or 0.0034 md. This value can be used to predict postshot gas recovery from the proposed Wagon Wheel experiment.

Cores are not yet available from Projects Rio Blanco and WASP.

Original manuscript received in Society of Petroleum Engineers office June 16, 1971. Revised manuscript received Dec. 20, 1971. Paper (SPE 3634) was presented at SPE 46th Annual Fall Meeting, held in New Orleans, Oct. 3-6, 1971.

Conclusions

The gas permeability of tight sandstone cores is markedly decreased with increasing overburden pressure. Most of the decrease takes place at pressures to 3,000 psi. At 3,000 psi, the permeability of unfractured samples ranges from 14 to 37 percent of the initial permeability. In fractured samples, permeability may be reduced to as low as 6 percent of initial permeability.

Water saturation also reduces the gas permeability greatly; however, the relative permeability does not change significantly with overburden pressure.

Permeability calculated from laboratory results are in good agreement with in-situ permeabilities determined from production test data. Although not confirmed, predictions for other projects appear to be reasonable.

References

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JPT

EXHIBIT NO. 15

DETERMINATION OF IN SITU FORMATION PERMEABILITY
FROM LABORATORY CORE ANALYSIS DATA IN THE
GONZALES CANYON TIGHT GAS AREA

The relationship needed to determine in situ permeability from core analysis data is published in a technical paper by Rex D. Thomas and Don C. Ward entitled "Effect of Overburden Pressure and Water Saturation on Gas Permeability of Tight Sandstone Cores", which is presented as Exhibit No. 14. The authors' studies involved taking routine laboratory air permeability measurements at the normal 100 psi or less external pressures. To simulate the effect of in situ conditions, these permeability measurements were then made at external pressures ranging from 500 to 6000 psi. The results of these tests were then plotted on a graph of Percent of Initial Permeability (ratio of permeability at 100 psi to a permeability at a higher pressure) vs. Pressure.

Figure 1, on page 51 of Exhibit No. 14, is one such graph which presents results of tests run on cores taken from the Pictured Cliffs formation. These cores were taken from Project Gasbuggy, located in Choza Mesa Pictured Cliffs field, T28-29N, R3-4W, Rio Arriba County, New Mexico. Cores from the Pictured Cliffs formation in the Gasbuggy area and from the Chacra formation in the Gonzales Canyon Tight Gas Area can be expected to have the same or very similar characteristics in that both formations are composed of low permeability sandstone.

The average laboratory air permeability for the Gonzales Canyon Tight Gas Area is 1.06 millidarcy. This value compares to laboratory permeability values of 1.59 millidarcy for core 4158 and 0.151 millidarcy for core 3978, as presented in Figure 1 of Exhibit No. 14. Because the acreage laboratory permeability value for the Gonzales Canyon Tight Gas Area is between the laboratory permeability values of cores 4158 and 3978, a point halfway between the curves for these two cores will be considered the best estimate of characteristics for the Gonzales Canyon Tight Gas Area.

The net confining pressure due to overburden at a depth of 3390 feet in the Gonzales Canyon Tight Gas Area is approximately 2733 psi. Entering

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the graph in Figure 1 at 2733 psi results in a permeability reduction factor of 0.20 which is caused by the overburden pressure on the Chacra formation.

The water present in the reservoir also causes the in situ permeability to be less than laboratory permeability as discussed in Exhibit No. 14. The 0.20 permeability reduction factor resulting from overburden pressure was determined from cores having 100% gas saturation. Figure 5 on page 53 of Exhibit No. 14 indicates relative permeability changes that occurred with changes in water saturation within the sample cores. For the Gonzales Canyon Tight Gas Area, the average core water saturation was 52%. Entering Figure 5 at 52% water saturation results in a permeability reduction factor of 0.18 for in situ water saturation.

The total permeability reduction factor used on laboratory core data to approximate reservoir conditions is obtained by multiplying the overburden reduction factor by the water saturation reduction factor. This product is 0.036 for the Chacra formation in the Gonzales Canyon Tight Gas Area. Therefore, the in situ permeability for this area is 3.6% of the 1.06 millidarcy laboratory determined permeability or 0.038 millidarcy.

The resulting 0.038 millidarcy in situ permeability obtained for the Gonzales Canyon Tight Gas Area by core analysis methods compares favorably with the in situ permeability value of 0.015 millidarcy determined for the Chacra formation in this area by Darcy's Law calculations. This favorable comparison with actual formation data add to the validity of this method of determining in situ permeability from laboratory core analysis data.

EXHIBIT NO. 16

SUMMARY OF CORE PERMEABILITY DATA
(Only Perforated Intervals Used)

	Well Name	Location	Total Sample Footage (ft)	Total Laboratory Permeability (md)	Average Laboratory Permeability (md)
1.	Amoco Production Company Jicarilla 146 No. 11 (well not completed in Chacra)	NE/SW Section 4 T25N, R5W	38	59.64	1.57
2.	Exxon Jicarilla J No. 9	NE/SE Section 6 T25N, R5W	34	5.95	0.18
3.	Amerada Petroleum Corp. Jicarilla F No. 5	NW/SE Section 16 T25N, R5W	12	1.51	0.13
4.	Amerada Petroleum Corp. Jicarilla F No. 4	NW/SE Section 18 T25N, R5W	18	50.22	2.79
5.	El Paso Natural Gas Co. Klein No. 12	NE/SW Section 34 T26N, R6W	10	1.91	0.19
	TOTAL:		112	119.23	

Average Laboratory Permeability = $\frac{119.23}{112}$ = 1.06 md

Average In Situ Permeability (3.6% of laboratory permeability) = 0.038 md

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EXHIBIT NO. 17

CURTIS J. LITTLE
GONZALES CANYON TIGHT GAS AREA
CHACRA FORMATION
RIO ARRIBA COUNTY, NEW MEXICO

Calculation of Formation Permeability Using Darcy's Law

$$\text{Darcy's Law: } Qg = .703\ Kh\ \frac{(Pe^2 - Pwf^2)}{Ug\ T\ Z\ \ln\ (.61\ re/rw)}$$

$$\text{or } K = \frac{Qg\ Ug\ T\ Z\ \ln\ (.61\ re/rw)}{.703\ h\ (Pe^2 - Pwf^2)}$$

where:

k = permeability of formation - millidarcies
Qg = gas flowrate, scf/day - 3890 scf/day for well tested
Ug = average gas viscosity - calculated to be 0.012 centipoise
T = bottom hole temperature - calculated to be 100°F - 560°R
Z = average gas compressibility factor - calculated to be 0.921
re = drainage radius for 160 acre spacing - 1320 feet
rw = wellbore radius - 0.17 feet
h = net pay height - average of 25 feet for the wells drilled in the Otero Chacra field
Pe = bottom hole pressure at drainage radius re - average of 868 psi for wells in the Otero Chacra field
Pwf = flowing bottom hole pressure - assumed equal to atmospheric pressure for maximum flowrate - 12.2 psi surface, 13.2 psi bottom hole
Gg = gas gravity - .7 - used for calculations of Ug and Z
Pc = pseudo critical pressure - 668 psi used for calculation of Ug and Z
Tc = pseudo critical temperature - 392°R used for calculation of Ug and Z

$$K = \frac{(3890)(0.012)(560)(0.921)\ \ln\ (.61\ \ 1320/0.17)}{.703\ (25)(868^2 - 13.2^2)}$$

$$K = 0.015 \text{ md.}$$

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 17
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

APPLICATION OF

CURTIS J. LITTLE

FOR DESIGNATION OF THE GONZALES CANYON AREA

OF THE OTERO CHACRA FIELD

AS A TIGHT FORMATION

RIO ARRIBA COUNTY, NEW MEXICO

Case No. 7489

February 17, 1982

Prepared by:

CURTIS J. LITTLE
Petroleum Geologist

KEVIN H. McCORD
Petroleum Engineer

BEFORE EXAMINER STAMETS
OIL CONSERVATION DIVISION
LITTLE EXHIBIT NO. 18
CASE NO. 7489
Submitted by McCORD
Hearing Date 2/17/82

APPLICATION OF CURTIS J. LITTLE
FOR DESIGNATION OF THE GONZALES CANYON AREA OF THE
OTERO CHACRA FIELD AS A TIGHT FORMATION,
RIO ARRIBA COUNTY, NEW MEXICO

Curtis J. Little is applying for a portion of the Otero Chacra gas pool to be designated as a tight formation under Section 107 of the Natural Gas Policy Act of 1978. The proposed Gonzales Canyon Tight Gas Area is located in the southeastern portion of the San Juan Basin. The area is located in Rio Arriba County, approximately 40 miles southeast of the town of Bloomfield in northwestern New Mexico.

Exhibit No. 1 displays the proposed Gonzales Canyon Tight Gas Area on a map showing the Chacra formation wells in the San Juan Basin. The Gonzales Canyon Tight Gas Area includes approximately 6,720 acres, described as follows:

T25N, R6W	Acreage
Section 16, All	640
21, All	640
22, All	640
23, S½	320
25, All	640
26, All	640
27, All	640
28, All	640
34, All	640
35, All	640
36, All	640

The Chacra formation in the Gonzales Canyon Area meets the criteria established in Section 107 of the Natural Gas Policy Act of 1978 to be designated as a tight gas formation in that (1) the estimated average in situ gas permeability throughout the pay section is expected to be 0.1 millidarcy or less, (2) the stabilized gas production rates, without stimulation, at atmospheric pressure of these gas wells are not expected to exceed the maximum allowable production rate of 91 MCFPD for an average depth of 3390 feet to the top of the Chacra formation in this area, and (3) no well drilled into the Chacra formation in this area is expected to produce more than five barrels of crude oil per day prior to stimulation.

Exhibit No. 2 is a Chacra formation completion and production map of the proposed Gonzales Canyon Tight Gas Area. The production figures presented for each producing well are initial potential, date of initial potential, average natural gas production rate for 1980, and January 1, 1981 cumulative production

of gas for the well. Exhibit No. 2 also presents completion and production data from some wells surrounding the proposed tight gas area for comparison purposes.

The Gonzales Canyon Tight Gas Area contains four Chacra formation gas wells, two of which are abandoned in the Chacra at this time. The average depth to the top of the Chacra formation in this area is 3390 feet. Examination of Exhibit No. 2 indicates that the Gonzales Canyon Tight Gas Area is on the southwestern fringe of the main body of Otero Chacra gas production. Examination of cumulative and current gas production rates also indicate the poorer quality Chacra reservoir rock in the Gonzales Canyon Tight Gas Area. A list of operator, well name and production figures for Chacra wells in the Gonzales Canyon Tight Gas Area is presented as Exhibit No. 3.

Exhibit No. 4 and 5 are January 1, 1981 cumulative gas production and 1980 annual gas production contour maps of the Chacra formation for the area encompassing the proposed Gonzales Canyon Tight Gas Area. These maps are color coded to distinguish natural gas production trends in the area. The red color in Exhibit No. 4 is used to distinguish areas with cumulative gas production greater than 1/4 BCF while the white indicates production less than this. In Exhibit No. 5, red is used to distinguish areas which had more than 12 MMCF of gas production in 1980. The white areas indicate areas with less than 12 MMCF of gas production in 1980.

Examination of Exhibit Nos. 4 and 5 shows that the great majority of the Gonzales Canyon Tight Gas Area is white, which indicates little or no gas production from the Chacra formation in this area. This small cumulative production and sparse well locations is due to the tight nature of the reservoir rock in the area.

The Gonzales Canyon Tight Gas Area is bordered to the northeast by the main trend of the Otero Chacra field. Exhibit Nos. 4 and 5 show this area is densely drilled with good Chacra wells, indicated by the red coloring in the area. The Gonzales Canyon Tight Gas Area is comprised of somewhat poorer quality reservoir rock than the main Otero Chacra trend. Exhibit Nos. 4 and 5 clearly indicate the poorer production characteristics of Gonzales Canyon Tight Gas Area wells from the wells in the main Otero Chacra trend.

Geology

The Chacra interval is a marine siltstone and sandstone whose source was to the southwest. The lithologic unit was deposited in relative deep water with the strike of sedimentation being northwest-southeast.

The form of gas entrapment in the Gonzales Canyon Tight Gas Area is stratigraphic. The interval outcrops approximately 30 miles south-southwest and dips to the northeast at approximately 90 feet-per-mile. Exhibit No. 6 is a structure contour map of the Pictured Cliffs formation which shows this regional dip.

Sample examination of the Chacra interval indicates the 130-foot zone to be a light gray, very fine grained siltstone. This siltstone has varying amounts of shale with carbonaceous and clay infilling, all contributing to the low permeability of the interval.

Exhibit No. 7 is a type log of the Chacra interval in the Gonzales Canyon Tight Gas Area. This well is the Curtis Little Salazar No. 3 well, located in the NW¼ of Section 25, Township 25 North, Range 6 West. The top of the Chacra interval on this type log is 3425 feet, with the base at 3553 feet. This log is representative of the Chacra formation characteristics outside of the main Otero Chacra trend.

Exhibit No. 8 presents cross section A-A' which portrays the Chacra formation characteristics in a northeasterly direction through the Gonzales Canyon Tight Gas Area. The log reference datum shown on this cross section is a bentonite which is referred to as the "Huerfanito Marker". The cross section illustrates the Chacra interval to be a continuous lithologic unit throughout the Gonzales Canyon Tight Gas Area. The cross section indicates better sand development in the main trend of the Otero Chacra field than in the Gonzales Canyon Tight Gas Area. The poor sand development and low permeability of the Chacra interval in the Gonzales Canyon Tight Gas Area is responsible for the low natural gas production characteristics exhibited by this area.

Stabilized Unstimulated Gas Production Rate

Obtaining stabilized unstimulated gas production rates for Chacra formation wells is not a standard procedure used by companies when completing their wells

in the San Juan Basin. Past experience has shown that these low permeability Chacra wells must be stimulated to obtain commercial production. However, in preparation for this Gonzales Canyon Tight Gas study, a three-hour unstimulated gas production test was performed on Curtis Little's Salazar No. 3 well, located in the NE/NW Section 26, Township 25 North, Range 6 West. Exhibit No. 2 shows that this well is located in the center of the Tight Gas Area. The unstimulated natural gas production rate from this well was 3.89 MCFGPD. This rate is well below the 91 MCFGPD allotted for tight formation gas wells having an average depth of 3390 feet.

The natural unstimulated production rate provided is not truly an unstimulated production rate from the Chacra formation. This well was acidized with 250 gallons of 7½% hydrochloric acid as a production aid to induce a flow channel from the wellbore to the formation through the perforations. This acidizing cleans up the flow path so gas can move more freely to the wellbore. True unstimulated natural production would not have the aid of this formation cleanup procedure to assist in gas production.

It can be expected that the actual natural unstimulated gas production rate would be less than the rate reported from the flow test taken after an acid treatment. Therefore, the average production rate of 3.89 MCFGPD can be considered to be the maximum obtainable unstimulated natural production rate from the Chacra formation in this area. This also indicates that the average unstimulated natural gas production rate from the Chacra formation in the Gonzales Canyon Tight Gas Area is not expected to exceed 91 MCF of gas per day.

Stabilized Unstimulated Oil Production Rate

The natural gas produced from the Chacra formation in the Gonzales Canyon Tight Gas Area is virtually dry gas. There has been no oil and condensate production reported for any of the wells now producing from the Chacra formation in the area.

These dry gas production figures indicate that no well drilled in the Chacra formation in the Gonzales Canyon Tight Gas Area is expected to produce, without stimulation, more than five barrels of crude oil per day.

Permeability

The Chacra formation in the San Juan Basin is dependent on stimulation techniques to be commercially productive due to the low permeability of the reservoir rock.

Exhibit Nos. 9 through 13 present core analysis data used to determine the average laboratory permeability to air for Chacra formation pay zones in this area. The exhibits contain the actual core analysis reports plus summary tables showing the analysis of cores taken from only the productive portion of the Chacra formation for each well. The cored intervals chosen for permeability averaging were determined by log examination of the interval cored for each well. Only cored intervals of sand that were perforated by the operator of the well were considered pay intervals and were then used for permeability averaging. The average laboratory permeability to air determined in this manner was 1.06 millidarcy.

The Chacra formation core data presented was taken from wells in the main sand trend of the Otero Chacra interval. The location of these cored wells is shown in Exhibit No. 2. It would be logical to assume that the average Chacra formation laboratory permeability in the Gonzales Canyon Tight Gas Area would be lower than the 1.06 millidarcy average permeability found for the main Otero Chacra trend. However, core analysis data is not available for the Gonzales Canyon Tight Gas Area and, therefore, the average permeability of 1.06 millidarcy was used as the average laboratory determined permeability for the Tight Gas Area. The actual in situ permeability of the Chacra formation in this area is less than the laboratory determined value due to water saturations and net confining pressures found under reservoir conditions.

Exhibit No. 14 presents a technical paper entitled "Effect of Overburden Pressure and Water Saturation on Gas Permeability of Tight Sandstone Cores" written by Rex D. Thomas and Don C. Ward of the U.S. Bureau of Mines. This paper presents relationships between laboratory determined permeability in cores and actual in situ permeability found in reservoirs. Exhibit No. 15 explains how in situ permeability is calculated from the core analysis using the technical paper presented.

Exhibit No. 16 is a summary of all laboratory core analysis results for the Gonzales Canyon Tight Gas Area. An average in situ permeability value of

0.038 millidarcy was calculated from the average laboratory permeability value of 1.06 millidarcy for the Gonzales Canyon Area. This 0.038 millidarcy in situ permeability value calculated from core data is well below the 0.10 millidarcy cutoff for tight gas determination.

Another method of determining formation permeability was performed in the Gonzales Canyon Area, making use of the natural unstimulated production test taken in the area. The average unstimulated gas flow rate of 3.89 MCFGPD, along with other Chacra reservoir data for the tight gas area can be used in Darcy's Law of fluid flow through a porous medium to calculate a reservoir permeability. This Darcy's Law calculation is presented as Exhibit No. 17.

Darcy's Law calculations report an average reservoir permeability value of 0.015 millidarcy for the Gonzales Canyon Tight Gas Area. This permeability value compares to the 0.038 millidarcy permeability value determined by core analysis methods. Both of these values are below the 0.10 millidarcy tight gas cutoff.

The reservoir permeability value of 0.015 millidarcy determined by Darcy's Law calculation is thought to be the best estimate of reservoir permeability for the Gonzales Canyon Tight Gas Area because it involves actual formation flow characteristics and reservoir parameters to determine formation permeability. Therefore, the estimated average in situ gas permeability throughout the Chacra formation pay section is expected to be 0.1 millidarcy or less in the Gonzales Tight Gas Area.

Fresh Water Protection

Existing State and Federal regulations will assure that development of the Chacra formation will not adversely affect or impair any fresh water acquifers that are being used or are expected to be used in the foreseeable future for domestic or agricultural water supplies. Regulations require that casing programs be designed to seal off potential water bearing formations from oil and gas producing formations. These fresh water zones exist from the surface to the base of the Ojo Alamo formation. The Ojo Alamo depth averages approximately 2200 feet in the proposed Gonzales Canyon Tight Gas Area.

Most Chacra wells drilled in the vicinity of the Gonzales Canyon Tight Gas Area are drilled with natural mud that will not contaminate fresh water zones.

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Existing State and Federal regulations will assure that development of the Chacra formation will not adversely affect or impair any fresh water acquifers that are being used or are expected to be used in the foreseeable future for domestic or agricultural water supplies. Regulations require that casing programs be designed to seal off potential water bearing formations from oil and gas producing formations. These fresh water zones exist from the surface to the base of the Ojo Alamo formation. The Ojo Alamo depth averages approximately 2200 feet in the proposed Gonzales Canyon Tight Gas Area.

Most Chacra wells drilled in the vicinity of the Gonzales Canyon Tight Gas Area are drilled with natural mud that will not contaminate fresh water zones.

Normal casing designs consist of 7" O.D. surface casing being set from the surface to a depth of 120 feet. Production casing used is 2-7/8" O.D. and is set from surface to total depth.

The surface casing is cemented in place by circulating cement to the surface, protecting the near surface formations from downhole contamination. The production casing is cemented from total depth to the surface or to a depth sufficient to cover the Ojo Alamo formation. This process protects the Chacra, Pictured Cliffs, and other shallow formations from contaminating the Ojo Alamo acquifer. Therefore, all productive and fresh water zones are protected by both casing and cement.

Stimulation of the Chacra formation involves varied fracture treatments, depending on the operator. Fracture treatments usually consist of a one or two percent potassium chloride water base fluid with sand, or a nitrogen-water foam base fluid and sand. Either treatment will not harm a fresh water acquifer. Fresh water protection is assured during these fracture stimulation treatments due to zone isolation caused by cementation. The large distance of approximately 1200 feet between the Chacra formation and the Ojo Alamo fresh water zone is further insurance that no existing fresh water zone will be contaminated by stimulation of Chacra wells in this area.

Therefore, New Mexico and Federal regulations will protect any fresh water supply that may be affected by drilling, completing and producing the Chacra formation in the Gonzales Canyon Tight Gas Area.

Conclusion

Evidence presented in this report substantiates the following for Curtis J. Little's proposed Gonzales Canyon Chacra Formation Tight Gas Area:

(1) For an average Chacra well depth of 3390 feet, the stabilized production rate at atmospheric pressure of wells completed in the Chacra formation, without stimulation, is not expected to exceed the maximum allowable rate of 91 MCF of gas per day;

(2) No well drilled into the Chacra formation in the Gonzales Canyon Area is expected to produce, without stimulation, more than five barrels of crude oil per day;

(3) The estimated average in situ gas permeability, throughout the Chacra pay section, is expected to be 0.1 millidarcy or less.

The proposed Gonzales Canyon Tight Gas Area meets all the specifications required as stated above and should be designated a tight formation in the Chacra formation under Section 107 of the Natural Gas Policy Act of 1978.

Dockets Nos. 7-82 and 8-82 are tentatively set for March 3 and March 17, 1982. Applications for hearing must be filed at least 22 days in advance of hearing date.

DOCKET: EXAMINER HEARING - WEDNESDAY - FEBRUARY 17, 1982

9 A.M. - OIL CONSERVATION DIVISION CONFERENCE ROOM
STATE LAND OFFICE BUILDING, SANTA FE, NEW MEXICO

The following cases will be heard before Richard L. Stamets, Examiner, or Daniel S. Nutter, Alternate Examiner:

ALLOWABLE: (1) Consideration of the allowable production of gas for March, 1982, from fifteen prorated pools in Lea, Eddy, and Chaves Counties, New Mexico.

(2) Consideration of the allowable production of gas for March, 1982, from four prorated pools in San Juan, Rio Arriba, and Sandoval Counties, New Mexico.

(3) Consideration of purchaser's nominations for the one year period beginning April 1, 1982, for both of the above areas.

CASE 7445: (Continued from December 16, 1981, Examiner Hearing)
(THIS CASE WILL BE CONTINUED TO THE EXAMINER HEARING ON MARCH 17, 1982)

Application of Harvey E. Yates Company for an NGPA determination, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks a new onshore reservoir determination in the San Andres formation for its Fulton Collier Well No. 1 in Unit G of Section 1, Township 18 South, Range 28 East.

CASE 7479: Application of Northwest Pipeline Corporation for amendment of Order No. R-2046, Rio Arriba County, New Mexico. Applicant, in the above-styled cause, seeks the Amendment of Division Order No. R-2046, which authorized approval of six non-standard proration units, Basin-Dakota Gas Pool.

The amendment sought is for the creation of the following non-standard proration units to be drilled at standard locations thereon: Township 31 North, Range 6 West, Section 25: N/2 (272.16 acres) and S/2 (273.3 acres); Section 36: N/2 (272.56 acres) and S/2 (272.88 acres); Township 30 North, Range 6 West; Section 1: N/2 (272.81 acres) and S/2 (273.49 acres).

CASE 7480: Application of Arco Oil & Gas Company for pool creation, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the creation of a new Upper Devonian gas pool for its Custer Well No. 1 located 1810 feet from the North line and 2164 feet from the West line of Section 6, Township 25 South, Range 37 East, Custer Field.

CASE 7481: Application of Arco Oil & Gas Company for amendment of Order No. R-6792, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the amendment of Division Order No. R-6792, which authorized the directional drilling of applicant's Custer Wells Well No. 1 to an unorthodox location in the Devonian and Ellenburger formations and imposed a penalty in the Devonian. By stipulation applicant and the offset operator have agreed that the subject well is not affecting the offsetting property and applicant herein seeks removal of the penalty imposed for so long as the well produces only from the present perforated interval in the Upper Devonian.

CASE 7459: (Continued from January 20, 1982, Examiner Hearing)

Application of Red Mountain Associates for the Amendment of Order No. R-6538, McKinley County, New Mexico. Applicant, in the above-styled cause, seeks the amendment of Order No. R-6538, which authorized applicant to conduct waterflood operations in the Chaco Wash-Mesa Verde Oil Pool. Applicant seeks approval for the injection of water through various other wells than those originally approved, seeks deletion of the requirement for packers in injection wells, and seeks an increase in the previously authorized 68-pound limitation on injection pressure.

CASE 7410: (Continued from January 20, 1982, Examiner Hearing)

Application of B.O.A. Oil & Gas Company for two unorthodox oil well locations, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks approval for the unorthodox location of a well to be drilled 2035 feet from the South line and 2455 feet from the East line and one to be drilled 2455 feet from the North line and 1944 feet from the East line, both in Section 31, Township 31 North, Range 15 West, Verde-Gallup Oil Pool, the NW/4 SE/4 and SW/4 NE/4, respectively, of said Section 31 to be dedicated to said wells.

CASE 7457: (Continued from January 20, 1982, Examiner Hearing)

Application of E. T. Ross for nine non-standard gas proration units, Harding County, New Mexico. Applicant, in the above-styled cause, seeks approval for nine 40-acre non-standard gas proration units in the Bravo Dome Carbon Dioxide Area. In Township 19 North, Range 30 East: Section 12, the NW/4 NW/4 and NE/4 NW/4; Section 14, the NW/4 NE/4, SW/4 NE/4, and SE/4 NE/4. In Township 20 North, Range 30 East: Section 11, the NE/4 SW/4, SW/4 SE/4, SE/4 SW/4, and NW/4 SE/4.

CASE 7482: Application of Wiser Oil Company for an unorthodox oil well location, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval of an unorthodox location 1295 feet from the South line and 1345 feet from the West line of Section 32, Township 21 South, Range 37 East, Penrose-Skelly Pool.

CASE 7483: Application of Adams Exploration Company for salt water disposal, Chaves County, New Mexico. Applicant, in the above-styled cause, seeks authority to dispose of produced salt water into the San Andres formation in the perforated interval from 4176 feet to 4293 feet in its Griffin Well No. 4 located in Unit A, of Section 10, Township 8 South, Range 32 East, Chaveroo-San Andres Pool.

CASE 7462: (Continued from February 3, 1982, Examiner Hearing)

Application of Marathon Oil Company for downhole commingling, Lea County, New Mexico. Applicant, in the above-styled cause, seeks approval for the downhole commingling of the Drinkard and Blinebry production in the wellbore of its C. J. Saunders Well No. 3, located in Unit C of Section 1, Township 22 South, Range 36 East.

CASE 7474: (Continued from February 3, 1982, Examiner Hearing)

Application of Union Oil Company of California for compulsory pooling, Lea County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Strawn, Atoka and Morrow formations underlying the E/2 of Section 25, Township 19 South, Range 33 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the well, and a charge for risk involved in drilling said well.

CASE 7484: Application of Anadarko Production Company for compulsory pooling, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Atoka and Morrow formations underlying the E/2 of Section 1, Township 19 South, Range 25 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the the well, and a charge for risk involved in drilling said well.

CASE 7485: Application of Berge Exploration for compulsory pooling, Chaves County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the Abo formation underlying two 160-acre proration units, the first being the NW/4 and the second being the SW/4 of Section 27, Township 7 South, Range 26 East, each to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said wells and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the wells and a charge for risk involved in drilling said wells.

CASE 7486: Application of MGF Oil Corporation for compulsory pooling, Lea County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests down through and including the Abo formation underlying the NE/4 NE/4 of Section 6, Township 20 South, Range 39 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the well and a charge for risk involved in drilling said well.

CASE 7487: Application of MGF Oil Corporation for compulsory pooling, Lea County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests down through and including the Abo formation underlying the SE/4 SE/4 of Section 31, Township 19 South, Range 39 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the well and a charge for risk involved in drilling said well.

CASE 7488: Application of Burkhart Petroleum Company for compulsory pooling, Roosevelt County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests in the San Andres formation underlying the SW/4 NW/4 of Section 13, Township 8 South, Range 37 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the well and a charge for risk involved in drilling said well.

CASE 7073: (Reopened and Readvertised)

In the matter of Case 7073 being reopened pursuant to the provisions of Order No. R-6558, which order promulgated special rules for the South Elkins-Fusselman Pool in Chaves County including provisions for 80-acre spacing units and a limiting gas-oil ratio of 3000 to one. All interested parties may appear and show cause why said pool should not be developed on 40-acre spacing units with a limiting gas-oil ratio of 2000 to one.

CASE 7074: (Reopened and Readvertised)

In the matter of Case 7074 being reopened pursuant to the provisions of Orders Nos. R-6565 and R-6565-A, which created the South Elkins-Fusselman Gas Pool in Chaves County. All interested parties may appear and present evidence as to the exact nature of the reservoir, and more particularly, as to the proper rate of withdrawal from the reservoir if it is determined that said pool is producing from a retrograde gas condensate reservoir.

CASE 6373: (Reopened and Readvertised)

In the matter of Case 6373 being reopened pursuant to the provisions of Orders Nos. R-5875 and R-5875-A, which created the East High Hope - Abo Gas pool in Eddy County, and promulgated special rules therefor, including a provision for 320-acre spacing units. All interested parties may appear and show cause why said pool should not be developed on 160-acre spacing units.

CASE 7489: Application of Curtis J. Little for designation of a tight formation, Rio Arriba County, New Mexico. Applicant, in the above-styled cause, seeks the designation of the Chacra formation underlying portions of Township 25 North, Range 6 West, containing 6,720 acres, more or less, as a tight formation pursuant to Section 107 of the Natural Gas Policy Act and 18 CFR Section 271.701-705.

CASE 7490: Application of Harvey E. Yates Company for compulsory pooling, Chaves County, New Mexico. Applicant, in the above-styled cause, seeks an order pooling all mineral interests down through and including the Atoka-Morrow formation, underlying the N/2 of Section 19, Township 8 South, Range 30 East, to be dedicated to a well to be drilled at a standard location thereon. Also to be considered will be the cost of drilling and completing said well and the allocation of the cost thereof as well as actual operating costs and charges for supervision, designation of applicant as operator of the well and a charge for risk involved in drilling said well.

CASE 7491: Application of Harvey E. Yates Company for designation of a tight formation, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the designation of the Atoka formation underlying portions of Townships 12, 13, and 14 South, Ranges 35 and 36 East, containing 46,720 acres, more or less, as a tight formation pursuant to Section 107 of the Natural Gas Policy Act and 18 CFR Section 271.701-705, said area being an eastward and westward extension of previously approved tight formation area.

CASE 7492: Application of Harvey E. Yates Company for designation of a tight formation, Chaves County, New Mexico. Applicant, in the above-styled cause, seeks the designation of the Atoka-Morrow formation underlying all or portions of Townships 7, 8, and 9 South, Ranges 29,30, and 31 East, containing 115,200 acres, more or less, as a tight formation pursuant to Section 107 of the Natural Gas Policy Act and 18 CFR Section 271.701-705.

CASE 7493: In the matter of the hearing called by the Oil Conservation Division on its own motion for an order creating and extending certain pools in Chaves, Eddy, Lea, and Roosevelt Counties, New Mexico.

(a) CREATE a new pool in Lea County, New Mexico, classified as a gas pool for Morrow production and designated as the East Bootleg Ridge-Morrow Gas Pool. The discovery well is Getty Oil Company Getty 15 Federal Well No. 1 located in Unit J of Section 15, Township 22 South, Range 33 East, NMPM. Said Pool would comprise:

TOWNSHIP 22 SOUTH, RANGE 33 EAST, NMPM
Section 15: S/2

(b) CREATE a new pool in Lea County, New Mexico, classified as an oil pool for Devonian production and designated as the North King-Devonian Pool. The discovery well is Samedan Oil Corporation Speight Well No. 1 located in Unit P of Section 3, Township 13 South, Range 37 East, NMPM. Said pool would comprise:

TOWNSHIP 13 SOUTH, RANGE 37 EAST, NMPM
Section 3: NE/4

(c) CREATE a new pool in Eddy County, New Mexico, classified as a gas pool for Atoka production and designated as the North Loving-Atoka Gas Pool. The discovery well is Gulf Oil Corporation Eddy GR State Well No. 1 located in Unit E of Section 16, Township 23 South, Range 28 East, NMPM. Said pool would comprise:

TOWNSHIP 23 SOUTH, RANGE 27 EAST, NMPM
Section 12: N/2

TOWNSHIP 23 SOUTH, RANGE 28 EAST, NMPM
Section 4: S/2
Section 7: All
Section 8: All
Section 9: All
Section 16: All
Section 17: All
Section 18: E/2

(d) CREATE a new pool in Lea County, New Mexico, classified as an oil pool for Drinkard production and designated as the Teague-Drinkard Pool. The discovery well is Alpha Twenty-One Production Company Lea Well No. 1 located in Unit B of Section 17, Township 23 South, Range 37 East, NMPM. Said pool would comprise:

TOWNSHIP 23 SOUTH, RANGE 37 EAST, NMPM
Section 17: NE/4

(e) EXTEND the West Atoka-Morrow Gas Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 18 SOUTH, RANGE 25 EAST, NMPM
Section 23: All
Section 24: W/2

(f) EXTEND the Atoka-Pennsylvanian Gas Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 18 SOUTH, RANGE 26 EAST, NMPM
Section 16: W/2

(g) EXTEND the Avalon-Morrow Gas Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 21 SOUTH, RANGE 26 EAST, NMPM
Section 2: Lots 1 through 8

(h) EXTEND the Brunson-Fusselman Pool in Lea County, New Mexico, to include therein:

TOWNSHIP 22 SOUTH, RANGE 37 EAST, NMPM
Section 5: SE/4

(i) EXTEND the Brushy Draw-Delaware Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 26 SOUTH, RANGE 29 EAST, NMPM
Section 26: E/2

(j) EXTEND the Buffalo Valley-Pennsylvanian Gas Pool in Chaves County, New Mexico, to include therein:

TOWNSHIP 15 SOUTH, RANGE 27 EAST, NMPM
Section 23: All
Section 26: All

(k) EXTEND the Cary-Montoya Pool in Lea County, New Mexico, to include therein:

TOWNSHIP 22 SOUTH, RANGE 37 EAST, NMPM
Section 4: W/2 SW/4
Section 5: SE/4
Section 9: W/2 W/2

(l) EXTEND the Crow Flats-Morrow Gas Pool in Eddy County, New Mexico to include therein:

TOWNSHIP 16 SOUTH, RANGE 27 EAST, NMPM
Section 35: E/2
Section 36: W/2

(m) EXTEND the South Culebra Bluff-Bone Spring Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 23 SOUTH, RANGE 28 EAST, NMPM
Section 25: S/2 SW/4
Section 27: SW/4

(n) EXTEND the Elkins-San Andres Pool in Chaves County, New Mexico, to include therein:

TOWNSHIP 7 SOUTH, RANGE 28 EAST, NMPM
Section 21: NE/4

(o) EXTEND the Empire-Abo Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 17 SOUTH, RANGE 29 EAST, NMPM
Section 19: S/2 SW/4

(p) EXTEND the Henshaw-Queen Grayburg-San Andres Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 16 SOUTH, RANGE 31 EAST, NMPM
Section 19: NE/4 NW/4

(q) EXTEND the Indian Flats-Morrow Gas Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 21 SOUTH, RANGE 28 EAST, NMPM
Section 26: W/2

(r) EXTEND the West Nadine-Blinebry Pool in Lea County, New Mexico, to include therein:

TOWNSHIP 20 SOUTH, RANGE 38 EAST, NMPM
Section 8: NW/4

(s) EXTEND the Peterson-Mississippian Pool in Roosevelt County, New Mexico, to include therein:

TOWNSHIP 4 SOUTH, RANGE 33 EAST, NMPM
Section 28: NW/4

(t) EXTEND the Race Track-San Andres Pool in Chaves County, New Mexico, to include therein:

TOWNSHIP 10 SOUTH, RANGE 28 EAST, NMPM
Section 7: S/2 SW/4
Section 18: NW/4 and N/2 SW/4 and SW/4 SW/4

(u) EXTEND the Railroad Mountain-San Andres Pool in Chaves County, New Mexico, to include therein:

TOWNSHIP 8 SOUTH, RANGE 28 EAST, NMPM
Section 2: NE/4 and E/2 NW/4

(v) EXTEND the Red Lake-Queen-Grayburg-San Andres Pool in Eddy County, New Mexico, to include therein:

TOWNSHIP 17 SOUTH, RANGE 28 EAST, NMPM
Section 7: S/2
Section 8: SW/4
Section 18: E/2 NW/4

(w) EXTEND THE West Sawyer-San Andres Pool in Lea County, New Mexico, to include therein:

TOWNSHIP 10 SOUTH, RANGE 37 EAST, NMPM
Section 5: SW/4

(x) EXTEND the Turkey Track-Atoka Gas Pool in Eddy County, New Mexico, to include therein:

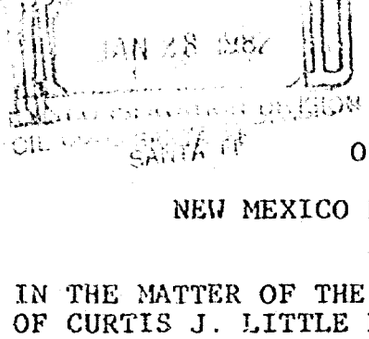
TOWNSHIP 19 SOUTH, RANGE 29 EAST, NMPM
Section 15: All

(y) EXTEND the Twin Lakes-San Andres Associated Pool in Chaves County, New Mexico, to include therein:

TOWNSHIP 8 SOUTH, RANGE 28 EAST, NMPM
Section 13: SE/4
Section 24: NE/4

TOWNSHIP 9 SOUTH, RANGE 28 EAST, NMPM
Section 12: S/2 NE/4

TOWNSHIP 9 SOUTH, RANGE 29 EAST, NMPM
Section 7: S/2
Section 8: NW/4



BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

IN THE MATTER OF THE APPLICATION
OF CURTIS J. LITTLE FOR
DESIGNATION OF TIGHT FORMATION,
RIO ARRIBA COUNTY, NEW MEXICO.

CASE 7469

CERTIFICATE OF FILING

Comes now CURTIS J. LITTLE, by and through his undersigned attorney, and hereby certifies that a copy of the complete set of all exhibits which applicant proposes to offer or introduce at the hearing on the above-referenced application, together with a statement of the meaning and purpose of each, has been mailed to the United States Geological Survey in Albuquerque, New Mexico, on this 28th day of January, 1982, as is required by Section D of the Oil Conservation Division's Special Rules and Procedures for Tight Sand Formation Designation under Section 107 of the Natural Gas Policy Act of 1978.

CAMPBELL, BYRD & BLACK, P.A.

By William F. Carr

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January 25, 1982 Case 7489

Mr. Joe D. Ramey
Division Director
Oil Conservation Division
New Mexico Department of
Energy and Minerals
Post Office Box 2088
Santa Fe, New Mexico 87501

Re: Application of Curtis J. Little for Designation of Tight Formation, Rio Arriba County, New Mexico

Dear Mr. Ramey:

Enclosed in triplicate is the application of Curtis J. Little in the above-referenced matter.

The applicant requests that this matter be included on the docket for the examiner hearing scheduled to be held on February 17, 1982.

Very truly yours,

William F. Carr

William F. Carr

WFC:lr

Enclosure

cc: Mr. Curtis J. Little
Mr. Kevin McCord

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

IN THE MATTER OF THE APPLICATION OF CURTIS J. LITTLE FOR DESIGNATION OF TIGHT FORMATION, RIO ARRIBA COUNTY, NEW MEXICO.

CASE 7187

APPLICATION

Comes now CURTIS J. LITTLE, by and through his undersigned attorneys, and as provided in the Oil Conservation Division's Special Rules and Procedures for Tight Formation Designations under Section 107 of the Natural Gas Policy Act of 1978 promulgated by Oil Conservation Division Order No. R-6388 on June 30, 1980, hereby makes application for an order designating certain portions of the Chacra formation as a tight formation under Section 107 of the Natural Gas Policy Act of 1978 and in support of its application would show the Division:

1. Applicant is the owner and operator of certain interests in the Chacra formation underlying the following described lands situated in Rio Arriba County, New Mexico:

Township 25 North, Range 6 West, N.M.P.M.
Section 16: All
Section 21: All
Section 22: All
Section 23: S/2
Sections 25 through 28: All
Sections 34 through 36: All

Containing a total of 6,720 acres, more or less.

2. The Chacra formation is expected to have an estimated average in situ gas permeability throughout the pay section of less than 0.1 millidarcy per foot.

3. The average depth of the top of the Chacra formation is 3390 feet and the stabilized production rate, against atmospheric pressure, of wells completed for production in said formation, without stimulation, is not expected to exceed 91 mcf of gas per day.

4. No well drilled into the Chacra formation in the above-described area is expected to produce, without stimulation, more than five barrels of crude oil per day.

5. A complete set of Exhibits which applicant proposes to offer or introduce at the hearing on this application, together with a statement of the meaning and purpose of each exhibit, will be filed with the Division and the United States Geological Survey at least 15 days prior to the hearing date as required by the Oil Conservation Division's Special Rules and Procedures for Tight Sand Formation Designation under Section 107 of the Natural Gas Policy Act of 1978.

WHEREFORE, Applicant prays that this application be set for hearing before a duly appointed examiner of the Oil Conservation Division on February 17, 1982 and that after notice and hearing as required by law, the Division enter its order recommending to the Federal Energy Regulatory Commission that pursuant to 18 CFR, Section 271.701-705, that the Chacra formation underlying the above-described land be designated a tight formation, and making such other and further provisions as may be proper in the premises.

Respectfully submitted,

CAMPBELL, BYRD & BLACK, P.A.

By _____
William F. Carr
Attorneys for Applicant
Post Office Box 2208
Santa Fe, New Mexico 87501
Telephone: (505) 988-4421

ROUGH

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

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

Application of Curtis J. Little for designation of a tight formation, Rio Arriba County, NM.

CASE NO. 7489

Order No. R-6937

ORDER OF THE DIVISION

BY THE DIVISION:

This cause came on for hearing at 9 a.m. on February 17, 19 82, at Santa Fe, New Mexico, before Examiner ALS.

NOW, on this _____ day of _____, 19_____, the Division Director, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

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

(2) That the applicant, Curtis J. Little, requests that the Division in accordance with Section 107 of the Natural Gas Policy Act, and 18 C.F.R. §271.703 recommend to the Federal Energy Regulatory Commission that the ~~Pictured Cliffs~~ Chacra formation underlying the following lands situated in Rio Arriba County, New Mexico, hereinafter referred to as the ~~Pictured Cliffs~~ Chacra formation, be designated as a tight formation in said Federal Energy Regulatory Commission's regulations:

Township 25 North, Range 6 West, N.M.P.M.
Section 16: All
Section 21: All
Section 22: All
Section 23: S/2
Sections 25 through 28: All
Sections 34 through 36: All

Containing a total of 6,720 acres, more or less.

(3) That the Chacra formation underlies all of the above-described lands; that the formation consists of marine deposits about 130 feet thick, composed of very fine grained siltstone having varying amounts of shale with carbonaceous and clay infilling; and that the top of such formation is found at an average depth of 3390 feet below the surface of the area set forth in Finding No. (2) above.

(4) That the type section for the Chacra formation for the proposed tight formation designation is found at a depth of approximately 3425 feet to 3553 feet on the Dresser Atlas Induction Electrolog dated December 19, 1981, from the Curtis J. Little Salazar Well No. 3, located in Unit C of Section 26, Township 25 North, Range 6 West, Rio Arriba County, New Mexico.

(5) That ~~the Gallegos, Gallup~~ one well produces natural gas from the Chacra formation within the proposed area being the Kimbell Oil Co. Salazar Federal ~~Gas~~ Well No. 1 located 1450 feet from South line and 1450 feet from East line of Section 22, Township 25 North, Range 6 West, N.M.P.M., Rio Arriba County, New Mexico.

(6) That the ~~Mesaka~~ Chacra formation underlying the above described lands has been penetrated by several other wells, none of which produced natural gas in commercial quantities from the ~~Mesaka~~ Chacra formation.

(7) ~~(6)~~ That based on an analysis of available data from existing wells within the proposed area and utilizing generally and customarily accepted petroleum engineering techniques and measurements:

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

(b) the stabilized production rate, against atmospheric, of wells completed for production in the Chacra formation, without stimulation, is not expected to exceed production levels determined by reference to well depth, as found in the table set out in 18 C.F.R. §271.703(c)(2)(B) of the regulations; and

(c) no well drilled into the Chacra formation is expected to produce, without stimulation, more than five barrels of crude oil per day.

(8) ~~(7)~~ That the Chacra formation underlying the area described in Paragraph 2 hereof is not being developed by infill drilling.

(9) ~~(8)~~ That the evidence presented in this case demonstrated that the application of incentive pricing is reasonably necessary to stimulate further development of the proposed tight formation underlying the area described in Paragraph 2 hereof.

(10) ~~(9)~~ That within the proposed area, there is a recognized aquifer being the Ojo Alamo, found at an average depth of ~~1640~~ 2200 feet or approximately ~~750~~ 1200 feet above the ~~Pictured Cliffs~~ Chacra formation.

(11) ~~(10)~~ That existing State of New Mexico and Federal Regulations relating to casing and cementing of wells will assure that development of the Chacra formation will not adversely affect the said aquifers.

(12) ~~(11)~~ That the Chacra formation should be recommended to the Federal Energy Regulatory Commission for designation as a tight formation.

IT IS THEREFORE ORDERED:

(1) That it be and hereby is recommended to the Federal Energy Regulatory Commission pursuant to Section 107 of the Natural Gas Policy Act of 1978, and 18 C.F.R. §271.703 of the regulations that the Chacra formation underlying the following described lands in ~~Sandoval~~ Rio Arriba County, New Mexico, be designated as a tight formation:

Township 25 North, Range 6 West, N.M.P.M.
Section 16: All
Section 21: All
Section 22: All
Section 23: S/2
Sections 25 through 28: All
Sections 34 through 36: All

Containing a total of 6,720 acres, more or less.

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

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

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

JOE D. RAMEY
Director

S E A L

fd/

CASE 7490: HARVEY E. YATES COMPANY FOR COMPULSORY POOLING, CHAVES COUNTY, NEW MEXICO

DOCKET MAILED

Date 2/5/82 (Poolees)