CASE NO. 3029

2 file

Application,
Transcripts,
Small Exhibits
ETC.

ORIGINAL

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
April 15, 1964

REGULAR HEARING

IN THE MATTER OF:

Application of Pan American Petroleum Corporation for permission to drill in the Potash-Oil Area, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks authority to drill a well to the Mississippian formation at an approximate depth of 12,600 feet, said well to be located 660 feet from the South line and 660 feet from the East line of Section 17, Township 20 South, Range 30 East, Eddy County, New Mexico, or to drill said well at an alternate location anywhere within a circle of 100 feet radius around the Barber Well No. 4-A, located 1639.2 feet from the South line and 2304.5 feet from the East line of said Section 17. The above location and the alternate location are in the Potash-Oil Area as defined by the Commission in Order No. R-111-A as amended.

CASE 3029

BEFORE:

A. L. (Pete) Porter
Governor Jack M. Campbell

TRANSCRIPT OF HEARING

MR. PORTER: We're going to take up next Case 3029. Before we get into this case, Mr. Walker asked me to express his regrets that he cannot be here today. He is very much interested in this case. I've kept him advised as to the arbitration

meetings all the way through. He has representation on his staff here and he assured me that he will review the transcript very carefully, also.

At this time we have with us Mr. B. H. Croft. Is Mr. Croft here?

MR. CROFT: Yes, sir.

MR. PORTER: We're happy to have you with us. He is a member of the Utah Oil and Gas Commission and he was interested in this hearing since apparently they're going to have some similar problems out there. Happy to have Mr. Croft.

At this time we will take a short recess so that the exhibits can be marked and put on the board.

(Whereupon, a short recess was taken.)

(Whereupon, Applicant's Exhibits Nos. 1 through 11, and AA and BB marked for identification.)

MR. PORTER: The hearing will come to order, please. Proceeding with Case 3029, the Commission would like to have appearances at this stage. Mr. Malone.

MR. MALONE: Appearing on behalf of the Applicant, Pan American Petroleum Corporation, are J. K. Smith, Division Attorney for Pan American Petroleum Corporation, Fort Worth, Texas; and Ross L. Malone of Atwood and Malone, Roswell, New Mexico.

MR. PORTER: Mr. Blackman.

MR. BLACKMAN: Appearing on behalf of Potash Company of America, Mr. Donald S. Stubbs and Mr. George Lohr, Denver, Colorado, and Roy H. Blackman.

MR. PORTER: Lohr, is that L-o-h-r?

MR. BLACKMAN: L-o-h-r; and Roy H. Blackman, Carlsbad, New Mexico.

MR. PORTER: Thank you, Mr. Blackman. Any other appearances to be made in this case? If not, the Commission will recognize Mr. Malone.

MR. MALONE: If it please the Commission, I'm sure that the Commission is aware of the nature of the application of Pan American and the issues in this case, and I do not propose to make an opening statement but rather to proceed with the presentation of evidence on behalf of Applicant in support of its application.

I would first like to offer in evidence on behalf of Applicant an Abstract of Title, which has been identified as Pan American's Exhibit double A or A-A prime, compiled under Cover Number 16781 of the Federal Abstract Company of Santa Fe, New Mexico, containing forty-five pages including the Certificate, and being certified on April 9th, 1964, at 8:00 o'clock A.M.

MR. PORTER: Do you want to offer this as an exhibit at this time?

MR. BLACKMAN: No objection.

MR. PORTER: The exhibit will be admitted.

(Whereupon, Applicant's Exhibit No. AA received in evidence.)

MR. MALONE: The exhibit which has just been admitted shows the record title to the Oil and Gas Leasehold Estate in the Southeast Quarter of Section 17, Township 20 South, Range 30 East, N.M.P.M., Eddy County, New Mexico, to be vested in the Office of the Commissioner of Public Lands and Barber Oils, Inc.

I now offer in evidence a photostatic copy, and I have the original instrument here which I would like to withhold, of a Trust Agreement executed under date of June 9th, 1938, between Neil H. Wills and Stanolind Oil and Gas Company, predecessor in name of Pan American Petroleum Corporation.

This Trust Agreement evidences the fact that Neil H. Wills, as the predecessor in title of Barber Oils, Inc., held in trust for Pan American all rights below a depth of 2500 feet in the Southeast Quarter of Section 17 which is involved, and this instrument is for the purpose of evidencing the operating rights vested in Pan American in the Southeast Quarter of Section 17.

GOVERNOR CAMPBELL: How are you marking that exhibit?

MR. MALONE: That is Exhibit double B.

MR. PORTER: Anyone have any objection to the admission of this exhibit?

MR. BLACKMAN: No objection.

MR. PORTER: The exhibit will be admitted.

(Whereupon, Applicant's Exhibit No. BB received in evidence.)

MR. MALONE: If it please the Commission, and with the consent of the Commission, on the basis of the exhibits introduced I would like to make a motion.

Comes now Applicant, Pan American Petroleum Corporation, and moves the Commission that the application of Pan American be granted on the record as now established and without further hearing; or, in the alternative, that the hearing be limited to the question of whether or not the proposed well of Pan American complies with the requirements of the Oil Conservation Commission for wells drilled in the Oil-Potash Area.

If I may address myself briefly to that motion, to explain the basis of it to the Commission and the Counsel, the Abstract which has been introduced in evidence shows that State of New Mexico Oil and Gas Lease B-2386 was issued to Stanolind Oil and Gas Company on January 10th, 1934; and that the rights here sought to be exercised by Pan American, which is the successor in name of Stanolind, are the rights which were granted by that lease on January 10th, 1934.

The Abstract offered in evidence also shows that the

potash lease under which the Protestant, Potash Company of America, asserts its rights, is Potash Lease Number M-873, which was issued by Frank Warden, Commissioner of Public Lands, on April 24th, 1939, five years after the issuance of the oil and gas lease and the vesting in the lessee of the rights under that lease.

It is the position of Pan American in relation to this situation that inasmuch as there was an existing oil and gas lease which is paramount and superior to the potash lease, and which embraced the property at the time the potash lease was issued, that the Potash Company's rights are in all respects subject to the senior and prior rights of the oil and gas lease under an oil and gas lease which had been in existence for five years.

We do not question the right of the State of New Mexico under its police power to establish reasonable regulations to govern situations where there is a joint operation, but the vested right of Pan American to explore for oil in the Southeast Quarter of Section 17, which was in existence for five years prior to the creation of rights under the potash lease, could not be subordinated to the right of the Potash Company under a junior lease to conduct mining operations; and that is the basis of the protest.

Now the protest before the Commission in this hearing

and on the basis of which the hearing is being held, is as follows:

"Objection of Potash Company of America: 1. Potash Company of America, a Colorado corporation authorized to do business in the State of New Mexico, hereby objects to the drilling of an exploratory test well in the Southeast Quarter Southeast Quarter of Section 17, Township 20 South, Range 30 East, Eddy County, New Mexico, and hereby states the land described above is within the Oil-Potash Area as set forth in Order R-111-A, Case 278, before the Oil Conservation Commission, as amended,"which we admit.

"2. Potash Company of America is the owner and holder of a State of New Mexico potash lease covering said land," which we also admit, but which lease undeniably is five years junior to the vested right of Pan American as lessee of the State of New Mexico to explore for and develop oil on the Southeast Quarter of Section 17; and Paragraph 3, "Drilling of the test well in the tract specified will result in waste of potash deposits of substantial value."

That is the basis of the protest here made to the Commission. Any ruling of the Commission which preferred the right to take potash over the senior and paramount right of Pan American to produce oil would be making the junior lease senior, and would be a taking of vested rights of Pan American

that were in existence at the time that the potash lease came into existence.

Under those circumstances, it is respectfully submitted that the only material question here is whether the proposed well meets the safety, casing, cementing, and other requirements of the Oil Conservation Commission regulations, but insofar as the protest would seek to have this Commission make a junior lease senior to the oil and gas lease by preferring the rights to mine potash over the right to explore for oil, it would be, of course, destroying a vested right and taking property without due process of law.

On that basis, we respectfully urge the granting of our motion.

MR. PORTER: Mr. Blackman.

MR. BLACKMAN: If the Commission please. Potash Company of America objects to the motion on several grounds, the first of which I will address to Mr. Malone's statement concerning the priority of the lease.

We will submit evidence to show that Potash Lease M-873 which is dated in 1939 was actually issued as a consolidation of three earlier leases which were dated in 1931, which are prior to the date of the oil and gas lease; that the oil and gas lease as initially issued and in its consolidated form contains language limiting the production of any other

minerals, reserving those minerals in the State and limiting their production to such production as will not reduce or tend to reduce the production of the potash. So we have a material issue of fact which will have to be brought out here, and we will submit those leases at the appropriate time.

Additionally, we will show that this not only will cause a tremendous waste of potash if this well is permitted to be drilled, but in all events, it will not be possible to appropriately develop the reservoir due to the location of the present works of the Potash Company of America, which will cause waste of oil; and for other reasons which we will make clear.

MR. PORTER: The Commission will deny the motion, Mr. Malone, and you may proceed with your testimony.

MR. MALONE: Does the Commission wish to swear the witnesses en masse or individually?

MR. PORTER: We would like to swear them en masse.

MR. MALONE: Lawson F. Jacks, E. D. Clements, Jimmie Rodgers.

MR. PORTER: Mr. Blackman, would you identify your witnesses?

MR. BLACKMAN: Mr. J. W. Woomer of Pittsburgh, Pennsylvania; Dr. Daniel M. Bass, Golden, Colorado; Mr. Houston Clark, Carlsbad, New Mexico; and Mr. J. B. Cummings of Carlsbad, New Mexico.

MR. MALONE: We would also like to have Mr. Louis C. Raymond of New York City, a rebuttal witness, sworn.

(Witnesses sworn.)

MR. PORTER: Let the record show that Mr. Raymond was sworn at the same time.

MR. MALONE: Mr. Jacks, will you take the stand, please?

* * *

LAWSON F. JACKS, JR.

called as a witness, having been first duly sworn on oath, testified as follows:

DIRECT EXAMINATION

BY MR. MALONE:

Q Will you state your name to the Commission?

A Lawson F. Jacks, Junior.

Q Where do you live, Mr. Jacks?

A Lubbock, Texas.

Q By whom are you employed?

A Pan American Petroleum Corporation.

Q In what capacity are you now serving?

A District Exploration Superintendent.

MR. PORTER: Is that Jacks?

A J-a-c-k-s.

MR. PORTER: Thank you.

Q (By Mr. Malone) What territory is included in the Lubbock district which is under your supervision?

A Eastern New Mexico and the western portion of

Texas from Dallas east to the New Mexico line.

Q Have you heretofore testified as an expert before the New Mexico Oil Conservation Commission?

A No, sir, I have not.

Q What was your professional education?

A I'm a geologist.

Q What was the degree you received and where did you receive it?

A My geological degree was received from the University of Tulsa in 1951, January.

Q Did you have a prior degree?

A Yes, sir. I have a degree in Mathematics and Physics from Ouachita Baptist College at Arkadelphia, Arkansas, in 1943.

Q For how long have you been employed by Pan American?

A Approximately thirteen and a half years.

Q During that period, in what positions have you been assigned?

A I have been a scout, a geologist, and my present position is a superintendent.

MR. MALONE: Are the witness' qualifications satisfactory to the Commission?

MR. PORTER: Yes, sir, they are, Mr. Malone.

Q (By Mr. Malone) Are you familiar, Mr. Jacks, with the original notice of intention to drill which was filed in

this proceeding by Pan American?

A Yes, sir, I am.

Q What was the initial objective which the company stated it then expected to drill to in this well?

A Drill to a depth of approximately 12,600 feet to encounter the Mississippian formation.

Q How is the proposed well designated, as Pan American what?

A Pan American No. 1 State of New Mexico "CS".

Q Will you state the circumstances under which the decision was made to apply for permission to drill to the Mississippian at the outset?

A Well, that is a normal operation within Pan American in Eastern New Mexico; when we're drilling a deep exploratory test, we normally set it up or ask that it be originally granted to the Mississippian. It's actually an inter-company thing.

It doesn't mean very much except from a standpoint that the Mississippian is the first deep geological marker, in our opinion, which truly reflects the structural attitude of the Devonian.

Q In the normal course of drilling a well which may ultimately be completed before the Mississippian, is the decision to continue drilling made at the time that you reach the Mississippian?

A It is.

Q Because of the reliability of this deep marker?

A Because of the reliability of the subsurface marker, the Mississippian.

Q It was on that basis that the application was filed in its present form?

A That is true.

Q Will you refer to Pan American's Exhibit 1, which is an overlay map that has been placed on the exhibit board, and distributed, and refer first to the base map and tell the Commission what it shows?

A Well, the base map, the acreage colored in yellow is the Pan American Oil and Gas Leasehold acreage in this immediate area. The black line with the hashered mark inside shows the location of the potash mines as of 1-1-63, to the best of my knowledge.

The red cross-hashered on the overlay is indicated as being the proven ore bodies; the green, possible extensions of the ore bodies; and the blue is area in which the drilling of a deep oil and gas test might endanger mining operation according to the Potash Company of America.

Q What was the source of the information which is reflected on this first overlay?

A Well, we procured that from representatives of the

Potash Company of America by means of a map they furnished us.

Q Was that furnished to you at the time that you first contacted them to discuss and see if an agreement could be reached for a well at the proposed location, or about that time?

A About that time.

Q The proposed location is shown as the red dot on the base map, and is shown as a twin to the Barber 4-A Well. In fact, there are alternative applications before the Commission at this time, are there not?

A Yes, sir, there are.

Q What was the location that was requested in the first notice of intention to drill?

A Originally it was in the Southeast Southeast of Section 17, Township 20 South, 30 East.

Q Why, if you know, was that location selected at that time?

A It was selected at that time because we felt that it was the most favorable spot for us to drill an exploratory test on our acreage.

Q Further,with reference to the Pan American acreage that's shown on that base map, how long ago was the blocking up of that acreage finally completed?

A A very short time ago, a matter of a few months ago.

Q Was the decision to apply for the drilling of a well in the area governed to a degree by when you completed the blocking of that acreage?

A It was.

Q Now will you refer to the top transparency or overlay which is labeled "Approximate Top of the Devonian", and tell the Commission what that portrays.

A This overlay, the one on top designated "Pan American Petroleum Corporation Geophysical Department, Approximate Top of the Devonian" is a copy of a geophysical map with subsea datums indicating the approximate top of the Devonian formation.

Q Approximately when was the geophysical exploration conducted on the basis of which that structure was mapped?

A Oh, a year and a half to two years ago.

Q Will you state whether or not in your opinion, on the basis of the geological and geophysical information which Pan American has accumulated, there is at the location here indicated a structure approximately conforming to the contours there appearing?

A There is, in our opinion.

Q Going again now to the original notice of intention to drill and the casing program which was listed in that, which stated the casing which the company proposed to use at

the time that application was filed, has there been a change in the thinking of the company in relation to the casing which will be used if this permit is granted?

A There has been.

Q What changes are those?

A The changes are primarily in the weight of the casing we propose to use.

Q Go ahead and outline that if you will.

A All right. Our surface casing, which is 20-inch casing, we are changing from 53.6 pound weight per foot to 94 pound weight per foot.

Q Is that the heaviest weight casing of that type that's available?

A To my knowledge it is.

Q All right. Proceed.

A Our first intermediate string, 13-3/8ths inch, we are changing from 48 pound weight to a 54 and a half pound weight to be set at 1400 foot depth.

Our second intermediate casing string at 9-5/8ths inch we are changing from 36 to 40 pound weight to be set at 4,000 feet; and our production string, 5-1/2 inch we are leaving the same, 17 to 20 pound weight at 13,000 feet.

Q What occasioned the change in the company's plan in relation to this casing?

A Well, after the arbitration meeting was held a couple of months back, we felt that anything we could do to cooperate and pacify Potash Company of America, we certainly wanted to do so that we could operate in harmony with them.

Q You did increase the casing program on that basis?

A Yes, sir, that's right.

Q That, of course, is subject to the approval of the Commission?

A Yes, sir, it is.

Q Are you prepared to file an amended N.I.D. or a changed notice if the Commission does approve the changes to which you've testified?

A We are.

Q The structure which you have testified to on the top overlay you have identified as a Devonian structure, and you testified earlier that the N.I.D. had been projected to the Mississippian. Will you state whether or not the Mississippian marker to which you referred is considered by you to be an authentic marker as far as the Devonian structure is concerned?

A It is in a local area.

Q Is the company prepared to drill the projected well at either of the two locations suggested immediately upon the granting of permission by the Commission?

A We are.

Q Now the alternative location or the one referred to in the second N.I.D. I have mentioned as being a twin of the Barber 4-A Well. Will you refer again to the base map for a moment and tell us what the dots appearing in Sections 17 and 20 on that map refer to, what they indicate?

A They are producing oil wells, producing from the Yates formation at approximately 1500 feet, thereabouts.

Q Is that from a horizon that is below the potash mining horizon?

A I believe it is; to my knowledge it is.

Q Do you know what the designation of that oil pool is?

A That's the Barber, I believe it's called Barber-Yates, if I'm not mistaken.

Q With reference to the Well 4-A there which you propose to twin, will you state what the company has in mind as far as the twinning is concerned?

A Well, we plan to drill our exploratory test approximately 100 feet from the No. 4 Barber Well and very close to the Barber Well, within 100 feet.

MR. PORTER: Just a minute. At that point, Mr. Jacks, would that be, that 100 feet be in any direction from the Barber?

A Yes, sir, any direction, but we have chosen, from our standpoint, the company's standpoint, to move slightly north due to the fact it's better operationally for our rig.

MR. PORTER: Thank you.

Q (By Mr. Malone) Is the company agreeable to any location within that circle with 100-foot radius that the Commission may authorize?

A Yes, we are.

Q Now, Mr. Jacks, will you refer to Pan American's Exhibit No. 2 which has been placed on the exhibit board and is now being distributed, and state what is shown by that exhibit. I believe that you should leave the witness chair and take the pointer and testify at the board if the reporter can hear you there.

What is portrayed by Pan American's Exhibit 2, Mr. Jacks?

A This particular exhibit is a map showing the present Permian production in this portion of Northeastern Eddy County and Northwestern Lea County of New Mexico. On the left side is a columnar section, geological columnar section indicating by colors what we consider the possible deep producing horizons in the immediate area where we propose to drill.

Q What are the three deep producing horizons which are shown in the margin?

A The blue is the Strawn formation, the red is the Morrow formation, and green is Devonian.

Q On the basis of the geological and geophysical information of the company, state whether or not it is your opinion there is a good geological possibility of production from one or all of those formations in the proposed well.

A In my opinion, all three of them are capable of producing at our proposed location.

Q Will you briefly indicate the other producing areas that are shown on this map and the formation from which production is obtained?

A Yes, sir. First, the red, the Morrow formation is designated on this particular portion of the map; I might say that a square such as this represents a township (indicating). The red is the Morrow production, gas production in these particular cases; the green is Devonian production here, Shugart Field; and the blue is the Strawn oil production at the Lusk Field and Querecho Plains here and the Pan American Big Eddy here.

Q Referring to the orange spot that is immediately west of the proposed location, --

A That is a Morrow gas well recently completed by Odesssa Natural Gas Company in October, 1963, I believe.

Q Is that production within the potash reserve area?

A Yes, it is.

Q Now referring to the dotted lines which appear on that map, what do they indicate?

A These dotted lines are some of the shallow production that exists in this portion of New Mexico that's currently producing, shallow production.

Q But you have shown only deep production which you expect to encounter in the proposed well on this exhibit?

A Yes, sir, that's true.

Q I believe you may resume your chair now.

Q On the basis of the geological and geophysical information which is available to you, have you undertaken to compute the areal extent of the productive area from each of these three horizons which you anticipate will be encountered in the proposed well?

A We have.

Q Starting first with the Devonian, will you tell us how many productive acres you anticipate there and the basis on which you make that estimate?

A Well, we anticipate 1825 acres, which we have planimetered out with the use of our geophysical map, utilizing the minus datum of 10,350, that's subsea datum shown on the overlay on the first map.

Q What was that number of acres again?

A 1825.

Q Do you anticipate oil or gas or do you have any basis for making that anticipation in the Devonian?

A Well, we anticipate both, of course, but I imagine that we will get gas in the Devonian.

Q With reference to the Morrow, what is the productive area that you would anticipate if a discovery is made in the Morrow at this location?

A Well, we would anticipate approximately 640 acres from the Morrow.

Q Why is that substantially smaller than the Devonian?

A It's due to the -- in our opinion and experience, due to the sedimentation of the Morrow formation, in that it is a lenticular sand, normally, of limited areal extent.

Q Does the company normally consider a Morrow well to prove up about 640 acres only?

A Yes, sir, that is true.

Q Is that the basis of your estimate?

A That is right.

Q Referring then to the Strawn, what would you anticipate in the Strawn?

A Well, again there we would anticipate -- well, not again there, but we would anticipate oil production from the Strawn.

Q Have you undertaken to estimate the areal extent there?

A Yes, I have, and we use 1825 acres or essentially the same thing as our structure on the Devonian has indicated.

Q Obviously, Mr. Jacks, until a bit has actually cut these formations, you have no firm basis for either saying that production is going to be obtained or the extent of it, do you?

A That is true.

Q But are the estimates to which you've testified reasonable estimates, based upon your experience and the knowledge and information available to you?

A Yes, I think they are.

Q Have the exhibits which have been identified as Pan American Exhibits 1 and 2 as to which you have testified been prepared by you or under your direction?

A Yes, sir, they have.

MR. MALONE: We offer in evidence, if the Commission please, Pan American's Exhibits 1 and 2, and rest with the witness on the record.

MR. PORTER: Any objection as to the admission of the exhibits?

MR. BLACKMAN: No objection.

MR. PORTER: The exhibits will be admitted to the

record.

(Whereupon, Applicant's Exhibits Nos. 1 and 2 received in evidence.)

MR. PORTER: Any questions of Mr. Jacks? Mr. Blackman.

MR. BLACKMAN: I would like to ask Mr. Jacks a couple of questions.

CROSS EXAMINATION

BY MR. BLACKMAN:

Q If I understood your testimony correctly, when you encountered the Mississippian you would then make a decision as to whether you would proceed or not into the Devonian, based upon what information you had picked up at that point?

A That is true.

Q You mentioned that you had initially chosen your first location in the Southeast of the Southeast of Section 17 as being the most favorable from your point of view. Why did you then change to the new location in the Northwest of the Southeast of Section 17?

A I believe I've already said that, but it was after the arbitration meeting with you people that we wanted to get along and I felt that the little bit of structure that I would sacrifice on my initial well by moving it over here where there's already a producing well, it would make you all feel

better not to drill another well other than the one that is already drilled, then I felt that we can sacrifice a little bit of structural advantage that I would have by drilling the original site.

Q What possible advantage did you think that the Potash Company might get out of your drilling next to another well?

A Well, you all objected to it, and I did know that we had a shallow well producing there, and inasmuch as there are two things involved, I felt like that by not sinking another shaft over an area which you all objected to, that possibly you would be pacified and not object to us drilling this well.

Q Were you maybe thinking that since the potash underlying that well was already committed or perhaps already had been lost, is that what you had in mind, that it wouldn't cause any increased losses of potash?

A Well, not particularly, but I felt that, in my mind, this was my own opinion, that there was casing through that potash at that point and that we probably will be producing quite some time, and that if I drilled another well next to it it probably would work out that it wouldn't condemn, in the Potash Company's mind, as much possible acreage as it would if I drilled another location.

Q That's based on the fact that you contend that the

potash underlying the Well 4-A is already condemned, is that what you mean?

A I don't know that it's condemned, but we do have a well sunk to 1539 feet at that point with casing in it.

Q Was this geophysical information that is set forth on your Exhibit No. 1 assembled under your direction?

A That is true.

Q Could you enlighten me as to whether it is possible, in your opinion, that there may be another structure similar to the structure that you show there going off to the north? I notice the contour lines at the top of that exhibit indicate a bending outward. Would that indicate the possibility that there might be another structure up north?

A Well --

Q Do you have any information about that?

A I don't have any information with me like that, but that could indicate a number of things. It could indicate a saddling across here, a saddling effect, or there could be another -- it could indicate a number of things. I wouldn't speculate on it.

Q It might be possible that there is another structure up there connected with this one through that saddle, is that true?

A I wouldn't speculate on it. I don't have the

information with me.

Q Do you have any information as to what might occur to the west, that is on the left side of that exhibit?

A I'm not at liberty --

Q I ask you a similar question about that.

A -- to help you. I'm not at liberty to classify geophysical information which is a security thing with Pan American, other than what is before me.

Q You testified that the dots appearing in Sections 17 and 20 on your Exhibit No. 2 were producing wells in the Barber Pool. Did I understand you correctly on that? No, excuse me, that's on Exhibit No. 1. It's on the underlay of Exhibit No. 1.

A Yes, that's what I said.

Q Is that true of all the wells there, all the dots? Are they all producing wells?

A Well, at the time we made this map we thought they were all producing, but I think that maybe there's one or two abandoned since then; I don't know.

Q How long ago was the map made?

A Oh, we made it back some time ago, I don't know the exact date. Two or three months ago, I suppose.

Q Two or three months ago?

A Yes.

Q Sometime since the 1st of January, 1964, would you say?

A Well, I don't remember the date exactly, but it was two or three months ago.

MR. BLACKMAN: That's all.

REDIRECT EXAMINATION

BY MR. MALONE:

Q This base map, Mr. Jacks, is an enlargement of the map that's maintained in the company for company records, the base map of which might have been prepared quite some time ago, might it not?

A That is true.

Q You have available here a witness who will testify as to the wells in the Barber Pool and what they are producing and how many of them are producing, do you not?

A Yes, sir, I do.

MR. MALONE: That's all.

RECROSS EXAMINATION

BY MR. PORTER:

Q Mr. Jacks, do you know whether or not the shallow wells here in the Barber Pool existed prior to the issuance of R-111-A?

A Sir, what is R-111-A?

Q That is the Commission Order which establishes the

regulations for drilling in the Oil-Potash Areas, which was issued somewhere around 1951. In other words, how old is this Pool?

MR. MALONE: We have another witness who will testify as to that.

GOVERNOR CAMPBELL: Can the parties stipulate as to the approximate range of depth of the potash deposits at this time so that we can view this testimony in that light?

MR. BLACKMAN: Yes, sir, the potash deposits in this area, the Southeast Quarter of Section 17, are on the average 700 feet below the surface.

GOVERNOR CAMPBELL: The top of the deposits is 700 feet below the surface, approximately, average?

MR. BLACKMAN: Approximately, yes, the deposit itself.

GOVERNOR CAMPBELL: What is the approximate average thickness of the deposit in this area?

MR. BLACKMAN: In one minute I will give that to you exactly. It's 4.13 feet.

GOVERNOR CAMPBELL: Thank you.

MR. MALONE: That's all, Mr. Jacks.

MR. PORTER: Does anyone have a question? Mr. Nutter has a question.

MR. MALONE: I'm sorry.

BY MR. NUTTER:

Q You stated that your estimate of productive acreage

in the Devonian would be 1825 acres, and that was at a subsea depth of minus 10,350, was it?

A Yes, sir.

Q Minus 10,350 closure on the seismic map?

A Yes.

Q What would be the subsea depth of the Strawn there?

A Let's see, I'll make an estimate. Oh, about a minus 8200, roughly.

Q And the Morrow?

A It would be in between there about 1,000 feet, about minus ninety-two, let's say.

Q Some mention was made of the fact that the notice of the intention to drill was to the Mississippian, but if the Mississippian indicated you should, then you would decide whether to go on to the Devonian. By the time you would have reached the Mississippian, you would already have drilled and penetrated through the Strawn and Morrow both, is that correct?

A Yes, that's correct.

Q Would they have been tested by that time?

A They would have been, in all possibility.

MR. NUTTER: Thank you. I believe that's all.

GOVERNOR CAMPBELL: Mr. Malone, did you have another witness who will testify in more detail as to the length of the various strings of pipe on this well?

MR. MALONE: On the proposed well and the Barber Well, also.

GOVERNOR CAMPBELL: Another witness will testify?

MR. MALONE: Yes, another witness, Mr. Rodgers. If the Commission is anxious to hear that testimony, I'll put him on next.

GOVERNOR CAMPBELL: No, no.

MR. PORTER: If no further questions, the witness may be excused.

(Witness excused.)

MR. PORTER: Call your next witness.

MR. MALONE: Mr. Clements, please.

* * *

EDWARD D. CLEMENTS

called as a witness having been first duly sworn on oath, testified as follows:

DIRECT EXAMINATION

BY MR. MALONE:

Q Will you state your name, please?

A Edward D. Clements.

Q Where do you live, Mr. Clements?

A Lubbock, Texas.

Q What is your address?

A 3816 27th.

Q What is your age?

A Forty-four.

Q By whom are you employed?

A Pan American Petroleum Corporation.

Q In what capacity?

A I'm Senior Geologist in Exploration.

Q For how long have you been employed by Pan American?

A Over sixteen years.

Q Will you state the education above the high school level which you received?

A My graduate degree in Geological Engineering from the University of Oklahoma, 1948.

Q Have you heretofore testified before this Commission as an expert?

A No, sir.

Q During the, I believe you said sixteen years that you have been with Pan American, what positions have you held?

A I've held the position of geological scout, junior geologist, intermediate geologist, geologist, assistant area geologist, area geologist, and now senior geologist.

Q In what areas have you worked?

A North Central Texas, Kansas, West Texas, Eastern New Mexico.

MR. MALONE: Are the witness' qualifications acceptable

to the Commission?

MR. PORTER: Yes, sir.

Q (By Mr. Malone) Mr. Clements, have you conducted certain studies and certain activities on behalf of Pan American in connection with the proposed Pan American State "CS" Well?

A Yes, I have.

Q I invite your attention to a topographical map which has been identified as Pan American's Exhibit 3, and before asking you to step to the board and explain that, I would ask whether or not it is correct that your activities in connection with the proposed well have related primarily to the underground water that's available in the area?

A It has.

Q Will you step to the board and state briefly to the Commission what is shown on Pan American's Exhibit 3?

A This is the Clayton Basin Quadrangle - Oil City Quadrangle of the U.S.G.S. topographical map. It shows the topography, and I have taken the liberty to take from the ground water paper 3 the subcrop limits of the Rustler formation which we consider as an aquifer in this area. It is between the two purple lines to the left of your map.

Q Do I understand that the outcropping of the Rustler is between the two purple broken lines on the west side of the

map?

A Yes, sir. This is from Ground Water Report 3, The Geology and Ground Water Resource of Eddy County, by Mr. and Mrs. Jones.

Q Is this the recharge area for the ground water that exists in the vicinity of the proposed well?

A It is.

Q Have you shown by green dots with the purple circle around them the location of other water wells in that area?

A This is water wells that I obtained water samples, or under my direction water samples were obtained, and from this area, to get some feeling of the ground water that is in this area of the Barber Area under discussion.

Q You are personally familiar with surface conditions in the area in the vicinity of the proposed well?

A Yes, sir, I am.

Q Describe generally the surface of the ground as it exists there and is portrayed by this topographical map?

A The topographical map shows that the Clayton Basin is in subsidence or an area of subsidence. We have a large number of depressions and so forth; actually, subsea-wise the lake to the west of the potash mines is about our lowest subsea level through here, but in general this is a Basin which is limited to the north by a ridge of Triassic on the north

and, excuse me, North and [illegible] to the north by a Loco Hills surface feature, and generally I can outline the Basin in the middle of the topographical map.

Q With reference to the red arrows shown on the map, what do they indicate [illegible] they show?

A The red arrows were put on this map from Ground Water Report 3 by Mr. Nordstrom and Mr. Jones. It's Plate 3 of the publication.

Q Do they show the direction of the movement of the ground water in the Rustler at this location?

A Yes, sir. This is the movement of ground water as compiled in this report.

Q And the proposed location is shown at the red circle on the map?

A Yes, sir.

Q Will you please speak into the microphone, please? Did you, within the past four weeks' period, at the direction of your employer, Pan American Petroleum Corporation, have occasion to supervise the drilling of a water well in the area that is shown on Pan American's Exhibit 1?

A I did.

Q What was the location of that water well in relation to the proposed well of Pan American?

A [illegible] 1,320 feet east and 450 feet

north of this "CS" proposed test.

Q Was that well drilled for the purpose of determining the availability of water to drill the well if the permit was issued, and to obtain information for this hearing?

A It was.

Q On what date was that well spudded?

A April the 3rd.

Q Who was the drilling contractor?

A Abbott Brothers of Hobbs.

Q What kind of equipment was used?

A Cable tool.

Q Did you actually analyze samples from that well and were you present at the time most of the drilling was going on?

A Yes, sir.

Q Were water samples caught at various depths and analyzed?

A They were.

Q Have you prepared a log of the well which was so drilled?

A Yes, sir.

Q I invite your attention to Pan American's Exhibit 4 which has been placed on the exhibit board, and ask you to state whether or not that is the log which you prepared.

A This is the log.

Q I'm not sure whether I asked you the total depth to which this well was drilled.

A 294 feet.

Q Will you step to the board and describe to the Commission the formations that you cut and the water that was encountered or otherwise indicated in that well?

A Yes, sir. I would like to explain some of these symbols, Mr. Malone. I think it would be helpful.

Q Go ahead, it's your exhibit and you explain it.

A The color log on the left is my sample log through the formations;where I have the numbers, depth numbers down the center of the column, I obtained cable tool samples from those depths. I used limestone or caliche as the blue color; red shale is red; sandstone is yellow; anhydrite is purple; the diagonal dashes is gypsum beds and the ultramarine blue is dolomite beds. The combination of these, like it would be a sandy shale, would be the yellow over the red.

I thought I would explain this before I started because this is not only a combination of my sample interpretation and what we did, I took the liberty to put the sample log on an electric log that I ran after getting to the total depth of 294 feet.

This is the description on an induction log that was run at completion of the drilling of this water well. The blue line is where I took water samples on the way down. To explain the formation from the Rustler outcrop above the red marker

which I've called the Rustler formation, it topped in this well at 58 feet. Above would be our aquifer area or Triassic overburden from the east.

Q In drilling this well, at what depth did you first encounter water?

A I first encountered water at the depth of 60 to 65 feet.

Q What, if you know, was the quantity that you encountered there?

A The water, we couldn't bail the water and of course our driller estimated somewhere greater than 60 to 90 barrels a minute. We could not get a drawdown on this well.

Q Was this in barrels per minute or gallons per minute?

A Gallons per minute, excuse me.

Q Was that water tested as to its potability?

A Yes, it was.

Q What was the information on that test? Is that shown on the exhibit?

A The chloride content and the sulphate content is shown.

Q Will you state whether or not that is considered to be good potable water?

A That is good potable water of the area which is under 4,000 parts per million total solids.

Q Will you describe the drilling which continued to the next encountering of water?

A The next, actually, after we got about 85 feet, catching samples, why, we drilled dry till about 105 feet. We started getting another water flow or coming into the well bore, and I attempted to set the first case string at 124 feet.

Q Were you successful in shutting off water with it?

A No, sir, we could not shut this water off by normal driller's means and so we sampled the water from this area and this, what I've marked is the water sample 2 at 125 feet.

Q Was it likewise what would be considered potable water of the area?

A Yes, sir. It is well within the same water.

Q Do you know at what depth below the surface the water stood after you encountered this?

A The water still had a tendency to rise to this 45 to 50 feet.

Q Continue, then, in relation to water encountered below there.

A Ultimately we were trying to determine what type of section this was, and we had already found quite a bit of water at 185; we still could not get a drawdown and I tried once more at 180 to shut off this water, which was unsuccessful. I took another water sample at 185.

Q Did you find the condition of that water to be potable?

A Yes, sir, it is potable water.

Q Then what did you do below the 185?

A The 185, in drilling our bail test, I noticed the water was getting, the mud in the drilling fluid was getting salty at about 255 feet. I took a bottom water sample and this is a salt water.

Q What was the solid content of that sample?

A Chlorides over 80,000 parts per million.

Q What, if you know, was the quantity of water that you there encountered?

A We had no way of telling,because we couldn't get a draw-down or couldn't shut off this water, the quantity of it.

Q Will you state whether or not on the basis of your knowledge of the geology of the area there is a salt water deposit generally at the base of the Rustler?

A Generally at the base of the Rustler. Now my work on this well, we are still, as I note on my log -- estimated the top of the Salada or base of the Rustler at 408 feet, and recall that we stopped at 294 feet. I felt like I was in the -- locally called the brine aquifer, and I saw no reason to drill this from 294 down to 408 with my knowledge in the area it is predominantly shales with thin gyp stringers and probably not carrying much water.

Q Would you state whether or not it's your opinion that all water encountered from that depth to the top of the Salada would

be salt water?

A In my opinion it would be all salt water.

Q Were Pan American's Exhibits 3 and 4 prepared by you or under your direction?

A Yes, sir.

Q Is there anything further with reference to either one of them that you would like to explain to the Commission?

A I would like to explain a little bit. This was borne out -- normally we do not on cable tool holes run logs in them. My specialty being log analysis, we did run electric logs in this hole to help clarify this cable tool, or these samples that we found going down. This is an induction electric log with a gamma ray imposed on it, which I ran a gamma formation density log in this well, also.

This clearly stipulates the water zones, or if you are familiar with logging the conductivity curve, low conductivity is fresh water; and my salt water encountered in this well at actually 235 by my conductivity log gives me an interval of fresh water, low conductivity fluids, and then my high conductivity fluids. I just offer that.

Q Will you state whether or not, on the basis of your interpretation of this log information, water deposits were encountered at the places which you have indicated on this Exhibit 4?

A They were.

Q With reference to the general character of the aquifer there, is this a solution cavernous area or is it a uniform area in which water is found in the Rustler?

A This is a solution cavernous area because my interpretation in that,we have a very few sands which normally we call water sands through here; therefore, this water is found in these solution caverns of the gyp,anhydrite and dolomite. We do have some dolomite stringers and breaking, if I had to break the Rustler,why, I would call it three zones in the Rustler, as I say on this log, predominantly solution gas.

Q Your legend shows that you encountered substantial quantities of gypsum in this well, is that correct?

A That is correct.

Q Could you estimate the total number of feet of gypsum that you might have encountered?

A I haven't, Mr. Malone.

Q It's the cross-hatched purple area?

A It's the cross-hatched purple, and possibly fifty percent of the formation from 58 feet to 235 contains gyp beds.

MR. MALONE: We offer in evidence Pan American's Exhibits 3 and 4.

MR. PORTER: Any objection to the admission of these exhibits?

MR. BLACKMAN: No objection.

MR. PORTER: They will be admitted.

(Whereupon, Applicant's Exhibits Nos. 3 and 4 received in evidence.)

MR. PORTER: Does anyone have any questions? Mr. Blackman.

MR. BLACKMAN: Yes.

CROSS EXAMINATION

BY MR. BLACKMAN:

Q I might ask Mr. Clements what data you used to estimate the top of the salt at 408 feet?

A In the Well No. 4-A, salt was encountered, it was from that well. There's a well to the east, directly east, a P.C.A. core hole; I believe they encountered salt at 380, and it was 420 to the east of us. That is my estimation.

MR. BLACKMAN: That's all.

MR. PORTER: Does anyone else have a question? The witness may be excused.

(Witness excused.)

MR. MALONE: Mr. Livingstone, will you take the stand, please? By way of a preliminary statement to the Commission, so far as this witness is concerned, perhaps a more orderly order of presentation might have been to put another witness on before him, but the next to the last exhibit which has been posted on the board, which I believe is Pan American's 9, the schematic cross section of the well and casing program, will be introduced by the next

succeeding witness and shows that a product known as Casing-Cote is proposed to be used. This witness, Mr. Livingstone, is an employee of Halliburton Oil Well Cementing Company. He is appearing here under subpoena. He is not involved in this controversy and he does business with both parties to it, and he doesn't want to make anybody mad.

MR. PORTER: Does this include the Commission?

MR. LIVINGSTONE: Yes, sir.

MR. MALONE: He is here for the purpose of explaining the product Casing-Cote, which has recently been introduced in the industry.

J. B. LIVINGSTONE

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. MALONE:

Q Will you state your name?

A J. B. Livingstone.

Q By whom are you employed, Mr. Livingstone?

A Halliburton Company.

Q Where do you live?

A 3109 39th Street in Lubbock, Texas.

Q What is your position with Halliburton?

A I'm Division Engineer for the Lubbock Division.

Q How long have you been employed by Halliburton?

A Approximately eighteen years.

Q How long have you been in the Lubbock office of Halliburton?

A Approximately eleven and one-half years.

Q Does that office have jurisdiction over Southeastern New Mexico for Halliburton?

A Yes, sir.

Q Have you had experience with cementing jobs, casing programs and the like in Southeastern New Mexico during that period?

A I have, yes, sir.

Q Have you also operated in other areas of the Permian Basin?

A Yes, sir, I have.

Q What was your professional education?

A I have a B. S. degree in Math and Chemistry from Wofford College located at Spartanburg, South Carolina.

MR. MALONE: Are the qualifications of the witness as an expert in oil well cementing acceptable to the Commission?

MR. PORTER: Yes, sir, they are.

Q (By Mr. Malone) Does Halliburton have a process which is known to the trade as Casing-Cote?

A Yes, we do.

Q Is that a new process that's comparatively recently been developed for the use in cementing of wells?

A Yes, it is relatively new.

Q How long ago was it first released to the trade?

A Approximately one year ago.

Q Have you had experience in the cementing of wells through the use of this Casing-Cote process?

A Yes, sir.

Q Have you had that experience in Southeastern New Mexico as well as other places?

A I have, yes, sir.

Q Will you now describe to the Commission the general nature of this process; and if you have available a sample we will identify that and use it.

A Yes,sir, I have a sample.

(Whereupon, Applicant's Exhibit No. 5 marked for identification.)

Q Do you have available a photograph of this sample which has now been identified as Pan American's Exhibit 5 that we could hand to the Commission to be looking at?

A Yes, sir, I have one in this article.

Q What is the purpose of the process known as Casing-Cote to which you have referred?

GOVERNOR CAMPBELL: Do you wish to see a picture of this?

Q (By Mr. Malone) Would you describe the process and the purpose for which it was designed?

A The purpose of this material that we call Casing-Cote, and that's spelled C-a-s-i-n-g dash C-o-t-e, which is our trade name for this product -- The purpose of the product is to increase the bonding between the cement and the casing surface, which gives the cement a greater adhesion to the casing surface.

It consists of a plastic which is one of the family of apoxies and coarse sand. The plastic material is applied to the pipe before it sets, and the sand is applied to the plastic covering, and when the plastic sets, it cements or it adheres the sand grains to the casing surface.

Q Is the casing then run and the normal cementing operation performed?

A Yes. When this material has been applied to the casing, it is allowed to set and then the casing is run in the well in the normal manner, and cementing operations are also performed in the normal manner.

Q I notice that on Applicant's Exhibit 5, your sample, that a portion of it is black and a portion of it is natural pipe color. Will you explain that?

A This sample is a representation of the material applied to a small piece of pipe. The three surfaces represented on this particular sample represent the coating that is normally received

on the casing from the steel mills, which is the dark end. The area in the center represents a section that has been sand-blasted to roughen the surface, and the end that has the sand grains attached to it is the completed Casing-Cote application.

What is obtained from this is the bonding is increased or the effectiveness of the bonding is increased tremendously by the use of this rough surface.

Q Has Halliburton performed tests to determine the relative increase in the strength of the bond between the cement and the Casing-Cote as compared to the strength of a bond between the cement and ordinary casing?

A Yes, we have.

Q How much greater is the strength of the bond that results from the use of Casing-Cote?

A Our tests indicate that the bonding strength represented in pounds per square inch of pressure, we have an increase in the pressure required to break the bond of from four to five times, comparing the Casing-Coted surface to the regular received surface.

Q Will you state whether or not through the use of Casing-Cote the likelihood of obtaining a uniform bond to the casing from a cement job is also increased?

A Yes, this is true.

Q For what purpose, if you know, has the Casing-Cote which

you have applied in New Mexico been used by operators?

A The purpose for which this material has been used is to aid in the prevention of the migration of fluids such as water, oil, or gas from one horizon or zone to another in the well bore.

Q Is Halliburton now selling this product internationally?

A Yes, sir.

Q And recommends it for use in appropriate cases?

A This is true.

Q Have you personally had an opportunity to examine the proposed casing and cement program in the Pan American well which is portrayed on Pan American's Exhibit 9, which will be introduced by the next witness?

A I have.

Q Do you have any recommendations or suggestions as to any way in which that could be improved?

A I do not. It is an excellent program, in my opinion.

MR. MALONE: That's all.

MR. PORTER: Does anyone have a question?

MR. BLACKMAN: I would like to ask a question, please.

CROSS EXAMINATION

BY MR. BLACKMAN:

Q Mr. Livingstone, if Casing-Cote is applied to a casing, and while the casing is being run into the well the Casing-Cote

is scraped against the side and scraped off, you would have the same approximate coating as you received when you received the casing from the mill, would you not?

A If the Casing-Cote were scraped off, this is true.

Q That's what I said, if the Casing-Cote was scraped off you would be back to the original situation, right?

A Yes.

Q Also, if the Casing-Cote, when it is in the well, is covered with drilling mud which is not properly removed, the cement will not bond to it, is that not correct?

A If the mud is not properly removed, it will not bond to it as well.

MR. BLACKMAN: Thank you.

MR. PORTER: Anyone else have a question? Mr. Malone, did you have anything further?

MR. MALONE: One further question.

REDIRECT EXAMINATION

BY MR. MALONE:

Q Have you, in your experience with this product, experienced any difficulty with the Casing-Cote being scraped off of the casing when it's being run?

A Yes, we have.

Q Has this in your opinion seriously affected the usefulness of the Casing-Cote for the purpose for which it was used?

A No, sir, we have no evidence to that effect.

MR. MALONE: That's all.

MR. PORTER: Any further questions? The witness may be excused.

(Witness excused.)

MR. MALONE: We offer in evidence Pan American's Exhibit No. 5.

MR. BLACKMAN: No objection.

MR. PORTER: The exhibit will be admitted.

(Whereupon, Applicant's Exhibit No. 5 received in evidence.)

MR. MALONE: Mr. Rodgers, will you take the stand?

JAMES T. RODGERS

called as a witness, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. MALONE:

Q Will you state your name to the Commission?

A James T. Rodgers.

Q Where do you live, Mr. Rodgers?

A Lubbock, Texas.

Q By whom are you employed?

A Pan American Petroleum Corporation.

Q What is your present capacity with Pan American?

A Petroleum Engineer, Senior Grade.

Q Have you had occasion to testify before the New Mexico Commission on prior occasions?

A Yes, sir, I have.

Q And you have testified as an expert Petroleum Engineer?

A Yes, sir.

MR. PORTER: Mr. Rodgers' qualifications are acceptable.

Q (By Mr. Malone) I assume that your present current responsibilities with Pan American are in the reservoir engineering field, Mr. Rodgers?

A Yes, sir, they are.

Q Have you had experience in well completion, as well?

A Yes, sir, I have.

Q Have you had occasion, in preparation for this hearing, to make a study of the Barber-Yates Oil Pool and the wells which are located in that pool?

A Yes, sir, I have.

Q I invite your attention and the Commission's attention to Pan American's Exhibit No. 7, which is now being distributed, and ask you to state what that exhibit portrays.

A Exhibit 7 is a base map of the Barber area showing the wells that have been completed in that particular area.

Q How are the wells that are now producing in the area indicated?

A The current producers are indicated by the red circles.

Q And how many current producers are there?

A There are nine wells currently on production.

Q Do you know from the allowable schedules what the allowable situation with reference to those wells currently is?

A Yes, sir, I do. Actually these nine wells have assigned to them only seven well units for the purpose of allowables. You will note in Section 20 slightly north to the center of the section there are four wells drilled on close spacing. Two each of these four wells share in allowable as a one-well spacing unit.

Q From what depth are the wells in this pool producing?

A These wells are producing from approximately fifteen, 1600 feet.

Q What date, if you know, was the Barber 4-A Well completed?

A The Barber 4-A was completed in July of 1942.

Q Do you have immediately available the other completion dates? Are they in that same range?

A To my knowledge they're in that same range. I do not have them listed here. Actually some of them were before that time.

Q Do you know what the cumulative production of the wells in the Barber Pool to date has been?

A The total field production as of the 1st of February, 1964, was 1,142,087 barrels.

Q Do you know what the cumulative production of the Barber 4-A is?

A The records that I have available to me on that well make it difficult to arrive at cumulative on it. I have a cumulative since January 1st of 1956 through the 1st of February, 1964. During that period of time, it recovered 12,081 barrels of oil. Prior to 1-1-56 I have only a total field cumulative and not a per well.

Q At what rate is the Barber 4-A producing currently?

A The latest production I have on the Barber 4-A is for the month of February, 1964, during which time it produced 299 barrels of oil, slightly in excess of 10 barrels a day.

Q Have you made a study to determine the recoverable oil remaining in place in the Barber-Yates Pool and the period of time that production can be expected to continue before the economic limits are reached?

A Yes, sir, utilizing the highest production performance, I have made such a study.

Q Is the study that you have made portrayed by Pan American's Exhibit 8?

A Yes, sir, it is.

Q Will you tell the Commission what Exhibit 8 shows and the conclusions that you draw from it?

A Exhibit 8 is a standard production decline curve for the

total Barber-Yates Oil Pool plotted on semi logarythmic paper as a function of time. Shown on the exhibit are the monthly pool oil production for the years 1962 and 1963 and prior to that time back to January 1st of 1956. The monthly average for each year is shown as a triangle.

Q On the basis of the information which you have plotted and your extrapolation of it, what are the remaining reserves of this pool?

A Based on extrapolation of the established decline rate of the pool at constant percentage, the remaining total field recoverable oil reserves as of the 1st of February, 1964, are 306,000 barrels.

Q Over what period of time will those reserves be produced, in your opinion, before the economic limit of production is reached?

A Approximately twenty years.

Q With reference to the judgment factor in your selection of the points from which to extrapolate, would you state whether or not the information shown on that exhibit would be subject to an even later date of abandonment?

A Yes, sir. If you will notice in the year 1963, and particularly during the latter part of the year, there has been an appreciable decrease in production from this pool, amounting to some six, 700 barrel a month increase. The information available to me does not permit me to state why this has increased.

However, utilizing normal engineering approaches, it would be perfectly reasonable to raise this decline or predicted decline rate line up to a value somewhat higher than where I have. I've taken off in 1964 here at roughly 2600 barrels a month. I could have raised the line up another seven, 800,000 barrels a month, which conceivably could increase the estimated life about three to four years.

Q I understand what you took to be a conservative approach to that problem?

A Yes, sir, I did.

Q Was it possible for you to extrapolate a curve on the Barber 4-A Unit that would mean anything?

A No, sir, it was not.

Q What is the reason it was not?

A This well is produced into a battery with other wells, and of course, production is reported on a per well basis; but the information available to us was not sufficient for us to actually analyze this well by itself. We are not or did not have any well test available on this well to us; consequently, we didn't feel it could be handled.

Q Do I understand that your testimony as to 1984 as a cut-off date for production in this pool applies to the average well in the pool?

A Yes, sir. In plotting a decline curve on a total field,

then you normally assume that the curve represents what you would call an average well within the field. Some wells will last longer, some shorter.

Q With reference to the Barber 4-A, will you state whether or not its recent production record has indicated that it is or is not an average well in the pool?

A The Barber 4-A is approximately an average well in the pool. It has shown some increases in the last few months after having been shut in for a few months. As I stated, in February it was up to 10 barrels a day or roughly 300 barrels a month.

The March, 1964 proration schedule has listed the allowable for this well as 20 barrels a day. Prior to that time the well had been exempted again. I do not know for sure the reason for this, although I do know the well had been shut in for some time until about a year ago when it was placed back on production.

Based on its allowable of 20 barrels a day, which is approximately one-seventh of the total pool allowable, and its favorable production characteristics in the last six months, it appears to be an average well.

Q Do I understand it is your opinion that it will be producing until approximately 1984?

A Yes, sir.

Q Have you made a study of the Oil Conservation Commission records and other evidence available to you as to the completion

of that Barber 4-A and the casing program that was used in it?

A Yes, sir, I have.

Q Will you describe that to the Commission?

A In drilling the Barber 4-A, 12-1/2 inch case string was set at 109 feet to shut off water entry into the well bore. This string was later pulled. The surface pipe as such is 8-5/8ths inch casing set at 437 feet and cemented with 50 sacks of cement. After setting the surface pipe the reports indicated that the well was drilled out with an 8-inch hole size to a depth of 1478 feet.

At this point, 7-inch casing was set and cemented with 50 sacks of cement. After cementing this string, the production string, the well was drilled out to 1539 feet and completed in the open hole interval from 1478 to 1539.

Q What does this information indicate the condition of the well or the hole and casing is opposite the 700-foot level at which mining is occurring by Potash Company of America?

A Using the annular area between the 8-inch hole and the 7-inch oil production string, and the volume of this annular space and the reported cement of 50 sacks, the calculated cement in the oil string is 800 feet from the surface. This would indicate that there is not cement in the annular space at the stated depth of the potash mine.

Q As you know, Mr. Rodgers, it is proposed, if the

Commission so authorizes Pan American, to drill the requested "CS" Well at a location within a circle of 100-foot radius around the Barber 4-A Well. What if any precaution does Pan American contemplate taking to be certain that it will not intercept or damage that well in any way?

A We will contact the operator, Barber Oil Company, and secure from them with their permission available records on this well, and after reviewing those records, determine what steps should be taken to assure that we will not endanger that well nor will we drill at a close distance to that well.

Q If it should be found necessary to do so in order to protect the well, is Pan American prepared to run a directional survey in the well, with the operator's consent?

A With the operator's consent, we would be prepared to run a directional survey in that well and determine the actual subsurface location of the well bore.

Q Are you familiar with the proposed casing and cement program of the Pan American "CS" Well No. 1?

A Yes, sir, I am.

Q I invite your attention to Pan American's Exhibit 9 which has been placed on the exhibit board, and is now being distributed, and ask you to step to the board and explain to the Commission in some detail the manner in which it is proposed to case and cement this well, if the Commission permits Pan

American to drill it.

A Our proposed program for this well includes a four casing string program. The surface pipe to be 20-inch diameter 94 pound per foot API grade H-40 casing to be set at 400 feet and cemented with Neat cement circulated to the surface as required by R-111-A.

The second string which we referred to as the salt protection string or the first intermediate string is proposed to be 13-3/8ths O.D., 54.5 pound API grade J-55 casing set at 1400 feet, again cemented with the required volumes sufficient to circulate, using a salt saturated one percent calcium chloride, 750 F.A. cement.

The second intermediate string or the 4,000 foot intermediate is proposed to be 9-5/8ths inch O.D. gradiated 36 to 40 pound per foot API grade J-55 casing set at 4,000 feet, and circulated with cement using 50-50 Pozmix Incor. and 100 sacks of Neat cement on the bottom.

The oil string or production string is to be 5-1/2 inch 17 to 20 pound per foot API grade J-55 and N-80, set at total depth and cemented with sufficient Trinity Inferno Slow-Set cement calculated to give a fill in the annular space to at least 600 feet above the top of the highest possible pay formation.

Q Will you refer to the areas in which it is proposed to use the Casing-Cote?

A The Casing-Cote is shown by the hashed marks as defined in the legend, and will be applied or is proposed to be applied on the salt protection string from a depth of 400 feet to 1400 feet, which includes the full exposed portion of that string and encompasses the State Mining depth.

In addition, a 200-foot section of Casing-Cote is proposed to be applied on the 5-1/2 inch production string above the highest perforations.

Q How is the location of those two applications of Casing-Cote selected, what is it designed to do?

A We selected these locations to assure good bonding on the salt protection string in the vicinity of the mine, and to improve bonding and strength characteristics of the cementing job above the producing formation.

Q Would that also prevent the passage of fluids through that area?

A It would improve the probability of any fluids passing through the area, yes.

Q I see at the top up on the Christmas tree something that is designated "Pressure Relief Valve." What is that?

A This is a safety feature that we have designed for this well.

Q Was this designed for this particular well?

A Yes, sir, it was.

Q In an effort to reassure Potash Company of America, and satisfy them as to the well?

A Yes, it was.

Q Will you describe it and how it would work?

A We propose to install a pressure relief valve connected to the annular space between the 5-1/2 inch production casing string and the 4,000 foot intermediate casing string. This will vent or allow to be vented this annular space at the surface at such time as the pressure within that space, or if such time should ever occur, would increase to a predetermined value. When the pressure increased, the pressure relief valve would open and bleed the pressure off and discharge it.

Q In the remote possibility that a casing leak might occur below, in any event below the 4,000-foot interval, what would occur with reference to any gas that might be in the annulus or in the well?

A Actually, if a casing leak occurs within this oil production string, the well fluids would enter into the annular space between the oil production string and the intermediate string and pressure up that annular space, migrating to the surface and being bled off by the pressure relief valve.

Q Do I understand that if, for instance, gas were migrating up the hole, when it reached the 4,000-foot level it would be vented through that pressure relief valve as a result of the opening that

you have left?

A Yes, sir, it would.

Q And that is the purpose of the uncemented interval below 4,000 feet?

A That's right.

Q Will you state whether or not, as a result of the arbitration session that was held, substantial changes were made in the casing program of this well, in an effort to reassure Potash Company of America?

A Yes, sir, they were.

Q Can you give an estimate of the approximate additional cost that Pan American is incurring on that basis for casing and Casing-Cote?

A Our bona fide or amended casing program as shown on this exhibit cost approximately $5,000.00 more than that originally proposed.

Q How does the protection that will be available in this well at the 700-foot level compare to the protection that now exists in the Barber 4-A at the 700-foot level opposite the mining horizon?

A Essentially, there's no comparison. We have here four strings of casing and a string of production tubing between the produced well fluids and the outside well bore. Two of these strings have full annular volumes of cement in addition to the

Casing-Cote, and the third string is vented through pressure relief. The Barber 4-A Well has no cement opposite the well bore at that depth and the annular space is open.

Q Is there anything further in connection with that exhibit that you would like to explain to the Commission?

A No, sir.

Q I invite your attention then to Pan American's Exhibit 10 and ask you to state what it is.

A Pan American's Exhibit 10 is again a schematic diagram of the well bore in the proposed State "CS" No. 1. The previous exhibit is not to scale due to the detail that we felt was necessary to show on it and attempts to draw it to scale would make it too large to handle conveniently. This exhibit is a simple schematic of the casing program drawn to a vertical scale of one inch equals 400 feet, and it shows the relative depth of the approximate mining area of 700 feet to the total depth of the well.

Q Will you resume your chair, please? Have you made a study to determine the strength of the casing, the shear strength of the casing at the level opposite the potash mine or 700 feet?

A Yes, sir.

MR. PORTER: May I interrupt a minute?

(Whereupon, a discussion off the record was held.)

Q (By Mr. Malone) You say that you have made a study to

determine the shear strength of the casing and cement at the 700-foot level in the proposed well?

A Yes, sir, I have.

Q What strength do you find?

A The strength of the combination casing string, four casing string at 400 feet is 1,951,000 pounds. I actually said the combination four string program, that's really just three strings. It does not include the strength of the 5-1/2 inch since it is not cemented at that depth. We included the bonded or bound-together portion. They have a total horizontal shear of 1,950,000 pounds.

Q Per square inch?

A No, that's pounds of force for shear.

Q You heard the testimony of Mr. Jack as to the areal extent of the potential producing area in the Strawn, Morrow and Devonian Pools which he anticipated might exist in the event that a producing well is completed here. Have you made a study to determine, on the basis of reservoir information available in comparable pools, the quantity of oil or gas which in your opinion might reasonably expect to be encountered in those reservoirs in the event the well does produce?

A Yes, sir, I have.

Q We are now distributing Pan American's Exhibit No. 11. Will you refer to Pan American's Exhibit No. 11 and state what is

shown in that regard?

A Exhibit 11 shows the estimated reserves of the three primary objective horizons, the Devonian, Strawn and Morrow, and the gross value, orking interest income and royalty value from these reserves.

Q What is the over-all figure, working interest income from the Devonian which might be anticipated?

A The working interest income that can be estimated from the Devonian is $5,590,000.

Q From the Strawn?

A $5,100,000.

Q From the Morrow?

A $1,430,000.

Q On the basis of the figures, will you give us the State and Federal royalty income figures which are shown at the bottom of the exhibit, which I would like to have included in the transcript?

A The State and Federal royalty income figures are based on straight acreage percentages in the 1825-acre area, and result in a value of State royalty from the Devonian of $675,000; from the Strawn, $630,000; and from the Morrow $169,000.

The value to the Federal government from the formations is $225,000 from the Devonian; $210,000 from the Strawn; and $56,000 from the Morrow.

Q Does your figure with reference to the State take into account any revenue from sales tax or severance tax at all?

A No, sir, it does not.

Q Assuming that to be approximately six and a fourth percent, how much additional amount would accrue to the State from taxes?

A These royalty figures are based on a one-eighth royalty so a tax of six and one-fourth percent would be exactly half of the royalty, so that the dollar value of taxes would be fifty percent of the dollar value of the royalty. For instance, in the Devonian, to the State we have $675,000 as value of royalty. In addition to that, the taxes would be one-half of that, which would be $337,500.

Q Mr. Rodgers, you obviously are not and cannot guarantee the existence of these oil and gas values in these reservoirs until they are drilled, can you?

A No, sir.

Q Have you, in making the study, made it on the basis of comparable reservoirs in the same general area, and applied the same factors to these computations that you have found to exist in these other comparable areas?

A Yes, sir, I have; all of these reserves are determined by analogy to producing formations -- or excuse me, fields producing from these same formations in the immediate area in this portion

of Southeastern New Mexico.

Q Assuming the correctness of Mr. Jacks' estimate as to the producing areas, are the figures which you have here offered on Exhibit 11 realistic, in your opinion?

A Yes, sir, they are.

Q Have you prepared the exhibits as to which you testified, or were they prepared under your direction?

A Yes, sir, they were.

MR. MALONE: We offer in evidence Pan American's Exhibits 7, 8, 9, 10, and 11.

MR. BLACKMAN: No objection.

MR. PORTER: The exhibits will be admitted into the record.

(Whereupon, Applicant's Exhibits Nos. 7, 8, 9, 10, and 11 received in evidence.)

MR. PORTER: Any questions, Mr. Blackman?

MR. BLACKMAN: Yes.

CROSS EXAMINATION

BY MR. BLACKMAN:

Q I would like to know, referring to Exhibit No. 11, whether or not all the figures on that exhibit refer to the production which you might expect from one well or from the total 1825 acres?

A For the Devonian and Strawn, they refer to the 1825 acres. For the Morrow, as stated previously, it includes only that proven

by one well or 640 acres.

MR. BLACKMAN: Thank you. That's all.

MR. PORTER: Mr. Nutter.

BY MR. NUTTER:

Q Mr. Rodgers, you stated that you would be willing to run a directional survey for a well, with the operator's consent. In your opinion, if the Commission should grant this application and permit Pan American to drill a well here, how close do you think you could drill the well to the existing well without endangering the well that's being drilled or the well that's already there?

A Mr. Nutter, I don't know that I can actually answer that. From what I have seen and heard, and with my experience with Pan American -- and I'm not claiming to be an expert on this -- I don't think we would want to get any closer than fifty feet to that well bore.

Q Your proposed surface location would be within 100 feet--

A That's right.

Q -- of the existing well?

A That's right.

Q Could you control your drilling in such a manner that you could assure the Commission and Potash Company of American that your proposed well would be no more than 100 feet from the existing well bore when it penetrated through the potash?

A Yes,sir, we could.

Q You could control it within that 100-foot circle?

A Yes.

Q Could you control it within a 175-foot circle of the existing well?

A Yes.

Q And down to, you say, fifty feet?

A Well, we could control it probably five or ten feet away from it. Of course, we wouldn't want to drill that close to it. By having a design plan of surveying the well as we drill it, we can control it.

Q You stated that you didn't think you would want to go closer than fifty feet. Would you be willing to go within fifty feet, or fifty feet from the existing well --

A Mr. Nutter,--

Q -- as you go through the potash?

A -- I'm not in the position to state that because that's not a decision that I could make. As I said, I'm not an expert on that phase of well drilling. I will state in my opinion, and I feel that I know enough to state at least an opinion, that we would be willing to drill within fifty feet. Exactly how close, I don't know.

Q When you are penetrating the potash zone, you'd be at an approximate depth of 700 feet, and then it would be another

700 feet before you would run your second string of casing of 13-3/8ths to 1400 feet. Would it be necessary to use any heavy mud in order to keep any pressures or anything like this under control?

A No, sir, it would not.

Q You stated that the shear strength, according to your calculations,at the 700-foot level was 1,950,000 pounds?

A No, that's at the 400 level. That includes the surface string. That's in the surface pipe, in the top 400 feet of the combination string.

Q Did you make any estimate of the shear strength at the potash level?

A Just a minute, let me refer to my notes. In developing a value for the 400-foot level, I should have enough numbers to give you an estimate at the potash level. It would be approximately 1,000,000 pounds.

Q 1,000,000?

A Yes, sir.

Q The difference being the loss of the surface pipe and the surface pipe's cement --

A Yes.

Q -- from that value. To your knowledge, are there any zones in this area which contain any hydrocarbons, other than the Yates zone, prior to the time that you would set your second

intermediate string at 4,000 feet?

A Not to my knowledge, there's not. That would be more in line with our geologist's studies than mine.

Q What is the present reservoir pressure in the Barber-Yates Pool?

A I have no pressures on that pool.

Q I presume all of these wells are pumping?

A That's right. That's my understanding.

Q Your Exhibit 11 reflects reserves from three different formations; however, your Exhibit No. 9 indicates that one string of tubing would be run and you have got one flow line there. In other words, you are talking about a single completion, or were you perhaps thinking of multiple completions or what?

A We have thought along the lines of a single or dual completion. Of course, this being an exploration well, we are not in any position to say exactly which of these formations will be productive. We will not have a triple completion, obviously, since we are only running 5-1/2 inch oil string casing. So it could be a dual completion.

Q If you were talking about a dual completion, would you modify the casing program in any way?

A No, sir.

Q In other words, 5-1/2 inch pipe would accommodate whatever tubing strings were necessary?

A Yes, sir.

Q The only thing that would be necessary to modify Exhibit No. 9 to provide for a dual completion would be the addition of possibly another packer and tubing string?

A Yes, this exhibit is drawn for a single completion with single production packer.

Q But in no way would the casing or the cementing program have to be altered for a dual?

A No, sir.

MR. NUTTER: I believe that's all.

MR. BLACKMAN: May I ask a question?

MR. PORTER: Mr. Blackman.

BY MR. BLACKMAN:

Q In your opinion, is this the very best casing program that you could conceive for this well?

A Yes, sir, it is, within all reasonable limits, in almost every instance. It does not apply to the oil string; it exceeds the API specifications but not by a great deal. For the salt protection string, the two strings at 1400 and 4000 feet, we have exceeded these specifications, gone beyond them.

Q Did I understand you correctly when you were testifying with respect to the Casing-Cote program that you have recommended here, that such a program would improve the probability that fluids would be denied access to the annular spaces?

A That's right.

Q But it wouldn't guarantee it, would it?

A No, sir, you can't guarantee that. As an engineer, I can't conceive of any fluids migrating at that shallow depth. It's beyond all reasonable probability in the language that I deal with, but of course, you can't guarantee it.

Q If there's enough pressure on them, then even at that depth, even at that shallow depth, if you put enough pressure on it it's a possibility, is it not?

A Yes, sir. The main thing I can't conceive is the pressure actually being in such a position as to cause any.

REDIRECT EXAMINATION

BY MR. MALONE:

Q In the event that such migration occurred, would not the relief valve and the escape hatch that has been provided in connection with it handle it?

A Yes, it would.

Q So it would not in any event endanger the 700-foot level?

A No, sir.

RECROSS EXAMINATION

BY MR. BLACKMAN:

Q If it migrated outside of your cement between the cement job and the surrounding rock, the annular space relief valve wouldn't do you any good at all?

A Let me explain. Referring to this exhibit again, below your 4,000-foot string you have an open annular space. In other words, we are not going to use a sufficient volume of cement to tie back in with the intermediate string. You have an open annular space that is tied into the vent channel; consequently, you cannot get a pressure build-up at any position in there to allow any pressure to be placed behind the pipe. You are venting prior -- or any pressures into the well bore prior to any confinement by casing string.

Q That open space in there which is not covered by cement between 4,000 and -- it's below 4,000 feet, that open space in there will admit whatever fluids are present down there, will it not, whatever corrosive fluids are present?

A Again, there will not be any producing formations above the top of that cement. If you notice there, we'll have to, after drilling the well, examining the well logs, determing the fluid-bearing characteristics of the various formations, then design the cementing program so there are no exposed fluid-bearing formations in that space.

Q Can you guarantee that?

A Within reason, I can guarantee that, because if one is present we will know it immediately and we'll have to go back in and put a little more cement in there.

Q Can you guarantee that the little more cement that you

put in will do the job?

A Yes, sir.

Q You can guarantee that?

A Yes, sir. We'll have to keep putting cement in there until we have no pressure at the surface on the annular space. I can't conceive of any fluid-bearing formations that bear fluids or any appreciable pressures being in there without our knowing.

Q Can you guarantee that your cement will probably bond at that location?

A Again, if it doesn't bond we'll have pressure indications at the surface, if there's anything open or channeled into that annular space.

Q What fluid will be in that annular space,in that open space?

A I am sorry, I don't understand you.

Q What fluid will be in that open space?

A From what source, cement drilling mud.

Q But it doesn't come up quite that far above the cement. What fluid will be in there?

A Drilling mud.

Q The annular space will be full of drilling mud?

A Yes, sir.

Q If your seal is imperfect at 4,000 feet, the gas or hydrocarbons could migrate out of it, couldn't they? You have

no seal at all there?

A Well, at 4,000 feet we have, of course, the seal is that second intermediate string cemented, and in order to have any migration behind that pipe, you would have to have a pressure differential such that the fluid could flow behind it. You cannot build up a pressure differential because the annular space opposite that is vented through the relief valve.

Q How much drilling mud would you have in that annular space?

A It would essentially be full.

MR. MALONE: If the Commission please, the witness is talking about one thing and the Counsel about another. The witness is talking about when the well is being drilled, and Counsel is talking about after it's completed, if I understood him.

MR. PORTER: Is that right, Mr. Blackman?

MR. BLACKMAN: I'm talking about what's in that open area below 4,000 feet after you have completed your well.

Q (By Mr. Blackman) What fluids would be present in there?

A It will be whatever fluid was in the well bore, which in all probability would be drilling mud.

Q If there is any fluid in the surrounding rock through which you have drilled in there, any corrosive fluids such as salt solutions or things of that sort, they would be there, too,

wouldn't they?

A Well, they would not; they could not enter the well bore in the presence of the drilling fluid, to any appreciable degree. Of course, we maintain constant surveillance of our drilling fluid properties, and if foreign fluids are entering the well bore, of course we're aware of it from fluids, and also the purpose of the drilling mud is to keep fluids from entering the well bore, or else, of course, your well would not be under control.

Q But it doesn't always work, does it?

A Most of the time, yes, sir.

Q But not always?

MR. SMITH: If it please the Commission, I think Counsel should define what he means by "it".

MR. BLACKMAN: That the drilling fluid prevents the entry of such things as gas blow-outs and such things as that.

A Yes, sir, there are blow-outs.

MR. BLACKMAN: Thank you. That's all.

MR. MALONE: I have some further questions of this witness, in the light of the interrogation.

REDIRECT EXAMINATION

BY MR. MALONE:

Q Will you step over here, Mr. Witness? It seems to me that there may be some danger that the, what I like to refer to

as your escape hatch here, is not being clearly identified. Will you please take a pencil and draw an arrow starting opposite the cement, indicating the direction of movement of fluids which might be moving up this well bore and the direction of movement into this annular space through the opening?

GOVERNOR CAMPBELL: This is on Exhibit 9.

MR. MALONE: Thank you. On Exhibit 9.

A The fluids from the source that you mentioned would enter the well bore into this annular space, and at that point create a pressure increase which will be transmitted to the surface through the annular space all the way, and out through the pressure relief valve.

Q Will the pressure in this annular space at all times be less than the rock pressure outside, so that any migration would have to occur in the annular space rather than outside of the cemented casing?

A The pressure from the source of fluid migrating would have to be greater than the pressure in the annular space, to enter the space.

Q Do you conclude from that that there is no practical possibility of migrating fluids continuing, as Counsel suggested, up the outside of the casing or out between the cement job and the formation, rather than going up the annular space and out the relief valve?

A That's right.

MR. MALONE: I think that's all.

MR. PORTER: Does that conclude your questioning, Mr. Malone?

MR. MALONE: It concludes my questioning and concludes the case-in-chief of the Applicant.

MR. PORTER: Does anyone else have a question? Mr. Nutter.

RECROSS EXAMINATION

BY MR. NUTTER:

Q Have you given any consideration to the use of a staging tool and bringing the cement on the 5-1/2 inch pipe up into the second intermediate string?

A We considered bringing that cement up, and actually we initially planned to bring it up until we decided on, or through discussing this thing, arrived at this relief valve idea. We felt that the relief valve, the pressure relief valve offers more safety advantages if the cement does not tie in with the 4,000-foot string. That way, as we just pointed out, there's no source from which fluids can come without first pressuring up or being introduced to that annular space.

Q That would be for fluids entering into the well bore from other formations between the top of the pay and the 4,000-foot casing shoe?

A That's right. If you please, I would like to clarify one thing. We have gone along this line about fluid entering there, and, really, the possibility of that is just so far remote that it's really a secondary thing that we're trying to accomplish with this pressure relief valve. This is primarily for a casing leak or movement of the produced fluids out that oil string into the annular space. Of course, secondarily, then, and of some importance, is the fact that it offers pressure relief for fluids from any source into the annular space.

Q The use of the pressure relief valve and mud below the second intermediate shoe gives possibly more protection insofar as fluids entering the well bore from other formations. However, as far as casing protection from the 5-1/2, would you not have better protection with the cement brought back into the intermediate string?

A You possibly could, yes, sir. It's --

Q It would be determined from the drilling of the well that there wouldn't be any pays or pressure below the intermediate string to the top of the pay?

A That's right.

Q That would have been determined in the course of drilling?

A Yes, sir, that's right.

Q But we're presuming that you have production at a depth

of some 12,000 feet, so you know you'd have pressure in the 5-1/2 inch pipe?

A Yes, sir.

Q So if you have a choice, then, of providing more protection against fluids entering the well bore from a direction that you know you have pressure, or providing more protection from a source that there may be pressure but you don't think there is, which is more advisable to protect against?

A Well, of course, if you know those conditions, it would be more advisable to protect against the known source.

Q I think you said a while ago that without the pressure relief valve you would get more protection by bringing the cement up, is that right?

A No, what I was trying to say was the use of cement up into the 9-5/8ths pipe would provide more protection from the pressure within the 4-1/2 inch pipe than the use of mud there and the pressure valve on the annular space.

Q As far as protection from pressure within the 5-1/2 inch pipe?

A Yes, sir, it would.

Q Have you made any estimate of the cost of two-staging or three-staging the cement on the long string and bringing it up into the 4,000 foot level?

A No, sir, I haven't. As I said before, it was initially considered for this well and actually had been planned on, so

it's not prohibitive, if the Commission in reviewing this should decide that that would be preferable, it would certainly be agreeable with Pan American.

Q Then the pressure relief valve could still be put on the annular space to determine if any leaks occur above?

A Yes, we could actually tie our cement back in with the 4,000-foot pipe and still use the pressure relief valve.

MR. PORTER: Any further questions? The witness may be excused.

(Witness excused.)

MR. PORTER: The hearing will recess until 1:30.

(Whereupon, the hearing was recessed until 1:30 o'clock P.M.)

* * * *

MR. PORTER: The hearing will come to order, please. The Commission will recognize Mr. Blackman.

(Whereupon, Potash Company of America's Exhibits A through S marked for identification.)

MR. BLACKMAN: If the Commission please, in presenting Potash Company of America's case, I will first have Mr. Houston Clark, who is our Vice President in charge of production. He'll give testimony on the general picture.

We'll follow that with the testimony of Professor Bass, a Petroleum Engineer, who will give specific testimony regarding

the reservoir which might exist. He'll be followed by Mr. Cummings of Potash Company of [illegible] for the purpose of identifying some exhibits that may have been in; and my last witness will be Mr. J. W. Woomer, a Consulting Mining Engineer from Pittsburgh, who will present specific testimony with regard to the subsidence at the surface and the convergence below the surface and the actions of the earth when the sub-adjacent support is moved on second mining; and any questions about mining engineering that may come up will best be addressed to Mr. Woomer, although I'll put in some testimony with Mr. Clark.

HOUSTON M. CLARK

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. BLACKMAN:

Q Will you state your name, please, Mr. Clark, and your current occupation?

A Houston M. Clark, Vice President in charge of production for Potash Company of America.

Q How long have you been with Potash Company of America?

A Twenty-three years.

Q Where did you receive your education?

A Rice University.

Q What is your professional degree?

A Bachelor of Science degree in Chemical Engineering.

Q Where are your headquarters?

A Carlsbad, New Mexico.

Q You are the officer of Potash Company of America in charge in Carlsbad?

A Yes, sir.

Q Mr. Clark, I hand you a document which has been marked as Potash Company's Exhibit A, and ask you to identify it, please.

A This is a Potash Mining Lease No. M-274, issued to Mason A. Lewis March 12, 1929.

MR. BLACKMAN: If the Commission please, I will have to ask your indulgence at this point. I had requested certified copies of all these documents from the Land Commissioner's Office for the purpose of introducing them into evidence as the certified copies, and the Land Commissioner has not been able to sign the certificates. I'll have to present the copies we have from our file copies. We are going to ask leave to withdraw them and substitute certified copies as soon as we can get them signed.

GOVERNOR CAMPBELL: Any objection?

MR. MALONE: I have no objection. I don't believe -- the lease is not dated March 12, 1929, it is dated June 30, 1931.

A If you please, let me correct that. I did read the date the Act was approved, rather than the date of the lease, which is the 30th day of June, 1931.

Q (By Mr. Blackman) I'll hand you a document marked for identification as P.C.A. Exhibit B, and ask you to please identify that.

A Assignment of Potash Lease M-274 from Mason A. Lewis to Homer H. Harris.

Q I'll hand you a document marked for identification as P.C.A. Exhibit C and ask you to please describe that.

A This is a Release of Potash Mining Lease M-274 from Homer H. Harris to the Potash Company of America.

Q Mr. Clark, do all three of those documents cover the Southeast Quarter of Section 17 in Township 20 South, Range 30 East, N.M.P.M.?

A Yes, they do.

Q And other property as well?

A Yes.

Q Mr. Clark, will you kindly read from Exhibit C the statement directly following the description into the record?

A "The relinquishment of the potash mining lease herein is made for the sole purpose of consolidating said lease with three others held by Homer H. Harris, to-wit: Potash Mining Lease No. M-306, Potash Mining Lease No. M-275, and Potash Mining Lease No. M-348."

Q Now I'll hand you a document marked P.C.A. Exhibit D and ask you to please identify that document.

A This is an Application for Lease on State Lands for Potassium, Sodium, Phosphorus, Etc., which states: "Whereas Potash Mining Leases Nos. M-274, M-275, M-306 and M-348 held by the applicant, have been relinquished solely for the purpose of consolidation into one lease, and desiring to secure such consolidation, I, Homer E. Harris of the City and County of Denver, Colorado, hereby make application for a lease for the development, exploration and production of potassium, sodium, phoshorus, and their salts and compounds, as authorized by the Act of the New Mexico Legislature above cited..." It then described the lands which are covered by the application.

Q Mr. Clark, I'll hand you a document marked P.C.A. Exhibit E and ask you to please identify this document.

A This is a certified photostatic copy of Potash Mining Lease No. M-873 dated April 24, 1939.

Q Is that the lease which is issued in consolidation of the Exhibits A, B, C, D, and F?

MR. MALONE: If the Commission please, we object to the question for the reason the the lease itself contains no recital of consolidation in it, no reference to any prior lease. It would be a violation of the parol evidence rule and it has not been shown that this witness has any personal knowledge of these transactions whatever.

MR. BLACKMAN: I will withdraw the question.

Q (By Mr. Blackman) Mr. Clark, I'll ask you to refer to the sketch placed on the wall which is identified with a large red "G" and ask you to please describe that.

A If I may step up here. This is a copy of a projected area of development which is presented to the Oil Conservation Commission once a year. This is the copy of the one presented in January of this year. The red area depicts open mine workings; the green areas, projected development areas within the next five years.

Q Mr. Clark, I'll hand you a document which has been marked for identification as P.C.A. Exhibit F and ask you to please identify that document.

MR. BLACKMAN: If the Commission please, I was not able to get copies of Exhibit F in time for presentation to opposing counsel and for the extra copies to the Commission.

Q (By Mr. Blackman) Please identify it, Mr. Clark.

A This is an unsigned -- I should restate this. This is a copy of the Assignment of State Potash Lease No. M-873 from Homer Harris to Potash Company of America dated August 7, 1952.

GOVERNOR CAMPBELL: What exhibit number is this?

A Exhibit F.

GOVERNOR CAMPBELL: Isn't that the lease?

MR. MALONE: I believe that is "E".

A That was "E", Governor.

GOVERNOR CAMPBELL: Excuse me. What is this again?

A Assignment of the Lease from Homer F. Harris to the Potash Company of America.

GOVERNOR CAMPBELL: Dated?

A August 7, 1952.

Q (By Mr. Blackman) Now, Mr. Clark, I'll hand you a document marked P.C.A. Exhibit H and ask you to identify that document.

A This is a plat of both the developed and undeveloped ore in the general area in which Pan American has made application to drill.

MR. BLACKMAN: This exhibit is presented principally so you have a letter-size exhibit showing this area.

MR. MALONE: Is this No. G?

MR. BLACKMAN: That is No. H.

MR. SMITH: Where is "G"?

MR. PORTER: "G" is the exhibit showing the open mine workings.

MR. BLACKMAN: That's right. It's on behind.

Q (By Mr. Blackman) Will you please comment on the reserves in the area of Exhibit H, potash reserves?

A Yes. On the plat as presented there is a cross-hatched red section which represents virgin potash. The cross-hatched blue section represents open mine workings. In the red cross-

hatched area, the ore averages in thickness 4.13 feet at a grade of 24.4.

GOVERNOR CAMPBELL: Hold on a minute. We don't have colored maps. What landmark is he referring to here?

A Can I trade with him?

Q (By Mr. Blackman) Yes, will you do that? I will ask you another question. The area on Exhibit H which has slanted marks to the right is colored on some exhibits pink.

GOVERNOR CAMPBELL: That's from the northwest to the southeast?

MR. BLACKMAN: That's right, and the other area which is slanted to the left from the northeast to the southwest is colored blue. Mr. Clark has previously testified that the blue marks represent open mine workings.

A In respect to the virgin potash area which is cross-hatched slanting to the right, the ore averages 4.13 feet, and this is 4.13 feet in thickness and 24.4 percent K_2O in grade.

MR. PORTER: 24 point what?

A 4. In that area there exists 3,800,000 K_2O tons of ore in place.

Q What would the value of that potash be, Mr. Clark?

A If we were to extract 90 percent of the reserve and recover 90 percent of that extraction in our surface plant processing, and sell it at the average price which we sold potash

for in the previous fiscal year, the value would be approximately $115,000,000.

Q Is 90 percent mining extraction and 90 percent mill recovery, are those two figures reasonable under the circumstances?

A Yes, they are.

Q Are you conducting mining operations at the present time in this area?

A No, we are not.

Q Will you kindly explain why we ceased mining in this area?

A We ceased actual mining operations in this area in 1957 because this particular ore is contaminated with carnalite to the extent that it created serious inefficiency in our surface plant operation.

Q Have we taken any procedures to correct this situation?

A Yes, we have. Subsequent carnalite contacts in this section of our mine forced the decision to modify our surface plant so that we could handle limited quantities of carnalite contamination. This modification was completed in 1963 at a cost in excess of $5,000,000.

Q When do you plan on returning to this area for mine development operations?

A Our current plans call for re-entry sometime the latter part of this year. The exact time depends upon the availability

of equipment which is now mining in other areas. The planned mining for this equipment should complete around the 1st of November and, give or take a month or two, we should be in there by the 1st of December this year.

Q Will you please describe the type of mining employed at P.C.A.?

A We use principally continuous mining machines coupled with conveyor belt haulage systems, and we mine with a standard room-and-pillar system driving rooms 32 feet wide on 72-foot centers, which leaves a pillar of approximately 43 foot square.

Q Do we use machine mining or conventional mining, and would you explain the difference?

A Machine mining is employed almost entirely by P.C.A. This, coupled with conveyor haulage systems, demands straight line mining, no devi tion in terms, as opposed to the system in which ore is drilled and shot down with dynamite and picked up and conveyed with mobile equipment.

Q Will you comment concerning the development program which would be entered into using machine mining and belt haulage?

A In this particular area, we would begin to drive a four-entry system from an existing working to the limit of the ore, and define that limit.

Q Then what?

A After reaching the limit, we would start a retreat opera-

tion mining on return from the boundaries back towards the existing haulage system.

Q Mr. Clark, will you please comment on the necessity of blending ore for the purpose of maintaining uniform mill heads?

A In particular mine we have two factors in this regard. One is grade of the ore in respect to its K_2O content. The other is the quantity of carnalite in the blended ore. Both must be controlled for efficient plant operation, and particularly the carnalite content must be controlled in order to have an efficient recovery within the plant.

Therefore, we mine and produce from various sections simultaneously, blending these ores to maintain these controlled conditions.

Q Will you comment on mining practices in the area, first mining and second mining, and distinguish between the two?

A In first mining we generally take on the average 65 percent of the ore in place. This varies, some of it is on the low side of 65, some is on the high side; but on the average, 65 percent is removed, in first mining.

In second mining, the average condition is to extract an additional 25 percent, which would give you a total on the average for total extraction of 90 percent of the ore in place.

Q When you complete second mining processes, will you kindly refer to Exhibits I, J, and K which are posted behind the

Commission and comment on what occurs on both first mining and second mining, and describe those three exhibits, please?

A Yes. First let me say, if the Commission please, I'll just give a general description of what these exhibits represent and later in our testimony Mr. Wilmer will give details on what happens.

The first sketch shows the situation in which first mining only has been done. This area here is the ore horizon. The darkened area represents pillars, the light areas represent rooms through which the ore has been extracted. Above the ore zones we show a generalized section of the various strata which exists above the potash zone to the surface.

The second sketch, Exhibit J, shows the situation in which pillar extraction has been undertaken. The weakened pillars have become too small and show an hourglass effect as they begin to fail. I might also say that although this is diagrammatic, it indicates a removal of about two-thirds of the remaining pillar.

This sketch, "K", depicts what's happened after the pillars actually fail. The roof in the ore zone has come down, it breaks into pieces and fractures to the first clay zone. We envision that the salt sections immediately above there, being plastic in nature, actually bend and flow and come down as a unit. As you get above that area and get into some of the more

solid structural formations such as the gypsum, the dolomites, we envision that you get actual and complete fracturing of the strata in those areas.

This phenomena carries clear to the surface, and as we [illegible] actually get surface cracking. The ground opens up in spots in a very un-uniform pattern.

We show on here a situation in which the pillar extraction is proceeding from right to left, and you will note a line here which, upon the right side we show fracturing, on the left we show no disturbance. The angle of this line has been determined by practical experience in the Potash Basin as 45 degrees.

In other words, on an angle from 45 degrees from the vertical, from the point at which the pillars have failed to the surface, within that area you get fracturing of the ground and distortion on the surface.

As you move this way with your pillar extraction, this line moves with you, so that this moves on along, this disturbance, as long as you continue to pull pillars and let the roof of the mine come down.

Q Mr. Clark, will you describe the current mining practice in the Potash Basin in leaving pillars for the protection of oil wells which may be in the potash area?

A Well, first of all, the practice is to leave a 100-foot

radius pillar around existing oil wells. This is a solid area pillar which is not entrenched upon.

Q These are principally the Yates wells?

A Yes.

Q Are there any high pressure wells around any working areas in the P.C.A. mine?

A No, there are not.

Q Will you also then please describe how close you can mine to an existing producing well?

A Well, we prefer to, in fact, we demand that we stay -- we do not let this subsidence area encroach on an oil well with this 45-degree angle and at a depth of 700 feet, which is average for this particular area we're considering. This means that on the surface you must leave, or around the well you must leave a barrier which is some 700 feet in diameter. When I say barrier, I mean that within that 700-foot radius pillar, we cannot permit second mining because this will occur.

Q You mentioned both diameter and radius. Will you kindly clarify it?

A 700-foot radius.

Q Is that 700-foot radius determined by the depth of the potash?

A Yes, the depth and this angle.

Q Are you conducting any pillar removal operations at

the present time, P.C.A.?

A Yes, we are. In an area just to the north and west of Section 17, we are retreating and splitting pillars in that particular area on an experimental basis to determine just what pattern or percentage of pillar extraction and rate of retreat to maintain for that particular area.

Q Mr. Clark, will you kindly give us an estimate of the value of the potash ore which would have to be left in a 700-foot radius pillar to protect a producing oil well in this area of the Potash Company of America mine?

A In this particular area of Section 17, the potash left in place would have a value of approximately a million dollars.

Q Mr. Clark, I'll hand you a document marked P.C.A. Exhibit L, and ask you to please identify that document.

A Exhibit L is a letter dated April 10th, 1964, written by Mr. R. S. Fulton, the Regional Mining Supervisor of the U.S.G.S., and addressed to Potash Company of America.

MR. BLACKMAN: I now hand the original of Exhibit L to Mr. Malone. Mr. Fulton is here in the audience if you would care to verify it further.

MR. MALONE: If it please the Commission, I don't know what the contents of this letter are. I will object to any testimony by this witness or through this letter as to matters in the knowledge of Mr. Fulton, who is available, who should

testify and be subject to cross examination as to them. As soon as I can read the letter, I will see if I can stipulate it in; otherwise, we would object.

If it please the Commission, the letter, from a very hurried scanning of it, contains a great deal of detailed testimony as to which we feel [illegible] presented for consideration in the case, it should be from the personal knowledge of the witness presenting it and not by hearsay letter. Because it is hearsay, we object to the admission of the exhibit.

MR. BLACKMAN: I won't offer this in evidence at this time. I have another witness who will testify to the details of just how we figure this. It has been customary in these cases to put in a letter of this kind simply to show the various methods, or the more or less generally approved method of calculating the value of potash reserves in place.

GOVERNOR CAMPBELL: You are withdrawing this, then?

MR. BLACKMAN: I haven't offered it. It's just identified.

MR. SMITH: Have you offered any exhibits?

MR. BLACKMAN: I haven't offered any.

MR. SMITH: I just wanted to be sure.

Q (By Mr. Blackman) Mr. Clark, what are your plans relating to second mining around potash core holes and shallow, low pressure oil wells?

A If I may, I'll discuss those in somewhat separate categories. On potash core holes, the plugging operations after the core was taken were all under the direct and close supervision of the engineering staff of P.C.A. We have complete records of these plugging operations, and in those cases in which the records show that the substantial and complete plug was effected, we will second mine in those areas.

MR. [illegible] all of the area including the core hole?

A No, sir. We will leave the 100-foot radius solid barrier pillar around the well, but we will second mine within this subsidence area. We will let subsidence take place but we will leave the 100-foot solid radius barrier pillar around it.

On shallow, low-pressure producing wells, we will not second mine. On abandoned or non-commercial shallow wells in which we can convince ourselves that a complete and adequate plug has been effected below the salt section, above the salt section, and through the salt section, we will second mine.

Q (By Mr. Blackman) Have you ever encountered any hydrocarbons in the mining operations at the Potash Company of America?

A Yes, we have.

Q Would you testify concerning those, please?

A Yes. In 1947, while driving our main south haulage

entry, we contacted a show of oil and methane. At that time the drive was stopped and offset and again taken up, and after another advance of some two or three hundred feet, we again made a contact of oil and methane. However, we passed on through the zone without difficulty at that time.

Q Did you encounter oil seeps in any other place in the P.C.A. mine?

A No oil seeps within the mine. However, we did core a test in an area somewhat close to this show within the mine, and found evidence of oil in that core.

Q Mr. Clark, I'll hand you a document marked P.C.A. Exhibit M, and ask you to please identify it.

A Yes, this is a plat that shows our main south haulage entry, the two areas in which we made contacts with hydrocarbons and also the location of an oil test known as the Continental Chase, which is in Section 8.

The first contact of oil-methane was 1400 feet from this well. The second contact was within 900 feet of the well, and the core hole which showed the presence of hydrocarbons in the core was some 1800 feet from this oil test.

I understand that this was a non-commercial producer abandoned in the late 20's.

(Whereupon, Potash Company of America's Exhibit No. N marked for identification.)

Q Mr. Clark, I hand you a physical exhibit here which has been marked P.C.A. Exhibit N, and ask you if you will please identify that.

A Yes, this is a section of the core taken [illegible] Core Well No. 107, and this particular piece of the core came from a depth of 930 feet 8 inches, and the upper end of it is oil-stained.

Q Mr. Clark, does Exhibit M reflect the locations of the oil seeps that you have mentioned and also the location of P.C.A. Core Hole No. 107?

A Yes, it does.

Q Do you know of any other areas where the salt section is charged with hydrocarbons?

A I can state that in Case No. 862, the Commission case in which Order No. R-111 was entered, that Mr. Standley, an Oil Conservation Commission engineer, stated that the salt section in the Hobbs Field --

MR. MALONE: We object to a re-statement by this witness of what the Commission engineer testified in a hearing in which there is a transcript that could be resorted to.

MR. BLACKMAN: If the Commission please, this is the very case in which Order R-111 and R-111-A were entered. It's one of the reasons why the order was entered was the testimony of the Commission witness.

MR. MALONE: The objection is on the basis that the evidence is hearsay from this witness.

MR. PORTER: The objection is sustained.

Q (By Mr. Blackman) Mr. Clark, what do you estimate is the remaining life of the P.C.A. operation in the Carlsbad area?

A Our present rate of production, and based on our present estimate of remaining ore reserves, it is sixteen years.

Q When will the mining be completed in the area shown on Exhibit H, P.C.A. Exhibit H?

A For all practical purposes, extraction in this area will be coordinated with complete extraction in all of our remaining mining property. As I mentioned earlier in my testimony, we must maintain a controlled K_2O content and a controlled percentage of carnalite contamination. In this particular area, we have relatively high grade ore in respect to K_2O content.

However, at the same time it is rather high, relatively high in carnalite content. So to use this ore from K_2O content to blend with lower grade ores in other sections of the mine, we will control this extraction. At the same time we will be controlling the carnalite content of the blended ore to the extent that we can stay within our design limits on our plan. So we project that we will [illegible] this area at about the same time we complete all of our [illegible].

Q Would you give us the approximate size of the present workings?

A In length, about six and three-quarters miles; in width, the widest point, about four and a half miles. We have open areas underground which total in length 825 miles, which are all completely interconnected.

Q Those openings underground are 825 miles long and how wide?

A Essentially they are all thirty-two feet wide.

Q About how deep?

A On the average, about 1,000 feet from the surface.

Q From the surface?

A Yes.

Q The height from the floor to the roof inside the opening, how much would that be on the average, approximately?

A The average would be in the neighborhood of five feet.

Q Could you give us the approximate value of one year's production at the P.C.A. at current prices and rates?

A Slightly in excess of $20,000,000.

Q Could you tell us how much that $20,000,000 of potash would generate in freight rates?

A This is an approximation, but freight would run about 70 percent of the sales price of the potash, so you would have something like $14,000,000 in freight paid for delivery of the

potash.

Q Right now, how many employees does P.C.A. have?

A About 800.

Q I hand you a document marked P.C.A. Exhibit P and ask you to identify that, please.

A Yes, this is a reduced copy of one page of the Esterhazy, Saskatchewan, Canada Miner, which is a local newspaper in Esterhazy, Saskatchewan, dated February 20, 1962.

It generally develops and outlines the potash production potential in the Province of Saskatchewan and relates that potential to other known potash areas in the world.

Q Mr. Clark, based on your knowledge of the potash industry and world-wide deposits, do the maps on this page fairly represent the world-wide potash deposits?

A To my knowledge, they do.

Q Mr. Clark, I hand you a document marked P.C.A. Exhibit Q. and ask you to identify that document.

A This is a certified copy of Public Land Order 2199 which withdraws public lands from oil and gas leasing for preservation and development of potash deposits belonging to the United States and in the State of Utah.

MR. BLACKMAN: If the Commission please, I think it's common knowledge that the land in Utah is in process of transfer from the Federal Government to the State Government. We

understand that that's ready for signature, it's all been approved. We don't have that proof now. It may already be transferred, perhaps we can get it.

We also understand that the State has withdrawn and issued some kind of an order withdrawing all the potash area from all oil and gas development.

GOVERNOR CAMPBELL: You are not offering this in evidence at this time?

MR. BLACKMAN: No, I don't have that.

Q (By Mr. Blackman) Mr. Clark, if a high pressure gas well were drilled through the potash deposits, would there be any change in the size of the solid pillar which would be left to protect the oil well?

A Yes, we would arbitrarily increase this to 200 feet.

MR. BLACKMAN: I think that's all for now.

MR. PORTER: Anyone have a question?

[illegible] you intend to offer these exhibits?

MR. BLACKMAN: Not right now.

MR. MALONE: If the Commission please, I'm entitled to find out whether or not these exhibits are out or in before I cross examine this witness. I think it would be appropriate for counsel to offer them if he thinks they are admissible. If he does not, I respectfully request the right to cross examine the witness after he does offer the exhibits.

MR. BLACKMAN: I have no objection to that. I was intending to present Mr. Cummings, who had prepared most of these exhibits, and he would testify that they were prepared under his direction. I have no objection to your cross examining Mr. Clark at a later date, but if you'll give me a few minutes here, I'll make an offer.

MR. MALONE: I would suggest, if Counsel would feel this was appropriate, that he go ahead and offer Mr. Cummings and establish that so we can get the exhibits before the Commission and have an opportunity to cross examine on the basis of that.

GOVERNOR CAMPBELL: I believe you should get these exhibits in evidence or out, one or the other, at an early time. You have presented them here.

MR. BLACKMAN: [illegible] satisfactory to you, Mr. Malone, if I have Mr. Clark step down and have Mr. Cummings take the stand?

MR. MALONE: Yes, entirely, sir.

MR. PORTER: Mr. Clark is excused for the moment. He may be recalled for cross examination.

MR. BLACKMAN: With respect to Exhibits A, B, C, D, E, and F, which are the leases, assignments, and releases on M-274 and M-873, I offer those in evidence. They are not certified. I ask leave to withdraw them and present certified

copies at a later date. In one case, the release that we have, or an application, is unsigned. The certified copy which is coming will be signed, but I can't get it until Mr. Walker returns.

MR. MALONE: If it please the Commission, by way of objection to certain of those exhibits, I would first like the record to show that the Abstract of Title introduced in evidence by Applicant as 16781, Federal Abstract Company, shows no prior potash leases as having embraced the Southeast Quarter of Section 17. Now maybe the abstracter, it appears that the abstracter has made a colossal bust if he has, that's just between him and me, but under the circumstances and in view of the fact that Exhibit D, for instance, is an unsigned office copy which does not indicate that it has been filed or approved, or when it was filed, I would suggest that only the instruments as to which certified copies from the Office of the Commissioner of Public Lands are furnished be admitted in evidence in the absence of further proof, because certainly an unsigned office copy of an application is no evidence of its validity.

GOVERNOR CAMPBELL: I believe Mr. Blackman said that they would offer certified signed copies of all of the documents in lieu of the copies that they have provided today, is that correct?

MR. BLACKMAN: That's correct, I assure you, Mr. Malone.

GOVERNOR CAMPBELL: On that assumption, what objection do you have?

MR. MALONE: I have no objection if they are furnished.

MR. BLACKMAN: They have been prepared, they are in the Land Commissioner's Office, and they say that no one can certify except the Land Commissioner himself, so that at the next recess we can examine them and make sure that this is entirely in order.

MR. MALONE: As you will appreciate, there was some consternation on my part, in view of the fact that I had thought I had bought a complete abstract of instruments relating to this property, and none of them appear in the abstract.

I would also like to state, if I may, for the record, that in making no objection to the admission of these instruments, I accept their authenticity but I do not accept them as being a continuation of right, as urged by Counsel. That, of course, is a legal question for argument.

GOVERNOR CAMPBELL: The instruments will speak for themselves in the legal sense in that regard, I assume. The effect is that the parties have stipulated that properly certified, authenticated copies of Exhibits A, B, C, D, E, and F may be received in evidence?

MR. MALONE: Correct.

MR. BLACKMAN: That's correct.

JOSEPH B. CUMMINGS

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. BLACKMAN:

Q Mr. Cummings, will you please state your name, occupation and residence?

A Joseph B. Cummings, Mining Engineer; present position with P.C.A., Administrative Assistant in charge of exploration. My residence is Carlsbad, New Mexico.

Q How long have you been employed by Potash Company of America?

A For approximately eighteen years.

Q In what capacity as chief of exploration for Potash Company of America, have you conducted searches for potash in other parts of North America?

A Yes. In addition to New Mexico, conducted exploration work in Saskatchewan, Utah, and a slight amount of work in connection with the potash deposits in Arizona.

Q Are you familiar with the methods of calculating the value of potash?

A Yes, I am.

Q The reserves in place and recoverable?

A Yes.

Q Mr. Cummings, I ask you to examine Exhibit L, which is a letter from Mr. Fulton addressed to Potash Company of America. The original doesn't seem to be readily available. I will ask you to refer to a photostatic copy of it. Mr. Cummings, have you examined that document before?

A Yes, I have previously examined this document.

Q Are you familiar with the contents ofit?

A Yes, I am.

Q Would you kindly explain to the Commission the method used for calculating the value of potash ore as set forth in Mr. Fulton's letter?

MR. MALONE: May I inquire if this is the exhibit to the letter that we're now referring to?

MR. BLACKMAN: The letter and the exhibit; yes, that [illegible] exhibit. May the record show that I'm now handing Mr. Cummings the original copy of Exhibit L.

Q (By Mr. Blackman) Will you kindly explain the method used by Mr. Fulton in calculating the values of potash deposits?

A Mr. Fulton has used, for arriving at average grade in thickness, information obtained from four core tests which were drilled within this 160-acre tract in which the application for the oil and gas well, drilling of the oil and gas well has been made. He has arrived at an average thickness of four feet and an average grade of 24.75 percent K_2O.

GOVERNOR CAMPBELL: Mr. Blackman, do you intend to call Mr. Fulton?

MR. BLACKMAN: Yes.

GOVERNOR CAMPBELL: Go ahead.

A The thickness and the grade are arrived at on a weighted basis. In other words, the sum of the products of the K_2O content and the thickness for each individual hole is divided by the sum of all the thicknesses for the four holes that are used.

MR. MALONE: May it please the Commission, I'm extremely reluctant to complicate the procedure in which we are involved here or to delay it or anything of the sort, but this is a very material part of this case.

The manner in which this information is being presented is not by the witness who did the work and who would be subject to cross examination with reference to it, but by a witness who apparently [illegible] with reference to it and has not been qualified as an expert in doing so.

The information, insofar as its admission into evidence is concerned, would be completely hearsay; and while, as I say, I want to expedite this thing and I'm perfectly willing for these witnesses to testify as to their estimates of value, I do object to this witness testifying to someone else's evidence of value who is not going to be offered as a witness.

MR. BLACKMAN: Perhaps I should ask Mr. Cummings some

additional questions about his qualifications.

Q (By Mr. Blackman) Mr. Cummings, are you familiar with the core test information available at P.C.A.?

A Yes.

Q Are you in charge of the department that regularly prepares the estimates of ore reserves?

A Yes.

Q Do you know of your own knowledge the average grade and thickness of the ore in the area depicted upon P.C.A. Exhibit H?

A Yes, I have the same information that Mr. Fulton used.

Q Can you testify concerning the value of potash in place and can you testify as to the value of potash that would be left in a 700-foot radius pillar in which no second mining would be conducted?

A Yes.

Q Will you kindly give us your estimate of the value of the potash in place in the area of the Southeast Quarter of Section 17, Township 20 South, Range 30 East in a 700-foot radius pillar in which no second mining would be performed? How much would the potash left be worth?

A Would you permit me to pick up my notes? I didn't know you were going to use me in this connection at this time.

Q Mr. Cummings, before you get further in this, I would

like you to not only give your further experience background -- you have already given your education -- but state what further experience you have had before you came to work for Potash Company of America, and what jobs you have had at Potash Company of America.

A Shortly after graduation from South Dakota School of Mines with a B. S. degree in Mining Engineering in 1935, I was employed at various gold mining operations in the Black Hills of South Dakota for a period of approximately five years. Subsequent to that time, I was employed by the U. S. Bureau of Mines as a Mining Engineer, situated at the Southwest Experiment Station in Arizona for a period of approximately five years, during which time I was conducting exploration, mine evaluation, and prospecting for various minerals, non-metallics and metallics.

Since coming to work for P.C.A. some eighteen years ago, I was [illegible] operation engineer, and in addition to that I was chief geologist for a period of time. I was Superintendent of Exploration and Development for a period of time. I was Resident Manager of the development operation in Saskatchewan, Canada for a period of approximately five years, during the development period, early development stages of that operation.

Since that time I have been in charge of all exploration work for the company, which has included primarily potash

exploration.

MR. BLACKMAN: Are Mr. Cummings' qualifications satisfactory to the Commission as a Mining Engineer?

MR. PORTER: Mr. Cummings' qualifications are satisfactory to the Commission. In fact, he has testified in this same vein a number of times before.

Q (By Mr. Blackman) Mr. Cummings, will you now please state your estimate of the value of the potash remaining in a 700-foot radius pillar in which no second mining is performed and in which there is situated a 200-foot radius pillar in which no first or second mining is performed in the area of the Southeast Quarter of Section 17 in Township 20 South, Range 30 East?

A The total tons of ore contained within the 200-foot radius solid pillar and the ore that would need to be left in

location of the drill hole, in which second mining would be denied, is 125,930 tons of ore, the value of which, recoverable value of which is $1,037,030.00.

Q Now, Mr. Cummings, I'll ask you again if you have examined a document marked Exhibit L, and whether you are familiar with its contents and the contents of the exhibit which is attached thereto.

A Yes, I am.

Q I'll ask you if that document details the methods of calculating the value of the reserves in the same fashion that you have?

A The methods used are identical insofar as the general procedure of calculating the values. Mr. Fulton has used a slightly different ore grade than I have, inasmuch as I have used the average ore grade for the entire area, that is, the entire unmined area which would be affected by oil and gas drilling.

Mr. Fulton, as I previously stated, has used the data for arriving at this that's obtained by analysis of four core tests that surround the subject location of the oil and gas well.

Q He has confined his grade and thickness area to the Southeast Quarter rather than to the entire area?

A Yes, sir.

Q Has he used a different specific grafity for potash?

A The other variables, so far as the two methods or the factors that are used in arriving at the value, is one of tonnage factor. Mr. Fulton has used 14 cubic feet of ore in place per ton, which is a generalized figure used in calculating reserves over the large area.

We used 15.3 cubic feet per ton for ore in place, which is based upon specific gravity analysis of our particular

ore.

Q You consider that the variations, the slight variations between your figures and Mr. Fulton's figures, are normal and reasonable in the circumstances?

A They are.

MR. BLACKMAN: I'll offer P.C.A. Exhibit L in evidence.

MR. MALONE: If the Commission please, we object to the admission of the exhibit as being hearsay, and in pointing out the vice in the receipt of such evidence, I invite the Commission's attention to the last paragraph on the first page of the letter, which is as follows:

"While I am not aware of the future production potential of the Barber pool, the pool has been producing since discovery in 1937. In the normal course of events it would appear that, to some degree, production should be declining and the pool [illegible] if this be true, it would not be unreasonable to assume that within the next sixteen years..." it will be depleted.

This is evidence contrary to evidence which has been presented by Pan American by a witness who was on the witness stand for cross examination. It is clearly hearsay and we object to its admission. We have no objection to this witness' estimate which he has given from the witness stand.

MR. BLACKMAN: The purpose of this exhibit is to show

that the ordinary methods used by the U. S. Geological Survey, who have lots of information that the rest of us don't have about other people's potash deposits, are entirely reasonable and that therefore this estimate of a million dollars for the loss of potash around a 700-foot pillar is entirely reasonable.

GOVERNOR CAMPBELL: He has testified that the methods used are reasonable, by the U.S.G.S.

MR. BLACKMAN: Yes, he has. He has testified that this document and the explanation with all of the detail in the exhibit as to just exactly how it's arrived at is also entirely reasonable. That's what I want to get in.

MR. PORTER: Objection sustained.

Q (By Mr. Blackman) Mr. Cummings, will you please refer to Exhibits I, J, K, G, and Q which are posted on the bulletin board behind the Commission, and state whether or not those exhibits were prepared under your direction?

A All with the exception of Exhibit G.

Q Who prepared Exhibit G?

A That was prepared by our Chief Mine Engineer.

Q Do these Exhibits I, J, G, and Q fairly represent the situation intended to be represented thereby?

A I believe they do.

Q I don't particularly care about Exhibit G.

MR. BLACKMAN: Exhibit G already appears in the

Commission files, and it's only there to show the general area of the mine so I do not have the engineer here who prepared it and I will not offer Exhibit G in evidence.

MR. MALONE: We will make no objection to Exhibit G.

MR. BLACKMAN: We will offer in evidence Exhibits I, J, and Q.

MR. MALONE: I would like to ask one or two voir dire questions with reference to one of the exhibits of this witness.

GOVERNOR CAMPBELL: Is "G" not in evidence?

MR. BLACKMAN: I will offer it in evidence.

MR. MALONE: I'll stipulate to it.

GOVERNOR CAMPBELL: He agrees to it.

VOIR DIRE EXAMINATION

BY MR. MALONE:

Q Exhibit K, Mr. Cummings, which purports to show a 45-degree reference line from the mining horizon to the surface of the ground, is not drawn to scale, is it?

A No, it is not. This is diagrammatic and it is not scaled.

Q You do intend to, or it is your opinion that a 45-degree reference line should be used, but the fact that the horizon from which you are mining is distorted in relation to it should be disregarded as to that exhibit?

A That's right. It is strictly diagrammatic and intended

only to clarify or depict, make more clear than we possibly could with words what we think actually happened.

Q Insofar as the broken formations and sediments which you have shown in the upper part of the subsided area there, you have never actually made any investigation of those sedimentations below the surface of the ground on the basis of which you can portray them in this fashion, have you?

A No, I never have.

Q You have looked at the surface of the ground and seen cracks in the surface of the ground, and on that basis have assumed that they extend down to the thick line which portrays the poly-halite and have drawn them in because of that?

A That's right.

Q So that you are not testifying here to the Commission that those breaks do exist on the basis of your personal knowledge or any investigation that you have made?

A I am not.

Similarly, with reference to the bending of the formations which you've shown in the [illegible] the poly-halite, you likewise have not had any personal experience on the basis of which you can tell this Commission that that's what occurs in an area of subsidence, have you?

A No, I haven't.

Q So that this exhibit could be frankly said to be merely

your impression of what you think happens under the surface of the ground, based upon an examination of cracks that you have seen in the surface?

A Slightly more than that. It is based upon some knowledge of the characteristics of sediments, plastic sediments and evaporates, which is common knowledge, that is, to anybody that's associated with the industry of geology.

Q But you have not actually made any study of this, made any cores, or do not have any information on it from which you can say this correctly portrays the condition?

A No, I haven't.

MR. MALONE: With that understanding, we have no objection to the exhibit being admitted.

GOVERNOR CAMPBELL: To any of the exhibits, I, J, K, and Q?

MR. BLACKMAN: I don't mean to offer Q now.

GOVERNOR CAMPBELL: I, J, K?

MR. MALONE: I think I would limit my statement to K. That's the only one that I examined Mr. Cummings on. With reference to Q - -

GOVERNOR CAMPBELL: He's not going to offer that now, as I understand it. I, J, and K are all that are being offered now.

MR. BLACKMAN: I'm going to ask him some questions on

that. I have kind of got the cart before the horse because of Mr. Malone's desire to have the exhibits introduced in evidence. Mr. Wilmer, the Mining Engineer, will testify to those and he has a lot of knowledge about it.

MR. MALONE: Of course his testimony will be acceptable when we receive it.

MR. BLACKMAN: It's all right, on the understanding now if you want them in I'll offer them. If you would rather wait until Mr. Wilmer has testified, I will wait.

MR. MALONE: May I ask a couple of questions on voir dire with reference to I and J?

VOIR DIRE EXAMINATION (Continued)

BY MR. MALONE:

Q What do I and J portray?

A I portrays what is actually, what has actually taken place during the first, or on completion of the first mining operations whereby only approximately sixty-five percent of the ore has been extracted. See this I have observed in our underground mining operation.

Q Insofar as the pillar in your underground mine, you have observed that?

A I have observed this in other mines, not in our particular mine, because we have not reached the stage at which this particular phase of second mining has taken place. Now --

Q This then -- I beg your pardon.

A With reference to I, yes, I have observed that.

Q With reference to J, this is what you anticipate will occur in your mine when you reach this point?

A I have actually seen this at operations where they are conducting second mining.

Q Now with reference to the formations that are shown above the mining horizon in both I and J, are they based on a core analysis or on geology or what is their basis?

A Based on core tests.

Q Are those core tests available? P.C.A. has the information that supports them?

A We do have.

MR. MALONE: On that basis we will make no objection to the admission of these exhibits as portraying what Mr. Cummings has testified.

DIRECT EXAMINATION (Continued)

BY MR. BLACKMAN:

Q Will you kindly refer to Exhibit Q which is posted on the bulletin board behind the Commission and identify that?

A Exhibit Q is a blown-up picture of the seismic structure reportedly on top of the Devonian, as submitted to us by Pan American.

MR. BLACKMAN: May I state for the record that Mr. Malone

furnished me with a copy of what I believe to be Exhibit 1.

MR. MALONE: Right.

MR. BLACKMAN: Pan American's Exhibit 1.

Q (By Mr. Blackman) What you have done is transfer the seismograph lines from this exhibit onto a plat?

A Right.

MR. BLACKMAN: I'll not offer that in evidence now. I am going to do a lot more work.

Q (By Mr. Blackman) Mr. Cummings, I'll hand you P.C.A. Exhibit H and M and ask you if those exhibits were prepared by you or under your supervision?

A Yes, they were.

Q Which?

A Both Exhibit M and H were prepared under my direct supervision.

Q Does Exhibit H fairly represent the areas of unmined potash and the mine workings in the vicinity of Section 17?

A Yes. Exhibit H represents very closely the location of the boundaries of the mine workings.

Q Does Exhibit M fairly represent the areas surrounding and in the vicinity of Continental Chase Oil Test and P.C.A. Hole No. 107 and the Southwest Air Course of the Potash Company of America?

A Exhibit M represents the location of P.C.A. core test

107 with respect to the Chase,Continental Chase Oil Test,and the mine workings labeled "Main South" represent the position of this particular entry with respect to the Continental Chase Oil Well.

MR. BLACKMAN: I'll offer in evidence Exhibit H.

MR. MALONE: We have no objection.

MR. BLACKMAN: I'll offer in evidence Exhibit M.

MR. PORTER: Any objection?

MR. SMITH: Just a minute.

MR. MALONE: I would like to examine on voir dire as to that exhibit.

VOIR DIRE EXAMINATION

BY MR. MALONE:

Q This is the exhibit which shows the location of seepages which it is thought came from the Continental Chase Well, is it not, Mr. Cummings?

A That is correct.

Q Do you have any information yourself as to when that well was drilled or when it was abandoned?

A It was approximately 1927.

Q That it was abandoned or drilled?

A It was abandoned at that time and it was drilled, I think, within a year of that time.

Q Do you have any information as to the casing that went

into the well or the cementing program that might have been followed?

A It's very sketchy. I don't know how reliable it is.

Q What is the source of it?

A It was a driller's log and information supplied by the driller or the operator to the U.S.G.S. In those days the information was not too accurate.

Q Right. Do you know whether the well actually produced or not?

A No, so far as I know, it did not produce.

Q It was drilled and reported as a dry hole?

A It did produce from the Yates but not commercial, non commercial.

Q Do you know whether or not the seep that was encountered was within a single area; in other words, from top to bottom, how thick was the section that was [illegible]

A Well, in the drill hole there were seven different horizons or members of the salt section that showed oil and gas or oil staining. These sections ranged from 646 feet in depth to 950 feet in depth.

Q There were areas between them in which there was no contamination?

A That is correct.

MR. MALONE: I think we have no objection to that exhibit.

MR. PORTER: Exhibits I, J, K, H and M will be admitted.

(Whereupon, P.C.A.'s Exhibits Nos. I, J, K, H & M received in evidence.)

MR. BLACKMAN: I'll offer in evidence Exhibit O, which is the certified copy of Public Land Order No. 2199 from the Secretary of the Interior.

MR. MALONE: We will object to it on the basis it is immaterial to any issue in this case. It is not pertinent. It relates to land in the State of Utah and to action of the U.S.G.S. which has no materiality to the issues in this case.

MR. BLACKMAN: On the contrary, I think it's very material that the Government has recognized, and the State of Utah, that the potash zones need to be protected, and it should be done here. I think it's quite pertinent that our potash

Utah where they have this protection.

MR. PORTER: The Commission will admit the exhibit for whatever we deem it to be worth.

(Whereupon, P.C.A.'s Exhibit No. O received in evidence.)

DIRECT EXAMINATION (Continued)

BY MR. BLACKMAN:

Q Will you please examine P.C.A.'s Exhibit P which is the photographic copy of the page of the Saskatchewan paper, and I will

ask you if, in connection with your exploration activities, you are familiar with potash deposits on a world-wide basis and also those particularly in the Province of Saskatchewan, Canada?

A I'm generally familiar and try to keep posted on what is going on throughout the world in connection with potash deposits. I am very familiar with the potash deposits in Canada, having spent some ten years in exploration and development within the Canadian potash belt.

Q In your opinion, does the exhibit fairly represent, the map which shows at the top showing world-wide occurrences of potash, does that fairly represent the existence of those deposits?

A Yes, I believe the exhibit gives a very general picture of potash occurrences throughout the world.

Q Now referring to the part of the exhibit which is labelled "Saskatchewan" and shows the potash belt, does that show in general terms the location of the [illegible] in Saskatchewan, you might say the mineable potash belt?

A I believe it does, in a general manner. It's relatively small scale. In connection with this, I might add that my knowledge through drilling that has been done in Saskatchewan since 1951, it has indicated a belt approximately 40 feet wide, some 250 miles long, containing very high grade potash beds that can be mined by conventional mining methods. In addition to that --

Q You stated 40 feet wide?

A 40 miles wide.

Q 40 miles wide.

A I'm sorry.

MR. BLACKMAN: Thank you. I'll offer Exhibit P in evidence.

MR. MALONE: We'll object to the admission of any portion of the Exhibit P other than two maps. We do not consider them to actually be material to any issue in this case, but we will make no objection to the maps themselves.

The text, which I have had no opportunity to read, which is strictly a hearsay statement by someone who lives in Canada, we object to it as being hearsay.

MR. BLACKMAN: We're fully agreeable to striking everything but the two maps.

MR. PORTER: The maps will be [illegible] Exhibit P

(Whereupon, P.C.A.'s Exhibit No. P received in evidence.)

MR. BLACKMAN: I also offer in evidence the Exhibit N, which is the core taken from Hole No. 107.

MR. MALONE: No objection.

MR. PORTER: We just have one copy of that. It will be admitted. You didn't have any objection to the Exhibit N?

MR. MALONE: No.

MR. PORTER: It will be admitted in the record.

(Whereupon, P.C.A.'s Exhibit No. N received in evidence.)

GOVERNOR CAMPBELL: Everything is in except Exhibit L, with the limitation on Exhibit P?

MR. BLACKMAN: Q is not in yet.

GOVERNOR CAMPBELL: Yes, all right.

MR. BLACKMAN: May I now excuse Mr. Cummings and you cross examine Mr. Clark?

MR. MALONE: I'll be glad to cross examine Mr. Clark or Mr. Cummings, whichever you prefer.

MR. BLACKMAN: Either one.

MR. MALONE: Mr. Cummings looks comfortable. We'll keep him there.

MR. PORTER: We had better take about a ten-minute recess.

(Whereupon, a short recess was taken.)

MR. PORTER: The hearing will come to order, please.

(Whereupon, P.C.A.'s Exhibit No. T marked for identification.)

MR. BLACKMAN: If the Commission please, I was going to put in one exhibit before Mr. Malone cross examines Mr. Cummings.

Q (By Mr. Blackman) Will you kindly identify the document that has been marked as P.C.A. Exhibit T and state what that is?

A This Exhibit T shows a method used in arriving at value

of potash which would be lost with a high test oil and gas well drilled within this particular area. It is broken down to show the loss in the 200-foot radius pillar, which is designated in the table as Area "A". It also shows the loss by denial of second mining within the 700-foot radius pillar, which is designated on the exhibit as Area "B".

Q Does it also show the method of calculation?

A It shows the method and the formula used in making the calculation, as well as the factors that were used.

MR. BLACKMAN: I'll offer in evidence Exhibit T.

MR. MALONE: Just one question. This is the computation that you testified to before the recess, Mr. Clifford, and is your own work?

A Mr. Cummings. Yes.

MR. MALONE: I beg your pardon, Mr. Cummings. We have no objection.

MR. PORTER: The exhibit will be admitted. Did you say this was Exhibit T?

MR. BLACKMAN: Exhibit T.

(Whereupon, P.C.A.'s Exhibit No. T received in evidence.)

MR. PORTER: Anyone have a question of Mr. Cummings?

MR. MALONE: Yes, sir.

MR. PORTER: Mr. Malone.

CROSS EXAMINATION

BY MR. MALONE:

Q Mr. Cummings, referring to Exhibit T for a moment, the 200-foot area shown in the center is a solid pillar that I believe you testified that you arbitrarily would expect to leave around any deep well that was drilled through this earth?

A Mr. Clark testified to that.

Q Oh, was that Mr. Clark?

A Right.

Q Do you have knowledge with reference to that 200-foot pillar and how it was determined that you would leave 200 feet?

A Yes. As a matter of fact, this was done jointly with Mr. Clark and with our Mining Department. We presently leave around producing oil wells, a shallow oil well where there is virtually no pressure, a 100-foot radius pillar.

The 200-foot radius pillar was arrived at more or less arbitrarily as being the minimum which we felt we should leave as a solid pillar because of various inaccuracies in surveying the location of the well and tying that in with our underground workings, and human errors that sometimes come about as a result of these things being misplaced or slightly misplotted on a map.

Q Now this danger of misplacing or misplotting or locating a well in relation to your workings would be the same whether you were dealing with a shallow or deep well, wouldn't it?

A Yes, it is. However, the additional radius for this well is primarily an added safety factor because of a much greater hazard that's being created by the drilling of a high pressure well.

Q That's in the opinion of Potash Company of America?

A That is right.

Q Have you had any assistance from outside professional sources in reaching this decision that you are arbitrarily going to double the amount of potash that you are going to leave around the well that's a deep well?

A We have had some assistance from Mr. Wilmer in this regard.

Q Was this assistance in connection with this case or prior to this case?

A It's in connection with this case.

Q You had had no assistance from him prior to that time?

A No, we did not.

Q And the arbitrary decision that you reached was reached by your own company within its own organization?

A That is correct.

Q Now with reference to the 700-foot of room and pillar that I believe you said you intended to leave around there, would that be left in the same condition that it was after you had finished primary or first mining?

A Yes, it would be.

Q It would not be necessary to leave it in that same condition in order to provide support for that area, would it?

A In my opinion, it would.

Q Do you mean to say that in your opinion the room and pillar that you are leaving in now is the minimum that would support a ceiling over the area with which you would be dealing here?

A We believe it is at this particular depth.

Q Then you compute the area, or the ore lost in Area "A", which is the 200-foot circle, at $251,000 in value, is that correct?

A That is correct.

Q And then in Area "B" you add an additional $785,630 in value?

A That is right.

Q Are you telling the Commission that this is the loss that Potash Company of America would sustain if this well is permitted to be drilled?

A I am telling the Commission that this is the value of the potash that would be left.

Q Have you made any attempt to ascertain what the actual loss the P.C.A. would sustain, as distinguished from the potash that would be left in the ground?

A No, I haven't.

Q It's a fact, is it not, that potash in the ground has to be mined, brought up, refined, shipped, and marketed, in order to determine what profit Potash Company of America makes from each ton of ore that it has in the ground?

A That is correct.

Q And then arriving at the adverse impact even if this area was left, would it not be correct that the profit per ton that Potash Company of America is making on its sales would be a measure of the loss that you'd sustain, rather than the value of the potash left in the ground?

A That is correct; however, it does not depict the true picture as to what the loss to the State of New Mexico would be.

Q I had reference to the P.C.A. in this instance.

A Insofar as P.C.A. is concerned, that is correct.

Q Can you tell us how much profit P.C.A. makes per ton of ore in the ground from its operation?

A I cannot do that because it's classified.

MR. BLACKMAN: I don't think this is proper cross examination on the basis of profit. There has been no testimony whatever as to profit per ton or profit by Pan American or P.C.A.

MR. MALONE: Well, if it please the Commission, I agree there hasn't been and I think it's high time there should be.

The implication is that P.C.A. is being damaged to the extent of the value of the potash left in the ground. It's obvious that any damage it's sustaining is the loss of profit on the potash, not the value of the potash in the ground.

We believe that accepted valuation principles support this, and it was on that basis that I was cross examining the witness.

MR. BLACKMAN: I think the proper measure of damage here is damage to the State. We are talking about conservation, not the profit of either Pan American or Potash Company of America. This loss of potash in here, Mr. Clark has testified that $20,000,000 represents the sales value of one year of potash. That represents 800 jobs for one year. The $20,000,000 is converted into $14,000,000 of freight rates.

How many times does it turn over, what does it mean to the economy of the State? That's the issue, not whether we make any profit on it or whether Pan American makes any.

MR. MALONE: I believe I would only say in response that the figures that were testified to by the witness and shown on Exhibit T show the total gross value of this ore, all of which is money that goes into the coffers of Potash Company of America.

MR. BLACKMAN: I don't think the witness testified to that. I think he testified that this is the sale value, the gross value, which is the figure amount received by P.C.A. There should

be no doubt about that, this is what the potash that is there in the ground would be sold for; this is the total price that would be received by P.C.A.

MR. MALONE: If the Commission please, it seems to me what we're trying to determine here is the economic impact of the deprival of the right to mine a given amount of potash. Either we arrive at that by looking at the profit that would be lost by the agency or the company that does that mining, or we take this gross value which they have introduced and go into the question of what their operating expenses are, what their expenses incident to getting that ore out of the ground and marketing it, and then we arrive at the question I'm asking, which is what profit per ton does Potash Company of America make on the ore which it mines and markets; and hence, how many dollars will P.C.A. be deprived of by leaving this in the ground for twenty years or until the completion of the production of this well.

MR. BLACKMAN: If the Commission please, I don't want to prolong this, but it seems to me that waste, conservation, and safety are the only real issues before the Commission now, and not profit at all.

GOVERNOR CAMPBELL: Does the order refer to correlative rights, R-111-A, or not?

MR. MALONE: It does, I'm sure it does.

GOVERNOR CAMPBELL: Mr. Malone, are the figures in Exhibit 11 net figures?

MR. MALONE: Figured in Exhibit 11 are gross value figures over the period of time that production would occur.

GOVERNOR CAMPBELL: Well, when you calculate working interest income, do you not deduct expense?

MR. MALONE: I was told that this was the standard method used by the Commission in their hearings.

GOVERNOR CAMPBELL: That's the reserve summary that you put in with regard to oil and gas.

MR. MALONE: Yes, that's correct. Yes, at the bottom of that exhibit, the witness tells me there is an asterisk which shows working interest income and shows expenses and taxes and so forth, taken off.

I believe I would like to, if I may, just say that in our rebuttal testimony we are prepared to offer further evidence on this issue of the actual loss of profits on the basis of accepted standards for valuation of property, so that the ruling that the Commission will make here will be of major significance insofar as the rebuttal case of Pan American is concerned.

MR. BLACKMON: I think it's totally irrelevant.

MR. MALONE: If it is irrelevant, the figures which have been offered by Pelsch Company of America are equally irrelevant, because the figures that they have used are based

on the total value, based on the sale price of potash.

GOVERNOR CAMPBELL: Off the record here.

(Whereupon, a discussion off the record was held.)

GOVERNOR CAMPBELL: Back on the record.

MR. PORTER: Objection overruled.

GOVERNOR CAMPBELL: Now, Mr. Malone what you are talking about really is the gross sales value less cost, less expenses?

MR. MALONE: That's right. What is that worth to the owner of it and what it's worth is the value that they have assigned to it here less what it costs to mine it, refine it, market it, and then we get down to the loss that they sustain by reason of inability to produce this for the present.

GOVERNOR CAMPBELL: You are talking about a comparable figure to what you have testified to in Exhibit 11, only as to potash, is that generally the case?

MR. MALONE: That's generally the case, and I'll have to analyze our exhibit here to be certain. I know our exhibit has operating expenses. I am not sure whether it has the drilling expense of the well to begin with in it. It can be developed on that basis. That's all I can state until I examine that with the witness, Governor.

MR. BLACKMAN: If the Commission please, it seems to me we're getting into an area here which might take us months to figure out. The operating expenses of an oil well as related to

the value of the hydrocarbons that might come out depends on what the reservoir is. We have no notion what the reservoir is. This is pure guesswork as to how much Pan American may profit from this particular area.

He's talking about some accepted standards or general standards that may be applicable to oil wells, and there may be such standards. We don't have anything like that in the potash industry.

GOVERNOR CAMPBELL: You don't have any general figure as to how much it costs you per ton to mine ore; is that what you are saying?

MR. BLACKMAN: We have, certainly, our accountants have information as to how much it costs in a general picture to mine a ton of ore, but when we're talking about something here, we are talking about a large body of ore which is thick in the middle and thin on the sides, and the question of where you'd lose it and how much you would lose is very much up in the air.

GOVERNOR CAMPBELL: You are talking about "X" number of tons of ore in a 200-foot solid pillar, and 700 feet away from it, aren't you?

MR. BLACKMAN: Yes.

GOVERNOR CAMPBELL: You know how much ore is; if it's impossible for you to testify to it, that's something else.

MR. BLACKMAN: I can't say it's impossible at the moment.

GOVERNOR CAMPBELL: If the witness can't testify, you can say so.

MR. BLACKMAN: I'll have to consult with some of our people and see. I don't think it is.

GOVERNOR CAMPBELL: What I'm getting at is I don't think we need to get into how much profit anybody makes here, but we're talking about net values as distinguished from gross values, aren't we?

MR. MALONE: That's basically it. All profit and net value come pretty close to the same thing when you get to the end of the rope.

GOVERNOR CAMPBELL: Well, they do. We are not interested in how much Potash Company makes. I guess their annual report shows that. We are trying to find out what the correlative rights of the parties are here. I think that's what the rule or the regulation says, the order says.

Certainly we do that frequently in connection with the correlative rights of two people in the oil operation. Our statute requires us to. We are just trying to do something of the same thing here, I suppose. What is the question now?

Q (By Mr. Malone) The question in effect was, can you state what part of the figure totaling $1,037,030 which you've stated is the value of the ore that would be left in the ground, what part of that is actual damage to Potash Company of America

in terms of loss of profit?

A No, I cannot.

Q You do agree with me that that figure does not represent the damage that P.C.A. would sustain?

A As I previously stated, that is the sales value of the potash that's left.

Q But it does not take into account mining expense, sales expense, or refining expense?

A It does not.

MR. BLACKMAN: I think, if the Commission please, if the Commission wants to get into that we will request now that Pan American bring in their books, because we'll want to cross examine them on all their expenses.

GOVERNOR CAMPBELL: The witness said he can't testify to that.

Q (By Mr. Malone) Now with reference to the pillars that have been left within your experience around oil wells in Southeastern New Mexico up to the present time, have you known of any 200-foot pillars being left?

A Yes, reportedly 250-foot radius pillars at the U. S. Potash operation.

Q Do you, yourself, have any knowledge of these pillars?

A Only as reported to me by their people.

Q You have not left any 250-foot pillars in P.C.A.?

A We haven't.

Q With reference to the so-called second mining or secondary mining to which I believe you testified -- or was that Mr. Clark?

A That was Mr. Clark.

Q That was Mr. Clark. Do you have any responsibility for the plan of secondary mining that's followed?

A I do not.

Q Then I suspect we'd better ask Mr. Clark about that. I believe that you arrived at the 700-foot radius on the basis of the 700-foot depth of the mine in relation to the so-called angle of reference of 45 degrees, is that correct?

A That is right.

Q What exactly does that 45-degree angle of reference represent as you have used it there?

A It represents the shear line where the support has been removed and convergence takes place within which there will be something as similar to the picture we show in Exhibit K in which we will have our broken-up condition of the beds overlying the salt with a flexing and folding of the salt beds.

Q What do you mean when you say a shear line?

A Within that area we will have some subsidence which is reflected on the surface.

Q And this subsidence that is reflected on the surface,

does it continue uniformly as you go down, or un-uniformly?

A It's rather un-uniformly. As indicated by surface surveys that have been run in areas where this has actually taken place, you'll have an up and down movement, you will have a sideways movement, and it will move in various directions.

Q Now when you talk about a shear force, just what do you mean, or a shear line?

A Shear line is along which this has taken place underneath, which, as shown on the left-hand side of our Exhibit K, the area is undisturbed but on the right side of it it becomes disturbed because it's within that area that is moving.

Q As a matter of fact, Mr. Cummings, have you ever actually known of a case of surface subsidence where a secondary mining of a four-foot vein of potash occurred?

A Would you restate the question?

Q Have you ever known of a case of subsurface subsidence where secondary mining of four-foot vein had occurred?

A No, I don't believe I have.

Q The fact is that the testimony that you have given up to this point with reference to subsidence has related to situations in which the mined-out vein was from 15 to 30 feet in thickness, wasn't it?

A Not necessarily. There have been areas of much less than that.

Q But you have never known of an area where there was only a four-foot vein?

A Not to my knowledge.

Q As a matter of mining fact, when the formations and sediments break, if they do as you have portrayed them, and drop down to fill that four-foot area as you have indicated, isn't it an accepted fact in mining engineering that a swelling occurs in those sediments so that they occupy a greater space after they have broken and dropped than they occupied in their native state?

A Yes, that is true. Actually, the area of subsidence as depicted on the surface, the drop will be about 60 percent of the opening, in other words, the bed thickness.

Q What is the percentage of swell which you would consider to be acceptable under the conditions of which we're here dealing?

A In other words, it would be the difference between, we'll say, three feet subsidence at the surface and a filling of four foot opening at the bottom.

Q I want this as a matter of mining theory and not as a matter of what you speculate has happened in these cases. Isn't there an existing formula or basis for estimating the amount of swell that occurs when those formations drop down?

A It varies with the type of formation. However, the experience record in the Potash Basin where subsidence has

actually taken place, where measurements have been made at the surface, this 60 percent figure has been developed.

Q That's without taking into account what may have happened in the water zones that exist in the Rustler formation, is it not?

A I might say --

Q Would you please answer that question?

A I will answer it, but I have to answer it in this manner, --

Q All right.

A -- if you don't mind. I must say that there are existing water courses and cavities in the overlying beds, the beds overlying the potash deposit above the salt section.

Q What portion of the subsidence results from these formations dropping into those water zones, as against the portion which results from the formation dropping into the mined-out area, it's impossible for you to determine, isn't it?

A It is impossible. It would be impractical to try to.

Q It is a fact, however, is it not, that in this area in places where there has been no mining, there has been subsidence in the surface over wide areas?

A That is true, caused in part by solution on top of the salt, removal of the salt which removes the support.

Q So that when you get a situation such as you have

portrayed here, and there is a certain amount of subsidence at the surface and a given amount of mining below, it's impossible to relate the amount of ore taken out at the bottom to the subsidence at the top unless you know what's happened in those water channels, isn't it?

A You can only base that upon the experience record within the area, within the district.

Q That would not take into account the portion of the subsidence that occurred in the upper beds and stopped in the water-bearing formation?

A No, it's a total measurement of subsidence.

Q Your assumption that 60 percent of the subsidence at 700 feet will be reflected at the surface does not necessarily indicate that that subsidence resulted in that salt in the Salada, does it?

A Well, I think it does.

Q But if I understood you, you agreed with me that part of the subsidence -- let me refer to this exhibit. You heard the testimony of Mr. Clements this morning as to the water zones?

A Right.

Q And P.C.A. is aware of the water zones and has referred to them in their reports as being a hazard to the mine beneath them at times, hasn't it?

A That's right.

Q So you know those water zones are there and you've also agreed with me that the solution ore going into solution of the aquifer has resulted in subsidence of the surface at places where no mining occurred at all, that's correct, isn't it?

A That is correct.

Q Then if the subsidence were triggered by the drop in the formation in the mine, but the number of feet or inches of subsidence actually resulted from the subsidence in this water zone and this water zone, it would not be possible to say that 60 percent of what you did here is necessarily going to result at the surface?

A I think it would because this is pre-existing, prior to the time that the secondary mining has taken place. By establishment of the grid system in the survey stations at the surface before second mining has started in what we would consider within a reasonable length of time, this subsidence that you are talking about has taken place over eons of time.

That exists, the ground is more or less stable; that is, from the standpoint, from a practical standpoint it is stable. These stations are established at that time, and measurements were actually taken, and despite this measurement this 60 percent figure has been developed.

Q Are you saying to the Commission that shear forces generated at the level of the mine when this mining horizon has

collapsed extend directly or clear to the surface of the ground within an area down to 45 degrees?

A When this movement has been triggered, within that area in which it has been triggered.

Q You say that the shear forces extend from the 700-foot horizon to the surface of the ground in the form of shear planes that are reflected in cracks in the surface of the ground, is that correct?

A I didn't say that, no. I say that the shear forces are going to be prevalent from the mining level to the surface as long as this subsidence is taking place, until it stabilizes.

Q And if those shear forces are prevalent all the way up, you are going to have cracks extending all the way up to the surface, are you not?

A Not necessarily. And this is based upon the characteristics of the variable beds. It is my feeling that what actually takes place in the salt section is this. The salt, because it is a competent member, it has the ability of transmitting pressures to the super-incumbent beds, it reflects in fold, in flow. The clastic sediments within the salt section will crack, they're less competent. They reach a certain point of strain, they're going to crack up.

The same is true in the clastic sediments that overlie the salt section. They are incompetent beds, relatively

incompetent beds and their elasticity or point of bending is reached much quicker stage than that of the salt formation.

Q Then if I followed you, you are saying that there are no shear zones that extend from the mined-out area to the surface of the ground through the exhibit which you have prepared?

A These beds have come down more or less as they are depicted on Exhibit K.

Q Are there or are there not, in your opinion, shear zones that extend from the mined-out area to the surface of the ground?

A I don't believe there are; otherwise, we would have had flooding of some of the areas in which the secondary mining has been conducted and subsidence has taken place.

Q How did you arbitrarily end the cracks that you have depicted here at this point on your exhibit?

A That is the top of the salt.

Q And it's your opinion that the movement which results in the fracturing of formations is limited to the Salada or is limited to above the Salada?

A There's movement in the Salada but there's not fracturing except in the clastic beds, the gypsiferous, the silty sections, the clay sections, and the [illegible] sections.

Q In fixing the 200-foot point which you have described, have you gotten any assistance from Lilliputian Oil Well

Cementing Company or any other competent source, as to the forces that might be exerted on the well in case of a subsidence of this type, and the forces that a well might be able to withstand?

A No, we haven't.

Q So you are strictly guesstimating in that regard?

A We took this as a more or less arbitrary figure, the same as the 100-foot diameter pillar around the shallow wells.

Q You, yourself, are not prepared to testify as to the forces which might be generated here and their effect on a well in the area?

A I believe the witness that Mr. Blackman is going to call, Mr. Wilmer, is much more competent than I am to testify.

Q So you are not saying to the Commission that a well drilled in the area which would, say, represent an angle of 68 or 70 degrees instead of your 45 degrees, would be damaged by the movement which you have depicted here?

A I'm saying that I would not want to be responsible fo. drilling that well.

Q You have not, however, made any study to determine the effect or the resistance of the well?

A I haven't. Mr. Wilmer has.

Q It's true, of course, that when this formation breaks up and drops, it has to have somewhere to drop, doesn't it? It has to have some space to fill?

A That's correct.

Q In the situation that you had here, the only space that's available to it is the four-foot mined-out area at the bottom of your drop?

A That's right.

Q And there is no increase in the horizontal space that's available so that the cracks which you have depicted here, there's no way that this formation can push out to the side and get space to take care of the cracks which you have depicted as occurring?

A So far as we know, there is not.

Q Do you still think as a physical fact that it's possible for this sort of fracturing to occur under those circumstances?

A As depicted here?

Q Yes.

A Yes, I believe that.

Q In the area, you said you had seen subsidence that had occurred where no mining had occurred?

A I have seen the so-called slumped areas. As a matter of fact, we have a number of them in our particular vicinity.

Q And they have no relation to underground mining, do they?

A These have no relation in our particular area.

Q And the cracks which you observed there are quite similar to the surface cracks which you observed in an area where there has been underground mining, are they not?

A Well, they are different in this respect, inasmuch as those serve as vehicles, as transportation for charging the water zones that exist above the salt and they have been leeched, and you might describe them as cavities whereby, these cracks are fresh cracks and they are breaks, more sharp.

Q What you are saying, if I understand you, is that they were the same type cracks to begin with but water has washed them out?

A That's right, dissolved it out and they have lost their original appearance. As I stated before, this has occurred over eons of time.

Q Would you agree with me that it is possible that cracks of the type which you have here depicted could result from a vertical slumping into these water-bearing zones and without relation to the slumping that occurs at the mined-out area?

A Well, this would be strictly speculative; in the first instance, you would have to know that the cavities existed.

Q They do exist in that area, do they not?

A We think they do. We have occasion to believe that there are cavities. A certain percentage of this is rock that is moving, that is going to tend to fill those cavities. They're

bound to, if the rock is moving all around them, it's going to follow the line of least resistance.

Q I believe if I understood you, then, you would agree with me that it was possible that these vertical cracks could be caused by that sort of slumping?

A There could be, there has been; we know that has occurred.

Q And that would be true whether there was a mined-out area below it or not?

A That is correct.

Q I'm not sure whether you ever gave me the percentage of swell that you thought would be applicable to a subsidence of 700 feet, such as you have attributed here.

A Would you clarify this for me, please? You mean the space occupied would be a certain percentage greater when it's broken than it is when it's in place?

Q Right.

A I think this is a more meaningful figure than this, and this is the measurement figure that I gave you, Mr. Malone, that it must swell. We'll say the difference between subsiding three feet on the surface, whereby it has filled an opening that is four feet underground; as to how much of this, how much swelling there it is difficult to say in this particular formation because we don't know how much of that we can attribute to being

taken up by these vugs that we have been discussing or these cavities.

Q Isn't it a fair conclusion from that, Mr. Cummings, to say that we do not know what happens when this subsidence occurs; that all you know is that there are vertical cracks in the surface which vary from the 45-degree angle to the edge of the subsided zone below?

A Yes, right.

Q And isn't it a fair statement to say also that we cannot describe that 45-degree angle as a shear zone or fault or a shear force that extends from the mined-out area to the surface of the ground?

A The shear forces take place within that zone.

Q And do not extend from the 700-foot level to the surface, in your opinion?

A The shearing of the formation I do not believe takes place throughout the salt section.

Q As a matter of fact, if there had been shear zones from the mined-out area to the surface, you would have introduced water into your mine every time you collapsed a section, wouldn't you?

A This would have been done.

Q That's one thing that we're certain of, there are no shear zones that extend down to your mined-out area?

A Except in the clastic members. That's the anhydrites, the silt zones, the clay zones, poly-halites.

Q They do not extend down to your mined-out area?

A They are represented here, Mr. Malone, by these, (indicating). We speak of the salt section but it's not all salt. We have here, for instance, immediately above our ore zone we have a salt bed. Above that is a clay zone and then we have another salt bed, and here is an anhydrite bed. This is poly-halite. These are all clastic sediments. What I've been trying to explain to you, and perhaps confused you, is that we believe that these will break, these clastic sediments will break the same as these clastic sediments up here will break, because of the forces that are exerted within this draw area between these two subsidence lines or shear lines.

Now the force is transmitted through here, but these beds will bend. They will break adjacent. We've seen cases where they have broken or snapped off to this first clay zone in areas where second mining has taken place, come down in slabs. But that is because of the thinness of this bed and the weakness of this point, and this is a weak area at the contact between the salt and between this clay zone; so it parts and it drops so far and it reaches its limit of the elasticity. Therefore, it will start breaking to pieces. That limit of elasticity is reached much earlier or with lesser bending in

these less competent members, the anhydrites and the clays and so forth; so our forces exist here in the salt formation but this fracturing doesn't take place throughout the salt formation.

Q If the fracturing actually occurs that you have portrayed up there, you have introduced fresh water into the salt water and provided an opportunity for salt water to migrate into the fresh water, have you not?

A Actually, I don't classify any of that water as fresh water.

Q Assuming for purposes of my question that the potable water described by Mr. Clements is in fact potable water, that result would have occurred, wouldn't it?

A That will occur and that condition is existent before subsidence takes place because of the very fact that we have these solution channels and these solution cavities presently existing, which has caused these slump areas on the surface, so they are interconnected at the present time.

As a matter of fact, in this particular area, the Clayton Basin, as I understand it, is a closed basin; and those, as you refer to them, fresh water zones are charged by the drainage and run off within that basin and to a large degree by migration down through these channels that do exist from the surface.

Q You would not deny that you are increasing the number of channels when you fracture a formation as you have portrayed there?

A I certainly would not.

Q And, in fact, you are greatly increasing the communication between fresh and salt water, are you not?

A We are increasing it and it will be increased, but it's a condition that does exist to a certain degree at the present time.

Q Are you aware of the fact that in every oil well drilled, it is necessary to cement off the fresh water to prevent the sort of communication that you are providing here?

A I am aware of that fact.

Q If you did not collapse your mined-out zone but followed a panel retreat, it would be possible for you to get almost as much of the potash as you are now recovering and still leave adequate supports insofar as subsidence is concerned?

A I would suggest that you direct that question to Mr. Woomer, who is a much better expert insofar as the mining production techniques are concerned than I am.

Q If you are not qualified to answer it, I certainly will. Do you know what angle of reference is used in connection with the construction of a shaft to a potash mine, insofar as subsidence is concerned?

A So far as leaving a pillar is concerned?

Q Yes.

A We normally leave a pillar the radius of which is equivalent to the depth. In other words, if you are at 700 feet, you are sinking that shaft to your ore horizon at 700 feet, you would leave it virtually unmined except for getting away from the shaft, an unmined solid pillar around the shaft 7500 feet in diameter. It was 2500 feet, it would be 2500 feet in diameter. Let me follow that, not 2500 feet in diameter, 700 foot radius -- 2500 foot radius.

Q And you have followed this practice uniformly both in Canada and in New Mexico?

A We have; as a matter of fact, we have expanded it a bit.

MR. MALONE: I believe that's all from this witness.

MR. PORTER: Any further questions of the witness? Mr. Blackman.

REDIRECT EXAMINATION

BY MR. BLACKMAN:

Q Do you know whether or not in the Carlsbad Basin there has been any second mining conducted in four feet of potash?

A I do not know.

Q So that since you don't know, you had testified that you didn't know of any surface subsidence where the mining area

was only four feet deep, that's because it has not occurred, is that true as far as you know?

A I don't know whether it has occurred or not. I have not observed it.

MR. BLACKMAN: Thank you.

MR. PORTER: Any further questions?

GOVERNOR CAMPBELL: Yes.

RECROSS EXAMINATION

BY GOVERNOR CAMPBELL:

Q You made a statement, Mr. Cummings, certain times on a rule of thumb about 60 percent. Would you restate that?

A The subsidence on the surface measured in feet will be about 60 percent of the opening, the thickness of the opening that is provided by the mine workings. In other words --

Q Does this take into consideration the possibility of vugular formations and all of that, or is that absent that condition?

A This is more or less a rule of thumb. It's an established empirical figure that is used for general cases.

Q Is that the maximum at the surface?

A No, it may be as much as 75 percent of the opening, the thickness of the opening to which this is dropped. It may be as little, I suppose, as 50 percent.

Q Does the surface subsidence decrease generally as you move to the outer edges of your angle?

A That's right, as shown here, your greatest measurement would be directly over the center.

Q Yes. Now where you are talking about the 60 percent is it at that the average?

A No, it's at that point.

Q So as you move away it would be less than 60 percent?

A It would be less, it would taper.

Q Until it reaches zero?

A Until it reaches zero.

MR. BLACKMAN: I might ask one question that would be helpful. Is it not true that Exhibit K is intended as a generalized representation, and the area between the two draw lines might be several thousand feet?

A That is true.

MR. BLACKMAN: In other words, explain what happens as you progress; is it not true that the draw line say on the left side of the picture moves to the left?

A If you are coming from right to left, as you move back here, this line keeps coming, advancing in this direction. This one will have been established back here. So this might represent as much as, say, four or five thousand feet. That is this measurement across here (indicating).

Q (By Governor Campbell) Let me finish my question here then. You have testified that in the area where this location is proposed in Section 17, the average thickness of

the formation bearing potash is 4.13 feet?

A Right.

Q Then what you are saying generally, with all of the qualifications that have to be made, is that the maximum subsidence at the surface, assuming a situation of this kind and recognizing that over a period of time it will cover an extensive area, would be 60 percent of 4.13 feet?

A That is correct. It would be approximately two and a half feet.

Q Or two and a half feet?

A Right.

Q So that as a general proposition we are talking about a maximum shearing effect between 700 feet and the surface of two and a half feet, is that correct?

A A total movement, yes.

Q At the maximum?

A Right.

Q If it was a complete movement?

A If it were a complete movement. If I may, I might explain that the 4.13 is the average throughout the area, and the minimum thickness that we have used in arriving at our ore reserve estimate and in arriving at this average thickness is 38 inches; and it will range in this particular area up to as much as six or seven feet in some parts of the ore body. But this is the overall average.

MR. MALONE: One other question, if I may.

MR. PORTER: Mr. Malone.

BY MR. MALONE:

Q With reference to the four feet that is available for drop, your exhibit indicates that the floor rises as well as the roof coming down, is this a fact?

A That actually happens; it's been observed.

Q So that there isn't actually four feet available in our situation for subsidence from above?

A But that is taken care of in the 60 percent figure that we have used. In other words, this figure that has been developed has been developed by actual measurements within the area. It's an average figure and this takes into account this because it's an actual measurement that has been made at the surface.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question? Mr. Nutter.

BY MR. NUTTER:

Q Mr. Cummings, I would like to know exactly for sure just what your policy is now around your core holes, you leave a 100-foot pillar, is that correct?

A That is correct.

Q But you do conduct secondary mining operations?

A That is correct.

Q Around a shallow oil producer, you leave a 100-foot

pillar?

A 100-foot radius pillar. As long as it is producing, we provide the extended pillar, which in this area would be 700-foot radius, in which no second mining would be done as long as that well is producing.

Q When the well is plugged and abandoned, what would be the case?

A We haven't arrived at that one yet. It is our intent for abandoned wells, if we can satisfy ourselves that we have achieved a plugging job that gives us protection, we will treat those wells the same as we treat the core tests. We will leave a 100-foot radius solid pillar; we would conduct second mining.

Q You would conduct secondary mining?

A Yes.

Q Around any high pressure producing well; however, it would be your policy to leave a 200-foot pillar?

A That is correct, solid pillar.

Q That's without any primary or anything?

A Nothing. It's untouched. It's a solid pillar.

Q Then naturally you would not conduct secondary mining operations there?

A Definitely not.

Q I presume that a high pressure well would have the same status, then, as a shallow well upon being plugged and abandoned; if you were satisfied it was properly plugged, then you might

conduct a secondary?

A If we were satisfied it was properly plugged, the same would apply.

Q In making your calculation of the reserves of potash, you used 15.3 cubic feet per ton, that is correct, I believe?

A That is correct.

Q Your estimate of value of those reserves, were those the same as Mr. Fulton used, $8.375 a unit or something?

A The price per unit for potash was identical in both cases; the total value arrived at is a slight difference between what Mr. Fulton arrived at and what I arrive at. His was nine hundred some thousand and mine was slightly over a million dollars. This is attributable primarily to the different tonnage factor that was used. I used 15.3; he used 16, which would reduce the tonnage where the area is the same.

Q Assuming you mined 65 percent on primary and recovered another 25 percent on secondary, you would have 90 percent mining, then in your computation of reserves you used 90 percent mill efficiency, too, is that correct?

A Approximately that on the average, yes.

Q In determining where the zone of subsidence is, have you gone solely by the cracks in the ground, or was this determined also from a system of bench marks or monuments that were laid out on the grid?

A It's laid out on a grid and determined by tying

surface surveys with the underground surveys.

Q How far apart would points on that grid be?

A Well, they vary. Actually, Mr. Nutter, we have not reached the state at which any subsidence has taken place in our immediate mine, but the practice by other companies is to establish these bench marks on 100 foot, on a 100-foot grid system.

Now observations are taken initially on most of those stations at various periods, we'll say one week apart, at shorter intervals in the early stages when subsidence is just beginning. Then, as I understand, as the subsidence progresses and the movement becomes less, the slowing down, that oftentimes these measurements are taken on, we'll say, every fifth bench mark.

Q How many actual, to your knowledge, surveys have been made on this grid system down in the Carlsbad Potash Area, to measure subsidence on secondary mining.

A Gee, I could not answer that. There's been many of them made.

Q Have they been made for potash which was being second mined at a 700-foot level?

A I believe in most cases the depth was greater than 700 feet. I know the average depth would be greater than 700.

Q I believe it was mentioned that some of this subsidence had taken place on second mining in areas where the potash beds were some 30 feet thick?

A I don't know of any quite that thickness there. There

have been some that have been over 15 feet. There are possibly some that are over 30 feet.

Q To your knowledge, no secondary mining has occurred in a four-foot bed?

A Not to my knowledge, but I would state that in all probability there has been some but I'm not familiar with it.

Q Assuming a bed of 15 feet was second mined, how long would it take this total subsidence to occur from the time of the second mining until the surface subsidence ceased?

A Until there was actually no movement?

Q Until there's no detectible movement.

A I could not answer that.

Q How long does it take it to approach 60 percent of the beds in the ground that were removed?

A Well, we'll say to the point where it almost stabilizes?

Q Yes, sir.

A As I recall some measurements that were made, and I believe this was put in testimony in one of our hearings, it was something like two and a half years from the time that second mining had taken place. Before this the ground almost stabilized; although there was still some movement, it was very slight.

Q I presume that if you have this fracturing of these incompetent beds up above, and a loosing of the material that compaction would slowly occur over a long period of time so that surface subsidence would actually continue indefinitely then?

A Some subsidence would be taking place for a long period

of time.

Q Is there any lateral movement of the bench marks?

A Yes, there is. There's lateral movement and up and down movement, vertical movement as well.

Q Has all of the lateral movement been, in reference to Exhibit K, towards the center of the exhibit?

A It's primarily toward the center of the exhibit, but it will move at angles up to say 90 degrees away from that on certain bench marks. It indicates that this thing is cork-screwing.

Q I see.

A The general pattern would be toward the center from the edges.

Q Has any subsidence ever been measured on any of the mines down there on primary mining only?

A To my knowledge there has not been. We haven't done any.

Q These pillars that you leave are elastic and would tend to squash down, so to speak, and expand laterally?

A We have in that connection measured so-called convergence by setting bench marks in the floor and the roof of our entries. By leaving 65 percent, there's no detectible movement of the back or the floor.

Q I see.

A At the depth at which we are mining.

Q In other words, 35 percent pillars support the roof

without detectible --

A The supports.

Q -- subsidence?

A Without detectible subsidence or convergence, we should say.

MR. NUTTER: Thank you.

MR. PORTER: Any further questions?

BY GOVERNOR CAMPBELL:

Q Mr. Cummings, one question about the general procedure that you would use over a period of years to do your second mining, is it the practice to mine on first mining -- you are operating only on one level, I assume, aren't you?

A That's correct.

Q That's all the ore you have?

A That's correct.

Q You don't have different strata of ores that you need to recover in the future?

A Not in this particular area. We do have in the northern part a bed that may be commercial down the line before we have exhausted the present mining.

Q In which event you would make that decision after you finished your first mining, as to mining the pillars out or mining above?

A That's right, it would be a matter of economics.

Q In this area, assuming there's only one ore body that justifies the mining, do you mine all the way out to the economic

limits and then back up to the shaft with the removal of the pillars, is that the procedure that you follow?

A That's the procedure. It's a retreat from the margins of the ore body back toward the shaft, providing, for the principal reason of keeping your main haulage-ways open back of you.

Q With regard to this immediate area again, when you talk about a period of time, what are we talking about in connection with the second mining and whatever subsidence might take place; how many years--

A I will answer the first part.

Q -- before you would be out of there?

A That is too long. We will be mining in this particular area in this manner, we estimate that at our present rate of operation our ore reserves will be exhausted in about 15 or 16 years. Now because of the fact that we do need to blend these ores for the purpose which Mr. Clark previously stated of maintaining a uniform mill head, mixing the lower grade ores with the higher grade ores, diluting the carnalite, the magnesium chloride, the potassium chloride which gives us trouble in our processing, keeping that dilution down to a tolerable rate, I would assume that we might still be mining in this particular area to the exhaustion of our ore reserves; in other words, some 15 years.

Now as to when it would be safe to drill an oil well or might be felt safe to drill an oil well, or the subsidence has completely quit, I think can only be determined by measurements after the second mining has been done. In other words, at what

point this will stabilize would be pure speculation at the present time.

Q Is it the position of your company, if you know, that there should be no further drilling for oil and gas in this area until you have exhausted your reserves?

A It is.

Q How large an area?

A Now you are speaking of this specific area?

Q I'm speaking -- yes, I am talking about the area colored in ink in Exhibit H.

A Also there will be second mining in the --

MR. PORTER: In the blue.

A -- in the blue. I might point out to you, I don't have an exhibit on the board, but the area involved would be this area from this sign that is down here in Section 8 extending over and would also include our area in blue on this map in which second mining has not been conducted, and would be from this point to this point; and, of course, up to this margin to here, so we would be talking about possibly a section and a half.

GOVERNOR CAMPBELL: That's all.

MR. PORTER: Anyone else have a question?

MR. MALONE: May I ask if the witness, during the recess tonight, would compute for me the effect on the figures on his Exhibit T which would result from his taking out the 100-foot pillar which he has testified that he is going to have

to leave around the Barber 4-A in any event, so we could get a net figure of the increased reserves that would be lost, rather than the total reserves as though there were no well already there.

A I am agreeable to doing that.

MR. PORTER: I don't know that there's going to be any night recess. The witness may be excused.

(Witness excused.)

MR. PORTER: Does anyone wish to cross examine Mr. Clark?

MR. MALONE: Yes, sir.

HOUSTON CLARK

called as a witness, having been previously duly sworn, testified further as follows:

CROSS EXAMINATION

BY MR. MALONE:

Q Mr. Clark, with reference to the carnalite which apparently exists in some greater quantity in the area of the proposed well, does the existence of the carnalite reduce the value of the ore where it occurs?

A The effect of an excessive amount of carnalite leads to a processing inefficiency in the refinery, which in turn reduces the recovery of the value of the ore; and therefore we sustain higher losses in our operation.

Q And the cost of processing that type of ore is greater than ore in which the carnalite is not as frequently encountered?

A This is correct.

Q Do you happen to know whether Mr. Cummings has given effect to the carnalite in the ore in the computation that he has made on Exhibit T?

A No, he has not.

MR. MALONE: The witness testified in response to my question that the occurrence of carnalite in substantial quantities reduced the value of ore, and that it was his impression that Mr. Cummings had not taken into account that reduction in the computation that was made on Exhibit T. I would therefore also like if, during the recess, which now seems more probable, Mr. Cummings would recompute these figures, giving effect to the existence of carnalite in the quantities there encountered.

MR. PORTER: Do you understand the request?

MR. CUMMINGS: I understand the request, but it's my feeling that it's taken care of. I have stated an average mill recovery of 90 percent. That takes into consideration the carnalite ores which we are treating today. The problem is -- maybe I shouldn't be doing this when I'm not on the stand, but the problem is this. If we have to treat excessive amounts of carnalite or if there are excessive amounts of carnalite, our recovery goes down; also it affects the product.

Therefore, our costs go up but within certain limits it has no appreciable effect because our new circuit takes care of it so it is considered when I've used that 90 percent recovery factor for the mill. So there's no basis for computing a

different value for the carnalite ore.

MR. MALONE: I shouldn't examine this witness at this point. I will ask Mr. Clark one other question to see if I can clarify this in my own mind.

Q (By Mr. Malone) In arriving at the value of a potash deposit which the company would be considering buying, would you give effect in reducing the price to the existence of the percentage of carnalite that occurs in the Southeast Quarter of Section 17?

A Well, that, Mr. Malone, is a real difficult question to answer because you would have to consider, one, the exact content of carnalite that might be in the over-all body that you are looking at; two, at what average rate of contamination that you can mine it; three, you would have to relate your plant investment cost to handle carnalite ores to the value of the ore; and it would be rather involved to arrive at whether or not you would reduce your offered purchase price to such a property.

Q Perhaps we could agree this would be better ore if it didn't have carnalite in it?

A That's a good statement.

Q Do you have any knowledge of any other potash mining operation in which in excess of 65 percent is recovered on the primary mining or first mining?

A No. The 65 percent is an average figure taken. I'm

sure it varies on both sides of the 65 percent, but as far as I know, everybody, at least in the Carlsbad Basin, uses a 65 percent figure for first mining.

Q Is there any difference in the type of retreat mining or secondary mining that's done by the various companies, to your knowledge?

A I would only have to assume that there is, Mr. Malone. I do not know for a fact that there is different approaches.

Q I understood that you are still experimenting with and considering the type of retreat mining that you will do in the P.C.A. mine?

A This is correct.

Q Have you given consideration to what is known as a panel retreat, which would result in no subsidence of the route after your secondary mining?

A No, sir, we haven't.

Q Do you know of the existence of any such process whereby there might be an additional recovery somewhat less than the 25 percent that you get with subsidence, but greater than the 65 percent you get on first mining?

A In our opinion, based on all of the technical information that we have been able to assemble, if you exceed in any substantial degree the 65 percent, you will begin to get subsidence. So as far as our plans are concerned, we expect to experience subsidence any time we appreciably exceed the 65 percent.

Q If the policy of the State should be established as opposing the subsidence of mines, would it be possible for you to recover anything in excess of 65 percent, in your opinion?

A Your question is, if the policy of the State was to --

Q Prevented subsidence of mines under these circumstances.

A I am not sure I'm clear on the question, but let me answer it this way. Our technical people are convinced that this subsidence will occur at any point in which we have a producing oil well and, for example, we shall talk about a high test well. We will not mine, second mine within the area of influence, which we feel to be in this area at 700 feet. We think the hazard is there and we don't think as a corporation we should accept it.

Q You have not actually experimented to determine whether 700 feet is a realistic distance?

A No.

Q And it is computed entirely on the basis of this arbitrary 45-degree line?

A It's computed from the 45-degree line which has been determined to be an average angle by experience of other producers in the Basin.

Q Do you consider that line to be a shear plane?

A I would say this: On the right-hand side of that line we feel that you have movement and it's particularly noticeable at the areas at the top of the graph in which you get actual fracturing. This is on the right-hand side of the line.

At the left of the line you have reasonably stable ground. In my opinion you would have a rather significant shear force at that point, because you have one body in motion and one stable, so you have developed considerable shear.

Q That shear, of course, can be developed only to the extent that there is an area within which the collapsed formation can move?

A This is true. This is what causes it.

Q And the four feet as you envisage, this would be the maximum area?

A Well, it depends on your mining height at whatever point you are extracting.

Q At the location we're dealing with here?

A Yes, which is an average and has been stated to vary from 40 inches to maybe 60 percent, in feet.

Q Do you agree with Mr. Cummings that a floor, in a situation like this, will swell, occupying that four feet one inch?

A From the technical information that we have secured from other companies, this has been evidenced, yes.

Q Do you have any measurement or estimate as to the amount of swell that occurs in the floor?

A I do not, no.

Q On the Exhibit E which has been offered by the Potash

Company, you do not show any fracturing below a formation, the dark blue formation that goes across. Can you identify that for us?

A That's depicted to be a poly-halite strata. This is the one you are referring to (indicating).

Q At what depth does that occur?

A It is diagrammatic so I can't tell you, Mr. Malone. It's shown to be just below the top of the salt; the top of the salt is shown at 400 feet, since this is only diagrammatic I don't know what that interval is.

Q So it would be,the actual fracturing that you have portrayed on this exhibit would extend from approximately 400 feet to the surface of the ground?

A That's approximately correct, yes.

Q There is no way that you can testify with certainty that fracturing occurs along that 45-degree angle below that poly-halite, is there; that is, along the shear plane?

A No, sir.

Q And that is just a reference line or an estimated line of 45 degrees?

A It's not estimated, it's been determined to be an average figure from experience in the Basin.

Q That average, however, is predicated on the relationship between vertical cracks and the subsidence point, is it not?

A Yes, it's been determined from the depth at which

the subsidence occurred, and measurement of ground movement on the surface.

Q There has been no determination that shear actually occurs over to that angle up to the surface of the ground, has there?

A Not to my knowledge.

Q Have you, in considering the safety precautions that your company should take around existing wells, made any study of the forces that can be withstood by properly cased oil wells?

A No, we have not.

Q Do you agree with Mr. Cummings that in this area there is surface subsidence and surface irregularity resulting from subsidence in areas where there has been no mining?

A I haven't observed it, Mr. Malone, but I am sure that Mr. Cummings has.

Q That surface is quite irregular out there with large cracks and cavernous areas, isn't it?

A I have seen what we refer to as sump holes in this general area. I wouldn't say that it's generally prevalent. There are sump holes on the surface but it does not generally exist within a small area.

Q Have you seen the U.S.G.S. literature on this subject?

A No, I haven't.

Q You would not disagree with the statement that such conditions do exist, if it was in the U.S.G.S. literature, would

you?

A I wouldn't have any reason to.

Q With reference to the water-bearing formations which occur in the Rustler, if fractures occur as has been depicted on Exhibit K, you are increasing the possibility of communication between the salt water strata and the potable water strata, are you not?

A Mr. Malone, not being a geologist, I would hate to comment on that, but certainly if those fractures did develop in an area which migrated to the curve, then that would happen.

Q I'm not a geologist either, but it seems to me like it would, too. Do you have any information as to percentage of swell that can be anticipated when fracturing such as this occurs?

A No, sir.

Q You do know that it is an established mining principle or an established principle that swell does occur when fracturing occurs, does it not?

A No, sir, I do not.

Q On the basis of your experience, would you assume it would take a larger area to contain a portion of that formation with the cracks in it than it would if there were no cracks?

A Yes, because you created some voids.

Q How many acres of potash reserves in Eddy and Lea Counties, New Mexico, does Potash Company of America have?

A I can't answer that question.

Q Could you give me an approximate figure? I was under the impression that you mentioned a figure in your first testimony and I can't find it.

A No, I didn't. I would rather not quote a figure. We can determine that for you and give it to you exactly.

Q Mr. Cummings was correct in stating the policy of the company that it will oppose any drilling of any oil wells in any portion of those reserves?

A Yes, sir.

Q And it is the feeling of the company that it should be permitted to complete both primary and secondary mining operations before any oil exploration occurs?

A Yes, sir.

Q Do you know whether or not in any of the mines in which secondary mining and subsidence has occurred, water has been introduced into the mine area?

A My information is that it has not.

Q You have recognized throughout the existence of your mine down there that the presence of the water above it does constitute a potential hazard as far as the mine operations are concerned?

A That is correct.

Q And you have taken precautions to try to prevent the introduction of that into the mine?

A Yes.

Q Do you consider that you are increasing the hazard to any degree by subsiding the mine and fracking the formations as you apparently have done here?

A Not unless there is a direct channel so created from the fractured water zone into the mine workings.

Q How can you be sure no such channel will be created?

A Well, if we leave -- this is the reason for, in the case of core holes in shallow wells, this is the reason for leaving the 100-foot radius barrier pillar, so that we will have protection against percolation into the mine.

Q But if the shear plane that you have described actually exists, you could be introducing water through, in effect, a fault or a shear plane just as a result of subsidence, couldn't you?

A Well, as earlier testified by Mr. Cummings, it's his opinion that we have barriers there that do not fracture, that come down as a complete member. They only bend and come down as a complete member; therefore, you have created no void and you still have a barrier from your water above.

Q Mr. Cummings could be in error in that opinion, you could be encountering a hazard, couldn't you?

A Yes.

Q With reference to the salts which occur above the sylvite that you are now mining, there are other formations of potash which you do not now consider to be economical, aren't

there?

A Well, in this particular area, yes, we have poly-halite that contains some potash. It is a very thin seam and there's no known process for recovery of potash from poly-halite at the present time.

Q Do you consider it impossible that through solution mining or other developments, it may become economic to mine such deposits in the future?

A You can't solution mine poly-halite; it's insoluble.

Q Or other mining devices?

A That's a little too general a question, I think, for me to answer. Do you mean poly-halite, can we mine poly-halite?

Q I just was seeking to find out if any of these other potash salts that exist here may have a potential future value even though at the present time you do not consider them to be economic.

A I would say in this particular area there are no deposits other than the one that we're now mining that have any possible commercial value.

Q Do you feel that there is any possibility that the gypsum and salt which occurs above the area in which you are mining could ever have any commercial value?

A In respect to the salt,we have as a by-product about 60 percent of the ore that we mine stacked up on the desert in New Mexico. Nobody has ever found any way to put it in a salable

form and been able to compete with known deposits of rock salt. Gypsum, I don't know too much about gypsum other than that in New Mexico in the White Sands there's something like four and a half billion tons of gypsum on the surface, and I would expect that a commercial production of gypsum would be much more practical there than it would be underground here.

Q It is true that this is part of one of the largest salt deposits in the Western Hemisphere, isn't it?

A Yes, this is a part of the Permian Basin which is a very large salt section.

Q Can you contrast for us the profitability of your first mining as compared to your second mining? In other words, is there a greater net return from your initial 65 percent recovery than there is from your later 25 percent recovery, on a per ton basis?

A Well, to get at some kind of a figure of profitability on that basis, I think, Mr. Malone, would take a considerable amount of detailed cost accounting work which we're not prepared to do at this time. We do not have that information available.

Q Two normally primary mining and production operations of all types are somewhat more profitable than the secondary one, are they not?

A Well, stated another way, the cost of mining on a primary basis is generally cheaper than on a secondary basis.

The profitability takes in a lot of other factors that must be considered. Generally speaking, the cost of second mining is generally higher.

Q That is really what I was trying to say but unable to do so. How many core holes has the Potash Company drilled in the reserves which it owns?

A This is an approximate figure; in Eddy County I believe our last test hole is Number 176.

Q And you contemplate leaving a 100-foot pillar around each of the 176 core holes in your secondary operation?

A Yes.

Q The percentage figures which you have given us take into account salt horses, do they?

A You mean in extraction?

Q Yes.

A Yes.

MR. MALONE: That's all.

MR. PORTER: Anyone have a question?

BY GOVERNOR CAMPBELL:

Q Mr. Clark, I want to get clear in my mind a matter that both you and Mr. Cummings have made reference to, and that again is with regard to the position of P.C.A. as to future development of your properties as related to oil and gas development. I refer you to Exhibit G, this one up here.

A Yes, sir.

Q As I understand that, the pink you are now working in some degree or another?

A Yes.

Q The green represents reserves that you presently believe on an economic basis you will develop, is that right?

A Yes.

Q Is that the limit of those at this time in your present calculation?

A This is the limit as we have them defined, Governor. However, we often find when we approach an estimated definitive limit of the ore body, it can well extend beyond it.

Q This is subject to contraction or expansion, depending on what your actual mining develops?

A This is correct.

Q But with that qualification, was your answer to Mr. Malone that it is the position of P.C.A. that they are going to oppose the drilling of any additional oil and gas wells in the pink and green areas?

A Yes, sir.

Q Until you have exhausted by first and second mining all of the economically recoverable potash reserves?

A Yes, sir.

Q Well, didn't you,at an arbitration hearing, approve this Odessa Dooley Well recently?

MR. BLACKMAN: If the Commission please, the approval

of the Federal Odessa Dooley Well was based upon a compromise and in a completely different situation than we have here.

GOVERNOR CAMPBELL: It is in the green area, isn't it?

MR. BLACKMAN: Yes, it is in the green area.

MR. PORTER: As I recall, this agreement came several weeks or even months after the arbitration meeting.

MR. BLACKMAN: That's correct.

GOVERNOR CAMPBELL: Well, I didn't want to ask --

MR. BLACKMAN: It was on the basis of one well.

GOVERNOR CAMPBELL: That was an exception to your present position, is that correct?

MR. BLACKMAN: That's correct.

MR. MALONE: May I ask, in that connection, if the Commission please, I understand that in addition to the ore body which is portrayed on this exhibit, Potash Company of America has had a very substantial ore body in Lea County, and whether the same policy is applicable to that ore body as well as the one portrayed on this exhibit?

A I might say in respect to the leases which are held by Potash Company of America in Lea County, we have for many years protested in every instance in which anyone wished to drill a well in that area. However, there have been so many wells drilled now that the commercial value of that ore deposit as of today is very doubtful.

MR. MALONE: You are protesting all wells that are

requested there?

A I believe that's a correct statement.

MR. BLACKMAN: I might just change it slightly. We are not protesting but we have filed a case up here and battled it out, the basis of the drilling of an oil well in the Lea County body. The Commission ruled against it. We state now that we have no further evidence to present in that case. On the position that the Commission will rule against, we see no point in protesting. On the basis of that, the Lea County deposit is of doubtful economic value now, as Mr. Clark stated.

MR. MALONE: You haven't surrendered the leases?

MR. BLACKMAN: No, we have not.

GOVERNOR CAMPBELL: This makes arbitration a little fruitless if that's the company's position in the future.

MR. BLACKMAN: Yes. I think so. On the basis of any wells similar to this in this area.

MR. PORTER: Does anyone have any question of Mr. Clark?

MR. BLACKMAN: I don't have a question, but I think that probably the policy of Potash Company of America should be stated, that it is our feeling that if we can get out all of the potash without any waste, we can later come in and get out all of the oil, tht there will not be any waste of the potash if the oil wells are not permitted to be drilled, and that it is not an unreasonable period of time to ask the oil companies to wait.

The oil would still be there if it is there now.
On the other hand, if the oil wells are drilled, the economic life of the potash mine will in all probability be ended before we are able to go in and properly plug any of the wells that are drilled, if there's anything there, because the productive life of a field in the Pennsylvanian or Devonian around there would probably be considerably in excess of twenty years.

MR. PORTER: That explains your position that you take on all proposed oil wells?

MR. BLACKMAN: In this area.

MR. PORTER: Yes.

MR. BLACKMAN: Yes.

MR. PORTER: Anyone have a question of Mr. Clark? He may be excused.

(Witness excused.)

GOVERNOR CAMPBELL: You have two more witnesses?

MR. BLACKMAN: I have two more, they will both be long.

GOVERNOR CAMPBELL: Is this a good time to break?

MR. BLACKMAN: I think this is a good time to break, as far as continuity, this is a good time to break.

MR. MALONE: Before you close the record, if the Commission please, we had reserved Pan American's Exhibit No. 6 for the picture and data on the Casing-Cote, and it did not get identified and introduced, although it was handed to the

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Commission at the time that the witness testified. If there's no objection, I will have it identified as Exhibit 6 and offer it in evidence.

MR. BLACKMAN: I would not object to it on the basis on which Mr. Malone has offered it, for the picture and description of what this process is.

MR. MALONE: That's the purpose for which it is intended.

(Whereupon, Applicant's Exhibit No. 6 marked for identification.)

MR. PORTER: The exhibit is admitted.

(Whereupon, Applicant's Exhibit No. 6 received in evidence.)

MR. PORTER: The hearing will recess until 9:00 o'clock tomorrow morning.

(Whereupon, the hearing was recessed.)

* * * *

MORNING SESSION
Thursday, April 16, 1964

MR. PORTER: The hearing will come to order, please. The Commission recognizes Mr. Blackman.

MR. BLACKMAN: If the Commission please, before we commence, I want to say for the record that Mr. Cummings has done his homework in answer to the question that Mr. Malone posed last night, and the answer is $60,000 for the value of the potash in the 100-foot radius circle. That can be checked out on the exhibit that was given to you yesterday.

MR. MALONE: In order that the record can be complete

on it. The number of tons is approximately 7,630, and the value approximately $60,000 in a 100-foot pillar around the present Barber 4-A Well. That's computed on the same basis as P.C.A.'s Exhibit T and the values that are shown on that. Thank you, Mr. Cummings.

MR. BLACKMAN: Dr. Bass, will you please take the stand?

DANIEL M. BASS, JR.

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. BLACKMAN:

Q Will you kindly state your full name and address?

A Daniel M. Bass, Jr., Golden, Colorado.

Q What is your present occupation?

A I am Professor and Head of the Petroleum Engineering Department at the Colorado School of Mines.

Q Will you kindly give us a resume of your education above the high school level?

A I did Bachelor of Science work at Louisiana State University, after which I was employed by Magnolia Petroleum Company, which is now Mobil, for approximately three years, after which I went to work for the Texas Petroleum Research Committee and at the same time did advance degree work at Texas A & M College.

After about two years with the Texas Petroleum Research Committee, I started teaching at Texas A & M. I taught there for approximately nine years. At the same time I did advanced degree work towards a Ph.D. During this interim at A & M, with the aid of deceased Bill Amicks, that is his name, we wrote a textbook entitled "Petroleum Reservoir Engineering". We also wrote a second textbook which has not been published because of his death, also on Petroleum Reservoir Engineering.

We contributed to the book which has been edited under the name of Tom Frick, which is entitled "Petroleum Production Handbook." We also published papers with respect to the secondary recovery, volatile oil reservoirs, the application of digital computers to petroleum problems, and a few other odds and ends.

After leaving A & M I went to Colorado School of Mines in 1962, and I have been there ever since.

Q When did you receive your Ph.D. and from what university?

A I will receive my Ph.D. from A & M as soon as I pass my French exam.

Q Will you kindly give us a resume of your consulting experience?

A I've done consulting work in South America and Africa and the Near East and Canada with respect to secondary recovery and primary recovery operations with respect to fields with differential oil properties which vary over a thickness of

some 2,000 feet, with respect to the application and modeling of oil reservoirs, of digital computers, with respect to hearings such as this one; and that's enough.

Q Very well.

MR. BLACKMAN: Are Professor Bass' credentials satisfactory to the Commission?

MR. PORTER: Yes, sir, they are.

Q (By Mr. Blackman) Professor Bass, will you kindly refer to the exhibit which is attached to the bulletin board which has been marked for identification as P.C.A. Exhibit No. Q. It is a plat which shows Section 17, Township 20 South, Range 30 East, New Mexico Principal Meridian, on which the contour lines on the approximate top of the Devonian as depicted by Pan American's Exhibit No. 1 have been extended.

Will you kindly make the following assumptions with respect to that exhibit: A: There exists at the location shown on that exhibit a closed Pennsylvanian or Devonian structure below 9,000 feet, having the configuration shown on said Exhibit Q, which is inhabited with oil, or with oil and gas to the third contour line.

B. There are no surface terrain problems, surface relief being nominal.

C. The reservoir consists of oil having a solution gas drive.

D. The reservoir characteristics and conditions are

the approximate average of what might be expected to be found in this location in Southeastern New Mexico.

MR. BLACKMAN: If the Commission please, while the regulations provide for 40 acres standard spacing, I have been informed and I understand the case to be that if requested at the appropriate time, 80-acre spacing will be allowed for the standard spacing rule for the development of an oil or oil and gas reservoir below 900 feet.

MR. MALONE: May I inquire if this is official or unofficial information as to what the Commission proposes to use?

MR. PORTER: I would say that the operator has an opportunity to ask for wider spacing. I wouldn't say that there would be a probability or make any statement like that, that it would be granted.

MR. BLACKMAN: I understood there was a possibility, and I therefore ask Professor Bass to assume that 80-acre spacing would be allowed and approved if an appropriate application was made therefor at the appropriate time, and the conditions warranted it. So I'll ask him to assume that it would be approved. This is for the purpose of the hypothetical question.

Q (By Mr. Blackman) On the basis of the assumptions which I have enumerated, will you kindly indicate on Exhibit Q an ideal development program, to recover the maximum amount of petroleum products from the reservoir? Please begin with the

proposed location near Barber Well 4-A, or 4-J as it is sometimes called, in the Northwest Quarter of the Southeast Quarter of Section 17, and number each well location without regard to order in which the wells might be drilled. In this connection, please consider the New Mexico statute governing waste, which reads as follows: "As used in this act the term 'waste,' in addition to its ordinary meaning, shall include: (a) 'Underground waste' as those words are generally understood in the oil and gas business, and in any event to embrace the inefficient, excessive, or improper, use or dissipation of the reservoir energy, including gas energy and water drive, of any pool, and the locating, spacing, drilling, equipping, operating, or producing, of any well or wells in a manner to reduce or tend to reduce the total quantity of crude petroleum oil or natural gas ultimately recovered from any pool ..."

When you have indicated the ideal drilling and development program on P.C.A. Exhibit No. Q, will you please comment on the pattern for the solution gas drive and also comment upon such variations as you might recommend in the event the reservoir has a water drive or a gas cap drive.

That's the end of the question, Professor, and if you'll kindly step up to Exhibit Q and mark your ideal drilling and development program on P.C.A. Exhibit Q?

MR. MALONE: If the Commission please.

MR. PORTER: Mr. Malone.

MR. MALONE: Again prefacing my objection with the

statement that any reasonable evidence, we are delighted to have go in in this case that will help the Commission reach a conclusion. I nonetheless am forced to object to the hypothetical question for the reason it assumes facts not in evidence.

Second, it asks the witness to construe the laws of New Mexico, which he has not shown himself qualified to do; third, for the reason that it assumes developments in the future on the basis of orders by this Commission which have not been issued, and assumes what the spacing pattern which will be promulgated by the Commission will be, and predicates that upon the application of the law which is to be made by a layman.

I think that if Counsel wishes to ask this witness to assume that 80-acre spacing is applied for, how many wells are there going to be and how many locations; that's one thing. But a question that takes into account the number of assumptions which have been read seems to me to be wholly useless in developing evidence that would be worthwhile in the hearing.

MR. BLACKMAN: If the Commission please, the purpose of this line of questioning is that we have before us at this time evidence of seismograph data which indicates a structure closure at that location. The evidence put in by Pan American's geophysicists indicates that they expect it to be occupied to the fourth contour line.

We had prepared this information in advance on the basis of rather guesswork about it, until Mr. Malone furnished me with a

copy of Pan American's Exhibit 1. Now it is our position that a reservoir, if one exists here, should be properly developed, and what would be an ideal development program and what would happen if we did not have an ideal development program, what would be the effect of various changes in an ideal development program in terms of loss of oil and gas in this reservoir, if such a reservoir exists.

We therefore propose to ask Dr. Bass to place his ideal development program on this structure upon the assumption that a reservoir does exist there, and then inquire as to what might happen under various circumstances.

MR. MALONE: I would supplement my objection and expand it to include the objection that the information proposed to be developed is immaterial to any issue in this hearing, for the reason that, as now explained, it is proposed to have this witness testify to the very things that the Commission would be considering if it were holding a hearing on the fixing of spacing and proration units.

Until information has been developed as to communication in the reservoir and other factors which are unknown and are not assumed in the question asked, it's impossible to determine what the spacing is going to be and what the economic loss or possible waste that might result from the development is going to be.

If what Counsel is seeking is merely the number of wells that would be placed inside those contours on an 80-acre spacing

pattern, we'll stipulate to whatever that is, but we do object to a question of this type which encompasses everything in the corral without providing a gate.

MR. BLACKMAN: If the Commission please, the issue must be faced. We can no longer in the State of New Mexico approach the problem of whether an oil and gas well should be drilled through potash beds on a one-shot basis. This is a much broader problem, a very much broader problem. To me, it is unthinkable that one well should be drilled and then shut-in because the proper development of the reservoir would require too much loss of potash.

If there is a reservoir of gas here, in order to prevent waste, as provided by the statute, it should be properly developed to produce the maximum amount of oil and gas in it. The statute is perfectly clear, and it doesn't require anybody with any particular qualifications to construe it.

It simply says "to produce the maximum amount of material in the reservoir." We want to investigate what would be an ideal drilling program. We appreciate that nobody has the information as to where this structure will be located. Nobody knows exactly how this would happen, but if it turns out that it is in exactly the positions that Pan American says it is according to their seismograph work, and if it has a little bit less reservoir area than their testimony indicates they think it has, then what would be the ideal development program?

It's a question that is certainly pertinent to this hearing. We have been going on here for quite some time and batting ourselves back and forth on the problem of who is interested in this thing, whether it's Pan American or P.C.A. That isn't the issue at all.

This Commission is charged with the duty of protecting the public. It's the public interest that is involved. It is not the interest of P.C.A. It's not the interest of Pan American. It's not an adversary proceeding between Pan American and P.C.A.

The real proceeding is before the Oil Conservation Commission, with the duty of protecting the public. The real party of interest is the State of New Mexico and the people of New Mexico, and we need to investigate this particular problem, and we must look at the over-all problem as it is and not on the narrow problem of whether a particular well should be drilled in this little location here, we should have one well, and whether that one well will cause a loss more to P.C.A. or more to Pan American. That isn't the problem at all.

The problem is one of conservation, that is the issue before this Commission now, and the question of the best method of doing it and the best evidence that we can produce on that question as to what those best methods would be are most certainly pertinent.

GOVERNOR CAMPBELL: As I understand it, your assumptions to this expert witness are that the contour lines are correct,

they are closed, that there is an oil reservoir in the Devonian --

MR. BLACKMAN: Pennsylvanian or Devonian.

GOVERNOR CAMPBELL: This is on top of the Devonian.

MR. BLACKMAN: It is a contour on top of the Devonian, yes.

GOVERNOR CAMPBELL: That it has solution gas --

MR. BLACKMAN: Right.

GOVERNOR CAMPBELL: -- or gas cap or water?

MR. BLACKMAN: Right.

GOVERNOR CAMPBELL: What is the ideal development pattern -- Oh, also assuming 80-acre spacing.

MR. BLACKMAN: Assuming 80-acre spacing.

MR. PORTER: The Commission will overrule the objection. We would like to have Professor Bass' opinion here as to what he thinks, his opinion as to what is the proper or ideal development of this pool, or anyone else who cares to state on the witness stand what the ideal development would be.

Q (By Mr. Blackman) Professor Bass, would you kindly proceed then?

MR. BLACKMAN: If the Commission please, Professor Bass has prepared a report in answer to the hypothetical question I have just proposed. While he's reading his answer, we have for presentation to the Commission and to Counsel a report of his answer.

MR. SMITH: Is this an answer to his question or a

report submitted to you that we are talking about?

MR. BLACKMAN: Would you ask the question again?

MR. SMITH: I am confused as to what your question is and his answer, and the statement about the report. Is this your statement to the hypothetical question?

MR. BLACKMAN: Yes, it is.

MR. SMITH: I think we should have a chance to look at the answer before we admit it into the record.

MR. BLACKMAN: He's going to read it into the record. The answer starts on page 8.

Q (By Mr. Blackman) Very well, Professor, proceed.

A You have asked me to indicate an ideal drilling and development program on 80-acre spacing for a Pennsylvanian or Devonian oil or oil and gas reservoir which occupies a producing structure which might be expected under average conditions in Southeastern New Mexico.

GOVERNOR CAMPBELL: This is the only portion of this, this is the only evidence, beginning at the bottom of page 8? You are not offering the whole thing?

MR. BLACKMAN: We will later.

A Page 1 through 8 is his hypothetical question, which I duplicated to avoid any confusion.

Q (By Mr. Blackman) Would you speak up a little louder, a little slower?

A The structure is assumed to be in the location and to

have the configuration as shown on P.C.A. Exhibit No. Q, to be inhabited with oil or oil and gas in the area inside of the closure depicted by the third closed contour line and to have a gas solution drive. Attached to the facing page hereof is a photocopy of a map which is designated Map No. 1 - Township 20 South, Range 30 East, N.M.P.M., which shows the same area and drilling and development program.

The wells on this map marked 1 and 2 are the wells represented by the present drilling application of Pan American Petroleum Corporation. The wells with the dark spots would be definite wells within the structure and the wells with the broken circles represent possible additional wells. Of course, knowing the structure as it is seen here, it is noted that I have not included any uncommercial wells, of which, one or two would probably be drilled in order to define the structure. The wells marked with the broken circles would all be potential wells and, in all probability, would be drilled during the development program. Thus it is seen that there are fourteen definite wells and four potential wells. Thus, the possibility of one or two non-commercial wells would indicate a potential between seventeen and twenty wells in order to completely define the oil accumulation within the structure.

The sequence of drilling these wells is at the present time difficult to define. The exact sequence of course would depend on what was found during the drilling of the initial

well. If this well were on top of the structure, as indicated, then it would be necessary to drill down-dip, flank wells in order to determine the limits of the hydrocarbon accumulation. If, as in most cases, the initial well were not exactly on top of the structure, and dip meter surveys and other information obtained during the drilling of the well indicated that the structure top were away from the present well, then the next well drilled would be an effort to define the structural top. It is nearly impossible to define an exact drilling program until after the first well is drilled into the accumulation.

This 80 acre development program would adequately produce the reservoir if it were of a solution gas drive type energy.

If the reservoir were of gas-cap type energy in which it was necessary to permit the advance of the gas cap in order to obtain maximum conservation then it would be necessary to drill essentially all of the wells which are denoted by a broken circle. This type drive would increase the number of wells which would be required for adequate depletion from fourteen to nineteen. In this case, considering that two non-commercial wells would be drilled, a gas-cap energy source would result in the drilling of the maximum number of wells on the structure, twenty-one wells.

Should a water drive energy source be prevalent then it would be unnecessary to drill the wells which are indicated by the broken circles and well No. 14. Probably two of the wells

indicated by a broken circle would be drilled during the development program and probably one non-commercial well would be drilled in defining the structure. Thus, a water drive energy source would require the drilling of the minimum number of wells on the structure, approximately sixteen wells.

The 80 acre spacing as indicated on Map 1 would probably be required for any oil accumulation which is found.

MR. BLACKMAN: If the Commission please, I have just indicated on Exhibit Q a red line marked "A" in Section 19 and "B" in Section 29. I have indicated that red line on there for the purpose of the next question.

Pan American has introduced Exhibit No. 7 which indicates that they plan, and their testimony indicates that they plan on the future operation of the Barber Pool for some time. Their proposed two locations and the arguments that they have been making that the potash is already dedicated and lost around the Barber Pool wells indicates that they would proceed to drill additional wells twinning the Barber Pool wells for the purpose of minimizing the loss of potash. So I have drawn the line "AB" which includes the Barber Pool wells and includes the wells on Professor Bass' ideal drilling program, which would in most cases twin present Barber Pool wells.

It would require in I think two instances a slight unorthodox location to exactly twin them. But on the basis of their contention that the potash has already been dedicated under

those wells, which contention we vigorously deny because we feel it can be produced, we now pose the next question to Professor Bass.

Q (By Mr. Blackman) What would be the effect on such an oil or oil and gas accumulation if the structure were divided as indicated by the red line designated "A" at one end and "B" at the other end on P.C.A. Exhibit Q and only those wells which are situated below or southerly of the red line A-B were drilled and produced for an initial period of fifteen years, there being no wells drilled or produced above or northerly of the red line A-B for such initial 15-year period?

MR. MALONE: If it please the Commission, for the record I object to the question for the reason that there has been no statement by Pan American of such an intention as is assumed in the question, and there is no evidence upon which such an assumption could be based.

GOVERNOR CAMPBELL: Mr. Blackman, other than the testimony that the location of the first well might be as a twin location to the Barber 4-A, what evidence is there or statement that this would be the intention of Pan American?

MR. BLACKMAN: The evidence that has been placed in here on the duration of the production from the Barber Pool. They have placed evidence in here that the Barber Pool is here. They have argued that by twinning their first location, we would not be wasting any more than, I suppose they will contend, that $60,000

worth of potash. That was changed here. I don't know what that contention is going to be, but I am raising a hypothetical question in the event they do proceed down this road.

If they proceed down this way or if the Commission should proceed down this road on the theory that the loss of potash would be minimized, what would be the effect on the remainder of the reservoir?

I think it's a perfectly proper question and it is one that directly involves waste.

GOVERNOR CAMPBELL: Of course, I'm sure that the Commission is aware of the limitations, obvious limitations on all of this kind of testimony. Everybody is assuming a lot of things until the hole is dug, if it is. With that condition of those obvious limitations, I would have no objection.

MR. PORTER: Objection overruled. The witness may proceed.

A The material which has been handed the Commission, at the middle of page 14 is a printed statement of the question as expressed by Mr. Blackman.

The map opposite on page 13 has a slightly different line than Mr. Blackman has depicted on Exhibit Q, although this line with respect to the reservoir encompasses the same volume. So if the Commission please, I would prefer to refer to the line which is included as Map 2 in the text that is included.

MR. MALONE: Rather than the one that's on the official

exhibit of the Commission?

A It wouldn't make any difference in the answer. The encompassing within the third contour is the same.

MR. MALONE: We object to any testimony predicated on an exhibit that is not in the case.

MR. BLACKMAN: I think the way to do that is to remedy the error which is solely mine, the placing of the line A-B. I will now place "A" -- I have now placed the line A-B as proceeding north along the west boundary line of Section 29 and 20 to the corner common to Section 17, 18, 19, and thus to the center of Section 17; then a quarter of a mile east and thence south to "B".

MR. SMITH: I wonder if it would be proper to inquire of this witness whether or not this exhibit was prepared under his supervision.

MR. PORTER: This line as drawn by Mr. Blackman here conforms to what you have on your Map 2 on page 13?

A Yes, sir, it does.

GOVERNOR CAMPBELL: Answer the question.

A Reading from the last paragraph on page number 14, Map No. 2, facing this page, indicates a dashed line A-B which is equivalent to the red line, also marked A-B, on P.C.A. Exhibit No. Q. The effect on conservation of the natural resources within such an accumulation would be dependent upon the mode of operation of the developer and on the energy source within

the oil accumulation itself. In order to properly answer this question it will be necessary to stipulate a behavior for at least three distinct types of energy sources. If the reservoir were a solution gas, gas cap drive or a water drive reservoir, one would expect a different performance; hence, each of these type drives will be discussed separately.

Solution Gas Drive

If the reservoir is a solution gas drive type then the recovery mechanism would be that of displacing the oil by the evolution of gas from within the oil. This is probably one of the least efficient drive mechanisms available if it is not aided in some fashion by gravity segregation and conversion to a secondary gas cap drive. It is entirely possible that a restriction of development to one segment of the reservoir would create conditions such that a secondary gas cap would be formed at the top of the structure. In any case, this restrictive development would be detrimental to the conservation of the petroleum within the structure. Such a development would force the oil and its associated gas in the undeveloped area to migrate around or over the structure in order that it might be produced. The force of gravity would work against migration over the top of the structure and would, in effect, leave oil in the lower portions of the structure and gas would migrate to the upper section. During the depletion of the developed portions the operator would be unable to produce his wells in a fashion which would prevent the pressure depletion and the migration of the gas from the area in which no drilling

had occurred. During this depletion stage the operator would be producing from wells, according to your red line, in approximately 38 percent of the volume of the reservoir, leaving approximately 62 percent undeveloped. Within this 62 percent of the total structure the operator would probably recover some 25 to 50 percent of the oil that he would recover were he able to fully develop that region. Thus the operator and the state would lose between 30 and 45 percent of the oil within the structure that would normally be recovered by a solution gas drive mechanism under full development.

The granting of permission to drill and develop this region fifteen years after the development of the southernly end of the structure would in all probability not be economic from the standpoint of primary recovery. During the pressure depletion in the southernly part of the structure, the energy for movement of the oil in the northern part of the structure probably would have been dissipated. Thus, even drilling within the structure where no previous production had occurred would not yield oil in the same quantities that were obtained during the initial development on the southernly end of the structure. To adequately remove the oil from this previously undeveloped area of the structure would require that the operator install a supplementary energy source, gas injection or water injection, to supply energy for movement of the oil from within the formation to the bore of the wells. Supplementation of the natural energy

would be costly and its initiation would depend on whether the producer could recover the required investment from the recoverable oil that remained in the formation.

In the outside case, in which a secondary gas cap is formed at the top of the structure, the operator could conserve some of the energy by not producing the secondary gas cap. In so doing, he would still not recover by primary means any additional oil and in all probability would recover less from the undeveloped side of this structure. This would mean that a restrictive development program would cause the producer to leave approximately 45 percent of the recoverable oil within the ground. The only advantage of the secondary gas cap is that after the end of the fifteen year period there is the probability that some of the oil in the undeveloped region could be recovered by means of expansion of this gas cap. Thus, the operator would be conserving part of the natural energy within the reservoir by letting gas accumulate at the top of the structure and later permitting this gas to expand and displace oil to the wells. The additional recovery which might be obtained during this second development program would be dependent upon the magnitude and size of the secondary gas cap. If the gas cap is small then little additional oil would be realized because the energy source would be insufficient to adequately deplete the undeveloped portion. If this gas cap is large and if it has been possible to maintain the pressure somewhere in the neighborhood of one half of the original pressure,

it would be possible to reduce the loss of this stage development program from 45 percent to some 15 or 20 percent.

It is fairly apparent that regardless of the mechanism which might be involved in the solution gas drive depletion of such a partially developed structure, some loss of petroleum would occur. The magnitude of this loss would be in the neighborhood of 15 percent for very favorable conditions and 45 percent for normal conditions.

Gas Cap Drive

If the structure had a hydrocarbon accumulation of the size shown in Map 2 and part of this accumulation were gas, to say the first contour, then the southernly area in which development is to be permitted would encompass part of the oil zone and part of the gas zone. This gas zone represents a concentrated source of energy which, if permitted to expand through the oil zone, acts as a more efficient recovery mechanism than solution gas alone. In a partial development, such as you have indicated, the presence of the gas cap can be a disadvantage during the depletion stage of the developed area. The gas is very mobile, it moves much more readily within the pore structure than does oil. Gas also transmits pressure changes much more readily than does a similar section of the reservoir containing oil. Hence, at any given time, the pressure within the gas zone would essentially be constant value over a large part of the original reservoir filled with gas. Thus the pressure in the undepleted area

would have ample opportunity to decline along with the decline in gas pressure. Also, partial development would tend to concentrate the expenditure of this gas cap energy in only a fraction of the oil saturated zone. The irregular decline in pressure would result in a tilting of the gas zone as depletion occurred. This tilting would cause the developed portion of the reservoir to be swept by gas with very little enlargement of the gas cap in the undeveloped region. To adequately deplete the section that is developed it would be necessary to produce a good portion of the original gas cap gas from the wells within the oil zone. The presence of the gas cap would retard the migration of oil from the undeveloped portion into the developed portion because of the greater ability of the gas to advance into the producing region. Thus, the initial loss due to partial development would be in the neighborhood of 35 to 40 percent of the normal recoverable oil. Development of this region after a delay of 15 years would recover some of the remaining oil. Advancing gas from the gas cap would not be as efficient a displacing agent after the delay because of the effect declining pressure has on the properties of the oil and the reduced ability of the operator to obtain maximum sweep with the advancing gas. If the pressure had been depleted to a very low level, the economics of developing this region would not be as good as if it had been developed along with the other section because of the energy content of the remaining fluids. Thus, even under the most ideal conditions, the

delayed development results in a total loss within the structure on the order of 15 percent of that which would be recovered had the structure been developed uniformly.

In all probability it would be necessary to supplement the energy within the reservoir with either gas or water injection which alters the economics and increases the cost. Regardless of the operator's practice of production, a delay of 15 years in full development would result in a loss of between 15 and 40 percent of that oil which would be recoverable under a standard, uniform development program.

Water Drive

If the oil accumulation within the indicated structure has a strong water drive around the periphery and if development were restricted to the southernly part enclosed by dashed-line A-B on Map 2 it would be necessary for the operator to concentrate his production in the upper segment of the structure in order to partially deplete the lower part of the undeveloped portion of the reservoir. Under these conditions, the production from the wells adjacent to the dashed line could be controlled so that it would be possible to partially pressure deplete and cause water invasion into the area in which no development had been permitted. Concentrating the production at the top of the structure would cause water to advance within the undeveloped region but would also cause extreme pressure losses around these wells and might endanger the completion of the well and reduce the recovery

efficiency of the water drive mechanism. The advance of water in the undrilled region would not occur as rapidly as the water advanced within the developed region because of the concentration of production in the developed area. Thus, the pressure distribution within the structure would have a tendency to cause water to migrate in a tongue like fashion into the developed area and a short advance in the undeveloped region. This manner of water advance would create a region near the top of the structure which would contain significant quantities of oil at the time the existing wells were invaded by water and forced into a non-commercial category. The loss in such a situation cannot be ascertained with a finite degree of accuracy because of the dependency of water invading the undeveloped region on the exact well locations, their relative production rates and the volumetric efficiency of water as a displacing agent. A fair estimate of the loss of recoverable oil would be in the neighborhood of 20 to 25 percent. If this region were developed after a period of fifteen years it would be a rather costly development program because the position to which water had advanced in the undeveloped region would be unknown. Thus, wells would be drilled which were un-economical to operate and for depletion purposes unnecessary. The recovery from this region would depend on the magnitude of the pressure reduction required to deplete or produce the undeveloped region. Additional oil could be obtained by development after a delay of fifteen years but a net loss of approximately 15 to 20

percent of the recoverable oil in the structure would still be left in the ground.

Summary

It is seen that regardless of the type of drive the idea of partial development of a structure, with full development being delayed for some fifteen years, results in a loss of recoverable petroleum and an increase in the cost of operation to the developer of this mineral resource. Unfortunately one cannot determine which type drive would be prevalent in a formation on this structure with present knowledge. The reservoirs which have been found in the potential oil bearing formations on this structure have indicated all three types of drive energies. Therefore, it would be inadvisable for an operator, both from a standpoint of mineral resource conservation and from a standpoint of economics, to delay development for a period of fifteen years on a part of a hydrocarbon accumulation.

Q Professor Bass, the alternate location proposed by Pan American Petroleum Corporation is within a 100-foot radius from existing Barber Field well 4-A, or properly designated 4-J. Will you please state your opinion as to the probable future economic life of that well?

A I have examined the production records of Barber Field well 4-J located in the Northwest Quarter Southeast Quarter of Section 17, Township 20 South, Range 30 East, N.M.P.M., covering the period beginning June, 1942 and ending with calendar 1963.

Based on that information, it is my opinion that well 4-J has a remaining economic life of from four to five years from the end of calendar 1963.

Q Professor Bass, will you also express a similar opinion as to the remainder of the producing wells in the Barber Field?

A I have examined the production records of the Barber Field, covering the period from 1941 through calendar 1963. As only the past production records were available, with no operating cost data, it was necessary that some limiting economic rate be assumed. All the answers which follow are based on a limiting economic rate of 45 barrels per month per well. Also, after studying well 4-J, it was assumed that only seven wells would be produced during the remainder of the field's economic productive life. Under these conditions, it is my opinion that the Barber Field can be economically operated through calendar year 1974.

Because of the uncertainty of the limiting economic conditions for the field as a unit, I examined the production records of each well individually. Using the same limiting economic rate of production, an estimate was made of the year each well in Barber Field would become uneconomical to operate. The results of this evaluation are shown on Figure 1 entitled "Barber Field - Abandonment Schedule". It is noted from Figure 1 that three of the wells in the Barber Field could be economically productive into the calendar year 1978.

Q Professor Bass, will you please comment on the average

values of hydrocarbons which have been produced in Southeast New Mexico from the Pennsylvanian and Devonian formations and make such comment as you deem appropriate concerning the value of the hydrocarbons which might be expected to be recovered under ideal conditions from a Pennsylvanian or Devonian reservoir confined within a structure such as that pictured on P.C.A. Exhibit No. Q and your Map No. 1?

A We are now starting at the middle of page 31. In answering this request I will discuss first the producing formations in the area and then the probable content of these formations.

Producing Formations:

The major oil and/or gas producing formations of Pennsylvanian age or older are:

(1) Bend

(2) Pennsylvanian

(3) Devonian

(4) Siluro-Devonian

(5) Simpson

(6) Ellenberger

All oil fields in the eastern half of the state which had produced ten million barrels of oil by January 1, 1962 from formations of Pennsylvanian Age or older are shown in Table I. All gas fields in the eastern half of the state which had produced five billion cubic feet of gas by January 1, 1962 from formations of

Pennsylvanian Age or older are shown in Table II. From a study of these two tables it becomes apparent that the Pennsylvanian and Devonian formations are the primary oil and gas producers of the group.

Since 1958 other fields have been developed which will soon join the ranks of these fields listed in the tables. The major fields which have been discovered since 1958 add very few new major producing formations to the list indicated prior to that time.

Discoveries as late as 1961 indicate that the Morrow formation may have possibilities of developing into a major gas producing formation and the Fusselman formation may have similar possibilities with respect to oil.

Also from studying the tables it is seen that forty acres per well is the predominant spacing in the oil fields and one hundred and sixty acres per well is the predominant spacing in gas fields.

QUANTITY AND QUALITY OF POTENTIAL OIL PRODUCTION

A review of the Pennsylvanian, Devonian or related producing formations indicate that the potential oil is of highest quality (40° API or higher) and hence will command top market price.

The Pennsylvanian, Devonian and related age formations are generally limestones or dolomites. These formations range in productive thickness from 10 to 200 feet with porosity

values from four to fourteen percent and initial water saturations from twenty to fifty percent. Using the lowest value of porosity and the highest value of water saturation results in an oil in place value of approximately 110 stock tank barrels per acre foot. The recoverable oil from this formation would be approximately 18 barrels per acre foot by solution gas drive and 45 barrels per acre foot by gas drive.

Using a porosity of fourteen percent and a water saturation value of twenty percent results in an oil in place value of approximately 620 stock tank barrels per acre foot. The recoverable oil from this formation would be approximately 125 barrels per acre foot by solution gas drive and 250 barrels per acre foot by water drive.

Combining the range of possible oil in place values with the wide range in thickness results in a very diverse potential economic value per acre. The minimum approximate value per acre would be for a ten foot thickness with four percent porosity, fifty percent water saturation and a solution gas recovery factor. This adverse combination of factors would result in a recovery of approximately 180 barrels of oil per acre with a value of approximately $540.00. The best conditions would be a formation 200 feet thick with a porosity of fourteen percent, water saturation of twenty percent and a water drive recovery factor. A reservoir under these very favorable conditions would recover approximately 50,000 barrels of oil per acre with a value of

approximately $150,000.00.

From the values presented above it is seen that any well drilled to formations in the Pennsylvanian or older formation on eighty acre spacing has the potential of finding oil valued at between $43,200 and $12,000,000. In this particular area the formation which had a potential income of only $43,200 would not be considered a commercial well although it would probably be produced to recover as much of the drilling cost as possible.

An average oil field in the Pennsylvanian or older formations would probably have a porosity value of 6 percent, a thickness of 75 feet and a water saturation value of 35 percent such that the oil in place would be 216 barrels per acre foot. The potential recovery from a well developed in an eighty acre spacing pattern would be between 233,000 barrels (solution gas drive) and 518,000 barrels (water drive). The monetary value of such a well would be between $700,000 and $1,554,000.00.

The worst, average and best possible reservoirs obtainable in the area are summarized in Table III. The tables follow this text.

Q Were all of the tables in this report prepared by you, Professor Bass?

A They are.

Q Are you generally familiar with the techniques and problems of cementing a deep oil or gas well?

A Yes.

Q Would you enumerate some of the problems of cementing a well penetrating a thick salt section with several known loss circulation zones above and below the salt section?

A In any region with loss circulation zones the major problem is to get adequate cement volumes in the desired locations. Two techniques may be used to cement casing in loss circulation zones. Both methods depend on putting the cement in the hole in stages.

Method I is to calculate the volume of cement required to fill the annulus from the bottom of the hole to the loss circulation zone and the volume of the cement that can be placed above the loss circulation zone without imposing too high a pressure on the loss circulation zone. This volume of cement is circulated into the annulus and permitted to obtain some set. A temperature survey is run to locate the top of the cement or a bond log is run to locate the top of the bond between cement and pipe. The casing is perforated at the top of cement or top of bond and with appropriate hole equipment in place, cement is circulated through the perforation to another preselected height in the annulus. This procedure may be repeated until cement fills the annulus to the desired height above the bottom of the hole.

Method II requires careful planning prior to the placement of the casing string in the hole. In this method special

gating devices are placed in the casing string which can be opened by plugs larger than a given diameter. The cement is again placed in the annulus in batches or stages with the first stage being displaced out the bottom of the casing, the second stage enters the annulus through the lowest stage tool and the third, fourth and other cement stages, if required, being pumped through sequentially higher stage tools. This method is desirable only when the location of the loss circulation zones can be accurately defined and it is known that each volume of cement staged into the hole will at least reach the height of the next stage tool.

Certain problems of cement placement are common to both of the methods previously mentioned. The major problems, other than loss circulation, are obtaining a uniform distribution of cement in the annulus and obtaining good pipe-cement and cement-formation bonds.

In order to obtain the most uniform distribution of cement in the annulus, centralizers are placed on the casing to try and provide an equal spacing between the hole and the pipe. Also to prevent channeling or "by-passing" of the cement, the velocity of the cement is controlled so as to obtain turbulent flow during the period of placement.

In order to improve the chances of obtaining a cement bond between the cement and the casing and wall of the hole the operator will usually prepare the pipe surface, use scratchers on the casing, use water ahead of the cement, control the

velocity of the water and cement in the annulus, and use excess cement volume so that mud contaminated cement at the top and bottom of the column can be placed in regions not desired to be cemented. The major difficulty in obtaining a cement bond is reaching the surface at which a cement bond is desired. In washed out sections of the hole the velocity may decrease so that plug flow occurs and the mud is not displaced from the washed out volume. The engineer designing the cement job will use a caliper log and set the velocity so as to have turbulent flow in the largest indicated hole size. If the caliper log accurately defined the hole size, then the cement placement will probably displace the mud from the hole.

Q Are special cements used in operations such as this?

A Yes, special chemicals can be mixed with the cement to provide desired properties, such as reduced weight, low water content, loss circulation material, setting retarders, et cetera. I am not familiar with the exact chemicals which might be used here, but such information could be obtained from Halliburton, Dowell or any other cementing firm by the engineer designing the cementing job. I am sure the properties of the cement would be considered in the design of any casing cement job.

Q Does taking all the precautions you have enumerated guarantee a good cement job?

A No guarantees are included. All of these steps are followed in a cementing job to create the most favorable conditions

for obtaining a good cement job.

Q If a cementing technique cannot be designed to guarantee a perfect job then how do you tell if you have any cement job at all?

A There are four major ways of obtaining a qualitative check on the quality of the cement job obtained.

Two of the methods are primarily designed to locate the top of the cement column if it is not circulated to the surface. A radioactive material may be added to the lead volume of cement slurry and a gamma ray log run to detect the location of the radioactive cement after placement. The other method is to run a temperature measuring device in the hole during the time the cement is "setting". A change in the normal temperature gradient is observed at the top of the cement column. By knowing the volume of cement placed in the hole and a good estimate of the volume of the annulus it is possible to estimate if channeling of cement or loss of cement has occurred. Neither of these methods will indicate the strength of the set cement; the bonding of the cement to the casing and the wall of the hole; whether cement encircles the pipe or is just located on a portion of the pipe surface; but does indicate the height to which cement has been placed; whether a measurable degree of channeling and loss circulation has occurred.

Another tool available for checking on the quality of a cement job is the Bond Log. This is a tool which generates

sonic impulses and measures the magnitude of the energy of these impulses that is transmitted to a receiving device. If casing is surrounded only by fluid it will transmit a greater amount of energy than if it is resting against something solid. This transmission of energy is much the same as a bell whose sound can be muted by placing anything of a semi-solid nature against its surface. Thus the Bond Log indicates whether or not a section of the pipe is resting against something solid. The Bond Log will indicate the following: when the pipe is completely surrounded by fluid; when the pipe is resting against something solid, cement, cavings or side of the hole.

The Bond Log will not indicate the following: the strength of the bond against the pipe, whether the bond encircles the pipe, whether cement is bonded to the wall of the hole.

The fourth procedure of testing a casing cement job is to apply pressure and check for cement failure. The pressure is applied inside the casing and to the bottom of the cement column. This procedure only checks the casing for leaks and the very bottom of the cement column. This test does not necessarily locate weaknesses in the upper part of the cement column unless they are so severe that casing leaks result. Of course the maximum bottom hole test pressure that can be used is determined by the depth to the bottom of the casing. A pressure cannot be used which would cause fracturing of the formations.

Q Is it possible that a casing cementing job could

satisfy all of the tests and still fail at some future date?

A Yes.

Q What might cause such a failure?

A Essentially three factors might cause the cement job to fail at some later date. These three causes may be summarized as follows: the original cement job just barely met the test requirements but did not have sufficient strength or bonding to either the pipe or the wall of the hole; pressure testing of the cement job caused expansion of the pipe which could cause a loss of cement-pipe bond on release of pressure; additional drilling after the casing has been set creates impact loads because of the drill pipe and temperature increases because of the returning drilling fluid. Both of these factors could result in a failure of the casing cement.

Q Is it possible that a casing cement job could be subjected to a greater pressure than that used in testing the cement?

A Yes, at shallow depths. Such a condition would normally only occur as a result of a "blow-out" during drilling when the "blow-out" preventors work. A formation with gas at 4500 psi at 10,000 feet could exert a pressure at 3800 feet in excess of 3800 psi and cause the formations to fracture. If casing were set in this example at any depth less than 3800 feet the formations between 3800 feet and the bottom of the casing would be subject to fracturing.

Q Could this fracturing cause a complete failure of the

cement job?

A It would unless the formations above the fracturing were competent enough to withstand the abnormal pressures and resulting deformation.

Q Does perforation of the cemented casing endanger the cement-casing bond?

A Perforating with jet charges does very little damage to the cement pipe bond, whereas, perforating with bullet guns would cause some fracturing of the cement sheath at the point of bullet entry. The effect of this fracturing normally does not extend any significant distance from the point of impact of the bullet. Hence, it probably would be concluded that perforation of the cemented casing does not hurt a good cement job. If the cement job is not a good one then any additional surface exposure could result in a complete failure of the cement-casing bond.

Q Is there any known non-destructive method of determining the inplace strength of a cement job in an oil or gas well?

A No.

Q If a high pressure gas well, such as Federal Dooley No. 1 which is drilled in the Getty Pool, which has a bottom hole pressure of 5000 psi, were leaking through the cement at the production perforations into the salt section at a rate of approximately 50,000 cubic feet per day, would it be possible to detect such a loss?

A I must answer your question with a conditional yes.

Q How would you detect such a loss?

A As you have stipulated the leak to be located at the producing perforations, the leak could not be detected using temperature and pressure measuring devices within the well during test periods. The only means of detecting such a small loss would be the use of a volumetric gas balance applied over an extended period of production. By observing the shut-in pressure after fixed intervals of production, it would be possible to determine that fluid was leaving the reservoir which was not accounted for by the production measured at the surface. The length of time required to detect this loss of fluid would depend on the rate of gas production and the size of the leak. Figure 1 shows the ideal performance and the performance that would be observed if the loss were uniformly one percent and ten percent of the total reservoir production. It is noted from Figure 1 that the smaller the leak the greater the value of cumulative production at which the leak can be detected.

If the gas reservoir was producing under the influence of a partial water drive, it would be difficult if not impossible to detect an underground loss of gas equivalent to one percent of the total gas removed from the reservoir.

Because of the possibility of water influx and the probability that a loss of 50,000 cubic feet per day would represent less than one percent of the production, one cannot answer your question with an unconditional yes.

Q If a non-commercial gas or oil well is plugged and abandoned, is there any way in which a leak may be detected around the cement outside the productive casing string?

A No.

Q Professor Bass, did you prepare Figure 1 and all of the other charts in this report?

A I did, everything but the typing.

MR. BLACKMAN: That's all. I will offer in evidence the entire report which Dr. Bass has just read.

MR. MALONE: If it please the Commission, it having been testified that the exhibits were prepared by Professor Bass, we will make no objection to their admission. We would like the record to show that Dr. Bass' answers to all questions propounded to him were read from a prepared manuscript and do not constitute the answers of the witness from the witness chair. We move that the testimony be stricken and object to the admission in evidence of the offered exhibit.

MR. BLACKMAN: If the Commission please, this is not an unusual method of presenting testimony in cases of this kind. It happens that we presented it this way for the following reason: We employed Professor Bass for the purpose of an expert petroleum engineer so we could find out what was going on. We asked him to prepare answers to these questions, and the report came to us in such form that it required very little changing in order to place it in the record just this way. May I ask one

question?

Q (By Mr. Blackman) Professor Bass, would you please state for the record whether the answers to the questions contained in your report are the ones which you would have given to those questions had they been propounded to you, from the witness stand?

A In answer to that, these are the same questions or answers that were given to you at the time that you first proposed the questions to me prior to the preparation of said report.

GOVERNOR CAMPBELL: I don't see any reason to have all of his testimony that he has given here in the record, plus doing it again in the volume of the report. The only thing that isn't in the record now are these exhibits that appear in the report tables. Can't we simply admit these maps and tables which he testified he has prepared, and not duplicate the record?

MR. BLACKMAN: That will be satisfactory. Because the entire report is already in the record, with the exception of the charts and tables and maps, Mr. Malone indicated no objection to those, it would not be necessary.

GOVERNOR CAMPBELL: Let's identify what they are and what we are admitting.

MR. BLACKMAN: Very well. Map No. 1 appears on page 9 which shows the same contours and same development program as is shown on P.C.A. Exhibit Q.

Map No. 2 which appears on page 13 shows the same in-

formation contained on Map No. 1 with the addition of a red line A-B, as previously described, as it exists on P.C.A. Exhibit Q.

GOVERNOR CAMPBELL: The next one is on page 29.

MR. BLACKMAN: Page 29 of the report entitled "Barber Field, Eddy County, New Mexico, Abandonment Schedule," Township 20 South, Range 30 East.

Pages 37, 38 and 39 of the report; page 37 being Table I, page 38 being Table II, page 39 being Table III referred to in Professor Bass' testimony.

Page 56 of the report, indicated as Figure 1, entitled "Gas Pressure Depletion with Underground Losses."

I offer all those charts and maps in evidence. I think perhaps I should have them marked as Q-1 through whatever it is.

GOVERNOR CAMPBELL: Now, Mr. Malone, he is offering in evidence Exhibits Q-1 through Q -- whatever the last one is there.

A It would be Q-1 through 7.

(Whereupon, P. C. A.'s Exhibits Nos. Q-1 through Q-7 marked for identification.)

GOVERNOR CAMPBELL: --Q-1 through 7, which are the charts, tables and so forth contained in the report and to which Professor Bass referred in his testimony.

MR. MALONE: If it please the Commission, our position in relation to this exhibit is if Professor Bass' testimony stands in the record, we think the exhibits should be admitted as being prepared by him, exemplifying his view on this.

In making that objection, we do not waive our objection

to the presentation of the testimony.

GOVERNOR CAMPBELL: Your motion to strike, that's right.

MR. PORTER: The Commission will overrule the motion to strike the testimony and will admit Exhibits Q-1 through Q-7 into evidence.

(Whereupon, P.C.A.'s Exhibits Nos. Q-1 through Q-7 received in evidence.)

MR. PORTER: Mr. Blackman, does that conclude your direct examination of this witness?

MR. BLACKMAN: Yes, sir, it does.

(Whereupon, a short recess was taken.)

MR. PORTER: The hearing will come to order. Mr. Malone.

CROSS EXAMINATION

BY MR. MALONE:

Q Dr. Bass, on what date were you first employed as an expert in this case?

A Either March 2nd or March the 3rd.

Q The work that you have done on it has been done since that time?

A That's correct.

Q Have you ever had occasion in your career to have any personal experience in Southeastern New Mexico?

A When I worked for Mobil I worked in Southwestern Texas and Southeastern New Mexico, yes.

Q That was for how long a period?

A Approximately two and a half years.

Q When was that?

A Up to 1952.

Q You haven't had occasion to be familiar with the developments in the State since 1952?

A You mean as far as the reservoirs within the State?

Q Yes.

A Yes. I have done consulting work with respect to reservoirs in the State since that time, yes.

Q In Southeastern New Mexico?

A Southeastern New Mexico.

Q Do I correctly understand that all of the answers that you gave to the questions by Mr. Blackman were predicated upon the assumption of an 80-acre spacing pattern promulgated by the Commission that would be applicable to our tentative oil pool?

A Yes.

Q And you, of course, are aware of the fact that in the Morrow Gas Pool we have 640-acre spacing in a number of pools in New Mexico, are you not?

A The question that he stipulated was for oil or oil and gas and did not include a gas fill as such. I am familiar that the spacing in New Mexico on gas wells is essentially 160-acre with many of them being 320 and special permission is granted in cases for 640; yes.

Q That isn't special permission, is it? Those are the pool rules that are applicable to certain gas pools that have been delineated by the Commission?

A I haven't checked into those.

Q You are not familiar with that?

A No, sir.

Q You say that the phrasing of the question by Mr. Blackman was such that you felt you should not consider gas reservoirs at all?

A That is correct.

Q So you have only considered oil reservoirs?

A That is correct.

Q Do you know, as a matter of fact, that the Devonian reservoirs in the vicinity of this location are in fact gas reservoirs?

A The Devonian is both productive of oil and gas in the area, yes, Lea and Eddy County.

Q I'm speaking of the immediate area of this well. Do you know what the Devonian produces in that area?

A I would presume, as you've stated, it's gas, from his stipulation in Exhibit 11.

Q And you have not given any consideration to the development of a gas pool in this area?

A No.

Q Now, I think, Doctor, that I would like to preface my

next questions with this statement, that I don't want the fact that I'm going to limit my cross examination to one single aspect of your testimony to indicate either that I did not enjoy your lecture or that I did agree with your conclusions.

A Thank you.

Q You testified, if I correctly understood you, that you had studied the producing history of the Barber Pool and that as a professional engineer it was your opinion, based upon the examination and research done by you, that the Barber 4-A well had a productive life of four to five years?

A Yes, sir.

Q On what basis did you extrapolate the production of that well?

A On the basis of its past history.

Q Do you have available the plotting that you did to reach that conclusion?

A I have down there in my briefcase, yes, sir.

Q May I examine it, please?

A Will you excuse me, please?

MR. PORTER: Sure.

Q (By Mr. Malone) The method for extrapolating a pressure production decline curve is a well-established one, and one that engineers don't disagree on, isn't it, Doctor?

A That all depends.

Q Have you examined Pan American Exhibit 8?

A I have.

Q Do you disagree with the computations or extrapolation that is made by Mr. Rodgers on that exhibit?

A Unfortunately, I do.

Q Perhaps fortunately. Will you tell us in what respect you disagree?

A The procedure that was used by Mr. Rodgers is primarily for a solution gas drive or gravity drainage type system. The Yates formation, according to record, is a water type drive system. This procedure just doesn't work.

Q In what respect is the extrapolation made by him inaccurate?

A In that the actual plotting of such information in a water depletion type system will not follow the semi-logarythmic decline.

Q What sort of decline does it follow?

A It can be done in one of two ways. One of them is to observe wells which have already been abandoned in the area and establish a decline for these wells in the area by those which have been abandoned. Another one is to plot the water-oil ratio of the producing wells as a function of time.

Q What did you do?

A I established a decline for the wells that were already producing and had been abandoned in the area. The Well 2-F was a prime example in the case.

Q So that your curve was not extrapolated on the basis of the production of the wells presently producing in the pool?

A Yes.

Q I thought you said that you had established it on the basis of wells which had heretofore ceased producing.

A The decline was, the method of extrapolating the decline was predicated on wells which had already been abandoned. The extension or the use of this decline was on wells which are presently producing.

Q Right. Now what figures did you use for the production of the Barber 4-A Well?

A The records which were furnished me that the Potash Company of America put together, which is here, and Mr. Joe Cummings prepared this information and explained it to me.

Q Are you aware of the fact, or were you aware of the fact at the time that you extrapolated this curve, that the Barber 4-A Well is producing into a common tank battery and that the reports of production from that well show identical production of oil and water for each month from the two wells producing into the tank battery?

A I was not informed that they were producing into a common tank battery, but I observed from the production records that they were awfully similar.

Q Does that raise any question in your mind as to the use of the production figures from an individual well alone in

extrapolating its life?

A Well, this depends on the records that you have available. If these are records which were supposedly predicated on a test procedure and the split of production is supposed to be accurate, then no. If the records were not reported correctly, then yes.

Q There would be at least some reason to have a doubt as to the exactness of that report under those circumstances, wouldn't there?

A In the case they are not reported correctly, yes.

Q In a situation of that kind, if there is a doubt as to the reporting of the production on a particular well in a nine-well pool, don't you think that the fairest, or do you think that the fairest and best basis for extrapolation is to take all of the wells in that pool rather than a single well?

A This would extend it to 1974, in which all wells were taken.

Q When you extrapolated all of them, you got to 1974?

A Yes.

Q You used, I believe, a 45-barrel per month abandonment figure, is that correct?

A Yes, that's a barrel and a half a day.

Q You noted that Mr. Rodgers used a 60-barrel per month abandonment limit, or did you?

A I had calculated it out and it seems to me he used a

total of 415 barrels or 413 barrels from 9 wells, which would not be that rate.

Q Are you aware of the fact that the 9 wells do not each have an allowable, but that some of those wells are on a single proration unit sharing an allowable?

A Yes, 2-G and 3-F and 3-G.

Q If in fact Mr. Rodgers used a 60 barrel abandonment point, if he had used a 45-barrel abandonment point as you did, it would increase the life of the pool three to four years, would it not, on the basis of his figures?

A On the basis of his type plot, yes.

Q But you do not agree with his type plot?

A No.

Q You had had no prior experience with the Barber Pool, I suppose?

A No.

Q Are you aware of the fact, Doctor, and did you take into consideration in your computations the fact that the Barber Pool has produced more oil in the last six months than it did in the preceding year and a half?

A So many of the wells have been shut in for as much as six months or so in the last year and a half.

Q Did you take that into account in your computations?

A No, this is fairly regular for many fields that this happens.

Q Now with reference to your conclusion that this is a water drive field, will you tell us whether or not in a reservoir which is a water drive mechanism, the amount of water produced by wells in the pool will increase as the life of the pool extends?

A That's right.

Q If you did not get a significant increase in the amount of water being produced, does it raise a question as to whether or not the pool is water drive?

A No.

Q In other words, you say that a water drive mechanism can exist in a pool which over a period of years has not increased the amount of water being produced?

A You are increasing the oil produced.

Q In this case we are increasing the oil being produced, are we not?

A Not over the total of years. Periodically, yes, it has existed this way over the life of the field. One field is high and one low, and this has gone on ever since the field was found.

Q Do you know the amount of water that is being produced now, compared to the wells in 1957?

A In some it's reported higher and some lower.

Q It's correct, is it not, as shown by the production figures that were furnished you by P.C.A., that the water-oil ratio in 1957 was approximately 10 to 1?

A Yes, approximately 11 to 1, I think.

Q I beg your pardon?

A I think on there I calculated 11 to 1.

Q And that in 1963 it is also 11 to 1?

A Yes.

Q Does that raise any question in your mind as to whether or not this is a water drive mechanism?

A No.

Q You are absolutely convinced that Mr. Rodgers was incorrect and you were correct in the type of extrapolation which you made?

A Yes.

MR. MALONE: I would like to have the two exhibits marked and introduced in evidence as Pan American's exhibits.

(Whereupon, Applicant's Exhibits Nos. 12 and 13 marked for identification.)

MR. PORTER: Any objection to the admission?

MR. MALONE: Exhibit 12 is the production figures furnished by P.C.A. to Dr. Bass, and Exhibit 13 is the extrapolation of his curve.

MR. BLACKMAN: May I see that extrapolation? No objection.

MR. PORTER: Exhibits 12 and 13 will be entered into the record.

(Whereupon, Applicant's Exhibits Nos. 12 and 13 received in evidence.)

MR. PORTER: Does anyone have a question of Professor Bass?

GOVERNOR CAMPBELL: I have a question.

MR. PORTER: Governor.

BY GOVERNOR CAMPBELL:

Q Professor Bass, on what did you base your conclusion that the Barber-Yates Pool is a water drive pool?

A Well, in going back over the records, and in the published material, published as of 1956 in the A.M.I.E. Statistics, it indicated at that time that the thing was an anticlinal structure and had a water drive, and a certificate or a sheet that was supplied me by Pan American -- I'm sorry, excuse me, by P.C.A., which was taken from an Oil Commission report which also indicated in that particular record, and this was as of mid 1956, that it was also anticlinal and had the water drive system.

Q These are both reports by someone?

A The Statistics volume is a tabulation which was put out by A.M.I.E. up through 1957, which was a tabulation by engineers in the area.

Q Of what, of statistical data on production or their --

A And reservoir characteristics.

Q A statement of reservoir characteristics?

A Yes, sir, including porosity thicknesses.

Q Did you base it upon your conclusions that you reached from these statistics or upon any comments in the reports that it was a water drive reservoir?

A Well, from that and from observation that these wells did in effect increase their water production, and some of the wells which had been abandoned; and the reason why it was impossible to use the water-oil ratio cut as a limit, some of the wells which had previously been abandoned have been carried to water-oil ratios of 50 to 1 before they were abandoned; some of the wells which had been abandoned would carry to water-oil ratios of 13 to 1 and then abandoned.

Q Was there any gas produced with these?

A Very little. I was told,again this would be hearsay, that the pressure there at the present time was approximately four pounds. Now this would be at the surface and this is just information I was told, so it's hearsay.

GOVERNOR CAMPBELL: That's all.

MR. PORTER: Any further questions? The witness may be excused.

(Witness excused.)

MR. PORTER: Call your next witness, Mr. Blackman.

MR. BLACKMAN: Call Mr. Woomer.

J. W. WOOMER

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. BLACKMAN:

Q Will you please state your name and address?

A J. W. Woomer, 1319 Oliver Building, Pittsburgh, Pennsylvania.

Q What is your occupation, Mr. Woomer?

A I'm the owner of J. W. Woomer and Associates, have been for twenty years, an independent mining engineering concern.

Q Will you please give us a resume of your educational qualifications?

A Beyond high school, I received a Bachelor of Science in Mining Engineering from the Penn State University, 1925; later Engineer of Mines degree in 1931. For nine years subsequent to my graduation in 1925, I worked in a series of companies, four companies to be exact, as mine engineer, mine superintendent, later general manager.

In 1940 I opened an office in Wheeling, West Virginia, as an independent mining engineer.

Q Will you please indicate some of your professional clients?

A Over a period of twenty years, I, principally small firms, have worked for most any railroad in the country you can think of, perhaps most steel companies, perhaps for the ex bank, the World Bank, the United States, the British Ministry, for the Ethiopians--and it's a long list, I tell you.

Q Would you kindly indicate your experience in potash mining?

A I first was employed in 1948 by the Southwest Potash Company, a neighbor to P.C.A. working similar potash in the Carlsbad Basin; and at that time we visited Germany and France to observe their potash methods before risking the money in that Basin.

Subsequently to that, I've had experience in Ethiopia in potash, French West Africa for U. S. Steel and Potash, Canadian Potash , and made some initial geological work in Mexico for the steel company in Mexico, in Chihuahua Province.

Q Are you presently engaged on any potash consulting work other than for Southwest Potash Corporation?

A In addition to being the Southwest Potash Corporation independent engineer, I am currently engaged by P.C.A. in this controversy.

I might say, to elaborate, that about 50 percent of the work that I've done over those twenty years has been coal and 50 percent in other minerals ranging from iron, copper, borate, uranium in the New Mexican and Grants area; salt, limestone, in Wyoming, the recent installation.

In subsidence matters I have been exposed to Canadian subsidence, coal mining under the sea in Chile, subsidence; and African subsidence for U. S. Steel and Potash. Presently and for twenty years I have worked for Texas Eastern Gas Transmission

Company in an area from Louisiana to Delaware, having to do with subsidence of overland pipeline matters.

More recently I worked for banks and real estate companies in and about Pittsburgh, Pennsylvania, where subsidence of housing in the area of Pittsburgh has become an acute controversial matter.

I am the author of, at the time of the gas storage controversy, the coal companies in Pennsylvania, I was the author of a six-page magazine brochure on subsidence problems created by gas storage in Southwestern Pennsylvania.

I at one time was President of the Society of Mining Engineers of the Mine, Metallurgical and Petroleum Engineers in 1958. I was a director of the American Institute of Mining, Metallurgical and Petroleum Engineers for 1957 to 1961.

I am fifty-eight years old.

Q Are you a registered professional engineer?

A I am in Ohio, Indiana, West Virginia, Pennsylvania.

Q Mr. Woomer, I'll hand you a document marked P.C.A. Exhibit H and ask you if you would explain how you would go about the development of the area shown in pink on that exhibit, which is the undeveloped potash area and which is slanted with slant lines from northwest to southeast.

A Even though harassed by the normal risks --

MR. BLACKMAN: I would like to ask if the Commission is satisfied with Mr. Woomer's qualifications as an expert mining engineer?

MR. PORTER: Yes.

MR. MALONE: Mr. Blackman, are you going to predicate your question upon the evidence that has been developed with regard to the thickness of the zone and all of this, or just --

MR. BLACKMAN: Not with respect to this question. This generally would apply to any area of potash in this location.

MR. MALONE: We object to the question as being immaterial if it does not relate to the conditions which are here involved.

MR. BLACKMAN: Very well. I'll amend the question.

Q (By Mr. Blackman) Mr. Woomer, referring to Exhibit H, particularly to the pink area which is slanted from northwest to southeast, indicating a potash deposit which has not been developed, and the blue area which is slanted from northeast to southwest which indicates open mine workings; and to previous testimony in this case which indicates that the potash deposit in the pink area has an average thickness of 4.13 feet and an average grade of 24.4 K_2O, will you kindly explain just how you would go about the development of a potash deposit of this type?

A Preceded by the U.S.G.S. and the Bureau of Mines and people who risk their money in the potash business, which is more truly spoken of as the sylvanite business, potash is a combination of KCl and NaCl, the NaCl being the common salt; that composite in some percentage makes the sylvanite.

I would answer your question, I would say in the area marked on that Exhibit H in red, I would expect with modern mining methods to recover 90 percent of that in place sylvanite ore. Insofar as the area in blue which I have investigated and which I concur with, that area has been what I call first mined and Potash Company of America can only expect to get about 25 percent more from those pillars as left.

The art of collapsing by second mining has been developed substantially since 1950, and we were responsible to a great extent for that, and if P.C.A. have invested tremendous money to date in exploiting that ore body and milling that ore body, did not expect 90 percent recovery from the area shown in red, they are missing a bet.

Q Upon the assumption that belt conveyor mining and machine mining would be utilized in the area, would you explain what are the first entries that would be run in a development system?

A In cooperation with the U.S.G.S. and Bureau of Mines, we originally determined, and it varies with grade of the ore, you can determine the strength called modulus rupture, and in the early days we determined from that information, which was very good, that 32 foot wide excavation was a maximum that could be undertaken in first mining of the potash; and that based upon their compressive strengths of that grade potash, we could only take 65 percent as a maximum on the first mining.

That varies from company to company with grade and with the height of the column. For example, U. S. Potash, with their thick potash they've got there first, or their program is complicated by what we call the "L" over "W", the height of the pillars; but in five-foot seam as in P.C.A., 65 percent is what we in mining lingo call the trigger. We would expect the company to attain and excavate 65 percent of the area in the first mining.

Later on, with conveyors which tie you to one direction, you can attack that 65 percent which is trigger and win as much as 25 percent more from those pillars retreating.

The 25 percent is not a figure that we bring out of the air. It has to do with the amount you can take from those pillars and still retain their strength to support the overlying overburden sufficiently to protect your men and your equipment, working outward from a given point.

Q Mr. Woomer, would you please explain the extent to which, using a belt haulage system, you are committed to a certain development program in the course of the exploitation of a potash deposit such as the one shown on Exhibit H?

A The constrast to old methods of exploiting potash, and we have learned that belt conveyors are modern, and men work very nicely with them, but they have the disadvantage particularly in the potash field, that you are married, as it were, to one direction. The installation and the movement of a belt is a costly matter and once you have committed yourself with sufficient

geological knowledge of the grade and the amount of potash to a belt, you are committed to that direction.

Q In the mining system which is sometimes called a retreat system, do you extend your development entries to the boundaries of the ore body in the beginning?

A That is the ideal way to exploit a body. However, the business man, under the profit motive, will sometimes attack and even second mine areas on the way to the periphery of an ore body. So I say again, the ideal way,from the standpoint of the risk involved, is to go to the periphery of the property and retreat, but it is not always done.

Q In any case, you would install your main haulage-ways first?

A Yes.

Q You would follow that with secondary haulage-ways?

A That is correct.

Q At which time you are then committed to the direction of your development program, is that correct?

A That is correct.

Q After that stage, it is extremely expensive to change?

A Yes, sir.

Q Now, Mr. Woomer, have you been furnished by P.C.A. and Dr. Bass with the ideal development program which he has planned for development of the potash ore body shown on P.C.A. Exhibit H?

A I have.

Q In your opinion, Mr. Woomer, what would be the protective pillar necessary to be left to protect a high pressure gas well in a potash deposit such as this deposit?

A May I answer by saying that I am completely out of sympathy with any permeability studies that may be made on potash per se. Hydrocarbons can permeate a strata in a contact in a mud seam in potash, even in halite, which is NaCl. Therefore, permeation is a matter of engineering ability to understand the situation. For example, we now have in New Mexico potash mines extremely large amounts of air. That's part of getting the efficiency of workmen and health of workmen, and we, under the worst conditions, could suffer more hydrocarbon penetration than we could fifty years ago, but we still -- the business man expects the engineer to make some determination; and when we say that a hundred foot of radius of potash should be around a shallow well, low pressure well, that is our best reconciliation of knowledge of permeability and the various strata.

When we say 200 feet in the high pressure of solid ore about a well whose location, I presume, is known at the potash horizon as a reconciliation, and it's the engineer which I came to be trying to protect the business man from risking.

Q Will you also state whether second mining could be performed in the area of such a well, and if so, how close would you recommend that second mining procedures be utilized? How close to a high pressure gas well?

A If a well were plugged perfectly so that I, as a mining man, could be assured that my workmen, my machinery would not be harassed, I would take all the potash right out to that hole, but I have no skill in plugging, and if it is adequately plugged; and I leave it alone, I don't know.

Q If you assume that this potash deposit is at a depth of 700 feet and assume that you are approaching a high pressure producing oil or gas well, how much of a protective pillar would you leave in which no second mining were performed?

A I would recommend to the business man they leave a 200-foot solid radius area around that well properly drilled or properly surveyed; and I would not approach with second mining within a 45-degree angle, which in this case would be 700 feet radius from the well. Otherwise I would draw by my second mining and collapse, I would draw the wellhead and destroy it at that point, at least.

Q Mr. Woomer, have you calculated the value of the potash which would be left in the mine in the pink area of Exhibit Q and Exhibit H, which is covered by the development program recommended by Professor Bass in the event of the drilling of Wells 1 through 17 and then also drilling either 18-A or 18-B, one of the two?

A I have no skill, it's a very vague thing, the value of potash in the ground to the several companies. That is a study of itself involving tremendous calculations of future exploitation of that potash. I did and have made studies of that area

before, and after such drilling, as portrayed herein on Exhibit Q, were done in that virgin area. It is my professional opinion and finding made from maps of my own that P.C.A., if such drilling as portrayed there, the number of wells as projected, P.C.A. must cope with that in addition to their other risks, they stand to lose by not being able to second mine that area two and a half million tons of potash on an 80-acre well spacing.

That two and a half million tons is total, of which they would lose 2,340,000 tons in the virgin area and 160,000 tons by being deprived of the right to take that 25 percent from the area which they've already first mined.

In addition to that, the remaining 13,700,000 tons of potash which they originally expected to get will be more expensive, due to such drilling and such need for protection; and I would say it is my best opinion that that particular potash is at least 25 percent less in value by being harassed by such areas.

Q May I clarify your answer a little bit? The original two and a half million tons, if I understood you correctly, would be within the area described by a circle having a diameter of 700 foot surrounding each of the wells?

A I clarified it. 2,340,000 tons they'd lose by that, plus the solid, and 160,000 tons of the other, making a total of two and a half million.

Q That's all inside the 700-foot radius circle?

A Everything inside.

Q The rest of your testimony on 25 percent of value is related to the --

A What they would have left outside.

Q -- to the potash which would be outside?

A Outside of the circle, they would be harassed by more expense.

Q Will you please refer to Potash Company of America Exhibits I, J and K, which are displayed behind the Commission, and explain in a general way what occurs when the underground support is removed?

A Based upon, as I mentioned, modulus of rupture information which was available, and actual practice that was available to us at the time, we decided to concur with P.C.A. and adopt a 65 percent extraction of first mining as a maximum. Actually, in the case of Southwest, we take 58, but we stay under the 65.

We would like when first mining, and I'm sure that the U. S. Bureau of Mines and U.S.G.S. would like us to take only 10 percent and take it all retreating. But we have to live and the economics of the industry dictate that we take it up to the so-called trigger, which from tests we know to be a maximum of 65 percent and they have so done in their prior mining.

In more recent years, in the last decade, whipped by

the U.S.G.S. and the Bureau of Mines to get more potash per acre, and I must say that after you are once in machinery and power and ventilation in such an area, the winning, the attacking, the construction of these pillars as shown here is not an expensive matter. It's more dangerous, but the hardware, once it's installed to do this excavation, should be utilized to do other excavation, in their case, to get 25 more percent.

They will destroy these pillars, get 25 percent. Now that 25 percent can be mathematically determined and it's related to the time you take, that is, production per shift and the grade of that column.

If that column, as in the case of U. S. Potash, where it runs up to 30 percent, that column is weaker than it is with anything like 34 percent.

Q May I interrupt you just one minute--

A And you must study that.

Q -- to see if I understand you correctly. When you talk about first mining of 65 percent, you mean first mining of 65 percent of the ore in place and second mining of 25 percent --

A More.

Q -- you mean 25 percent of the original ore in place, so that the total removed is 90 percent?

A That is correct. This is 90 percent.

Q Thank you. Carry on.

A This is 65. This can be carried on for miles if you

like this destruction. When this is done properly, and every grade determines the strength of the pillar, even in these pillars we have what the Bureau of Mines calls an exudation of liquor at the center of these in Carlsbad; contrary to Canada, this center of this pillar is the weakest part, it's the richest part and it exudes a KCh liquor and gradually will hourglass, but in first mining staying below 65 percent recovery it's not serious and it's measured in years at a thirty-second of an inch, it is so small.

When you attack these pillars, 25 percent in their case, and destroy them, leaving this pillar, you have in effect a collapsible prop, a combination of KCl and NaCl, the which yields, this overburden tends to come down and fill the void.

We get convergence in second mining after we go far enough. Pictorially, due to the distance, this can only be shown in strength. This distance here I can best illustrate here, in the case of Southwest Potash is five to 600 feet. What it will be in P.C.A.'s case with the richer ore will be something less, maybe 400 can be calculated. So this distance is at least four to 600 feet.

When you have what is called a first break, when you have a vertical static load of this overburden, which is about 144 pounds per foot in their case, 700 feet times 144, you get what is called a first break. It's a very terrifying thing to workmen working in this area. This comes down and subsequent

to that first break -- and that's part of the extra cost that you entail if you are entitled to that -- subsequent to that break, Mother Nature in the crust of the earth assumes a 45-degree which has been measured in Carlsbad, incidentally, by grids put on the surface.

When we get a convergence -- we call it convergence -- with the bottom, this pounds per square inch here and pounds per square inch here heaves into that void and we get a subsidence in the surface as shown pictorially here, coming down and filling that void.

This has been measured and without equivocation I, as an engineer, have adopted the 45 as being safe for the business man to risk. He must not build a structure anywhere in this area. He can build a structure if he wishes there, and the chances are this excavation would only drop to there, but it will drop and it will draw 45 degrees, leaving this down and leaving this surface down.

As you move further, this 45 degrees is shown in one dimension here, but it has in an isometric, it has another dimension, too, it's 45 this way also. It's hard to visualize but a draw isn't in one direction, it's in another plane.

We, for example, are conscious of two draws pacing each other like that 45 degrees, but he must economically get production from the crew working in this area but still have this subsidence. This subsidence unloads the psi, the pounds per square

inch of this mass, and leaves. Many, many attack these pillars and do to them what is shown here, winning 25 more percent, ultimately getting as much as 90 percent out of the collapsed area.

That technique is not new the world over. That angle will vary with material; in this case we know it's 45 degrees. I have seen angles of 15 degrees under certain conditions. We study them specifically in open cavity work and stripping work where Mother Nature tends to assume in time such an angle of repose, we call it there.

We know about swell, we know about shrinking, we know about angles, and we as engineers know sediments as compared to volcanics and know they'll behave as shown here. I think this pictorialization is very good.

Q Will you describe, Mr. Woomer, what is going on along the 45-degree angles that are shown on Exhibit K marked by arrows; explain the nature of it?

A This area is what we call an unstaple area. It won't become stable. It's a very inexact science, what we use is as much as six shears before an area will become unstaple.

This area which is straight down assumes stability and equilibrium because of this filling of the void much quicker than this or this. On this area here, I repeat, we would not build a structure even though this has come to rest as portrayed here. The maximum subsidence in the middle, and a lesser to no subsidence at the edge, we would not erect any building on that

unstable ground for -- it's very inexact, but six years is a good figure.

Q Would it be fair to describe that as a shear zone?

A It's not exactly a shear, although this plane is subject to the forces of a shear. This material behaves differently, it may hang up in weight. These cracks indicate mostly air voids. In subsidence, the distance from here to here was one thing when it was untouched, as shown here, but when you subside that the distance becomes longer; and Mother Nature, in the crust of the earth,can only meet that situation by the elastic limit, as it were, of that halite; and there's a big controversy among engineers whether this cracks instantaneously and flows shut, or whether it never cracks, whether it just elongates. We could argue that for weeks. That's an engineering argument.

We don't care, we know this 45 and this may hang up and let go all of a sudden, and we have instantaneous forces here like in Alaska, that in four seconds are tremendous forces. We have no way of knowing, and very little work has been done.

We know if I drill there for a foundation drilling, what I find in a three or four inch hole won't satisfy any prudent business man to build a structure on that area.

Q What, in your opinion, would happen if there were already a structure there, such as an oil and gas well which were drilled down through that, or a water well?

A That, to a business man, with any opening through there represents a hazard, a risk of shear, of movement which is beyond the elastic limits of any steel casing. In these days when we talk about megaton bombs and what-not, we are talking about millions of tons, and Mother Earth's crust, this potash happens to be 700 feet from Mother Earth's crust; even 700 feet could exercise tremendous force.

Q If an oil well or a water well were already drilled through there before you completed the second mining and before this convergence occurred, what in your opinion would happen to it?

A I wouldn't leave my operating man approach that well less than 700 feet, within 700 feet. I would keep that 45 so that that well were in solid ground. I wouldn't -- my risk would be too great that I might shear that well.

Q Would you do that for safety reasons?

A I would. The men and the equipment that I might be applying to the second mining, if I approached that well and sheared it and leave gas or any hydrocarbon, added to my normal risk would be tremendous. A business man wouldn't exercise such a risk. That potash, it wouldn't be worth it.

Q Mr. Woomer, have you been in attendance at this hearing from its total period beginning yesterday morning?

A Yes, sir, I have.

Q Did you examine the exhibits submitted by Pan American which showed a casing program which they would propose?

A I was interested as an engineer, but I have no knowledge and I cannot help you on that at all. I have no authority on plugging. All I can say in answer to a previous question of yours, if it's adequately plugged I will do a lot of things, but adequately, I have no skill in that.

Q But I wanted your opinion, if you have one,as to what might happen to a casing program such as proposed by Pan American with that well approached by final mining and with this shear zone to intersect the well.

A I have a great respect for engineers and their ability. I have a poor respect for workmen to do what they're told and what is designed for workmen. When the whistle blows they'll go home, and they don't do things the way they are supposed to do them even if they are watched.

As a business man subject to such a risk, having made a tremendous risk in mill, shafts, mining equipment, and I wouldn't go near it; but as an engineer, I have to bow to the fact that engineers make nice pictures.

Q You are saying, then, even with that program you would not approach within 700 feet of any well that was drilled in this potash area we are talking about at the present time?

A Positively not.

MR. BLACKMAN: That's all for now.

MR. MALONE: If it please the Commission, it's almost twenty minutes of 12:00. I think the cross examination of this

witness could be expedited if I could have the lunch recess to talk to my mining engineer, who knows more about the subject than I do. I ask a luncheon recess be taken at this time.

GOVERNOR CAMPBELL: Let me ask him a few questions.

CROSS EXAMINATION

BY GOVERNOR CAMPBELL:

Q Mr. Woomer, have you made a study of the present operation being conducted in the immediate area of the blue that's shown on Exhibit H?

A I haven't been underground at P.C.A. Two miles from there at Southwest I was underground three months ago.

Q In other words, you have no knowledge of the present operation or present intentions, present directions of the mining operations adjacent to where this proposed location is?

A No, sir, I have no absolute knowledge.

Q By that same token, I would assume you would have no knowledge with regard to the time element involved in completing what you said should be done as a general proposition, as to when and how long it might take?

A That enterprise?

Q Yes, sir.

A No, sir, I have no knowledge.

GOVERNOR CAMPBELL: That's all.

MR. PORTER: Anyone else have a question? The hearing will recess until 1:00 o'clock.

(Whereupon, the hearing was recessed until 1:00 o'clock P.M.)

AFTERNOON SESSION
Thursday, April 16, 1964

MR. PORTER: The hearing will come to order, please. Mr. Malone, I believe you indicated you had some questions to ask of Mr. Woomer, the last witness. I'll ask Mr. Woomer to take the stand.

CROSS EXAMINATION (Continued)

BY MR. MALONE:

Q Mr. Woomer, do I correctly understand that you have been the consultant for Southwest Potash Company since it commenced its operations in the Carlsbad area?

A Even a year or so before.

Q And you are at the present time?

A Yes.

Q In general, is the plan of mining that you have given your approval to here by Potash Company of America similar to the one that you have laid out for Southwest?

A Yes, sir.

Q So that in effect you have been giving your blessing to your own work when performed by Potash Company of America?

A I can say that we've made money, I'll put it that way.

Q The four feet seam of mineable ore that we're dealing with here, does Southwest have a comparable seam four feet in thickness?

A Very similar, yes.

Q What is the depth of that in the Southwest mine?

A Their average, about 1,000 feet.

Q It's considerably deeper, then?

A It will average more than 700, too, here.

Q Has Southwest undertaken any secondary mining yet?

A Yes, we have been at it for five or six years.

Q Have they, in your experience, or do you have personal knowledge of their having subsided an area in which the ore vein was four feet or less?

A Yes, I observed the grid that we put in the initial area on the desert, and I can only say to you at that point that--I tell you, that taking the elevations on that grid was a surveyor's nightmare; the circles went around in a ring and it was very difficult.

Q Yes. The weights and pressures that would be involved at 1,000 feet would be somewhat greater than at 700, would they not?

A Yes, that's a good statement.

Q And did you personally, or have you personally had any connection with the measuring of the surface subsidence at the point that you are sure the underground withdrawal was with the four-foot deposit?

A Oh, positive experience.

Q What surface subsidence did you find there?

A Maximum was four and a half feet, tapering off to zero,

as shown here graphically. Yesterday here I heard the figure 60 percent used across the board; probably it's between 60 and 66.

Q If it's between 60 and 66, how would you get a four and a half foot surface subsidence from a four-foot withdrawal?

A It takes me over into the cubication of the ore. The four -- three, four foot reported by P.C.A. in the testimony is the ore itself. To mine ore, even with continuous miners, you have a contamination in your excavation. Usually I will say it's greater than the height of the seam, but the measurement seam is recorded here, that's for cubication purposes. It's acres times height of ore gives you your tons. But in actual mining you have a contamination.

Q What would have been the actual measurement of ceiling to floor of the opening which collapsed at the Southwest mine that you referred to?

A It will run - we try to keep it on the ore at -- because we have less solution at four and a half feet but we have as much as six and a half feet in places. You must understand that four and a half, 4.31 feet reported here is an average that's made up of highs and lows. All averages are made up of highs and lows.

Q Are you familiar with the general condition of the surface of the earth at this point or in the vicinity of these mines?

A Oh, yes, very familiar.

Q How would you describe it in its natural state as regards being cavernous or uniform or --

A Solution chambers, as at the Carlsbad Caverns, that is an outstanding example. We have all through that desert country which raises some cattle and so forth, we have so-called sink holes which may be a million years old. Overlying proper surveying, we know where we are subsiding and that country is, we consider it of secondary value and it's very easy for us to put a grid and get the subsidence.

Q In an area where there has been no underground mining, there still is surface subsidence?

A There's sink holes,not subsidence. I wouldn't call it subsidence, it might have been a million years ago.

Q There are cracks, for instance, in the ground?

A No.

Q You never have seen any surface cracks?

A Oh, yes, a crack in the P.C.A. area, in the Carlsbad area due to wind-blown sand heals itself in a relatively short time, 48 hours. We at Southwest had a cow in a crack; of course, it was the best cow in the County. Basically, it's very difficult. You have to be there when subsidence is happening to really trace a crack.

Q You have never seen any cracks in the surface of the earth in that area?

A Oh, yes, hundreds of them, traced them.

Q Other than resulting from mining operations?

A Oh, I've seen sink holes. Oh, yes, the country is full of sink holes.

Q I'm not sure I know what you are describing as a sink hole.

A A sink hole in this sediment -- when New Mexico was laid down it was laid down horizontally. We know that the underlying strata above the Salada is limes and dolomites, and it's subject to water solutions over millions of years, and that makes a void and causes a sink hole.

Now whether it's one million years or one hundred thousand years or two million years, some of those sink holes, I'm sure, that you find in that area are as old as the Carlsbad Caverns.

Q But there are surface depressions?

A Oh, yes.

Q Which are of the general character of a local subsidence?

A Oh, yes, U.S.G.S. maps portray all that situation.

Q And that condition exists without reference to mining operations?

A It exists before mining.

Q Yes.

A Pardon me. If we had a lot of rain in that area, and which we don't, and had tremendous lakes in such sink holes, we

would be very careful in second mining, but that isn't the case, you see, so we can collapse and make a sink hole deeper in that area without any problems arising.

Q Have you ever observed any -- what might be described as just vertical slumps in this area?

A Beg your pardon, slumps in the surface?

Q Yes.

A The situation portrayed on Exhibit K, I have personally observed on the surface; and as a matter of fact, I commented on the making of that exhibit and the portrayal of the slumpage of the surface, as you call it, due to the second mining there is very realistic and a very, very fine exhibit, in my opinion.

Q You feel that it correctly portrays what happens under --

A Yes, absolutely, from my personal knowledge of grids.

Q You have not actually core drilled a subsided area or made an underground study to determine by excavation what occurs beneath the surface of the ground, have you?

A From the potash seam upward, we have, at least in one instance, put a raise, a raise is up to the salt halite, to determine whether the zones of enrichment above were intact, had come down in good shape.

As far as penetrating the area so-called the Rustler above the Salada to the surface, I have no experience in that. I doubt if anybody has. It's of no interest to us. We know the behavior of sediments.

Q I gather from your testimony this morning when you said that engineers were arguing about when those salt beds came down, there was an instantaneous crack or closure or whether no cracking occurred?

A Yes, engineers disagree on that. It doesn't matter, really.

Q It's your conclusion, in any event, that after the subsidence of the area below the top of the Salada, there are no fractures in the formation on down to the mined area?

A There cannot be or else we would have Rustler water in the mine workings. They must close instantaneously, as they did in my experience in Chile with the work under the ocean, we have the pressure of the ocean but we have instantaneous cracks in the mud, but they close immediately and the ocean does not come into the underground workings. It's very similar to that that -- the behavior of sediments.

Q You are satisfied that no fractures extend below the top of the Salada?

A They couldn't be. We would have erosion, fresh water, and we couldn't stand it.

Q If we had shear forces from the subsidence that occurs there, would we not expect to find some fractures in that formation?

A Pardon me a minute.

Q Yes.

A This is what we call a drag here. This halite, this

salt has dragged down and it might have opened instantaneously there and created a tremendous instantaneous shear. We don't know. I don't know, certainly, and nobody knows.

I can argue, as I said. All I know is that the distance from there to there is greater than it originally was, and it's either cracked or elongated within its elastic limit. That's all I can say.

Q With reference to the fractures that occur above the point to which you have just directed your attention, do you feel that they do exist throughout that Rustler formation as portrayed?

A From our experience the world over in subsidence of sediments, yes.

Q You are familiar with the water zones or the water-bearing zones which exist above that point in the Rustler?

A I am.

Q At the base of the Rustler, the salt water deposit is of rather substantial character?

A Rustler - Calebral water, yes.

Q Do you consider that there is any possibility of contamination or communication between the fresh water zones and that salt water zone as a result of those fractures?

A Oh, definitely. There's complete contamination and communication in this area. There is no contamination of anything in this area, wet or dry, with this area, that we know. That's all we can say.

Q But within the area which makes up the Rustler, including the salt water deposit at the base of the Rustler and on up to the surface, there is complete contamination?

A There must be in second mining. Without mining, when the earth is in equilibrium, that is very questionable. Otherwise we would have intercourse between the Rustler and Calebra. We find it in shaft sinking, particularly. When we second mine and collapse, there's nobody here can say that piece will be that shape. That is a pictorial representation of an air space situation.

Q Whatever the shape, communication between the salt and fresh water is inevitable?

A Oh, yes.

Q If this fresh water deposit in the Rustler actually extends over a larger part of the area, and if the normal migration of that water is toward the Pecos River, we could expect this contamination to extend through the area which is below the elevation of the point where the secondary mining occurs, couldn't we?

A I'm not a skilled geologist. Are you asking me a question or making a statement?

Q Could you expect that to occur?

A I wouldn't know.

Q If you contaminate the spring, you are going to contaminate the water that comes out of the ground?

A I have no skill as a historical geologist.

Q You wouldn't care to express an opinion on that?

A No.

Q You have no doubt in your mind as to the contamination that occurs in the Rustler at this point?

A When we have second mining, definitely.

Q Had you been aware of the fact that in the drilling of oil wells, for instance, the regulations of the Commission require the cementing of these water zones in order to try to prevent communication and contamination?

A Only hearsay. I have exact information only in sinking shafts insofar as they may be similar situations; worse, if anything.

Q Are the principles that you have described in determining the area which must be excluded from secondary mining to protect an oil well, are those same principles applied to the same degree with reference to the shafts of potash mines?

A When you sink a shaft anywhere in the world, you provide stability, you try to keep the earth's crust as it was normally before you sank the shaft. We have shafts that have tremendous bends in them and still we run cages and skips in them. The shifting of the earth's crust, we have at present no way of knowing either the tremendous force involved or the incidence.

I may sink a shaft here and tomorrow I can have a

movement in the earth which would destroy that shaft. That's one of the risks that the potash people have taken already in sinking the shaft.

I, as an engineer, and I spent my life not risking money but talking to business men who do risk money; all I can do is point out that it's a risk.

Q Do you know what pillar is required by the U.S.G.S. around shafts in this area?

A I heard that question asked yesterday and you can't do that until you know the plant size and you have to speculate on how much the plant will be expanded; you protect the whole plant site. I don't protect the part of the shaft. Therefore, any formula that takes, say, 45 degrees from the shaft collar, is wholly inapplicable because you have to protect only the shaft. You protect the plant and possible enlargement of the plant.

Q With reference to the 45-degree line portrayed on Exhibit K, is it your testimony that it is your opinion that an actual shear plane occurs at approximately that point whenever subsidence of this type occurs?

A The 45 degrees, that I know from actual experience and from actual excavations. What happens when this unstaple ground slips on that plane, exerting a tremendous instantaneous force, I or nobody else has any way of measuring.

Q It is possible, is it not, that there could be a

vertical slump in the area? I believe I would restate that question, please, to ask whether or not it is your opinion that in an instance of this kind there in fact occurs a breakage and slippage of the formation, extending all the way along that shear line and clear down to -- you've said it doesn't penetrate below this point here, I believe?

A No, I said it might instantaneously penetrate.

Q But there is no re-mining shortly thereafter?

A No, water gets in.

Q To all intents and purposes, our shear plane is from the top of the Salida to the surface?

A No, the total thing is shear but that shear is unmeasurable. This shear we know doesn't open up or close instantaneously. That shear may stay open as long as I previously testified, six years.

Q This shear that occurs here likewise results in a slippage of these formations, does it not?

A Oh, it must.

Q If these formations slip and bend as you have portrayed them, is it not entirely possible that the formations above will slump vertically down, rather than be subjected to a continuation of a shear force such as the 45-degree angle would indicate?

A The answer to your question is too speculative for an engineer to answer.

Q Then you think --

A We don't know what happens under there.

Q At least you feel that you could not answer it?

A No. I have already testified that the water does percolate through, and so that loose, unstaple ground, whether this hangs up there, then instantaneously falls, or whether it falls every second, every minute, to assume this final gradiation, all we know is the final answer. We know it ultimately will do that. We know from actual surveys of grid of this subsidence, we know that in time that point comes to rest.

Q Am I correct in understanding, however, that the 45-degree angle has been established and is accepted on the basis of the angle from the point at which the subsidence begins to the crack which is farthest from this point?

A That's the engineer's way of portraying it, yes.

Q That's the surface crack that they have found on the surface of the ground?

A Yes, that particular point very seldom discloses a crack. It takes a transit to pick it up, it's so small at that point.

Q It gets out here and the subsidence would be only an inch or two, perhaps?

A Very small.

Q How rapidly does that increase in degree as you proceed toward the center of the subsided area?

A In the case that I have intimate knowledge about, zero

to four and a half feet, from four and a half foot excavation, and everything here happened in six months' time; but this ground stayed in motion, particularly this ground here, outside of here, stayed in motion for as much as six years, the motion being very small. The initial -- you call it slumps, I call it subsidence, occurred in a very short time.

Q It is true that the characteristics of action in the soil from about this point out are somewhat different than those which you find in the center area?

A I would say so, yes. Time is the essence.

Q With reference -- It is?

A As shown here by the big blocks and the small blocks, that's a better way of showing that, you see.

Q All right. Thank you. The estimate of approximately two and a half million tons, I believe, of potash that you felt might be placed in jeopardy or lost in the event of the development of the structure which is involved in this case, was predicated entirely on 80-acre development or an 80-acre spacing of the wells, was it not?

A That's right.

Q That, of course, would be increased if it was 40-acre spacing, and decreased if it was wider spacing?

A Exactly.

Q Are you aware of the fact that spacing up to 640 acres in gas wells is in force in New Mexico at the present time?

A No, I'm not aware of that.

Q Are you sufficiently familiar with the development of oil properties to know whether or not a situation such as this, in which all of the working interest in approximately 6,000 acres of this is in single ownership, might have some effect on the development program?

A In that respect I only have one contention, that any drilling should be done of potash. How much ground, I don't know about.

Q I take it you fully agree with and support the policy statement of the officials of P.C.A., that in your opinion no drilling should be permitted where potash operations are contemplated or in potash reserves?

A In view of the figures I've given here, I absolutely agree that no drilling should take place until that potash is gone.

Q You would recommend to the Commission that there be no development of the oil resources of this area until eighteen years, after which potash mining will presumably be finished?

A If you can find highs of potash, good bless you, but you must not destroy that potash mining. The risk in Carlsbad alone, it's fantastic the amount of money that has been risked there in the exploitation of certain reserves which have been calculated from drilling, and to add to that risk, to me, is just destroying a good thing.

Q I had wanted to ask you one other question when we were at Exhibit K. If this was open pit, if those 45-degree angles were portrayed there with an open pit mine so that all the material between those two lines had been removed, what, in your opinion, would the angle of repose be?

A We would try, with various controls and solidification, we would try to hold that angle till we got the goodies of the rich mineral out. We would try to hold that angle as steep as possible but Mother Nature finally, we know, would take it to the angle of repose of that particular material, and in this case there is an engineering argument as to whether this is the angle of repose or the angle of draw; and you will find engineers on both sides.

If you make a pile of sand, it assumes a certain area, a certain angle. When you make it later on, it slumps, and so it's a very, very inexact science, but the answer to your question is, an open pit, we would try to obey that angle and not remove this dirt but we ultimately know if we didn't solidify the dirt and get the equipment and men out of here, that Mother Nature would assume its angle.

Q If I understand you, you are saying that the shear plane portrayed at 45 degrees is the equivalent of the angle of repose in the event the materials within it had been removed?

A That is controversial. I can't answer that. Many engineers will say so. In my opinion, that is the angle of repose

of that composite mass. Who am I to say, since we have all kind of different materials, what is the angle of repose?

Q You have a great many compensating pressures where the inner space is filled with sediments that do not exist in an open pit, don't you?

A No. That portrayal there is exactly as an open pit would be in sedimentary rather than metamorphic or igneous, that is, the sediment. You would have extrusivication in an open pit, just exactly the same as you see it there.

Q With reference to the forces that you feel are liberated when there is a collapse of a mined-out area, I think you referred in your testimony or likened them in your testimony to the forces in an earthquake, perhaps. Is that a standard concept?

A No, that is my own concept as an engineer, saying that the forces that existed in Africa or in Alaska recently are very similar to Mother Nature re-adjusting itself to a stability and I don't think there's any human alive today can say what that would be.

Q The subsidence in Alaska was much greater than what we would obtain here at a four-foot --

A It's a matter of a question when you lose a cow in one of those cracks and you see the pictures in Life magazine of the Alaska situation, of an automobile in a crack, very similar.

Q Have you ever had any experience yourself with the effect of subsidence on an oil or gas well?

A I testified that I appeared in Pennsylvania, in the Texas Eastern Gas Transmission desire to store gas in depleted sands, which were four thousand feet, the coal seam. The merchantable coal seam, in many cases metallurgical quality, were at that point four to five hundred feet. We had a subsidence problem that came from recovering that valuable coal, and the fact that we might shear a well with high pressure injection and withdrawal to lower sands, caused consternation among the coal people who had risked their money.

The gas companies at that point had very little money to risk. They were going to use old wells into the old sands. We had a controversy for a year, and I appeared many times and made much the same testimony, that the collapse of coal and the collapse of potash here were very similar.

The collapse of ground is a collapse of ground, and this area and these forces are so tremendous that no man-made material will withstand it.

Q That is your opinion, that no man-made material will withstand the forces?

A I have so testified many times.

Q Are you aware that none of the oil wells in Alaska were injured by the earthquake which occurred there on Good Friday?

A No, I'm not aware.

Q If you found that to be true, that the casing in the oil

wells in Alaska, many of which were only forty miles out of Anchorage, was not injured in that quake, would it cause you perhaps to reconsider some of the statements you have just made?

A No, no. I wasn't there. I have been in Alaska at Anchorage, but I wasn't there at the time of the earthquake. I know that certain streets were not hurt and other streets were damaged beyond repair. So I can't portray the earth's crust, I don't know any man here with any engineering training who can portray the earth's crust movements.

Q You would still be prepared to say that in your opinion no man-made material could withstand the forces in this subsidence, in spite of the fact that all of the oil wells in Alaska withstood the force of the earthquake on Good Friday?

A I would so advise the business man, as an engineer; it's a bad risk.

Q Have you made any study of the casing program that was portrayed on Pan American's exhibit in an attempt to determine the strength of the steel and cement which would be subjected to any of these forces?

A I saw the drawing but I made no study.

Q You made no study?

A No, sir.

Q Have you ever made a study or is there a study available as to the forces, which would measure the forces that might be involved in a subsidence of some two to three feet?

A When we first laid transcontinental pipelines from Louisiana to Delaware, we employed the Patelle Institute in Columbus, Ohio, to make elasticity tests of wells, elastic tests of pipe and deformation, and we as engineers, I personally subsided minerals, coal, clay and limestone under those lines, and came up with certain formulas. They were a reconciliation of the movement of the earth's crust due to that mining and its effect upon such man-made pipe; and fortunately, I'm able to report to you that the Patelle findings were favorable in that instance.

There we had a horizontal pipe which would slide in a ditch and could be elongated to take care of subsidence, and I can see no similarity to our problem in that, and I am not qualified to discuss your problem.

Q You really are not qualified to discuss the effect of subsidence on pipe?

A I didn't say that. Your problem. I said I can't discuss your problem of vertical pipe, only insofar as I was exposed to it in Pennsylvania in this gas storage.

Q And horizontal pipe?

A No, the gas storage was vertical. Even then I wasn't exposed to the subsidence problems that you have in this case.

Q Do you have any familiarity with the angle at which a drill pipe operates in a hole which is being purposely slanted?

A Purposely slanted? As an engineer I had some experience

in petroleum mining in Wyoming, and we allowed them only two degrees deviation. In the Gulf Coast and Corpus Christi, we drilled vertically, Texans drilled vertical and horizontal holes through salt domes and intersected potash stringers. Outside of that I have no experience.

Q In the evaluating of mineral properties, is it true that the measure of value is the value of ore in place?

A If I am in business and have a sales organization and have friends and outlets, I might risk my money for four or five, six percent. If I'm not in the business and entering the business and have to cultivate and do all those things, I might demand as much as 20 percent, so when you get into valuation, you get into speculation of what the risk is, and a knowledgeable engineer is cognizant of those things; certain industries now are only making four or five percent,make it. Yet on an average, they will make twelve percent after taxes; and so you, sir, evaluating a ton of potash to P.C.A. as an enterprise from which there's tremendous money risk, are subject to tremendous error in selecting a rate of risk. You can pinpoint the years and you can, the discount years, but the rate will be speculative no matter what you do. It's different.

Q Now as a matter of fact, this isn't such an unusual procedure, is it; whenever a mining property is condemned it's necessary to arrive at a value of that property, isn't it?

A The engineer arrives at it, but he says it carefully.

He says, "What is the greatest amount you can afford to pay if you demand six or eight or ten percent on your money?" He's very careful not to say that is the value. Only lawyers and other people take that statement and make that value. That's wrong, he doesn't say that.

Q There are other areas in which lawyers and engineers disagree, too, are there not?

A Yes, you'd be surprised. He very carefully says that statement, "That is the greatest amount you can afford."

Q I don't think you have answered my question. My question was if it wasn't necessary to value mineral properties in condemnations, in purchases and day-to-day occurrences; the valuing of mineral properties is not an unusual occurrence, is it?

A I answered your question by saying that valuation is a misnomer. The engineer very carefully says, "The greatest amount you can afford to pay."

Q It seems to me you can answer that yes or no.

A No; but I won't.

Q Then we will understand your testimony to be that you refuse to state whether or not the valuation of mineral properties for purposes of condemnation, purchase, and other like purposes, is not unusual.

A I won't leave my organization say, "Do that." No, no, that's right.

Q It is true, is it not, that a mineral deposit which cannot

be brought to the surface of the earth and disposed of at a profit has no value in the ground where it lies?

A Exactly.

Q That is correct?

A Oh, yes.

Q And the value of the ore in place depends entirely on your ability to dispose of it at a profit after you get it up where somebody can use it?

A After you get a return on your risk and your money back, the value flows with the ore, yes. You have to get a return on your risk, in this case tremendous money risk, in mills and shafts and so forth.

Q Regardless of what that rate may be and what that investment may be, it's still the profit which represents that rate which determines the value of the ore in place?

A Profit --

MR. BLACKMAN: If the Commission please, I would like to enter an objection to this line of testimony. Mr. Malone keeps trying to bring in here the problem of profit as if this was a contest between P.C.A. and Pan American, which it isn't. This is a conservation proceeding.

The State of New Mexico is vitally interested in this case and it's conservation of the natural resources which is the most important thing, and prevention of waste, and profit to either P.C.A. or Pan American is not the issue at all.

It might be a minor side issue, but this is not a controversial contest between the two of us. It's trying to be placed in that posture.

MR. MALONE: If the Commission please, I am forced to observe that if Counsel's statement is correct and this is a matter of conservation of natural resources alone without reference to the profit that might be incident to producing them, the salt deposit at this location should be of equal concern to this Commission as the potash which it is considering, because each is a natural resource and each is in the soil and is a product which is used by the people in the United States.

So the value of any ore is dependent entirely upon what can be done with it if you own it. The value of a natural resource to the citizens of New Mexico is in terms of what that ore is worth at the surface, what it can be sold for, and whether it can be profitably produced; and if it can't, it has no value; and so to say that profit will not be considered in this proceeding is to put it on an almost ludicrous plane.

MR. BLACKMAN: I think Counsel made my point when he said it's the value, it's the value that it can be sold for. That's what I have been contending. I admit the relevancy of the profit element as to whether or not it can be produced.

MR. PORTER: The Commission will overrule the objection.

REPORTER (Reading): "Regardless of what that rate may be and what that investment may be, it's still the profit which

represents that rate which determines the value of the ore in place?"

Q (By Mr. Malone) Do you agree with that statement?

A We don't say the value with the engineers. We say the greatest amount the willing buyer can give the willing seller. That's different. P.C.A. isn't a willing seller to start with, and therefore it would be a very difficult valuation in that respect.

Q Will you state whether you do or do not agree with the concept that the profit that can be made from the mining and marketing of a natural resource is the measure of its value?

A I beg the Commission's pardon. I answered the question by saying the words "valuation," getting confused with the "greatest amount I can afford to pay," and while he is quoting the engineer's concept, so-called Hoskall formula of evaluation, the engineer very carefully says that it's "the greatest amount that a willing buyer can give a willing seller and make a return on its investment." It's not as simple as he tries to make it.

Q Do you deny the correctness of the statement that I made?

A I only admit that you have to go through profit to get at the value of the commodity.

Q Further than that, you are unwilling to answer the question?

A Yes, sure.

Q You said that you were currently engaged in some studies

resulting from the subsidence of the surface in coal mining areas in Pennsylvania, I believe?

A Well, I have been recently, not currently; finished.

Q Had you been able to design the original mine and mining operation, would you have been able to avoid the subsidence problems which you now are dealing with?

A I can only answer that by saying originally we in the coal fields drew a circle around the well and said, "That's all right." This Commission, this study we have made, has recognized this draw, this angle of draw, and we now are required and require operators in Pennsylvania to leave much more ground than the formula left, because finally the powers that be have recognized draw; the things do draw.

Q I don't believe you understood my question, or at least you didn't answer it. My question was whether, if you had been in control of the design and mining operations at the locations where this subsidence occurred, you would have been able to prevent the subsidence occurring?

A I am sorry, I don't understand the question. I'll answer but I don't understand it.

Q It sounds quite simple.

A I answered by saying originally we didn't, but the purpose of the Commission was to determine -- there was something wrong, that we were now faced with high pressure gas and we must as coal people, as engineers, we must advise people to

recognize that excavations have an angle of draw and might shear such a pipe line. That was the purpose of the Commission and we did recognize that fact. That's the best answer I can give.

Q Do you know of any mining plan of operation available for use in mines such as the one under consideration in which the amount of subsidence here portrayed could be reduced or controlled?

A No, sir. That is mathematical. The 65 and the 25 are mathematical within the limits of practical operation, and time enters into it, time, production per man. You must destroy those remaining pillars to that extent to cause subsidence.

If you have to destroy them, you cause what we call a creep, and you get motion all through the earth's crust. You must destroy and unload those pillars and leave that come down, and then you unload and leave your men and your machinery and enjoy a suitable working area.

My answer to your question is that once you've passed that 65 percent, and if you take 66 you'll start things in motion; but if you take 90 you'll drop it and unload the pillars and therefore there's no -- you either stay below the so-called trigger which I testified to before or you go all the way.

It's a function of the strength of that ground as measured underground and as calculated, reconciled with time.

Q Will you describe the secondary mining operation which is referred to as panel retreat?

A Yes, sir, I can. If I may, I'll refer to this Q.

To a mining man, this has a dimension this way and this way, and it's, these are a thousand feet to the inch (indicating). This is a very sizeable area of ground, and we have learned that to unload this we must move at a certain rate and we must have a certain front, we call it a front; and we'll assume for the moment, I don't know, but they're going to retreat to this line, the line where I'm holding, and they have to go in in the panel and come out; and as they go in, they'll take several years to go in, and one-third of it out, about one year out, three years in and one year out is a good measure; but they have to do it one, two, three, four, five times.

This morning I testified this thing has another dimension. It has a dimension this way, and if I go in on a panel controlling my millhead with a sizeable thousand-foot front, which is a norm in the area, about fourteen working plates, working with these I come out and I create this situation ahead of me but I also create a situation behind. When I come out the next panel, my unstaple ground crosses and I have an awful underground situation causing loss of potash and a limited grade control.

It's better to -- we do work panels and we particularly work them in advance to make money as we go rather than go to the edge of the property, but they need at least a thousand feet to control their millhead grade. The machinery and the men are dedicated to this area, and they have to operate it twenty shifts a week for mill reasons; and they try to avoid this third dimension

here, and the panel system has that disadvantage and so you will find, in answer to your question, that a normal panel, this thing having the dimension, being as big as it is, it is not unusual to mine a whole front and bring a whole front back, enjoying forty places to enjoy millhead, another part of the mine to which machinery is dedicated to men and air and power to help the millhead average by enjoying greater diversification; but this is a tremendous area.

Q Panel retreat is used in certain types of mining to achieve control subsidence, isn't it?

A It is, yes. So is long haul mining used, also.

Q In your opinion, is either of those systems suitable for use in potash mines?

A I think they do use it.

Q You think that they do use it?

A P.C.A. will use it.

Q The panel retreat system?

A The P.C.A. will use what you call a panel system. Their front is not unusual; in coal, for example, and every mineral has a different front, a different angle of collapse, maybe their front will be at least a thousand feet, and this thing has tremendous dimensions, 9,000 feet from here to there, and five to nine across (indicating). It's tremendous.

Q The panel retreat system which divided that into rectangular rooms with a span 260 feet, equalling 260 feet,

perhaps would be possible, would it not, at this depth?

A No. 72-foot centers, and that's this (indicating), 72-foot centers, the dimension that you give would only provide four working places. We cannot control grade in potash mining with four working places. Neither can we effectively work a crew. We have cutting, blasting, drilling, scaling. We have a certain fixation of places, and any dimension that you speak of, four or 500 feet divided by 72 gives us too short a front.

We must have, and it's not unusual in the area and been proved by actual experience, we must have ten or fourteen places for grade control and for this proper work of subsidence.

You see, on the second mining you are only getting twenty percent, you are after thirty-five ton per man, a hundred ton per three crewmen. You must have enough working places to properly disperse those men, to pay your way, to make some money. Any panel retreat, the whole thing is based on retreat. In P.C.A.'s case, they've already testified they are going to retreat from the property line in every case, and that is adopting this other retreat.

The panel part I only answered by saying that you must have at least a thousand feet and probably 1300 feet to control grade and effectively work your men; but you do retreat.

Q In the situation such as portrayed on Exhibit K where subsidence in a limited area has occurred, what would you consider to be an acceptable swell factor in the formation there which

subsided?

A Oh, I don't know. I know that this material exposed to these waters in the Calebra and Rustler here swell and these shrink (indicating), and we have air spaces; and the combination of the two, what happens in the earth crusts, nobody knows.

We don't drill to find -- and we have no interest in that. We know, and the business man respects our knowledge, we portray what is going to happen, what we think is going to happen. That is good enough to risk money. We don't drill that and discover how much swell and how much shrinkage.

Q Swell does occur in a subsided area, does it not?

A Mostly from the air spaces.

Q Would you answer my question yes or not; does it occur or doesn't it occur?

A Yes.

Q It does occur?

A Yes.

Q Would you give us what you consider to be an acceptable percentage of swell under conditions such as these?

A No, and nobody else can.

Q You are unwilling --

A We know in open cavity mining -- I will tell you what we know. We know in open cavity mining if we throw this material out like in stripping, we have a 28 percent swell average in coal and sediments; we know that. We also know that if we permit

enough passage of time, that spoil bank slumps and the swell becomes much less. The slumping is because the air is thrown out and the air exists in these, air exists in here (indicating) and when you stop getting water and when you start getting air, I can't answer that. Nobody can.

Q Do you have any opinion as to whether a five percent swell factor would be in the ballpark in that area?

A No, no opinion at all.

Q You made the statement in your direct examination that you were slightly out of sympathy with permeability studies? Would you tell us just on what basis you are out of sympathy with permeability studies in relation to problems such as this?

A Hydrocarbons can migrate in various things. I didn't say that I was out of sympathy with permeability studies as such. I don't think you can draw a conclusion by making a permeability study on potash ore of a certain grade, because you could turn around and make one in the mud seam, in the halite, and of it all, you might get some semblance of orderliness, but in Saskatchewan the potash crystals in those ten or fifteen foot seams are large. In Carlsbad they're small and they are different.

If I took a permeability study of Carlsbad potash up in Saskatchewan, a knowledgeable engineer would laugh me to death. You get two answers. I made the statement that I, as an engineer, use all the tools and all the facts I can get to protect the business man; but I would always, if it -- That's my statement.

Q The 700-foot room and pillar area, 700 feet in radius room and pillar area which you feel is necessary to protect this well is arrived at entirely on the basis of the 45-degree reference line or shear angle portrayed on this exhibit, is it not?

A That's right.

Q And if that angle is in fact too low, it would not be necessary to leave that large an area of support, would it?

A If it weren't 45?

Q If the angle of 45 were too low; in other words, let's suppose 75 degrees were the true shear angle.

A Then we would go closer to the well.

Q You could go closer to the well and leave a smaller room?

A Yes, that is scientific; the draw is scientific.

Q As I understand you, the area below the dark line on Exhibit K, which I believe is a vein of poly-halite --

A Yes.

Q -- is impervious to water from above?

A It could be.

Q Well, you said that water would have gotten into the mine if it were not, didn't you?

A Let me answer your question -- Oh, this under the Salada?

Q Yes.

A Yes, you are right.

Q Then if there was a leak of gas or oil in a casing above that mine, it would not affect the mine area, would it?

A As long as it was out by this point (indicating).

Q If it were within the area?

A Here (indicating).

Q There?

A A perforation.

Q And above the top of the poly-halite?

A Any perforation of a well from here up, since water will not enter, I, as an engineer, would say gas would not enter but the business man, if the business man were prudent he would not believe me.

Q That, of course, is a matter of opinion?

A I have been reversed by business men many times.

MR. MALONE: No further questions.

MR. PORTER: Anyone else have a question of this witness? He may be excused.

(Witness excused.)

MR. PORTER: Mr. Blackman, does this conclude your testimony?

MR. BLACKMAN: I have only the exhibits to finish up and I have the certified copies here for your examination of several exhibits which have already been introduced, and I would like to ask permission to withdraw them and substitute these; and I would like for Mr. Cummings, which he can testify to right from here, identify Exhibit Q and the underlay of Exhibit Q and

the circles of 700-foot radius that you have placed upon there; and ask you if the underlay was made under your supervision and fairly represents the potash and open working area in there and if the circles are drawn to scale to represent a 700-foot radius?

MR. CUMMINGS: They are.

GOVERNOR CAMPBELL: Mr. Blackman -- Well, go ahead.

MR. BLACKMAN: I have here just for convenience, this exhibit doesn't require anything, it's only a miniature representation of Exhibit Q and I will have Mr. Cummings identify it and put it in the record.

MR. BLACKMAN: Mr. Cummings, I hand you a document --

GOVERNOR CAMPBELL: Why doesn't he come up here? I want to ask him some questions, anyway.

J. B. CUMMINGS,

recalled as a witness, having been previously duly sworn on oath, testified further as follows:

REDIRECT EXAMINATION

BY MR. BLACKMAN:

Q Mr. Cummings, you've testified before in this case. I hand you a document marked P.C.A. Exhibit S and ask you if that is a miniature size replica of Exhibit Q, which represents the same material that now appears on Exhibit Q.

(Whereupon, P.C.A. Exhibit No. S marked for identification.)

A This Exhibit S was prepared under my supervision,

and it does represent a smaller scale replica of Exhibit Q.

MR. BLACKMAN: I'll offer Exhibit S in evidence at this time.

MR. MALONE: No objection.

MR. BLACKMAN: I also offer Exhibit Q in evidence at this time.

MR. PORTER: Exhibit S will be admitted. Any objection to Exhibit Q?

MR. MALONE: No objection.

MR. PORTER: Exhibit Q will be admitted.

(Whereupon, P.C.A.'s Exhibits Nos. Q and S received in evidence.)

MR. MALONE: I would, if it please the Commission, in connection with Exhibit G, like to ask Counsel that he will stipulate that there are approximately 13,000 acres embraced in the colored area on chat exhibit. The reason that I request it is that the section lines are not clear, at least on mine, and it took a bit of computing to determine the approximate area involved.

GOVERNOR CAMPBELL: All colored areas, pink and green?

MR. MALONE: All colored area, pink and green.

MR. PORTER: Let the record show that Exhibit Q was admitted.

Q (By Mr. Blackman) Do you know the answer to that, Mr. Cummings?

A I don't know the exact area. It seems to me that the figure that you called it, about 13,000 acres, is in the ballpark,

but I haven't actually measured it.

MR. MALONE: I have a witness who undertook to run it up, and I'll put him on the witness stand if you want me to do it.

MR. BLACKMAN: If I had some basis on which to do so, I am willing to admit it if it's somewhere in that area.

MR. MALONE: Perhaps Mr. Cummings could check it and see if he could agree with it after he's off the witness stand.

MR. PORTER: Yes.

MR. BLACKMAN: That constitutes our case-in-chief. Excuse me, Governor.

GOVERNOR CAMPBELL: I would like to ask Mr. Cummings a few questions.

RECROSS EXAMINATION

BY GOVERNOR CAMPBELL:

Q Mr. Cummings, I have been waiting to get some information which I thought might be forthcoming, which it seems to me ought to be a part of this record. Are you acquainted with the present operations of P.C.A. in the area involved here?

A I am in a general manner, yes.

Q Well, do you know where they're working underground?

A Yes, I do.

Q Referring to P.C.A. Exhibit Q and the well locations, the hypothetical well locations, and the numbers which have been placed on Exhibit Q by Professor Bass, do you have that in front of you or can you come up here and see it?

A Yes, I have it here.

Q Let's take the areas of open workings which are adjacent to the wells on the east side of the contour wells 6, 5, 16, and 11, and 17, 12, and 17,--

A Right.

Q -- in which, if any, of those areas are you now extending your mining operations from west to east?

A Presently we are not working in this area. Those specific locations that you have mentioned, or proposed, we'll say hypothetical locations, are within or on the edge of existing mine workings.

As Mr. Clark testified, it is anticipated that equipment will be available to resume working in this area, which will probably start with the development of the virgin ore body, taking off at some point along here (indicating) from our existing workings.

Q Where are you working now?

A We're working -- I believe Mr. Clark can tell you that more specifically than I can.

GOVERNOR CAMPBELL: Well, I want to find out from somebody where you are mining and where you intend to mine in the future.

MR. BLACKMAN: May I suggest, Mr. Cummings, that you refer to Exhibit G?

A This is what we'll have to refer to.

MR. BLACKMAN: Will you please point out the approximate

locations on Exhibit G where we are mining at the present time?

Q (By Governor Campbell) Where men are working.

A Mr. Clark can do that.

MR. BLACKMAN: May I have Mr. Clark do it then?

A I might, with your indulgence, Governor, point out that this area here and this area (indicating).

GOVERNOR CAMPBELL: I understand that. Now, Mr. Clark, do you want to come up here and show me where you are working the mines now?

MR. CLARK: If you will wait just a moment until I get a map which shows some coordinates that are not on that generalized section.

MR. BLACKMAN: We can set this up here and Mr. Clark can testify from it up here. Maybe we can put it in evidence and get an exhibit number.

GOVERNOR CAMPBELL: Does this show where you are working now?

MR. CLARK: Yes.

GOVERNOR CAMPBELL: Do you have any objection to this being in evidence?

MR. BLACKMAN: No.

GOVERNOR CAMPBELL: Mr. Malone, do you have any objection to this being in evidence?

MR. MALONE: No.

MR. BLACKMAN: For the sole purpose of showing where we are now mining.

MR. MALONE: Is it indicated on there where it is occurring now?

MR. CLARK: No, I'll have to point it out. What this shows is our open mine workings.

HOUSTON CLARK

recalled as a witness, having been previously duly sworn on oath, testified further as follows:

RECROSS EXAMINATION

BY GOVERNOR CAMPBELL:

Q Can you point it out on Exhibit G?

A Yes, if I may be permitted to orient myself from this to go to this. We are working one section in here, Governor, (indicating).

Q You are pointing now to the northwest of the area marked in blue or gray in Exhibit Q, is that correct?

A This is correct.

MR. MALONE: Would you want to go ahead and make a mark there to get it on the exhibit?

Q (By Governor Campbell) Will you put an "A" on Exhibit G identifying the area you are talking about?

A Yes.

Q You are mining there?

A Yes.

Q What direction are you moving?

A At the present time, this entry here has run to salt. We

are retreating here. We have another machine working here which is still in ore and it is moving in this direction (indicating).

Q Now looking to the southeast of the area in pink, crossing the open mine area that you show on Exhibit G to the southeast, are you doing any mining in that green area to the southeast?

A This area here (indicating)?

Q Yes, sir.

A No, sir.

Q When did you last mine in that area?

A 1957.

Q And I believe you testified that you stopped your mining there because you ran into some constituent of the ore --

A Yes, this is correct, Governor. In several areas along in here we contacted a high carnalite content in the ore, and that's the reason for stopping the mining at that time.

Q As I understand it, this required a different type or modification of your milling equipment to take care of this?

A This is correct.

Q So you, in '57, moved into an area where this carnalite was not present?

A That is right.

Q Can you state, or does your company have plans at this time with regard to re-entering that area which is the area involved in this matter?

A Yes, we do. We intend to resume operations in here

sometime near the end of this year, and when I say sometime near the end of this year, I qualify it because we are going to use equipment that is now mining here in these fringes. When these machines complete this, this equipment is then allocated to begin work here (indicating). Now we know --

Q How long does it take you to mine with your present equipment, distance-wise? How much progress do you make?

A Well, I can give you some information in this fashion. With one continuous mining machine driving a four entry development entry; that is, we'd be carrying four faces forward, which would be our main haulage-way in respect to the development of this ore, we would advance at the rate of about 250 feet a month, with one machine carrying four entries 32 feet wide.

Q How far, now, again?

A 250 feet a month.

Q 250 a month?

A Yes.

Q Do you know now where you would commence that operation, north, south, on that southeast area to which we have been referring?

A Well, we have two possibilities. There was an entry development started here and an entry development started here. Probably we will take this entry (indicating).

Q You'll probably take the northernmost one?

A Yes.

Q Where does that appear on Exhibit Q, can you tell?

A It must be right here.

Q That's at the northern portion of the contour?

A Yes.

Q How far is the presently proposed location of this well from the present open mined area?

A Let's see, I don't know which one of these is 4-A.

Q I believe it's this well right here which shows as No. 1 on Exhibit Q; these are thousand feet --

A No. 1 is southeast. That's the approximate location of that well.

Q What's the approximate distance from the present operation, the closest?

A It's about 2400 feet.

Q About 2400 feet to the proposed location, which would be a twin to the Barber 4-C?

A Barber 4-A.

Q 4-A. Are you also operating at the present time mine workings in other areas of your pink shown on Exhibit G?

A Yes, we are working in this area here (indicating).

Q You are now marking that with an "X"?

A Shall I make it a "B"?

Q Make it a "B", yes. You are working in that area and you are moving out into the green bounding it there to the east, south?

A Yes. In most cases, as we are doing here and also here (indicating), we are developing towards the end of the ore bed.

Q Where else?

A Five west. Let me see where five west is. We are in this area here, that's C.

Q You are working in Area C to the southwest?

A That's right. Now at the present time those are our three principal producing sections. We have some minor development work going on in other areas, but these are our major producing sections.

Q I presume that you determine the areas in which you will operate on the basis of the quality of the ore and the location of your equipment, et cetera?

A This is true.

Q Normal business considerations, is that correct?

A Yes, sir.

Q Do you have any areas shown there in green which you presently consider to be under present mining techniques, accessibility, to be non-commercial?

A Well, I'll answer that this way, Governor. We don't know exactly where the edge of the green actually is. In these developments, we have determined where it is; for instance, I mentioned that we had come to the edge of the ore body there and were retreating.

Q Yes.

A This was determined by, our cutoff was determined by the average millhead that we could maintain with the production from all places, and when this grade of this ore became too low to let us maintain that over-all grade, we stopped.

Q That could be true in any area where you are moving away from your actual known quality ore?

A This is right, when we are moving towards the fringe or the edge of the ore deposits as established by core holes.

Q Do these identify your leases, or you say you have identified something outside your red there that is not commercial, but you have still got your lines shown outside and are asking that there be no oil development within that area?

A I must have mis-stated myself. This defines an area of cutoff, based on our present drill hole information. We think with that information that we can go essentially to the edge of the green in all cases. Here's an example in which we didn't make it.

Q But you still show the green out there?

A Yes.

Q When do you readjust these limits?

A These are readjusted once a year.

Q Those are filed with the Commission, as I understand?

A Yes, in January of each year.

GOVERNOR CAMPBELL: I think that's all.

MR. MALONE: May I ask a couple of questions of Mr.

Clark, also?

MR. PORTER: Yes.

BY MR. MALONE:

Q In relation to the carnalite which caused you to stop mining in 1957 in the area that's adjacent to the proposed location, do you have to maintain a fixed percentage of carnalite in order to keep the mill running, also?

A In order to maintain an efficient milling operation, yes, we do.

Q If the concentration of carnalite in a particular area is higher than will permit this ratio to be maintained, what do you do?

A We limit the quantity extracted from that area, so in blending with the other ores we come up with a composite carnalite content that is satisfactory.

Q I understood that this high carnalite area included a portion of your reserves that are adjacent to this proposed location, is that correct?

A Yes. Our contacts between the blue and the pink in this particular area are high in carnalite.

MR. MALONE: Let the record show that the line indicated is the second contour line on Exhibit G; on the northwest portion of Exhibit Q.

GOVERNOR CAMPBELL: Exhibit Q.

MR. MALONE: Exhibit Q, I beg your pardon.

A I was not referring to a contour line.

Q (By Mr. Malone) No, I was trying to identify --

A It's the contact between the blue and the pink.

Q Which is adjacent to that contour line?

A Yes.

Q I was only trying to locate it on the map.

A All right.

Q Is it possible that there is, within the reserves, that you have an excess of carnalite ore so that when you have completed all of your mining operation there will remain unmined carnalite?

A We do not anticipate this, because we have evaluated our remaining reserves in respect to carnalite content, and thereby designed our plant to handle what we expect to maintain as an average carnalite content of the ore fed to the plant throughout the remaining life of this ore body.

Q On the basis of maintaining that average, do you or do you not anticipate that there will be unmined carnalite when you conclude your operation?

A We do not anticipate that there will be unmined carnalite.

MR. MALONE: That's all.

MR. BLACKMAN: May I ask one or two questions to clarify something?

REDIRECT EXAMINATION

BY MR. BLACKMAN:

Q How many mining machines do we have in operation at the

present?

A Thirteen.

Q If you put two machines in driving an entry, obviously it would go twice as fast as with one machine, as driving an entry system?

A This is correct.

Q You testified that we stopped mining out in the northeast area there when you ran into too low grade ore. Can you tell us how low grade that was, or what was the grade when you stopped?

A Yes, at the time that we stopped extraction, we were mining 48 inches of about nine percent K_2O.

MR. PORTER: Does anyone have a question of Mr. Clark while he's available? He may be excused.

(Witness excused.)

MR. MALONE: May we look at the certification during the next recess?

MR. PORTER: Certainly. Did you say this concludes your testimony, Mr. Blackman?

MR. BLACKMAN: That concludes our testimony.

MR. PORTER: Mr. Malone, will you have rebuttal testimony?

MR. MALONE: We will. We will have two witnesses.

MR. PORTER: We are going to take a ten minute break.

(Whereupon, a short recess was taken.)

MR. PORTER: The hearing will come to order, please.

The Commission will recognize Mr. Malone. Mr. Blackman, did you have something?

MR. BLACKMAN: Just one thing, if the Commission please. I introduced in evidence in the course of the hearing Exhibits A, B, C, D, and F as copies, and I have now secured certified copies of the State Land Commissioner of those exhibits; and I ask leave to introduce the certified copies and withdraw the other copies that have been already introduced.

MR. MALONE: We have no objection to the authenticity of the instruments. We renew our objection to the materiality in view of the fact they predated the lease under which operations are now being conducted.

MR. PORTER: The others I believe were admitted, and so these will be substituted. Mr. Malone.

MR. MALONE: Mr. Raymond, will you take the stand, please?

LOUIS C. RAYMOND

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. MALONE:

Q Will you state your name, please?

A Louis C. Raymond.

Q Where do you live, Mr. Raymond?

A I live in [illegible]

Q What is your address there?

A 1129 Hardscrabble Road.

Q In what business are you engaged?

A In mining consulting work.

Q By whom are you employed?

A Ford, Bacon and Davis, Inc. of 2 Broadway, New York City.

Q Ford, Bacon and Davis is a consulting engineering firm, is it not?

A It's a world-wide engineering firm. It's seventy years old this year. They've pioneered in steam plants and gas pipe lines. They're currently employed or involved with engineering design, construction, management, valuation appraisal work.

Q Is a portion of this work in the field of mining engineering?

A Yes.

Q How long have you been with Ford, Bacon and Davis?

A Over eighteen years.

Q Where did you attend college?

A Oregon State School of Mines.

Q What degree did you receive from that school?

A B. S. in Mining in 1930.

Q Did you have further postgraduate education?

A Yes, I received a degree of M. S. in Geology at Massachusetts Institute of Technology.

Q What is your address there?

A 1129 Hardscrabble Road.

Q In what business are you engaged?

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Q By whom are you employed?

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A Over eighteen years.

Q Where did you attend college?

A Oregon State School of Mines.

Q What degree did you receive from that school?

A B. S. in Mining in 1930.

Q Did you have further postgraduate education?

A Yes, I received a degree of M. S. in Geology at Massachusetts Institute of Technology.

Q What year did you receive that degree?

A 1932.

Q Were you actively engaged in underground mining operations subsequent to your graduation?

A I was.

Q Will you state briefly where they were, and the nature of them?

A Well, I worked in the Coeur d'Alenes as an underground timber man and contractor before finishing college. After getting out of college, I was in active mine operations for over seven years with the Mountain Copper, Limited, in an engineering capacity, and finally Assistant Superintendent.

Q What was your employment following that?

A Well, I was mineral specialist for the U. S. Tariff Commission for a period, and following that I went with Ford, Bacon and Davis.

Q Since you have been employed by Ford, Bacon and Davis, will you describe briefly the type of work in which you've been engaged?

A Mining engineering and mine examination and valuation, and general mine layout and organization problems.

Q Has this included design and the planning of underground mining operations?

A It included the layout of mine operations in cooperation with other engineers.

Q Have you had any experience relating to subsidence problems in underground mines?

A I have.

Q Will you state briefly the nature of that experience?

A I had charge of a fairly large and serious subsidence problem involving three large mines mining back to back at a depth of about 1,000 feet; and around them was a town of Setford Mines. My job was to value the destruction or hazard and to lay out the mine control of mining excavation so that the three mines could continue operations without serious damage to each other; and I had to predict the mining subsidence for a long period ahead. We have a record of over twelve years now of this prediction.

Q Has the mining experience that you have referred to, this and other experience, taken you to other countries besides the United States?

A Yes, I have been on a roof control problem in the Nagiev in the Near East. I have been involved in mining operations in Chile, Bolivia, Brazil, in Canada, in the West Indies, and Jamaica, and Africa.

Q And Africa. Is all of this related to hard rock mining of various types?

A Hard rock mining including underground and open pit.

Q Have you also done work for some of the major corporations of the United States, such as the United States Steel?

A Yes, U. S. Steel. We have done work for New York Zinc, Sara de Pasco, Alcoa, Reynolds Metals.

Q World Bank?

A World Bank, and foreign governments.

Q Have you had any occasion to deal with problems incident to high pressures in underground cavities?

A I have.

Q State what that was.

A I had charge of a project involving the large underground cavern storage of natural gas under high pressure, and previous to that I did quite a lot of pioneer research in migration and permeability of natural gas under very high pressures in sediments.

Q Did you hold some of the first patents that were granted on the underground storage of high pressure gasses?

A I held patents in the United States and in Canada.

Q Have you written various professional treatises?

A Well, I've written a chapter on Mine Evaluation for the Sealey Mud volume called Mineral Economics. I wrote a paper on gas storage.

MR. MALONE: Are the witness' qualifications acceptable?

MR. PORTER: Yes, sir, they are.

Q (By Mr. Malone) Mr. Raymond, you were requested by Pan American Petroleum Corporation to make a study of the problems incident to its application to drill the well here under considera-

tion and the relationship to the potash mining operation, were you not?

A Yes, I was.

Q Will you describe briefly the preparation that you made for that study?

A Well, I studied the official reports, U.S.G.S. survey, the Bureau of Mines and the State Engineer reports, and reports of the Potash Company of America; and I also had conferences with officials of various organizations and professional people involved with this field here first-hand.

Q Were you afforded an opportunity by Potash Company of America to go below the ground in their mine in preparation for this hearing?

A Yes, they gave me the privilege of going underground and observing part of their underground operations.

Q Did you go on the surface of the ground in the area of the potash mines and observe subsidence which had occurred there?

A After going under the adjoining mine, I did go up on the surface and observe the subsidence that they had discussed with me.

Q I should have asked you this question in connection with your qualifications. Have you had occasion to do mining consulting work in the State of New Mexico prior to this?

A Yes, I have.

Q In connection with the uranium mines?

A The uranium mines, involving the evaluation of uranium properties with roof control properties and water horizons above it.

Q You have been present during this hearing and heard the testimony in the hearing with reference to the potash operations and the relationship between them and the proposed well, have you not?

A I have.

Q Have you made a study of the problems which you feel will result from the proposed dual use of this property, with particular reference to the safeguards that should be taken to prevent damage to the well?

A I have.

Q Have you prepared some exhibits demonstrating the study that you made and the conclusions which you have reached?

A I have.

(Whereupon, Applicant's Exhibits Nos. 14, 15, and 16 marked for identification.)

Q Would you refer now to Pan American's Exhibit 14 which has been posted on the board and which is now being distributed. Will you refer first to the figure on the left-hand side of Exhibit 14 and tell the Commission what it portrays?

A Well, first notice that this is drawn to scale, vertical and horizontal. It has the same scale. This is a profile section along a log of the Potash Drill Hole No. 63, a copy of which was

furnished me by P.C.A.

Q Where is that drill hole located with reference to the proposed well?

A Well, it's the nearest drill hole they have to the well, proposed well site. I think it's about twelve, 1400 feet.

Q All right. Will you continue?

A What I plotted, what I was trying to show in this entire exhibit would be the physical conditions on which to base an analysis of the subsidence problem and any problems related to protection of shafts or wells.

Now it's been testified previously that we have a four-foot bed of potash, a little over four feet. We have 300 feet, more or less, of competent salt beds; on top of that you have the Rustler, with two significant aquifers; on top of that, some unconsolidated sediment.

Now Exhibit 4 of Pan American which I didn't have at the time I prepared this, went into much greater detail as to the nature of these sediments in this upper zone. They show a much greater zone of aquifer and solution cavities than I have shown here, definitely. The fact is, their zone goes down, their cavity zone, we'll call it, about 285 feet, so that this is a shrinkage of the situation.

That is all as far as the left side is concerned.

Q Will you refer to the right side and relate that?

A Well, now, after considering the general regional area,

the literature on it over the mine itself, and reading reports on problems of shaft sinking, these are an indication of my interpretation and I think it's been more or less confirmed by others that we do have cavernous zones here that are subject to collapse.

As a matter of fact, the literature has abundant references to this type of topography. I might say it also has reference to the fact that we do have tension cracks here that are fresh. To Mr. Woomer I would say, at least they refer to cattle being caught in these cracks where there are no mine operations; so that the main thing is here that we do have solution cavities here and we have a salt brine horizon which is well known.

Q When these vertical cracks which are shown at the upper part of your exhibit occur and there has been no mining beneath it so there has been no mine subsidence, what occurs to cause that?

A Well, I think it's generally called vertical slump. This material caves because it's too weak and the rock is weak, so this collapses and you have a vertical slumping and some compaction, no doubt, especially if there's a lot of water in that zone or a lot of water, boulders, and sand in this zone here (indicating).

Q Does vertical slump of that character pose any problem to a shaft or a well or a casing of an oil well that might be vertically through it?

A Well, we have taken into consideration the forces that

could be developed by such slumping.

Q Are those forces of any significance where they're occasioned only at the surface, of that character?

A Well, they are not -- The terms of magnitude, we will call this slumping and subsidence. Subsidence is a very broad term. This sort of thing I do not consider dangerous.

Q Do you consider that it would endanger an oil well?

A No, I do not.

Q With reference to the brine horizon that you have shown there, you've heard testimony by former witnesses that any subsidence which causes vertical cracking will result in contamination of those waters. Do you agree with that conclusion?

A Any flexing -- Would you restate that, please?

Q Any movement, any subsidence of that area which results in cracks such as those shown on Exhibit K above you will result in contamination of the fresh waters by the salt water that occurs in the Rustler?

A That could be, yes.

Q Would you move to your Exhibit No. 15 and to the left half of that and state what that portrays?

A Well, I've shown a theoretical shaft here, using the accepted shaft pillar diameters, recently accepted, at least, which says you use two-thirds of the depth as a diameter and that makes a radius of 233.3 feet, to be exact.

Q When you say "recently accepted", accepted by whom do you mean?

A The U.S.G.S. It's not a ruling, I understand, it's been accepted as far as certain cases, recent cases.

Q What is the significance of the reference lines which you have shown there?

A Well, if you draw -- I am using a 45-degree reference line. I've assumed the worst conditions for this shaft, a concrete shaft, and I think any engineer that examined this, examined this depth plus the differential shear at that point will know that we have a large safety factor, a very large safety factor in design.

Q In your opinion, is that two-thirds of the depth as to diameter going to provide adequate safety factor for that shaft?

A I think this is a prudent situation in this case, with this depth and with this thickness.

Q Now you have heard testimony in this case that there is what was first described as a 45-degree reference line in cases of mine subsidence, and was later identified as being a 45-degree shear zone. Will you state whether or not in your opinion the subsidence which has been described here actually results in a shearing of the formation along that 45-degree reference line?

A I do not consider this a shear line, a line of shear meaning that if you have forces working at opposite directions,

and you have a pressure difference, and the pressure difference exceeds the shearing strength of the material, you have a movement along that plane. That's what I mean by a shearing plane; I guess we should call it shearing plane.

Q Is that the type of force which might endanger a well or a mine shaft if it was in excess of the power to withstand it?

A Yes.

Q In your opinion, is that the type of force with which we must be concerned in protecting oil wells against possible subsidence?

A Yes, I think we have to consider a considerable force in shear.

Q If I understand you, you have said that the 45-degree reference line does not represent a shear plane. What in your opinion does that 45-degree line represent?

A In this particular case, it represents a line connecting the edge of a pillar where you have -- this is room and pillar with 60 or 65 percent, say, with a line of zero, there's no effects on the surface beyond this point noticeable. In other words, you can have, from this point on (indicating), you can have distribution of tension cracks, and you so find them on the surface.

Q Is your 45-degree line shown on your Exhibit 14 the same thing that's been portrayed up on Exhibit K above as being the edge of the broken zone there?

A That's right.

Q As I understand you, you say that you do not consider that to be a line along which shear force is exerted?

A That's correct.

Q Will you explain to the Commission how you account for the occurrence of the vertical slump out at the extremities there that makes the 45-degree angle in relation to the subsidence?

A Well, I was trying to give anyone a scale of measurement of forces here, making assumptions. The assumption I made was that if you had a vertical slump 400 feet along one side of this well, and if that pressure differential developed because of that instantaneously, if that could be confined to a single plane; if so, that you have on one side of your wall a four-foot drop, a four-foot slump from here on down (indicating), the total pressure on one side subtracted from the total pressure on the other side would give a shear differential of actually -- it would be less than 300,000 pounds, actually is less than 300,000 because there's an internal friction factor that we would have to use in a case of this type of material that would decrease that 300,000 pounds by a significant amount.

Now no one, as far as I know, has ever measured this friction factor for this material. Therefore, I have not applied it. I have bent over backwards saying that if you had a four-foot drop and had a place for it to go, and it extended down to 400 feet, and if all the force to the differential stress was along

one shearing plane, you would have this differential.

Not only that, but I've shown here that the strength of well string, 1,951,000 pounds, assumes horizontal shear. Now if you increase that shear to 45 degrees, the material being sheared of course would be greater and this would increase maybe by thirty percent or so. So that actually I have bent over backward to show the worst possible conditions.

I'm not saying this would occur because I don't think so. It's too ideal and not only that, but the deepest slumping zone we have here, according to Exhibit 4, at least, would be about 285 feet down, less depth.

Q Now, Mr. Raymond, from that I take it that that 1,951,000 pounds of strength of the well string that you have used is the one testified to by Mr. Rodgers?

A That's right.

Q Will you state whether or not in your opinion subsidence in that 400 foot area would damage a well which it is proposed to case and cement as the well in this instance?

A Assuming a type of secondary mining here, a controlled secondary mining, and assuming these thicknesses and this depth, I do not see any danger in the stresses developing in this zone here, this triangle, sufficient to rupture that pipe.

As a matter of fact, that pipe will not fail in shear, it will have to by collapse, and this depth is so shallow we can't conceive this four strings collapsing when they're filled

together with cement.

I mean we are talking about something that's quite academic as far as trying to collapse this pipe with surrounding pressures, because you have a pressure, if this drops four feet, you have pressure on this side, we'll say this side of that reference line (indicating). Let's say, assuming this pipe is a wall, you have pressure on this side and pressure on this side and it's a differential we are concerned about.

Q You have heard the testimony that Potash Company of America feels or has made the arbitrary decision, as it was described by their witness, that they will leave a 200-foot pillar around this well if it is drilled, and in an area with a 700-foot radius, they will leave the room and pillar condition which existed at the end of first mining.

Will you state whether or not in your opinion the safety of the well or the people in the mine requires that amount of potash to be left in the mine?

A It does not require that amount of potash to be left in the mine.

Q What in your opinion is adequate and over-adequate protection of that well against subsidence at 700 feet with a four-foot zone which has been mined?

A I show here a 100-foot of solid, following convention here, at least; then an outer 200 feet of room and pillar first mining. I consider that adequate.

Q That is a 100-foot pillar around the well and a 200-foot radius circle in which first mining is conducted but second mining is not?

A It makes a 300-foot circle, radius circle.

Q Now with reference to the 45-degree reference line which you have said you do not consider to be a shear line, have you attempted to determine what in your opinion is the limit of the area in which shear forces that might endanger the well would occur?

A Well, we have a zone here where shear forces could, under certain circumstances, injure the well. This is difficult, I must admit, to analyze on short notice, but I do not consider -- I wouldn't recommend putting a well in this zone while it's undergoing -- What happens here, according to their own field survey, that you have a slump, a very mild slump, zero to a fraction of an inch up to a few inches; and when you get near an edge of a pillar you have a differential showing and a curve and then a kind of a Basin slump, so you get a maximum out here; so there was a zone there where you did have shear, there's no doubt about that.

Q What angle do you feel is acceptable as defining the limits of those shear forces?

A Well, for a pipeline, it's my opinion that 67 degrees is an adequate safety factor here.

Q And how do you relate the vertical cracks which appear in the surface and the slumping that occurs there from a point on

out between your 67-degree line and the 45-degree line; how do you relate that to the subsidence?

A Well, I'll say the basis of my comments are based on mining. I have driven drifts out into this area to study what's happened. In this area up here, if we have a flexible bed or a bed that flows, we'll say semi-plastic, you have a settlement here and it's just like bending the pages of a book very slightly. You have minute cracks over a wide area. These are tension cracks. There is no shear in a tension crack, it's the opposite of a shear.

Now actually, what you have microscopically, if you take -- let's take the pipeline and give it a little bend. You could have some microscopic or small tension cracks here with some very microscopic horizontal movements if this were bent as a continuous layer or a fluid; so you can get sort of a fish bowl bend here. I'm not saying it's going to be that extreme with this sub-condition because your subsidence is working from a point that's fairly shallow.

Q In your opinion, would the extent of that bend endanger either the well or the mine operations that may be conducted in the area?

A It would not, in my opinion.

Q Have you made a study of the potash that would be left in the ground if your recommendation of a 100-foot pillar and 200-foot room and pillar circle were left around the proposed well?

A I have.

Q Will you state the basis on which that study has been made?

A Well, the basis is that I have assumed that 300-foot radius circle, and I have assumed that in the center you would have a solid pillar, but I also assumed that in any mining in this fringe area you would, over the long period, you would not recover more than 85 percent.

Part of that material remaining would be salt horses or conditions that bend, and cut-outs of the ore, perhaps, and I mean that last 10 percent, you just wouldn't get, as Mr. Woomer has stated. You would have to leave that as pillars in the mineable area.

MR. MALONE: May I have this exhibit marked?

(Whereupon, Applicant's Exhibit No. 16 marked for identification.)

Q (By Mr. Malone) I invite your attention to Pan American Exhibit 16 which has now been placed on the board and which was also distributed with the original exhibits, and ask you to show the computation which you made and the value which you arrived at.

A Well, the first total ore in the solid pillar, we give 8,000 tons and I corrected that for -- I didn't make a correction for material already denied due to uncertain location and the existing 100-foot pillar.

Q In other words, you have not taken into account the testimony of the Potash Company that they expect to leave a 100-foot pillar there in any event?

A I have not.

Q As well as a 700-foot room and pillar area?

A I have not. Then I've taken out the unrecoverable under any circumstances, you know, an average long term projection. Then I have considered the outer circle of 64,000 tons and I take out of that the unrecoverable 15 percent and the recoverable 60 percent and the amount denied in the solid is 6,840; the amount denied in the outer circle room and pillar circle, is 16,100; total, 22,940 tons or about three days mining at the reported capacity.

Q How have you arrived at the value of the ore in place?

A I've used, we will say, conventional commercial valuation procedure. I have analyzed the annual reports of the P.C.A. and I show here the '63 annual report figures and the average for '61 through '63.

Net sales less cost of sales, and by the way, I didn't take out of the cost of sales, as I showed down here, exclusive of exploration and research and depletion, so I have not penalized their profits by that amount, by that figure.

The profit from operations are shown here; I take out the Federal and State taxes shown here; and then I divide by the tons of ore at capacity, which is a little over 8,000 tons per day for 350 days around the clock, which is 2,750,000 tons, around about, and you get for 1963 $1.49 per ton of ore in place, and $1.44 for the average.

I've used, rounded it out to $1.45 per ton of ore in

place. That's a profit on the ore if you mine it and accept it as a blended material and get the average mill recoveries that they've been experiencing in the last three years.

I haven't penalized these earnings for any added costs of mining or any lower recovery factors. I take that present value times the number of tons and I get the value over a period of years and discount it. I'm allowing them 10 percent, which is about the highest risk factor. They stress the point of high risk. That's about as high a risk factor as we can get by with as far as clear negotiation, and I use a 10 percent compound interest discount factor for a period of eight years, and that was taken arbitrarily by taking half of their reported annual reserves as of the last report.

Q What figure do you come up with as reflecting the monetary loss on the basis of ore in place which would remain if the mine were collapsed as suggested by you?

MR. BLACKMAN: If the Commission please, I don't wish to belabor the point, but I do wish to record my objection to the relevancy of this testimony.

MR. PORTER: Your objection will be noted.

A For the ore in place I have $33,263,00. I didn't try to round it out. But I also penalize anyone that buys this, I allow P.C.A. the depreciation they would have obtained from operations from their plant if they had been allowed to mine this pillar, but they have been denied that so I've added to the

value of ore in place the denied depreciation, which is $15,520.00.

Q And your final figure is $15,520.00?

A Let me look and see. Yes, because I have added in, although I don't show that, an addition in here, but I end up -- I'm sorry, I will correct this. This included the add-back and I've added -- I mean this is a discounted present value of future profits from the ore that would be mined, assuming eight years hence.

MR. MALONE: That's all.

MR. PORTER: Any questions?

CROSS EXAMINATION

BY MR. BLACKMAN:

Q Mr. Raymond, referring to Pan American's Exhibit 14, was the material on the left-hand side of that based solely upon the information given to you by P.C.A. in that log?

A This --

Q Is that what you made up from that?

A This is the log, and I have taken this faithfully from your log, those distances, these generalized descriptions of the formations I have taken from the geologic literature.

Q So the material on the right-hand side in which you talk about some sink hole topography there --

A Yes.

Q -- where did you get that information?

A It's very well exposed on the U.S.G.S. topographic

maps and the literature is filled with references to not only hole slumps, pits, but also pits that have moved fairly recently because you have these vertical tension cracks where the cows got caught in them.

Q Did I understand you to say that you understood Mr. Woomer to say that a cow had fallen in a crack like that?

A No, he mentioned that a cow fell in a crack. No, I'm just saying that the U.S.G.S. mentioned this sort of topography and this sort of thing, and you can look at the map and see it's what we call Carr's topography.

Q Did you observe any?

A Yes.

Q Where?

A I was up on the surface and they pointed out a pit where the rattlesnakes occur. I examined --

Q Where was that?

A The topography map, I was on the Duval property.

Q Is that when you were on the Duval property with Mr. Jordan of P.C.A. and the Mine Superintendent of Duval?

A I was with them part of the time, yes, I was with them on the surface.

Q And you were with one or the other of them all the time?

A I was with two men, one from Potash and one from Duval.

Q As a matter of fact, isn't the big crack that you saw up there, didn't they tell you that was caused --

A No, that's something else. The crack that I did observe, I did go over the surface on the Duval property. I had visited the Duval mine and observed that they were retreating along a long wall about 700 feet or so, and that it was about over 12 feet, and they were collapsing the mine back in back of them; and I observed that they were using roof control methods to control the back roof bolting.

I observed that the caving behind indicated, in my judgment, around 30 percent swell factor in the arched area that I was looking at. After that I went above this zone. They said that I was above it and I have no reason to believe I was not. And I examined the cracks in relation to a profile section they had shown me in the office. This is not -- this has no reference to that.

Q Do any of your exhibits have any reference to that?

A Not that I know of, no, none of my exhibits.

Q None of your exhibits have any reference to that?

A I have not used any information from Duval. I observed it.

Q Have you had any other experience in potash mining?

A I've had experience in recoveries, solar recovery of potash in Central America. I evaluated Chile nitrate from solar evaporation.

Q Solar evaporation solution?

A That's right, but not underground. But I have had

experience in gypsum mines, low seam gypsum mines.

Q Is this the only potash mine that you have ever been in, Duval mine, underground potash mine?

A I have been in the Dead Sea operations; that's not a mine.

Q That's not a mine?

A No.

Q Is this the only time that you have observed a crack in the surface in Southeastern New Mexico in the neighborhood of underground mining and removal of subjacent supporting a potash mine?

A I have seen similar subsidence around a salt dome operation in Texas.

Q But you ignored that information?

A No, I haven't ignored it. I hope, I'm trying to not ignore any information. I'm trying to get the facts.

Q If I understood your answer to the question initially, when you were testifying on your experience, that all your experience has been in hard rock mining, is that correct?

A No, I said I had had experience in hard rock mining and open pit mining and dredging, I mean it depends. I was applying my experience more to this case. I have had thirty-five years of experience and it's quite a long record.

Q How long did you spend in making the investigations that you made preparatory in the Carlsbad area?

A Well, I was only underground during that one day, but I spent about two and a half to three weeks discussing this problem with various officials and studying the literature and the maps, the Bureau of Mines data on this.

Q Would you please explain to me again what your testimony with respect to Exhibit 15 on the left side, in which you've mentioned something about a U.S.G.S. rule; what did you say about that?

A I didn't say it was a rule. I said it was not a rule. I said it's been accepted, this pillar diameter principle, two-thirds the depth as a diameter.

Q By whom was it accepted?

A By the U.S.G.S.

Q Where is that information available; where did you acquire that information?

A From the U.S. official.

Q From whom?

A Mr. Fulton.

Q As a matter of fact, didn't Mr. Fulton tell you that that 700-foot diameter pillar should be solid?

A No, he said -- I asked him three times, I think, not entirely this way, but this first 100 feet -- I'm talking about a shaft now, was -- No, I must admit this is all solid and I show it all solid.

Q The first two-thirds of 700 feet then on a radius would

be solid?

A This is solid on that radius, 233.3 feet.

Q Did he not also tell you at that time that no second mining would be permitted within a radius equal to the depth of the ore near a shaft?

A You mean -- when?

Q When you were talking to him recently, when you were down in Carlsbad; isn't that when you talked to him?

A No, I asked him what the accepted pillar was as far as these shafts are concerned. As a matter of fact, the secondary retreat hasn't been involved in this property so far.

Q Oh, so you were not intending to indicate any secondary mining outside this 233 foot pillar?

A Eventually you would certainly retreat and take that out, I would assume.

Q You didn't discuss this with him with reference to secondary mining within a radius equal to the depth?

A All I noticed was that we had room and pillar mining around those areas.

Q If you were not going to have any secondary mining outside that 230-foot radius, that you note on there, why do you have any draw zone or 45-degree angle there at all?

A You mean this angle?

Q Yes.

A I've just shown this here for a reference to calculate a

shear on a concrete shaft. It's just purely for reference.

Q If you did no second mining outside it and up to that point, there wouldn't be any shear, anyway, would there?

A I assume that you could eventually retreat from this point out, and that is what I'm referring to, my calculation as to stress assumes that you'd eventually mine that out.

Q As a professional consulting engineer, would you recommend that second mining be conducted within 233 feet of a shaft at a depth of 700 feet?

A Yes, based on previous testimony and my own judgment, it's fairly well accepted that this room and pillar up to this extraction point has been safe, does not allow for any, as you call, subsidence. Now eventually you would retreat to this shaft position. In other words, you retreat, your second mining is done from your outer zones of your mine toward your shaft.

Q Now if I understand what you are saying, you are saying that within your 233 -- or here you have 200 feet plus 100 feet, that that would be safe to first mine, is that correct?

A Repeat your question, please.

Q Are you now saying, or do I understand you to testify that in your schematic on the right side of Exhibit No. 15, you would show 60 percent extraction on first mining?

A In this area.

Q In that area?

A From this 100-foot radius up to 300 feet, I would have

room and pillar, 60 percent mining.

Q Except as a last resort, when you were finally moving out of your mine, would you as a professional engineer advise a mine operator to move up to the shaft within the area described by a radius equal to the depth of the ore zone?

A I would advise the situation shown here as far as this oil well is concerned. As a matter of fact, from a theoretical approach, if I were given the problem, engineering problem of protecting this shaft from shear at this depth, theoretically, I say, you can mine a circle around this and throw the shear to the outside and you'd have a zero shear, there would be no differential in that zone if you had a uniform slumping.

Now I'm not advising that because I doubt if you could get any uniform slumping, but you'd certainly take your shear away from your well.

Q Now I further understood you to testify that you didn't think the forces generated along the draw line, along the 45-degree line, would be sufficient to shear a casing having a strength of 1,950,000 pounds, is that correct?

A That's correct.

Q Let us suppose that in the area which is between your 67-degree angle line and the 45-degree angle line --

A 67, yes.

Q -- in that area --

A Yes.

Q -- and along the 45-degree angle line, you have a situation in which when the subjacent support is removed below, the material will move downward pretty much as a unit, let's assume that, pretty much as a unit?

A No.

Q You don't think that will occur?

A No, not as a unit.

Q You don't think it's possible it could occur?

A I'm not exactly sure what you are asking. You are asking can this entire mass move as a unit along that line, the 45-degree line?

Q No, I'm saying that the movement could occur that way, yes.

A This mass, this whole mass could move along that one line down some place, if it had a place to go.

Q Yes. And if you remove the subjacent support, it would have a place to go?

A No, the reason is if you had an open pit here, as Mr. Woomer explained, you would have an angle of repose here, he would put it up and eventually, I agree with him, but that's assuming you take out all this material here (indicating), which is a force against that plane or against a plane here; and I mean that is the angle of repose where there is no shear, there's no stress, differential stress.

Q It has reached equilibrium, is what you mean?

A Yes, when you move all this stuff out it has, if you leave all this stuff in here then you have got something entirely different. This angle, I accept here. Now let me explain this. It's a well-known principle and it's demonstrated by Mr. Woomer, I'm sure, that when you start secondary mining, designing rooms, for instance, is just like designing a house. From your gable, the forces go down to the walls of the house. In a mine your forces go down from the top of the arch down to the pillars.

Now if you want to build a church with a wide nave, you bolt a lot of timbers together and you can widen those pillars and you do it underground by roof bolts.

Now, if you can't afford roof bolts, then I am not advising that here, then you can say, "Well, we'll let this come," and what happens, actually, with a 30 percent swell factor this arch would not be very high, the stresses would be from the top into this pillar so that as you draw more and more out, this line starts to go up and finally comes to rest.

Now this well developed, now the U. S. Bureau of Mines, and I have done this myself, there's a relationship between the amount of material you draw out and the volume over the subsidence--what I call true subsidence area. In other words, if you kept drawing material out here more and more, you'd finally start this movement that you are talking about, but the first thing you have to have is a place for this to go, and for a long time you are filling this hole. If you assume that you had all this subsidence

and you only had four feet plus any swell we would get in the ground, that four feet collapse here, it's less than one percent swell. I've never heard of any capable -- By the way, this rock, this halite over the top of this we have shearing strengths of the halite. It varies from 2,500 pounds per square inch to 5,000 pounds per square inch or at an average of 3,500 pounds per square inch. It's equivalent to the shearing strength of concrete.

I'm not saying this is 300 feet of concrete because actually you have lamination partings there and the rock is weak in tensile strength; and naturally, if you get the span too wide, this one foot, the tensile strength will be exceeded and the roof will collapse; and, of course, that's what happens.

But the collapse -- and if you will look at it, you will see, as Mr. Woomer said, you will have quite a good swell factor.

Q I would like to stay away from the swell factor for the moment.

A Yes.

Q I would like to ask you again about movement along that shear line, that you don't think it's possible for that to move down in such fashion that it might hang up on the well and concentrate the stresses that you have noted on here as 300,000 pounds many, many times, if it hooked up on that well?

A Well, I'll try to explain this. I tried to explain it once by a warping effect, you have tension cracks. It's like a

book. If you go down in a mine, say, underneath this, say a warped bed, you'll find these little layers displaced a little bit. As a matter of fact, if this is plastic, you can't have a shear plane. You have gliding zones all along the whole height of one of these beds. You do not have a concentrated force.

As a matter of fact, if you'll watch the roof bolts in these mines in Duval, you'll find that they have bent over in accord and with my description of this gliding, and you can put quite a bit of bend in a pipe or in a roof bolt. The thing is, I am not concerned about a collapse; in a shallow depth, this is a thing that we should design against. I've allowed a 45-degree line to be safe, up to this point, but there are no forces above this point that are strong enough to shear that pipe, in my opinion.

Q You are absolutely convinced of that?

A Well, that's the record.

Q And you are absolutely convinced of that, after having spent a total of about a day and a half in the Carlsbad area?

A Well, I spent many years, I have spent twelve years examining subsidence where many, many millions of dollars are involved, where safety was involved, and where the townspeople were involved, the governments were involved; and I, on the basis of that, this loose use of the word subsidence is a little danger= ous; actually, subsidence has zones.

It's like a rock being dropped in water, you have ripples,

and you get out to a point here where you've shown here, there's no movement, there's no displacement along here. You get bending motion but there's been no movement in your diagram, and I don't see, unless you -- I don't know how you could get all that stuff cracked up like that to begin with, but I must agree you've got collapse here, but that's a tremendous amount of energy to do this.

Q Mr. Raymond, if I tell you that there are six operating potash companies in the Carlsbad Basin, and that it is uniform practice in those six operating potash companies that they do not do any second mining within an area having a radius equal to the depth of the potash zone from the surface, would you say that all of the engineers involved in that, would you say that everybody in charge of those operations is wrong and you are right?

A Well, I find by the record that the mines change their rules. It would not --

Q If I say to you that that is the case now and has been uniformly in the past, are you now saying that everybody there is wrong?

A I'm saying that the people, the mining staff have changed their mind over a period of years as to the problems here. It would not -- they were afraid to bring this down because they were afraid of water. Then they changed their mind and they are bringing it down, so I would say that's a change in concept of the structural features here.

Q Certainly. Are you now saying they are wrong in main-

taining those pillars?

A I would say that they're going way beyond any reasonable hazard in this particular case that I'm talking about, these depths, these thicknesses as involved here.

Q You would recommend taking that chance, notwithstanding --

A I'm not recommending anything to any mining company outside of this particular problem, because I have not studied their own problems. They vary from mine to mine, and I state this without any doubt. The Duval mine I was in was 1400 foot deep. They had subsidence above them and there was a zone above the pillar, let's say the pillar was here, above the pillar they had a differential shear, you could see it; there's no doubt about that.

MR. BLACKMAN: If the Commission please, on the basis of the testimony that Mr. Raymond has given, which indicates that he does not have a sufficient knowledge to testify to conditions of this kind or to make recommendations within the Carlsbad potash zone, when obviously everybody is doing something, I move that all his testimony be stricken from the record.

MR. PORTER: Motion overruled.

MR. BLACKMAN: If the Commission please, for the sole purpose of impeaching this witness, I now re-offer Potash Company of America's Exhibit D, which is a letter from Mr. Robert Fulton to the Potash Company of America which was previously offered.

Mr. Fulton is in the room, and due to regulations of the

U.S.G.S., he is not permitted to testify, but he can identify his signature on that letter and I now offer it into evidence for the purposes of impeaching this witness.

MR. MALONE: If the Commission please, Counsel wishes to impeach this witness and the witness is available to do so; he certainly has the opportunity to, but a hearsay document unadmissible in evidence and unsupported by testimony is not an acceptable means of impeachment and we object to it for that reason.

MR. BLACKMAN: In the alternative, we move to strike all of his evidence concerning his representation as to what the U.S.G.S. told him the rules were.

GOVERNOR CAMPBELL: Let us rule on the first motion.

MR. PORTER: On your first motion, Mr. Blackman, it's the Commission's ruling that the letter still will not be admitted into the record, the letter from Mr. Fulton with the U.S.G.S. to which you refer.

MR. BLACKMAN: In the alternative, I renew my motion to strike all of Mr. Raymond's testimony as to what he heard from the U.S.G.S. and U.S.G.S. approval of any of this material.

GOVERNOR CAMPBELL: Didn't you ask him the question yourself?

MR. BLACKMAN: I asked him if the U.S.G.S. told him that, and he testified that the U.S.G.S. had given him approval of this thing. Mr. Fulton's letter here shows to the contrary, and I ask that it be placed in evidence; and if it's not going

to be placed in evidence, if that's your ruling, then I move that his testimony in the first instance, and in the second instance on cross examination with relation to this, be stricken.

GOVERNOR CAMPBELL: You referring to the testimony at which he arrived at the 233.3 feet?

MR. BLACKMAN: Yes, that's the testimony.

MR. MALONE: If it please the Commission --

MR. BLACKMAN: Also I'm referring to his representation that the U.S.G.S. approved that.

GOVERNOR CAMPBELL: As I recall, you asked him where he got that figure, and he told you, and now you are asking that your question and his answer be stricken.

MR. BLACKMAN: Yes, I am asking that my question and his answer be stricken if I can't get the letter in which shows it to be not so. I'm really asking that his representation on direct that this is a policy of the U.S.G.S. be stricken.

GOVERNOR CAMPBELL: I don't believe, Mr. Malone --

A Your Honor --

GOVERNOR CAMPBELL: Mr. Malone, what do you say to this?

MR. MALONE: I beg your pardon?

GOVERNOR CAMPBELL: What do you say to this?

MR.MALONE: Oh, I say, if it please the Commission, he is asking that this testimony be stricken because he thinks it is incorrect. I know of no principle of law that permits testimony to be stricken because Counsel thinks it is incorrect. If he has

available admissible evidence to show it's incorrect, he has a perfect right to put it on. I appreciate the difficulties under which he's laboring because of the restriction of the U.S.G.S., and its regulations, but certainly that does not modify the rules of evidence.

MR. BLACKMAN: I renew my motion with the additional ground that his original testimony was hearsay.

MR. PORTER: Mr. Blackman, the Commission will deny your motion.

MR. BLACKMAN: That's all of my cross examination.

MR. PORTER: Anyone else have a question of this witness? He may be excused.

(Witness excused.)

MR. PORTER: Call your next witness, please.

MR. MALONE: We would like to recall Mr. Rodgers for a brief rebuttal testimony. Mr. Smith will interrogate the witness.

JAMES T. RODGERS,

recalled as a witness, having been previously duly sworn, was examined and testified further as follows:

REDIRECT EXAMINATION

BY MR. SMITH:

Q Will you state your name, please?

A James T. Rodgers.

Q Are you the same J. T. Rodgers who earlier testified in these same proceedings?

A Yes, I am.

Q By way of a sidelight on this matter, I wish you would state your qualifications again to the Commission. I know you have testified earlier, but they may not recall some of the matters involved. For instance, where did you go to school?

A I received a B. S. degree in Petroleum Engineering from Louisiana State University.

Q Is that the same school that Dr. Bass attended?

A Yes, it is.

Q And you got your Master's Degree from Texas?

A Yes, University of Texas.

Q Did you also work for the Texas Petroleum Research Committee?

A Yes.

Q Is that the same outfit that he worked for?

A Yes.

Q Were you an Assistant Professor of Petroleum Engineering in Texas University?

A Yes.

Q You were also a Professor at Texas Tech for three years?

A Yes, I was.

Q You were in the room when Dr. Bass testified, were you not?

A Yes, sir.

Q And you recall his testimony to some extent?

A Yes, sir.

Q With reference to the estimated dates of termination of production in the Barber Field, I would like to ask you first as to whether or not you have made some investigation since his testimony as to the figures that he has submitted?

A Yes, sir, I have.

Q Will you turn to the production figures, which I believe is Exhibit 12. Referring to that, comment as to what you consider to be the validity of his testimony.

A Mr. Smith, I'll also need to refer to his exhibit in the report that he had, I'm not sure which number was assigned to it, it's the map that shows the expected dates of abandonment in the various wells in the field.

Q What page is that in the report?

A That's on page 29 of the report.

GOVERNOR CAMPBELL: Professor Bass' Exhibit 2-5.

Q (By Mr. Smith) Comment as to what you consider to be the validity of his testimony respecting the termination dates.

A Mr. Bass stated that he based his termination dates by studying the wells within this pool that have been abandoned, and I am not sure exactly what method of extrapolation he used, but under normal engineering calculations it's perfectly acceptable to use wells within a field that have been abandoned to establish trends either in decline rate of production, water-oil ratio performance as related to cumulative oil recovery and such

other factors.

When such a method is utilized, then the remaining life of the wells currently producing within the field are directly proportional to the current producing status of these wells with respect to their oil producing rates, and also their water-oil ratios. Under such a circumstance, I have reviewed these anticipated dates of abandonment of the various wells and I find several things here that I cannot agree with, from the standpoint of generally accepted theory, when utilizing the method that Mr. Bass did.

Q What is the first point of departure?

A Referring to the upper right-hand portion of this Exhibit Q-6, and actually in the area under question, the Well No. 4-J as shown on this, he shows an abandonment date on that well in 1967. The well immediately south of that, the 1-A, has an abandonment date of 1975, some seven years later.

I have here a Xerox copy somewhere of the January, 1964, New Mexico Oil and Gas Engineering Committee monthly report for the Barber-Yates Field, which reports the oil production for the No. 4-J Well as being 266 barrels for that month, and the oil production for the 1-A Well as being 264 barrels for that month. The water production from these two wells was 3100 barrels from each well.

So these wells have actually the same oil-producing rate and water-oil ratio; under these conditions I cannot see

how the remaining difference, the remaining life of some seven years out of a total of ten years could be calculated.

Q Do you have a second point of departure?

A Yes, sir, going down into Section 20, looking at Well 1-B, which is in Unit B of that section, and Well No. 1-C, these wells are both shown to have an abandonment date of 1978. Well No. 1-B, according to the Engineering Committee report, is producing at a rate of 282 barrels of oil per month with a water-oil ratio of 13 to 1. Well No. 1-C is producing at a rate of 895 barrels of oil per month with water-oil ratio of 4.3. That's a threefold difference in both oil producing rate and water-oil ratio; yet these wells are supposed to have the same remaining life.

Q Do you notice any other discrepancies in his testimony and conclusions?

A Still in Section 20, going down to the north central portion, Well 3-G and 3-F have actually the same relationship as Well 1-B and 1-C, and yet again they have the same date of expected abandonment.

Q Is there any way you can account for any such discrepancy as that occurring either by mistake or some misinterpretation on his part?

A No, sir, with the data available to me, I cannot account for it. As I said, he did not specifically state what his methods were.

Q What comment do you have to make concerning whether or not this may or may not be a water drive field?

A In my opinion, this reservoir is not being produced under an active water drive.

Q Upon what factual evidence before you do you base that conclusion?

A I would like to refer back to his Exhibit No. 12 which I believe was, these particular points were discussed in cross examination. In 1947 the water-oil ratio from this pool was 10 to 1. In 1959 it was 9 to 1, in 1963 it was 11 to 1. Any effective water-oil ratio has been constant over the period of time from which we have any production data from this field. This is not conducive to a water drive reservoir.

Theoretically, and under actual operating conditions, a water drive reservoir is one in which you normally experience a period of production at low or no water production, and at some stage in the life of the field, water begins to break through and you experience after this break-through a rather rapid decline in production.

These wells, for as long as we have data, have been producing at a constant water-oil ratio. There's no indication of the rapid decline in production over the last seven or eight years as shown by our Exhibit 8.

Also with reference to my Exhibit No. 8, which is an extrapolation of constant percentage decline for this field, it is

my opinion that is a valid extrapolation using accepted petroleum engineering methods and well-supported by the previous or highest performance history of this field. The seven years period shown on their production indicates that this reservoir is declining on constant percentage and with no change in water-oil ratio; it's a valid extrapolation.

Q Mr. Rodgers, Dr. Bass commented upon certain literature that he had referred to in connection with his examination of the Barber Hills Field. Are you familiar with any of the literature that he may have been speaking of?

A No, I am not.

Q Would you have any idea in point of time as to whether any earlier reports could have mislead someone as to whether or not this is a water drive field?

A Yes, sir, I do.

Q What is your comment with respect to that?

A In a number of cases in New Mexico and elsewhere where I have done reservoir studies, I have run into the situation where in the early life of a field it's very easy to decide that this field is either a water drive or not a water drive, based just on that data. However, the field has not progressed to a so-called settled stage of production that we now have in this field to really justify such conclusion without bottom hole pressure data and numerous other data that are not available on this field.

In other words, what I am trying to say, back in the

1940's, specifically around '45,'46, some of the wells on the southern end of this reservoir were abandoned. I do not have any per well production on these wells, and again it would be reasonable to assume that they were abandoned due to high water production. This reservoir has high water production, it has had it since discovery as far as I know; and when you start getting around the edge of it, I'm not surprised at all that you ran into some poor wells. There is no evidence, however, that there has been any advancing of a water-oil contact in this reservoir.

Q Have there been any wells abandoned in this field since 1956?

A No, sir, there have not. Excuse me, sir. I am going to have to elaborate on that point.

Go ahead.

A According to Mr. Bass' Exhibit Q-6, he shows the No. 2-J Well in Section 20 as having been abandoned in 1956. That is correct, but according to my production figures, it did not produce any oil in '56 or '57 or '58.

Consequently, I would modify my answer to your question to say that to my knowledge there have been no oil producing wells abandoned since 1956.

Q With respect to whether or not some of these wells which Dr. Bass testified were shut-in may have had any effect upon the later increased production, what is your comment with

respect to that matter?

A Excuse me, would you repeat that?

Q Well, I believe that Dr. Bass made some comment in his testimony as to the fact that there were certain wells had been shut-in that might account for the increased production. Do you have any comment representing that portion of his testimony?

A Yes, sir, in general, the only wells that have been shut-in for extensive periods of time are the wells located in the north central portion of Section 20 where we have two wells on each of two 40-acre units. During the times that one of these two wells were shut in, the unit still produced at its established rate of oil production, so at no time did we have in this area a shut-in of a 40-acre unit for a period of time.

MR. SMITH: No further questions.

MR. PORTER: Mr. Rodgers, would you say that in your opinion, if this was a water drive pool, do you think it would have been watered out by now, based on its performance?

A Yes, sir, I would.

MR. PORTER: Any questions of Mr. Rodgers?

MR. BLACKMAN: Yes.

RECROSS EXAMINATION

BY MR. BLACKMAN:

Q What do you think is the drive of this pool?

A I think this is a depletion drive reservoir.

Q A depletion drive reservoir?

A Yes.

Q Would you explain that, please?

A That is a reservoir that is producing from, or is deriving its energy for production from the pressure originally present in it, with no outside source of energy supplied to it. In other words, as you withdraw oil, the pressure drops and at some point it will be down to a point where you cannot withdraw any oil.

Q Well, if it's producing from the pressures originally in it and the water is coming in, isn't the water moving in displacing the oil?

A Sir, there's no evidence here that the water is displacing the oil. These, we say, have had high water-oil ratios back near their completion times; there are no changes in them. It more, to me, indicates that they had a high connate water saturation or in addition to depleting an oil zone, you might say depleting a water zone.

Q What fills up the voids when the oil moves out up in the well; water, isn't it?

A No, sir, in a depletion drive those voids are filled by gas.

Q Oh, then the gas is causing the oil to move in towards the well?

A Sir, I don't have any knowledge of how much solution gas is in this pool. There are no gas sales. There's no gas

production reported to the Commission. I'd say in general in a depletion drive, that is the case. I would have to assume, of course, there was some gas in solution in this oil. I'm not familiar with the --

Q That's an assumption?

A It's certainly a valid assumption. I will state I have never seen a reservoir in this part of the country that didn't have any.

Q Well, how much gas would be necessary to be there; would it be enough to operate a pump motor or something like that?

A I can't answer that. I don't know.

Q If this field doesn't produce enough gas to operate a pump motor, would you say that it still was a solution gas drive?

A Sir, this reservoir is currently 80 percent depleted, which is in the later stages; in many cases, you have very little gas production by that time.

You asked me what filled the void space. That would be referring to gas in the reservoir, not gas produced at the surface. You would have to have a gas saturation build-up in excess of equilibrium before you produced any of this to surface.

Q Do you know if it has ever produced any gas?

A I don't know.

Q Are you familiar with the paper by Matthews et al defining the type of decline curve you used in your Exhibit No. 11?

A No, sir, I'm not.

Q Does one point define a decline point, define a decline curve?

A What type of decline curve?

Q Any type of decline curve.

A No, sir, it takes two points to get a straight line.

Q Do you have your production data there from which you made your exhibit?

A Yes, sir, I do.

Q Will you please check these figures with me?

A All right.

Q I show here 1963 production from Well 4-J was 1372 barrels.

A I have it listed by months; yes, sir, that is approximately.

Q And 1-A at 3600 barrels.

A What section -- 1-A, all right, I am with you. That's approximately right, yes, sir.

Q And 1-B at 3281 barrels.

A May I comment on those first two?

Q I'd rather you would come along with me.

A Excuse me.

Q 1-B, 3281.

A What are we in now, Section 20? I haven't used the same well numbers. That's the reason I'm having a hard time.

Q Well --

A 1-B in Section 20. Would you repeat that number?

Q 3281.

A That would be approximately right. Again I am looking at monthly figures and just average.

Q 2-G and 3-G combined at 2384.

A All right.

Q And 1-C at 2860.

A Yes, sir.

Q And 2-F and 3-F, we understand 2-F is not producing and has been shut-in for some time, at 7402?

A 2-F is still carried on the proration schedule and they are reporting production from that 80-acre unit. The production would be somewhere around 7,000.

Q I show 7400.

A That's fine.

Q And Well 2-M at 5637?

A Yes, sir.

Q That is a total of nine wells, --

A That's right.

Q -- if 2-F is in, and eight if it isn't?

A Yes.

Q I understood your projection of the well life of Well 4-J to be on the basis of the field average, is that correct?

A Yes, sir. I stated approximately that it would be close

to field average.

Q And yet this data shows that this is not an average well at all but the worst well in the field?

A That's right, it does. However, that well was only produced for six months during that year. That's the only time and period it has been shut-in. According to production data, that well was shut-in in the fifth month of 1962 and was not returned to production until the eighth month of 1963.

PROFESSOR BASS: January of '63.

A That's not what I have. These data are from the New Mexico Oil and Gas Engineering Committee reports.

Q (By Mr. Blackman) Did I understand you to say that you didn't have any information available on the early history of these wells prior to 1957?

A I don't have any information available that affects my opinion - - I have scattered bits, but it's not --

Q Are you aware of the publication by the Roswell Geological Society called their Roswell Geological Society Symposium, August, 1956?

A No, sir.

Q It shows the data on all the wells in that part of the country.

A No, sir.

Q You didn't check that out?

A No, sir, I did not.

MR. BLACKMAN: That's all.

MR. PORTER: Does anyone else have a question of Mr. Rodgers?

MR. MALONE: That concludes the testimony to be offered by the Applicant.

MR. PORTER: The witness may be excused.

(Witness excused.)

MR. MALONE: I would like to complete the record on the number of acres, which Mr. Cummings was going to check. This has to do with the pink and blue areas on Exhibit H, I believe. Mr. Cummings, was that H?

MR. CUMMINGS: I think it's G.

MR. MALONE: It's the large pink and blue which shows the present workings and the reservoir area of Potash Company of America, and we have agreed that the acreage shown in the two colors aggregates between twelve and thirteen thousand acres.

At this time, the Applicant having shown that the application conforms to the requirements of the order of the Commission with reference to potash-oil area wells, renews its motion that the permit be granted on the basis of the seniority of the oil and gas lease under which its rights are plain.

MR. BLACKMAN: I would like to have one witness surrebuttal, very short. I want to call this witness, for the purpose of explaining, he's the geologist of the U. S. Borax Corporation, United States Borax and Chemical Corporation, he has specific

orders from the Geological Survey as to what they are to do.

MR. PORTER: Have your witness come forward.

MR. BLACKMAN: Call Lowell Page, please.

(Witness sworn.)

LOWELL PAGE

called as a witness, having been first duly sworn on oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. BLACKMAN:

Q Will you please state your name and address?

A Lowell Page, 1501 West Ural, Carlsbad. I am Senior Geologist for U. S. Borax and Chemical Corporation in Carlsbad.

Q Have you previously testified before this Commission, Mr. Page?

A I have.

MR. BLACKMAN: Are his qualifications acceptable?

MR. PORTER: Yes, they are.

Q (By Mr. Blackman) Mr. Page, will you kindly explain to the Commission the orders you have received or your company has received from the United States Geological Survey concerning the pillar, solid pillar which must be left around your shaft?

A A matter of a few months ago, we made a specific request to the U.S.G.S. for permission to mine ore in our shaft pillar. The shaft pillar actually is a pillar around two shafts. It's an oval-shaped pillar with a radius of 1250 feet. The shaft

depths are approximately 1,000 feet. We have a solid pillar of ore 500 feet radius from each shaft, and the balance of the 250 feet has been first mined to a percentage of 50 percent. We requested this permission to mine additional tonnages in the shaft pillar. The request went to Washington, it was returned to us, a letter from the U.S.G.S. denying us permission to mine any additional ore in the shaft pillar either as first mining or final mining.

Normally in our mining our first mining is 60 percent extraction, our shaft pillar first mining is only 50; but we've been denied at this time the right to mine any additional tonnage within the 1250-foot radius of each shaft.

Q Mr. Page, percentage-wise, how much ore is U. S. Borax now mining from second mining and how much from first mining?

A It varies, of course, --

Q Approximately?

A -- a little bit, but generally speaking, our daily production or hoisted tonnage of ore in Carlsbad is from 50 to 70 percent from second mining or from pillars. The balance is first mining.

Q Mr. Page, if second mining was foreclosed to U. S. Borax, would you give us an estimate of the remaining economic life of that mining operation?

A Well, it would be zero, for the simple reason that the first mining is out of one area, the only area of any major virgin ore left, and we couldn't mine enough tonnage out of this virgin

ore area to keep our plant running. It would be below the break-even point on tonnage that we need.

MR. BLACKMAN: That's all.

MR. MALONE: No questions.

MR. PORTER: Anyone else have a question of Mr. Page?

CROSS EXAMINATION

BY GOVERNOR CAMPBELL:

Q Why did you request the U.S.G.S. to permit you to mine this ore from around your shaft?

A Due to the sequence of mining, we are mining close to the shaft pillar, retreating toward the pillar, and we were requesting permission to retreat some second mining into the pillar and first mining part of the pillar for reasons that have been shown during this hearing, that the economics of moving equipment around and everything else, we had the equipment there and operating close to them.

Q How much would you have mined?

A We would like to have mined within 1,000 feet radius, which is the depth this is, the belabored 45-degree angle, but we would first mine a -- well, I can't give you an exact percentage or tonnage, we would try to first mine a considerable part of the solid block.

GOVERNOR CAMPBELL: That's all.

MR. PORTER: The witness may be excused.

(Witness excused.)

MR. PORTER: Does anyone have anything further to offer in this case? Any statements?

MR. FULTON: I would like to make a statement

MR. PORTER: Mr. Fulton.

MR. FULTON: Mr. Fulton, U.S.G.S. in Carlsbad. Apparently there is a serious misunderstanding in connection with the conversation I had with Mr. Raymond on shaft pillars in general.

GOVERNOR CAMPBELL: Are you going to make a statement in contradiction to a witness here?

MR. FULTON: No, I'm saying that there is a misunderstanding.

GOVERNOR CAMPBELL: Are you prepared to testify?

MR. FULTON: I'm not prepared to be a witness, no, sir.

GOVERNOR CAMPBELL: Mr. Blackman and Mr. Malone, I don't know how many statements there are going to be here, but this is a case where apparently both parties are trying to protect the record, and the Commission is anxious to get in what needs to be in to make a decision; but we, I think, are constrained from permitting unsworn statements which could not be put, or will not be put into evidence.

MR. FULTON: Apparently the impression has been created that the U.S.G.S. has changed its position and its standard. This is not so.

GOVERNOR CAMPBELL: What's your position?

MR. MALONE: We will object to the presentation of any

evidence by way of unsworn statement. We would request an opportunity to cross examine under oath anyone who wants to give testimony that's to be considered in the case or relates to an issue in it.

The statement which could be made at the close of the case is merely a statement of position on the issues of the case, not the statement that he disagrees or there was a misunderstanding of a witness. We don't have any desire to have a misunderstanding with the gentleman. I don't think we have. I think he has misconstrued the testimony.

Unless he's willing to take the witness stand, I don't believe it would be appropriate to be admitted, and we would object.

GOVERNOR CAMPBELL: There is quite a difference between a general statement of position by the U.S.G.S. on the case, which is sometimes given, and a statement by a representative of the U.S.G.S. as to testimony that has been given here in the case. It would seem that way to me, and our attorney seems to concur in that. Can you make a statement as to the general position of the U.S.G.S. in this case?

MR. FULTON: Yes. U.S.G.S. has not maintained the position --

GOVERNOR CAMPBELL: No, I'm talking about this case.

MR. FULTON: In what respect?

GOVERNOR CAMPBELL: As to the granting or not granting

of the application in this case, do you have a statement to make for the U.S.G.S. in that regard?

MR. FULTON: Yes, sir. Speaking for myself, the mining branch, no, I think permission to drill this well should not be granted. I base this on true conservation.

GOVERNOR CAMPBELL: On what?

MR. FULTON. Conservation.

GOVERNOR CAMPBELL: You are speaking for U.S.G.S.?

MR. FULTON: Yes. If there be true mineral deposits there, I think true conservation requires a maximum extraction of each be maintained; due to the circumstances it looks that this can't be done at the same time, but it can be done at a different time, perhaps. I would urge the conservation viewpoint be given a great deal of consideration.

MR. PORTER: Mr. Anderson, did you have something to say?

MR. ANDERSON: John Anderson, Regional Oil and Gas Supervisor, Geological Survey. We, of course, are not directly involved in the proposal to drill this well because it's on State land; in fact, the old Nestor State land; this area, Sections 16, 17, 18, 19, and most of the West Half of Section 20 are State of New Mexico lands.

However, there is a strong possibility if this well were drilled and became a producer that the Geological Survey, because of Federal lands in the area, would become involved.

These Federal lands are in Sections 7, 8, 9, East Half of Section 20, and all of Section 21. Now the chief involvement of the Geological Survey in drilling of wells in the so-called potash area comes about what sequence of event -- I will keep this as brief as I can. Back in 1939, about 42,000 acres of lands in the potash area were withdrawn by order of the Secretary of the Interior because they were known or believed to contain potash, and the Secretary at that time felt that these lands should be withdrawn from oil and gas operations because of possible interference with potash mining operations.

Then along in 1951, the Secretary apparently changed his mind and most of this 42,000 acres was restored, and I guess it was early in 1952 that we had a big raffle or drawing in Santa Fe for most of this 42,000 acres.

However, the rule for leases on this 42,000 acres contained a stipulation which says in effect, this: That no wells will be drilled for oil and gas in this potash area on these leases at locations which in the opinion of the Regional Supervisor or of the Geological Survey would cause undue waste of potash deposits or interfere with mining operations or create a hazard to mining operations. Every lessee has agreed to that and it is the duty of the Geological Survey to enforce these stipulations.

Now on the lands that probably will be involved in this case, I am taking it on the basis of the structure that has been

indicated by Pan American, portions of 7, 8, and 9 possibly would become involved. Now the leases in Sections 7 and 8 and 9 all contain this potash stipulation; and, in fact, only last month the Geological Survey made a finding on a proposal by Phillips Petroleum Company to drill a Yates well in the South Half of Section 8. That proposal was rejected because in our opinion a well drilled there would cause waste of potash or interfere with mining operations or create a hazard to mining operations.

Of course, at the same time we gave Phillips Petroleum relief from the drilling and producing obligations of the lease. Their lease will be continued indefinitely until such time as the Supervisor is of the opinion that a well can be drilled which would not cause waste of potash or not cause interference with mining operations.

We made that finding for the South Half of 10. We have made similar findings in possibly, oh, 12 or 13 other cases involving lands in the potash area.

Now the South Half of Section 8, in which we have already made that finding, is in a very similar situation as a well drilled in the South Half of Section 17, also. If this well is drilled in the South Half of Section 17 as proposed by Pan American, definitely, and it becomes a producer, a commercial producer, other wells are going to have to be drilled on the various lands in various ownerships around that to prevent drainage; and there again we would be faced with making a determination, can

these offset wells be drilled? They're going to be necessary to protect from drainage, and at the same time we are on record and believe that these wells can't be drilled without violation of the stipulations.

So for this reason, the oil and gas operations branch of the Survey is of the opinion that the drilling of this well should be denied at this time.

GOVERNOR CAMPBELL: Mr. Anderson, I understood you to say 7, 8, and 9, and the East Half of 20?

MR. ANDERSON: The East Half of 20 and all of 21, Federal lands, Governor.

GOVERNOR CAMPBELL: Then what you have said would apply to present existing oil and gas lands in 20 and 21, also?

MR. ANDERSON: No, the leases have been continued by production, and the stipulations were only placed in those leases that were issued in 1952 and to any renewals or extensions of existing leases.

MR. PORTER: Anyone else have a statement that they would like to make in the case?

MR. MALONE: If it please the Commission, the Commission has heard the testimony in this case, and I don't think that anything would be served, or that I could be of any assistance to the Commission in summarizing it. I therefore want to limit my remarks to a very brief reference to the seniority of the oil and gas lease which is being considered.

I recognize that this is a legal question which can be adjudicated at the Courthouse, but it equally is a consideration for this Commission, and on the basis of which this Commission's actions would be reviewed at the Courthouse if the permit is denied. It is suggested by the Potash Company that because they had prior leases on this property and surrendered those leases in order to take a new lease which encompassed a larger area, that there is a continuity of priority which would extend back prior to the issuance of the oil and gas lease.

The fallacy in that position is clearly demonstrated by the fact that the three leases which they surrendered for consolidation had a two-year term yet to run. The Statute prohibits a lease in excess of ten years, and the new lease issued under which they are now operating was for a ten-year period, thus clearly establishing that it was a new lease and not a consolidation of an existing lease for the balance of the lease terms; or, in the alternative, it was an invalid lease as having created a leasehold estate that extended over a ten-year period.

The statements which appear on the relinquishment of the leases that were filed are ex parte statements by the lessee and relinquish, or which under no circumstances could bind the Commissioner of Public Lands or the State of New Mexico, and we respectfully submit that on the basis of the record here and the vested right of this oil and gas lessee, that the Potash Company accepted its lease knowing that it was junior to the

existing oil and gas lease. They relinquished their prior leases knowing that there was an oil and gas lease on this property, and voluntarily subordinated any rights to develop potash to the prior rights of the oil and gas lessee.

On that basis, as well as on the basis of the testimony which we think clearly shows that this property can be developed without undue interference with mining operations, we request that the application be granted.

MR. PORTER: Mr. Blackman.

MR. BLACKMAN: If the Commission please, we can have a nice hassle arguing the legal question, but I will simply pass it by saying that the lease, the prior lease, the application for lease and releases speak for themselves, and do contain the clause that "the workings of said lands under such lease, for such other minerals shall not be permitted where such operations will prevent or materially interfere with the operations of the Lessee hereunder," which is the Potash Company of America's predecessor.

The testimony here shows pretty definitely what occurs as a matter of practice in the potash industry with respect to the loss of potash around particular wells. It shows what the practice is and what everybody believes to be the thing to do, what we couldn't do otherwise, at least in our Federal land, anyway; and I think it is pretty clear from Mr. Woomer's testimony and from the testimony of Mr. Cummings with respect to the area

and the value of potash inside the closed 700-foot radius circles, Mr. Woomer said $20,000,000 worth of potash would be lost if such a development program such as this was imposed; Mr. Cummings said the value of the potash in the circle was about $1,000,000, which he later took $60,000 off of. We are still talking about something in the general area of $20,000,000 of potash losses.

Now we also have brought before the Commission the proposition of an assumed situation; we couldn't do anything else. We are trying to figure out what should happen to an oil and gas reservoir, if one is found. It seems to us patent that if there is a reservoir it should be properly developed. Anything less than a proper development program would certainly constitute waste.

Now we have objected strenuously to the issue of profits as related to this situation at all, and I would like to point out to the Commission with respect to Exhibit 11 which was put in by Pan American on which they show some working interest income there, that they have indicated expenses of all kinds in somewhat the neighborhood of a little over nine percent. Something around seven percent is taxes. So they're taking two percent for some other expenses, probably maybe trucking or pumper or something like that, but that doesn't show the picture at all. That's a completely ridiculous picture.

I went over and looked up the earnings of Standard of Indiana, and their income before taxes, as related to their

gross income, is only nine percent, so there's been a lot of things in here that haven't been taken off; and if they'd take off the proper expenses in here we would be in about the same place.

The important thing, it seems to me, is not that at all. This is not and should not be a controversy between Potash Company of America and Pan American, although that's what it turns out to be, certainly; and we are certainly the contestants but the real question, the real question here is conservation, it's waste, and to some extent safety. We've brought in the question of safety without any criticism whatever against the oil and gas industry. It necessarily sounds somewhat critical, but it isn't. We recognize the ability of these folks to do the very best job possible, and that they do do and try, they do their very best; and the people that they employ are the best and the materials that they employ are the best, but even in spite of that, errors and failures do occur; and which those things do occur when we're dealing with tremendous pressures that we might encounter here, such as we already have in Federal Dooley 1.

There is a question of safety, and we certainly don't want a disaster like they had out in Utah. The way we feel about it is that it has been amply demonstrated that if a drilling program such as would be required to adequately produce a reservoir in this location were imposed upon this area, that we would positively lose potash worth in the neighborhood of $20,000,000, and it would be permanently lost and we would never

be able to get back in there and get it because the oil wells will be there, and we'll be scared to death to approach them.

Alternatively, we have shown that if a partial development program were adopted, that partial program would constitute waste of oil or oil and gas, if it happened to be combined. These figures are very general, but they amount to a lot of money, and I ask you to think about that in this light, that the losses which would be incurred on the basis of partial development would be the seven or eight wells which were included below the red line A-B, seven or eight million dollars there. But the oil and gas losses would be an additional seven or eight million dollars, so we would be talking about a loss to the State of some $15,000,000 and it would be a permanent loss. It certainly would constitute waste.

The Commission has the problem of being the referee in here and of representing really the people and the State and conservation; and there is one method and one method only whereby no losses need be incurred. Pan American has been sitting here on this lease for twenty-six years before deciding to do anything about it. Another 15 or 20 years is not going to make any great deal of difference to them.

On the other hand, if this much potash is lost to Potash Company of America, according to Mr. Clark's testimony, we would be talking about an entire year's operation for some 800 people. This interests me very much. I am personally concerned, I am one

of the 800. We have not only this position, not only the losses that would be incurred right here, but we have a much broader problem, a much broader problem. At Potash Company of America alone we have the possibility of a pool in this location of a deep structure in this location about a mile and a half to the east, we have a P.C.A. pool which is a Yates formation and which may have some production in the Devonian and Pennsylvanian underneath it. There's the Getty Pool about two miles to the west which has large Yates formations and has a producing gas well on it.

I have been advised that there are some arguments about whether there's one to the north, either the northeast or northwest, another possible deep structure. We have Yates production in the area of the northwest area of our mine where the Velma case was litigated, and there's a possibility of a deep structure there, also.

The northwest, in the Hackberry Pool, there might be a deep structure. So far as P.C.A. is concerned, we have the possibility of five or six of these things, five or six of the same problems and eternal hassles about whether a particular well should be drilled or it shouldn't. The only way to meet the issue is to meet it headon, and it certainly must be met headon and must be met in the area of the broad problem because there isn't anything involved in this case except conservation and waste and safety.

MR. PORTER: Anyone else have anything further to say in the case?

MR. BLACKMAN: I wonder if I might suggest, this is quite a complicated case and it might be in order for the parties, and we suggest that we do it, that we submit proposed findings of fact and the form of an order. I would suggest the following procedure for Mr. Malone's approval, that when Mr. Porter receives this copy of the transcript that he write a letter to Mr. Malone and to myself setting a date on which we would submit our proposed findings and proposed form of order and such remarks as we care to put in writing at that time, and that he fix the date which would -- I now leave up in the air for Mr. Malone's comment as to when that date might be, to say not less than two weeks or more than four, just as a suggestion.

MR. MALONE: I think it would be appropriate for the parties to file requests at such time as the Commission has received the transcript and considered the case and is prepared to announce a decision. It seems to me that would be the appropriate time, under the circumstances, and at that time we could present our requests on either side, whichever way the Commission goes, and the record would be complete.

MR. PORTER: When the Commission has made a decision in this case, you will be so advised, and at that time you will be requested to submit your findings and the form of an order.

We will take the case under advisement, and the hearing is adjourned.

* * * *

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the New Mexico Oil Conservation Commission was reported by me, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this 9th day of May, 1964.

Ada Dearnley
ADA DEARNLEY

My Commission Expires:

June 19, 1967.

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