OIL CONSERVATION COMMISSION

STATE OF NEW MEXICO

TRANSCRIPT OF HEARING

CASE NO. 149

MARCH 21, 1951.

E. E. GREESON
COURT REPORTER
UNITED STATES COURT HOUSE
TELEPHONE 2-0672
ALBUQUERQUE, NEW MEXICO

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO

March 21, 1951

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Case 149: This is the Crossroads pool 80-acre versus 40-acre spacing question which was continued to March 20 by Order R-45 dated 12-29-50. Companies have been asked to furnish all remaining information available on the Crossroads pool.

BEFORE:

Hon. Governor Edwin L. Mechem, Chairman
Hon. Guy Shepard, Member
Hon. R. R. Spurrier, Member and Secretary

REGISTER:

G. T. Hanners
U. D. Sawyer
Lovingston, New Mexico

John Major
Oil Development of Texas
Amarillo, Texas

E. A. Paschal
Oil Development of Texas
Amarillo, Texas

Charles E. Shaver
Humble Oil and Refining Company
Houston, Texas

J. R. Puckett
Magnolia Petroleum Company
Kermit, Texas

L. J. Gude
Oil Development Company of Texas
Amarillo, Texas

Frank Purdum
Subsurface Engineering Company
Tulsa, Oklahoma

Bernerd A. Ray
Consulting Geologist
Midland, Texas

M. B. Penn
Mid-Continent
Tulsa, Oklahoma

E. J. Pierce
Mid-Continent
Midland

J. H. Crocker
Mid-Continent
Tulsa, Oklahoma

E. P. Keeler
Magnolia Petroleum Company
Dallas, Texas

Foster Morrell
U. S. Geological Survey
Roswell, New Mexico

Robert E. Murphy
Magnolia Petroleum Company
Roswell, New Mexico

E. E. Kinney
N. M. Bureau of Mines
Artesia, New Mexico

Hiram M. Dow
Roswell, New Mexico

Wm. Ed McKellar, Jr.
Magnolia Petroleum Company
Dallas, Texas

E. C. Iden
Oil Development Company of Texas
Santa Fe Pacific Railroad Company
Albuquerque, New Mexico

Mrs. U. D. Sawyer
Crossroads
New Mexico

Don G. McCormick
Carlsbad, New Mexico

George Hirschfeld
N. M. O & G. E. C.
Hobbs, New Mexico

Elvis A. Utz
Oil Conservation Commission
Santa Fe, New Mexico

H. A. Nedom
Amerada
Tulsa, Oklahoma

C. V. Millikan
Amerada
Tulsa, Oklahoma

R. U. Fitting, Jr.
U. D. Sawyer
Midland, Texas

George Graham
Oil Conservation Commission
Santa Fe, New Mexico

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MR. SHEPARD: The meeting will come to order. This is a continuation of Case 149 which was continued until yesterday and recessed until this morning by agreement.

You may proceed, Mr. Dow.

MR. DOW: Mr. Commissioner we appreciate the full Commission being present because this is the third hearing,

you might say, of this case, and if you will bear with me just a minute I would like to just briefly state the historical background of this case, and in as brief a manner as I can what has gone before.

The case pertains only to the Devonian formation as the same exists within the confines of the Crossroads pool in Lea County, New Mexico.

The discovery well in this pool was commenced in September, 1947. About 8 months thereafter this wildcat wlll was completed in the Devonian formation at a total depth of 12,258 feet. On May 6, 1948, the initial production taken indicated 995 barrels flowing through a 3/4 inch choke in 6 hours and 20 minutes. The well cost $355,640.39.

We believe the records of this Commission will verify the statement to the effect that this well was the deepest oil producing well ever built in the State of New Mexico at the date of its completion. Needless to say, the well created a great deal of excitement not only in New Mexico but also throughout the producing states generally.

About one month following the completion of the Crossroads discovery well, a meeting of the operators, of all operators, and lease owners in the vicinity of the discovery well was called and held in Tulsa.

The meeting was representative and well attended. The operators in this meeting were favored by the presence of Mr. Spurrier and Mr. Morrell of the United States Geological Survey and Mr. Glenn Staley.

The State of New Mexico extended every cooperation. Pursuant to action taken in the Tulsa meeting a plan was agreed upon and an application lodged with this Commission to enter an appropriate spacing order for the pool.

Section 13 E of the Conservation Act provides: "Whenever it appears that the owners in any pool have agreed upon a plan for the spacing of wells, or upon a plan or method of distribution of any allowable fixed by the Commission for the pool, or upon any other plan for the development or operation of such pool, which plan, in the judgment of the Commission, has the effect of preventing

waste as prohibited by this act and is fair to the royalty owners in such pool, then such plan shall be adopted by the Commission with respect to such pool; however, the Commission, upon hearing and after notice, may subsequently modify any such plan to the extent necessary to prevent waste as prohibited by this act."

A hearing was conducted then before this Commission on July 15, 1948. Pursuant to notice as required by law. That is, notice to all interested parties. And on July 19, 1948, the plan for 80-acre spacing was approved by this Commission, Order No. 779. We here quote findings of fact made by the Commission found in the Preamble of its Order 779. That is the order in which we are now coming to show cause, or continuation of the hearing to show cause why it should not continue in effect.

Paragraph Three of the Preamble in Order 779 reads as follows: "That due to conditions established by the aforesaid discovery well, the Commission finds it advisable to amend and supplement its present rules, regulations and orders to properly cover the question of development of leases and spacing of wells now or hereafter drilling to, into and producing from the Devonian formation, encountered at a depth below 12,000 feet in the Crossroads Pool."

And Paragraph 5 and 6 reads as follows:

"5. That the Devonian formation, as found in the discovery well below 12,000 feet, is a common source of supply which should be drilled and developed on a program other than that normally followed under the present rules, regulations, and orders of the Commission, particularly Order No. 637, effective March 1, 1946, with respect to units of proration, spacing and assignment of allowables, because of the depth of such wells, the time necessary to drill, and the high costs attached thereto, in addition to the hazards and scarcity of materials.

"6. That in the interest of the State of New Mexico and in the interest of the general public, encouragement should be given to operators to explore and develop the natural resources of the State by the establishment of a proper and equitable spacing and development program."

Since the date of the Order eight wells, not including the discovery well, have been drilled to and into the Devonian formation; three of which have been plugged and abandoned and five of which are presently producers.

The probable average drilling time for each well is 6 or 7 months. The probable average cost of each of said wells exceeds a quarter million dollars. The Mid-Continent alone - I will refer to the transcript of the November 21, hearing where it has such a paragraph in the summary, Page 55 of the transcript showed the total amount of money we have spent on the four wells discussed, including the drilling well; $1,725,901.10. The total revenue from these four wells is $913,087.90. The balance of money spent and not recovered, which is the difference between those two figures, is $812,813.20, which is approximately one-half of the total money spent as of the date of the hearing of November 21, 1950.

By a letter dated October 19, 1950, U. D. Sawyer and Dessie Sawyer through their attorney informed the Commission of their ownership of some 1200 acres in the Crossroads Pool, and complained that on account of the 80-acre spacing in the Devonian - and I quote "the value of their property was being unjustly diminished and the marketability thereof being unduly impaired". They made no statement of facts indicating that waste, as defined in the Statute, had or was occurring in the Devonian - Crossroads Pool. Nor that correlative rights were not being protected. And without such an allegation it was our contention that the Commission was without jurisdiction to act.

Thereafter under authority of Section 8 of Order 779, the Commission issued a notice dated October 27, 1950, ordering all interested parties to show cause before the Commission on November 21, 1950 why 80-acre spacing should be continued in effect in the Devonian - Crossroads Pool.

Upon the day of the hearing the Mid-Continent Petroleum Corporation and the Magnolia Petroleum Corporation and the Santa Fe Pacific Railroad Company and the Oil Development Company of Texas, being owners and operators in the pool, appeared and lodged a legal objection to the Commission's order on the ground that their rights had become vested and could not be affected in a collateral

attack of this nature, and asserted that the Commission had authority to modify its spacing order only to prevent waste and to protect correlative rights.

And at the outset of the hearing, the operators took the position that it was the duty of the informant to assume the burden of proof. But the operators at the same time expressed a willingness to be of further assistance to the Commission and to present evidence to strengthen the belief of the Commission in the justice and fairness of its previous order, and following that statement, the operators did proceed and offered the testimony of three witnesses.

The uncontroverted testimony of each witness was to the effect that water influx or water drive constitutes a source of reservoir energy in the Crossroads Pool in the Devonian producing formation. All witnesses, petroleum engineers, testified from their studies of the Devonian formation in the Crossroads Pool it was apparent to them from reservoir behaviour since the issuance of Order 779 that the Order was a proper one and should not be changed.

The informants and their attorney were present at the hearing, and their attorney interrogated the witnesses produced by the operators, but presented no evidence. On the 29 of December, 1950, the Commission entered an order finding, and we quote: "And the Commission is not able to determine from such testimony whether or not 80-acre spacing and proration units over the pool as a whole has, or will prevent waste, preclude inequities, and/or preserve correlative rights in the said Crossroads pool."

And it ordered the case continued to March 20, 1951, at which hearing all available pertinent information from all producing wells in the Crossroads pool shall be presented to the Commission. The operators are appearing now. They are adhering to the legal position heretofore stated. But in order to be fair with the Commision and all concerned, they are now prepared to go ahead, as before, and present their evidence.

Now in this case for Mid-Continent Petroleum Company appears Mr. J. H. Crocker of Tulsa, attorney; for Magnolia

Petroleum Company appears Mr. Ed McKellar of Dallas, attorney; for the Santa Fe Pacific Railroad and the Oil Development Company of Texas appears Mr. Earl C. Iden of Albuquerque; and as local counsel I represent both Mid-Continent and Magnolia.

Now, we are prepared to present witnesses which in our judgment will furnish the information required by the order of the Commission dated December 27, 1950.

MR. SHEPARD: You may proceed Mr. Dow with your witnesses.

MR. DOW: If we may do it, the witnesses of course are petroleum engineers, their testimony is technical and at the former hearing Mr. Crocker interrogated the witness for Mid-Continent and Mr McKellar for Magnolia and Mr. Iden for the Santa Fe Pacific and the Oil Development Company.

The witness for Magnolia - for Mid-Continent - is Mr. Bernerd A. Ray, geologist; Mr. Frank Purdum, petroleum engineer; and Mr. M. B. Penn, petroleum engineer - and will you announce yours Mr. McKellar.

MR. McKELLAR: Mr. Jim Puckett

MR. DOW: Mr. Iden.

MR. IDEN: J. C. Major.

MR. DOW: Then Mr. Crocker will proceed with our witnesses. Now, we of course took the position at the outset it was up to the informants to make a case, but we went ahead and we are willing to do that now, although we understand the informants have a witness at this time. I presume Mr. Hanners will put him on after you hear our witnesses.

MR. SHEPARD: Will you announce your position, Mr. Hanners.

MR. HANNERS: Our position in the matter, if the Commission please, is that the transcript of the first hearing in 1948 shows that the 80-acre spacing pattern was proposed by the Mid-Continent as a temporary measure,

based upon the drilling of only one well, and on the assumption that the four section area which had been designated by the nomenclature committee as the Crossroads - Devonian field would be productive of oil from the Devonian formation throughout the entire area. And that the order as shown by the transcript of that hearing was adopted purely as a temporary measure. That subsequent facts have not shown in and of themselves that the order should be further continued as a exception to the normal state-wide pattern.

At the hearing in November of 1950 the observation was made by a member of the Commission that the testimony submitted by the operators wasn't sufficient to show in and of itself certain technical data and information about the field, and the order was continued until this date so that the companies might submit any additional information they had available. We have available as a witness to advise the Commission Mr. R. V. Fitting, a petroleum engineer at Midland.

Our position in the matter would be that the applicant having obtained the order as a temporary exception from the normal state-wide pattern that the Commission retain jurisdiction in the original order to review the matter after the history of the field had been further developed. And that we are here now for the purpose of permitting the Commission to consider whether this exception order should be further continued in effect.

(All witnesses sworn by Mr. Graham.)

MR. CROCKER: If the Commission please, we will offer Mr. Ray first as a witness, he will testify as a geologist.

MR. DOW: I take it that the transcript of the preceding hearing of November 21 is part of the record of this hearing?

MR. SHEPARD: Right.

MR. DOW: All of the hearing.

MR. SPURRIER: Mr. Crocker before you start let's remind everyone that there is nothing to be said here today that won't be important and let's take it slowly and let's make sure that the people who are hear to listen can hear.

MR. CROCKER: We will be very glad to cooperate to the best of our ability.

BERNERD A. RAY,

having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. CROCKER:

Q Will you state your name, please?

A Bernerd A. Ray.

Q Where do you live, Mr. Ray?

A Midland, Texas.

Q What is your profession?

A Consulting geology.

Q Are you a graduate geologist?

A I am a graduate geologist, attending school and taking mining geology at the University of Minnesota, and then followed up by one year at the University of Oklahoma specializing in petroleum geology.

Q Have you been in consulting geological work in Midland and in connection with fields in New Mexico, Texas, Oklahoma and other producing states?

A Yes.

Q Have you done a considerable amount of work in the state of New Mexico?

A Yes, I have.

Q What fields in New Mexico have you given thought and study as a geologist?

A Well, Monument, Hobbs, Langlie, all the fields in Lea County, and the Lovington pool. Some work in the Denton pool and the Crossroads and the Bough pool.

Q Have you recently done geological work and given study to the Devonian reservoir as it exists in the Crossroads pool, New Mexico?

A Yes, I have.

Q Did you make a map?

A Yes.

Q To exemplify your work?

A Yes.

MR. CROCKER: We offer it for identification as Exhibit 1.

Q Mr. Ray I show you a map or plat which has been identified as Mid-Continent Petroleum Corporation Exhibit 1. Will you examine this Exhibit and inform the Commission as to what it is, who made it, if you know, and interpret the showings thereon and - you might do that at this time and we will put it up on the board.

A This map is contoured on the top of the Devonian dolamite, and the red line you see outlining the pool, that is the water datum, minus 82 hundred feet and up until a short time ago we thought minus 82 hundred feet was the water datum. In drilling below that you would get water. Above minus 82 hundred you would encounter oil. But recently the Mid-Continent 1-A well and the Magnolia 1-C are now producing considerable amounts of water. And this present map has been perimetered, and we find inside this red line there is approximately 450 productive acres within that red line. There is a structure that is

Circular in area namely with expanding water coming from all sides and forcing the oil up dip through crevices or vugular fractured dolamite. And we have cores here to show and illustrate the type of porosity we have in this pool. The permeable portions is the cracks and joints in the formations. There is no intercrystalline porosity in the formation. All the oil is coming through these cracks and through the vugs of the formation. And having a very affectiv water drive it is gradually pushing the oil up dip into the higher portions of this structure as the oil is being taken out. Now the permeability is through these fractures and vugs and our porosity is mostly through these fractures and vugs and our porosity, is mostly through these minute cracks in the formation.

I think these cracks are horizontal and vertical. And the oil in place is in this fractured dolamite and vugular portion of the dolamite. There is very little gas connected with this oil. There is only 40 cubic feet of gas per barrel of oil. It is as close to being a 100 per cent water drive field I believe we have an example of today. That I can think of right now. Usually at this depth you have a great deal more gas in the oil. A water drive field is more or less the reverse of your gas cap fields. The gas cap fields, when the field is being produced the gas will expand and your more productive wells will be the ones down dip on the flanks, whereas in the water drive fields the wells higher on the structure will ultimately produce more oil than the wells out on the flanks and the wells out on the flanks will go to water first.

Frequently in water drive fields we have zones of permeability which is more or less through this vugular porosity and through the fractures and joints. On the west side we have evidence of a fault, which I just learned the other day from the oil development company that they had extensively tested their well here to prove to them it was faulty. Now this fault may run on down to this Mid-Continent 1-B in section 34. Otherwise, we don't know for sure whether we have water communication at this vertical fault or not. But we could very easily. But on the south and the east and the north side to date we don't know of any faulting in there. And I think we have a very effective water drive approaching the field

from all directions, with one exception here that somebody might dispute that, there would be no communication on the south side.

Frequently in an oil field where you have water drive that way, a denser pattern might hasten the production of water and it is my opinion these wells will drain that field sufficiently. The engineers I think will bring that up later, that they have found that the bottom hole pressures have been very uniform. That there is very little fluctuation as the field is producing oil. The highest part of the structure, which is about the center of that section (indicating on the map), there is about 1180 feet of drop from the lowest well to the highest position on the structure which is - in any direction here it is less than a mile. That structure as I said before just covers approximately 450 acres and you have actually about 75 acres to a well now.

As I mentioned we have this very sharp west dip, which may be due to this fact. And we have our dip in the other four directions which is a little bit more uniform. I believe there is some truncation in the field there. There has been a little erosion on top of the structure.

The oil companies encounter the oil formation 25 to 75 feet in. And any wells drilled out around the edge here would be right at water datum.

Q Are you speaking of the north edge?

A Yes, or this edge here.

Q The north edge of the reservoir and in section 27?

A Yes. One of the reasons for closing this structure on the north as I have, these two wells are flat on the Bettenbaugh limestone. That is the evidence I submit here. The reasons for that structure to close there. That it doesn't go on northward. This dolamite encountered in this formation is very massive and dense and there is no intercrystalline porosity. Thereby, all your oil is coming through these fractures and these vugs and joints. Do you think we should show those cores, or do you have some questions?

Q Mr. Ray have you examined the cores taken from the actually producing formation in this reservoir?

A Yes, sir, I have.

Q Do you have any core or cores available by which you might analyze the physical pieces?

A Yes.

Q Will you produce them?

(Off the record while the cores are brought forth and unpacked from the boxes.)

THE WITNESS: I would like to show you these cores. (Off the record.)

MR. CROCKER: Mr. Ray I hand you herewith a physical exhibit which has been identified as Mid-Continent's No. 2. Will you please inform the Commission what this Exhibit is.

A This Exhibit is the core from the discovery well, showing the vugular porosity, which many of these holes are connected by little minute fractures and cracks horizontally and vertically. This black material you see here is frequently called dried oil or Gilsonite, or very often spoken off as asphalt. But you see all these cores show a considerable amount of that Gilsonite.

Q How was that core recovered and from what depth was it taken?

A This was taken from 12,229 feet in the discovery well. There was a diamond core bit that was used in extracting it out of the formation.

Q Was it taken from the Devonian formation?

A It was taken from the Devonian formation.

Q Is that a producing section of the formation?

A Yes, this is part of the producing formation in the

Crossroads pool. Now as to the Exhibit -

Q (Interrupting) I hand you a physical Exhibit which the reporter has identified as Mid-Continent's Exhibit 3. Will you explain the Exhibit fully to the Commission?

A This core was taken at 12,235 feet. I show it to you as an illustration of how it was fractured. Minute little holes or vugs in there throughout the core. Here it has been fractured also showing a little of the Gilsonite from the formation - from the discovery well.

Q Mr. Ray, I offer you a physical Exhibit which has been marked by the reporter as Mid-Continent's Exhibit 4. I will ask you to explain to the Commission what it is and make such comments on it as you desire.

A This is an example of the formation in that it is quite dense and hard. There is a little chirt that does occur in the Devonian formation. But as dense as it is there are a few cracks and a few small holes where oils come through. But this particular piece just happens to be a little more dense than some of the others.

Q Was this core taken from the discovery well?

A Yes.

Q At what depth?

A 12,247 feet.

Q All right. Mr. Ray here is a physical exhibit which the reporter has identified as Mid-Continent's Exhibit No. 5. Will you tell the Commission what it is and explain or analyze -

A This Exhibit shows some -

Q First let us - is that from the discovery well?

A This is from the discovery well.

Q And at what depth?

A 12,221 feet.

Q Is that from the Devonian formation?

A It is from the Devonian formation. It shows a little cracking and breaking here. Possibly brecciated a little. It has been cracked and re-cemented. It also shows the joints or cracks here on the edge and vertical cracks through here plus a lot of gilsonite in these cracks and joints.

Q Mr. Ray I hand you a physical Exhibit which the reporter has designated as Mid-Continent's Exhibit No. 6. Will you please explain the Exhibit?

A This was taken at 12,228 feet from the discovery well. Mid-Continent's discovery well. It shows your vugular porosity here and its accidentally being broken through here by a fractural crack. Likewise here it is broken and here we find the gilsonite or dried oil throughout the core. Most of the cores are similar to this one.

Q Mr. Ray I hand you herewith a physical Exhibit which the reporter has identified as Mid-Continent's Exhibit No. 7. Will you tell the Commission what it is and analyze it for the benefit of the Commission please?

A This is from the discovery well, Mid-Continent's 1-A Sawyer and shows a great deal of minute fractures and cracks running vertically. A few of them you can see take an horizontal axis. It shows some of this vugular porosity with some Gilsonite in the vugs.

MR. HANNERS: What is the depth on that Mr. Crocker ?

THE WITNESS: We had it written on here some place.

(Off the record.)

THE WITNESS: That depth is 12,221.

MR. HANNERS: Exhibit 7 and 5 are the same Exhibit?

THE WITNESS: Yes. It fits onto No. 5. This illustrates the vugular porosity and the cracks and joints in it.

And it has the appearance of being brecciated a little bit on the inside of the core, but we see the asphalt of gilsonite throughout that core.

Q Mr. Ray I hand you a physical Exhibit which the reporter has identified as Mid-Continents Exhibit No. 8. Will you please tell the Commission what it is and analyze it?

A This is from the Mid-Continents discovery well at 12,182 feet which is near the top of the Devonian where it was encountered in this well. It shows a very dense massive dolamite with a few cracks running vertically, just a few vugs in the core with some gilsonite along some of the fractures. I believe that is all on that.

Q Mr. Ray, in view of the individual analyses you have made for the purpose of the Commission, do you have a general summary statement as a result of all of the cores, what the general indication is as to the reservoir, as to its permeability, and any further statement to generally summarize what you have been testifying to as to each of the separate Exhibits?

A I believe each of these cores illustrate the type of porosity we have in the Crossroads oil pool. It is vugular, fractured, and minute little cracks throughout. And the oil is being produced from these vugs and cracks and joints. There is no inter-crystalline saturated dolamite in the Crossroads pool. All the oil occurs in this type of fracturing and vugular porosity.

Q Mr. Ray, what does permeability really mean? Is it the ease with which the oil flows through?

A Yes.

Q What is porosity?

A Porosity would be the minute openings around your crystalline grains where oil would be permitted to lodge.

Q I believe you testified that it is your belief that the oil or the reservoir energy in the Devonian formation is in

the nature of an effective water drive?

A Yes.

Q Does that mean that as the influx of water comes into the formation that it pushes the oil up dip?

A Pushes the oil up dip.

Q And is it your thought these holes and fractures you have spoken of, that that affords a method -

A That is the communication.

Q Of communication. In view of what you have testified to, do you think that the reservoir lends itself to what is called 80-acre spacing, and that one well will effectively drain all recoverable oil from 80-acres?

A Yes, it is my thought it will in this particular field due to the type of porosity and fracturing and jointing we have.

Q Is it your thought as a geologist and from the investigation you have made and the testimony you have given that Order 779 should be modified, altered or changed with respect to the 80-acre spacing this Commission provided for in that Order?

A No, I don't think it should. I think it should remain an 80-acre spacing.

MR. CROCKER: I believe that is all we have with the witness.

MR. SHEPARD: Mr. Hanners.

CROSS EXAMINATION

By MR. HANNERS:

Q On how many wells, Mr. Ray, did you take similar tests?

A How many wells?

Q Yes, sir.

A I believe your Dessie well was cored, wasn't it, but those cores are not available.

Q They were not available to you?

A No.

Q So your testimony is confined to your observation and analysis of the core test taken from the discovery well?

A Yes.

Q You spoke of the water drive, Mr. Ray. Where would the water drive be with reference to the sections from which you took those cores?

A Where would the water drive be?

Q Yes, sir. Is it horizontally to it or vertically below it, where is the water?

A Well, I think the water datum is about minus 8200, and as you produce your field the water has a tendency to move upward in your hole.

Q So then is the water below the section from which you took those core tests?

A No. In some of these cores they are in the water datum now. Mid-Continent well is producing a considerable amount of water today.

Q Is there any water horizontal to the sections from which you took those cores?

A Horizontal?

Q Yes, sir.

A There could be but it would be very hard to say that except we know the well is producing a considerable amount of water per day and the bottom, or total depth, is minus 8192.

Q Mr. Ray, where did the water come from that that well is

now producing today?

A I think it is coming from below and possibly from the sides.

Q Below and possibly from the sides?

A Yes, sir.

Q Now the area from which you took the cores, is that the area from which production is being had in the discovery well now?

A Yes, sir. These cores are from the producing formation today.

Q You have taken tests from 12,221 to 12,237, that would be 16 feet?

A There is one Exhibit here near the top at 181.

Q Is that well producing from that wide a pay section now?

A What are those perforated intervals, Mr. Penn?

Q Mr. Ray, do you know from what area the discovery well is now producing?

A What area?

Q At what interval?

A Yes it is producing from about 81- it is producing from 8141 minus.

Q Yes, sir.

A Above that depth. The total depth was 8192.

Q Is that above the interval from which you took these cores?

A No, that is -

Q What is the elevation on the well there?

A It is 4033.

Q That added to your 8141 minus would give a figure of 12,171. Is that the interval from which the well is now producing?

A Yes.

Q Then these tests you took were from the interval below that?

A With one exception. There is one core from 181.

Q That would be 11 feet below the interval from which the well is now producing. Wouldn't that be true, Mr. Ray?

A I didn't quite get that question.

Q You took one core from 12,182?

A Yes.

Q You testified the well was producing from 12,171. So your nearest core would be 11 feet below the interval from which the well is producing, wouldn't it Mr. Ray?

A Pardon me. I was looking - the total depth is 8225 minus - excuse me. The plug back is minus 8207. And the top of the Devonian is minus 8073.

Q Well, so that we can clarify it, are these cores which you have laid on the table taken from the interval from which the well is now producing?

A I think so. Let me check here. Plug back depth is 12,232.

Q From how wide an interval is the well now producing?

A From there back to - may we have the perforations Mr. Penn.

Q Now, Mr. Ray, you have the figures now for the well where it was perforated and from which it is now producing.

A Yes, sir.

Q Would you read your figures, please sir?

A From 12,100 to 142; 12,152, 12,182.

Q Now, is that the area, the interval from which the well is now producing?

A Yes.

Q Then your tests were also from below that figure were they not?

A These cores, yes. I believe they are with one exception.

Q Your Exhibit No. 8 was taken from 12,182 feet?

A Yes, I believe so.

Q Then all of the other six Exhibits or five Exhibits were taken from the area below that from which the well is now producing?

A Yes, sir.

Q Now do you have any cores -

A (Interrupting) Originally this well was producing from this formation. But when water encroachment came in they plugged part of the hole where these cores were cored?

Q You have testified that the cores now on the table have evidenced, to which you have applied technical names, showing the movement of oil through them, is that right?

A Yes, sir.

Q What were the words used to describe the black portions in the Exhibits?

A Gilsonite or dried oil or frequently called asphalt.

Q What became of the oil in place in those cores when that well was plugged back to 12,182 feet, some distance above the section from which those cores were taken?

A What has become of the oil?

Q Yes, sir.

A I think some of the oil has been moved up into the formation higher.

Q How much has been moved up into the formation higher, what percentage?

A That would be very hard to state.

Q So some oil was left in place in this formation in the interval from which you took these tests when the well was plugged up at 12,182 feet?

A No, I wouldn't say that any oil had been left in the formation. It is more easy to understand that the oil has been gradually, been moved, up dip as the well was produced.

Q Well, the water drive which pushes the oil up dip, will it bypass any of the oil and leave it in place in those formation

A It can, and in cases it does when you produce a formation too rapidly.

Q What percentage of the oil/was left in place in the formation from which you took those core tests when the well was plugged back above them to 12,182 feet?

A That I couldn't answer. I don't know how much oil, if any, had been left there.

Q But you would not say oil wasn't left in place in that area from which the samples were taken when the well was plugged back to 12,182 feet?

A No, I think there is a greater probability the oil has moved up dip.

Q Now, did you study the core analyses of those samples?

A Yes, sir.

Q You have laid out on the table ratherlarge Exhibits. How much of the material comprising one of those Exhibits is analyzed in one of those core analyses, how big a chunk?

A Analyzed?

Q Yes, sir.

A The core laboratory analyzed the cores, didn't they?

know how
Q Do you/much of a section of one of those Exhibits is analyzed by the laboratory, how big a chunk?

A I think in these - they will vary in size - what is it? One or two inches at a time.

MR. PENN: All of it.

A All of it.

Q Are you satisified, Mr. Ray, the entire core was analyzed by the laboratory?

A Yes, sir. It was tested by the core laboratory in Midland, I believe.

Q Now do you have the analyses from the core test in the laboratory?

A Mr. Penn the engineer has it.

Q Have you studied them over?

A I have looked them over, yes.

Q Do you have any core analyses from any other wells?

A In this field?

Q Yes, sir.

A I have one core analysis in the Dessie-Sawyer.

Q When were these tests taken, when did you do your work?

A Just recently I looked at their core analyses.

Q When was that?

A About a week ago.

Q Now where are the core analyses in these Exhibits you have here? Are they available today?

A Yes, sir, I think Mr. Penn the engineer has them.

Q Now would those analyses shows the permeability of those sections you have laid out on the table?

A Yes, sir.

Q And they show uniformity of the permeability of that section

A No, I don't believe they do.

Q Will there be variations in the permeability of those sections lifted by those core tests?

A Yes, sir.

Q Will there be wide variations in the permeability?

A Yes, there would be. If you get one piece as dense as that (indicating one of the Exhibits), you wouldn't have any analysis.

Q Then the wider the variation in the permeability of that section, the wider is the variation of your movement of oil into the well, is that right?

A Yes, there may be some variation, some formations will vary in permeability.

Q And unless you had the core test from all the wells in the area and had studied the analyses of them, you would not assume those tests applied to the behaviour of the whole

basin, would you, Mr. Witness?

A The behaviour of the wells is illustrated by these wells around here, I think. Magnolia's well is making water, Mid-Continent's discovery well is making water.

Q Now, if the Magnolia well is making water and the discovery well, which is the A-1, is making water, and if the wells north of there, which would be the Oil Development Companies 2-27 and the Sawyer D, were not making water, then what is your opinion as to the source from which that water is coming in those two wells on the south?

A It is probably bottom water. The reason these other wells are not making any water, they are completed much higher in the section.

Q So the water already coming into the two wells on the south is coming from what direction?

A Probably from south, southeast, and south, southwest.

Q Now, you said something a while ago about a fault on the west side. Is this the area indicated by the little blue check marks along this west side?

A This line right here, yes.

Q What was the difference in the depth of the southeast well drilled by the Santa Fe, 1-27 -

A Yes.

Q And the 2-27? What was the difference between those two wells?

A About 800 feet difference.

Q 800 feet difference in the top of the Devonian?

A Yes.

Q And this would indicate to you as an engineer -

A That you have a very sharp, steep dip to the west.

Q Do you have a fault in there?

A Could very easily be.

Q Do you describe that as a fault?

A Until just yesterday I did not have the information from - the Oil Development Company told me they had tested their well extensively running deep meters, and so forth, which convinced them they hada fault in their well.

Q Now, would that fault be about midway between the Santa Fe No. 1 and the Santa Fe No. 2-27?

A No, I don't believe it is. I believe it approaches the Santa Fe 1 welland then could possibly run down to the Mid-Continent well in section 34.

Q Now, how do you fix the line of your fault at the place you have indicated on the map?

A The Mid Continent well?

Q Yes, sir.

A In section 34 and the Oil Development well in 27 is the general control for that fault.

Q Now are there any other faults in the field there?

A Not that I know of definitely but there could be.

Q Now did you find in the core tests that wehave here the material called breccia?

A Yes, I think there is possibly some.

Q What would it indicate when you find it?

A It frequently indicates you have a structure that has been truncated and small pieces broken up have been re-cemented.

Q Is that indicative of a fault in the area?

A No. You can find it in a fault area, you can find breccia adjacent to or in the fault.

Q Now what is indicated on your map by the red line?

A The water datum, minus 8200.

Q Have you drawn a line on the map that would indicate the limits of the Devonian reservoir there?

A Yes, I think this red line here indicates the limits of it.

Q You spoke a while ago about the Bough field or Betenbaugh formation. On your map I notice you have in the Mid-Continent A-1 the Betenbaugh formation at 5586 and then the number C the top at 5586, and then the two wells immediately north of it and the 2-27 well at 5523 and in the D well at 5555. Now what does that indicate?

A Those are the subsea datums of the Betenbaugh limestone. That is where the Betenbaugh was encountered.

Q Now, what is the difference in elevation at which you found the Devonian formation in the 2-27 well and in the Dessie Sawyer well?

A The 2-27 ?

Q Yes, sir.

A Oil Development Company?

Q Yes, sir.

A The difference? The difference was encountered?

Q Yes.

A 7705 in the Oil Development well, and in the Mid-Continent Dessie Sawyer well it was 7674.

Q It would make a difference of 31 feet structurally between those two wells?

A Yes, sir.

Q Now the 2-27 well or the U-D Sawyer D well are they making any water?

A No.

Q So the water drive isn't coming from that direction is it?

A Those wells are completed at a minus 7838 and a minus 8110.

Q Then what information do you have to support your statement that the water in the A-1 well and the Magnolia 1-C is coming from what direction?

A I think it is coming? We can't say definitely and be positive it is coming from any particular direction. The assumption in the oil business is that it is probably moving in laterallly from more than one direction.

Q Your testimony is that it is the assumption it is probably moving in laterally from more than one direction?

A Yes, sir.

Q But you have no reliable information on which to base that statement, is that right?

A Well, except that the Magnolia well is making water when they started out not to make water and that they were completed near the water datum.

Q Howmuch lower than the 1-A well?

A You see the Magnolia encountered the Devonian at minus 8191 or 9 feet above normal water datum.

Q By the way I have just observed another thing. The Betenbaugh formation in the two wells on the north side of 27, both are shown at 5587 and 86?

A Yes.

Q Which is exactly the same as that formation in the Dessie No. 1 and in the 1-C?

A Yes.

Q So that part of the formation is absolutely horizontal, isn't it?

A Apparently is. But it has been our experience in this area that considerable thickening takes place below the Betenbaugh line.

Q Then how do you justify the drawing of this line on the north side of Section 27?

A I took an average interval from the Betenbaugh to the Devonian of two or three of those wells.

Q Which ones?

A Magnolia 1-C, and then I took the Oil Development No. 1 dry hole, and then I took one of the higher wells in the field.

Q Which higher well in the field?

A As I recall I believe it was No. 1, Dessie Sawyer.

Q Now if you took the Dessie Sawyer in the comparison you have just made, where did you find the Devonian - up near the Magnolia Pennsylvanian well No. 1 in section 22?

A Where I took that interval?

Q Yes, sir.

A Just a minute. It would be about 7674, but you are taking the highest well in the field.

Q Now that would be the top of the Devonian at the same interval you have found it in the Dessie well?

A Yes, sir.

Q Then why did you close the north end of this basin, of this structure?

A We have two wells that are flat, and I have taken an average of two or three of the wells, intervals.

Q Well, now if you average the Dessie Sawyer well with the one immediately below it or with the Oil Development Company well north of it, I am trying to find out Mr. Witness your justification for closing the structure, structural limits on the north side of this field as you have in your map?

A How else will you take it into account if you have two wells that are flat? You close your contours - you would spring it east-west, wouldn't you?

Q But those four wells that we have been discussing are almost flat on your Betenbaugh lime?

A Yes, sir.

Q Do you feel wholly justified in the closing of the reservoir you have made on the north side here?

A Yes, sir.

Q Do you feel there might be a fault in the north side of section 27?

A I don't know if there is a fault or not.

Q You don't know whether there is or not?

A No.

Q Now, when did you discover there was a fault on the west side?

A Yesterday from information from the Oil Development Company.

Q Isn't about the only way you could really determine where there is a fault in the north part of section 27 would be by the drilling of the well up there?

A Yes .

Q If there be variations -

A (Interrupting) You might not drill it in the right place to get that information, too.

Q If there be variations in the permeability of the sections from which you have taken those cores, there would be variations in the permeability throughout the entire reservoir?

A Yes, sir.

Q And the greater the variation in the permeability of the rock the greater the variation in the movement of oil through it, isn't that true?

A Core analysis had a very high permeability of these cores due to all the fracturing and the vugular porosity.

Q But the greater the variation - it would produce a non - uniform situation through the field, wouldn't it?

A Well, I don't know there is any great variation in the core analyses.

Q Have you studied the core analyses as to the permeability?

A Yes.

Q From how many wells?

A From the two wells Mid-Continent had.

Q Those are the only two wells cored in the field. And you have no test as to the permeability from any of the other wells?

A No, other than production performance.

Q Now, what is the range in permeability shown by the cores and the tests which you have studied?

A The range in the permeability?

Q Yes, sir.

A I believe Mr. Penn or the engineers will bring that up later.

Q You don't recall?

A No, I don't recall the figures.

MR. HANNERS: I believe that is all.

REDIRECT EXAMINATION

BY MR. CROCKER:

Q Did you testify that in your experience as a geologist that you have done geological work in examination of cores from other Devonian reservoirs in the State of New Mexico and western Texas ?

A Yes, sir.

Q I will ask you if the cores that you have presented here an analyzed for the benefit of the Commission are representative of the general characteristics of the Devonian reservoirs in which you have done geological work in eastern New Mexico and western Texas?

A I believe you have the same type formation in your Bagley pool, the Hightower and the Knowles pool. Those three pools are typically like this one. They don't have any intercrystalline porosity in those three fields. It is fractures and vugular porosity they have.

Q I believe you testified to the Commission in response to Mr. Hanners question you had examined the core analyses of the cores taken from our well, did you not?

A The Dessie and the 1-A

Q Are these cores fairly representative of the condition developed by the analyses of the one taken from the Dessie well?

A Yes, sir, that is correct.

By MR. McKELLAR:

Q Isn't it true, Mr. Ray, that that laboratory core analysis would show a porosity or permeability considerably less than that which actually existed in any reservoir of a fractured type such as you have testified about?

A Yes, sir.

Q In other words, the core analysis of the porosity and permeability which the Mid-Continent is able to obtain from the core laboratories did not actually reflect the true porosity and permeability of this Crossroads Devonian reservoir?

A That is true because they wouldn't have any way of testing those fractures.

Q They do not take the fractures into consideration?

A No.

Q That was my understanding. Now, Mr. Hanners asked you questions in respect to the amount of oil left in place. In your opinion isn't it true, as a practical matter, that the technical men of the oil industry know that no type of reservoir drive mechanism will completely flush the formation one hundred per cent? In other words, it is impossible to get 100 per cent recovery?

A That is true.

Q And isn't it further the opinion of geologists and petroleum engineers that in any field in which you have an effective water drive, you obtain the maximum oil recovery from the formation?

A That is true.

Q While it is my understanding that is impossible to compute the actual percentages but from the best data that the engineers have been able to obtain through study of water drive reservoirs, do you have any idea of what those percentages would be, or is it an engineering question?

A It is more of an engineering question.

Q It is more of an engineering question?

A Yes, sir.

Q Then we will take that up with the engineers. Now, you testified as to the presence of Breccia?

A Yes, sir.

Q Now, the mere fact that breccia is or is not found in a core, is that any indication as to whether a fault does or does not exist in the immediate vicinity?

A No.

Q In other words, it isn't a matter to even be considered in trying to determine whether or not a fault exists, in your opinion?

A Yes, that is right.

Q All right. Now there has been some indication here in testimony that you just decided a definite fault existed between the two Oil Development Company wells at a late date, yesterday?

A Yes, sir.

Q But did you, when you made your study and before consulting, before having a chance to examine the results of the data obtained b y Oil Development, was it your opinion or not that some definite geological unconformity exited in that area?

A Yes, due to the fact that we have such a steep dip, west dip there.

Q In other words you had determined through your studies that a steep dip did exist there?

A Yes, sir.

Q In your opinion at that time it could very easily have been a fault?

A Yes.

Q And after examining data made available to you by Oil Development, you were convinced in all probability a definite fault existed?

A Yes, sir.

FURTHER CROSS EXAMINATION

By MR. HANNERS:

Q Mr. Ray, there was an application filed in this case some months back by the Santa Fe Pacific and the Oil Development Company, and with it there was an Exhibit marked Exhibit A. I am going to hand it to you and ask you if the red line drawn on that map could represent the fault you have drawn on your map?

MR. McKELLAR: Mr. Chairman, before that Exhibit is tendered to the witness, I would like to have one issue clarified. I don't think that Exhibit was entered in this case. I think it was an Exhibit tendered by the Oil Development Company in an application for exception to the spacing rules. Unless it is part of the case, I object to it being tendered to the witness.

MR. SHEPARD: Was it entered as an Exhibit in the last hearing?

MR. IDEN: I was just using this for my own information.

MR. HANNERS: The file discloses this map in it.

MR. McKELLAR: I don't recall that ever being entered in this case. It is the map which the Oil Development Company entered in their application for a spacing rule in order to obtain their 2-27 well . I don't think the record will indicate it is part of this case.

(Off the record.)

MR. SHEPARD: It is about noon and I think we can adjourn. We will stand in recess until 2:00 o'clock.

(Noon recess.)

MR. SHEPARD: The meeting will come to order.

MR. DOW: Mr. Chairman, I want to say this at the outset, that all of us here appreciate the pressing engagements of the Governor and appreciate his coming over this moring.

I have talked it over with all counsel and if at any time the Governor feels he ought to be attending to other business, it is perfectly agreeable with us to proceed before the other two commissioners. We wanted you to feel free in that respect.

GOVERNOR MECHEM: Thank you, sir.

MR. DOW: We know you would anyway, but we wanted you to know our feelings.

GOVERNOR MECHEM: Thank you. I am jumping from water to oil today.

MR. SHEPARD: Mr. Hanners I believe you were cross examining.

MR. HANNERS: No further questions.

MR. SHEPARD: You may call your next witness, Mr. Crocker.

MR. CROCKER: First, we would like to formally tender the Exhibits 1 through 8 inclusive offered by Mid-Continent Petroleum Corporation. I would like in connection with the physical Exhibits that are before the Commission to make a suggestion, if it is agreeable, that after these Exhibits shall have served their purpose, the full purpose of the Commission and of Mr. Hanners, we would like to have the privilege of withdrawing them and taking care of them because they are originals and cannot be duplicated.

We would very much prefer to keep them in our custody after they have completely filled their purpose.

MR. SHEPARD: They can be returned.

MR. CROCKER: Will Mr. Spurrier then advise us when we might pick them up and take them?

MR. SPURRIER: Yes, sir.

MR. CROCKER: All right, thank you. Mr. Ray, I believe you are excused unless the Commission says -

MR. SHEPARD: You may call your next witness, Mr. Crocker.

FRANK PURDUM,

having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. CROCKER:

Q Your name is Frank Purdum?

A Yes, sir, my name is Frank Purdum.

Q Mr. Purdum what is your profession?

A I am a petroleum engineer.

Q Are you a registered engineer in any State?

A I am a registered engineer in Oklahoma also in the State of Texas.

Q Do you operate an engineering company?

A Yes, own and operate a subsurface engineering company. We specializae in oil well testings.

Q How long have you been in the business of testing oil wells?

A 15 years more or less.

Q Mr. Purdum, has your firm, under your supervision and direction, tested any of the wells drilled by Mid-Continent Petroleum Corporation in the Crossroads pool?

A We have conducted tests on the Mid-Continent wells in the Crossroads pool.

Q Will you describe to the Commission what type of tests you have made?

A We measured the amount of oil and gas produced. We measured the bottom hole pressure in the well, both with the wells flowing and with them shut in.

Q Will you tell the Commission please how you go about testing an oil well for the bottom hole pressure and how you measure it?

A Our method is to actually run an amerada instrument into the well, bottom hole pressure recording instruments, it records the pressure at the bottom of the well. Naturally, if the well is flowing it would record flowing bottom hole pressure. If the well is shut in, it would record the static pressure.

Q Mr. Purdum, would the results of your work on the Mid-Continent wells indicate any trend with respect to bottom hole pressure.

A Yes, there was a distinct trend in the field as shown by these tests. There was practically no change in bottom hole pressure in the wells from the - in the reservoir rather - from the original test we ran on the U. D. Sawyer A-1 in the middle of 1948, until the test we ran in February on the U. D. Sawyer C-1. There has been practically no change in the shut in bottom hole pressure.

Q When did you make those tests?

A We have conducted those tests from the time shortly after the first well was completed in the field which was some time in the middle of 1948.

Q When was the last one?

A The last test was in February of this year. That was on the recently completed well, the C No. 1 well.

Q Yes, sir. What importance or significance is the fact that there has been no appreciable loss in bottom hole pressure during the four and ahalf or three years you have had the reservoir under observation?

A The significance of the fact there has been very little change in pressure, practically no change in pressure, indicates a very active water drive present in the field.

Q Did you conduct any other tests?

A Yes. We conducted other tests in the field. In order to determine if there was communication through the reservoir between the wells.

Q How do you do that?

A In this particular instance, we shut two of the wells in - I am talking about two of the Mid-Continent wells, the U. D. Sawyer D 1 and the Dessie Sawyer No. 1 wells. We shut both of those wells in and ran several - a series - of bottom hole pressure tests until the maximum pressure was recorded by our instruments. That would be maximum standard pressure. We then left one of the wells shut in and flowed the other well and measured - ran the bottom hole pressure test on the well left shut in until we found a distinct drop in bottom hole pressure in the well that was - that remained shut in.

Q Does that mean you first shut in both wells or all wells you were testing to get the pressure stabilized or to an equilibrium?

A Yes, that was the idea, to have some stable pressure to start from so that when we would denote the drop in pressure in the well that was still shut in, that it could only be from the effect of flowing the other well.

Q You opened one well and had a recording gauge in the bottom

of the shut in well?

A Actually didn't leave the recording gauge in all the time during the test. It took sometime. We withdrew the instrumen and ran it back in at different times.

Q After you conducted that operation, what was the result under your interpretation?

A The result was that we did detect a drop, a measureable drop, in bottom hole pressure in the well left shut in.

Q And when one well was opened and flowing?

A Yes.

Q What do you conclude from this drop of pressure that was recorded on the shut in well while the other well was flowing, what did that indicate to you?

A To me it indicates, and I think it is conclusive, that the wells are pressure connected through the reservoir, and they can be actually flowing oil from one well to the other across that distance.

Q Well, is the drop in bottom hole pressure in the shut in well due to the flowing - due to the other well flowing - does that have any special significance in the reservoir? I guess you have just answered that question unless you care to further amplify it.

A There is a special significance in this particular reservoir due to the high permeability. There isn't much drop in the well that is flowing. The difference between the shut in and the flowing pressure isn't much. And it is of special significance in this test that we did detect the measureable drop in bottom hole pressure due to the large permeability. It designates a very free flow. That is, between the wells much larger than otherwise would be designated.

Q Well does the result of the test indicate to your mind that the order originally issued by this Commission, No. 779

fixing a spacing as on the basis of one well to 80-acres was a proper Order, that the reservoir now lends itself to the conclusion that was a proper Order, and that one well will in fact adequately and efficiently drain the recoverable oil from a tract equivalent to 80 acres?

A Yes, these tests show that a well in this reservoir can drain even more than 80-acres. It shows relatively free movement of reservoir fluid between the wells. It also shows that there is an active and forceful water drive that has maintained the bottom hole pressure, and this natural drive should flood the reservoir in a natural manner and allow the present wells to produce substantially all of the recoverable oil.

MR. CROCKER: Thank you. I believe that is all from this witness.

CROSS EXAMINATION

By MR. HANNERS:

Q Mr. Purdum, how much was the drop in pressure you spoke of in the well that was shut in?

A The drop in pressure sir?

Q You said you had two wells shut in, and opened one and observed the drop in bottom hole pressure in the well shut in. How much was that?

A It was ten pounds.

Q Ten pounds?

A Yes, sir.

Q Ten pounds out of how much pressure?

A Something over 4800 pounds.

Q It dropped ten pounds out of 4800?

A Yes, sir.

Q Now, did you take any other tests on any other wells up there?

A At that particular time?

Q Yes.

A During the interference test I mentioned?

Q Yes.

A No. The other two wells were pumping, and the C well wasn't completed at that time.

Q You based your test on the Dessie Sawyer in the northeast of the southwest and the U. D. Sawyer well D-1 in the southwest of the northeast?

A I am not thoroughly familiar with the location but it was the Dessie Sawyer - it was the Dessie Sawyer and the U. D. Sawyer 1-D. Those were the two wells that we tested at that time. Now, I suppose you are still referring - you see we ran quite a few tests in the pool. Now, you are talking about the interference test, am I right, sir?

Q Yes. Did you run any other similar interference tests?

A No. These were the only two we could run at that time. There were no other wells available.

Q And about all that test showed is that you had a drop of ten pounds out of 4800 pounds bottom hole pressure?

A That is right.

Q And from that you conclude that 80-acres would be efficiently drained by one well?

A That and the other test we ran. You see we have run tests in the field since 1948.

Q Do you have the evidence or the reports of those other tests that you ran, Mr. Purdum?

A I don't have the tests with me, no, sir.

MR. HANNERS: That is all.

MR. MCKELLAR: I have one question I would like to ask.

By MR. McKELLAR:

Q The fact that this bottom hole pressure in the well shut in in your interference test, Mr. Purdum, the drop was only ten pounds from the original bottom hole pressure of approximately 4800 pounds, is it your opinion this drop of ten pounds could have only been occasioned by the fact that oil was being drained from around the closed well by the well which was open, at least fluid was being drained?

A That is right. Ten pounds in our instruments with the meters we use is a measurable amount. There is no mistaking the fact that you can detect ten pounds. In fact, we can detect less.

Q In other words, fluid was being withdrawn from the area around the closed well by the well that was open? There was inter-communication between the two?

A There is no question in my mind.

MR. McKELLAR: Thank you sir.

MR. SHEPARD: Any further questions? If there are no further questions, you will be excused.

(Witness excused.)

MR. SHEPARD: The next witness, Mr. Crocker.

M. B. PENN,

having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. CROCKER:

Q Will you please state your name?

A M. B. Penn.

Q Mr. Penn what is your profession?

A Petroleum Engineer.

MR. HANNERS: Mr. Crocker, we will admit the qualifications of Mr. Penn.

MR. CROCKER: All right.

Q Mr. Penn were you a witness as a petroleum engineer before this Commission at the hearing conducted on November 21st in this particular matter?

A Yes, sir.

Q I am going to ask the reporter to please identify this. I hand you Mr. Penn what has been marked as Exhibit 9 of the Mid-Continent Petroleum Corporation and I will ask you to please tell the Commission what it is, what it means, and give us an interpretation, if you will please.

A The information shown on this Exhibit is what is commonly called in the oil business performance curves. These curves were prepared under my direction and set out the data on all the wells that produce from the Crossroads-Devonian pool. This set of curves might look complicated at first glance, but I would like to explain and point out the simple facts they set out. The heavy line in the middle portion of the sheet is the daily average production. You can see that the daily average production started in May 1948, when the discovery well was drilled.

MR. McKELLAR: That is daily production of oil Mr. Crocker?

THE WITNESS: Yes, that is oil. A curve immediately above merely denotes the time at which each of the completed wells, each of the oil wells was completed. And you will see that in the early part of 1949 when the Magnolia 1-C and the Mid-Continent Dessie Sawyer wells were completed the production curve increased from about 200

barrels a day to about 500 barrels a day because of the two new wells. Then in the later part of 1949 when the one D-Sawyer was completed, the production increased from approximately 500 barrels a day to about 750 barrels a day. Nothing of any significance happened then to the oil production until the Magnolia well and the Mid-Continent discovery well were put on the pump in the early part of 1950. In the latter part of 1950 the Oil Development well was completed and increased production to 1200 barrels a day. Our well 1-C was completed in the later part of last month, and its increase in production is not shown on this curve.

But in the month of March the allowable at 350 barrels per day, the production of oil in the field had increased to about 1600 barrels a day. That will bring the curve up to something like this as I have shown with the red line. Now the lower curve on the sheet is an explanation of the water production. And the water production increased rapidly when Magnolia and Mid-Continent put their two wells on the pump. The dotted lines show the cumulative amount of oil which gradually increased throughout the life of the field on up to the present time.

There is 655 thousand barrels produced from the field. The most significant data on this sheet is the pressure curve at the top of the page. Tests were made by Mr. Purdum's firm. The fact that the bottom hole pressure curve is practically a straight line, inasmuch as that is the ideal condition you can have in a reservoir, when bottom hole pressure declines you are running out of energy. The amount of energy is decreasing rather. The fact that we have had a constant and steady bottom hole pressure in this field is further proof of the fact that we have an effective water drive which will produce the maximum amount of oil from the reservoir.

Q Now you have analyzed the Exhibit Mr. Penn. Have you given all of the conclusions or observations you care to make with respect to that Exhibit?

A Yes.

Q May I ask whether or not since the hearing was had

November 21st and the work that Mr. Purdum has done in conducting pressure surveys since that time, are you still of the same opinion you were at the time you testified in the case to the effect that in view of this water drive condition that one well will adequately and efficiently deplete the reservoir on an 80-acre pattern, as authorized and provided and ordered in the Commission's Order No. 779?

A It is most evident and easily understandable why that is true. All the data that we have been able to take on this field, such as the mechanical arrangement of the permeability, you might call it, in the cores; the fact that the porosity is cavernous; and the fact that the porosity isn't a matter of the space between sand grains or the space between small crystals; the fact that we have an active water drive without any bottom hole pressure decline, and most of all the fact that the interference test Mr. Purdum has described depict the actual communication between the wells by actual pressure measurements that show the effect this cavernous porosity has upon the reservoir we are dealing with here. Whenever an engineer tells the layman that here is something very unusual, I can understand that the layman might think that is just the way of convincing him of something. But in all fairness and in all truth, I say this is a most unusual reservoir. Mid-Continent Petroleum Corporation would be highly pleased if all of the reservoirs they produce had an effective water drive such as this one, and a cavernous porosity, and an infinite permeability, so that we can produce the oil without having to inject any gas or water, as we do in many reservoirs; not only to get an appreciable amount of oil out, but even to make the wells pay out.

Q Mr. Penn the testimony you have given, does that relate generally speaking, to the entire Devonian reservoir? You are not speaking of just any specific particular well or tract? Your testimony covers the entire reservoir?

A Yes. These data are made up from the information which has been furnished us on the Oil Development Company - Santa Fe well and the Magnolia well and our own well.

Q Are you now, so far as any observations are concerned

pertaining to the reservoir - if you will, I would like to ask you if you know how many tons of steel is employed in each of these producing wells in the Devonian reservoir, approximately, if you know?

A I believe it is approximately 200 tons.

Q 200 tons of tubular goods in the -

A Yes.

Q Now, Mid-Continent drilled a dry hole southwest of the discovery well. That well I understand has been plugged and abandoned?

A Yes.

Q Can you tell the Commission how much steel was recovered from that operation, and how much steel is left or buried or beyond recovery that must remain in that dry hole?

A I would estimate that approximately half of the s teel remains in the well.

Q 100 tons of it?

A Yes, sir.

MR. CROCKER: Just a minute please.

(Off the record.)

MR. CROCKER: I believe that we are through with Mr. Penn.

MR. SHEPARD: Mr. Hanners.

CROSS EXAMINATION

By MR. HANNERS:

Q There is one matter you testified about at the earlier hearing that Mr. Crocker did not question you about and I wonder if you have any of the dollars and cents figures as

to the pay out of the wells to supplement the information you had in November?

A Yes.

Q Hasn't the Dessie Sawyer well paid itself out since we had the hearing in November?

A I believe within a very few dollars the Dessie Sawyer and the D-1 well - at this sitting - I believe you can say those are paid out.

Q And you have had about the same monthly return of pay out since November that you had had up to that time on the other well?

A Except for the slight increase in allowable.

Q So the picture is a little bit better now than it was in November?

A Yes.

Q The two wells that have been paid out are the Dessie Sawyer well that started production in February of 1949?

A That is right.

Q That showed a total cost of 444 some odd thousand dollars?

A I believe I gave you the figure at the last hearing.

Q And that has been recovered and 24 more?

A The well is now paid out, and I gave you the information at the last hearing. I don't have it before me right now. I can get it if the Commission wishes.

Q The U D Sawyer began production in August 1949?

A The U D Sawyer 1-D.

Q And you showed costs there of $344,000, which has been

paid out in 17 months of operation, hasn't it?

A The well is now paid out, yes.

Q Now, you spoke of tests that you had - through a period of time. What additional data or information have you prepared to submit to the Commission about those matters since our hearing in November?

A I intended to present nothing more to the Commission about those. I have the data up to February the 1st which as I said a while ago, if you wish to cross examine about -

Q Since the hearing in November you did submit one Exhibit to the Commission by letter, didn't you Mr. Penn?

A Yes.

Q What was that Exhibit?

A During the last hearing, Mr. Spurrier asked me if I had any core analyses. I replied that I did and I would be glad to send him copies of those analyses which I did shortly after the hearing.

Q On what well do you have the core analysis?

A I sent him a core analyses of cores taken from the Dessie Sawyer well which were quite complete. And I sent him a core analyses of cores taken from the 1-A well, which was the discovery well.

Q How many cores were analyzed in the tests on the Dessie Sawyer well you put in your report?

A To my knowledge about 20.

Q And how many completed on the D well?

A Three.

Q Now did that report you submitted show any additional

variation in permeability?

A Yes.

Q How wide a range did it show?

A I believe the permeabilities exhibited were from practicall zero to in the neighborhood of four or five thousand millidarcs.

Q How do you account for the wide variation?

A May I show the Commission with one of these cores?

Q Surely, speak freely.

A In the first place I would like to say that permeability is the measurement, the arbitrary measurement, of the ability of a fluid or of air to move through rock. The high permeabilities were obtained by the cavernous material here. The high permeabilities measure the actual ability of the oil to move through this reservoir because the oil is in the cavities. Now, the low permeabilities were in materials such as you see right here. (Indicating an Exhibit.) That is as hard as your front steps. Nothing is going to move through that. So that the low permeabilities depict the rock that contains no oil, or if it did, it couldn't get out. And the high permeabilities explain the ability of the oil to move very freely through these cracks and vugs and holes you see through here.

Q Now, Mr. Penn in order to advise the Commission as to the permeability throughout the reservoir you had made similar tests from all the wells, didn't you?

A No, I didn't. A lawyer might but an engineer wouldn't.

Q The only Exhibit you have submitted is from 18 or 20 cores from the Dessie and three from the U D Sawyer D?

A Those are all the core analyses we have. If we had more, I would be glad to give them to you. It is quite expensive to obtain these cores. You don't just send the bucket down and get them. You have to work for them.

The management decides whether they will core or not core, and that is the reason we don't core every one.

Q You spoke of the permeability as being that quality in the rock which permitted fluid to pass through it. What becomes of the oil in the rock where there isn't great enough permeability to permit it to move through? Is that oil ever recovered?

A In any recovery that Mid-Continent ever made that was produced by normal methods, nobody ever recovered all the oil. If he mined the stuff he couldn't and took it out with a spade.

Q What percentage of oil in this reservoir would be recovered from such wells as the ones from which you took these cores?

A The engineers more or less commonly agree that a water drive reservoir, such as this one, that 60 to 80 per cent of the oil will be recovered?

Q Then there would be 40 to 20 per cent of the oil left in place?

A That is correct.

Q Now in speaking of the water drive pressure, would it by-pass some oil in place through the rock as it creates the energy that operates the fluid?

A I am not aware of your definition of by-passing.

Q Well, I don't have a technical way to describe it other than to say this. Will the water drive leave some oil in place as it passes through?

A I think I have already testified to that.

Q Is that about 60 to 80 per cent recoverable oil that you have referred to?

A The water drive produces 60 to 80 percent of the oil in place. That is called recoverable oil. The oil that is produced.

Q Now in the Sawyer well where you plugged back up to a higher zone, had you recovered 60 to 80 per cent of the oil in place -

A (Interrupting) Mr. Hanners, I am speaking of the reservoir as a whole.

Q I am speaking of the Sawyer well. Did you recover that same percentage of oil out of this formation -

A (Interrupting) In what volume are you speaking?

Q In the A-1 well have you recovered 60 to 80 per cent of the oil at the time you pulled up above the area from which you took these cores?

A We took all oil out of the well. Now, what area around the well are you talking about?

Q Mr. Penn, have you attempted to draw the limits of this Devonian reservoir - I mean the outside limits, such as one of the other witnesses has on his map?

A No, I haven't.

Q You do not have an Exhibit similar to the one introduced by the first witness that you have prepared showing the northern limits of the field?

MR. CROCKER: Isn't that a geological question, Mr. Hanners? Don't you think it is a geological question?

MR. HANNERS: I will leave it to the geologist if this witness is not able to answer it. Will the Commission permit me just a moment.

(Off the record.)

Q Mr. Penn, over what distance in footage did you recover the oil through the A-1 well horizontally?

A I don't know.

Q Do you know over what distance in footage any of the wells

are recovering the oil?

A No, I don't.

MR. HANNERS: That is all.

MR. SHEPARD: Any further questions.

BY MR. McKELLAR:

Q Mr. Penn, you testified that a number of those wells have - a number of the Mid-Continent wells, - drilled through this Devonian formation have of course paid out. But the subject matter before the Commission is the Crossroad-Devonian reservoir. We are not particularly interested in any one of Mr. Sawyers wells or the Santa Fe wells. We are dealing with a reservoir problem. Has this Devonian reservoir paid out?

A No, it hasn't.

Q It hasn't? I have one other question or two. Have you furnished the Commission with all the data which Mr. Spurrier requested at the November hearing?

A I am under the impression I have.

Q And you are now in a position, I take it, to furnish the Commission with any additional data which you have available and which you can obtain that they might desire before they render an opinion in this case?

A Definitely, yes

Q The fact of the limits, productive limits, of the Crossroads-Devonian formation, is that a geological or engineering question?

A I hope it is a geological question. I haven't prepared anything on it.

Q That is the reason you haven't taken this up, is that right?

A That is right.

Q I have one other question. You testified in your opinion this reservoir being an active water drive with practically unlimited permeability and in all probability will recover something between 60 and 80 percent of the recoverable oil in place -

A I would like to correct that statement. It will recover 60 to 80 per cent of the oil in place.

Q That is correct. Which will mean we must leave under our present methods of operation approximately between 20 and 40 percent of the oil in place?

A That is correct.

Q Which we will not be able to recover under primary means?

A That is correct.

Q How does that compare with the amount of oil which would have to be left in place in reservoirs which didn't have this type of permeability and didn't have water drive, for instance in a gas expansion field?

A If the oil were to be lifted to the surface in such a field as this by only the dissolved gas - of course, we have to assume there is more gas dissolved in the oil than there is here -

Q I am assuming this is a gas cap oil-gas expansion, any type other than water drive?

A In such fields we have recoveries from 10 to 40 per cent of the oil in place recovered.

Q In other words, the performance which you anticipate in this reservoir is just about as good as the know-how of the oil industry is able to make it?

A It is the most efficient.

Q This is an ideal situation?

A This is, yes.

MR. McKELLAR: That is all I have.

MR. HANNERS: I have one further question, Mr. Penn.

A Yes.

BY MR. HANNERS:

Q Have you made a study to determine the ultimate pay out of this reservoir?

A Ultimate pay out?

Q Ultimate recovery to be obtained from this reservoir?

A Yes.
Q Have you a report on that?

A No I don't. Those are confidential figures, Mr. Hanners, and I believe the Commission will recognize in the face of the federal tax picture and other things -

MR. McKELLAR: This will get into the ad valorem tax picture, sir. If we knew how much oil we had under the acreage, we could be taxed.

MR. HANNERS: Isn't that what we need to know in order to properly consider the matter before the Commission?

THE WITNESS : No, it has nothing to do with it. We are talking about only one thing, and that is the ability of the wells already drilled to produce all of the recoverable oil from the reservoir, and we had testified they will do it. The tax picture nor the profit picture nor anything else has anything to do with it.

Q Did you have a report prepared just recently as to the productivity index for each of the wells in that field?

A Yes, sir, I do. I furnished the Commission with that, Mr. Hanners,in the hearing on the A-well.

Q You haven't had that prepared since then?

A No, no more reports.

Q And that is based only on the A-1 well?

A Yes.

Q Have you made them on the other wells?

A Yes.

Q Have they been submitted?

A No.

Q Do you propose to?

A No. We will, if the Commission asks. They are substantially the same. They range from three to forty pounds per day pound drop. The Commission has asked for static bottom hole pressures and we have furnished those. One other thing I would like to say Mr. Hanners. You are inferring here something I don't like a bit.

MR. HANNERS: Feel free to speak, Mr. Penn.

A I don't like anyone to infer we keep anything secret from the Commission. We have never kept anything secret from the Commission. We have run additional tests since this last hearing and we have furnished them to the Commission. There is nothing secret from the Commission in the way of reservoir data.

MR. HANNERS: I am not inferring that at all, Mr. Penn. That is all I have.

MR. SHEPARD: We will take a five minute recess.

(The record may show Exhibit 9 was formally

tendered in evidence by Mr. Crocker.)

MR. SHEPARD: You have another witness, Mr. Crocker?

MR. CROCKER: That closes our case. I believe Mr. McKellar has something.

MR. McKELLAR: I would like to call Mr. Jim Puckett. He is our District Engineer for the Kermit District, and the previous record in the case will show, in which he has testified, that he is qualified and this is one of the pools in his territory and the record will show Magnolia has one well, being our Santa Fe Pacific well, completed in January, 1949.

JIM PUCKETT,

Having been first duly sworn, testified as follows:

DIRECT EXAMINATION

By MR. McKELLAR:

Q Mr. Puckett, will you please review the production history of our well?

A The Magnolia Santa Fe Pacific C-1 was completed in January 1949 and flowed initially clean oil, and within a couple of days started making water, some 20 to 25 per cent, and continued to flow for approximately 8 months, after which time it was put on the pump. The water percentage has continued to increase, and as of January, 1951, the water percentage was somewhat in excess of 50 per cent. I believe the daily average production from the well for January is 150 barrels of oil and 193 barrels of water.

Q 150 of oil and 193 of water?

A That is correct.

Q Have you made an engineering study of this Crossroads-Devonian reservoir on the, based upon the data, obtained from wells other than the -

A I have made a study of the data that has been presented to the Commission.

Q In your opinion from your studies, what is the principal type of drive mechanism present?

A It would be very definitely a strong water drive.

Q Please explain to the Commission upon what you base your answer to the last question.

A The bottom hole pressure history primarily. There has been no decline in bottom hole pressure as shown by the Exhibit No. 9 presented by Mid-Continent. There isn't enough gas in solution in the oil to be of any benefit as a producing mechanism in this reservoir. The only source that is available is the water. And the bottom hole pressure history will bear that out.

Q As I understand your answer, there is two things; one: a constant bottom hole pressure and the fact that there isn't just sufficient gas present to indicate either a gas expansion cap or any other type of mechanism?

A The bottom hole pressure history primarily, or of course the fact that there isn't sufficient gas present.

Q From your studies Mr.Puckitis it your opinion one well will efficiently and adequately drain 80-acres in this reservoir?

A It is.

Q Is it further your opinion the wells presently producing from this reservoir will efficiently and adequately drain this reservoir?

A It is.

MR. McKELLAR: I have no further questions.

CROSS EXAMINATION

By MR. HANNERS:

Q As a matter of information, Mr. Puckett, was your C-well drilled above the water table as shown on Mr. Ray's chart?

MR. McKELLAR: We weren't furnished with a copy of Mr. Ray's chart I don't think.

A The chart there shows the top of the Devonian at minus 8191 and Mr. Ray shows the water datum as minus 8200.

Q Where is the bottom of your well?

MR. McKELLAR: Our well is bottomed at 12,257.

Q Using your minus figure again?

A This Exhibit shows the total depth as a minus 8233. That information was in the previous record. I don't have it immediately available. I can get it.

Q Your well was clean and free of water when you completed it wasn't it?

A It produced a couple of days.

Q In a couple of days it made water?

A Yes.

Q But when you completed it there was no water at the time?

A To the best of my knowledge there wasn't.

Q Now what is the direction of that water drive, what is the source?

A The source of the water drive?

Q Yes, sir, directionally.

MR. McKELLAR: That is primarily a geological question, but I have no objection to my witness answering it if he has made a study of it.

A The source of the water drive is the aquafer, the water

surrounding the structure.

Q Where is the water coming from to the 1-C well?

A The Devonian Reservoir.

Q But from where, the south, the east, or below?

MR. McKELLAR: I am going to have to object to that question. It is a geological question.

MR. SHEPARD: He may answer the question if he knows

Q If you know - I want to be fair with you.

MR. McKELLAR: The point I want to point out is that this particular data isn't the subject of this man's study, and of course for that reason it is highly probable he hasn't made a study.

MR. SHEPARD: He might state if he has.

MR. McKELLAR: Speak up Jim if you have and if you know, answer it.

A State the question again.

Q Where does the water come from you find in your 1-C well?

MR. McKELLAR: You mean the direction?

MR. HANNERS: Yes, sir.

A I wouldn't know.

Q Unless you knew the source of the water drive, you wouldn't be familiar with this whole reservoir would you?

A You say source and then you say direction.

Q I mean the same, directionally?

A The source is as I stated, the aquafer, surrounding the reservoir.

Q But unless you know the direction -

A I don't see that it makes any difference which direction it comes.

Q Do you know the direction?

A No, sir. I know it gets there.

Q Do you know whether it comes in horizontally or vertically?

A No, I couldn't state definitely.

Q Do you know where the water comes from that is found in the Sawyer A No. 1 well?

A I would say it came from the same source, the aquafer surrounding the structure.

Q But directionally?

A No I don't know the direction.

MR. HANNERS: That is all.

REDIRECT EXAMINATION

BY MR. McKELLAR:

Q Mr. Puckett does the direction from which this water comes make any difference so long as the water is there and the bottom hole pressure is maintained, and will the direction from which it comes make any difference to the real issue as to whether or not one well will effectively and adequately drain 80-acres?

A I can't see it would.

Q It is your opinion the direction would make no difference?

A That is right.

MR. McKELLAR: That is all.

MR. SHEPARD: Any further questions.

(Witness excused.)

MR. SHEPARD: Call your next witness.

JOHN MAJOR,

having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. IDEN:

MR. IDEN: If the Commission please, Mr. Major and I also appear here representing the Santa Fe Pacific Railroad Company, which is an owner of mineral rights in the field, and the Oil Development Company of Texas which is an operator.

Q Mr. Major, will you state your name please?

A John Major.

Q And you testified previously at a previous hearing in this case?

A Yes, sir.

MR. HANNERS: we will admit the qualifications of the witness.

MR. IDEN: All right.

Q As a preliminary to what you expect to state here today will you give a little short general review of what you heretofore stated in order to connect it up.

A Yes, sir. At the previous hearing I testified concerning the history of the drilling and the completion of the Oil Development Company of Texas Santa Fe-Pacific Well No. 2-27, located in the southeast quarter of the northwest quarter section 27. The previous record shows that this well was acidized. I would like to correct this at this time. This well wasn't acidized, and it does flow by natural flow.

Following this I presented and explained as an Exhibit a graph showing the shutin and flowing bottom hole pressure behaviour of this well 2-27 during the period from November 4 to November 6th. This graph illustrated in my opinion the rapid adjustment of bottom hole pressure from flowing to shutin position, indicating a high degree of permeability. It is because of this interpretation that I wish at this time to correct the previous record to show that the well wasn't acidized, and that the pressure performance reflects the natural reservoir condition.

Q Now, Mr. Major, since the previous hearing what additional data or information, if any, can you give to the Commission?

A The Oil Development Company of Texas completed well No. 2-27 and a geologist analyzed our well cuttings. These well cuttings in size from 1/8 to 1/4 of an inch and are irregular pieces. The pay interval wasn't cored nor were there any electrical or radioactive logs taken. As a result of this we had no data to present on porosity and permeability as was previously asked by Commissioner Spurrier. We do have as additional information a graph showing the daily production performance of our producing well No. 2-27.

Now this graph isn't based on engineering data. It is based upon the field production inasmuch as recordings of daily production, using wellhead equipment; that is, the pressure gauges are not accurately calibrated.

Q Do you have several copies?

A Yes, sir, I do.

Q The graph which you have referred to has been Marked Exhibit 1 of the Oil Development Company of Texas and the Santa Fe Pacific. Will you please explain that to the Commission in such manner as you care to showing what it is intended to convey?

A Yes, sir. This is a fairly non-technical graph. Across the bottom of the graph I have months, and the little small squares each represent one day.

Now curve No. 1 which has a red index and is in solid lines, is the barrels per day that the well has produced. Curve No. 2, which is near the top of the page, is a dotted line with an orange index and it shows the choke and the restricting devise fittings and 64th of an inch that were used to obtain the production as shown in curve 1 .

Curve No. 3 which is a dash line and has a blue index, shows the resulting gauging and casing pressure. The two read approximately the same. They may vary ten or 15 pounds but read about the same. It shows the flowing pressure which results through this well's restriction on the choke size and with the daily production. Curve No. 4- it is dotted down at the bottom of the sheet - it merely shows the cumulative production of oil from the well.

MR. IDEN: We offer in evidence as part of the witness's testimony Exhibit No. 1.

MR. HANNERS: No objection.

MR. IDEN: Do you have anything else, Mr. Major, you wish to give to the Commission?

A Yes. Commissioner Spurrier asked opinions as to the direction of the water drive in this field. The Oil Development Company of Texas has previously testified that in their opinion the field is limited to the west by a fault. It is my opinion therefore from the known data that the water drive doesn't come from the west, but maybe from the north, the east, the south, dependent upon the effect of this water body or aquafer that surrounds the reservoir. In this morning's examination there appeared to be some question as to the exact location of this fault to the west. It is the opinion of the Oil Development Company that this fault bisects the abandoned Mid-Continent B well and lies closely adjacent to the abandoned Oil Development Company well No. 1-27 The reason that at this time we place fault close to 1-27 is based on the crooked hole in well 1-27 below the depth of 10,500 feet. In drilling this well we carried very little weight on the bit in these lower depths, but it was impossible to drill a straight hole in the well. The deviation from vertical in this well was approximately - it varied - it was about 5 degrees. I don't have the well records with me.

I am recalling that. But I believe up to 5 degrees because that was the limiting factor on the drilling contract, and he was very worried about the crookedness of the hole. I would like to explain this particular action a little more fully. In the lower part of this well, as I say, we carried very little weight, very few drill collars, and tried all speed and revolutions, and tried to get the hole to straighten up, but it couldn't be done. Somedays the drilling contractor cut as little as 20 to 23 feet. As I say, this came up this morning. I would like to show the Commission the way it was shown to me by the driller how this particular action works. Now if you will assume - would you like to see this Mr. Hanners?

MR. HANNERS: That is all right, keep your seat.

A If you will assume this rubber eraser on this pencil is the bit, and the pencil is the drill part, and you have your control clear up here two miles away, you twist this bit and the bit has sharp edges. The main cutting force is to the outside of the bit, the center of it having a pulvurizing action. It has a tendency to walk in a clock-wise direction, which is normal in drilling operations. But now when you come up against a fault - (off the record) when you come up against a sloping plain or fault like that, your bit edge digs in to the edge toward the fault and it has a tendency to walk up like that (indicating and illustrating with the pencil) climb. That is the reason behind my present placement of this fault near well 1-27.

Q Do you have anything else Mr. Major or does that conclude what you had in mind?

A I believe that is all.

Q What you have stated here today together with what you have heretofore testified to in this case, so far as you know that gives the Commission what the facts are which you believe pertinent to the matter?

A Not all of them that are pertinent, but all that we have.

Q I mean pertinent to the Commission?

A All that we have, yes, sir.

MR. IDEN: I think that is all.

MR. HANNERS: We have no questions.

MR. SHEPARD: If there are no further questions, you will be excused.

(Witness excused.)

MR. IDEN: That is all we have.

MR. DOW: I wish to place in the record a letter from the Phillips Petroleum Company that was written in connection with this hearing to Mr. Spurrier.

(Marked Exhibit 1 Dow.)

And I wish to place in the record a statement by Mr. Cecil Buckle of Sinclair who was obliged to leave yesterday He desired I place this statement into the record, because the record as written of the former hearing wasn't exactly clear to him and he wanted to clear it up. I won't take the time to read them to the Commission. Just put them in. That I guess is our case.

MR. HANNERS: If the Commission please we have a petroleum engineer to put on the stand to discuss this matter with you.

MR. SHEPARD: You may proceed.

R. U. FITTING,
having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. HANNERS:

Q Your name is R. U. Fitting?

A Yes, sir.

Q You reside at Midland, Texas?

A Yes, sir.

MR. McKELLAR: We will waive the qualifications of Mr. Fitting as a petroleum engineer.

A I am also a consulting geologist.

Q Have you been engaged in that practice for some years?

A Yes, sir, about 18 years.

Q And have an extensive practice in it? Mr. Fitting, have you devoted your attention recently to a study of the Crossroads-Devonian field so that you would be in a position to testify before the Commission about the matter today?

A Yes, sir.

Q Will you explain generally the manner in which you have proceeded to that qualification?

A My immediate study of the Crossroads field has been confined to the last ten days, during which time I reviewed all records that had been placed before the Commission and all of the data that has been here submitted. I have also made a study of the well records and well history. The production of water and the production of oil in the field The bottom hole pressure records that are available in the Commission's files. I found in the file, in the Commission' file, covering the exception by Oil Development Company, the map that had been submitted by Mr. Major in November and also a cross section of the field and 20 of the core analyses submitted by Mid-Continent, and I found productivit index data on the Oil Development-Santa Fe Pacific 2-27 well and the Sawyer A-1, and I found in the transcript the costs of wells and the other matters that have been recited by the witnesses here today.

Q Have you reviewed all of the information contained in the files of the Commission relative to the first hearing in 1948 and the hearing in 1950 about the matter?

A And in addition the file or the record of November 1949, a hearing of the Oil Development Company and in addition I had all available electric and gamma ray logs in the field, and well completion practices and the study of production records, which isn't reflected by the Commission records from these hearings.

Q What is the matter we should take up first?

A I would like to refer to Mid-Continent's Exhibit 1.

Q That is the one the witness Mr. Ray had this morning?

A Yes, sir.

MR. HANNERS: Where is that map? Would you place it on the easel?

MR. McCORMICK: We all have copies.

THE WITNESS: I will just refer to it here.

Q Will you examine that plat and in your own way proceed to explain to the Commission the matters of significance as disclosed by that map?

A I will be glad to. We have all heard Mr. Major testify as to the existence of a fault to the west of their 2-27 well. I wish to point out that the difference in the top of the Devonian in the two wells that are located 1320 feet apart is on the order of 800 feet, and would require a dip in the nature of 35 degrees or over in the top of the formation were that to be explained without faulting. I certainly subscribe to the faultthat has been put there by the prior witnesses. I note though on this map that it is contoured without reference to the fault in that the minus 8200 feet datum is shown as the limits of the production of the pool. I also note that the two Pennsylvania producers to the north have encountered the Betenbaugh lime, which is some 2000 feet up the hole from the producing section at exactly the same point as two of the producers in the field. And I think it is an unfair interpretation to show this field is limited to the north by the present development. I have added up the top of the Betenbaugh lime in all the producers in the field, and added to it the interval between that marker and the top of the Pennsylvanian in all the producers in the field, and I feel that the top of the Devonian productive horizon in the 1 and 1-D wells, those Pennsylvania wells, would be minus 7916, which would be 215 feet above the total depth of the Magnolia 1-C, which was originally completed clean. Consequently, it appears that the limits of this pool have not been defined to the north, and furthermor, in view of the fact that there is a fault

on the west side of the field, there is every reason supposedly that additional faulting would be found in the area Whether it will be of sufficient magnitude to change the contours on the top of the pay, I couldn't anticipate; but it is a reasonable expectancy this field can be continued to the north. Another thing I would like to point out is that the original water table in this field must have been below minus 8243, which was the total depth of the Magnolia 1-C, Santa Fe Railway, and not minus 8200 as shown on this Exhibit, because that well, as testified to by Mr. Puckett, was clean on completion. It is my estimation of the well production from U. D. Sawyer 1-A of Mid-Continent or Magnolia's 1-C that the vertical fracturing which has been testified to and can be seen in these cores has resulted in the coning of water from the water which underlies this field and has resulted in the drowning out of portions of the pay section by that coning effect. The Commission must realize where there is two or three hundred feet of pay section available in these wells it is necessary the wells drain between wells a distance of as much as 16 or 1800 feet in order to completely drain your fields. Consequently, the reduced pressure permits water to come from below because of the shorter distances with greater ease than it does permit it to come from the edge of the field. I believe this covers my observations about this particular Exhibit.

Q Now have any other Exhibits been introduced to which you would like to direct your attention especially?

A No, I think not.

Q Now what matter would you next prefer to take up in your study of the field?

A One other matter that I was directed to by Mr. Hanners was the definition of waste as it is defined in the New Mexico Statutes, and as I read the Statutes, it states that all of the oil must be produced. It doesn't permit any avoidable physical waste. And I quite agree with Mr. Puckett when he states in none of these fields will it be possible to produce all of the oil. There is some unavoidable physical waste in the production of any oil field. The question is, how best can you produce the field so that you have the least of this unavoidable physical waste. It is my feeling that the

existence of vertical fracturing in this field permits the coning of the water table under each of these wells because of the short distance to the water of the greater number of outlets in this field. If we had wells one foot apart, those cones would be so intersected it would be a flat water table coming up and drowning out the wells. But where they are so far apart, as in 80-acre spacing, the wells would be drowned out before the full 80-acres ascribed to the well can be completely drained of its oil.

(Governor Mechem called from the hearing.)

Q Now Mr. Fitting what would be the consequence of the matter you have discussed in your last answer when viewed in the light of our definition of waste?

A I think that waste can be avoided by the drilling of additional wells.

Q Would waste result by the drilling of wells on an 80-acre pattern in the manner you have just explained by your last answer?

A Yes, it would.

Q Will you proceed with your explanation of the various factors which you have considered in arriving at a conclusion as to the proper spacing in the well pattern to be employed in this field?

A Since it is obvious wells can't be drilled in this field one foot apart because you couldn't get the return of the investment on the well, the question comes down to one of economics, and that is how many wells can you afford to drill with this type of reservoir. The economics that are demanded in order to know the answers to the question I don't find in the files and records of this field. I find only the cost of wells. I have made a calculation of the pay out of a top allowable well which would be on the order of 17 months, which 1 - D experienced. The question is how much oil would be recovered additionally by the drilling of additional wells. In my opinion the record of the U. D. Sawyer 1-A and the fact that so much of the section had to be abandoned because it was found to be water bearing and drowned out, is full evidence of what can be anticipated in the future on the other

other wells as the water level cones up into the well bores of these other remaining water free wells.

Q Are there any other matters which you have considered and about which you would further want to advise the Commission in arriving at your conclusion as to the proper spacing pattern in this field?

A The uniform development of a field of this kind is demanded by the fact that water can cone into the wells. The present spacing pattern in the field isn't uniform. Wells would be demanded at all of the forty acre points in order that there be equal distance between all of the wells that are in the proven productive area of the Crossroads pool.

Q Now would the uniformity of spacing them tend to minimize the damage caused by the water encroachment into the two wells on the south?

A Yes, indeed it would.

Q Would you explain this to us?

A The cones of water which rise in these wells would be uniform cones. They would intersect one another in such a manner that there would be a more uniform movement of the water table into the oil bearing section of this reservoir.

(Governor Mechem returns to the room.)

There is one other matter. The present 80-acre spacing order precludes the drilling of a well in the northwest of the northeast of section 27, which is immediately north of the Mid-Continent 1-D well. Now the Mid-Continent 1-D well encountered the top of the Devonian at minus 7810, or 423 feet above the total depth of a well that was completed clean and probably close to the water. And there is evidence from the indications of the upper markers in the wells to the north that that location would be productive of oil in the Devonian. At the present time the Mid-Continent is faced with having to get an exception to the 80-acre order in order to drill that particular location because the pattern location would be in the northeast of the northeast of section 27.

Q Now, Mr. Fitting, if a prudent operator as that term is ordinarily understood in the oil and gas industry, owned the lease on the north half of the northeast of Section 27 that would include, of course, the two locations you have just mentioned. If a prudent operator owned that lease, would he, with prudence, drill a well anywhere in that 80-acre tract?

A I certainly don't want to claim that Mid-Continent isn't a prudent operator, they definitely are. But if the operator owned that tract alone and didn't have a vested interest in the reservoir I believe he certainly would drill a well there because I think it would be productive. In fact, I think I can find somebody that would be happy to spend the money to drill that lease.

Q And in your opinion it would be productive in the Devonian formation?

A Yes, sir, and it is outside the limits as shown by Mr. Ray on his map. Thus you come to one other proposition this 80acre spacing results in, and that is incomplete development of the field because the pattern location doesn't look particularly attractive, and off pattern locations require an exception, and a company like Mid-Continent owns the bulk of the field, and don't care to get the off pattern location, or presumably so, and it results in the fact that we have the situation that the field, in my opinion, isn't completely developed.

Q Do you attach any significance to the fact that the Oil Development Company made an off pattern location on the well No. 2-27?

A I don't attach any significance except to the fact that the 80-acre must run north and south on the tract which is assig ned to it. Or assume that is the case.

Q Coming down to the south of the map in section 34, would a prudent operator owning a lease in the northeast quarter of section 34, conduct any drilling operation?

A I believe I would prefer to drill, if I proposed to drill the location, which would be the northwest of the northeast

quarter.

Q South of the A-1 discovery well?

A Yes, sir.

Q And would it be in the wrong end of our present 80-acre spacing?

A Yes, sir, it would be an unorthodox location, based on the fact that the present 80-acre order requires drilling in the northeast northeast.

Q Now are there any other things shown or indicated by this map that we should discuss?

A I think not.

Q Now what other matters have you considered in qualifying yourself to answer questions today as to what is the most workable spacing pattern in the Crossroads pool.

A I have no further comment to make except that I don't believe that the current pattern is getting the full recovery of oil from the field and that the 40-acre pattern will materially increase the ultimate recovery from the field, and the fact that a well will pay out in 17 months at top allowable, the question comes to one of economics as to whether the field will support this development. And in my opinion it will.

Q Is it your opinion that the 80-acre pattern now prevailing in the Crossroads field is conducive of the production of waste?

A It certainly is.

Q Is it your opinion the 40-acre pattern would afford a more orderly and acceptable and practical development of the Crossroads reservoir?

A And that less waste would occur under a 40-acre pattern than under the 80-acre pattern.

Q Can you think of anything else?

A No, sir.

MR. HANNERS: Your witness.

CROSS EXAMINATION

BY MR. McKELLAR:

Q Since you testified last as to the economics, and it is probably foremost in the mind of the Commission at the time you testified, since one well would pay out in a period of some 17 months, you thought that was a good indication the reservoir could afford additional exploration. If I misunderstood your remarks, please stop me. Is it your opinion that the Mid-Continent 1-C drilled in section 34 paid out in 17 months or is it your opinion that the Magnolia 1-C produced in section 26 will pay out in 17 months, or is it your opinion the Oil Development Company 1-27 will pay out in 17 months?

A I would like to take the question in two parts. First, I didn't quite say what you said I said. I merely said the top allowable well in this field will pay out in 17 months, now of course those wells which you have mentioned which are dry holes are not ever going to pay out.

Q Nor are wells on any low structure - or any of the low structure wells?

A There is a question about the Magnolia not paying out.

Q Not in 17 months?

A It might not give you an immediate profit but I understand at the present time it has produced 83,864 barrels, 88,560 barrels as of the end of January, and about 172,000 barrels will pay out a $350,000 well.

Q But you have neglected the operating expense which we have incurred for the past two years?

A In making that calculation I didn't. I assumed an operating

expense of $35.00 a day or ten cents a gross barrel.

Q I just simply want to point out while some of these wells have paid out in 17 months, it is certainly no indication that any well drilled within the reservoir will pay out in that length of time?

A I agree on that.

Q It must be a goodwell, a top allowable well?

A Yes.

Q Going back to the first of your testimony, you testified in your opinion the total limits of this reservoir had not been properly defined, and probably the structure map, which was introduced as Mid-Continent's Exhibit 1, could conceivably have erroneously shown this top productive limit, is that right?

A That is substantially correct, yes, sir.

Q Assuming this map which was introduced did not properly show that limit, how would that affect the basic issue which is before the Commission, which is will one well effectively drain 80-acres?

A I merely pointed out that the present 80-acre order leads to the incomplete development of the reservoir, and particularly the Crossroads reservoir, in my opinion in the north end has not been completely developed.

Q Is it your belief that if Mid-Continent developed on 40-acre spacing, that there would be more incentive for them to step out than there is if they know they will get an 80-acre allowable if they hit an 80-acre well? Or is it because the incentive of 80-acre spacing is more conducive to exploration than the contrary?

A My answer to that is at the present time it is my understanding this field meets only a 40-acre allowable.

Q Is it your opinion that there is more incentive for an

operator to drill additional wells on a 40-acre spacing than there would be on an 80-acre spacing?

A There is certainly less risk of stepping out and of getting these dry holes that have been secured in the past.

Q And there is also less profit?

A Yes, I expect there would be less profit to the operator per well. But I also want to point out there are several 40-acre wells proven beyond question of doubt. The well in the northwest of section 27 would certainly be a proven location.

Q But the fact that the well would be productive if drilled would have nothing to do with the basic issue of whether one well will effectively drain 80-acres in this reservoir?

A Unquestionably one well in 80-acres in this reservoir will partially drain the reservoir, but we have the experience in this reservoir that wells have been drowned out by water, in my opinion, coning up, by water, before all the 80-acres assigned for that well had been produced by that well. Consequently, there would be a reduction of waste by drilling the additional wells.

Q Is it your opinion that the present producing rate 350 barrels per day is sufficient to distribute the oil water contact so as to prevent this coning of which you speak?

A I don't believe it can be handled entirely by the producing rate. The field first has to be drilled on a uniform spacing pattern, which it isn't now. Then there will be the matter of determining whether the field then can sustain a 350 rate or not.

Q It is a M. E. R. question then, I take it?

A It will be after complete development of the field. It isn't now. It is one of spacing now.

Q You testified as I understood a minute ago that the greater number of outlets in the field would ultimately recover the greater amount of oil and would avoid waste?

A Yes, sir.

Q Is it your opinion we have an effective water drive in this reservoir?

A That is unquestionable.

Q Are you aware of this book which has been published on the physical processes of oil production by Mr. Muskat?

A I have read parts of it.

Q Mr. Muskat, who, I think, has been qualified as an expert engineer before this Commission, has made a statement at page 817 of his book, "Since the energy for oil expulsion, in reservoirs in which there is a complete water drive through out their producing ranges, is provided by an excited infinite source, and as the distance of travel of the invading water in covering the oil reservoir is essentially independent of the well density, the overall physical ultimate recovery should not be materially affected by the well spacing." Is there any way to reconcile your opinions with this expression by Mr. Muskat?

A Mr. Muskat's opinionswere based entirely on uniform fields, where the water table can arise not along fissures and not along abnormally high permeability routes as appears in this field, but where your adequate permeability is segregation under the differentials permitted by gravity between oil and water. He goes on to say in the last page of his book, if I may read back to you, that the problem you have here is one that is not yet solved. "In practical operations, the well spacing would be determined -

Q Which page?

A 897. "In pracitcal operations the well spacing should be determined primarily on the basis of reservoir continuity and economic factors pertinent to the particular reservoir of interest."

Q Read on sir, the next line there please.

A That is all I want to read. You may read the rest.

MR. McKELLAR: For the record the next line, continuing, reads: "The initial well spacing plan should be made as wide as possible."

MR. SPURRIER: If I might say something here, it is my own personal opinion that quoting from what the news reporters call it "out of context" isn't very impressive in a meeting like this. Or in a problem like this. You have to study the whole thing or read the whole chapter. A few sentences are not particularly to the point.

THE WITNESS: There is one thing though, Mr. Spurrier. Mr. Muskat has been referred to here and the basic principles on which this book is written, as he states in the book many times, certainly he is dealing with a uniform reservoir, which we are not dealing with here. And he states that on the next to the last page, and if I may read that I will stop reading from his book: Here it is on page 903, the beginning of the second paragraph. "Aside from its inherent basic complexity the physics of oil production is beset with many specific involved problems; one of the most serious of these is the treatment of the non-uniform reservoir" which is what we have here.

Q Conceding we have a fractured non-uniform type of reservoir, is it your opinion that the porosity in this type of reservoir is somewhat unlimited?

A No, indeed no. The porosity is comprised of pervious materials, although that is very small and maybe water bearing.

Q I am sorry, the permeability of the reservoir, the manner in which the oil must move through the reservoir?

A Oh, it has many cracks, and you have many fractures in here. The one well completed close to water there might have fracturin that permits the water to rise vertically in that well. The other well there may be -

Q (Interrupting) But it was in the wells in which we have the cores?

A apparently it was and apparently in the well owned by Magnolia because the well immediately showed water.

Q Will this coning or bypassing, will not the same condition occur, apply on a 40-acre spacing?

A Would you restate the question?

Q You testified that the location of one well to each 80-acres would cause bypassing or coning?

A Yes.

Q In this reservoir. Would not the same condition exist on a 40-acre spacing program?

A It will exist on any pattern. But my point is that these cones are so widely spaced that there has probably been little effect on the oil-water contact at the points far distant from the wells, and where 40-acre wells would be drilled -

Q Then I take it that the manner of spacing, that is, one well to 80 or one well to 40, would or would not affect the coning? Isn't it a question of the rate of the reservoir withdrawal, rather than the question of spacing?

A No. It is a question of both. You have to have uniform spacing of wells because around the bottom of each well there is a cone of water built up. Some of these intersect well bores, some do not.

Q As long as the reservoir was produced at a proper rate with a constant bottom hole pressure, wouldn't the water successfully flush out this oil from the cracks and crevices and vugs?

A No, sir, I don't think so. You have mistaken the static pressure in these wells for the flowing pressure. Mr. Purdum testified the productivity index varied from five to 40. That means that the flowing pressure producing 350 barrels per day varies from about 400 pounds less than the static to about 8 lbs. less than the static, so that the producing pressure, the pressure at which these wells produce, is quite variable. Those pressure drops are the things responsible for the rise in water along these fissures.

Q That is correct. And as the reservoir is drained and water

slowly comes in will not the oil be flushed into the bores of the wells?

A Not if the wells are drowned out as 1-A was by the coning of water.

Q Getting down to 1-A, you testified that a prudent operator might possibly drill a well on the north half of section 34, is that correct?

A I testified that if he wanted to drill a well there, I didn't say a prudent operator would, I said if he wanted to drill a well there he would drill in the northwest of the northeast, rather than the northeast of the northeast, which the present rule would require him to drill.

Q You are aware that section 34 isn't presently under lease by any company? It has been released and is on the market with apparently no takers.

A I didn't know it was on the market. I knew Mrs. Sawyer my client owned it.

Q At least, it isn't under lease by any of the present operators in this field?

A Which makes Mrs. Sawyer an operator as well as Magnolia.

Q She isn't an operator in the Crossroads pool?

A She owns acreage which is productive.

Q The operator, under New Mexico law, if the Commission cares to have me define the law -

MR. SHEPARD: I believe we know what the operator is.

MR. McKELLAR: I don't have any further questions of the witness.

MR. SHEPARD: Any other questions?

REDIRECT EXAMINATION

BY MR. HANNERS:

Q Mr. Fitting, I want to ask you about this book written by Mr. Muskat. Do you have some articles appearing in this book about the same subject matter we have been discussing?

A I have an article which he quotes rather freely in the book.

MR. McKELLAR: But your article isn't dealing with well spacing and the reservoir, is it sir? That is Chapter 14.

A I am not sure.

Q Do you think of anything we should go into other than the testimony you have already given?

A I think not.

Q Any matter you think we may have overlooked?

A I don't believe so.

Q Is it your considered opinion that the spacing pattern in the Crossroads field should be the normal state-wide 40-acre pattern?

A In order to prevent avoidable waste, yes.

MR. HANNERS: That is all.

MR. McKELLAR: I have no other questions.

MR. SHEPARD: Any other questions? If not the witness will be excused.

MR. HANNERS: Let me have just a moment and I think we are ready to conclude.

(Off the record.)

That is all if the Commission please.

(Governor Mechem leaves the hearing.)

MR. SHEPARD: Do you have any rebuttal?

MR. DOW: I don't know whether Mr. Millikan wants to make a statement or not. You might inquire if anybody else has any further testimony. We have no further testimony.

MR. SHEPARD: Do you have any further testimony Mr. Hanners?

MR. HANNERS: No, sir.

MR. DOW: Does the Commission want to hear argument?

MR. SPURRIER: I don't know about Mr. Shepard and I don't know about Governor Mechem but I thought perhaps you wanted Governor Mechem to hear a closing argument.

MR. DOW: As you will.

MR. SPURRIER: Yes, sir.

MR. DOW: We were just going to put it up to the Commission whether they wanted to hear a closing argument. That has been our thought all the way along.

MR. SPURRIER: It is up to you. I would be glad to listen to it.

(Off the record.)

MR. DOW: We will submit the case without argument.

MR. SHEPARD: We will wait just a minute. This gentleman might want to make a statement.

MR. DOW: Mr. Millikan, would you like to make a statement for the record.

MR. MILLIKAN: I would be very pleased to do so if the Commission will permit.

MR. SHEPARD: Go ahead and make your statement.

MR. MILLIKAN: Gentlemen, my name is Millikan, the initials are C. V. I am Chief Engineer of the Amerada Petroleum Corporation. Our company has no physical interest in this pool. We do however operate in three other pools in the State of New Mexico, and one in Texas producing from this Devonian formation. The character of the Devonian in those

pools is substantially as the Exhibits which have been submitte in this hearing in the performance of the wells and of the reservoir as a whole, being quite comparable to my understanding of the Crossroads as based on the testimony which has been presented to you today. I think there is no question that this is a water drive. In fact, it is one of the most active water drive pools of any which it has been my experience to work with. That applies not only to Crossroads but also to these other Devonian pools in each of which our company owns a majority interest. Being a very active pool and having this type of porosity and permeability as demonstrated not only by core analyses but by the actual performance of the wells, I think we can anticipate a much higher recovery of oil than we normally recover or expect to recover from reservoirs. Reference has been made a number of times in discussing these cores, and it is amply demonstrated here that the reservoir is non uniform. It is possible to reach a lack of uniformity that is so consistent over an area that it becomes uniform. In other words, we can have what I heard one time expressed as homogeneous heterogeneit (laughter) even with that there are these strata of more dense sections of the lime which will prevent or at least largely retard vertical migration of the oil through the reservoir, and the even migration is still more or less parallel to the bedding planes of the reservoir that perhaps applying less in the case of a reservoir of this type than it will in sandstone. But nevertheless still existing. The question has been raised here about uniformity of spacing. If I may comment for just a moment about 80-acre spacing, which has been proposed here and which does exist with one exception, is a uniform spacing. That is, the wells are equi-distant between each other the same as they are on a 40-acre spacing, such distance of course being greater. But nevertheless is a perfectly uniform square and spacing. I will call the attention of the Commission to Exhibits which were presented at a hearing by me on June 20, 1950 on the Knowles pool in which that is explained in some detail. I would also call the attention of the commission to th fact that
/the recommendation of 80-acre spacing in the State of New Mexico is new only in name. that under state wide rules wells are permitted to be placed three hundred and thirty feet out of the corner of a regular quarter-quarter section. That must then recognize then that a well located 330 feet out of the corner of a quarter-quarter section will drain an area extending through the diagonal corner of that 40, that being a distance

which is one-half of the diagonal of an area of 90 acres square, in the form of a square, I should say. That has been the fact since the first rules of this Conservation Commission, and in practice has been in effect since substantially the first, at least the first major, development in the State of New Mexico. The fact that also - that also is explained in some detail in the Exhibits referred to. That also calls attention to the fact that I believe the majority - I have forgotten the percentage - but I believe the majority of the wells in Hobbs are so located. About 28 or 29 per cent of all the wells drilled in the Monument field are so located. So that we speak of the large areas that are drained by wells when we talk of 80-acre spacing, and yet we seem to be surprised that a well will drain such a large area, still it has been in common practice in the State of New Mexico since major oil development started.

Not only that, but in these older areas which were so drilled, the permeability of the formations is very substantially less than is indicated here; and in most cases a low, or for all practical purposes substantially no, water drive. I would like to bring up another point on this drainage and movement of oil and gas through reservoirs. We seem to think there is something phenomenal about it. And yet when we get into the movement of water through a reservoir we think little of water moving over great distances. I think most people in the State of New Mexico are familiar with the Artesian water basin around Roswell in which water moves from the outcrop of that lime some distance to the west of Roswell into these wells. The effect of excessive withdrawals from these water wells has been recognized for many years. The number of wells which can be drilled is now controlled by the state, and yet that is moving through a formation which is surprisingly comparable in its characteristics with the lime reservoir samples some of which are lying on the table before you. The state engineer's records show substantial interference of wells, and rather quickly, in those water wells. Much more quickly than we find normally in the oil reservoirs, for good physical reasons which I would be glad to go into if the Commission cares to go into it. And so there is no difference in the principles involved here as compared with the handling of these water wells.

Now as to the rate of withdrawal from these

reservoirs, I think the Commission might be interested in considering what has happened at Knowles. In that pool the allowable was increased, doubled from a 40-acre base to an 80-acre base effective January 1st of this year. For a few days after that those wells did make that double allowable, which at that time was somewhat less, but at present is 702 barrels per day. The capacity of those wells to produce without artificial lift has dropped now to approximately 400 barrels per well and they are producing for all practical purposes let's say wide open. I anticipate they will settle down at about that rate and we will produce, continue to produce some 1300 barrels of oil per day or perhaps a little less, for quite sometime in the future. Now, that is 1300 barrels per day from the reservoir. That is regardless of the number of wells that were there. I think it would make no difference if we doubled the number of wells and tripled and quadrupled the number of wells, I still think our production would be 1500 barrels per day.

The nature of the reservoir is such as to limit that production unless we go on with an artificial lift, which might create these higher differential pressures, and thereby tend to create physical waste or at least that is possible. In view of the fact that this reservoir has all the appearances of the same nature of the reservoir at Knowles and at Bagley and at Hightower, with which I am quite familiar, I think there is every reason to believe that the wells which are there will recover the maximum ultimate recovery of oils from those wells, from that reservoir. And will do so without physical waste. Not that they will recover 100 per cent, but they will havemuch higher than normal recovery. That drilling any additional wells may possibly take the oil out a little faster, but will not increase the amount of oil produced. I think that is all I have, gentlemen, unless there are some questions you care to ask.

MR. HANNERS: If the Commission please, after Mr. Millikan's statement, I observed Mr. Morrell sitting there. I wonder if he would care to make a statement.

MR. SHEPARD: Do you care to say anything Mr.

Morrell?

MR. MORRELL: No, sir.

MR. SHEPARD: Anyone else. If not the case will be taken under advisement and we will stand adjourned.

MR. DOW: Mr. Commissioner, I don't believe the reporter identified Mr. Buckle's statement as an Exhibit which I introduced into the record and if he will identify that(marked Exhibit 2 Dow).

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STATE OF NEW MEXICO)
) SS
COUNTY OF BERNALILLO)

I HEREBY CERTIFY that the foregoing and attached transcript of hearing in Case 149 before the Oil Conservation Commission on March 21, 1951, at Santa Fe is a true record of the same to the best of my knowledge, skill and ability.

DATED at Albuquerque, this 5th day of April, 1951.

E. E. Greeson

E. E. GREESON.

My Commission expires August 4, 1952.

EXHIBIT NO. 1 DOW:

PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

March 15, 1951

In re: Hearing to Reconsider Order No. 779
Set for March 20, 1951

The Oil Conservation Commission
State of New Mexico
Santa Fe, New Mexico

Attention of Mr. R. R. Spurrier, Secretary

Gentlemen:

The Oil Conservation Commission of the State of New Mexico has set for hearing on March 20, 1951, the matter of reconsideration of Order No. 779 in Case No. 149 entered July 27, 1948, establishing 80-acre spacing pattern and proration unit for the Crossroads Devonian pool below 12,200 feet in Lea County, New Mexico.

As a lease owner in New Mexico and the owner of potentially productive acreage in the vicinity of the Crossroads Pool, Phillips Petroleum Company urges the Oil Conservation Commission of the State of New Mexico to retain the provisions of its Order No. 779 as issued on July 27, 1948. We respectfully submit that the Commission in this instance should give consideration to the depth of production, to the fact that the reserve in-place in the Devonian formation can be efficiently drained by one well to 80-acres, and that the drilling of more than one well to each 80-acres will, in our opinion, constitute an unwarranted use of steel in a very critical time of shortage.

We respectfully offer this statement to the Commission in support of the present 80-acre spacing order, with the additional thought that unless a well-spacing program suited to the conditions found to exist in the deep reservoirs in New Mexico can be obtained, there will be a decline in exploration for and development of those deeper reservoirs.

EXHIBIT 1 DOW (continued)

Yours very truly,

s/ C. P. Dimit
C. P. Dimit

CPD:MN
CC Mid-Continent Petroleum Corporation
Tulsa, Oklahoma
Attention of Mr. A. E. Pierce

- - - - -

EXIBIT NO. 2 DOW

Statement by Mr. Cecil R. Buckles, attorney for Sinclair Oil and Gas Company.

The transcript of the proceedings in this matter on November 21, 1950, does not quite reflect my exact statement at that hearing. What I said then and desire to place in the record now is that at the risk of burdening the Commission with a "me to" position on behalf of our company, we desire the record to show that Sinclair Oil and Gas Company as an operator in New Mexico is vitally interested in there being established and maintained in the state, spacing of one well to 80-acres where it is shown that such 80-acre spacing will adequately drain the formation without injury to the correlative rights of parties in interest.

Sinclair has no acreage within the limits of the Crossroads Pool and we were not present at the first hearing in this matter in July, 1948 but at the November 21, 1950 hearing we suggested that the high cost of drilling and completing wells to the depth of 8 to 10 thousand feet, being in the neighborhood of 3 to 5 hundred thousand dollars could be a factor resulting in less wells being drilled even on 40 acre spacing. We made a similar statement at the hearing on the Knowles pool.

Now subsequent events in our national affairs adds the necessity of giving gave consideration to the conservation of tubular steel in the oil development program where conditions permit and with this our company is in full accord.

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