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Report to Cecil D. Andrus, Secretary, Department of the Interior; by J. Dexter Peach, Director, Energy and Minerals Div.

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The Naval Petroleum Reserves Production Act of 1976 calls for studies on: (1) procedures for developing and distributing petroleum resources of the National Petroleum Reserve in Alaska (NPRA), and (2) values and alternative uses of lands in the NPRA. The first study entails making an assessment of the hydrocarbon potential of NPRA, using data from the exploration program. Considering the difficulties of exploration in the arctic and deadlines imposed for the studies, conduct of the exploration program has been commendable. However, direction of the program has not maximized chances for discovering hydrocarbons or for assessing the hydrocarbon potential of the NPRA. Problems include: lack of clear objectives for the program and an explicit plan for carrying it out, uncertainty over the duration of the program, and a mandate to drill too many wells in too short a timeframe without adequate time to collect and analyze data relating to site selection and analysis. The Secretary of the Interior should: develop an explicit overall plan for the Congress setting forth the status of the NPRA exploration program and his best estimate of the amount of additional exploration needed to complete an assessment of hydrocarbon potential, better define goals of the NPRA exploration program, consider offering legislation to extend deadlines for studies, and consider the desirability of allowing industry to conduct exploration and development. (ETW)

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

8563

ENERGY AND MINERALS
DIVISION

B-66927

December 5, 1978

The Honorable Cecil D. Andrus
The Secretary of the Interior

Dear Mr. Secretary:

This report discusses the results of our review of the petroleum exploration program in the National Petroleum Reserve in Alaska (NPRA). The scope of our review as well as details of what we found are included in an enclosure to this letter.

Under the Naval Petroleum Reserves Production Act of 1976 (Public Law 94-258), jurisdiction of NPRA was transferred from the Department of the Navy to the Department of the Interior, effective June 1, 1977, with a mandate to continue the exploration program started by the Navy. The same law also called for separate studies on: (1) the best procedures for the development, production, transportation, and distribution of petroleum resources of NPRA--with recommendations due Congress in January 1980 (Section 105(b) study), and (2) the values (other than hydrocarbon) and other uses for the lands--with recommendations due the Congress in April 1979 (Section 105(c) study).

The Section 105 (b) study also entails making an up-to-date assessment of the hydrocarbon potential of NPRA, using data from the exploration program. Your Department plans to use the results of the two studies to develop recommendations to the President and Congress on what future use to make of NPRA.

We believe the exploration program is not being directed to either maximize chances for discovering hydrocarbons or provide for an overall assessment of the hydrocarbon potential of NPRA. While Public Law 94-258 prescribes no deadline for the exploration program, the exploration effort is being influenced heavily by deadlines imposed by the Sections 105(b) and 105(c) studies and thus may be brought to a conclusion without the kind of information on hydrocarbon potential needed from your Department for the President and the Congress to determine what to do

with NPRA. We believe more time for these assessments is needed. Factors contributing to the problem include the following:

--Lack of clear objectives for the program and an explicit plan for carrying it out, which has allowed the program to proceed in divergent directions--sometimes toward testing major structures for commercially producible hydrocarbons (i.e., an oil discovery objective), and other times toward gaining information over a wide area of NPRA (i.e., an overall assessment objective). (Establishing an overall assessment as the primary objective would provide the best basis for developing your recommendations to the President and the Congress.)

--Uncertainty over the duration of the program which, along with the absence of an explicit and up-to-date plan, has complicated decisionmaking on long-lead procurements and advance construction of pads for future drilling--activities which are vital in exploring an environmentally-sensitive area such as NPRA. (The current uncertainty over whether there will even be a fiscal year 1980 drilling program exemplifies this condition.)

--A mandate to drill too many wells in too short a time frame which has limited the amount of time available to collect and analyze data leading to site selection and restricted the amount of testing and analysis actually carried out at sites once selected.

CONCLUSIONS AND RECOMMENDATIONS

We recognize that the difficulty of conducting an exploration program in the arctic is increased by the extreme delicacy of the tundra during the summer, necessitating that virtually all seismic surveys, site preparation, positioning of materials and supplies, and drilling be accomplished during the winter season. Considering the large scope of the activity and the deadlines imposed, conduct of the exploration program has been commendable. Yet the program has been needlessly rushed. More time and evaluation are appropriate, leading to information which would be of use to the Congress in deliberations on the future use and management of NPRA.

Since exploration data is a major input into the latest assessment being made of hydrocarbon potential under the Section 105(b) study, it would seem appropriate to put off any

recommendation to the President and the Congress with regard to disposition of NPRA until your Department has a reliable basis for estimating its hydrocarbon potential.

We recommend that you develop and lay out an explicit overall plan for the Congress setting forth the status of the NPRA exploration program and your best estimate of the amount of additional exploration--along with time and cost--required to complete an assessment of hydrocarbon potential which will be sufficiently reliable for the Congress to use in deciding how to proceed on the program. You should develop such a plan and submit it to the Congress by January 20, 1979, in order for it to be fully considered prior to submission of the 105(c) report, due April 1979, and for budgetary and legislative considerations.

In coming up with the plan, you should better define the goals of the NPRA exploration program--including establishing the primary objective as an overall assessment of hydrocarbon potential--the time frame available for any further exploration, and the most cost-effective way of carrying it out. You may also want to offer legislation to extend the current deadlines for the required Section 105(b) and 105(c) studies.

Because the Federal cost of exploration is a concern, your plan should consider--as an alternative--the desirability of allowing industry to conduct any additional exploration and development. Under this alternative, the Department's role should be limited to supplementing private drilling activity as necessary to ensure that the overall goals of the exploration program are achieved.

While such a plan is being considered and approved, we believe exploration should continue at a slower, more systematic and purposeful pace.

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We plan to provide copies of this report to several House and Senate committees and to brief them on the matters discussed. Section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report; a like statement to

the House and Senate Committees on Appropriations should accompany the agency's first request for appropriations made more than 60 days after the date of the report.

We appreciate the cooperation and courtesies extended to our staff during this review.

Sincerely yours,

J. Dexter Peach
Director

Enclosure

E N C L O S U R E

EXPLORATION OF THE NATIONAL PETROLEUM RESERVE IN ALASKA

This report provides information on the history of the exploration program in the National Petroleum Reserve in Alaska (NPRA), notes the need for an exploration plan predicated on a clear statement of program objectives, discusses the limited amount of data acquisition and analysis which has preceded well site selections, and cites other problems encountered in exploration.

Our review was conducted between June and October 1978 and included a review of documents and discussions with officials of the U.S. Geological Survey in Anchorage, Alaska; Menlo Park, California; Denver, Colorado; and Reston, Virginia; the Bureau of Land Management in Anchorage and Fairbanks, Alaska; the State of Alaska in Juneau and Fairbanks, Alaska; and contractors in Anchorage, Alaska; Houston, Texas; and Los Angeles, California. We also discussed our observations and conclusions with independent geologists in Ft. Collins, Colorado; Houston, Texas; and Bakersfield, California.

HISTORY OF EXPLORATION IN NPRA

NPRA encompasses an area of about 37,000 square miles --larger than 12 States but only about 6 percent of Alaska-- and is located on Alaska's North Slope west of Prudhoe Bay (see map, p. 2). NPRA was designated a petroleum reserve in 1923 based in part on oil seeping from the ground near the northern coastline. Since then, estimates of hydrocarbons in place have ranged up to 100 billion barrels, and even to "another Kuwait." A more recent assessment prepared by U.S. Geological Survey (Survey) geologists in 1976 was 1.9 billion barrels of recoverable oil.

The Navy's program

Exploration of NPRA was under the jurisdiction of the Navy until June 1, 1977. Between 1944 and 1953, 36 test wells were drilled in and adjacent to the reserve, resulting in the discovery of one oil field, one gas field, three other possible gas fields, and two minor oil deposits. This program was "recessed" in March 1953 without discovery of petroleum

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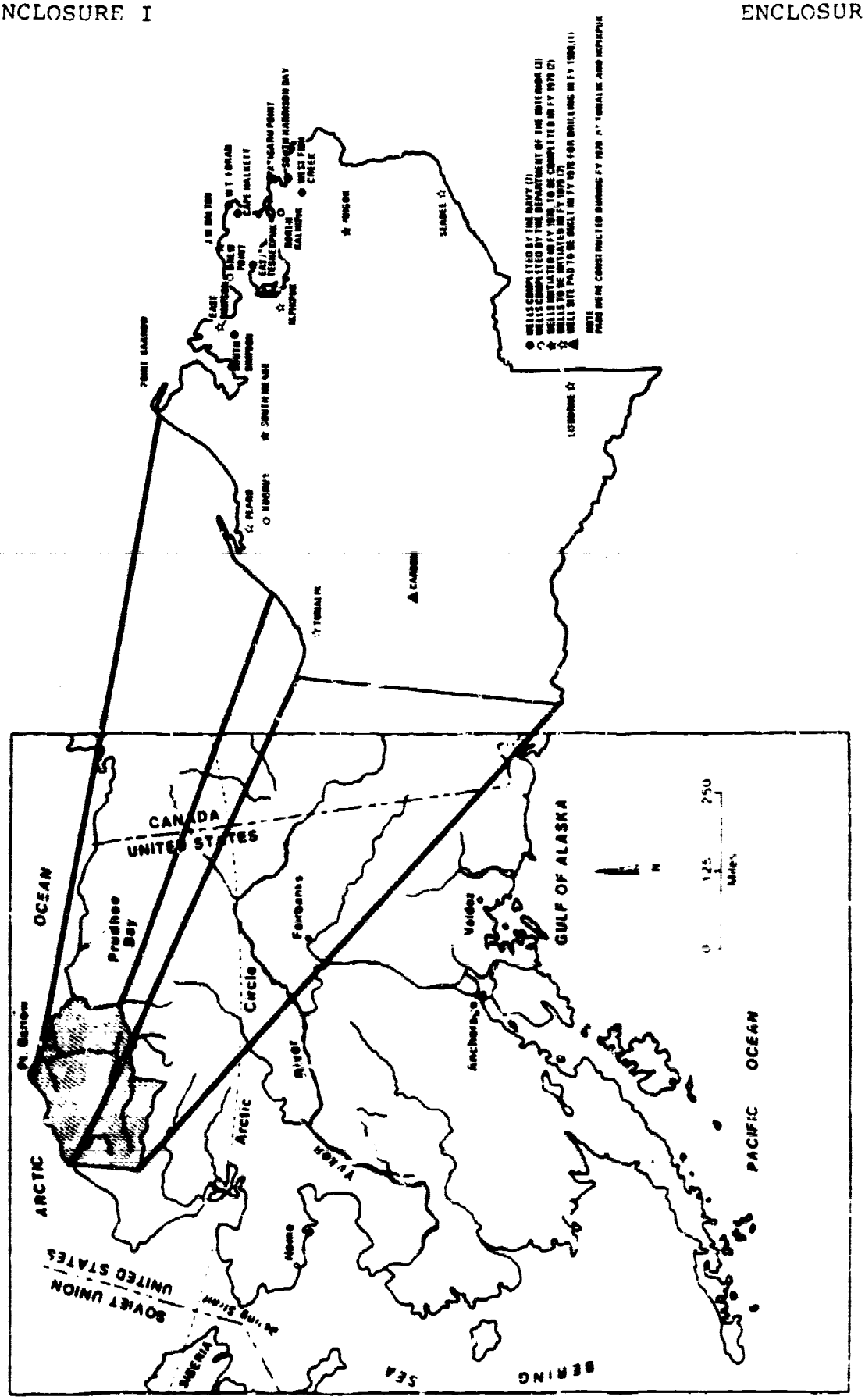

NATIONAL PETROLEUM RESERVE IN ALASKA

reserves deemed large enough to justify the high cost of arctic development and transportation, although gas wells in the Barrow area provide fuel for local use. Between 1953 and 1975, seven shallow gas wells were drilled in the South Barrow field, and one was drilled southeast of Barrow.

In 1974, the Congress directed the Navy to resume exploration of the reserve. Navy plans called for drilling 26 wells and conducting 10,235 line-miles of seismic surveys over a 7-year period, ending with fiscal year 1980.

The Navy planned to have completed by June 1, 1977, 9,035 line-miles of seismic surveys, to have drilled eight wells, to be near completion of a ninth well, and to be in the process of drilling a tenth well.

But the Navy had not achieved these objectives. Instead, only seven wells had been drilled and none were in process (see map, p. 2). More significantly, in the view of Survey officials, only 7,774 line-miles of seismic surveys had been conducted. All wells were dry, although oil shows at one site were interpreted to mean that oil had migrated through this site.

The Interior program

Through Public Law 94-258, the Congress transferred responsibility for management of NPRA from the Navy to the Department of the Interior. Starting June 1, 1977, the Department was to continue exploration and to notify the Congress of any changes to ongoing (Navy) exploration plans. The legislation does not specify a date for completion of the exploration program. The Survey assumed the Navy's contract for exploration which included the 26-well goal and the related fiscal year 1980 deadline. The program is administered by a prime contractor but much of the drilling, geophysics and facility development is being carried out by subcontractors.

This same legislation also set in motion two other NPRA programs in addition to the exploration activities:

--A study (due January 1980) to determine the best procedures to be used in the development, production, transportation, and distribution of petroleum resources in the reserve (Section 105(b) study).

--A second study (due April 1979) to determine the values of, and best uses for, the lands contained in the reserve, taking into consideration (1) natives who live or depend

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upon such lands, (2) the scenic, historical, recreational, fish and wildlife, and wilderness values, (3) mineral potential other than petroleum, and (4) other values of such lands (Section 105(c) study).

A new assessment of potential petroleum reserves, using data from the exploration program, is also being prepared as part of the former study. Based on the results of these studies, the Department plans to provide the President and the Congress with recommendations for the future use of NPRA.

COMPROMISES ON PROGRAM GOALS

Compromises have been made between divergent program goals. The exploration program is being conducted to both (a) test major structures for commercially producible hydrocarbons and also (b) obtain stratigraphic information over a wide area of NPRA. This compromise could result in neither objective being achieved.

A Department of the Interior report states that an optimum drilling strategy for discovering hydrocarbons may not be identical to a strategy directed at estimating resources. Hydrocarbon deposits, it states, usually occur in clusters, rather than randomly over an area. Hence, for a fixed number of wells, the theoretically optimal drilling strategy for maximizing the quantity of discovered hydrocarbons is to sequentially drill each potential cluster until an actual discovery is made and then drill many of the remaining wells within that cluster. On the other hand, the optimal drilling strategy for minimizing the uncertainty of an estimate of total value of all the clusters is to drill at least one well into every potential cluster.

Program actions raise questions as to how these two potentially conflicting goals are being met. For example, of the 10 wells completed to date under the 26-well program, 9 were drilled in a 4,000 square mile area along the northeast coast. Two additional wells are planned for this section in 1979. This leaves only 15 wells to be drilled in roughly the other 90 percent of the reserve (33,000 square miles). This concentration of wells would seem to indicate that the program goal is hydrocarbon discovery, not overall assessment. Survey officials told us that if hydrocarbon discovery were the clear goal, all wells would be drilled in this northeast area.

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Similarly, two wells (Inigok and Ikpikpuk) about 40 miles apart are to be drilled simultaneously toward several of the same rock layer objectives because officials believe hydrocarbon accumulations could exist at either location. This strategy would also seem to indicate a hydrocarbon discovery goal at a cost of geologic information across broad areas of NPRA.

Some strategists suggest that there is little to be gained in an assessment program by drilling more than one structural test to the same objectives within a play 1/ unless there is reason to anticipate different source or reservoir conditions.

In the view of Survey and contractor officials, the fiscal year 1979 drilling schedule includes well sites where seismic data indicates structural trap accumulations which could be large enough to be economically exploited. It also includes sites selected for geologic information. One site (Tunalik), estimated to cost $47 million, is to be drilled to 20,350 feet and, according to program officials, is being drilled primarily for geologic information. Data for another site (South Meade), being continued from 1978, was initially interpreted to indicate a structure, but under another interpretation, would indicate otherwise. And at a third site (Ikpikpuk) the estimate of maximum oil accumulation potential is 182 million barrels, whereas a Federal Energy Administration study estimates that arctic fields of 500 million barrels or more would be necessary for economic recovery. These site selections would indicate an objective of overall assessment.

One consultant to the Survey questioned the practice of continuing to drill small, undefined structures which, even if they exist, could not contain economically recoverable hydrocarbons.

The Navy plan was aimed at locating and testing large structures where oil accummulations, if present, would be economically recoverable. The Director of the Survey described the current program as a minimum sampling strategy with tests

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1/A prospect or group of prospects with similar geological and geophysical attributes that indicate a combination of elements favorable to the accumulation of hydrocarbon deposits.

in each type of structure in each province to develop a viable estimate of resource potential. The Survey's assistant director for environmental conservation, responsible for this program area, testified that the program is a resource appraisal designed to result in an "informed decision" about petroleum potential. He also stated that the biggest structures and best prospects are being selected for drilling. Some Survey officials told us the program is aimed at assessing resource potential while also drilling where accumulations are likely. Contractor officials told us they are simply trying to find hydrocarbons.

Program goals have not been clarified in an overall exploration plan. The Survey has generally followed the plan developed by the Navy in 1973-75. That plan called for wide-grid seismic surveys beginning in the north and progressing south. It also described well site locations by region based on geologic and operational considerations.

Knowledge of the reserve has increased substantially since the Navy plan was developed. The number of identified plays has increased to 40 for the study on potential hydrocarbon reserves, and could exceed 100 under certain definitions. Survey officials were unanimous in their opinions that, based on what they know now, 26 wells do not represent an adequate sampling upon which to base a reliable estimate of hydrocarbon potential. Yet no new plan or strategy has been developed to prescribe exploration and site selection rationale in NPRA.

Completion of the originally planned 26-well program would result in a drilling density of one well about every one million acres. Survey officials described this as a minimal effort. The program chief for the Survey stated that 26 wells will not provide a definitive analysis. The Survey's assistant director for environmental conservation stated that 26 wells is not an adequate sampling for an exhaustive exploration program. And the chief of NPRA operations for the Survey told us that some features of geologic interest will go unexplored due to the compressed schedule.

LENGTH OF PROGRAM UNCERTAIN

The lack of a current exploration plan leaves open the question of how long the program should last. The Navy's schedule originally contemplated completion in fiscal year

1980, and the Survey assumed that schedule. In January 1978, however, the Secretary of the Interior told the Senate Committee on Energy and Natural Resources that unless significant discoveries or favorable indications of major hydrocarbon resources are revealed by the 1978 and 1979 drilling, the Department plans to terminate the drilling at the conclusion of the 1979 program. This decision was based on their current knowledge of NPRA and was to be subject to periodic review as drilling results became available. This Administration position calls for a total of only 19 wells. Follow-up wells are to be drilled after 1979 only if there is a discovery of potentially commercial hydrocarbons. The Committee Chairman, in March 1978, urged that at least the originally planned 26 wells be drilled.

Congress subsequently added $30.5 million to the Department's fiscal year 1979 budget to purchase and position supplies to drill up to seven additional wells in fiscal year 1980. Purchasing and positioning supplies is estimated to cost $15 million while the remaining $15 million is for associated support work, additional seismic work, and contract management costs. The Department's current view (November 1978) is to position supplies and plan for follow-up drilling in the event of a discovery of potentially commercial petroleum deposits and initiate closeout in 1979.

Uncertainty over program duration has complicated program actions. For example, the procurement of certain supplies should be completed as much as 18 months in advance of use because of the arctic climate and the brief period during which the polar ice pack will permit barge traffic. This calls for long-lead planning and reasonable certainty on future years' activities.

In addition, officials explained that gravel pads upon which drilling rigs sit can be constructed a season in advance of drilling to maximize the time available for actual drilling during the subsequent winter seaon. Advance pad construction is inhibited, however, by uncertainty over when the program may end.

PROGRAM COMPRESSION HAS RESULTED IN LIMITED WELL SITE SELECTION ANALYSIS AND SUBSEQUENT EVALUATION

The program to drill 26 wells by fiscal year 1980 has compressed the time available for data analysis leading to site

selection and for evaluation of well results. In addition, it appears that the required completion date of January 1980 for the section 105(b) study of oil and gas development alternatives within NPRA has impacted on the perceived time frames for exploration activities. The Survey and the Department believe that data developed after the completion of the 1979 drilling program will be of little value in formulating recommendations and proposed legislation concerning the future of NPRA.

In some cases, necessary data from seismic shooting was late or incomplete when sites were selected, and the geologic features for which sites were chosen remained undefined. Therefore, some sites became questionable as new data arrived, and others were changed or dropped after decisions had been reached and even after the contractor had begun work. These conditions raise questions about all site selections--questions which remain valid whether the objective of the program is assessment of overall hydrocarbon potential or hydrocarbon discovery.

Compressed program decisionmaking was created by the 1980 deadline, the 26-well goal, and the less-than-planned program accomplishments by the Navy in the 4 years immediately prior to transfer to the Department. Instead of averaging three to four wells each year as planned by the Navy, the Survey is planning to drill six to seven wells each year. Instead of averaging 18 months between the collection and analysis of data and drilling as foreseen in the Navy plan, the Survey has had, in some cases, only days to interpret and study the data and, in other cases, seismic and geologic data has not been available when decisions were reached. Survey officials told us that the 18-month collection and analysis time was desirable and efficient.

Agency and contractor officials generally agreed that the drilling program is about one season ahead of data collection and analysis. Some officials told us that six or seven wells per year are too many for adequate analysis and evaluation.

Seismic survey data late and incomplete when well sites selected

Seismic surveys and analysis provide information on subsurface geologic features for use in selecting drilling sites. This information helps identify geologic formations and structures in which hydrocarbons may have accumulated.

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Survey and contractor officials described an efficient exploration program as one in which wide-grid reconnaissance seismic testing is shot and analyzed in the first year, small-grid seismic in the second year, and drilling in the third. Wells are generally not drilled without seismic data and detailed seismic data is desirable before drilling. Detailed seismic data has not been available in most areas of NPRA. More seismic data, particularly small-grid data, is needed to optimize either an assessment or a hydrocarbon discovery goal.

The Navy's plan for 10,235 line miles of seismic shooting would result in a wide-grid with north-south lines about 6 to 8 miles apart and east-west lines about 12 to 14 miles apart. The intent of this pattern is to detect major structures.

Officials explained that, in general, interpretations of wide-grid seismic data tend to suggest structures which are larger than reality. As closer seismic lines are shot, structures are redefined and reduced in size or, in some cases, eliminated (see Exhibit A, p. 20). Wide-grid seismic lines in the southern portion of NPRA show several large structures. Conversely, most of NPRA from the mid-section northward is shown to be void of major structures.

Seismic data has been available only late in the site selection process in NPRA. Decisions on each winter season's drilling sites are scheduled to be made by June 1 to allow for site evaluation and survey before winter freeze-up. Several weeks are required from seismic shooting to data interpretation and availability. Some seismic interpretations from the winter 1977-78 season were not ready in late September 1978. In a May 8, 1978, memo the Survey's chief of NPRA operations announced modifications in seismic shooting locations to provide "data urgently needed for locating the drilling targets" for fiscal year 1979.

The Survey encountered problems in several 1979 well site selections.

--For the Lisburne well site, only raw, uninterpreted seismic data was available at the June 1 site selections meeting, yet a decision was made to drill in that area during the coming season. By June 15, a "shape" map was available which showed only structures, not rock layers. By early October, both the Survey and the contractor had prepared new, significantly different maps of the area to take into account data overlooked in June as well as further

seismic interpretation. A decision was then made to move the well site about 2-1/2 miles east to be higher on the structure. A contractor geophysicist advised that the original site was so far on the flank of the structure as to likely be dry. No small-grid or detailed seismic had been shot in the vicinity. Consequently, only one wide-grid seismic line had been shot to describe the subsurface geology. One geologist described it as a highly tenuous location. While officials hope that a hydrocarbon trap, or "closure," exists at the site (and therefore the possiblity of a hydrocarbon accumulation), they cannot know until other seismic lines are shot and interpreted. Yet the well is scheduled to be drilled during the coming season without any further seismic surveys.

--For the Tapkaluk well site, no seismic data was available on June 1, and a final decision on the site was deferred. By June 15, seismic interpretations showed the site to be more shallow than had been estimated. Study documents proposing the site stated that the type of trap was "unknown," and that closure was dependent on "faulting, erosional unconformity, and regional dip." These conditions did not materialize, and by September 5, 1978, the chief of exploration strategy was advised that seismic data did not show much of interest, and that preliminary interpretations showed no structure present at the site. In addition, the site was controversial due to potential adverse environmental impacts. On October 13 the site was replaced with another. We were told that reducing the scope of the work for fiscal year 1979--by not selecting another site--was not a viable alternative because of contract commitments, rig availability, and the 26-well goal. (An additional rig had been brought in for the 1979 season.)

--For the Carbon site, at which a drilling pad is to be constructed during fiscal year 1979, a "back-up" site was selected on September 7, 1978, which had been defined in recent seismic interpretations. A study was in process comparing the two sites. Meeting notes indicate the new site, 6 miles west of

the original site, was preferable from a financial and engineering standpoint, but closure was uncertain. While seismic interpretations in September showed closure, those prepared in October did not. Closure at the original site, though certain, could not be precisely mapped. A final decision had not been reached at the time of our review. It was judged advisable to send site survey teams to this and other "back-up" sites before snowfall so as to have the sites available if the need were to arise.

--At the Tunalik well site, also scheduled to start in fiscal year 1979, early seismic data showed a structure with closure. Subsequent seismic work reduced the size of the structure by about half and raised questions as to its existence at all. As of October 6, the site was said to be "poorly defined on a few seismic lines," and had "some possiblity of structure." The site is to be drilled anyway to gain information in that part of the reserve and to test structural closure and rock layers to considerable depth. The Survey was already committed to this location, having constructed a drilling pad, roads, and year-round airstrip during fiscal year 1978 at a cost of about $14 million.

--Additional seismic work is scheduled in the vicinity of another 1979 site (Peard) which, according to a Survey geophysicist, could then indicate the site should be moved. Fiscal year 1979 seismic survey data will provide considerably better definition of the site but by then the well will have been drilled.

Late and incomplete data has also resulted in premature drilling and late site abandonment. For example, one well drilled in fiscal year 1978, South Meade, is to be reentered and completed in fiscal year 1979. Available seismic data leaves closure uncertain at that site. Seismic interpretors optimistically drew a structure with closure at that site on planning maps, but Survey and contractor officials told us that the site could have legitimately been portrayed as a "nose" with no closure and therefore no hydrocarbon accumulation potential. Additional seismic surveys, to be conducted in this area in fiscal year 1979, could determine the existence of a structural trap. The site will thus be validated or invalidated only after drilling has been completed. Exhibit B, page 21, compares these alternate seismic interpretations.

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The Maguriak location, included for pad construction in final decisions and contracts for fiscal year 1978, was dropped during the drilling season because of small closure and a simultaneous test of similar geologic settings nearby. Because not enough information on the site was available, such as total depth, the site was not considered to be a good prospect. The Survey paid $348,000 to the contractor for the cancellation, including costs incurred prior to cancellation. Within 6 months the site was reconsidered as still more evaluation took place and it was again selected, this time for inclusion in the 1979 program. In July 1978 the site was again dropped, this time attributed to "recently processed velocity data" from another well, which showed significantly greater depths and smaller closure than had originally been estimated.

Only one well site (Carbon) has been selected for advance preparation for fiscal year 1980. At that site, a drilling pad is to be constructed during fiscal year 1979 to maximize the length of the subsequent drilling season. The chief of exploration strategy explained that if the program ends in 1980, the remaining 1980 sites will be one-season wells, and thus will be drilled to shallower depths than would be possible with a less compressed time schedule. Much of the unexplored south and west portions of NPRA have deeper rock layer objectives than can be reached in shallower, one season wells. Officials consider the geologic information and gas potential at greater depths to be of great importance.

Other analyses needed to optimize well site selections

Certain other tests, deemed advisable to help assure that the best sites are selected for drilling, have not been conducted, due in part to short-time deadlines and limited technical staff. For example, variations in the thickness of permafrost present serious problems in mapping subsurface structures by seismic reflection. Permafrost, or permanently frozen ground, can vary by several hundred feet in thickness within short distances. Seismic waves are distorted on passing through permafrost. Permafrost distortions alter the size and shape of structures shown in seismic surveys, and could show structures which do not actually exist. Survey and contractor officials, as well as their consultants, have cited the need for detailed analysis of permafrost impacts on seismic data through detailed velocity studies in both the coastal plains and foothills sectors.

One geologist involved in Prudhoe Bay exploration told us that wells there had been aimed at a structural trap presumably formed by a large roll-over towards the coastline. Both features were found to be non-existent permafrost distortions.

One consulting geologist retained by the Survey told us that he could not be certain, with one or two exceptions, that any NPRA wells have actually penetrated a structure or stratigraphic trap to date. Another consultant questioned the precise locations of the wells as drilled, because oil shows indicate large accumulations could exist in the vicinity and, with better pre-drilling analysis, could have been located.

On September 26, 1978, the prime contractor recommended that a study be conducted to help develop methods for dealing with permafrost problems. The study proposal noted continuing concern over permafrost and nagging difficulties of permafrost distortion of subsurface structure. The proposed study was to to be based on reinterpretations of existing seismic data, rather than on a more time-consuming and costly test hole drilling program.

Another analysis which has not been conducted involves determining the location of "pinch-out zones" of several rock layers as they thin to the north. One consultant to the Survey developed alternate locations of these zones and proposed that work be done to better define their actual locations. This work would involve reinterpretation of existing stratigraphic information. He also recommended to the Survey that a fiscal year 1979 well site selection be postponed until such analysis is done. Wells should be located in proximity to, but not beyond, these pinch-out locations as oil could migrate toward the pinch-out.

A contractor official told us that this analysis will require 2 to 3 months of work, can be done through reprocessing existing data, and is included in their future work plans. It thus will come too late to be of use in the site selection process.

Environmental protection compromises and extra program costs due to program compression

The need to drill 26 wells by 1980 has resulted in decisions to trade off certain environmental protection

measures for time savings. In some cases this has also resulted in extra program costs.

The Survey has elected to drill certain wells year-round instead of drilling only during the winter. Winter drilling limits adverse environmental impacts because snow and ice protect the tundra from damage. One well was drilled during the summer of 1978 and four are scheduled for summer drilling in 1979.

One area of NPRA cited in Public Law 94-258 for maximum protection of surface values--the Utukok River area--is also to be drilled year-round due to program compression ,except for a temporary suspension during the caribou calving season--early May through mid-June.

In addition to environmental risks, summer drilling necessitates year-round airstrips which, if not previously in existence, cost about $7-10 million each to construct. Two such airstrips approximate the cost of another medium depth well.

Although site-specific environmental assessments are being prepared as supplements to the May 1977 final environmental impact statement on the exploration program, they have not always been completed before pad construction and the start of drilling because of late site selection and program speed. The following table shows the timing for completion of environmental assessments for well sites established during fiscal year 1979.

Fiscal Year 1978 Environmental Assessments (EAs)

Well Site	Date work started at site: Pad construction	Drilling	Date EA Finalized
Inigok	1-24-78	6-07-78	10-24-78
Tunalik	2-02-78	Not started as of Oct. 25, 1978	Not finalized as of Oct. 25, 1978
Kugrua	12-03-77	2-12-78	11-30-77
South Meade	12-08-77	2-07-78	12-28-77
North Kalikpik	12-07-77	2-27-78	2-23-78
Drew Point	12-01-77	1-13-78	12-09-77
Ikpikpuk	12-07-77	Not started as of Oct. 25, 1978	Not finalized as of Oct. 25, 1978
South Barrow #16	12-27-77	1-28-78	"
South Barrow #17	1-19-78	3-03-78	"
South Barrow #19	1-28-78	4-18-78	"

The Inigok well had been drilled to almost 13,000 feet (of a projected 19,750-foot goal) before the environmental assessment was completed.

In an April 1978 memorandum, the chief of the plans and environmental assessment section for the Survey stated that because of late decisionmaking on well site selections he was concerned about being able to conduct timely, on-site environmental assessments of fiscal year 1979 well sites. As of October 25, 1978, none of the site-specific environmental assessments for the fiscal year 1979 program had been completed.

The Alaska State director of the Bureau of Land Management advised the Survey that exploration strategies should be selected by eliminating operational alternatives until the least environmentally costly plan has beer selected. Late site selection does not allow time for sufficient environmental study. Also, late environmental assessments bring with them the risk of less than adequate consideration of adverse impacts and possible alternate mitigation measures.

Program compression restricts complete well site evaluation

A Survey official explained that core samples provide information on rock porosity and other geologic characteristics, including the hydrocarbon source potential quality of certain rock layers. Such information is of high value in either assessing the hydrocarbon production potential of NPRA or actually discovering hydrocarbons.

Because core drilling is slower than conventional drilling, program compression has limited the amount of core samples being taken as drilling progresses. At one well, drilled to 12,588 feet, the need to expedite work allowed time for the recovery of only three core samples totaling 32 feet, as compared to a plan for between 300 to 600 feet. At another well, core samples totaled 34 feet. The Navy's coring program averaged only 20 feet per well.

The contractor's drilling chief told us that rigid rig movement schedules have been established to drill the mandated number of wells each year, leading to the 26 well total by 1980. The head of the contractor's drilling department told us that coring test time provides the only flexibility in drilling and rig movement schedules and if delays in drilling occur coring must be curtailed.

To improve the limited coring situation for future wells, the chief of exploration strategy plans to develop a depth and structure coring plan for each well. The first of these plans, developed for a deep (20,000 foot) well, calls for coring totaling 550 feet. Officials explained that a contract requirement for 750 to 1,000 feet of coring for a well of this depth was to allow for extra coring if a good reservoir were penetrated.

Program compression resulted in failure to reach the planned depth objective at one well drilled during the fiscal year 1978. Depth to bottom had been underestimated and a decision was reached to stop drilling and move the rig to a new location before spring break-up. One Survey geophysicist advised the chief of exploration strategy that it was critical to try to reenter the well before drilling any other deep wells in the area. He stated that leaving this well unfinished affected decisions to drill other wells. The Survey does not now plan to reenter and complete this well, yet includes it as one of its 26-well program. The decision to leave the site was based on the need to move the rig to another well and on the prospect of learning about the undrilled portion of the site from nearby wells.

Another shortfall at drilling sites is the engineering of wells to limited depths. Three fiscal year 1979 sites are not planned to reach basement rock, below which it is believed that hydrocarbons could not be economically recoverable. Preselected casing sizes will permit drilling only to the depths planned--and thus if it were later decided to drill to greater depths, entirely new wells would need to be undertaken. The chief of exploration strategy told us that one fiscal year 1979 well site, engineered to 15,000 feet, could likely produce considerable gas at 20,000-22,000 feet. But he explained that if further exploration is to be conducted, an entirely new well will need to be drilled to achieve that depth. Stopping at an intermediate depth also limits available geologic information which the chief of exploration strategy considers highly important for adequate overall assessment of NPRA.

LIMITED DOCUMENTATION OF DECISIONS AND WELL SITE PROSPECTS HAMPERS PROGRAM PLANNING AND REVIEW

The Survey has not developed complete and timely documentation on either potential drilling sites or on site selection rationale. As a result, known information is not available for all responsible officials to consider, alternate sites

ENCLOSURE I

cannot be readily compared, and certain information is retained only in the minds of individuals associated with the program.

A December 1977 Survey memorandum cited the lack of a written and documented analysis of drilling and exploration proposals and called for a "catalog" of the pertinent aspects of each prospect as an aid in decisionmaking. This has not been accomplished. In an April 1978 memorandum, the administrative contracting officer suggested that the adequacy of recordkeeping be fully assessed, stating that drilling data from past wells left "a lot to be desired."

As of October 1978, information on the geology of well sites selected for fiscal year 1979 had not been fully documented. For example, we asked the Survey's office of exploration strategy in Menlo Park for information on the fiscal year 1979 well sites--reservoir objectives, thickness, and porosity; knowledge of closure; and other data. We were advised that such information--while essential to the decisionmaking process--had not been compiled and would require an "inordinate amount of time" to provide. Officials agreed that this information would have been highly useful and we believe that it should be available to the Government program manager. We were able to obtain it readily from the subcontractor in Houston.

Several fiscal year 1979 well sites were selected at a June 1, 1978, meeting. Site proposal documentation and prognosis were provided only 6 days in advance of selection for two sites, and were not prepared at all before selection of two other sites. Some information was "laid on the table" at a June 15 meeting, precluding evaluation in advance of decisionmaking.

Maps, drawings, and charts have not always been signed and dated to permit identification of current versions. Some have not been updated to portray current test results. Minutes or summaries of site selection meetings have not always been prepared. For example, one June 1978 meeting at which sites were selected, moved, and dropped has never been recorded. Survey officials concurred that better, more complete documentation of site selection rationale would be desirable.

CONCLUSIONS AND RECOMMENDATIONS

We recognize that the difficulty of conducting an exploration program in the arctic is increased by the extreme delicacy of the tundra during the summer, necessitating that virtually all seismic surveys, site preparation, positioning of materials

and supplies, and drilling be accomplished during the winter season. Considering the large scope of the activity and the deadlines imposed, conduct of the exploration program has been commendable. Yet the program has been needlessly rushed. More time and evaluation are appropriate which we believe could lead to better information for use by the Congress in deliberations on the future use and management of NPRA.

Since exploration data is a major input into the latest assessment being made of hydrocarbon potential under the Section 105(b) study, it would seem appropriate to put off any recommendation to the President and the Congress with regard to disposition of NPRA until the Department of the Interior has a reliable basis for estimating its hydrocarbon potential.

We recommend that the Secretary of the Interior develop and lay out an explicit overall plan for the Congress setting forth the status of the NPRA exploration program and the best estimate of the amount of additional exploration--along with time and cost--required to complete an assessment of hydrocarbon potential which will be sufficiently reliable for the Congress to use in deciding how to proceed on the program. The Secretary should develop such a plan and submit it to the Congress by January 20, 1979, in order for it to be fully considered prior to submission of the 105(c) report, due April 1979, and for budgetary and legislative considerations.

In coming up with the plan, the Secretary of the Interior should better define the goals of the NPRA exploration program --including establishing the primary objective as an overall assessment of hydrocarbon potential--the time frame available for any further exploration, and the most cost-effective way of carrying it out. The Secretary may also want to offer legislation to extend the current deadlines for the required Section 105(b) and 105(c) studies.

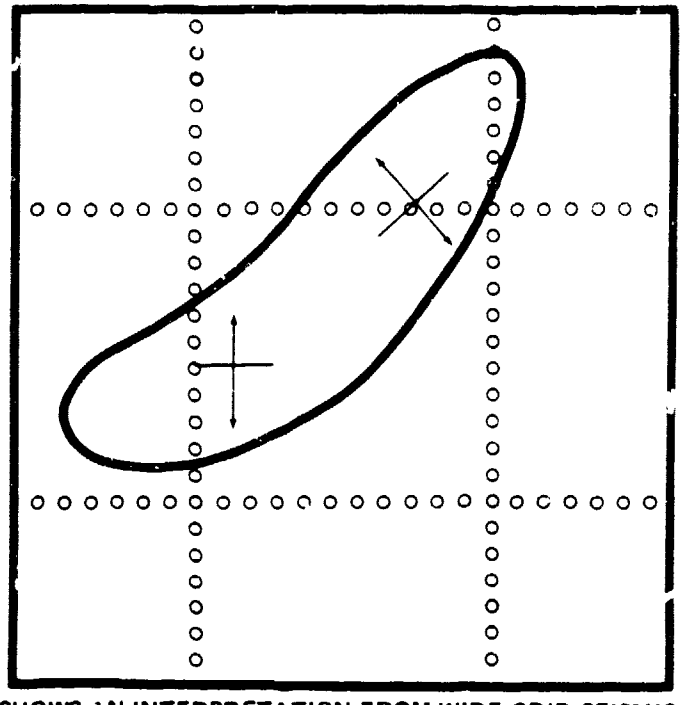
Because the Federal cost of exploration is a concern, the Secretary's plan should consider--as an alternative--the desirability of allowing industry to conduct any additional exploration and development. Under this alternative, the Department's role should be limited to supplementing private drilling activity as necessary to ensure that the overall goals of the exploration program are achieved.

While such a plan is being considered and approved, we believe exploration should continue at a slower, more systematic and purposeful pace.

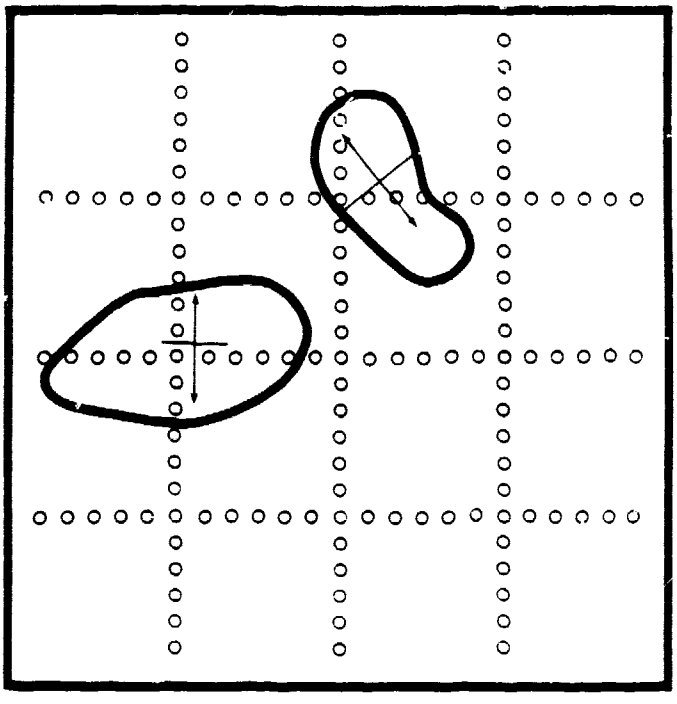
E X H I B I T S

EXHIBIT A

INTERPRETED SIZE OF STRUCTURES FROM WIDE-GRID, AS COMPARED TO MORE DETAILED, SEISMIC DATA



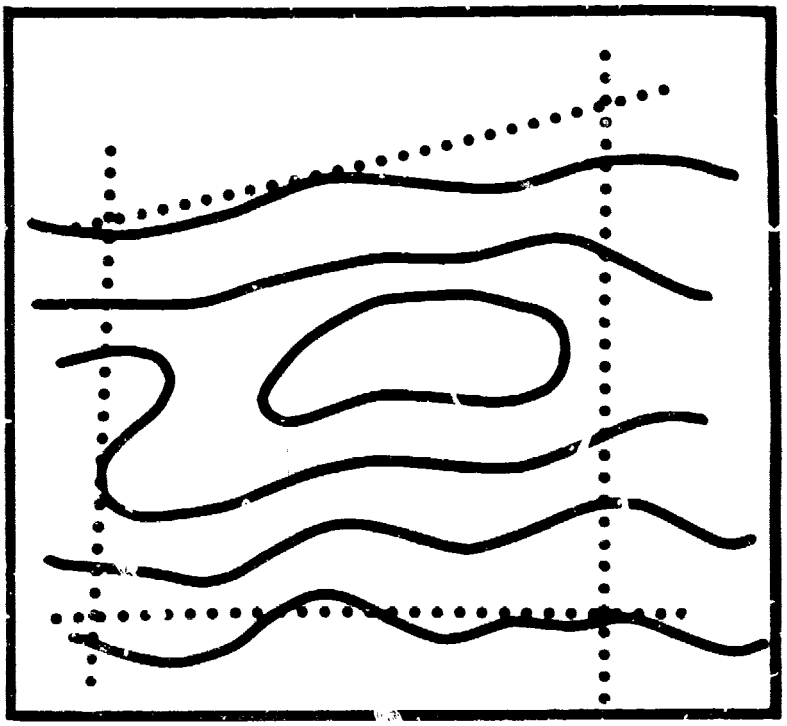
THIS ILLUSTRATION SHOWS AN INTERPRETATION FROM WIDE-GRID SEISMIC DATA OF A LARGE STRUCTURE TRAP WHERE HYDROCARBONS COULD BE TRAPPED. AN OFFICIAL TOLD US THAT THIS REPRESENTS A REASONABLE EVALUATION OF WIDE-GRID DATA. (SEISMIC LINES ARE SHOWN AS DOTTED LINES; ARROWS POINT TO LOWER DEPTHS.)



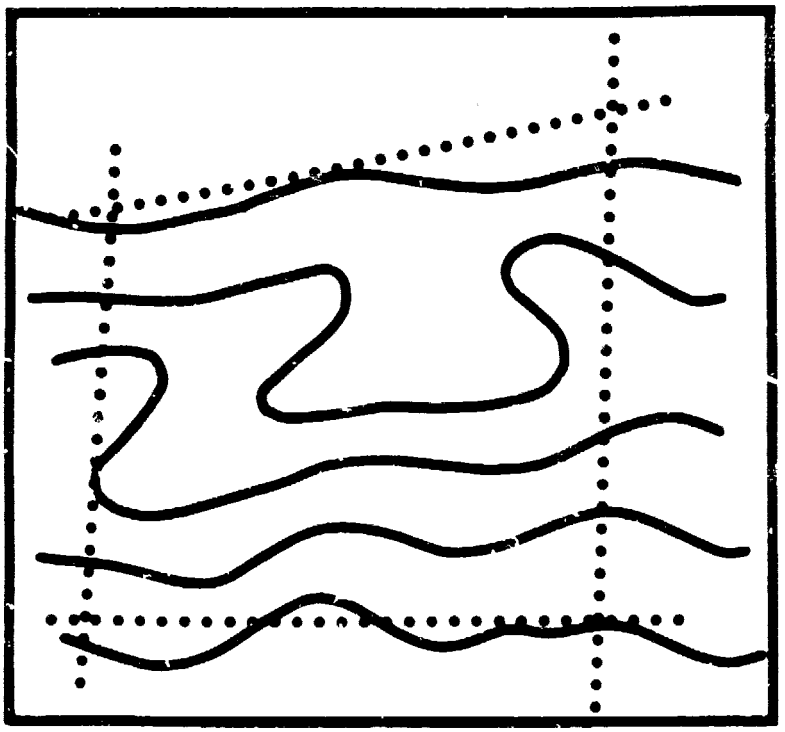
THIS DRAWING REPRESENTS THE SAME AREA PORTRAYED IN THE FIRST ILLUSTRATION, BUT SHOWS TWO SMALLER STRUCTURES RATHER THAN ONE LARGE ONE. THIS INTERPRETATION REFLECTS ADDITIONAL, MORE DETAILED, SEISMIC SURVEYS.

EXHIBIT B

SOUTH MEADE WELL SITES (BASAL CRETACEOUS)



THE DRAWING ABOVE SHOWS THE PRE-DRILLING SEISMIC INTERPRETATION AT SOUTH MEADE--STRUCTURAL TRAP WITH CLOSURE. DOTTED LINES SHOW WIDE-GRID SEISMIC LINES.



ALTERNATE SEISMIC INTERPRETATION SHOWING A "NOSE" RATHER THAN A STRUCTURE WITH CLOSURE. UNDER THIS INTERPRETATION THERE WOULD BE NO POTENTIAL FOR OIL ACCUMULATION.