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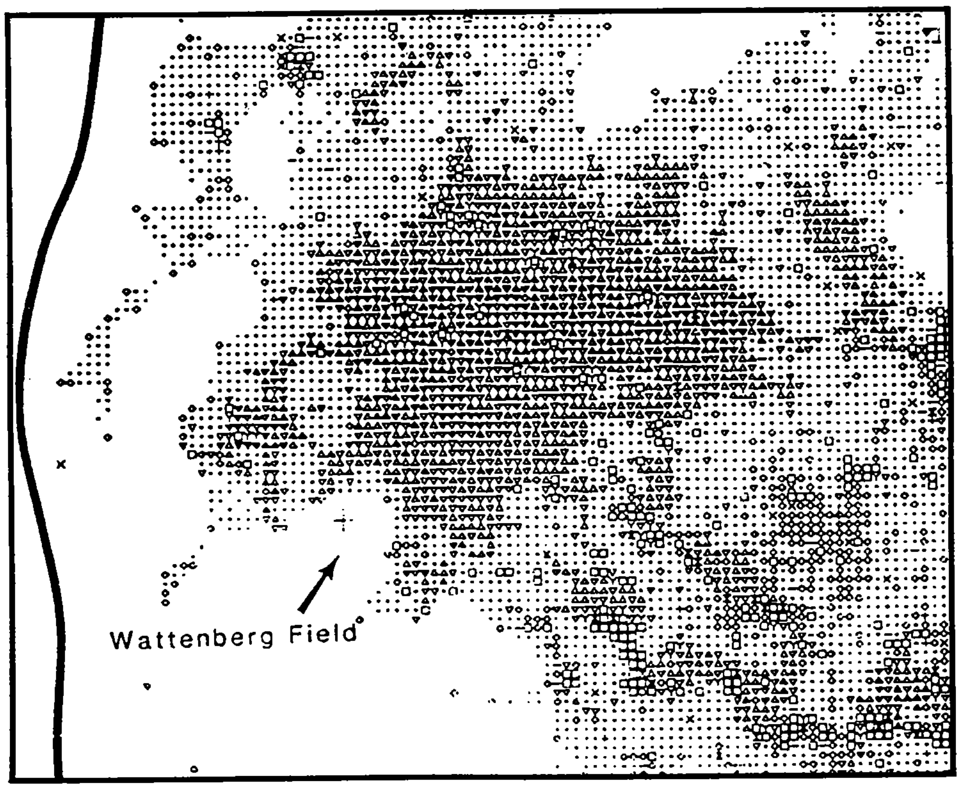
Special Publication 88-3

Proceedings of the First Conference on Oil and Gas Information and Data-Base Management

Coordinated by
Michelle J. Summers



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PROCEEDINGS OF THE FIRST CONFERENCE ON OIL AND GAS INFORMATION AND DATA-BASE MANAGEMENT

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Michelle J. Summers

Oklahoma Geological Survey
Charles J. Mankin, Director
The University of Oklahoma
Norman, Oklahoma

1988

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PREFACE

The first conference on oil and gas information and data-base management was sponsored jointly by the Bartlesville Project Office of the U.S. Department of Energy and the Oklahoma Geological Survey. This conference, held in Norman, Oklahoma, October 20-21, 1987, brought together representatives from 14 states, the U.S. Department of Energy, and the U.S. Geological Survey.

The theme of the conference was to develop a better understanding and appreciation of the magnitude and diversity of information available on oil-and-gas activities from state and federal agencies. The rationale for this theme is based on the recognition that future domestic hydrocarbon production, at least on-shore in the lower 48 states, must come increasingly from additional recovery from prior discoveries. Thus, a broad range of geological, reservoir-engineering, and production-history information on currently producing as well as abandoned fields is expected to become more important in such future developments.

Presentations by representatives of each of the states, the U.S. Department of Energy, and the U.S. Geological Survey provided a good view of the diversity and complexity of hydrocarbon information available in the public sector. Not only does the type of information collected vary substantially from state to state, but the systems employed to collect, store, and use that information cover an equally broad spectrum as well.

This conference therefore achieved its objective--namely, to examine the diversity of philosophies, methodologies, and procedures used in the collection, management, and utilization of hydrocarbon information by public-sector agencies. The conference provided also a better understanding among the participants of the reasons for this diversity. Hopefully, the papers contained in these proceedings will convey to the reader some of this same understanding and appreciation. If so, perhaps this conference will have served as an important first step in the eventual establishment of a nationally compatible system of hydrocarbon information.

The Bartlesville Project Office of the U.S. Department of Energy and the Oklahoma Geological Survey are pleased to have had the opportunity to sponsor jointly this first conference. Furthermore, we are pleased to dedicate these proceedings to Mr. Robert Folstein, former director of the Bartlesville Project Office and currently senior science advisor to the deputy assistant secretary for oil, gas, shale and special technologies, U. S. Department of Energy, Germantown, Maryland, who recognized the need for such a conference and provided the encouragement necessary to cause it to happen.

Charles J. Mankin, Director
Oklahoma Geological Survey

TORIS
AN ASSESSMENT AND PLANNING TOOL

BY: R. Michael Ray, Acting Deputy Director
Bartlesville Project Office
U. S. Department of Energy

INTRODUCTION

The Department of Energy (DOE), Bartlesville Project Office (BPO), uses an analytical system to assist in its planning and implementation of the Enhanced Oil Recovery (EOR) Program. This system is called the Tertiary Oil Recovery Information System, abbreviated TORIS, and it contains the data bases, modeling capabilities, project management, and supporting software to enable a wide variety of analytical assessments and program planning scenarios to be made.

The intent and purpose of the Oklahoma Geological Survey/Bartlesville Project Office meeting is to discuss collection, management, and utilization of state-level oil and gas information. This important aspect of resource management allows the state agencies and the federal government to determine the impacts of various economic and technical changes on the economies of the states and the nation. Thus, this presentation will discuss the needs of BPO to collect data and will focus on the utility made of that data.

DESIGN CONSIDERATIONS

The first steps in designing an analytical system are to review the current status of the resource and to review the goals and objectives in creating such a system. Knowing the current status of the resource bounds the analytical techniques that can be used, and defining the specific goals and objectives to be accomplished sets the type of analyses that are required. In a multifaceted program such as the EOR program at BPO, the main consideration is to be able to select, from the varied assortment of proposed research projects, a group of projects which will provide sufficient information from which EOR may be implemented in a significant portion of the oil resource. In effect, BPO is trying to implement an EOR program that will deliver the largest impact on the remaining oil resource per dollar spent in research. As shown in figure 1, about 493 billion barrels of oil have been discovered in the United States, and, of this, about 163 billion barrels will ultimately be produced by conventional primary and secondary methods. Of the remaining 330 billion barrels of oil, currently proven EOR technology reserves are estimated at about 4 billion barrels, which leaves a total target for expanding existing or implementing new EOR technologies of about 326 billion barrels. In the 1984 NPC study, the NPC estimated about 15 billion barrels of incremental oil could be produced through successful application of implemented EOR technologies to known reservoirs at an oil price of $50.

Currently the U.S. is importing about 40 percent of our oil demand, and this demand is expected to increase with time. Unfortunately, our production rate of oil is declining. EOR, as shown in recent studies (see figure 2), could offset this decline in production, but, at this time, EOR is not sufficiently well developed to provide the necessary volumes of oil required. At present, EOR has only been fully implemented in a few highly favorable geologic settings such as in California (thermal recovery) and in Texas (gas injection). Another facet of EOR oil production is that it has been shown to remain limited despite sharp price increases (see figure 3). There are many reasons for these facts and conditions -- some are technical and others are economical. In review of the technology, EOR simply does not perform as expected in all cases, or, in other words, EOR is not predictable in all reservoir conditions (figure 4). Lack of accurate predictability implies risk in implementing EOR technologies and, since EOR requires significant front-end and operating costs to implement, EOR has had limited growth.

DOE has a stated research goal to provide adequate resources at reasonable cost with the mission of performing high-risk, long-term, research which will complement oil industry sponsored research. The BPO, in implementing the EOR research program, has developed a program that supports DOE's goals through research to improve the understanding of the 300+ billion barrel, known, remaining oil resource and the technologies for producing it. As shown in figure 5, the program consists of two research areas that focus on resource and process research problems. Process research focuses on specific problems involving the EOR production technologies and includes such basic research studies as rock/fluid interactions in chemical flooding and mobility control in gas flooding. Resource research focuses on characterizing the resource and the conditions under which it exists and includes three-phase relative permeability, residual oil saturation, data base implementation, and process modeling research. The measure of our success is demonstrated through improved predictability and more effective recovery in EOR applications.

Program planning requires adequate information from which to make sound, logical decisions. In the case of EOR, adequate information includes knowledge of the conditions of the total oil resource as it exists, the current status of the recovery technology, and the projected impacts of improving either the recovery technology or resource understanding. Add to this knowledge of available budget and manpower and any changes in policy or administrative guidance and the planner has sufficient information to plan an effective research program. To provide an estimate of the information required for planning, TORIS includes a modeling capability to predict EOR recovery under various economic and technological scenarios, a data base of current and historical EOR projects, a data base of the U.S. reservoir resource, a data base of oil properties measured from oils collected nationwide, and program planning and support software to provide an interface between the data and the planner.

HISTORICAL DEVELOPMENT

The TORIS concept began in 1978 with a contract to Intercomp Resource Development and Engineering, Incorporated, of Houston, Texas. Under this contract, Intercomp was to design and implement a data file of reservoirs amenable to surfactant flooding and to develop a rapid, accurate model to estimate the economical recovery of oil due to surfactant flooding. Realizing the potential applicability of such a model, BPO (then the Bartlesville Energy Technology Center, BETC) issued Intercomp two additional contracts to develop a steam drive and a miscible carbon dioxide flood model. Also in 1978, another company was developing data bases of reservoir and EOR project data.

In 1982, the National Petroleum Council (NPC) reviewed the existing analytical system for possible use in their study on EOR potential for the Secretary of Energy. The NPC, expending about 70 man-years of effort in their study, evaluated, augmented, and enhanced the existing system and developed additional models for the polymer, in-situ combustion, and alkaline processes. For the reservoir resource data base, the NPC added over 1,200 additional reservoirs and validated the data for those reservoirs which contained a minimum of 20 million barrels oil at discovery. At the completion of their study in 1984, the NPC had developed a computerized system to analyze the resource of the Nation and estimate the potential EOR recovery under various oil prices and technology levels.

Since 1985, BPO has supported the Interstate Oil Compact Commission (IOCC) in studies designed to estimate the impacts of state supported incentives for EOR applications. To date, these studies have been performed for New Mexico and Oklahoma, and a new study has just begun for Texas. In these studies, the reservoir data base has been improved through state-supplied data, and the models have been modified to include state and federal income calculations as well as to include provisions to calculate the implications of several forms of tax related incentives.

TORIS ANALYTICAL SYSTEM DESCRIPTION

The TORIS analytical system includes data bases, models, and support software to provide data to plan an effective, efficient, research program. The data bases are an integral and important part of the analytical base for TORIS as they provide technical and statistical information on the current status of EOR technology and also provide the modeling data necessary for estimating the effects of changes in various technical and economic conditions. The models, using reservoir data supplied through the reservoir data base, are used to estimate the technical and economic oil potential, the annual oil production rates under stipulated capital and supply constraints, and the economics involved in the oil production. With the assumption the data bases are current and accurate, the interplay between these various components, as shown in figure 6, ensures the data used in all analyses does represent the current understanding of the process technologies and resource base. Due to their importance to the TORIS analytical system, the data bases and predictive models will be further described in the following sections.

EOR Project Data Base

The EOR Project Data Base contains data on 1258 EOR projects that have been or are active in the United States. As shown in figure 7, the data base contains data collected from contractual sources which include the 1979 Energy Regulatory Administration's Tertiary Incentive Program (430 projects planned or started) and a Gulf Universities Research Consortium data collection (completed in about 1978), from data collected through the DOE Cost-Share Program (27 projects), from research and development reports in the literature, and, recently, from state agencies. This data base is used to assess the state-of-the-art in EOR technologies, to supply data for statistical analyses, and to provide data, where the data are sufficient, for EOR process-predictive model calibrations. A brief examination of the distribution of these EOR projects, as shown in figure 8, shows that thermal recovery is the dominant process in the West, gas injection is the dominant process in the South, and chemical recovery is the dominant process in the mid-continent regions.

Reservoir Data Base

The reservoir data base contains data on about 3700 reservoirs which represents over 74 percent of the oil discovered in this Nation. The data were originally collected through contractor-supplied data and public data bases such as the Petroleum Data System at Oklahoma University. The NPC reviewed and, where necessary, corrected the existing data. They also added data on about 1200 new reservoirs. Basically, this data base contains data on the rock and fluid volumetrics measured both at discovery and at current conditions, fluid properties of both injected and reservoir fluids, geologic variables, and the development and performance data necessary for predictive modeling using the TORIS system. Figure 9 gives a partial list of the individual data elements under each of these general classifications. At the conclusion of the NPC study, the data base contained data by state ranging from a low of 13 percent of the original oil in place in Kentucky to as much as 95 percent of the resource in Texas and Alaska. Figure 10 shows the coverage for each state. Additional data have been collected through recent EOR potential studies which have included the Interstate Oil Compact Commission (IOCC) studies of Oklahoma and New Mexico, a National Laboratory (Argonne) study of the Ohio Valley, and other DOE sponsored National studies. For most of the IOCC studies, state agencies have reviewed existing data and have supplied additional data where needed.

An important part of any oil reservoir data collection effort is validation and verification of the data themselves to guarantee it is consistent with known engineering principles. As new data are entered into the data base, they are checked with an automated routine developed by the NPC to determine possible data inconsistencies.

Predictive Models

The models incorporated into the TORIS system include, as shown in figure 11, process predictive, economic, assignment, and timing models. By design, these models must be utilized in the order shown, as each predecessor model provides the data input to the model that follows it. The predictive model calculates the injection and production volumes of fluids in a single pattern of an EOR project. The injection and production values are input to the economics model where the economic production of fluids is calculated, multiple pattern developments are initiated, and a complete cash flow analysis is performed for the project. The output from the economic model is used, with the output for all other potential projects/reservoirs, in the assignment model to assign one process to each reservoir. This is necessary as a specific reservoir may be a candidate for more than one EOR process technology. The selection of which process is assigned is based on maximum values of either oil production or economics, whichever is preferred. At this point, a process can also be mandated to a reservoir based on knowledge of EOR processes currently in use or designated to be used in the future. The output of the assignment model, one process assigned per reservoir, is used as input to the timing model. The timing model basically times the initialization of the project start into the study. The "start-date" for each project is assigned based on selected economic criteria (most-economic first) or on an "as-available" basis, where "as-available" is defined as when the reservoir reaches its economic limit for its current production technology. The "start-date" can also be postponed due to user-selected supply constraints in development capital, drilling-rig availability, and injectant supplies.

As each EOR process technology type (gas, chemical, thermal) is sufficiently different from the other types, no universal economic package is currently available. Therefore, each predictive model contains an economic model to estimate the economic recovery for each reservoir modeled. By design, each predictive and economic model pair's output is similar and, as such, can be used in the assignment model. The assignment and timing models are designed to be used in a global assessment in which multiple reservoirs are modeled, assigned, and timed into a study.

To ensure accurate and reliable models, each model was reviewed in detail by the EOR experts in the major oil companies that were involved in the NPC study. In the development stage, each model was calibrated for accuracy against oil-field histories and against simulations of oil fields. This same process was used by the oil companies to verify the physics and engineering, calibrations, and economics of the models, and, where necessary, the oil companies modified the models to agree with known calibration data. The predictive/economic models have been published and are available from BPO upon request. The supporting models, such as the assignment and timing models, and the reservoir data base are not available at this time.

EXAMPLES OF RESEARCH RESULTS

The analytical system described above has been used in many studies to estimate the impacts of various possible events. Figure 12 shows some of the more important studies that BPO has performed or assisted in performing since the analytical system was completed in 1984. These include studies for the DOE to determine the impacts of various technology and economic scenarios (BPO planning, and assessment of the impact of proposed tax changes), two NPC studies, and two state-supported studies.

The NPC studies included efforts to determine the estimated EOR contribution to total oil recovery into the next century. Figure 13 shows the estimated EOR oil production rate for various oil prices and technology levels as reported in the 1984 study. This figure shows that research and development to achieve the "advanced case" technologies will be a significant contributor to total EOR recovery in the United States. A statistical analysis of the EOR potential for each state, as estimated in the NPC study, shows (see figure 14) that most of the EOR potential is in the six major producing areas, as you would expect. What you would not expect is that the relative ranking of EOR potential by state is not identical to the relative ranking by state of oil discovered or of oil produced. This type of information does assist EOR research and development managers in determining the major reservoir types that will produce the most significant volumes of oil from EOR, thus reducing the total target of reservoir research programs.

The two state studies were performed by the IOCC to determine the impacts of state-supported incentives for improving EOR activities within the specific states. Figure 15 shows the results of one of the studies, the study performed on New Mexico's reservoirs, which indicated that incentives were representative of an increase in oil price of $4 per barrel. Figure 16 shows that the state income from EOR activities will increase significantly at the specified oil price shown in the figure. What is not shown, but was included in the study, is that the incentives are price-dependent and do not increase the state's revenues at oil prices beyond a specific price range. Yet these studies did show that, in Oklahoma and New Mexico, incentives do benefit the state and increase oil production within calculated oil price ranges.

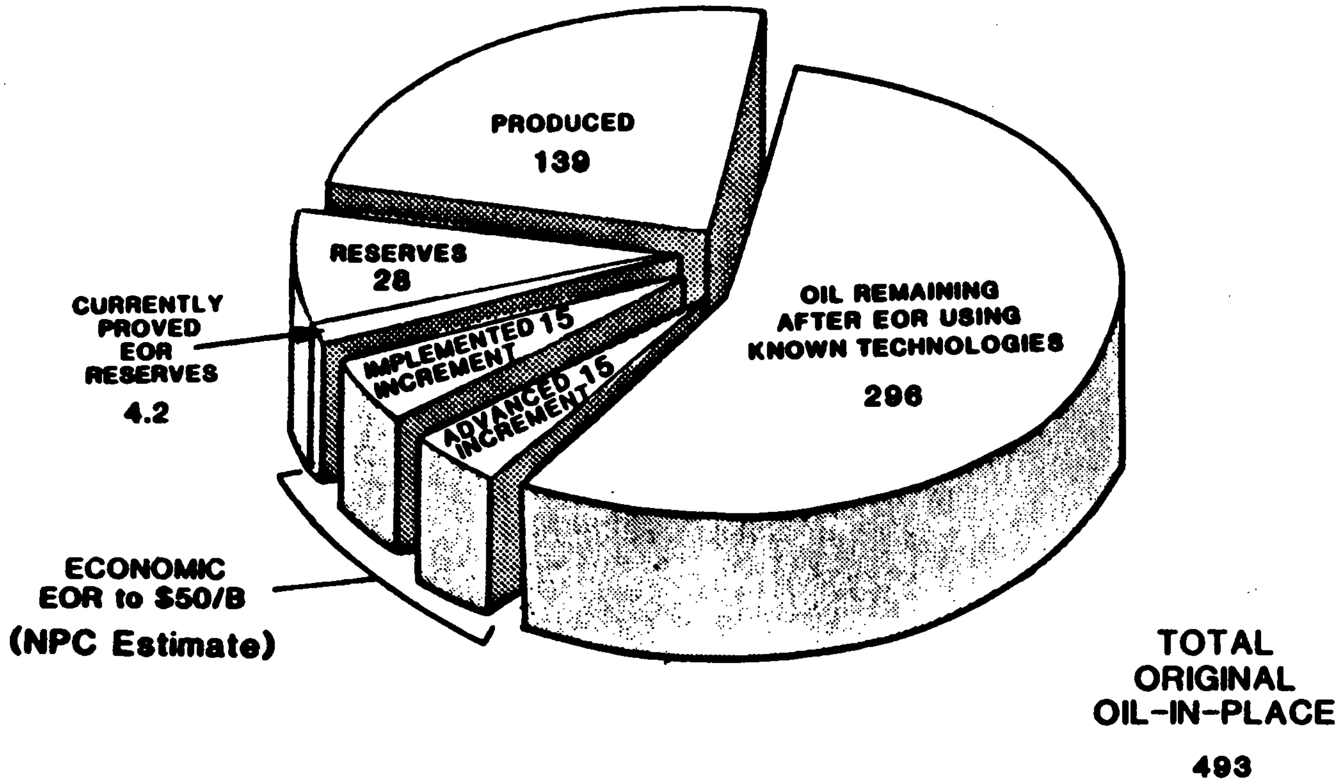
CURRENT STATE STUDIES

The Texas Bureau of Economic Geology has been performing reservoir studies to classify reservoirs into "plays" for determining the volume of mobile oil that exists in the reservoirs. Targeting reservoirs that contain significant volumes of mobile oil for further development will assist the Nation in producing more oil from the known resource, which, in turn, will help in reducing the amount of oil imported each day. BPO is currently participating in an IOCC/Texas study to evaluate incentives for EOR activities. At the completion of this study, we hope to use the concept of "plays" to estimate the volumes of mobile oil available throughout the Nation. BPO, using the results from a recent National study, calculated the amounts of mobile oil existing at or near original saturations in the reservoirs studied. This was a coarse calculation based on estimated ultimate recoveries, but the results showed some interesting aspects. Figure 17 shows the geographical distribution and volumes of the mobile-oil resource calculated in this study. This resource represents a major source of oil which, as shown in figure 18, could increase the current estimates of oil-recovery potential from 14 percent of the remaining oil by EOR to 34 percent by EOR plus in-fill drilling.

The results of the in-fill drilling studies performed by BPO and the results of the Bureau of Economic Geology's efforts in Texas have caused BPO to examine the concept of "advanced oil recovery." Advanced oil recovery, or AOR, supports a broad geoscience research subprogram which will strive to identify additional reservoir characterization techniques to allow identifying and quantifying the bypassed oil and the oil not contacted due to structural "pockets." The geoscience program, as under the EOR program, will still support geoscience research to better predict oil recovery using EOR technologies. This geoscience program is still in its infancy and will be partially implemented in fiscal year 1988.

FIGURE 1

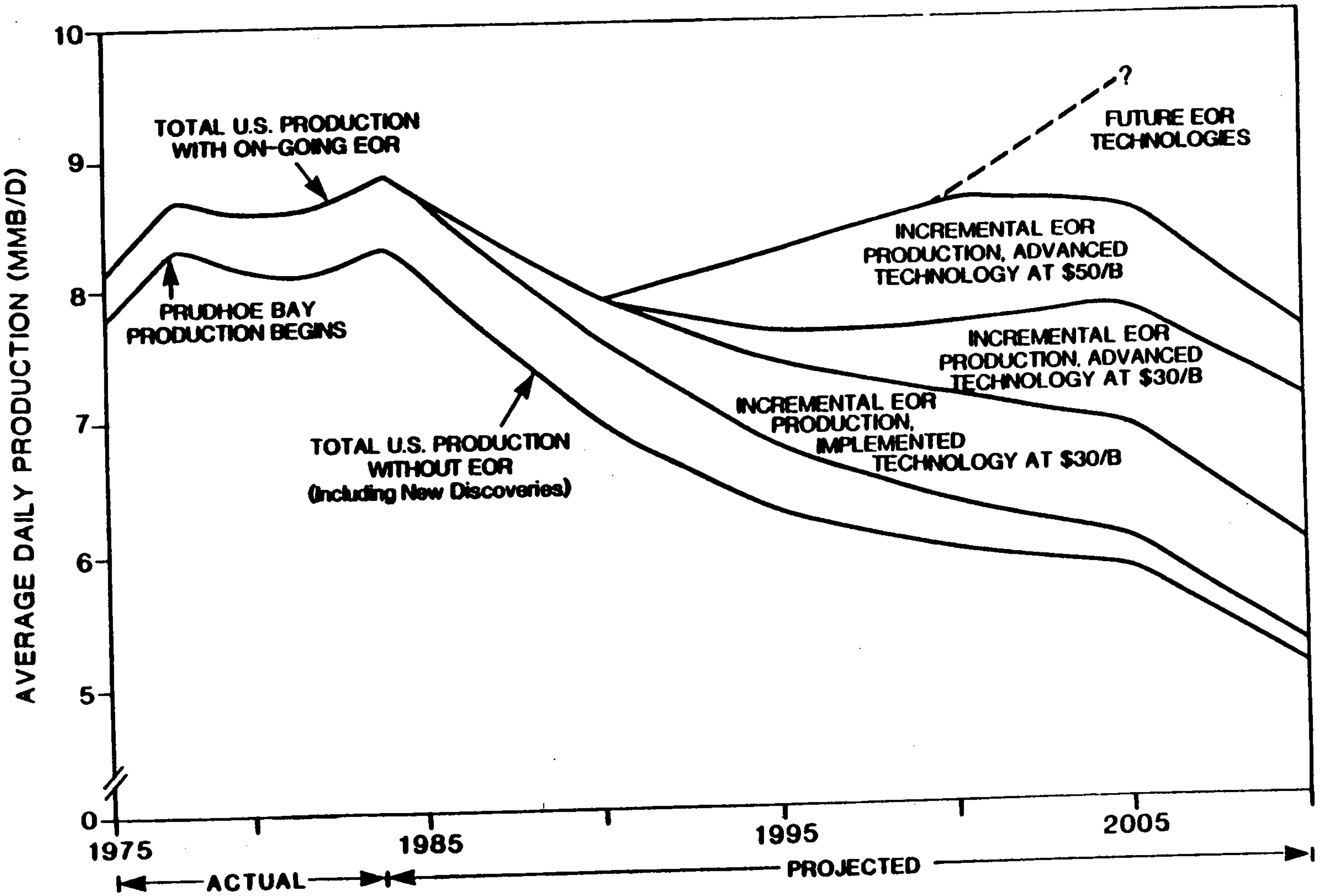
DISTRIBUTION OF KNOWN U.S. OIL-IN-PLACE AFTER EOR (BILLIONS OF BARRELS)



SOURCES: BARTLESVILLE PROJECT OFFICE, 1985.
NATIONAL PETROLEUM COUNCIL, 1984.
ENERGY INFORMATION ADMINISTRATION, 1984.
AMERICAN PETROLEUM INSTITUTE/AMERICAN GAS ASSOCIATION/
CANADIAN PETROLEUM ASSOCIATION, 1979.

FIGURE 2

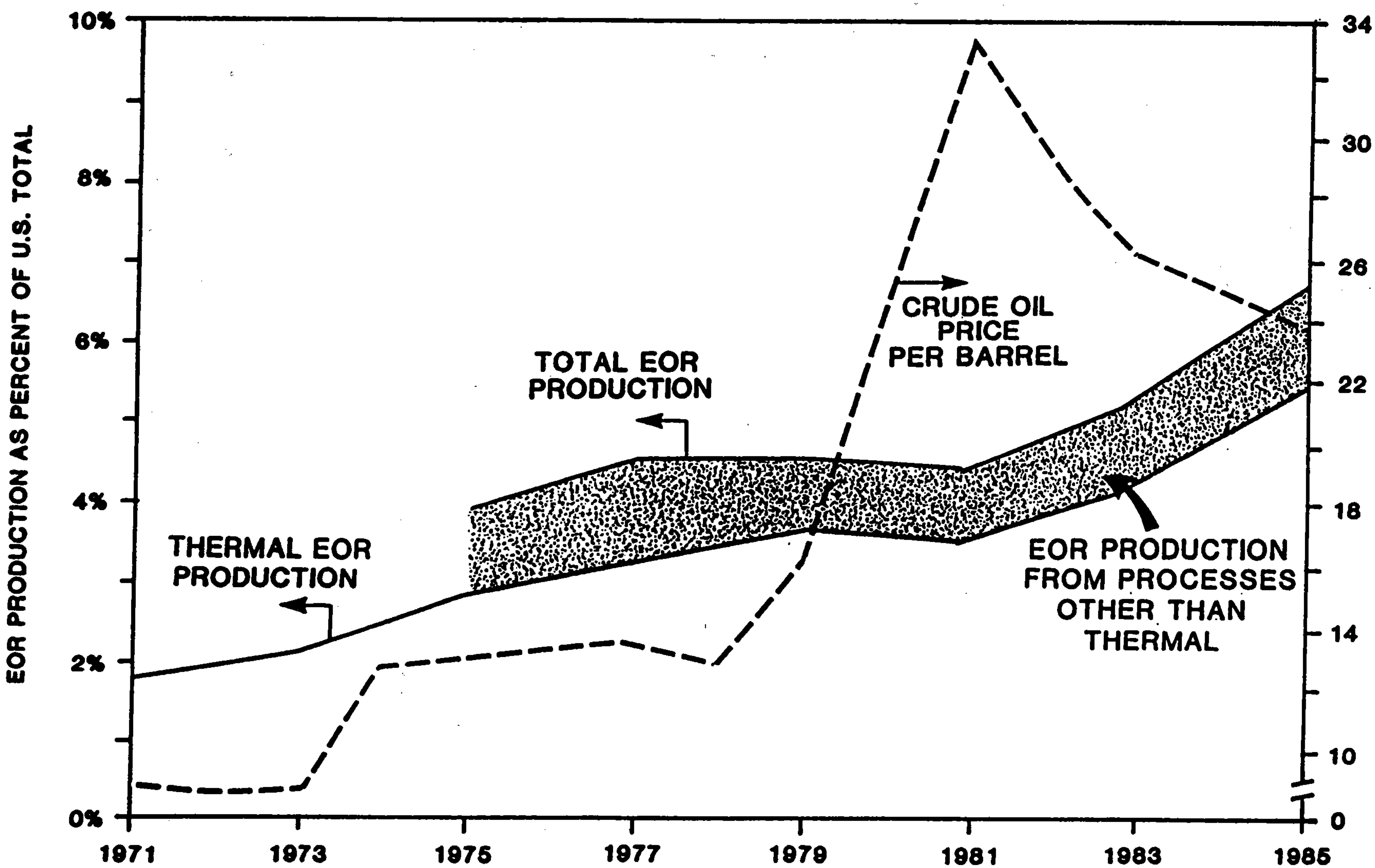
Projected U.S. Oil Production and Estimated Contribution of EOR (NPC Implemented & Advanced Cases)



SOURCES: NPC, 1984
DOE, 1983
OIL AND GAS JOURNAL, 1984

FIGURE 3

EOR Production Has Remained Limited Despite Sharp Oil Price Increases



SOURCES: Oil and Gas Journal, 1971–1986.
API, 1986.

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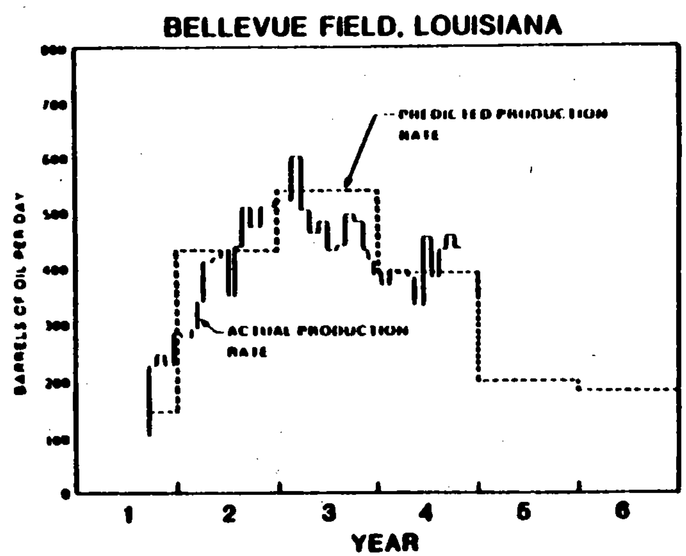
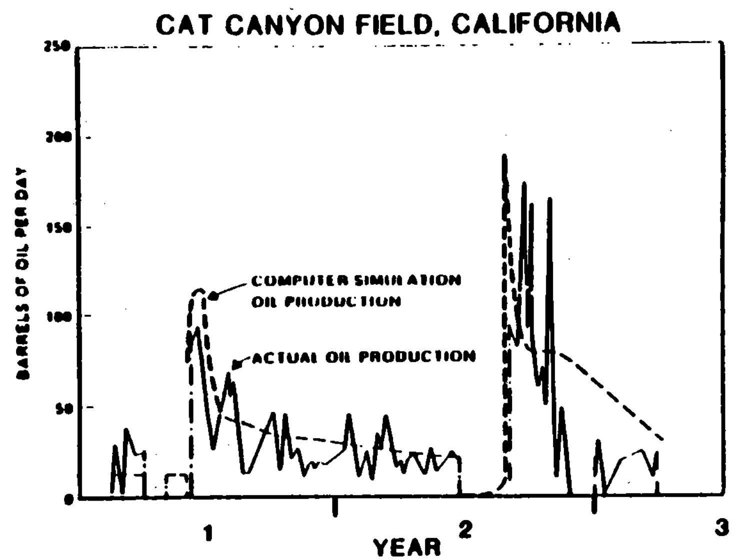
FIGURE 4

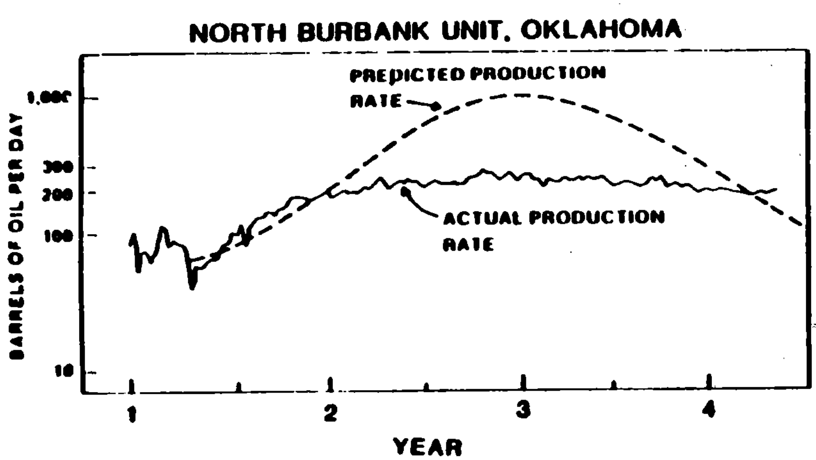
Enhanced Recovery Projects Have Often Failed To Perform As Predicted In Actual Field Settings

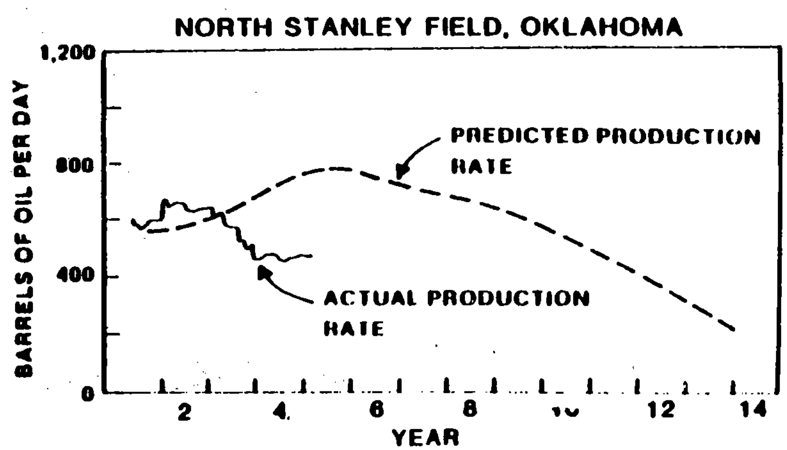
SOME HAVE HAD ACCEPTABLE PERFORMANCE ...





BUT MANY HAVE FAILED TO PERFORM AS PREDICTED





SOURCE: U.S. Department of Energy, 1980

FIGURE 5

WORK BREAKDOWN STRUCTURE OF EOR RESEARCH PROGRAM

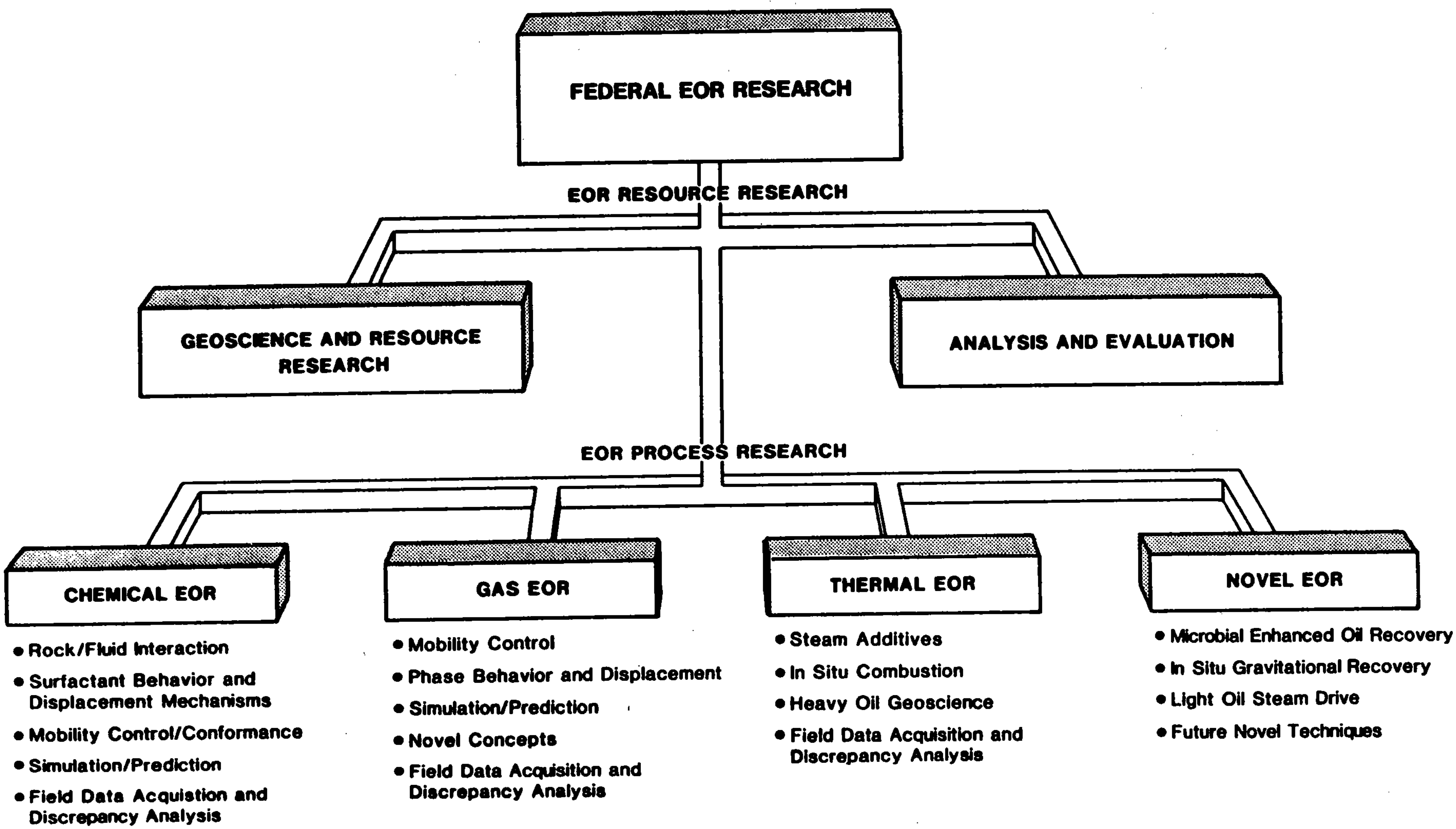


FIGURE 6

TORIS Synthesizes the Current Understanding of Remaining Oil and Applicable Technology Through Three Lines of Research, Analysis, & Interpretation

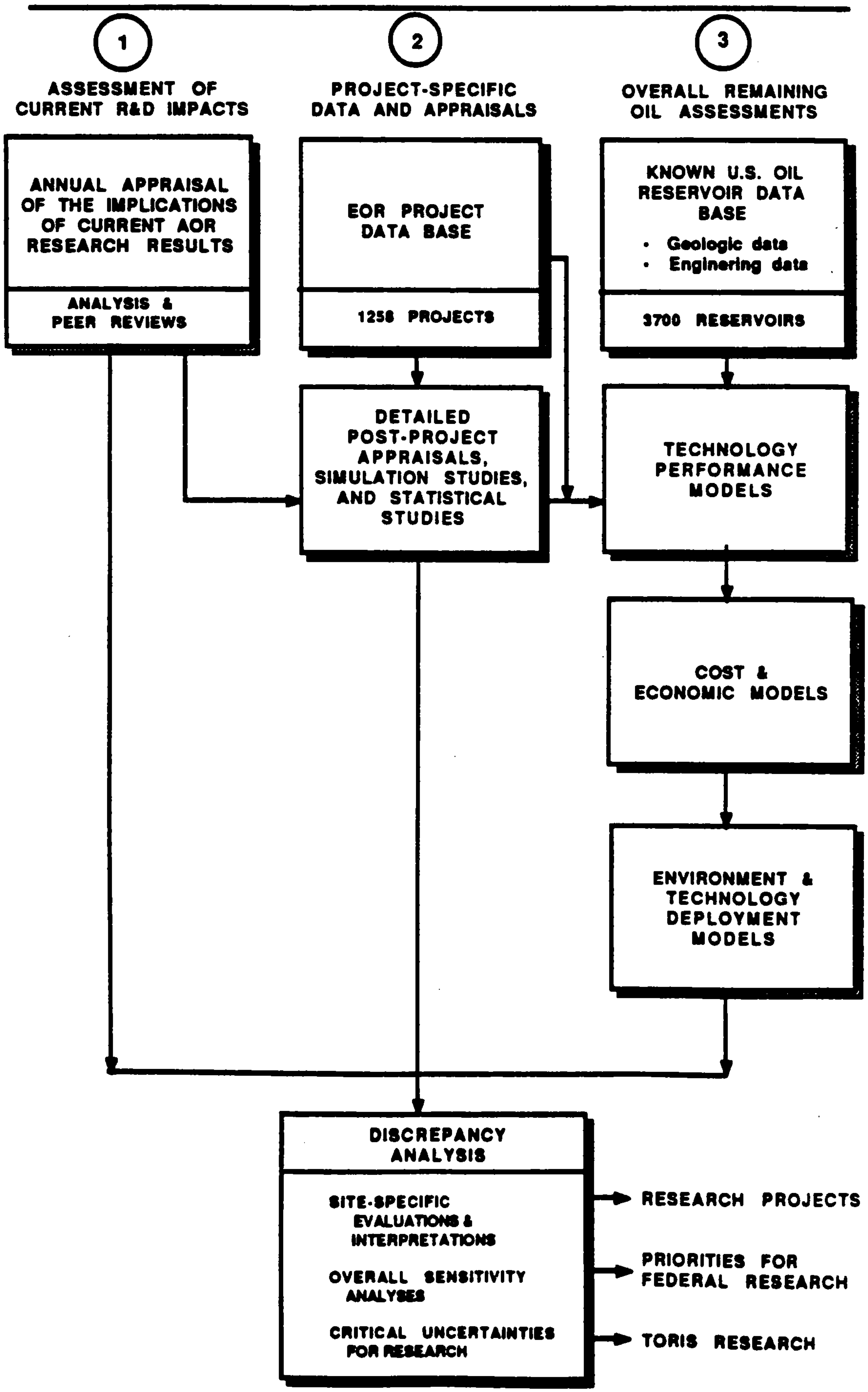


FIGURE 7

SCHEMATIC OF THE EOR PROJECT SUBSYSTEM

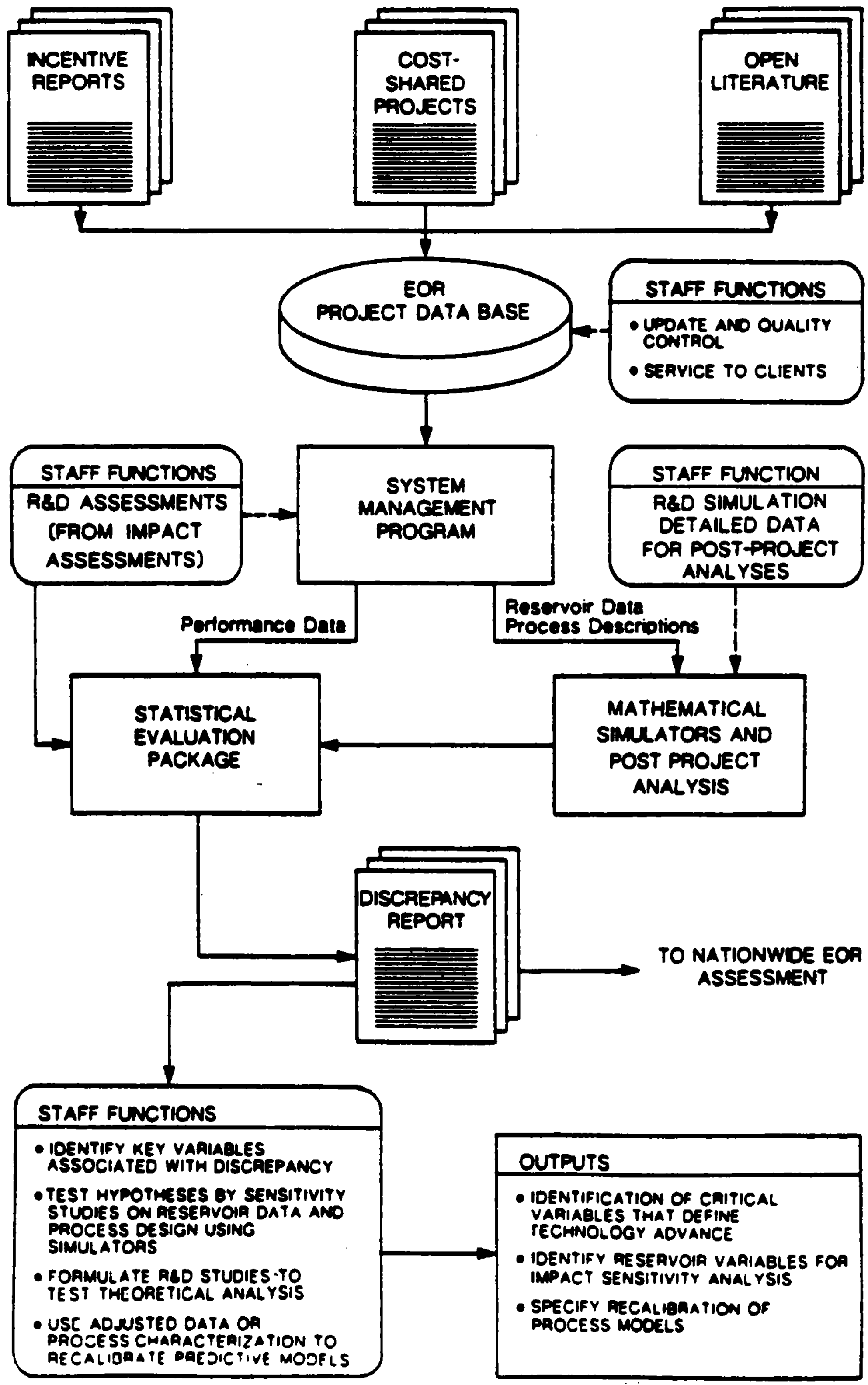
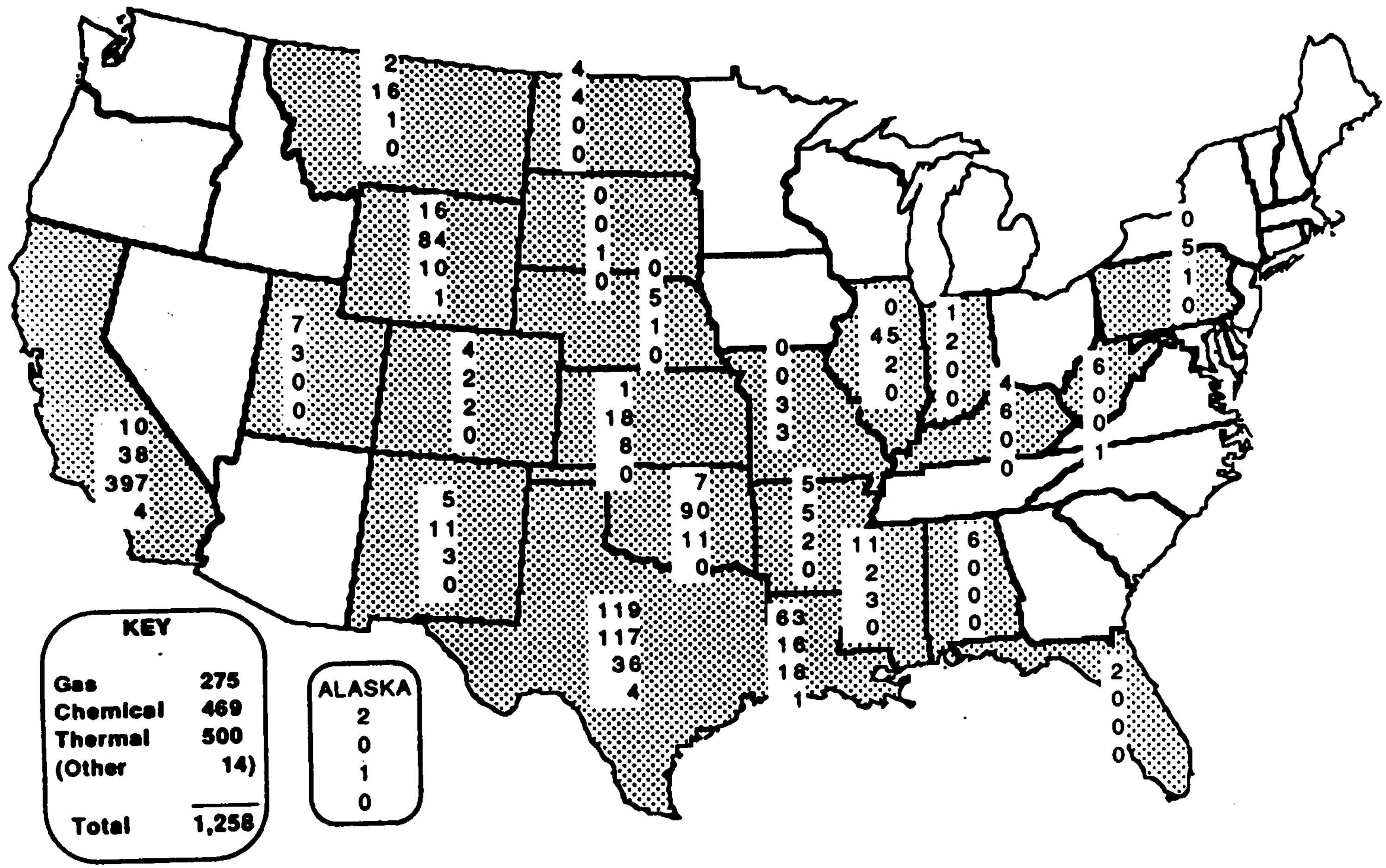


FIGURE 8

EOR Project Distribution by State



SOURCE: BPO, 1987

FIGURE 9

KEY ELEMENTS IN TORIS RESERVOIR DATA BASE

ORIGINAL VOLUMETRICS

- Original Oil-In-Place
- Reservoir Area
- Net Thickness
- Porosity
- Initial water saturation
- Initial oil saturation
- Initial oil formation volume factor
- Initial free gas saturation

GEOLOGIC VARIABLES

- Lithology
- Depth
- Temperature
- Original and current pressure
- Permeability
- Permeability variation index
- Clay content
- Gross thickness
- Dip angle
- Geologic age, basin, play (being added)
- Presence of gas cap, faults, shale breaks
- Depositional system (being added)
- Heterogeneities (being added)

CURRENT VOLUMETRICS

- Current oil saturation (swept zone)
- Current oil formation volume factor
- Current water saturation (swept zone)
- Estimated residual oil saturation (swept zone)
- Current formation volume factor
- Current free gas saturation

FLUID DATA

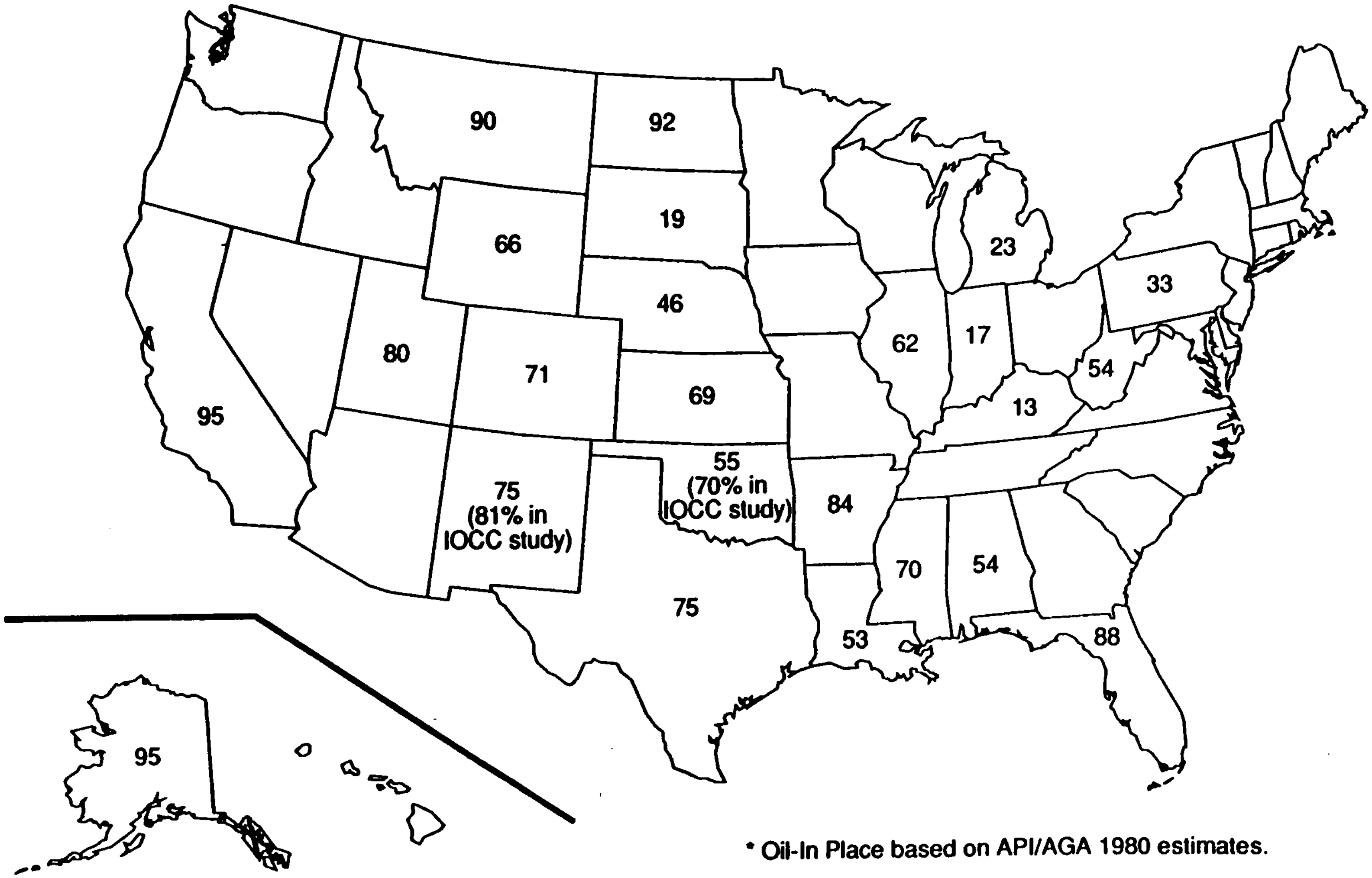
- Oil gravity & viscosity
- Connate water viscosity
- Connate water salinity
- Injection water salinity
- Crude oil fractions & properties (being added)

DEVELOPMENT & PERFORMANCE

- Recovery efficiencies (primary, secondary, total)
- Cumulative production
- Cumulative injection
- Annual production and injection (being added)
- Initial GOR
- Current GOR
- Current injection rate
- Well spacing
- Number of producing & injecting wells
- Water cut (being added)

FIGURE 10

Coverage of DOE/TORIS Data Base (Percentage of Oil-In Place* Contained in Data Base)



* Oil-In Place based on API/AGA 1980 estimates.

FIGURE 11

TORIS COMPUTER MODELS

- **Technology performance prediction**
  - -- Incremental production = f (individual reservoir properties, recovery technology design, & process effectiveness)
  - -- Existing models: gas miscible, chemical (alkaline, polymer, surfactant-polymer), and thermal (steam drive, in-situ combustion)
  - -- New models: gas immiscible, light-oil steam, steam soak, injection profile modification, targeted infill drilling

- **Economics**
  - -- Discounted cash flow analysis of implementing the recovery technology design;
  - -- Costs = f (oil price, reservoir properties, current field conditions, & technology specifications)
  - -- Full State and Federal tax and economic activity analysis

- **Technique assignment**
  - -- Current technology commitments
  - -- Maximize either incremental recovery or financial returns

- **Timing and development**
  - -- Project initiation = f (conventional production decline & economic viability)
  - -- Realistic phasing of projects over time
  - -- Market penetration of technological advances
  - -- Logistical and environmental constraints

FIGURE 12

SIGNIFICANT USES OF TORIS

- **1984 NPC STUDY ON EOR POTENTIAL:**
  - -- 4 oil prices
  - -- 2 technology levels
  - -- 3 discount rates
  - -- 1,100 reservoirs > 50 MMbbl OOIP

- **1985 ANL STUDY ON ACID RAIN**
  - -- Ohio Valley only
  - -- CO_2 requirements supplied by flue gas
  - -- CO_2 prices ranged from \$0.50 to \$3.00 in \$0.25 increments
  - -- 4 oil prices (base technology only)

- **1985 NPR (#3, CASPER) SCREENING STUDY:**
  - -- Shannon reservoir
  - -- Pilot study
  - -- Multiple processes evaluated

FIGURE 12 (continued)

TORIS USES, CONTINUED

- **1985 DOE/HDQ TAX REFORM STUDY:**
  - -- Current Federal Tax Structure
  - -- Treasury I Federal Tax Proposal
  - -- Treasury II Federal Tax Proposal

- **1985-1988 IOCC STATE STUDY:**
  - -- Individual analysis completed for:
    - New Mexico (1986)
      - -- 7 oil prices
      - -- 2 discount rates (lower rate interpreted as technology advance)
      - -- 3 tax cases
      - -- 1 process technology (carbon dioxide)
    - Oklahoma (1987)
      - -- 7 oil prices
      - -- 2 discount rates
      - -- 3 tax cases
      - -- 7 process technologies
      - -- 2 technology levels (current or "implemented", and as "advanced" through R&D)
  - -- Texas (1988) - ongoing; expansion of scope to include both EOR and targeted drilling for unswept mobile oil

FIGURE 12 (continued)

TORIS USES, CONTINUED

- **1986 NPC "OUTLOOK" STUDY:**

  -- 7 oil prices (start @ $12/bbl)
  -- All processes
  -- Current technology level only
  -- Updated costs, prices, and tax structures

- **1986 NATIONAL SECURITY STUDY**

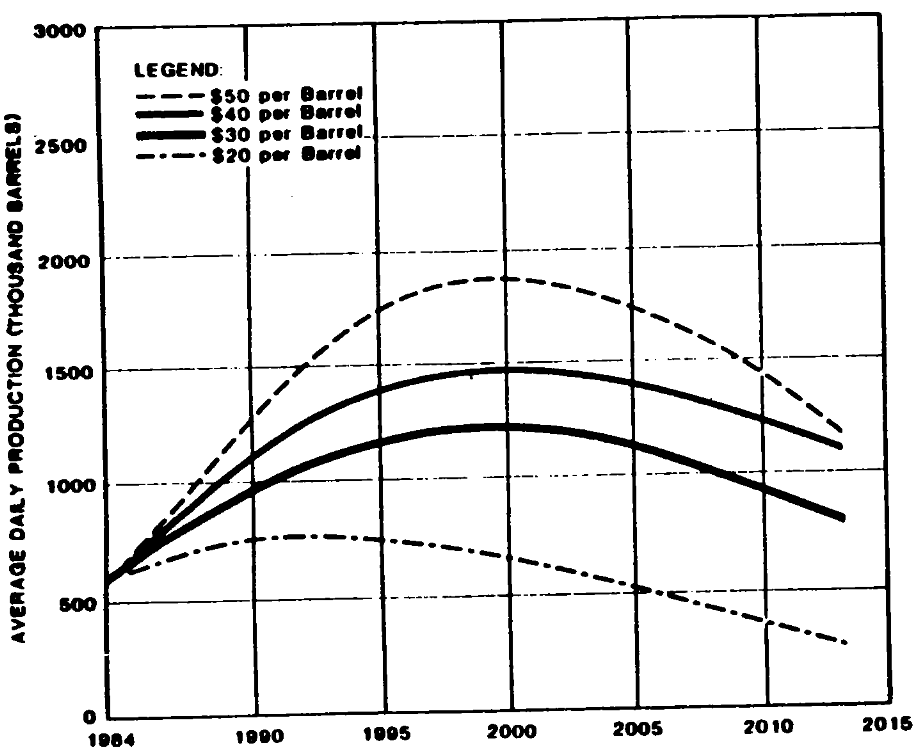
  -- Fast response reservoirs studied
  -- In-fill drilling evaluated using polymer model
  -- EOR evaluated across all process technologies
  -- "Quick" preliminary study performed
    - 1 technology level (implemented technology)
    - Single oil price
    - Single discount rate

- **BPO PLANNING EXERCISES**

  -- State-of-the-art assessments
  -- EOR potential studies
  -- Program planning (CPM)
  -- Checks "improvements" in technology
    - Areas of applicability
    - Impact of improvement
    - Efficiency of R&D expenditures
    - Alternatives to R&D direction

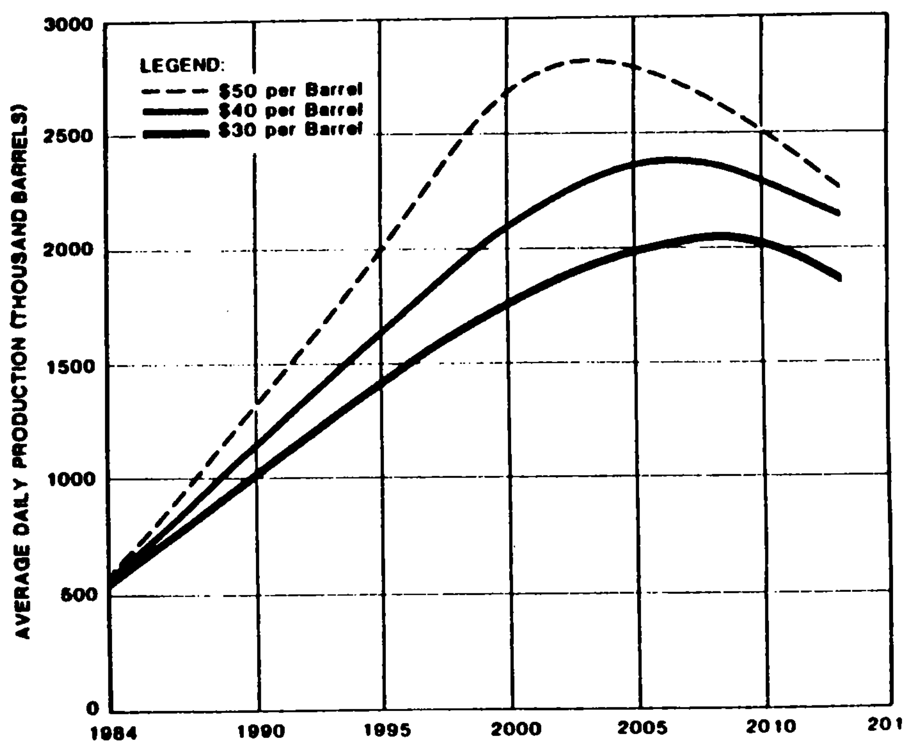
FIGURE 13

NPC Estimated EOR Production Rates By Oil Price
(Implemented Technology)



SOURCE NPC, 1984

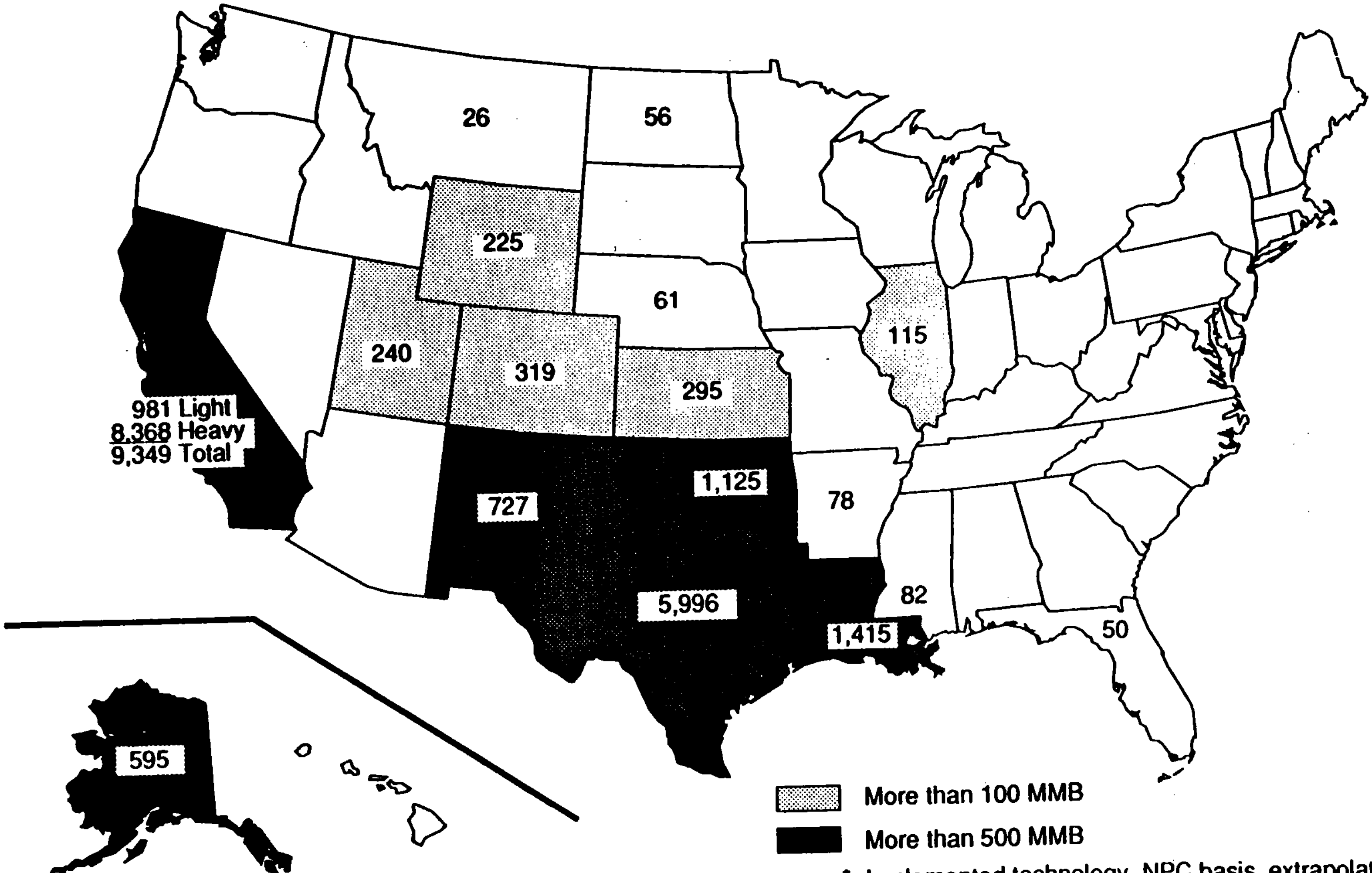
NPC Estimated EOR Production Rates By Oil Price
(Advanced Technology)



SOURCE NPC, 1984

FIGURE 14

Geographic Distribution of EOR Economic At $30/B Oil Price* (Millions of Barrels)



More than 100 MMB

More than 500 MMB

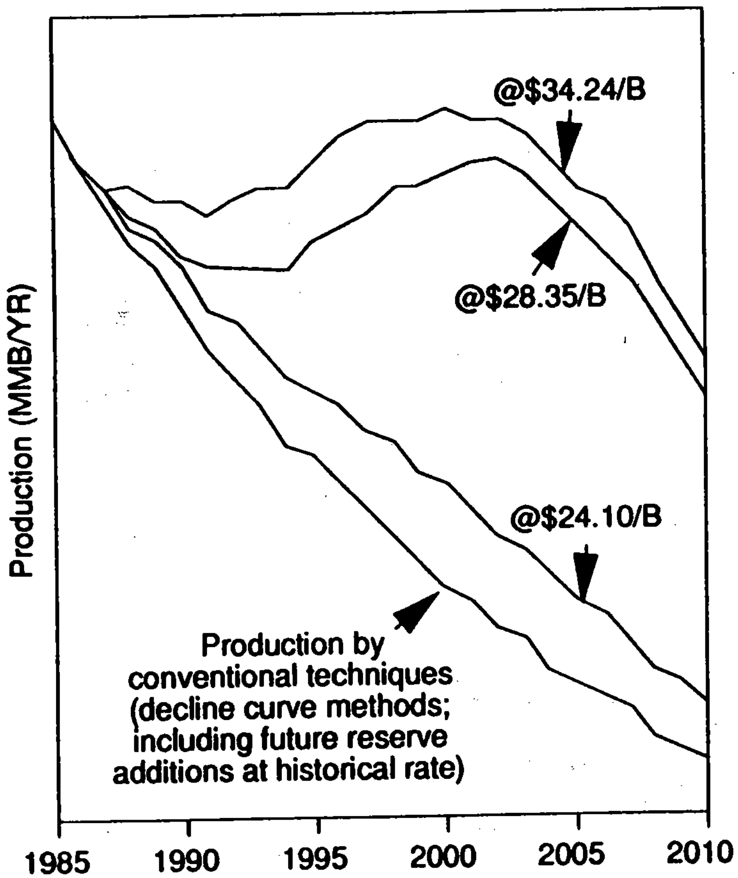
* Implemented technology, NPC basis, extrapolated.

Source: BPO/TORIS, 1987.

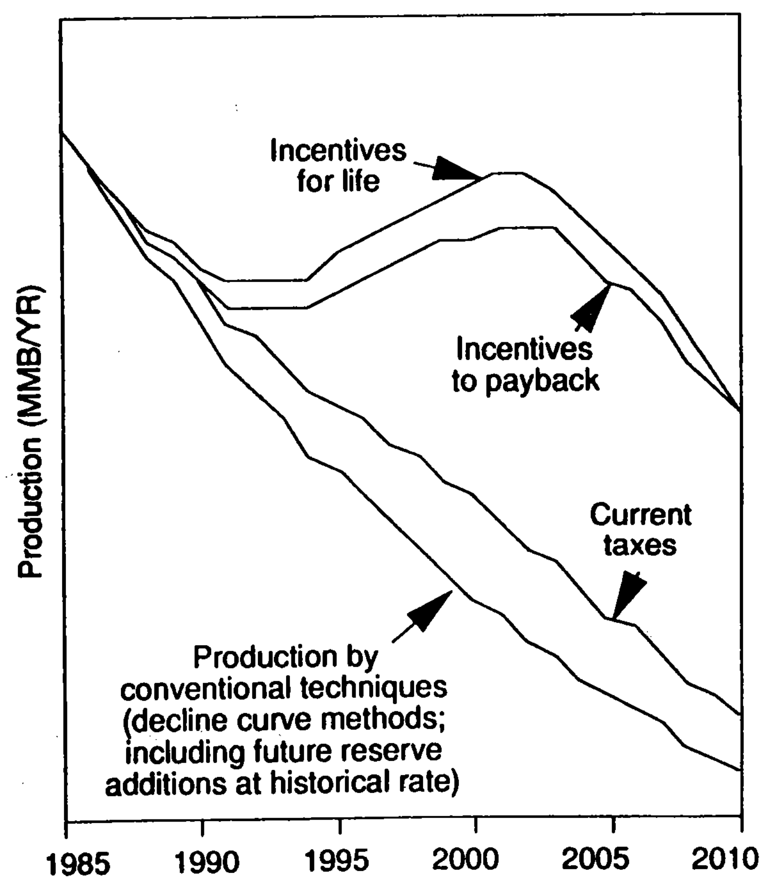
FIGURE 15

POTENTIAL FOR CARBON DIOXIDE FLOODING IN NEW MEXICO

Estimated Overall New Mexico Production by Conventional Techniques and Carbon Dioxide Flooding, 1985-2010



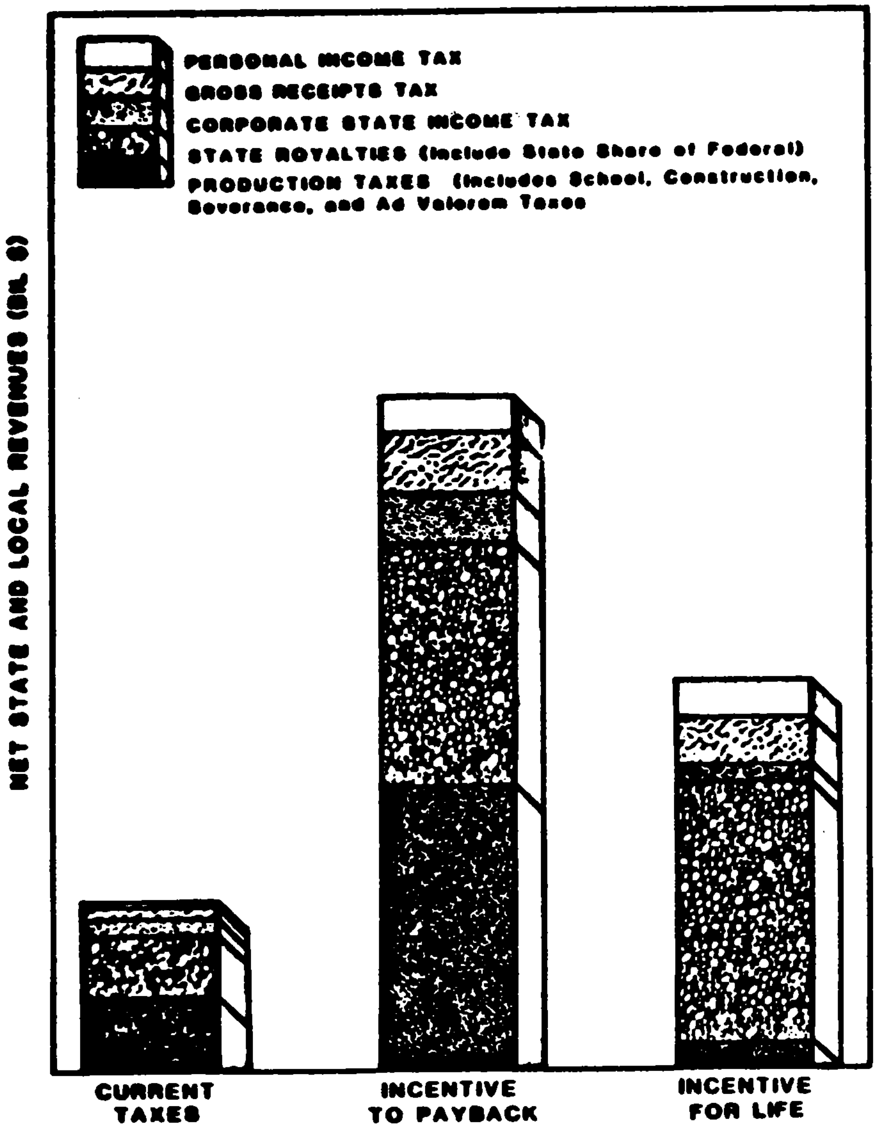
Estimated Overall Potential of New Mexico Oil Production at $24.10/B Under Three Tax Incentives for Carbon Dioxide Flooding



Source: IOCC, BPO/TORIS, 1987.

FIGURE 16

ESTIMATED NET REVENUES TO NEW MEXICO STATE AND LOCAL TREASURIES OF THREE TAX STRUCTURES AT $24.10/B



ESTIMATED NET REVENUES TO NEW MEXICO STATE AND LOCAL TREASURIES OF THREE TAX STRUCTURES AT $24.10/B

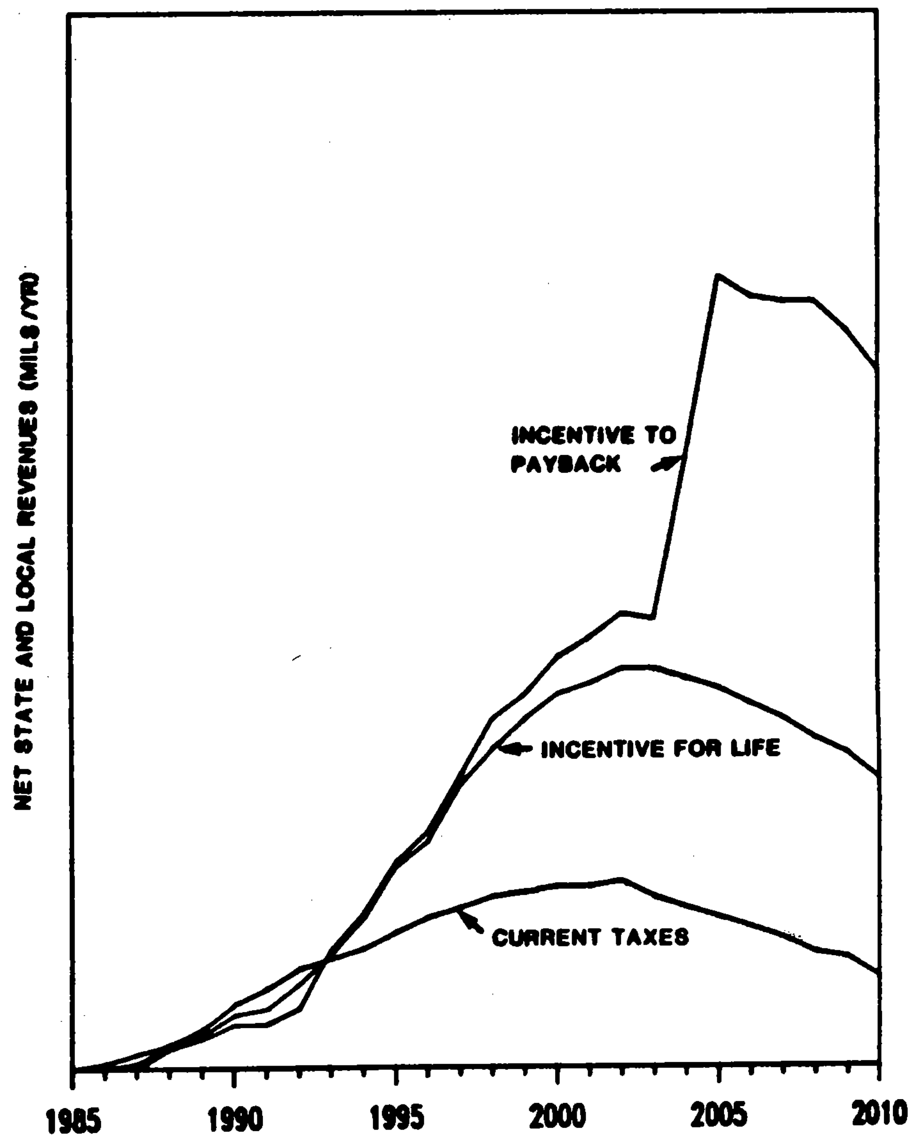
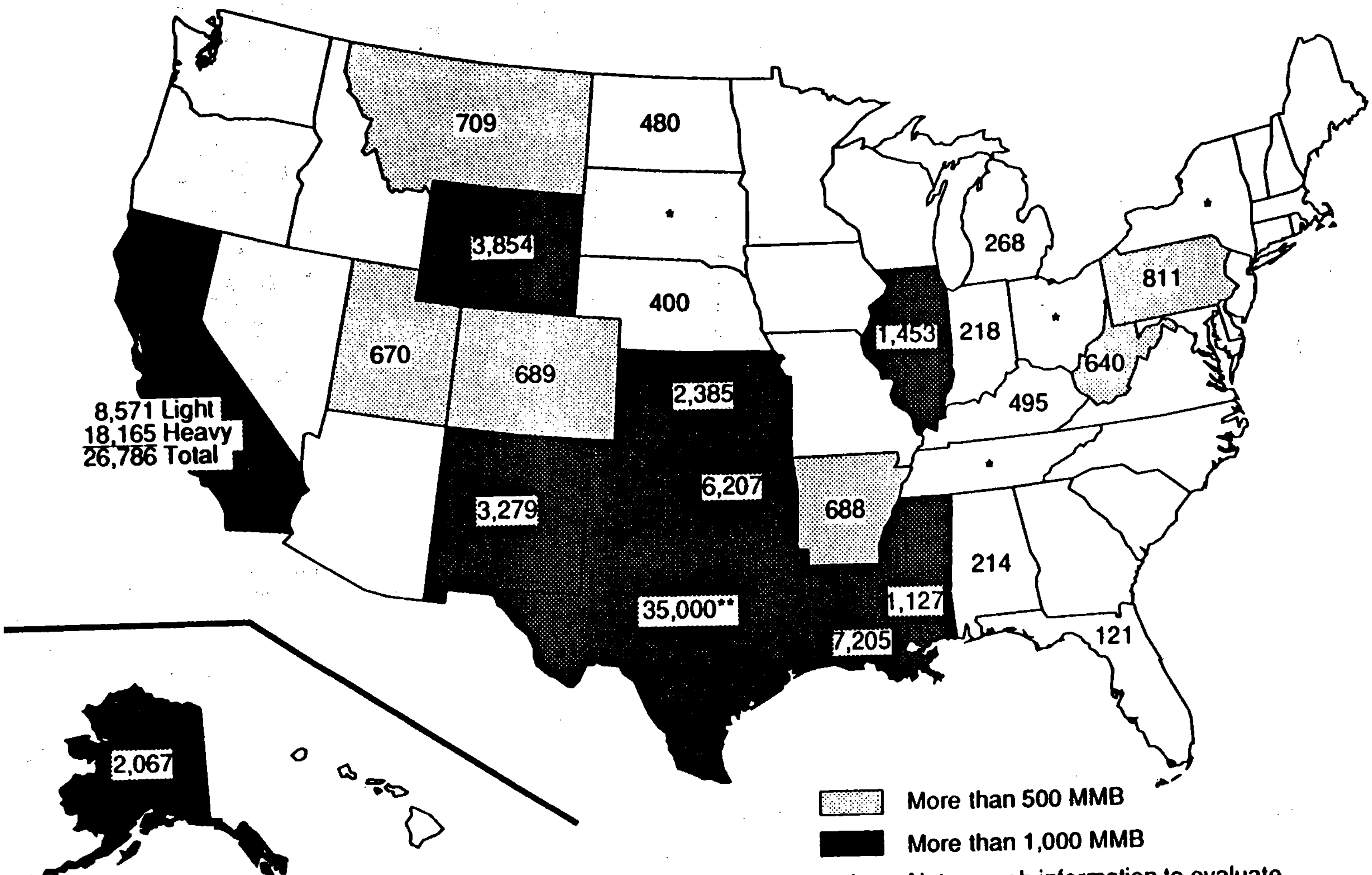


FIGURE 17

Unswept Mobile Oil After Conventional Recovery (Millions of Barrels)

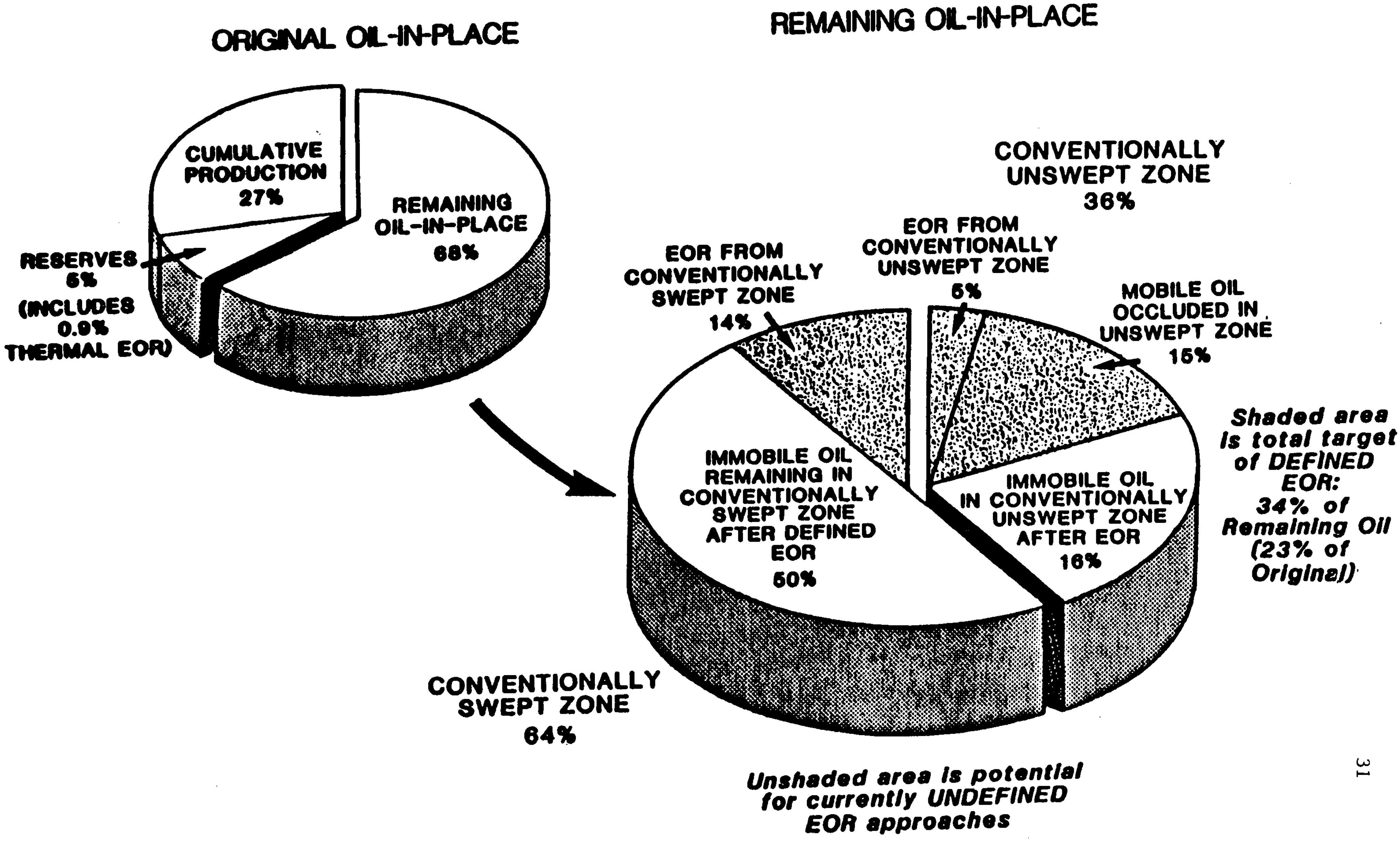


- More than 500 MMB
- More than 1,000 MMB
- * Not enough information to evaluate
- ** Based on W.L. Fisher, Texas Bureau of Economic Geology, 198

Source: BPO/TORIS, 1987.

FIGURE 18

Up to One-Third of the Remaining Oil may be Amenable to EOR



OIL AND GAS INVESTIGATIONS AND COMPUTER APPLICATIONS, BRANCH OF PETROLEUM GEOLOGY, U.S. GEOLOGICAL SURVEY

by

D.L. Gautier, T.S. Dyman, and K.I. Takahashi

INTRODUCTION

The Branch of Petroleum Geology, U.S. Geological Survey, is primarily responsible for conducting topical and regional research concerned with geological, geochemical, and geophysical applications related to the origin, migration, accumulation, and distribution of oil and gas resources. The data and knowledge acquired through this research provide the basis for assessments of the oil and gas resources of both public and private lands in the United States. The results of research conducted under the Oil and Gas Investigations Program also provide useful scientific insights for small oil companies, which drill many of the wildcat exploration wells in the United States.

Computerized information and data systems, which are an important part of this responsibility, are accessed continuously by Branch personnel as a normal part of their research activities. In addition, data are regularly generated within the Branch as part of the research effort, and integrated with existing data systems and computer software.

The purpose of this paper is to describe the major research components and the integrated data and computer systems of the Branch of Petroleum Geology within the framework of the Branch mission. Any use of trade names and trademarks in this manuscript is for descriptive purposes only and does not constitute an endorsement by the U.S. Geological Survey.

RESEARCH GROUPS

The Oil and Gas Investigations Program comprises five strongly integrated research groups, which conduct petroleum-related research and assess undiscovered oil and gas resources in the United States. The equipment, facilities, and expertise required for the program research are present within the U.S. Geological Survey. The five principal research groups are (1) organic geochemistry, (2) reservoir characterization, (3) geophysics, (4) Alaskan petroleum geology, and (5) resource assessment. The computer-and-data-systems group supports the digital-processing needs of these research components.

The organic-geochemistry group investigates the origin and thermal evolution of organic-carbon-rich petroleum source rocks in petroliferous sedimentary basins. These studies provide basic information concerning the generative capacity of potential source beds and the origin of petroleum. Geochemical investigations of oils, gases, and source rocks provide a means of identifying and classifying hydrocarbons with respect to their sites and modes of origin and the volumes of oil and gas originally yielded by source rocks. Studies of thermal maturation, hydrocarbon-bearing fluid inclusions, and hydrologic settings of petroleum help determine the sites of origin and migration pathways for oil and gas and provide the means for predicting their distribution in potentially productive basins.

The reservoir-characterization group conducts sedimentologic, mineralogic, geochemical, and petrologic studies of conventional and unconventional reservoir rocks that are the ultimate site of petroleum accumulations. These studies define the geometry, distribution, porosity, permeability, and chemical sensitivity of hydrocarbon reservoirs, and thus provide the basis for evaluating reservoir quality on a national, regional, or local level. Current emphasis of the reservoir-characterization group is on the geologic evaluation of selected reservoirs in the United States to provide a data base on which decisions regarding-enhanced-oil recovery (EOR) techniques are based.

The geophysical-investigations group conducts computer-based modeling, processing, and interpretation of seismic geophysical data. These activities establish the structural framework of tectonically complex regions of the Earth's crust, yield direct information about the structural and sedimentary style of petroliferous basins, and provide a means of evaluating subtle sites of petroleum entrapment.

The Alaskan-petroleum-geology group is concerned with investigations of hydrocarbon resources in frontier provinces in Alaska, especially petroleum resources of the North Slope and interior basins, and the distribution of shallow gas-hydrate accumulations beneath tundra in northern Alaska. Ongoing studies are developing the basic petroleum geology for interpreting the distribution and abundance of oil and gas in northern and central Alaska, and have recently been involved in appraising the undiscovered petroleum resources of the Arctic National Wildlife Refuge (ANWR). Ellesmerian rocks of the North Slope basin have been selected as the site of a pilot study for a sophisticated petroleum system analysis and a geochemical material-balance assessment.

The resource-assessment group has primary responsibility for conducting assessments of undiscovered oil and gas resources in onshore areas of public and private lands and of state lands offshore. The group utilizes the findings of each of the other groups, as well as expertise from other programs within the U.S. Geological Survey, such as Basin Studies and Geothermal Studies. Knowledge of petroleum geology acquired by scientists within the U.S. Geological Survey provides the scientific basis for an evaluation of the distribution, abundance, and recoverability of oil and gas resources in the United States and other countries. For the Federal Lands Appraisal Program (FLAP) the group is currently producing an assessment of undiscovered oil and gas resources on Federal lands using a play-analysis approach.

COMPUTER SUPPORT

The computer-support group assists both the research groups and administrative-support staff within the Branch of Petroleum Geology in all phases of computer programming, data-systems support, and existing software applications. Computer-programming support includes writing new computer programs or modifying existing programs for research and administrative applications. Data systems support includes accessing available data bases, developing new data bases, and integrating several data files into new or existing data bases. Software-applications support includes training Branch personnel to use available computer programs, and evaluating and acquiring new programs. Computer-support-group staff participate in data-base and software-system advisory and evaluation committees for future and ongoing research applications. To this end, computer-and-data-systems-support goals include proper dissemination of oil and gas information for research activities.

Computer Systems

Facilities include a new 2200-square-ft computer room, and two user rooms for terminals and user access. Table 1 contains a list of computer systems and available support software now housed in the facility. An interagency contingency agreement with Minerals Management Service (MMS) will allow access to an additional VAX 11/780 processor for the Branch of Petroleum Geology before the end of calendar year 1987. The Branch will have complete access to the system which will be housed in our facility. MMS will use the system only as a backup in case their computer systems fail. The additional computing capability will allow more on-line storage of large data bases.

Communications options and networking on the Branch VAX 11/780 are flexible. The system can be accessed throughout the United States using Geonet and Tymnet networks maintained by the U.S. Geological Survey. Interactive user sessions and file transfers are possible within the network. The VAX 11-780 and MicroVAX II are networked together using DECNet and Ethernet, allowing users on either system to transfer files and mail messages or documents to other users on either system. This network will soon be expanded to include the DISCO VAX 11-780.

The VAX 11/750 at the Branch facility in Menlo Park, California, is maintained by the Branch of Pacific Marine Geology for several groups within the U.S. Geological Survey. The Branch of Petroleum Geology provides partial support for this system. The DISCO VAX 11-780 is housed in a separate facility maintained by the geophysics group. This system is used mainly for seismic data processing and reprocessing, and seismic interpretation within the geophysics group.

The MicroVAX II provides word-processing capability for the Branch. WPS-Plus software is being used by clerical and geologic staff and can be accessed with terminals in many offices, in the centrally located user rooms, or by dial-up telephone lines from remote facilities. Printers are located in several easy-to-access locations. Using WPS-Plus, documents can be transferred between technical and clerical staff for editing and review and to other U.S. Geological Survey facilities.

Two Macintosh personal computer systems are being used for graphics and word processing, and desk-top publishing support. In addition, at least three IBM-PC systems are currently used for spreadsheet, word-processing, data-base, graphics, and statistical applications.

DATA MANAGEMENT

The Branch of Petroleum Geology uses TECH/SYS and DATATRIEVE for storage and retrieval of large data files on the VAX 11-780. TECH/SYS is a file-management and data-retrieval system designed by Petroleum Information Corporation of Denver, Colorado, that uses a command file of data and format specifications to retrieve data on up to four data bases at one time (Petroleum Information Corporation, 1984). TECH/SYS was originally designed to retrieve well-history data from Petroleum Information Corporation's Well History Control System (WHCS), but is also used now to access the Petroleum Data System (PDS) and the NRG Associates Significant Oil and Gas Fields File. TECH/SYS was recently updated and enhanced by Petroleum Information Corporation to better accommodate specific characteristics of WHCS data. DATATRIEVE is a retrieval program marketed by Digital Equipment Corporation that has data-base-updating and file-management capabilities which are tied into the VMS operating system.

DATA SYSTEMS

The Branch of Petroleum Geology accesses Petroleum Information Corporation's Well History Control System (WHCS), the Petroleum Data System (PDS), and the NRG Associates Significant Oil and Gas Field File (Table 1). WHCS contains geologic, engineering, production and formation test, and descriptive location information for more than 1.7 million wells drilled in the United States. Parts of the WHCS data base are alternately stored on magnetic tape, disk, or in computer memory, depending on the level and variety of Branch use.

PDS is a historic oil and gas field and reservoir file containing geologic, engineering and production data for more than 80,000 fields and reservoirs in the United States (Dyman, 1978; 1979). PDS annual production figures are presently acquired from Petroleum Information Corporation, but no system is available to update geologic data for existing fields and reservoirs.

The NRG Associates Significant Oil and Gas Fields File is similar to PDS, but only includes data for fields with ultimate recoverable resources larger than one million barrels. This file also contains reserve data and is updated annually.

Several project files are in various stages of development. These include (1) one-line well and deep-well files; (2) Powder River, San Juan, Denver, and Anadarko basin well files; (3) petroleum-geochemistry file; and (4) National Petroleum Reserve in Alaska (NPRA) data file. The one-line and deep-well files are unedited WHCS extract files used for resource assessment and basin analysis. They are maintained on the VAX 11/780 and accessed by simple retrieval programs. The one-line file contains identification, location, and completion data for all wells in WHCS. The deep-well file contains location data and total depth for all wells in WHCS drilled deeper than 15,000 feet.

Basin-analysis data files are maintained for the Evolution of Sedimentary Basins (ESB) Program within the U.S. Geological Survey. These files are edited or unedited WHCS extract files in various stages of development. ESB geologists selectively edit WHCS formation tops for structure and isopach maps and stratigraphic cross sections. The petroleum geochemistry data base is in early stages of development. Data may include but will not be restricted to vitrinite reflectance, API gravity, Thermal Alteration Index, Total Organic Carbon (TOC), and selected gas chromatography. The development of this data base will include mechanisms for storing and retrieving both new and archival data from the Branch geochemical laboratory. The NPRA data base contains geochemical, geophysical, and geologic data from wells and outcrops on the North Slope of Alaska (Wilcox and others, in press).

The computer group is currently designing a bibliographic and document-tracking data base for Branch manuscripts. The new system will replace a document-card system now in use and will provide data on the status of manuscripts and make bibliographic data readily accessible by subject and author.

Project data bases are designed for Branch use, and data from these data bases are made available through U.S. Geological Survey publications.

APPLICATIONS SOFTWARE

Applications software includes programs for digital mapping, statistical analysis, and data display. Many digital maps are produced using Dynamic Graphics Corporation's Interactive Surface Modeling (ISM) system. Special ISM features include menu-driven parameter selection, file-management, graphic editing, zooming and panning of graphic data, and grid and data manipulation (Dynamic Graphics Corporation, 1986). ISM is used with WHCS data to produce isopach, structure top, and total-sediment-thickness maps. Petrologic, geochemical, and geophysical data can also be readily mapped. Figure 1 represents a portion of an ISM-generated deep-well map using the deep well WHCS extract file (Takahashi and Cunningham, 1983).

Exploration-intensity maps for the Federal Lands Appraisal Program (FLAP) are generated using the U.S. Geological Survey's Regional Geophysical Software Library (RGSL) (Evenden, 1975). Figure 2 represents a portion of one of these maps for Cretaceous well penetrations in the Denver basin using WHCS data. The retrieved well data are entered into a set of Fortran programs which code the drill holes for production rank by geologic formation. The basin is subdivided into grid cells, where each grid cell is assigned a symbol based on petroleum production and occurence (Higley and others, 1986).

The Geologic Analysis System (GAS) was developed by Petroleum Information Corporation and contains computer software to graphically display and statistically analyze geologic and lithologic data. The Stratigraphic Report Graphic (SRG) is a stratigraphic-applications program within GAS that accepts sedimentologic, paleontologic, lithologic, paleoecologic, and nomenclatural data for outcrop sections and cores, and displays these data in a scale-variant format (Petroleum Information Corporation, 1984; Dyman and others, 1985).

The Sample Data System (SDS) is a statistical and graphic module within GAS. SDS statistical programs include correspondence, factor, and cluster analysis; the graphic module generates triangular and cross plots (Petroleum Information Corporation, 1984).

Additional Branch software includes the Statistical Package for the Social Sciences (SPSS), MINITAB, TELLAGRAF, and several administrative programs for personnel staffing and budget functions within the Branch. Several petroleum-resource-assessment computer programs such as FASP have also been developed within the Branch. FASP is a fast appraisal system for petroleum-play analysis using a reservoir-engineering geologic model and an analytic probabilistic methodology (Crovelli and Balay, 1987).

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Wilcox, L.A., Coit, T.A., and Magoon, L.B., in press, The National Petroleum Reserve in Alaska computer data and graphics system--an aid to geologic interpretation, in Gryc, G., ed., Geology of the National Petroleum Reserve in Alaska: U.S. Geological Survey Professional Paper 1399.

TABLE 1. COMPUTER SYSTEMS SPECIFICATIONS AND SOFTWARE, BRANCH OF PETROLEUM GEOLOGY.

SYSTEM	LOCATION	SPECIFICATIONS	SOFTWARE SYSTEMS
VAX 11/780	Denver, CO	8 megabytes memory. 7 gigabytes disk storage. Color graphics terminals, plotters, digitizers. VMS operating system. DECNet communications.	Data and applications software. MINITAB,SPSS,ISM,RGSL, GAS (see text for details). Well History Control System (WHCS). Petroleum Data System. NRG Associates Oil and Gas Fields File.
MICROVAX II	Denver, CO	16 megabytes memory. 456 megabytes disk storage. Laser text printers. DECNet communications.	WPS-plus word processing.
VAX 11/780	Denver, CO	24 megabytes memory. 1.2 gigabytes disk storage. VMS operating system.	DISCO seismic processing. EXPLORER software pkg.
VAX 11/750	Menlo Park, CA	4 megabytes memory. 1.1 gigabytes disk storage. VMS operating system.	Office of Energy and Marine Geology applications.
IBM and Macintosh PCs	Denver, CO	Variable	Graphics, technical applications, word processing, and admin. applications.

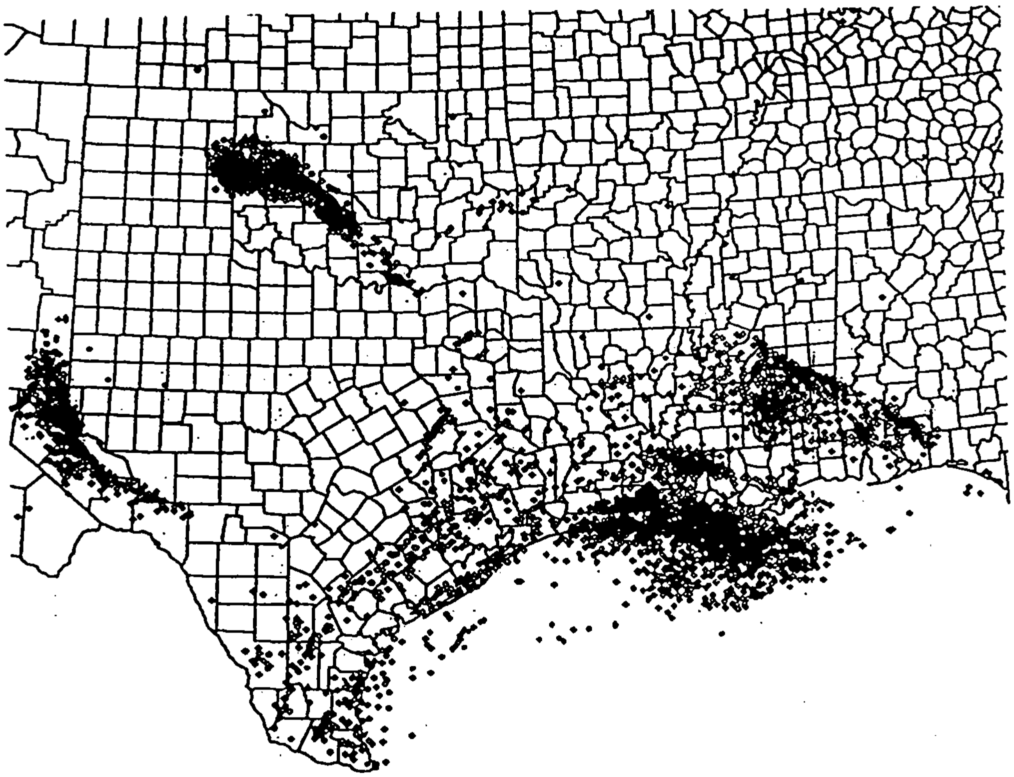


Figure 1.--Map of a portion of the southern United States showing wells drilled deeper than 15,000 ft (Takahashi and Cunningham, 1983).

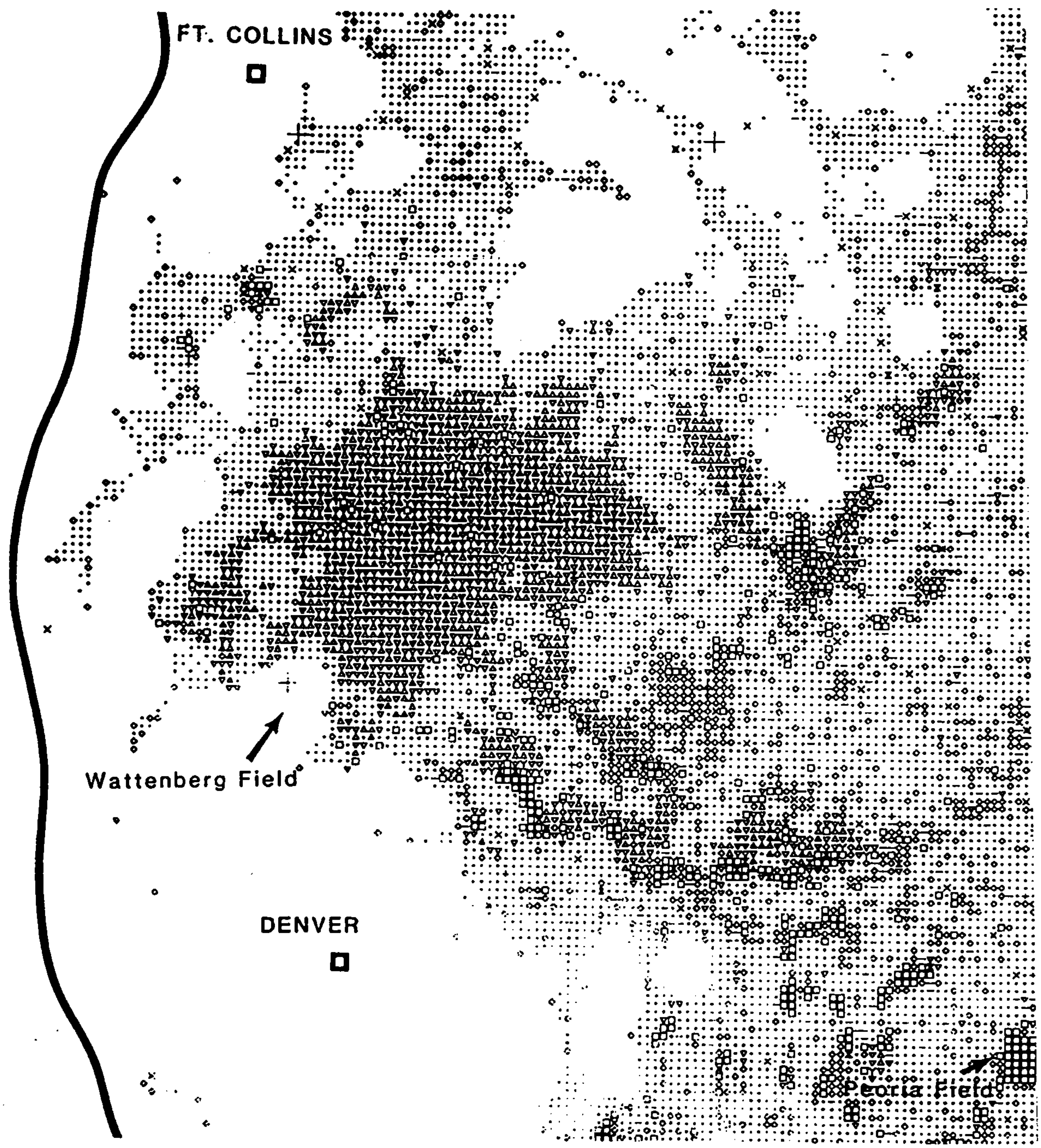


Figure 2.--Exploration intensity map of the J Sandstone in the Wattenberg Field area, Denver basin (Higley and others, 1986).

ARKANSAS OIL AND GAS COMMISSION

Randall L. Jerry, Petroleum Engineer, El Dorado, Arkansas

In Arkansas the oil and gas industry is regulated primarily by the Arkansas Oil and Gas Commission, which is located in El Dorado. Some areas of the industry such as the underground injection of oil-field fluids and drilling muds are also regulated by the Arkansas Department of Pollution Control and Ecology, which is located in Little Rock. Any records filed with the Arkansas Department of Pollution Control and Ecology are also required to be filed with the Arkansas Oil and Gas Commission; therefore, the Arkansas Oil and Gas Commission remains the primary source of oil and gas records in our state. The Arkansas Geological Commission does not regulate any oil and gas activities.

The Arkansas Oil and Gas Commission has only two office locations. In addition to the Home Office in El Dorado, which maintains all oil and gas records, we have an office located in Ft. Smith, which maintains records on only the wells in the Arkansas portion of the Arkoma basin. These records are maintained for the convenience of the gas industry located in the area. In El Dorado we are presently constructing a new office building for the Arkansas Oil and Gas Commission. After much study we think we have designed this new building to accommodate the information-seeking public.

Presently, none of our records are on a computer system. We provide the public full access to our permanent records, and even allow those records to be checked out and taken from the building.

In my conversations with many of the land persons who work in our office, as well as some other offices, I have learned that most of the other conservation offices' records are filed by section, township, and range. Our well and production records are currently filed alphabetically by field, operator, and lease name, which requires the dependence upon updated field maps. The well logs are filed by section, township, and range, but there is no means to cross-reference the log to the well or production records.

There are many problems that our office as well as industry face because of our current filing system. Retrieval of our records in most cases is an extremely slow process, and in some cases nearly impossible. Since the public has full access to our permanent records and records are allowed out of the office, we have lost irreplaceable records and continue to run that risk.

In order to solve some of these problems, our office has recently purchased microfilming equipment and an IBM System 36 computer. Currently we are in the process of filming our records and setting them up on the System 36. Once our data base is completed, the information may then be retrieved by numerous methods, as can be seen on the Selection menu. In the process of setting up our data base for our records we have tried to be storage-conscience in order to minimize the storage requirements for the data base. We have also tried to design our display outputs to be as similar as possible to our permanent records, to provide for a smoother transition to the new system. After the system is up and running we plan to utilize the data base in generating monthly and annual reports. We also plan to use the system for calculating and maintaining remaining reserves for the state.

Our office is currently in the process of searching files and recording data on data-entry sheets in order to expedite the data-entry process. We hope to complete our data entry and to be utilizing the system within a couple of years.

ARKANSAS OIL AND GAS COMMISSION

SELECTION MENU

1. AOGC Number
2. Field
3. Operator
4. Lease
5. Number
6. County
7. Sec-Twp-Rge
8. Location
9. Unit Description
10. Reservior
11. Total Depth
12. Perforated Interv
13. Permit Date
14. Commence Date
15. Completion Date
16. Abandoned Date
17. API Number
18. Serial Number

Menu Option = ______________

WELL DATA

AOGC NO: ___-___-___-___

TYPE WELL: ___ API: ______________ SERIAL: ________ COMMENCE DATE: ________ COMPLETED DATE: ________

FIELD: ______________________ ZONE: ______________________________ COUNTY: ____________

OPERATOR: ______________________________ LEASE: ______________________ NUMBER: ________

UNIT DESCRIPTION: ______________________________ UNIT SIZE: ____ TD: ______________ ELEVATION: ________

LOCATION: ______________________________ SC TW RG: ________ ALLOWABLE FACTOR: ___ % ORDER: ________

COMPLETION PROGRAM

CONDUCTOR: ______________________________

SURFACE: ______________________________

INTERMEDIATE: ______________________________

PRODUCTION: ______________________________

TUBING: ______________________________

PACKER: ______________________________

PERFORATED INTERVALS: ______________________________

ACIDIZED: ______________________________

FRACTURED: ______________________________

INITIAL PRODUCTION DATA

DATE TESTED: ________ LENGTH OF TEST: ______

PRODUCING METHOD: ______ FLOWING WELLHEAD PRESS: ________

CHOKE SIZE: ____ SI WELLHEAD PRESSURE: ________

OIL: ________ GAS: ________ BSW: ________ GOR: ______

GRAVITY: ____ OPEN FLOW: ________ BHP: ________ @ ______

TEST DATA

DATE TESTED: ________ MAX DEL: ________ AOF: ________

SHUT IN WELLHEAD PRESS: ________ ALLOWABLE: ________

OIL PURCHASER: ______________________________

GAS PURCHASER: _____ ___% _____ ___% _____ ___% _____ ___% _____ ___%

ABANDONED DATE: ________ REMARKS: ______________________________

CMD 1 = Production Data   CMD 2 = Next File   CMD 3 = Print   CMD 4 = Selection Menu

GAS PRODUCTION

MONTH	ALLOWABLE	PRODUCTION	OVER PROD	CUM PROD
JAN	________	________	________	________
FEB	________	________	________	________
MAR	________	________	________	________
APR	________	________	________	________
MAY	________	________	________	________
JUNE	________	________	________	________
JULY	________	________	________	________
AUG	________	________	________	________
SEPT	________	________	________	________
OCT	________	________	________	________
NOV	________	________	________	________
DEC	________	________	________	________
TOTAL		________	________	________

CMD 2 = Next File CMD 3 = Print CMD 4 = Selection Menu

INJECTION VOLUMES

MONTH	ALLOWABLE	INJECTION	OVER INJECTION
JAN			
FEB			
MAR			
APR			
MAY			
JUNE			
JULY			
AUG			
SEPT			
OCT			
NOV			
DEC			
TOTAL			

CMD 2 = Next File CMD 3 = Print CMD 4 = Selection Menu

OIL PRODUCTION

MONTH	OPENING	ALLOWABLE	PRODUCTION	DISPOSITION SALES	DISPOSITION OTHER	ENDING	GAS
JAN	____	____	____	____	____	____	____
FEB	____	____	____	____	____	____	____
MAR	____	____	____	____	____	____	____
APR	____	____	____	____	____	____	____
MAY	____	____	____	____	____	____	____
JUN	____	____	____	____	____	____	____
JUL	____	____	____	____	____	____	____
AUG	____	____	____	____	____	____	____
SEPT	____	____	____	____	____	____	____
OCT	____	____	____	____	____	____	____
NOV	____	____	____	____	____	____	____
DEC	____	____	____	____	____	____	____
TOTAL			____	____			____
CUMULATIVE			____	____			____

CMD 2 = Next File   CMD 3 = Print   CMD 4 = Selection Menu

CMD 5 = Associated Gas Production

ASSOCIATED GAS PRODUCTION

MONTH	ALLOWABLE	PRODUCTION	SALES	LEASE USE	VENTED	INJECTED	GAS PLANT
JAN	______	______	______	______	______	______	______
FEB	______	______	______	______	______	______	______
MAR	______	______	______	______	______	______	______
APR	______	______	______	______	______	______	______
MAY	______	______	______	______	______	______	______
JUN	______	______	______	______	______	______	______
JUL	______	______	______	______	______	______	______
AUG	______	______	______	______	______	______	______
SEPT	______	______	______	______	______	______	______
NOV	______	______	______	______	______	______	______
DEC	______	______	______	______	______	______	______
TOTAL		______	______	______	______	______	______
CUMULATIVE		______	______	______	______	______	______

CMD 2 = Next File   CMD 3 = Print   CMD 4 = Selection Menu

OVERVIEW OF OIL AND GAS REGULATIONS AND INFORMATION IN FLORIDA

Walter Schmidt, Chief, Florida Geological Survey

INTRODUCTION

The regulation of oil and gas resources in Florida is authorized by Chapter 377, Part 1, of the Florida Statutes. Under that authority six administrative rules have been promulgated to oversee and regulate exploration and production. The specific rules are Florida Administrative Code Chapters 16C-25 General; 16C-26 Permitting; 16C-27 Drilling; 16C-28 Production and Flowlines; 16C-29 Injection Wells, Well Workovers, and Abandonments; and 16C-30 Wetlands and Submerged Lands.

Currently the Florida Geological Survey is in the process of revising and amending these rules, partially in response to new statute language being added in 1987, and partially to replace antiquated operational language.

PERMIT INFORMATION

Permits regulated include (1) application to drill an oil or gas well, (2) application to drill a water injection well, (3) workover notifications, (4) plugging and abandonment of wells, (5) authorization to transport oil or gas from lease, and (6) application to conduct geophysical exploration operations.

Permit and well information is filed at the main Survey office in Tallahassee, and in our two field offices in Ft. Myers and Jay. This includes permit information such as the company organization report, their bonds, location and lease descriptions, engineering data for casing or plugging programs, seismic data, wireline logs, and cuttings or core samples.

The Oil and Gas Section maintains a computer (IBM-PC) inventory of oil and gas well data. The inventory currently contains well data for approximately 1,200 wells. Data input for each well includes permit number, oil field or wildcat well location by section-township-range-county, operator, contractor, well name, well status (service, dry hole, producer), total depth, and date of completion. Plans include adding approximately 30 new parameters to this list. A search program, written in Basic, can sort the data on any of the existing parameters.

Three other Basic programs are used by the Oil and Gas Section; these programs include a reserves-analysis program, a chloride-analysis program, and a production-data-listing program. In addition to these, the Section uses Lotus 1-2-3 to maintain an inventory and tracking system of geophysical-exploration permits. Future plans include implementing a Lotus inventory and tracking system for drilling and drilling-related permits.

All samples, cuttings, cores, logs, and well records are held confidential for a period of six months after completion. An additional 12 months can be obtained if requested by the operator in writing.

Information relating to the location of geophysical operations is held confidential unless released by the applicant. When geophysical activities are conducted on state-owned mineral lands, the state may require copies of the noninterpreted information derived from these activities. This information is held confidential for 10 years.

INTERAGENCY COORDINATION

For drilling applications in the south-Florida Big Cypress watershed, a Big Cypress Swamp Advisory Committee has been set up. This committee reviews and inspects proposed drill sites and recommends actions to the Geological Survey regarding the permit application. The committee consists of the Chief of the Geological Survey, the Executive Director of the Florida Petroleum Council, a representative from an organized conservation group, a hydrologist, and a botanist. In addition, other interested agencies attend committee inspections to offer input regarding their jurisdiction. This would include the South Florida Water Management District, the Department of Environmental Regulation, the Game and Fresh Water Fish Commission, the county, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. National Park Service, and several conservation groups, in addition to landowners and the public.

In other areas of the state, Geological Survey staff inspect the site, then other agencies are contacted to see if they have specific concerns.

Other jurisdictions that may apply to oil and gas exploration include the Florida Department of Environmental Regulation and the U.S. Army Corps of Engineers dredge and fill permits if in wetlands, a water management district consumptive-use permit, and local county permits. If geophysical exploration crosses rivers or streams or state-owned lands, a Division of State Lands use agreement will also be required, as would other forms of permission from other land owners.

CURRENT POLICY AND STAFF

It is the public policy of Florida to conserve and control the natural resources of oil and gas and the products made therefrom; to prevent waste of said natural resources; to provide for the protection and adjustment of the correlative rights of the owners of the land wherein said natural resources lie; to encourage and cause the development of oil and gas; and to safeguard the health, property, and public welfare of the citizens of Florida.

To this end the Florida Survey has 12 staff assigned to oil and gas regulation, five in the main office at Tallahassee, four in the Ft. Myers field office, and three in the Jay field office. The breakdown is nine professional engineers and geologists and three secretarial.

The newest program administered by the section is the geophysical seismic-observer program. The 1986 Florida Legislature amended the law requiring that independent third-party observers witness all drilling, loading, detonating, and plugging of all shot holes using explosives for seismic exploration. These observers are reimbursed by the applicant for services rendered; however, they work under the direction of the state oil and gas staff.

COLLECTION, MANAGEMENT, AND UTILIZATION OF ILLINOIS STATE-LEVEL OIL AND GAS INFORMATION: A VIEW TO THE NEXT GENERATION

John D. Yeko
Head Computer Scientist, Geological Records Unit

The Illinois State Geological Survey (ISGS)

The ISGS, located on the campus of the University of Illinois at Champaign, is a division of the Illinois Department of Energy and Natural Resources. Since 1905, scientists of the ISGS have been collecting data to support the study of the geology and mineral resources of Illinois. ISGS programs of basic and applied research, data collection, and public service have two major goals: (1) to strengthen the state's economy by promoting responsible development and use of state mineral resources, and (2) to improve the quality of life for citizens of Illinois by providing information vital to the development of sound environmental policy.

Organizationally, the Survey is divided into four groups, the Mineral Resources Group, the General and Environmental Geology Group, the Chemistry and Minerals Engineering Group, and the Administrative Group (fig. 1). The Geological Records Unit is administered as part of the Oil and Gas Section, which is part of the Mineral Resources Group.

The Geological Records Unit (GRU)

The Geological Records Unit has the legally mandated responsibility to act as the state repository for drill-hole data and to collect and organize these data into an information base for access by the general public, government agencies, institutions, industry, and survey staff (Illinois Revised Statutes, 1981, Ch. 96.5, Para. 5409, Sec. 6). Data are currently made available through on-site access and through the sales of copies. These data are also summarized and published in map, statistical, and list form. The oil and gas industry and Survey staff access the data daily. Public inquiries for data are fulfilled at the rate of 150 per week.

Current Collection

Currently, the GRU houses paper files for over 280,000 wells dating from pre-1900 to the present. Some 100,000 of these wells are related to oil and gas; the remaining 180,000 are water wells, coal and mineral tests, and engineering borings. Information included in these files consists of:

a) permit;
b) all logs (sonic and dip-meter logs are not required but often submitted);
c) Illinois well-completion report;
d) plugging affidavit (if one exists);
e) GRU well-summary sheet (formation tops, treatment fluids, etc.);
f) commercial-scout-services cards.

Oil and Gas Information Flow

Oil and gas information is received by GRU from several different sources. Figure 2 depicts the data sources and flow. Permits are issued in Springfield, Illinois, by the Oil and Gas Division of the Department of Mines and Minerals (DMM), the Illinois regulatory body. Twice a week photostatic copies of newly issued permits are sent from DMM to the GRU. Permit information is entered into a computer data base and the location is hand-plotted on a set of oil and gas development maps that are available for public use in the GRU. A file folder is created to hold anticipated data and filed by location in a single set of files.

Permits are valid for one year from issuance date; therefore, a monthly computer search is used to determine all non-drilled locations for removal from the development maps.

Illinois statutes require that an inspector be present when surface casing is set for a well. Reports are signed by both the driller and the inspector, and sent to the DMM in Springfield. Copies accompany the twice-a-week permit shipments to the GRU. The existence of a surface-casing report indicates that a well has been drilled and establishes the date for data submission.

State law requires that the well-completion report and all logs (except sonic and dip-meter) be submitted to the GRU within 90 days of well completion. Once each month the unit generates a list of wells that were drilled more than 120 days earlier, and for which required information has not been received. Operators are then sent reminder letters requesting the overdue data. Currently, the state is considering denying permits to any operator who is delinquent on 5 or more wells.

Logs are submitted by the operators directly to the GRU. Information may be held confidential for one year after completion of drilling, if requested by the operator.

Well-completion forms, containing information as to the final well status, casing types, perforations and treatments, are submitted by the operators to the DMM in Springfield. These are photocopied and sent to the GRU.

The Survey subscribes to both Petroleum Information and Scout Check commercial scout services. GRU receives scout tickets for all oil and gas wells reported by both services. Upon receipt of scout tickets, all well data are recorded on GRU summary sheets. The well is reported in the Oil and Gas Development Report for that month. The Oil and Gas Development maps are updated with current well status.

Formation-top values are taken from the service-company cards and compared against each other and against any values that may have been reported on the logs or by the driller. If top values are within 2 feet, they are entered into a computer file along with a commercial-service-company source code. If values show any greater discrepancy, a GRU or Survey geologist examines the logs to resolve any disagreement. The agreed-upon values are then entered into the computer, along with a code identifying the geologist who picked the tops and resolved the differences.

Any subsequent data, such as mechanical-integrity tests, cased-hole logs, or plugging affidavits, are added to the files when received.

In the case of plugging affidavits, state law requires that an inspector be present when all wells are plugged. These reports are then filed by the inspectors with the DMM, who in turn photocopy the reports and send them to the GRU. Upon receipt of the affidavits, the well locations on the Oil and Gas Development maps are updated and the affidavits are added to the file for the wells. The well-status codes are then changed in the computer history file.

Computerization —— The Historical Perspective

In 1968, ISGS began the process of entering oil and gas and other borehole information in a computer data base. Between 1968 and 1980 data for 197,000 wells were entered. These data included the location (in the legal-description format), log availability, and other "header" - type data.

Also in 1968 an effort to digitize the state land-survey grid was initiated, and a computer program was developed to convert legal descriptions to Lambert X-Y coordinates in the Lambert Conformal Conic Projection. This effort was completed in 1971, and the Survey released the digitized grid and software to the general public, under the product name Illimap.

From 1980 to 1984 no additional well-data points were added to the well data base. Forty thousand additional historical well-data cards were punched but were not added. No updates were made to the data base to reflect changes in well status.

The number of staff members in the GRU was low as the oil price boom began. The demand for data during this time tripled, forcing the GRU staff to spend considerable time filling orders for data. The demand was so high that staff were unable to fulfill the paper-processing aspect of the work at times.

In September 1983, the Department of Energy and Natural Resources (ENR) acquired a Prime Computer with the ARC/INFO Geographical Information System. In 1984, the well data and the Illimap system were moved from a University of Illinois IBM computer to the ENR Prime. Additionally, staff has been increased from six in 1983 to 15 in 1987 to handle the required effort.

During the last three years, numerous entry screens and applications have been developed to utilize the data base. The conversion of sequential files of data to a relational data-base system proceeded with some facility. However, the conversion from the graphics Illimap data base/software to ARC/INFO data base and legal conversion software was difficult and required additional time. Difficulties involved with the Illimap conversion stem from the irregular section shapes, partial sections, and Indian Boundaries. Parts of the original grid were re-digitized to provide greater conversion accuracy.

Current System Capabilities

The current computer data base consists of four related data tables, each having different wells representing data base growth as data items have been added to the data-base design over time. Data table 1 has 225,516 wells; it contains the original data items keypunched when the data base was first started. Data table 2 is an expansion of the basic header-type data. Started in 1984, this data table tracks each permit, relating workovers, deepenings, and conversion, and providing a more complete well history (15,000 wells). Data table 3, created in mid-1985, contains completion information for each well reported in the monthly drilling report since that time (5,000 wells). Data table 4, started in January 1987, contains geological tops, core descriptions, initial potentials, and treatment information (4,000 wells). This table contains all the information that the survey has for a well; it also contains references to core analyses or any other type of chemical analyses that may have been run on any samples.

Future Innovative Directions

The worst mistake that can be made in data-base development is to allow the data base to remain static. As a data base increases in size, its use both in numbers of accesses and in the complexity of each use also increases. Limited access has been extended to other state agencies. In doing this, software and hardware limitations have become apparent. A program design for additional hardware and software has been completed to expand the limited performance of interactive prime-time access. In addition, plans include public real-time access. Data are currently available for sale to the public on both printed and magnetic media, based upon areal and logical criteria. Areal criteria include such factors as county, township, range, section; logical criteria include such features as producing formation, and total depth.

The Role of the Personal Computer --- Internal (ISGS)

The Personal Computer (PC) can provide an immediate "shot in the arm" to any existing mainframe data base. Over the last year the GRU has placed four PCs and a laser printer into the data flow pattern.

The PCs are used for data input, verification, and generation of hard-copy summary reports. In addition, the PCs are connected through direct 9,600 baud lines to the PRIME mainframe. Software was developed and implemented to allow for data to be entered into the PC "holding" files. These data are then verified and printed before the data are uploaded into the mainframe data-base tables.

Multiple benefits result from this PC usage: (1) Data-base management software is mainframe-memory-intensive; by moving the entry software to the PC, mainframe usage is reduced, allowing the mainframe to be used by other software. (2) There is an overall decrease in "downtime"; personal computers are single-user-dedicated, so that there is no impact due to scheduled or unscheduled mainframe downtime, nor is there adverse response time due to heavy user loads. (3) Many PC software packages provide an overall ease of use that is much better than those available for mainframe computers; in addition, "user-friendly" software for entry and verification of data can easily be developed using PC languages and data-base packages. (4) Error-checking and correction are all handled before the data are loaded, reducing the problem of multiple users trying to update the same mainframe data-base table at the same time. Most mainframe data-base software packages restrict the update privilege to one user at a time. This would prohibit two individuals loading/changing data at the same time. With PC entry, actual updates to the data base are made in batch runs during off hours.

The Role of the Personal Computer --- External (Public)

The majority of external data-base users are expected to be small independent oil companies. In recognition of this fact, software is being developed to allow for external communication and use of the mainframe data base by PCs. The PC will be used as a communications device. Plans include general on-line access to the mainframe data base through a modem and a system that gives menu access to different data-base tables and fields. Such a system already exists on the ENR Prime; however, well data have not yet been made part of the available data. Charges will be based on connection time and the number of records examined. The major benefit is that a data count (i.e., PRINT # WELLS IN ...THAT...) will be charged only connect time, and a small user's fee. Once data have been selected, these data may be downloaded to the user's PC to create a localized data base. GRU plans to provide an IBM-PC-based software package to the public for management of the data. The user will then be able to use commercially available software to produce maps or to do other statistical operations.

Relational Data-Base Technology —— The Software Problem

Today's relational data-base management software packages (DBMS) have advanced greatly from their sequential data-file beginnings. Despite this progress, there are still shortcomings to these systems:

1) Searches through large data bases like the 280,000 records in our well files require more time than is available to respond to phone queries by industry and the public.

2) DBMS software packages are memory-intensive packages. Multiple users executing lengthy searches that compete for machine resources with other application software (i.e., gridding and contouring software) often result in big dollar requests for memory and machine upgrades. With each upgrade overall use and data volume also increase.

3) There is no accepted universal query language for data-base use. The lack of a universal language becomes a problem in a multi-vendor shop, or when trying to share data-base front-end software. The same DBMS will often have a slightly different implementation on different machines, resulting in dissimilar commands. User training is therefore more difficult. Releases of new versions of a DBMS package may not be available at the same time for all support machines. Communications within a multi-vendor shop may also cause problems. The ISGS has a PRIME and plans to add a VAX. Which machine should house the data-base software? How should data transfers be effected? Should a duplicate data base be maintained, utilizing, in the best case, duplicate disk space, and in the worst, duplicate manpower?

4) Most software DBMSs provide for a transaction log that may be saved and used to recover previous versions of the data base. However, short of keeping another on-line backup system, little can be done in the event of disk failure. In dealing with a real-time system, the threat of a hardware failure is a real concern.

Choosing the correct machine and software has an impact on the timeliness and probability of the overall success of the data base.

Intelligent Data-Base Machine —— The Hardware Solution

The ISGS has elected to pursue a hardware solution to software data-base problems. An IDM (intelligent data-base machine) is a fully relational data base implemented on specialized hardware to perform the DBMS functions. Such a computer is installed between existing computer(s) and the data-base disk drives and can function as a stand-alone data-base computer or as a back-end processor serving one or more mini, micro, or mainframe computers. This machine can offload the host computer, relieving it of resource-consuming data-base-management tasks.

Because the hardware contains the DBMS, the host machine needs only to keep a small overhead program running, thereby limiting required host memory. This overhead software consists of a small FORTRAN program which accepts the data-base request and passes it to the IDM. Data are retrieved by the hardware and passed back either to the screen or onto the host disk. Because the DBMS program is burned into the chips rather than executed in general memory, execution time is much faster than for a software-based DBMS.

Since the IDM can be hooked to various mainframes as well as mini-computers, data are available to all machines from the single data base. The retrieval language is the same for all machines, including the PCs. The language may be either SQL (the IBM and Oracle standard) or QUEL (the VAX INGRES standard).

The IDM is specially designed with data integrity in mind. The system maintains a transaction log that is written to disk before the action has been taken and flagged after the action has been completed. Data recovery can be accomplished by use of the log. The hardware can support mirrored disk packs, which are duplicate copies of the data on two disk drives. In the event of a head crash, data can be used from the remaining drive. When new records are updated, both drives must be written to. However, when a request takes place, the hardware determines which drive has its head closest to the desired data and the read occurs on that drive.

Maximum data-base size is dependent upon system configuration. However, an entry-level system with base configuration will support 50+ data bases with 32,000+ tables per data base. Table size is limited to 250 columns by 2 billion+ rows. Total user support is for 128 to 400 users, depending upon memory.

ISGS Data Base —— The Shape of the Future

During the next two years, the ISGS expects to update to this new data-base technology and continue to expand our data-base use.

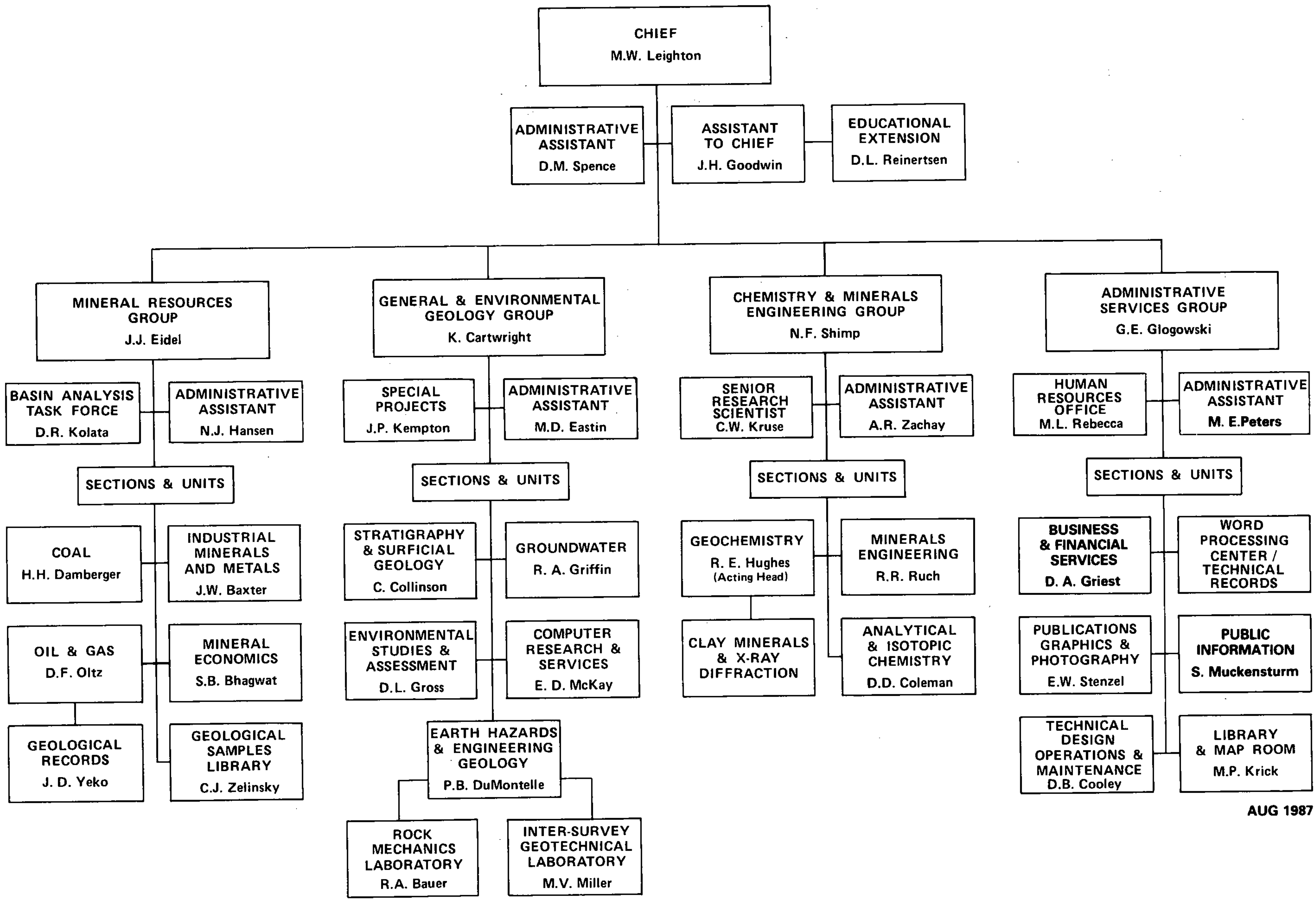
A joint effort between the Survey and the Department of Mines and Minerals is in an advanced planning stage to develop the software required to assist inthe permit-issuance process. Direct lines between Springfield and Champaign will be utilized to scan for duplicate locations, sample-set requirements, and particular areal problems (e.g., mined-out areas).

The permitting of Class II injection wells will require utilization of the data base to determine depth to freshwater aquifers and to check all wells within 0.5 mile radius for proper plugging. Along with a mapping package, examination of aquifer extent from surrounding wells will also be available. Interactive phone inquiries and direct public use will be possible.

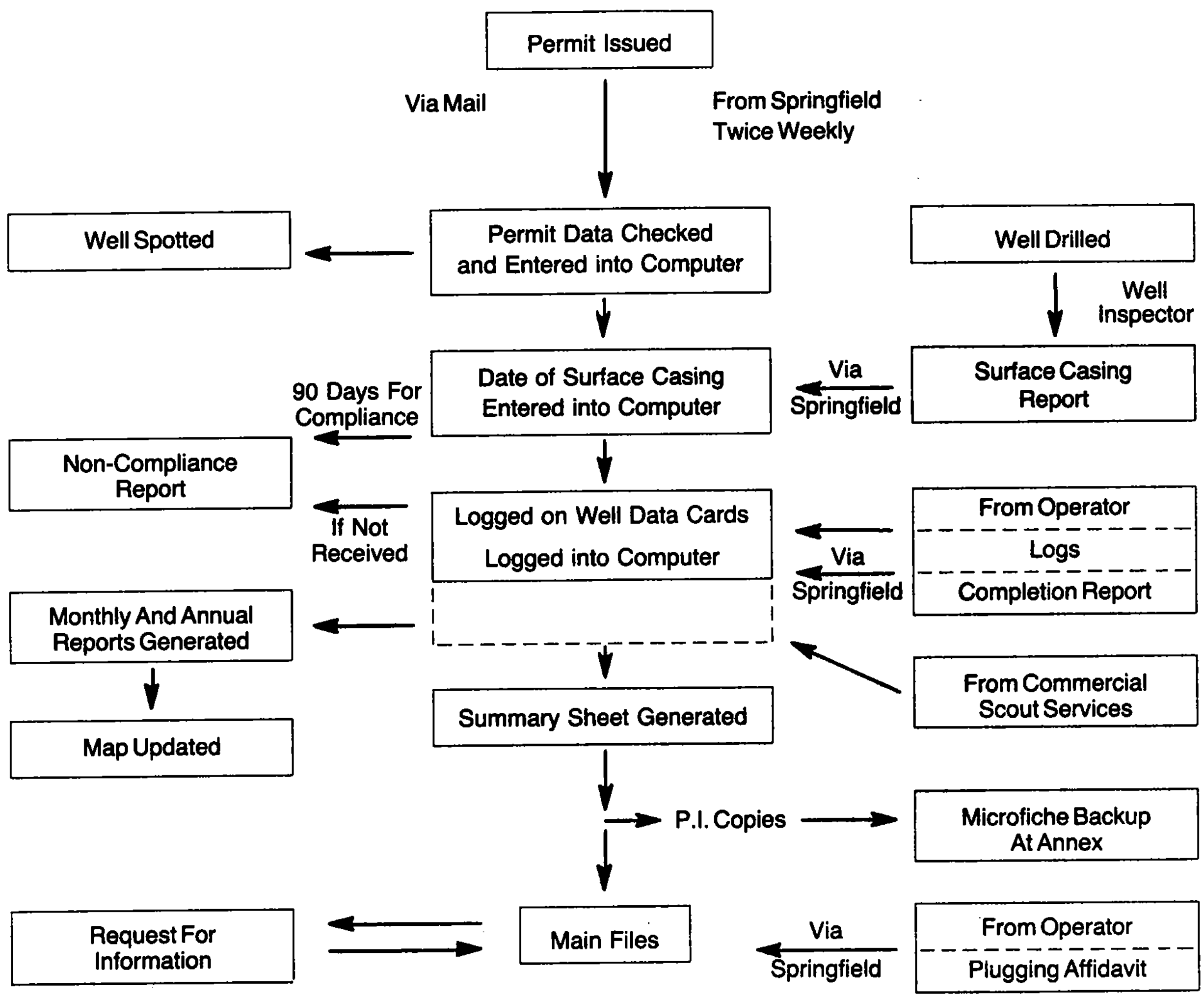
Last, this system will form the backbone of the Oil and Gas Section's reservoir-characterization and enhanced-oil-recovery support effort by providing rapid data-management techniques that will allow us to relate data from numerous studies and evaluate possible trends in an effort to define reservoir heterogeneity and the impact of contrasting enhanced-oil-recovery procedures. The ISGS is now integrating these data with sample analyses and sample sets which represent over 740 million feet of drilling in Illinois. Sample sets are housed in library form at the ISGS and are available for inspection by industry and the public. Linkage between data bases such as TORIS at the Bartlesville Project Office of the U.S. Department of Energy and the ISGS data bases may alleviate the need to transfer data by letter, as at present.

The next generation of ISGS data bases will provide an example of the utility of an IDM in a system with on-line communication between government agencies, industry, and the public.

ILLINOIS STATE GEOLOGICAL SURVEY



ILLINOIS OIL AND GAS DATA FLOW



OIL AND GAS INFORMATION IN KANSAS

CURRENT ACTIVITIES, FUTURE TRENDS

Comments by David R. Collins, Ph.D.
Manager, Technical Information Services
Kansas Geological Survey

CURRENT ACTIVITIES

The principal state agencies collecting oil and gas information in Kansas are the Department of Revenue (KDOR), the Oil and Gas Conservation Division of the Kansas Corporation Commission (KCC), and the Department of Health and Environment (KDHE). Although not a state agency, the Kansas Geological Survey, which is a division of The University of Kansas, has long been the State's primary repository of records relating to the oil and gas industry. Drillers logs, completion reports, and other records which operators are required to file with the KCC are forwarded to the Kansas Geological Survey. These records are made available to the public through the Survey's oil and gas library, operated by staff from the Survey's Technical Information Services Section (TIS). TIS also maintains numerous other data sets relating to the oil and gas industry in Kansas. These include Petroleum Information's well-history control system, oil and gas lease-production histories, scout-card files, sample logs, and an archive of electric logs. In addition, the Kansas Survey operates a core library in Lawrence and a well-sample library in Wichita. The salaries of about half of the staff at the Wichita office are paid from fees generated by use of the well samples. Oil and gas information relating to Kansas is also maintained by numerous commercial vendors and by professional societies, notably the Kansas Geological Society, with offices in Wichita.

An important primary source of information has been reports filed with fees collected by the three state agencies listed previously. The 1986 session of the Kansas Legislature consolidated the reporting and payment procedures on fees collected by these state agencies, establishing a single report and payment submission to the Department of Revenue, with subsequent distribution of monies and information to appropriate agencies. Some problems have been associated with this consolidation, particularly related to transmission of production data to data repositories such as the Geological Survey and to vendors such as Petroleum Information. A working group has been established with representatives of the Department of Revenue, the KCC, Kansas Geological Survey, Petroleum Information, and other data vendors to improve the distribution of data by the Department of Revenue.

Because the Kansas Geological Survey is the primary public repository for oil and gas information in Kansas, the rest of this report will focus on the operations of the Survey's Technical Information Services Section (TIS). TIS staff members have continuing responsibility for maintenance and updating of the Survey's extensive collection of oil and gas records.

Procedures have been implemented to control access to the well-log archives, to establish a record of the locations of logs removed from the archives, and to identify logs which have been lost.

A sortable file of information on wells with logs or samples held confidential has been prepared for the Wichita Well Sample Library. A program for addition of new or renewed confidential wells to this file and automatic listing of wells to be released will be developed to run on the library's Zenith computer.

TIS has created a KGS Data Directory. A data-entry program has been designed to facilitate addition of new data-set descriptions to the data base, approximately 120 data-set descriptions have been entered, and the on-line Data Directory Query System is operating. A PC version is under development. The descriptions of almost one-fourth of the data sets in the KGS Directory are being sent to the USGS for inclusion in the Earth Science Data Directory.

A data-entry program has also been developed for computer entry of critical information on newly received completion cards. From this information, maps can be automatically generated to show recent trends in total drilling, dry holes, successful wells, type of production, producing zones, and total depth.

During the Survey's recent efforts in production of the Kansas proposal for the Superconducting Super Collider, TIS staff members were involved in searching oil and gas records (driller's logs, scout cards, sample logs, and wire-line logs) for all usable information on formation tops in the study area. The group generated structure maps on multiple formations of interest. In the process a great deal was learned about improvements which need to be made in quality control of data sets.

A major area of concern relates to error-detection feedback. Scientists conducting detailed area studies frequently identify significant inaccuracies in one or more well-history data sets. Such errors are corrected in the data bases for their specific research projects, but feedback rarely occurs to the original primary data base. The Kansas Survey is working on methods for improved feedback of problems identified within these primary data bases.

TIS staff members respond to a continual stream of requests for conventional mineral-information services. These requests involve locating and copying oil and gas records, summarizing lease-production histories on specific fields or areas, and a long list of oddities which would provide good script material for the Twilight Zone.

The Kansas Geological Survey has been a leader in development of software for analysis of oil and gas data. SURFACE II and KOALA are two systems that have developed worldwide use. The Survey will continue to maintain its commitment to the idea that access to the capability to analyze information is as important as access to the information itself.

FUTURE TRENDS

Technical Information Services was originally conceived as a focal point within the Survey for development of a first class system providing information services in the geosciences. The resulting information system would employ new techniques in electronic data processing and computer science. Objectives include creation of facilities for the development of project data bases, for identification of and access to available data/software, for interactive computer-graphic display of analytical results (particularly those related to analysis of spatial data), and for production of maps to convey the information. This concept will be applied to management, analysis, and distribution of oil and gas information.

The following statements are from the Survey's request for budget enhancements for FY88 and FY89:

> "Section III: New Directions and Funding
> ... Technical Information Services: ...Other state agencies stress the need for data acquisition and for accessibility of data through publication of computer-assisted maps rather than older forms of narrative publication. This technology transfer related operation will eventually require enhancement...
> The other area of Technical Information Services that needs enhancement for FY88 is the basic staffing and operation of computer data base development and access. Integration of the efforts of the automated cartography section and the data bases for advanced data presentation should be initiated immediately,... Business development is closely tied to information access and technology transfer. The KGS intends to lead in these areas..."

Methods will be improved and standards established for responding to requests for area studies of drilling and production histories. Response procedures will include: request for an area base map from Automated Cartography, search of the Well History Control System (WHCS) and listing of all well data in the area, comparison of our multiple sources of well data with the WHCS to evaluate completeness of the WHCS (driller's logs, scout tickets, completion cards, e-logs, sample logs, Wichita Well Sample Library holdings list, Herndon maps, etc.), possible digitizing of lease boundaries, printout from our production-history files of lease and field production histories, automated analysis of production declines with plotting of lease or field decline curves, comparison of computer files on production history from PI with other sources (Dwight's, Vance Rowe, Department of Revenue, etc.), development of a master data base for the study area (including augmenting the WHCS), production of appropriate maps by Automated Cartography to accompany a resulting KGS Technical Report. When established, this procedure will be more thorough, of more lasting value, and probably easier to accomplish than the existing methods. The reports may have a significant commercial value.

Staff from the Survey's Advanced Projects section have been working for some time on methods of evaluating production-decline curves which are superior to methods applied on commercially available decline-analysis software. Development will proceed on related software which the Survey could make available to the local oil and gas industry.

Continued improvement of the KGS Data Directory will occur, along with development of a KGS Software Directory for Survey staff and (in a possibly restricted version) for the general public. While currently limited to a system for obtaining information about data sets, the Survey's ultimate objective is to provide users with the ability to find an appropriate data set and then have direct access to the data. These developments will be related to improvements in the on-line searching capabilities of the Bibliography of Kansas Geology and other reprint catalogs to be developed for the Survey's library.

Several automated data sets are currently being made available on floppy disk or as a computer printout. These include the Kansas plugging report, the cumulative-field-production histories, and the annual oil and gas production report. Response from early users of these products suggests that some improvements could be made in data format which would improve demand for the products. In a related activity, the Kansas Geological Survey is currently represented on the AAPG Data Standards Committee, which is considering the issue of appropriate standards for data-exchange formats.

TIS has begun development of a system for automated production of a periodic petroleum-statistics report. This effort will be coordinated with the KCC and their report on Kansas energy statistics. To conserve initial data-entry requirements the Kansas Survey is negotiating with the Kansas Independent Oil and Gas Association (KIOGA) to obtain computer data files which Midwest Research Institute prepared for KIOGA as part of its 1984 Kansas Oil and Gas Database.

An essential element for transfer and display of information generated in a typical geologic study is the facility to produce high-quality maps integrating feature attributes with base-map data. Acquisition of a relational data-base management system will enhance capabilities to associate multiple attributes with point, line, and area features currently handled by the Survey's Geodata Interactive Management Map Analysis and Production (GIMMAP) system. Analytic capabilities of the system currently relate to topologic analysis of the digitized data for system data-base structuring and metric analysis, such as distance, length, and area measures related to mapped features.

The automated cartography capabilities of the KGS have been used in numerous research projects in conjunction with software for geologic or hydrologic analysis and interpretation of data. However, the cartographic, analytic, and interpretive software has not been developed into an integrated, geologically oriented, interactive information system. This is a primary area of development with which Technical Information Services will be involved in the coming years and will play an important role in display of oil and gas information.

A final aspect of the Survey's future plans for handling of oil and gas data involves the issue of growth of geoscience information and the related problems of data storage and access. Much of the data and technical information accumulated by the KGS is received in hard-copy format, not immediately compatible with computer entry. This material must be stored in an organized fashion which permits ease of location. Examples of this type of data set include driller's logs and electric logs from oil and gas wells. Both data sets expanded by 50% or more during the past decade. The driller's logs (KCC form ACO-1) are single-page forms. This data set occupies over 230 feet of shelf space, with information on more than 250,000 wells. The electric logs are stored in a collection occupying more than 1000 running feet of shelf space. A rough estimate indicates that the collection contains information from over 100,000 miles of drill holes in the Kansas subsurface.

Conversion of this material to computer storage on conventional magnetic disks is impractical because of the vast quantities of data involved. A solution to the mass-storage problem exists in the recent developments of optical disk technology. Documents can be run through an optical scanner, creating a digital transformation of the image which is then engraved by laser on an optical disk. Data sets already in digital form can be written directly to an optical disk. Our interest in these systems stems from the fact that orders-of-magnitude more data may be stored on small rigid optical disks than with current magnetic storage technology. Optical disks ranging in size from just under 5 inches to 12 inches in diameter can store anywhere from 500 megabytes to 3.2 gigabytes of information per disk. They have the further advantage of an apparent infinite shelf-life for data storage in this format. Currently available technology would reduce 230 shelf feet of driller's logs to a box of ten 5.25-inch optical disks. Readers for the CD-ROM technology now cost about $500 and can be attached to standard PCs. The Kansas Geological Survey intends to actively pursue the use of this technology for distribution of oil and gas information.

Oil and Gas Activities, Maryland

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Maryland Geological Survey
Department of Natural Resources
State of Maryland

The Maryland Department of Transportation, through the district offices of the State Highway Department, issues permits to conduct seismic operations along State routes.

The Maryland Geological Survey (MGS) of the Department of Natural Resources (DNR) issues drillers permits for a one-year period on a fiscal year basis beginning July 1 each year. It also issues well-drilling permits on the legal advice and review of the application by the Assistant Attorney General's Office of the DNR. The MGS compiles quarterly production statistics from Columbia Gas Transmission Corporation and monitors exploration and drilling activity within the state and bordering states. It reports oil and gas data to Petroleum Information, World Oil, AAPG, IOCC, NE Oil World, IPAA, DOE, and is the customary source for disseminating oil and gas information to the general public. None of this information is computerized and there are no immediate plans to do so. Since 1888, there have been about 385 wells drilled in Maryland (including some "deep" water wells). The rate of drilling for the past 10 years averages one or two wells per year, a number not yet too overwhelming for manual input. The MGS also obtains the required completion reports and geological logs on these wells.

Each County Health Department must have an erosion and sediment-control plan on file and obtain a local grading permit for well-site construction.

If water is to be used on site from a stream or a drilled water well, a drilling permit and/or a water-appropriation permit must be obtained from the Water Resources Administration of DNR.

If the same waters are to be discharged after use, a surface-water-discharge permit must be obtained from the Waste Management Administration of the Department of the Environment.

There is the possibility of prolonged public hearings on some of these latter permits, such that water is often trucked in and later disposed of in adjacent states, whenever an oil or gas well is drilled in Maryland. Thus far, only natural gas has been produced; no oil has been encountered.

OIL AND GAS DATA-MANAGEMENT ACTIVITIES OF THE MICHIGAN DEPARTMENT OF NATURAL RESOURCES, GEOLOGICAL SURVEY DIVISION

by Steven E. Wilson

Michigan oil production began in 1886. However, meaningful production did not start until 1927. With production came regulation. Regulatory activities culminated in Act 61 of the Public Acts of 1939. Act 61 has been amended through the years. These minor changes notwithstanding, Act 61 has served as the infrastructure for Geological Survey Division oil and gas program definition and activity. In 1986, Michigan production came from 836 oil fields, 392 gas fields, 49 gas storage fields, and 6 liquid-petroleum gas fields.

In Michigan, four State agencies gather and manage oil and gas data. The Department of Commerce, Michigan Public Service Commission, is responsible for prorating dry-natural-gas production. The Department of Natural Resources (DNR), Geological Survey Division (GSD), is responsible for permitting, prorating, and keeping records. The DNR Real Estate Division is responsible for State royalties. The Department of Treasury, Motor Fuel, Cigarette and Miscellaneous Taxes Division is responsible for State severance tax.

Since 1978, I have been involved with the GSD Geologic Information Systems (GIS). Understandably, I am most familiar with systems used by the Michigan GSD. I am not knowledgeable enough to comment on the other systems. Therefore, my comments are restricted to personal experience.

The agencies noted above have formed a committee to determine how data acquisition and entry can be streamlined and more effectively cross-checked and validated. One basic recommendation is that only one agency should serve as a central collection point for the State. Furthermore, computer-readable materials will be encouraged. We hope to have a report for our respective managers by January. With their concurrence and support, the system will be presented to industry for comment. After review and comment by management and industry, we hope to put the system to work. The report is not yet available. If you would like a copy, when it becomes available, please contact Geologic Information Systems Unit, Michigan DNR, Geological Survey Division, Box 30028, Lansing, MI 48909.

Although the GSD primarily is a regulator, it has resource-management mandates as well. The GSD is responsible for monitoring and managing many aspects of oil and gas activity. Permitting, bonding, and monitoring the plugging of all wells is conducted by the Permit and Bonding Unit. Determination, monitoring, and enforcing proration of oil reservoirs is done by the Proration and Technical Evaluation Unit. Collecting and maintaining subsurface information is under the purview of the Subsurface and Petroleum Geology Unit. If it is determined that a field is a dry-natural-gas reservoir, jurisdiction is transferred to the Michigan Public Service Commission.

A strong, effective compliance program helps the GSD gather data needed for regulation and management. Records can be held confidential during drilling, and for 90 days after completion. If, after due administrative process, an operator still has not filed all records due, permits for drilling can be denied.

For the GSD, computer based oil and gas data management began in 1978. The first mainframe computer application was implemented in 1981. Program development has been accomplished by a staff of up to three programmers. The actual number of programmers who have worked on the GSD GIS is 10. The current programmers have developed a thorough knowledge of GSD programs, in addition to their data-processing skills.

In 1985 we began converting GSD GIS programs. Program development is migrating from a Burroughs-based hierarchical data-base environment to an IBM-based relational data-base environment. The conversion has been traumatic, but the net results should be improved performance. The resulting system will be a more comprehensive system than before. Not only were the strong points of the old system converted, but old problems were corrected. This is because we now have a better definition of the system than when we started. The conversion will transfer program development to a computer over which the DNR has direct control. By itself, conversion is not desirable. However, we were able to use it to our advantage.

Another aspect that has been addressed by the new system is production accounting. This has been accomplished by assigning production-unit identification codes (PRU). This coding resolves the many-to-one and one-to-many accounting problems that are not resolved by API or permit number alone. Furthermore, by assigning PRUs to various tables we can readily and very accurately produce statistics by formation, geography, or whatever is needed.

There are three major components in the GIS. These parallel the organization of the GSD described above. To date, only one component is being beta tested. The first part is expected to be operational by December 1987. Having worked through the learning curve on the new system, program development should progress more quickly. We anticipate another 24 to 36 months before conversion is complete.

While the GSD GIS was developing, changes occurred elsewhere. In 1981 the Department of Natural Resources, Land and Water Management Division, began development of a statewide computer cartographic system called the Michigan Resources Information Systems. The system uses Intergraph software and operates on a Digital Equipment VAX computer. The most recent geologic application was the compilation of a State Bedrock Geology Map. The new map was compiled from computer-digitized versions of hand-contoured county maps. Base-map information and the related geology could be printed separately or combined, at any scale. This made editing and replotting much simpler than before. We plan to use the planimetric, cadastral, and land-use information compiled in this mainframe environment in our PC/AT-based cartography system. This graphics base will be merged with oil an gas data to produce location, contour, and isopach maps.

In 1983, an IBM 5520 Administrative System was installed. This is a shared-resources system designed for word processing and data-file manipulations. There are seven work stations and two printers in this system. They are located in the Lansing office and are connected via synchronous communications to the IBM 4381. These work stations function as word processors and as terminals to access the mainframe programs, peripherals, and other systems. The mainframe, with its communications servers, is acting as the hub in a star topology network.

Late in 1984 the first group of IBM personal computers were installed. The Survey now has 30 personal computer installed in 11 locations across the State. There are 24 PCs, 2 PC/ATs, and 4 Compaq Plus units in use. The PCs will eventually serve as data-acquisition and query stations for mainframe applications and continue to provide stand-alone functions. The main applications program is the integrated package Framework II, published by Ashton-Tate. Framework performs well and serves most of our needs. Some user needs require additional specific applications programs. Presentation graphics, data-base, and cartography top the list. We hope to be expanding our desktop publishing and computer-cartography capabilities this year. Expanding desktop publishing capabilities, we will take advantage of the file-transfer capabilities between the PCs, the 4381, and the 5520. This will also help us optimize use of our laser printer.

Telecommunications is achieved both synchronously and asynchronously. The synchronous links are between the DNR mainframe and terminals or PCs, with emulation capabilities. Data transmission occurs at a baud rate of 9,600. This high transmission rate requires special "conditioned" telephone line. PCs converse using 1,200-baud asynchronous modems over normal telephone lines.

The GSD produces several reports from the GSD GIS. Quarterly and Annual Prorated Production Summaries, an Annual Statistical Summary, and a many internal cross-reference listings are available for sale. Initially these reports were very expensive. But, the cost goes down every time we regenerate the reports to reflect the changes and additions in the GIS since the report was last run. One proration report is approximately 250 pages long.

Many problems have outcropped along the way. The most obstructive problem has been the alleged "acquisition system" that has been foisted upon obtainers of computer equipment. The process is a hindrance. I believe it has cost the State money due to lost opportunity to take full advantage of this rapidly evolving technology.

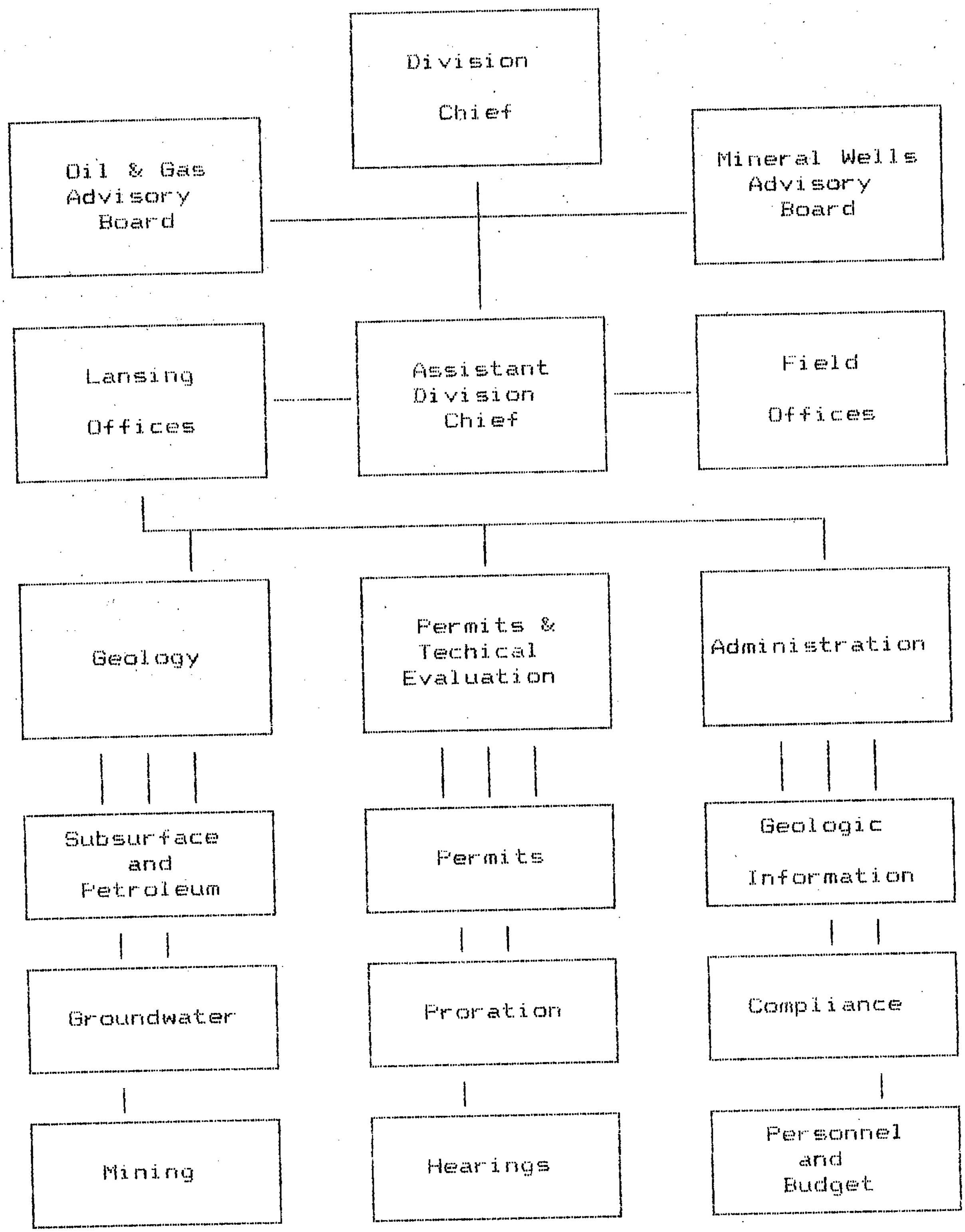
To date at least nine studies have been done on various aspects of the GSD GIS. Theses studies were done to define overall system needs and a long-range plan. How much can come from a study that lasts only months and covers such a broad scope? It would be better to develop analysis capability in-house.

Planning, funding, and the budget process require that someone determine what will be needed when, and how much it will cost. With the rate of technological change bordering on mutation, this job is difficult. Numbers and cost are an integral part of planning. Luckily, computer cost most often go down. Users needs change as the system develops. However, this is still a worthwhile exercise if new, proven technology can be added to the system and not disrupt work or bankrupt the budget.

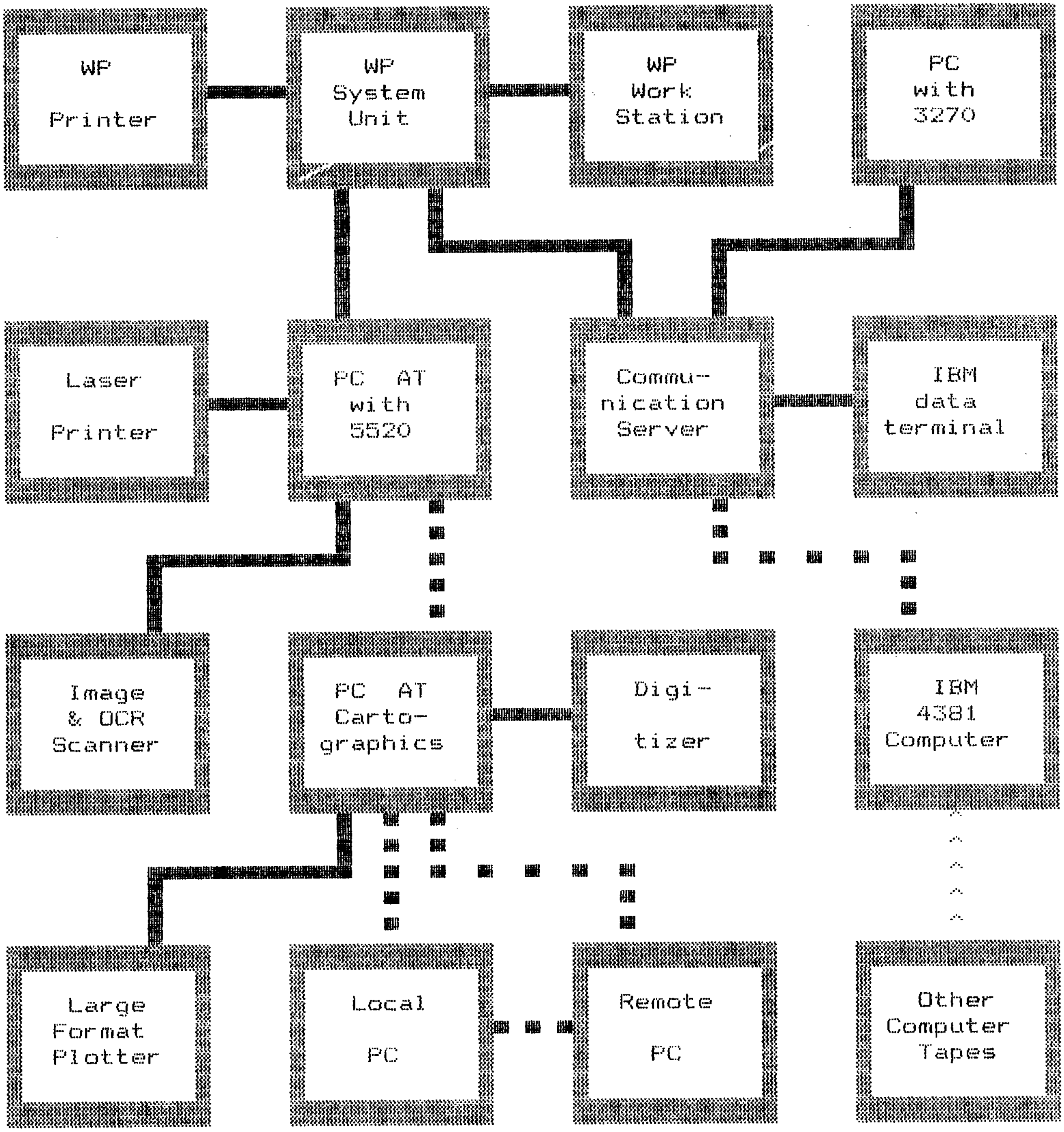
Power struggles are near the top of the list of problems. I have encountered "people versus machines" confrontations. Some employees were honestly concerned that computers could put someone out of work. Not likely. They were reassured when they saw that computers could make some jobs easier and that no one lost a job as a result. However, an organization should be ready for the eventuality that computerization may result in reassignment of personnel as work loads change.

The perennial battle of future return versus present expenditures goes on almost daily. The most common guise is cost justification. The problem is magnified when no one will quantify how much return equals justification.

Luddites or antitechs are another common pill. These are the people who do not want to change from the way it is done now. I have found that focusing attention on the accomplishments of a more receptive person helps. When the Luddites find out, by the example of others, that change will not adversely affect them, they find it easier to accept. If antitechs have access to decision-makers, you might have to do extra duty to avoid backsliding. Accentuating the positive works here too.



GENERALIZED GEOLOGICAL SURVEY DIVISION ORGANIZATION CHART



SCHEMATIC DIAGRAM OF GSD GIS COMPONENTS & CONNECTIONS

(solid line) = Direct connection

■ ■ ■ = Telecommunication link

^ = Manual transfer

OIL AND GAS DATA MANAGEMENT

IN MISSISSIPPI

BUREAU OF GEOLOGY

OIL AND GAS BOARD

by

S. CRAGIN KNOX
Mississippi Bureau of Geology
4 December 1987

THE MISSISSIPPI BUREAU OF GEOLOGY

The present Mississippi Bureau of Geology was conceived and founded by the State Legislature on March 5, 1850, as the Agricultural and Geological Survey of the State of Mississippi. The Survey was initially based at the University of Mississippi in Oxford. The Survey's first responsibilities were centered around the completing of a geologic map of the state and compiling both a geologic and agricultural report to the Legislature. The original map was published in 1854, with updates in 1857 and 1860. The first publication, "Report on the Agriculture and Geology of Mississippi," was published in 1854.

In 1906, the Legislature passed a bill creating the Geological Survey of Mississippi, with an associated increase in responsibilities and staff. The Survey's responsibilities in the field of economic geology were even more diversified by the discovery of natural gas in Monroe County, Amory Field, in 1926, and in Hinds County, Jackson Gas Field, in 1930, and the discovery of oil in Yazoo County, Tinsley Field, in 1939. As Mississippi is an oil-producing state, the preservation of cuttings and cores donated by the oil companies to the Survey is of utmost importance. Space allotted for the sample library to provide for the storage of the cuttings and cores was filled to capacity by 1958. In December of that year the request for additional space was presented to the Mississippi Building Commission. At this time it was concluded that to serve the oil industry to the maximum the sample library should be located in Jackson and not at the University. The Building Commission agreed to provide the land and approximately one half of the needed finances with the stipulation being the balance required would be supplied by the local oil companies. The sample library, located at 2525 North West Street, Jackson, was first occupied in June 1960. The Survey was at this time located in two different and widely separated places. The new sample library was located in Jackson, while the Director and the majority of the staff remained at the University of Mississippi, separated by a distance of approximately 165 miles. The relocation of the Director and the entire Survey staff to Jackson was undertaken and completed in late 1962.

The State Legislature passed an Act, effective July 1, 1979, combining several agencies of similar functions into the newly created Department of Natural Resources, with the Survey becoming the Bureau of Geology. The Mineral Lease Division was added to the Bureau of Geology by the same law creating the Department of Natural Resources. The Mississippi Bureau of Geology presently employs a professional staff of 19 and a technical support staff of 9.

The Bureau presently maintains a Geological Library having over 3000 linear feet of shelving. Holdings include publications of the Mississippi Bureau of Geology, other state geological surveys, United States Geological Survey, trade journals, professional organizations, societies, Canadian Geological Survey, and other foreign countries. Coverage of southeastern and Gulf Coastal geology is emphasized. The library receives, at present, approximately 300 publications and maps monthly. A full-time staff librarian oversees the library.

The Sample Library maintained by the Bureau has a floor area of approximately 80,000 square feet. Shelves, seven high, are utilized to store well cuttings and cores. The Bureau has cuttings from over 5,500 wells, and cores from over 740 wells have been donated by the oil companies. In addition, cuttings donated by the water-well contractors and cuttings and cores from test holes drilled with the Bureau's two drill rigs are retained. (See Appendixes I, II, and III)

The oil and gas industry has had a major impact on the economic growth of the State of Mississippi. A total of 7,435 oil wells, 1,315 gas wells, and 14,377 dry holes had been drilled by the end of 1986. The Bureau of Geology has on file more than 14,000 electric logs on these wells, as well as scout cards on almost all of them. A data base of completion information will be available on computer sometime in 1988. In addition, production data, by field, is presently being loaded into a dBASE III file. This file will allow access to well data in any of the following combinations.

1. Field
2. County
3. Abandoned vs. operating
4. Discovery date
5. Section - township - range of discovery well
6. Cumulative production
7. Productive intervals

This file will allow quick access to a wealth of data on any of the many fields that have been discovered in Mississippi. (See Appendix IV for input format.)

The Mineral Lease Division of the Bureau of Geology is responsible for granting seismic permits and for the leasing of state-owned land for the exploration and production of oil, gas, and other minerals. The Division strives to maximize state revenues and negotiates leases for state-owned land on a competitive-bid basis. A complete inventory of state-owned land and mineral holdings has recently been undertaken, and dBASE III files are being used to cross-reference the data. (See Appendix V.)

MISSISSIPPI STATE OIL AND GAS BOARD

From the spring of 1903, when the first exploratory well was drilled in Mississippi, until 1934, completion records were submitted on a voluntary basis by the operator to the Mississippi Geological Survey. The Legislature realized the need for some type of organized record keeping and permitting of all oil and gas wells drilled in the state and made the following declaration of policy.

§ 53–1–1. Declaration of policy.

It is hereby declared to be in the public interests to foster, encourage and promote the development, production and utilization of the natural resources of oil and gas in the State of Mississippi; and to protect the public and private interests against the evils of waste in the production and utilization of oil and gas, by prohibiting waste as herein defined; to safeguard, protect and enforce the co-equal and correlative rights of owners in a common source or pool of oil and gas to the end that each such owner in a common pool or source of supply of oil and gas may obtain his just and equitable share of production therefrom; and to obtain, as soon as practicable, consistent with the prohibition of waste, the full development by progressive drilling of other wells in all producing pools of oil and gas or of all pools which may hereafter be brought into production of such, within the state, until such pool is fully defined.

It is not the intent nor the purpose of this law to require or permit the proration or distribution of the production of oil and gas among the fields and pools of Mississippi, on the basis of market demand. It is the intent and purpose of this law to permit each and every oil and gas pool in Mississippi to be produced up to its maximum efficient rate of production, subject to the prohibition of waste as herein defined, and subject further to the enforcement and protection of the co-equal and correlative rights of the owners of a common source of oil and gas, so that each common owner may obtain his just and equitable share of production therefrom.

SOURCES: Codes, 1942, § 6132-01; Laws, 1948, ch. 256, § 1.

The Legislature created an appointed board of commissioners that has jurisdiction and authority over all persons and property necessary to enforce effectively the provisions of all laws relating to the conservation of oil and gas in Mississippi.

The Mississippi State Oil and Gas Board presently employs a staff of 36, including geologists, petroleum engineers, oil and gas inspectors, and data processors. In addition, technical-support staff members assist in record-keeping. Personnel of the Mississippi State Oil and Gas Board are empowered to collect data; to make investigations and inspections; to examine properties, leases, papers, books and records, including drilling records and logs; to examine, check, test and gauge oil and gas wells, tanks, refineries, records and reports. They permit all oil and gas exploration activities inside the state boundaries. They presently maintain files on almost all of the 23,087 oil and gas wells that have been drilled in Mississippi.

The Mississippi State Oil and Gas Board publishes a monthly main-frame computer-based compilation of production statistics that includes:

1. Production by fields and pools
2. Individual well production
3. New wells and workovers
4. Dry gas and abandoned wells
5. Extraction-plant and refinery activities

An annual production report is also published. It includes:

1. Basic production chart on the oil and gas reservoirs in Mississippi
   This is a reflection of the record contained in individual ledgers for each field on the production of oil, condensate, gas, and water.

2. Annual production by county

3. Mississippi oil and gas fields
   Chronologically shown are the name of the field, reservoir, county, field location, discovery date, and discovery wells.

4. Plugged and abandoned wells during the year

5. Salt-dome discoveries
   Chronologically shown are the name of the dome, county, location, discovery date, discovery well, salt record, and flank-test record.

6. Production tabulation
   Cumulative production January 1 through December 31 and production by fields and reservoirs during the year.

APPENDIX I

Structure for database: F:logfile.dbf
Number of data records: 3850
Date of last update : 10/19/87

Field	Field Name	Type	Width	Dec
1	COUNTY	Character	15	
2	FILNO	Character	5	
3	OWNER	Character	60	
4	LOCATION	Character	11	
5	SEC	Character	3	
6	TWN	Character	3	
7	RNG	Character	3	
8	LOGTOP	Numeric	4	
9	LOGBOT	Numeric	4	
10	LOGDATE	Date	8	
11	GDELEV	Numeric	4	
12	ROTELEV	Numeric	4	
13	WELLTD	Numeric	4	
14	RUNS	Numeric	2	
15	LOGTYPE	Character	40	
16	UNIT	Character	40	
17	DRILLER	Character	30	
18	WELLDI	Numeric	5	2
19	SCREEN	Character	10	
20	CHEMANAL	Logical	1	
21	PUMPTST	Logical	1	
22	AQUIFER	Character	25	
23	YIELD	Numeric	4	
24	SWL	Numeric	5	1
25	RECDDATE	Numeric	4	
26	REMARKS	Character	200	
27	ACC	Numeric	5	
** Total **			501	

APPENDIX II

Structure for database: F:corefile.dbf
Number of data records: 698
Date of last update : 01/25/88

Field	Field Name	Type	Width	Dec
1	COUNTY	Character	25	
2	OPERATOR	Character	25	
3	FEE_NAME	Character	35	
4	LOCATION	Character	12	
5	SECTION	Character	3	
6	TOWNSHIP	Character	3	
7	RANGE	Character	3	
8	FIELDNAME	Character	25	
9	FILENUMBER	Character	22	
10	CORETOP	Numeric	11	3
11	COREBOTTOM	Numeric	11	3
12	ERATHEM	Character	50	
13	SYSTEM	Character	50	
14	SERIES	Character	50	
15	GROUP	Character	50	
16	SUBGROUP	Character	50	
17	FORMATION	Character	60	
18	MEMBER	Character	50	
19	REMARKS	Character	50	
20	RN	Numeric	4	
** Total **			590	

COUNTY : JASPER

FILE NUMBER: C-197.0-.21

LOCATION : Section 17 - T2N - R12E

DEPTH TO TOP OF CORE: 14048.000 ft.

FIELD NAME: WEST PAULDING

DEPTH TO END OF CORE: 15775.000 ft.

OPERATOR : GETTY OIL CO.

RECORD NUMBER: 282

FEE NAME : #1 IKE MYERS ESTATE 17-8

ERATHEM : MESOZOIC
SYSTEM : JURASSIC
SERIES :

GROUPS : LOUARK
SUBGROUPS :

FORMATIONS : HAYNESVILLE-BUCKNER, BUCKNER, SMACKOVER
MEMBERS :

REMARKS :

READ :<F:>:COREFILE :Rec: 282/698

APPENDIX III

Structure for database: F:warrior.dbf
Number of data records: 427
Date of last update : 06/27/86

Field	Field Name	Type	Width	Dec
1	OPERATOR	Character	30	
2	WELLNAME	Character	30	
3	LOCATION	Character	11	
4	SEC	Character	3	
5	TWN	Character	3	
6	RNG	Character	3	
7	COUNTY	Character	15	
8	STATE	Character	15	
9	FILENUMBER	Numeric	10	1
10	BOXES	Numeric	3	
11	TDEPTH	Numeric	7	1
12	BDEPTH	Numeric	7	1
13	FIRSTFM	Character	24	
14	LASTFM	Character	24	
15	REMARKS	Character	136	
16	ELOGS	Logical	1	
17	FORMCODES	Character	136	
18	ACCESSNO	Numeric	7	
** Total **			466	

APPENDIX IV-A

FIELD NAME: HEIDELBURG WEST COUNTY: JASPER

GROUP: EUTAW-TUSCALOOSA FORMATION:

MEMBER: Sec. 29 - T1N - R13E

DISCOVERY DATE: 06/16/44

```
ZDDDDDDDDDDDDDDDDDDD?
3  PRODUCTION TYPE  3
3                   3
3  OIL [T or F]: T  3
3  GAS [T or F]: T  3
@DDDDDDDDDDDDDDDDDDDY

ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD?
3 WELL STATUS: PR   PR = PRODUCING FIELD 3
3                   SI = SHUT-IN FIELD   3
@DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDY
```

READ :<F:>:POOLS :Rec: 12/105 : :

APPENDIX IV-B

Structure for database: F:pools.dbf
Number of data records: 105
Date of last update : 12/08/87

Field	Field Name	Type	Width	Dec
1	FIELD	Character	30	
2	GROUP	Character	25	
3	FORMATION	Character	25	
4	MEMBER	Character	25	
5	COUNTY	Character	15	
6	SEC	Character	3	
7	TWN	Character	3	
8	RNG	Character	3	
9	DISC_DATE	Date	8	
10	OIL	Logical	1	
11	GAS	Logical	1	
12	STATUS	Character	2	
** Total **			142	

APPENDIX V

Caps

MISSISSIPPI STATE LAND RECORDS DATABASE
DATA ENTRY SCREEN 1

AGENCY: MISSISSIPPI PARK COM. DEED NAME: MISSISSIPPI PARK COMM.

COUNTY: HANCOCK AGENCY CONTACT: UNKNOWN

SECTION LOCATION: of , Sec.9 - Township 9S - Range 14W

BLOCK NO.: LOT NO.: DEED BOOK PAGE: X9 PG155

PARCELS: ACRES: 72.00 COST: $ 0.00

DATE PROPERTY ACQUIRED: 04/26/72 HOW ACQUIRED ?:

DATE PROPERTY ASSESSED: 04/26/72 MARKET VALUE: $ 101000.00

LAND USE: BUCCANEER STATE PARK TIME REQUIREMENTS [T,F] ?: F

SENSITIVE AREAS IDENTIFIED WITHIN PROPERTY: UNKNOWN

MISSISSIPPI STATE LAND RECORDS DATABASE
DATA ENTRY SCREEN 2

SURFACE LEASE STATUS: UNKNOWN SURFACE ACRES LEASED:

MINERAL LEASING: GRANTOR RESERVED ALL MIN MINERAL ACRES LEASED: 0.00

To ENTER Additional Remarks in the COMMENTS memo field, you must:

1> Position Cursor over the MEMO FIELD Below;
2> Hold the [CONTROL] Key & Press [HOME] Key;
3> After Entering Remarks-Hold [CONTROL] Key & Press [END] Key to return to this screen

memo

Press [PGDN] When Data Entry Completed
===== ====== ==== ==== ===== =========

APPENDIX V-B

Structure for database: F:missland.dbf
Number of data records: 454
Date of last update : 12/08/87

Field	Field Name	Type	Width	Dec
1	AGENCY	Character	25	
2	GRANTEE	Character	25	
3	COUNTY	Character	16	
4	QUAR_SEC	Character	6	
5	OFQUAR_SEC	Character	6	
6	SECTION	Character	7	
7	TOWNSHIP	Character	3	
8	RANGE	Character	3	
9	BLOCK_NO	Character	6	
10	LOT_NO	Character	5	
11	DED_BK_PG	Character	14	
12	PARCEL_NO	Character	21	
13	TIME_REQ	Logical	1	
14	ACREAGE	Numeric	9	2
15	HOW_ACQUIR	Character	10	
16	COST	Numeric	11	2
17	DAY_AQUIRE	Date	8	
18	DAY_ASSESS	Date	8	
19	MKT_VALUE	Numeric	11	2
20	HOW_USED	Character	30	
21	MIN_LEASE	Character	25	
22	MINERALS	Numeric	7	2
23	SENSITIVE	Character	25	
24	LSE_STATUS	Character	15	
25	LSE_ACRES	Numeric	7	2
26	CONTACT	Character	25	
27	LAS_UPDATE	Date	8	
28	COMMENTS	Memo	10	
** Total **			348	

NORTH DAKOTA OIL AND GAS COMPUTER DATA BASES

Marvin Rygh
North Dakota Geological Survey

During the late 1970s the North Dakota Geological Survey initiated an oil-well computer data-base-management system utilizing the mainframe computer at the University of North Dakota. Initial data entered included basic oil-well file information such as well name, operator, location, and current status.

Expansion and refinements of the data-base-management system have included obtaining an IBM System/34 in 1982 as the Survey's in-house computer. The Survey had been sharing the System/34 with the UND Medical School from 1980 to 1982. The System/34 is now linked to six terminals and five IBM PCs throughout the Survey's offices, including a terminal in the Wilson M. Laird Core Library.

The Survey's computer network is linked to the University of North Dakota's IBM 3090 mainframe computer. The IBM 3090 is used mainly for running the Surface II contour program and large-scale pen plotting. The 3090 is also used to transfer data acquired from other sources to the System/34. All file data can be downloaded to the PCs for further analysis.

The Survey's oil and gas data files are utilized basically in three ways: in-house use (listings, mapping, etc.), published lists (N.D. Well Schedule), and specific listings upon request. Primary access to well information is by NDGS well number. Data may also be retrieved to a work station using well-location or well-name searches. Selective data from any file may be listed on hard copy according to specific field search parameters using the Data File Utilities program (DFU) or individually written programs for listings larger than DFU's capabilities. All data is sold on hard copy only, and all revenue received from the sale of computer data is forwarded to the state general fund. There is no provision for a revolving fund at this time.

The Survey presently has eight files for oil and gas well data. They are listed as follows:

Oil and Gas Computer Files
North Dakota Geological Survey

GS.LEGAL......Oil and gas well legal description file
GS.COMP.......Oil and gas well completion file
GS.CORE.......Oil and gas well core file
GS.YPROD......Monthly oil field production file
GS.WPROD......Monthly individual oil well production file
GS.CHEM.......Oil- and gas-well chemical water analysis file
GS.OILAN......Oil analysis file
GS.TOPS.......Oil- and gas-well formation tops (in-house only)

The contents of each file are listed at the end of this paper.

Other agencies in North Dakota have oil and gas data bases. The North Dakota Industrial Commission, Oil and Gas Division (NDIC), is responsible for oil and gas conservation regulation in the state. Computer data obtainable on hard copy from the NDIC are listed as follows:

Oil and Gas Computer Data
N.D. Industrial Commission, Oil and Gas Division

- Individual Well Production
- Decline Curves
  - Exponential Field Decline
  - Exponential Well Decline
  - Hyperbolic Field Decline
  - Overall Field Performance (including GOR, BHP, days produced)
  - Individual Well Performance including days produced
  - Subsurface Structure Maps
  - Well Location Maps

The North Dakota Department of Health is responsible for the enforcement of air-pollution-control regulations in the state. The Department of Health has compiled a data base of all oil wells that produce gas with high concentrations of hydrogen sulfide. These data are used mainly for monitoring of air-quality problems. The NDGS has utilized these data to compile a statewide map showing H_2S concentrations in various producing formations.

Future plans of the North Dakota Geological Survey are to continue to expand existing files and create new data sets. A new file including all DST report data is presently being constructed. A catalog of oil analyses will be published in the near future. This will be very similar to the N.D. Well Schedule and Water Chemistries Catalog which have been published in the past two years. Additional production data are continually being entered, and there are plans to enter all available gas analyses into the computer. N.D. Industrial Commission oil-field orders will also be entered in the Survey's data-base system. One hope for the future is to have the capability to generate computer-plotted oil and gas field maps.

APPENDICES

Oil and Gas Computer Files
North Dakota Geological Survey
Grand Forks, North Dakota

Files available

GS.LEGAL.........Oil and gas well legal-description file

GS.COMP..........Oil and gas well completion file

GS.CORE..........Oil and gas well core file

GS.YPROD.........Monthly oil field production file

GS.WPROD.........Monthly individual oil well production file

GS.CHEM..........Oil and gas well chemical water analysis file

GS.OILAN.........Oil analysis file

GS.TOPS..........Oil and gas well formation tops (in-house only)

Oil and Gas Well Legal Description File
GS.LEGAL

NDGS well number
Surface location (township, range, section, quarter-quarter, and footage)
Bottom hole location (township, range, section, quarter-quarter, and footage)
Elevation (ground, KB)
Total depth
Original operator
Original well name
Current operator
Current well name
Field name
Status of well (permit, producing, recompleted, abandoned, etc.)
Completion date
Number of completions
Plugging date
Logs available (scale, interval, log types)
Deepest formation penetrated
Bottom hole temperature (^{o}F)
Casing record (surface, intermediate, long string)
API well number

Oil and Gas Well Completion File
GS.COMP

NDGS well number
Surface location (township, range, section, quarter-quarter)
Completion date
Plugging date
Field name
Producing formation
Producing interval
Commingled (yes/no)
Number of completions
Total depth
Initial oil production (bbl/day)
Initial water production (bbl/day or %)
Initial condensate production (bbl/day)
Initial gas production (MMCF/day)
Gas-oil ratio (SCF/day)
Choke (64ths)
Oil gravity (API^{o})
Status of well (flowing, pumping, gas lift)
Tite hole status (yes/no)
Discovery well (yes/no)

Oil and Gas Well Core File
GS.CORE

NDGS well number
Surface location (township, range, section, quarter-quarter)
County
Field name
Original operator
Original well name
Core available:
- Type of core (whole core, slab, chips, cuttings, thin sections)
- Formation
- Depth interval
- NDGS core library location number

Core cut (from completion report)
Core received
Perforated interval
Deepest formation penetrated
Core analysis (yes/no)
Geologic report (yes/no)
Sample instructions

Monthly Oil Field Production File
GS.YPROD

Field name
Formation
Year
Monthly oil production (bbl)
Monthly water production (bbl)
Monthly water injection (bbl)
Yearly oil production (bbl)
Yearly water production (bbl)
Yearly water injection (bbl)
Cumulative oil production (bbl)
Cumulative water production (bbl)
Cumulative water injection (bbl)
# of 1st quarter producers
# of 2nd quarter producers
# of 3rd quarter producers
# of 4th quarter producers
# of 1st quarter water injectors
# of 2nd quarter water injectors
# of 3rd quarter water injectors
# of 4th quarter water injectors
Geographical limit of field (extreme north, south, east, west townships which encompass field)
County(s) (maximum of three)

Monthly Individual Oil Well Production File
GS.WPROD

NDGS well Number
Formation
Year
Monthly production (bbl)
Monthly water production (bbl)
Yearly cumulative oil (bbl)
Yearly cumulative water (bbl)
Total cumulative oil (bbl)
Total cumulative water (bbl)
GOR (semiannual)
BHP (semiannual)
Days produced (per month)

Oil and Gas Well Chemical Water Analysis File
GS.CHEM

NDGS well number
Surface location (township, range, section, quarter-quarter)
County
Formation
Tested interval
Temperature
Resistivity, measured
Resistivity, calculated
pH
Ion concentrations (ppm):
- Calcium
- Magnesium
- Sodium
- Chloride
- Carbonate
- Bicarbonate
- Sulfate
- Iron
- Potassium
- Barium
- Chromium
- Lithium
- Hydroxide
- Nitrate

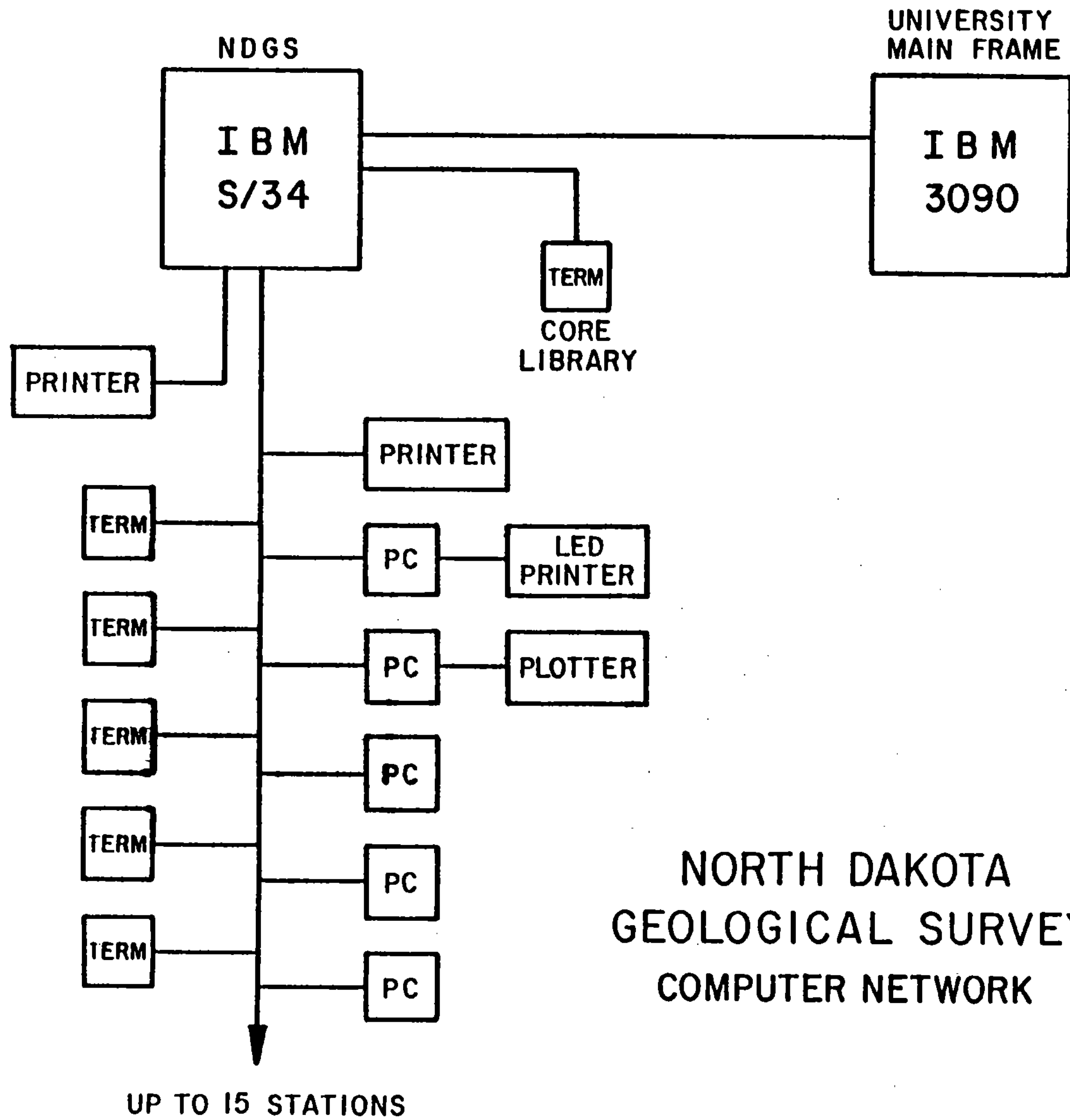
Hydrogen sulfide concentration
Sample date
Sample type (DST, produced water, unknown)
DST number (if applicable)
DST test type (top, middle, bottom, sample chamber, unknown)
Total dissolved solids
NaCl equivalence
Specific gravity
Primary salinity
Secondary salinity
Primary alkalinity
Secondary alkalinity
Chloride salinity
Sulfate salinity
Remarks

Oil Analysis File
GS.OILAN

NDGS well number
Formation
Source
Surface location (township, range, section, quarter-quarter)
County
Tested interval
Sample date
DST number
Specific gravity
API gravity
Salt content (lbs/1000bbl)
Pour point (^{o}F)
Kinematic viscosity (centistokes @ 100^{o}F)
Saybolt viscosity (seconds @ 100^{o}F)
BS & W (%)
Paraffin content (%)
Asphaltene content (%)
Sulpher (%)
Distillation type
Sample size
Boiling point (^{o}F)
Gasoline (%)
Kerosene (%)
Residual crude (%)
Percentage loss
Distillation data
Remarks

Oil and Gas Well Formation Tops
GS.TOPS

NDGS well number
Surface location (township, range, section, quarter-quarter, and footage)
Elevation (KB)
Stratigraphic tops (formation and depth)
Deviated well (yes/no)
Tite hole (yes/no)



NORTH DAKOTA
GEOLOGICAL SURVEY
COMPUTER NETWORK

THE OKLAHOMA GEOLOGICAL SURVEY'S NATURAL RESOURCES INFORMATION SYSTEM: OIL AND GAS SUBSYSTEM DESIGNS

by Mary K. Grasmick

INTRODUCTION

Over the past few years, the Oklahoma Geological Survey has become increasingly committed to building computerized systems containing the State's geological data. Petroleum data have received a special emphasis in this commitment, as this is an area of vital interest to Oklahoma. This paper presents a summary of the oil and gas system development thus far, and of future plans. Before going into details, some background information about the Survey and its efforts is in order.

THE OKLAHOMA GEOLOGICAL SURVEY

The Oklahoma Geological Survey (OGS) was established in 1908 as an agency responsible for collection and study of information regarding the State's geological resources. Housed within the University of Oklahoma, it functions as a research and public-service organization, interfacing the academic needs of the University with the policy needs of the State and the information needs of the general public. OGS serves as a repository for numerous documents, including well samples and cores, well logs, scout tickets, and completion reports; these documents are made available to the general public through the Survey. Regulatory responsibilities which relate to the geology of the State are held by a diversity of other state agencies; OGS plays a support role for these activities by providing the geologic expertise required for informed decision-making.

The Survey has a staff of about 25 professional and 25 support staff members. Included with the professional staff are petroleum and coal geologists, stratigraphers, economic and engineering geologists, geophysicists, cartographers, analytical chemists, and geologic editors. Associated with the Survey is a University department named Geological Information Systems (GIS). GIS is basically a research and data-processing department, with a staff that includes programmer/analysts, data-entry operators, and data-quality personnel.

Annual appropriations for OGS have been at a level insufficient to fully support the development and maintenance of large-scale computerized systems; much of the work that is in process is dependent upon auxiliary funding through grants with outside agencies. The Oklahoma Geological Survey receives an annual legislative appropriation of approximately $1.6 million. This amount is supplemented each year through grants and contracts that average about $400,000, and through proceeds from the sales of publications and other products totaling about $100,000 per year. OGS systems development and support activities by Geological Information Systems are funded primarily through grant monies totaling approximately $260,000 for this year. Hopefully, additional funding will allow a sustained progress rate on these projects in the coming year.

THE NATURAL RESOURCES INFORMATION SYSTEM OF OKLAHOMA

In late 1985, the Oklahoma Geological Survey defined a goal of developing an integrated system of computerized information on the geological resources of the State of Oklahoma. This effort, called the Natural Resources Information System (NRIS) of Oklahoma, was undertaken in response to the great need for more accurate, detailed, and accessible information on the non-biological resources of the State. Since funding constraints precluded the immediate full-scale development of the concept, initial emphasis for the system has been placed on computerizing information relating to the energy needs and resources of the State and Nation, particularly in the areas of oil, gas, and coal resources.

Oil and natural gas have been critical resources for Oklahoma since the establishment of statehood in 1907. In fact, petroleum production began prior to statehood with the completion of the No. 1 Nellie Johnstone in 1897. Thus, petroleum has been of primary interest to the Survey since its inception, and is a major thrust for the development of NRIS. The remainder of this paper describes the oil and gas subsystems of NRIS, which currently are under development.

Another energy area that currently is under development by the Survey is the construction of a data base containing point-source information on coal resources within Oklahoma. The Coal Subsystem of NRIS is composed of two primary files: one contains stratigraphic data, the other is for analytic (chemistry and organic-petrography) data. A point-source identification number serves as the link between the two files, and as the point location on quadrangle maps for a digitized representation of the data. Goals for further expansion of the NRIS system include the areas of non-fuel mineral resources and water information.

OIL AND GAS INFORMATION NEEDS

In general, the State of Oklahoma is not known for its advanced state of machine-readable oil and gas data. State agencies responsible for oil and gas regulation and information have only recently begun efforts to computerize their data systems. Over the years, the primary data sources for Oklahoma have been the commercial organizations that disseminate oil and gas data. Given the methods by which these commercial organizations have been forced to obtain Oklahoma data, and the fact that their appropriate emphasis has been on the quantity and speed with which the data are collected and released, it is understandable that in many areas the historical quality of the data is lacking.

TYPES OF INFORMATION NEEDED

Throughout the work that the Survey has done over the years, several key areas have been defined that repeatedly would have benefited from a computerized information source. These information needs provided the foundation upon which the oil and gas subsystems of NRIS were formulated.

Well histories: The Survey is frequently involved in intensive research, or is asked to provide specific information, on geological characteristics of various areas in the State. When such special projects are undertaken, an initial requirement is to gather in-depth information on all of the oil and gas wells that have been drilled in the area. Historically, that information has been contained in scattered documents and libraries, accessible only through extensive manual searches.

Field outlines: Over the years, the process of defining the boundaries of oil and gas fields in Oklahoma has been possible only through manual efforts to reconcile producing records with known field boundaries. Given the large number of producing areas within the State, and the immensity of the manual reconciliation task, the "official" definitions of field boundaries usually have been significantly out of date, and frequently determined to be erroneous. One result of this situation is that Oklahoma has had an unusually high number of field consolidations and divisions. In some cases a particular producing area has been assigned as many as five "official" field names over the years. Clearly, a need exists to more quickly provide the comprehensive information required to determine appropriate field boundaries.

Mapping: A logical extension to the ability to update field outlines is the ability to map those new outlines. By maintaining computerized location information in a systematic and easily updated format, updated field maps (as well as other maps of geological interest) can be generated with relative ease.

Production by field and by formation: The ability to allocate oil and gas production to specified fields is fundamental to the geological understanding of the oil and gas industry's past, present, and future within the State. As time goes on, the accessibility of information on production for specific formations within oil and gas fields is becoming just as critical. Particularly in the last year, there has been an increased awareness of the need for improving oil-recovery percentages, both through in-field drilling and through the application of enhanced recovery techniques. This is especially true in Oklahoma, where a large amount of drilling has taken place, and the remaining resource base lies primarily in discovered but unswept mobile oil, and oil which may be produced through enhanced-recovery techniques. Detailed and accessible information on formations and production is critical to both the basic research that is needed on oil-recovery methods, and the application of proven recovery methods to promising areas.

NRIS USERS

The Oklahoma Geological Survey has traditionally served a number of "audiences" in its role as a state information agency. These same audiences will be the primary "users" of the Natural Resources Information System and, when possible, have been instrumental in defining the "user needs" for the system.

The most obvious users of the information housed within OGS are the Survey researchers. As mentioned, the OGS is called upon to perform a variety of geological investigations, most of which have been completed in the past through extensive manual efforts. The results of the NRIS development will greatly improve the timeliness and comprehensiveness of these investigations. The OGS staff is made up of geological, rather than computer, professionals. Therefore, one of the goals for the NRIS system is to make it usable by the geological staff. This includes putting together user routines and documentation that will allow the OGS staff members to perform some of their own retrievals and data manipulation.

Since the Survey is housed within a university, the University faculty and students are also a significant user group as well as a resource for the NRIS work. NRIS data will be accessible for academic scientific research as well as the more applied research areas. In designing the NRIS system, faculty members have played a technical advisory role, which serves as a way of assuring that their research needs are considered within the system design. Geology graduate and undergraduate student employees are playing a key role in much of the coding work that is required for the data.

As a state agency, OGS has a responsibility to make the results of its efforts available to the general public as well as to other state offices. So far, NRIS data has only been made available through a few specialized "consultation" efforts. It is anticipated that a public announcement of the data availability will be made early in 1988. Before that time, a number of "data release" decisions will be made. For example, it is expected that some standard products will be defined from the NRIS data, and hopefully most user needs can be accommodated through these products. (Previous experiences in releasing data have shown that specialized consultations and retrievals are very costly for both the Survey and the client.) OGS plans include the production of standardized reports, such as reports of production by field, or reports of all data available on wells in specified geographic areas. Machine-readable copies of data subsets will be made available on diskettes as well as mainframe magnetic tapes. An underlying assumption for the OGS data release is that the Survey does not want to adversely affect commercial data sources. Both the formats of the data releases and the user-access charges will be determined within this framework.

HARDWARE AND SOFTWARE ENVIRONMENT

In order to understand some of the system-design decisions that have been made for NRIS, a brief background of the available hardware and software environment is useful.

UNIVERSITY COMPUTING CENTER

Since the OGS is housed within the University of Oklahoma, it has access to the University's mainframe computer facilities for its processing needs. The development activities for the NRIS work are funded through grant monies with the GIS department; once the systems are fully operational the OGS will be responsible for the computer charges. Because of this, a major consideration in the design of the system is its ongoing operational costs.

Hardware capabilities: The University's mainframe computer is an IBM System 3081 with an MVS operating system. This system is used for most administrative, research, and instructional activities within the University, although in recent years some decentralization has occurred with the installation of smaller systems in various parts of the campus. The University computer system has a variety of printers and plotters that are accessible both at the main computer center and at several remote job-entry stations conveniently located around the campus.

Software capabilities: In many respects, NRIS would be well suited for the capabilities of a data-base management system. However, at this time the University does not have a DBMS, and given the rate at which the IBM 3081 system is becoming impacted, it is expected that the University will not get a DBMS until it gets new or greatly enhanced mainframe capabilities. The University capability closest to a DBMS is a package called GIPSY*. GIPSY is an information management system originally developed by the University of Oklahoma that has some, but not all, of the features of a DBMS. It also has a number of features not usually found in a DBMS that are particularly useful for NRIS; these features will be addressed in a subsequent section of this paper. The University computer also has SAS, the Statistical Analysis System, which is being used as the primary reporting and analysis tool for NRIS.

Data storage options: Online disk storage space on the University system is relatively scarce and therefore quite costly. As would be expected, offline tapes are a much less expensive storage option. Given the sizes of some of the files for NRIS, the relative costs of these two storage facilities have been an important design consideration. The University has recently converted to a cartridge system for its tape-storage facilities; this has resulted in a greatly improved response time for jobs

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* Registered Trademark

that require a tape setup, making tape storage a reasonable option.

ADDITIONAL UNIVERSITY CAPABILITIES

In addition to the IBM 3081 system, OGS has access to several other computing capabilities because of its ties to the University. For example, the University's School of Geology and Geophysics has its own computing capabilities through a DEC VAX 11/780 series system. This VAX system is on a network with the IBM 3081, and so the capability exists for downloading the NRIS data to the VAX for specialized analyses. OU is also in the process of linking into a supercomputer network called MIDnet, linking 11 midwestern universities. Thus far, the details of these potentials have not been explored.

OGS/GIS CAPABILITIES

Both OGS and GIS have several IBM (or compatible) AT and XT personal computers. Subsets of data can easily be downloaded from the mainframe NRIS files for special analyses on these machines. It is expected that many of the OGS users will be able to more easily run applications on the data through personal computers, due both to the relative costs of using the PCs, and to their areas of expertise in computer usage. The software packages commonly used by OGS staff members include Lotus 1-2-3, Mapmaster, Microsoft Chart, and dBASE III Plus.

DATA SOURCES

Another necessary prerequisite to an understanding of the NRIS development is an overview of the sources that are available for oil and gas data in Oklahoma, and the strengths and weaknesses of those sources. Through the NRIS efforts, OGS will have the capability to provide feedback to some of these sources, and engage in cooperative efforts to improve the overall quality of oil and gas data for Oklahoma.

OKLAHOMA CORPORATION COMMISSION DATA

The Oklahoma Corporation Commission (OCC) is the regulatory agency responsible for the collection of drilling completion reports (called Form 1002A) for all wells within the State. Since about 1900, between 300,000 and 350,000 wells have been drilled in Oklahoma; about 250,000 to 275,000 completion reports are on record for these wells. These completion reports are the foundation for the well-history information within the Natural Resources Information System.

The Corporation Commission has recently begun an effort to computerize their oil and gas records system, with an emphasis on monitoring activities with respect to the agency's regulatory requirements. As part of this effort, OCC has begun keying and processing the "current" 1002A forms that are being filed with their agency. Since OCC also has an interest in obtaining historical well data for the State, OGS and the Corporation Commission are planning to develop a data exchange, trading the historical records computerized by the Survey for the current records from the Corporation Commission. This cooperative effort should result in a cost savings for both agencies.

SUPPLEMENTAL WELL DATA

Supplemental data on oil and gas wells are available through libraries of scout tickets, well logs, and core and drilling samples. OGS is the repository for many of these data; additional libraries exist throughout the State. These libraries contain huge amounts of accessible well information; the primary restraining factor in adding these data to NRIS is the availability of personnel resources to encode the data.

OKLAHOMA TAX COMMISSION DATA

The Oklahoma Tax Commission (OTC) is charged with the collection of taxes on revenues from oil and gas leases within the State. The Commission is also the one agency that has a computerized system of production reporting for Oklahoma; since 1983, the computerized production data have been available to the public from the OTC. On a monthly basis, OTC releases a tape of reported production for all oil and gas leases (or subleases) in the State. In addition to the lease identification production data, this tape reports the township, range, section, and quarter-section location of each lease or sublease; these location data provide a key link in later determining the field assignment for each lease.

The formation names associated with the producing leases or subleases are also reported to the Tax Commission, which provides the starting point for determining production by formation. OTC is not in a position to geologically evaluate the appropriateness of the formation names that are being reported to them on the tax forms, though they have the goal of monitoring this aspect of their data-collection system. To meet this need, the Survey and the Tax Commission plan to develop a "formations editing" system, in which the Survey analyses of appropriate formations for different fields or areas of the State will be used by the Tax Commission to require appropriate reporting by the taxpayers.

OKLAHOMA NOMENCLATURE COMMITTEE DATA

The Oklahoma Nomenclature Committee of the Midcontinent Oil and Gas Association is the organization charged with designating the official oil and gas field names and outlines within Oklahoma. This Committee meets approximately every two months, and is composed of volunteer members from government and industry. The results of each meeting are released in a set of "Blue Sheets" that describe the results of their actions for each affected oil and gas field. These Blue Sheets are the official source of field information for Oklahoma, and are the foundation for field location and history information in NRIS.

As previously discussed, the Nomenclature Committee has historically relied on extensive manual efforts in order to determine producing areas and thereby define field outlines. Over the last several years, the OGS has begun working more closely with the Nomenclature Committee, serving in a geological advisory capacity for the Committee decisions. As part of this effort, OGS has begun generating computerized reports of producing areas that are not within designated field boundaries, as a way to facilitate the field evaluation process. Through the ongoing NRIS efforts, this feedback system is being further developed, with expectations that the entire field definition process within Oklahoma will become more timely and more accurate.

DOE/EIA FIELD CODE MASTER LIST

The Energy Information Administration of the U.S. Department of Energy assigns field codes to all domestic oil and gas fields as a means to standardize field identifications throughout government and industry. In order to make field information from NRIS compatible with other available data bases, and make use of the DOE/EIA's efforts to systematize the process of assigning field codes, the DOE/EIA field code is being used as a key identifier for all field information in NRIS.

During the process of reconciling NRIS fields with the DOE/EIA fields, some discrepancies are inevitable, particularly for very old field names that are no longer used, and for very recent field designations. OGS and GIS staff members interact with DOE/EIA personnel to correctly assign codes for all fields.

SYSTEM-DESIGN FACTORS

In addition to the information goals that were defined for NRIS, several other factors and goals have affected the system-design decisions and the overall project developments.

HIGH DATA QUALITY

A primary goal for NRIS is to build a system with the highest possible data quality, even though quality-assurance measures do increase the costs of building the system. Editing routines are being implemented to flag data items on the file that do not meet designated standards, and whenever possible data are corrected to meet those standards. Through these efforts, the OGS strives to correct coding and keying errors and to report data consistently (e.g., using standardized volumetric units and date formats), even though it is not always possible to correct data that were inaccurately reported in historical records.

As a part of this quality-assurance effort, all data that are being manually keyed and entered into the system are verified through 100% redundant keying. Given the keying difficulty of much of the data, this step is critical to having the cleanest possible data, even though it is a costly step.

COST EFFICIENCY

Given the large quantity of Oklahoma oil and gas data being added to NRIS, it is most reasonable at this time to perform the production processing for the system in the OU mainframe environment. As the costs of working within the mainframe environment are high, the NRIS design had to take these costs into account. The relative costs of storage, update, and applications options have all been considered.

The capabilities of smaller computers are rapidly expanding, and their associated costs are decreasing. With these changes, an eventual purchase of an in-house OGS computer system--with the conversion of the NRIS production stream to that system--may be advantageous; however, currently it is not a feasible option.

COMPATIBILITY WITH USER EXPERIENCE

The system needs to be relatively simple to understand and manipulate by a variety of users for a variety of applications. Given the costs of operating in the mainframe environment, and the experience that most OGS users bring to the system, it is desirable to have an ability to download subsets of the data to the personal-computer level for specific applications. With the expected use of the data by students, faculty, and the public, as well as the OGS staff, new applications should be fairly easy to develop by individuals unfamiliar with the system. User routines and documentation are being developed to facilitate these activities.

FLEXIBILITY FOR FUTURE SYSTEM CHANGES

In some respects, NRIS can be thought of as an evolutionary system; it is expected that future design changes will be relatively routine, based on the addition of new hardware or software capabilities, new data accessibility, or new ideas about information needs. The subsystems need to be designed in a way that facilitates the implementation of enhancements.

One method that is being stressed within NRIS development is the use of structured programming standards, in particular with those parts of the system that are being developed in COBOL. Each program is being written with the consciousness that it will most likely be changed in the future, and not necessarily by the same individual that wrote the program in the first place.

FLEXIBILITY FOR STAFFING FLUCTUATIONS

There is a potential for significant fluctuations in staffing and funding levels for the NRIS work; therefore, an important consideration in structuring the work is to assure that the project does not regress during times of low funding or staff turnover, even though the rate of progress may be slowed.

Some aspects of the NRIS work require a great deal of data entry and coding. Much of this work can be accomplished by students, who provide a relatively inexpensive labor pool, but one with high turnover. The rate at which this work will be completed is directly dependent on the staffing and funding levels; however, the work is structured and documented so that core staff members can maintain some degree of progress even during periods of low funding and high turnover, and new staff members can very quickly begin to accomplish productive work.

Given the potential for staffing fluctuations, it is important that the computer systems are not "person-dependent", but can be run or modified by various individuals with minimal learning curves. While programmer/analysts are needed to complete the initial systems development, the ongoing operation of the system will be accomplished by students and nonprofessional staff, with minimal programmer intervention. Thus, as programs are completed, they are added to formalized operational job streams that are subject to standard production controls. Backup capabilities are maintained through the use of generation data groups; transaction files and operations logs are maintained for audit trail capabilities. The programming staff can devote its efforts to system enhancements rather than basic maintenance and operations.

Another factor that is being stressed within the NRIS system development is the preparation of thorough system, program, and operations documentation. This effort is key to the "transferability" of programs between programmers, and the ability to operationalize the ongoing processing activities.

The rules for structured programming and documentation increase the time and costs required for the system-development activities, making it tempting to abandon those rules in order to generate a product as quickly as possible. However, in the long run the NRIS system will profit by an adherence to these standards.

SYSTEM OVERVIEW

Attachment 1 presents a view of the overall schematic for the oil and gas portions of NRIS. There are actually two major subsystems within NRIS for oil and gas data: the Oil and Gas Well History Subsystem and the Oil and Gas Production (OGP) Subsystem. Within the well subsystem, various historical records are maintained on individual oil and gas wells within the State. The well history records can be viewed as relatively static; in theory, once all the historic data for a well record (or a well workover record) have been entered and edited, there will be few additional updates for that record. The production subsystem is designed primarily to store monthly production totals by lease, by field, and by county for the State; thus, the OGP is a much more dynamic subsystem, with regular updates expected for most of the records.

WELL-HISTORY FILES

The well-history files are designed to provide historic "snapshots" of information on oil and gas wells. Most of the data are based on information reported during the drilling of wells: geological and engineering data on well completions, formations, initial production tests, well logs, cores, and samples.

The basic system-development work is now completed for the well subsystem, although some system enhancements have yet to be implemented. The data coding and entry efforts are now in process, and are being approached on a regional basis. The initial emphasis has been on processing the approximately 30,000 records for the southeastern corner of Oklahoma; it is expected that this effort will be essentially completed by the end of 1987. Since the coding, key entry, and editing of well records are very labor-intensive activities, progress on the well subsystem is directly tied to funding levels for the project; it is expected that processing for the entire State will take from three to seven more years, depending on funding levels.

LEASE MASTER FILES

The Lease Master Files of the Oil and Gas Production Subsystem are designed to maintain data on all oil and gas leases or subleases within the State. Data items include monthly production totals, producing formations, and locations (county and township, range, section, and quarter-quarter section).

System development efforts for the Lease Master files are currently in process. It is expected that the production updating system will be in place by early 1988. One important component being built into the Lease Master system is a formations editing routine. This component should be fully implemented within a few months after the production updating.

FIELD MASTER FILE

The Field Master File of the OGP Subsystem is designed to store information on all current and historical oil and gas fields within Oklahoma. Data items on the field file include monthly production totals, cumulative production totals, discovery well and abandonment data, and locations (county and township, range, section, and quarter-quarter section). Also, field "alias" or "chronology" information is maintained to record historical changes in field designations due to field consolidations, renaming, or divisions.

A prototype system developed for the field-level data is now operational. This prototype was developed due to both the relative urgency of obtaining field-production information, and the need to explore the details of an appropriate system design for the field file. Activities to develop and convert to the new system are now under way. The basic identification, chronology, and partial location data are now on file. The quarter-quarter location data are in the process of being coded, and should be completed by the end of 1987. The new system's processing of production data should be operational by early 1988.

COUNTY MASTER FILES

The County Master File is designed to maintain monthly production totals by county. This information could be obtained by aggregating production from other files. However, it is information that is used relatively frequently, e.g., for contextual analyses or for downloaded personal computer applications; maintaining county-level data in a separate file both simplifies and lowers the cost of these retrievals.

As with the field file, a prototype system was developed for the county file. However, the conversion to the new county system is now completed.

LINKING THE OIL AND GAS FILES

Through various key data items, records from the files in both subsystems can be linked for use in particular applications or analyses. The Oklahoma Tax Commission Lease Number is maintained on records on the Well History files, as well as the Lease Master files, so that information can be aggregated for all wells within a particular lease. The DOE/EIA Field Code is used as the key identifier on the Field Master File, and is also assigned to lease records through a match process based on the field and lease township, range, section, and quarter-quarter section locations. By extension, the field code can also be linked back to well records associated with assigned leases. FIPS county codes are maintained on all records on all files, so that analyses by county are simplified. (Since field boundaries often overlap county lines, field data cannot always be aggregated strictly by county.)

OIL AND GAS WELL-HISTORY SUBSYSTEM

Some of the design details for the Oil and Gas Well-History Subsystem warrant additional description. Several sample pages from the dictionary for the Well-History Subsystem are provided in Attachment 2. (Since the dictionary is about 30 pages long, it is not included in its entirety in this document; however, copies of it are available on request.)

DATA SOURCES

Well-completion reports (1002A forms) are the primary data source for the Well-History Subsystem. A sample 1002A form is provided in Attachment 3. The goal for NRIS is to add data from all available 1002A forms. As might be expected, over the years the formats for these forms have been modified several times. We have defined six basic format styles from all of the variations, and have designed the file specifications to promote the standardization of the data added to the file despite these variations. Approximately 700 data items have been defined for 1002A information; this figure includes "repeating" data items such as the names, tops, and bottoms for multiple formations. (For an example of these repeating data items, see the Oil and Gas Zones Section on page two of Attachment 2. As many as six occurrences of zone data can be recorded for a well record, requiring 18 data items.)

Supplemental data are being added to the well subsystem in a variety of ways. Some supplemental data are being computerized through parallel activities. For example, efforts are under way to computerize the index system for the OGS Core and Sample Library. In addition to being a valuable effort in itself, it can also be merged with the 1002A records to complete the well-history information.

Some supplemental data are only available through special research. Manual research efforts are required to extract information from the well-log library or from scout tickets. If "1002A data items" are incomplete for a well, scout-ticket information may be used to fill in the missing data. Given the additional costs and efforts required to obtain these data, the plan for NRIS is to complete this type of research on a special-project basis, with efforts focused on specific regions in the State.

A primary function of the supplemental data items is to provide references for the existence of cores, samples, and well logs in various libraries. By recording this information in the Well History Subsystem, researchers are spared the efforts of searching through the libraries to determine if there are samples available for the wells they are investigating. Slightly over 100 data items have been defined to record all of these supplemental data thus far. As additional supplemental data sources are defined, it is expected that additional data items will also be required.

SYSTEM-DESIGN ISSUES

Clearly, there are special processing considerations when working with a file that contains over 800 data items, and potentially will contain data on 300,000 wells. Both storage space and processing times become important design factors.

For the well-history files, the GIPSY storage and retrieval system was selected as the most flexible and efficient tool available. As a direct-access system, GIPSY requires that data be stored online for updating and retrieval purposes, which as previously mentioned is rather costly. However, GIPSY has a number of features which make it particularly suitable for storing the type of data in the well subsystem, and these features became the overriding factor in the design decisions for the well-history files.

One feature of GIPSY is that it handles variable-length and "sparse" data items efficiently. GIPSY only reserves as much space for a data item on a given record as is needed for the text that is input, and no space is required for data items that are missing from a record. One record might have 10 bytes of information for a data item, a second record might have 200 bytes of information for the same data item, and a third record could have no information for that data item; GIPSY would require 10, 200, and zero bytes of text storage for these three situations. Furthermore, for any given data item, there is no limit to the length of the text entered for an item; detailed scouting-report summaries can be added to a record without any significant problems.

The file size issue for the well subsystem also led to the decision to implement both a working file and a master file for the Well-History Subsystem. New records are initially added to a working file. All well records are subject to editing and supplemental research, resulting in numerous updates to the records; this updating takes place on the working file. Once a record has been edited and updated, it can be added to the master file, and deleted from the working file. This process is designed to keep very "active" records that are still being updated on a file that is a manageable size, while "completed" records can be stored on the larger and more cumbersome master file. (Currently, the file-development activities are still in their early stages, and the working-file size is small enough so that no records have been moved to the master file.)

As special needs are defined (e.g., the core-library index), small auxiliary systems are being developed to meet those needs. Those small systems can then be merged into the Well History Master File, either temporarily or permanently, to pull together data items of interest. The addition of new data items to a GIPSY dictionary is a relatively simple matter. GIPSY is also flexible enough to allow the subdivision of the Well-History Master File into smaller files, if necessary. Particular groups of data items easily can be split off into other files, and merged with the Master File for specific applications.

DATA FLOW DIAGRAM

Attachment 4 is the "Level 0" data flow diagram for the processing in the Oil and Gas Well-History Subsystem.

Books of 1002A forms, organized by township, range, and section, are maintained in a library at OU. According to systematic criteria, groups of these books are checked out from the library, and all forms in them are photocopied for processing. Preliminary processing steps include batching and logging the forms into a tracking system; reviewing the forms for duplications, amended submissions, and workover records; and submitting each form to an editorial "preliminary scan". This preliminary scan, performed by geology-student employees, is completed in order to impose standard conventions on reported data items, and to flag or translate the reported information into formats that can be easily understood by the data-entry staff. Forms are then keyed, verified, and added to the working file.

Once the 1002A information has been added to the working file for a well, an edit program produces a listing of detected errors for the record, and the geology students review and correct the data whenever possible. Wells that are in designated special project areas are researched for the supplemental data items. All update transactions are processed to the working-file records. It is possible that the editing and supplemental research cycle will be completed several times for a given well record before it is considered "clean". When the working file gets large enough to create space and processing problems, the "master-file update" processing will be implemented for completed well records.

OIL AND GAS PRODUCTION SUBSYSTEM

The overriding design issues for the Oil and Gas Production (OGP) Subsystem are very different from those that governed the design of the Oil and Gas Well-History Subsystem, and so the design of the production subsystem is also very different. As previously mentioned, the production subsystem is relatively dynamic, with regular ongoing updates expected for most records. While there is some variation in the amount of data per entity in the production subsystem, it is much more predictable than the variation in the well data. For these and other reasons discussed below, sequential file designs with multiple-record formats were selected for the OGP Lease, Field, and County Master Files. Record formats for these files are shown in Attachment 5.

DATA SOURCES

Two primary data sources are being used for the OGP Subsystem: the Oklahoma Tax Commission's (OTC) monthly tapes of production by lease (or sublease), and the Oklahoma Nomenclature Committee's bimonthly releases of "Blue Sheets". The DOE/EIA Field Code Master List is used as a supplemental source for the OGP effort.

The Oklahoma Tax Commission actually releases two tapes each month: the OTC Master tape contains the lease identification, formation, and location data, and the OTC Detail tape contains the lease-production reports filed during the month (including late reports and corrected reports for previous months). Each month, these two tapes will be processed to add the new information to the OGP files. There are over 120,000 leases and subleases in the state per the OTC Master; about 60% of these have produced since the OTC began releasing these tapes in 1983.

The Oklahoma Nomenclature Committee "Blue Sheets" are received every several months, and are manually reviewed and coded for input into the Field Master File. About 3,000 fields are currently designated as "official" (or potentially producing) by the Nomenclature Committee; another 3,000 names have been "discontinued" but are available through historical records. The DOE/EIA Field Code Master List is used as a reference tool for field-code assignments during the Blue Sheet review processing.

SYSTEM-DESIGN ISSUES

Based on expected file sizes for the OGP Subsystem, particularly the Lease Master File, and the relative consistency (compared to the well files) of the data on the OGP records, it was determined that the most appropriate design for the OGP Subsystem is a sequential file system, with fixed-length records, based primarily on COBOL production programs. File storage is on cartridge tapes, chosen for cost effectiveness. This design also was chosen because of its relative simplicity for users, and the ease with which it could be transferred to other systems.

In order to accommodate the variations that do exist between leases and fields, the system was designed with variable-record-formats that can have a variable number of occurrences for a given lease, field, or county. For example, the "Production Record" format, used on all three files, is designed to hold one year (12 months) of reported volumes for a given hydrocarbon type, for a given lease or field. Thus, a field that produces oil, associated gas, natural gas, and condensate will have four production records for each year in which it produces; a lease that only produced oil during the first six months of 1985 will have only one production record. Similarly, the "Location Record" format on the field file has space for five unique township/range/section locations. Small fields have only one location record; some of the largest fields have over 100 location records.

With the multiple record type format, it is also relatively simple to split files into smaller subsets of data items, if desired. It is also relatively simple to add new record types if a new category of data items is to be added to the subsystem.

As previously mentioned, one specific area that needed to be addressed in the OGP subsystem was the editing of formation names that are reported to the OTC. There are actually two components to this editing. First, names are reported using a wide variety of conventions, including various abbreviations and creative spellings. Often, several formation names are reported, or comments will be included within the formation data item on the

OTC tape. The first task in formations editing, then, is to standardize the formation-name spellings, split the multiple formations into multiple data items, and delete the irrelevant text. A "string search" program currently under development will analyze each byte in the reported data, perform a series of editorial tasks, and hopefully accomplish most of this standardization. The second component in formations editing will be a check to determine the geological validity of the reported formations. The OGS geological staff is responsible for developing listings of valid formations by field or by area of the state; these listings will be used as edit criteria for the second component of the formations editing, and will be the basis for feedback to the Tax Commission on the validity of reported formations.

Another area that required specific consideration within the OGP Subsystem was the encoding of the township, range, section, and quarter-quarter section (TRSQ) locations. Maintaining these data on the file serves two purposes: matching of lease records to their appropriate field locations, and building routines that could map the locations of fields and leases. These locations have to be recorded on the file in a systematic (and hopefully efficient) manner that will facilitate both of these activities. The scheme that was selected requires a 24-byte data item for each township, range, and section in which the field or lease is located; eight of the bytes record the TRS, and the remaining 16 bytes are "on/off" flags for the 16 quarter-quarters that exist within each TRS. These 16 bytes have the values of "0" or "1", depending on whether the field or lease is located in the specific quarter-quarter. Based on this coding, the algorithm to match lease and field locations is fairly straightforward. Efforts to develop mapping applications to the TRSQ level of detail have not begun, so the implications of this coding scheme for mapping algorithms have not been fully explored; however, it is expected that this systematic representation can be translated into x-y coordinates and mapped without any great difficulties.

DATA FLOW DIAGRAM

Attachment 6 shows the data flow diagram for the OGP subsystem.

New fields are added to the Field Master File by manually coding and keying new Blue Sheets when they are released by the Nomenclature Committee. Through researching the DOE/EIA Field Code Master List, field codes are assigned to the new records. If a DOE/EIA field code has not been assigned to the field yet, the DOE/EIA is notified of the need for a new code, and a dummy code is used for the field until an official code is assigned.

New records are added to the Lease Master File from the OTC Master tapes. Lease Master records are then matched to Field Master records according to their TRSQ locations, and when possible a field code reflecting that lease's field assignment is added to each lease record. Each month, the OTC Detail tapes are used to update monthly production totals for all leases and subleases, and for all County Master records. Based on the field codes assigned to leases on the Lease Master File, that monthly production is then aggregated by field and updated to the Field Master File. County production updates also reflect an aggregation of reported lease data.

The formations-editing process on the Lease Master File, previously discussed, is one of two areas in which feedback will be provided to the Tax Commission. The other potential problem area in the OTC data is when production reports on the OTC Detail file do not have corresponding OTC Master records. These records will be stored on a Lease "Nomaster" file so that the production is monitored until OTC can be informed of these cases and release appropriate corrections.

Feedback to the Oklahoma Nomenclature Committee will be primarily through maps of "unassigned production" within the state; i.e. maps that show the locations of producing leases that could not be matched to a Field Master record. The Nomenclature Committee can then define new fields or revise field outlines appropriately, and through the new Blue Sheet releases the information will get fed back into the system. Those previously unassigned leases can then get a field code assignment, and the Field Master records will be appropriately updated with both the current and historical production from the newly assigned leases.

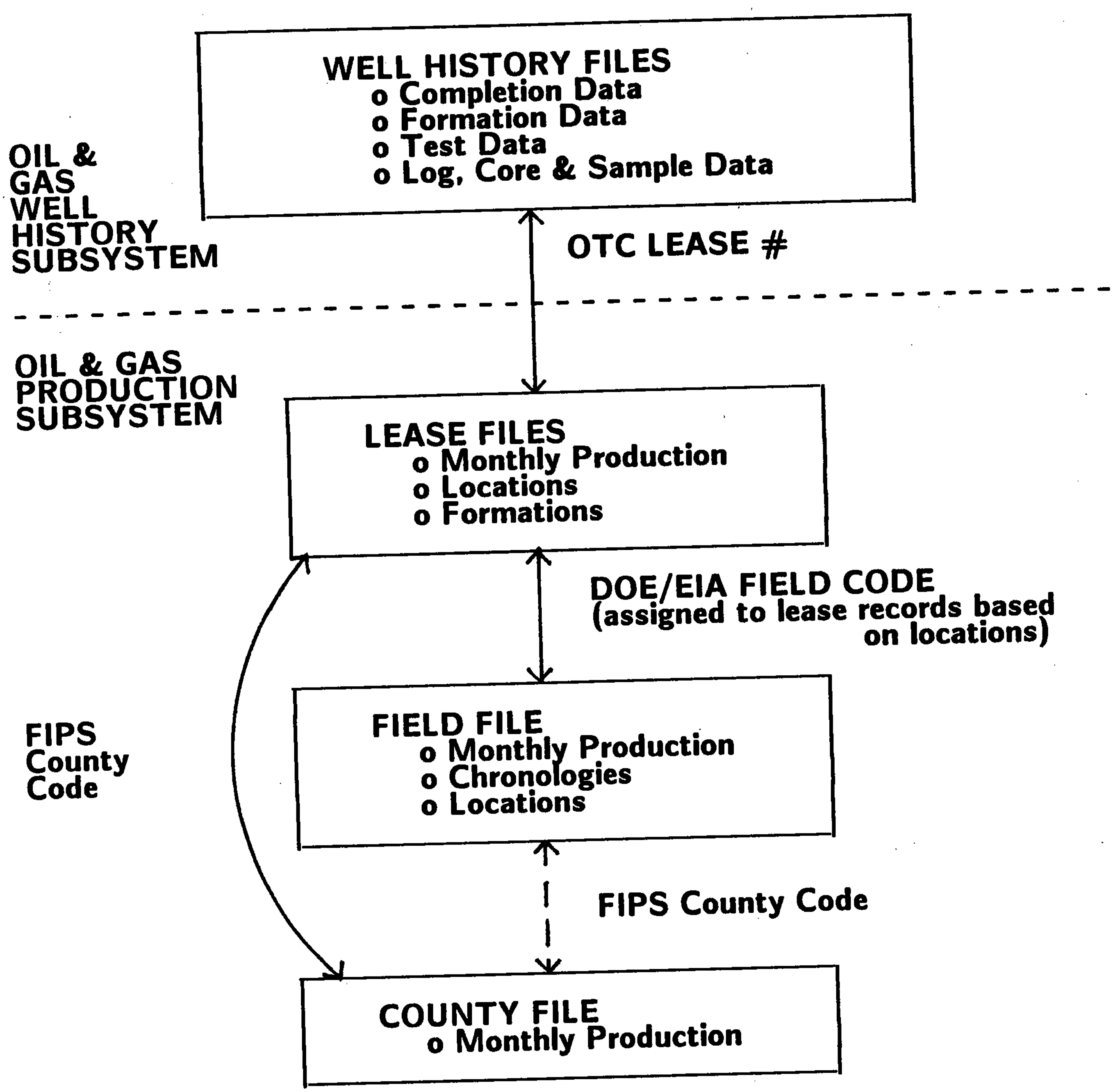
Once several years of production data have been added to the Lease Master File, it is expected that the file size will begin to cause significant processing problems. For this reason, a Lease Archive File is planned; production records over two years old will be migrated to the archive file for storage.

CONCLUSION

The efforts undertaken by the Oklahoma Geological Survey have provided learning experiences that have been valuable to the staff involved in these developments and, hopefully, can also be valuable to others involved in similar data-processing. Since the oil and gas subsystems of the Natural Resources Information System are still under development, experience may result in a final design that varies from the specifications presented in this paper. Hopefully, as the data become more available to users, new feedback and new ideas will be generated that can result in enhancements to the system design, and new challenges and experiences for those involved in the system development.

ATTACHMENT 1

Natural Resources Information System
Oil and Gas Subsystems



OIL AND GAS WELL HISTORY SUBSYSTEM

DATA DICTIONARY

DATA ITEM	DESCRIPTION
.H10	10 OKLAHOMA CORP. COMM. WELL COMPLETION FILE
.H20	20 WELL IDENTIFICATION SECTION
ID	40 OGS IDENTIFICATION NUMBER -
APINUM	50 API WELL NUMBER -
OTCLEAS	60 OTC COUNTY LEASE NUMBER -
OTCOPID	65 OTC / OCC OPERATOR ID NUMBER -
CCID	70 CORPORATION COMMISSION FORM ID NUMBER -
FORMTYP	80 FORM TYPE -
RDATE	90 DATE FORM RECEIVED -
SDATE	100 DATE FORM SIGNED -
SIGNER	110 FORM SIGNED BY -
BATCH	115 BATCH NUMBER -
KEYDATE	120 FORM KEYED ON -
.H30	130 LOCATION SECTION
STCODE	150 STATE POSTAL CODE -
COUNTY	160 COUNTY NAME -
COCODE	170 COUNTY CODE -
FIELD	180 FIELD NAME -
FLDCODE	190 FIELD CODE -
LAT	200 LATITUDE -
LON	210 LONGITUDE -
SECTION	220 SECTION -
TWNSHIP	230 TOWNSHIP -
RANGE	240 RANGE -
QUARTER	250 QUARTER SECTION -
OPER	260 OPERATOR NAME -
OPADDR	270 OPERATOR ADDRESS -
OPADDR2	280 OPERATOR ADDRESS LINE 2 -
OPCITY	285 OPERATOR CITY -
OPSTATE	290 OPERATOR STATE -
OPZIP	300 OPERATOR ZIP CODE -
OPHONE	310 OPERATOR PHONE NUMBER -
FARMNAM	320 FARM NAME -
WELLNO	330 WELL NUMBER -
NAMNUM	340 LEASE NAME AND WELL NUMBER -
DRILSTR	350 DRILLING STARTED -
DRILEND	360 DRILLING FINISHED -
FRSTPRD	370 DATE OF FIRST PRODUCTION -
CMPDATE	380 COMPLETION DATE -
PLGDATE	390 PLUGGING DATE -
FTSL	400 DISTANCE FROM SL OF 1/4 SECTION (FT.) -
FTWL	410 DISTANCE FROM WL OF 1/4 SECTION (FT.) -
SHUTIN	415 SHUT IN WELL -

ATTACHMENT 2
page 2

OIL AND GAS WELL HISTORY SUBSYSTEM

DATA DICTIONARY

DATA ITEM	DESCRIPTION
ELEVDRK	420 ELEVATION OF DERRICK FLOOR (FT.) -
ELEVGRD	430 ELEVATION OF GROUND (FT.) -
ELEVKB	435 ELEVATION OF KELLY BUSHING (FT.) -
ELEV	445 ELEVATION (FT.) -
CHARWEL	440 CHARACTER OF WELL -
.H40	450 WELL COMPLETION TYPE
SINGLEZ	460 SINGLE ZONE COMPLETION
SINGORD	470 ORDER NUMBER -
MULTIZ	480 MULTIPLE ZONE COMPLETION
MULTORD	490 ORDER NUMBER -
COMMING	500 COMMINGLED COMPLETION
COMMORD	510 ORDER NUMBER -
.H50	520 LOCATION EXCEPTION INFORMATION
LOCEXCP	525 LOCATION EXCEPTION
EXCORD	530 LOCATION EXCEPTION ORDER NUMBER -
PENALTY	540 PENALTY -
INCRDEN	545 INCREASED DENSITY
INCRORD	550 INCREASED DENSITY ORDER NUMBER -
.H60	555 OIL OR GAS ZONES SECTION
.H6501	570 01
OGZNAM1	580 OIL / GAS ZONE NAME
OGZNFR1	590 OIL / GAS ZONE START DEPTH
OGZNTO1	600 OIL / GAS ZONE END DEPTH
.H6502	610 02
OGZNAM2	620 OIL / GAS ZONE NAME
OGZNFR2	630 OIL / GAS ZONE START DEPTH
OGZNTO2	640 OIL / GAS ZONE END DEPTH
.H6503	650 03
OGZNAM3	660 OIL / GAS ZONE NAME
OGZNFR3	670 OIL / GAS ZONE START DEPTH
OGZNTO3	680 OIL / GAS ZONE END DEPTH
.H6504	690 04
OGZNAM4	700 OIL / GAS ZONE NAME
OGZNFR4	710 OIL / GAS ZONE START DEPTH
OGZNTO4	720 OIL / GAS ZONE END DEPTH
.H6505	730 05
OGZNAM5	740 OIL / GAS ZONE NAME
OGZNFR5	750 OIL / GAS ZONE START DEPTH
OGZNTO5	760 OIL / GAS ZONE END DEPTH
.H6506	770 06
OGZNAM6	780 OIL / GAS ZONE NAME
OGZNFR6	790 OIL / GAS ZONE START DEPTH
OGZNTO6	800 OIL / GAS ZONE END DEPTH

ATTACHMENT 2
page 3

OIL AND GAS WELL HISTORY SUBSYSTEM

DATA DICTIONARY

DATA ITEM		DESCRIPTION
.H70	810	CASING & CEMENT INFORMATION SECTION
.H7501	860	01 CASING SET / CEMENT (LINE 1)
CASTYP1	865	CASING SET TYPE -
CASSIZ1	870	CASING SET SIZE (INCHES) -
CASWGT1	880	CASING SET WEIGHT (LBS/FT.) -
CASTHD1	875	CASING SET THREADS -
CASGRD1	890	CASING SET GRADE -
CASFT1	900	CASING SET FEET -
CASDEP1	945	CASING SET AT DEPTH OF -
CASPLS1	885	CASING PULLED SIZE -
CASPLL1	895	CASING PULLED LENGTH -
CSGTST1	910	CASING TEST PSI -
CEMSAX1	920	CEMENT SACKS -
CEMFIL1	930	CEMENT FILLUP -
CEMTOP1	940	CEMENT TOP -
CEMCHG1	905	CEMENTING CHEMICALS (GALLONS) -
CEMCHM1	915	CEMENTING CHEMICALS (MAKE) -
CEMMTH1	925	METHOD OF CEMENTING -
CSGTBF1	935	CASING TEST BAILING FLUID BUILD-UP (FT.) -
MUDAMT1	10010	AMOUNT OF MUDDING -
MUDMTH1	10020	MUDDING METHOD -
MUDRES1	10030	RESULTS OF MUDDING -
.H7502	950	02 CASING SET / CEMENT (LINE 2)
CASTYP2	955	CASING SET TYPE -
CASSIZ2	960	CASING SET SIZE (INCHES) -
CASWGT2	970	CASING SET WEIGHT (LBS/FT.) -
CASTHD2	965	CASING SET THREADS -
CASGRD2	980	CASING SET GRADE -
CASFT2	990	CASING SET FEET -
CASDEP2	1035	CASING SET AT DEPTH OF -
CASPLS2	975	CASING PULLED SIZE -
CASPLL2	985	CASING PULLED LENGTH -
CSGTST2	1000	CASING TEST PSI -
CEMSAX2	1010	CEMENT SACKS -
CEMFIL2	1020	CEMENT FILLUP -
CEMTOP2	1030	CEMENT TOP -
CEMCHG2	995	CEMENTING CHEMICALS (GALLONS) -
CEMCHM2	1005	CEMENTING CHEMICALS (MAKE) -
CEMMTH2	1015	METHOD OF CEMENTING -
CSGTBF2	1025	CASING TEST BAILING FLUID BUILD-UP (FT.) -
MUDAMT2	10040	AMOUNT OF MUDDING -
MUDMTH2	10050	MUDDING METHOD -
MUDRES2	10060	RESULTS OF MUDDING -

ATTACHMENT 3
page 1

Sample Form 1002A

Form 1002-A
Rev. (1985)

10A. OTC/OCC Oper No.
1. API Number
2. OTC Prod. Unit No.

This form is an Original ☐ Amended ☐ Why? ______

To be filed within 30 days after drilling is completed

OKLAHOMA CORPORATION COMMISSION
OIL AND GAS CONSERVATION DIVISION
Jim Thorpe Building / Oklahoma City, Oklahoma 73105-4993

PLEASE TYPE OR USE BLACK INK ONLY

3. County ______ Sect. ____ Twp ______ Range ______
4. Lease Name ______ 5. Well No. ______
7. Well Located ______ ¼ ______ ¼ ______ ¼
8. ______ Ft From S.L. of ¼ Sect. and ______ Ft. From W.L. of ¼ Sect.
9. Elevation: Derrick Floor ______ Ground ______
10. COMPANY OPERATING ______
Address ______
City ______ State ______ Zip ______
11. Drilling Started ______, 19___ Drilling Finished ______, 19___
12. Well Completed ______, 19___ Date-First Prod. ______, 19___

640 Acres

6. Locate Well And Outline Lease

13. TYPE COMPLETION
Single Zone ______
Multiple Zone ______ Order No. ______
Commingled ______ Order No. ______
LOCATION EXCEPTION ______ Order No. ______
INCREASED DENSITY ______ Order No. ______

14. Penalty ______

15. OIL OR GAS ZONES

Name	From	To	Name	From	To

16. CASING & CEMENT

	Surf. & Prod. Casing Set				Csg Test	Cement		
Type	Size	Weight	Grade	Feet	PSI	Sax	Fillup	Top
Conductor								
Surface								
Intermediate								
Production								
Liner								

17. TOTAL DEPTH ______

18. PACKERS SET
Depth ______ Type ______

(Over)

19. COMPLETION & TEST DATA BY PRODUCING FORMATION

	1	2	3
FORMATION			
SPACING & SPACING ORDER NUMBER			
CLASSIFICATION (Oil, Gas, Dry, Inj. Well)			
PERFORATED INTERVALS			
ACID/VOLUME			
FRACTURE TREATED? Fluids Amounts			

INITIAL TEST DATA:

Date			
Oil-bbl/day			
Oil-Gravity (°API)			
Gas-MCF/day			
Gas-Oil Ratio Cu. Ft/bbl			
Water-bbl/day			
Pumping or Flowing			
Initial Shut-In Pressure			
CHOKE SIZE			
FLOW TUBING PRESSURE			

A record of the formations drilled through, and pertinent remarks are presented on the reverse.

I declare that I have knowledge of the contents of this report and am authorized by my organization to make this report, which was prepared by me or under my supervision and direction, with the data and facts stated herein to be true, correct and complete to the best of my knowledge and belief.

______ Signature ______ Title
______ Address ______ City ______ State ______ Zip
______ Date ______ Phone

ATTACHMENT 3
page 2

Sample Form 1002A

22. LEASE NAME ____________ 23. WELL NO. ____________

PLEASE TYPE OR USE BLACK INK ONLY

(RULE 3-205) FORMATION RECORD

Give formation names and tops, if available, or descriptions and thickness of formations drilled through. Show intervals cored or drillstem tested.

24.

NAMES OF FORMATIONS	TOP	BOTTOM
TOTAL DEPTH		

FOR COMMISSION USE ONLY

Well Completion Report Checklist

APPROVED / DISAPPROVED

1) ITD Section
a) No Intent to Drill on file
(1) Send warning letter
(2) Recommend for contempt
2) Authorized Surety
a) No Surety filed ____________
b) Expired Surety ____________

Financial Statement/Letter of Credit/Bond
3) Spacing and Pooling
4) Well Spudded prior to approval
5) Insufficient surface casing ____________ required ____________ set
6) No test data
7) Change of location
8) Well location "off pattern"
Spacing Order No. ____________
Size Unit/pattern ____________
Formation(s) ____________
9) No record found
10) Other: ____________
(Please specify appropriate number from initial rejection letter or other problem found)
11) Status: ____________

Was an electrical survey run? ______ ______ (YES / NO). Date last log was run ____________

Was CO_2 encountered? ______ ______ (YES / NO). If so, at what depth(s) ____________

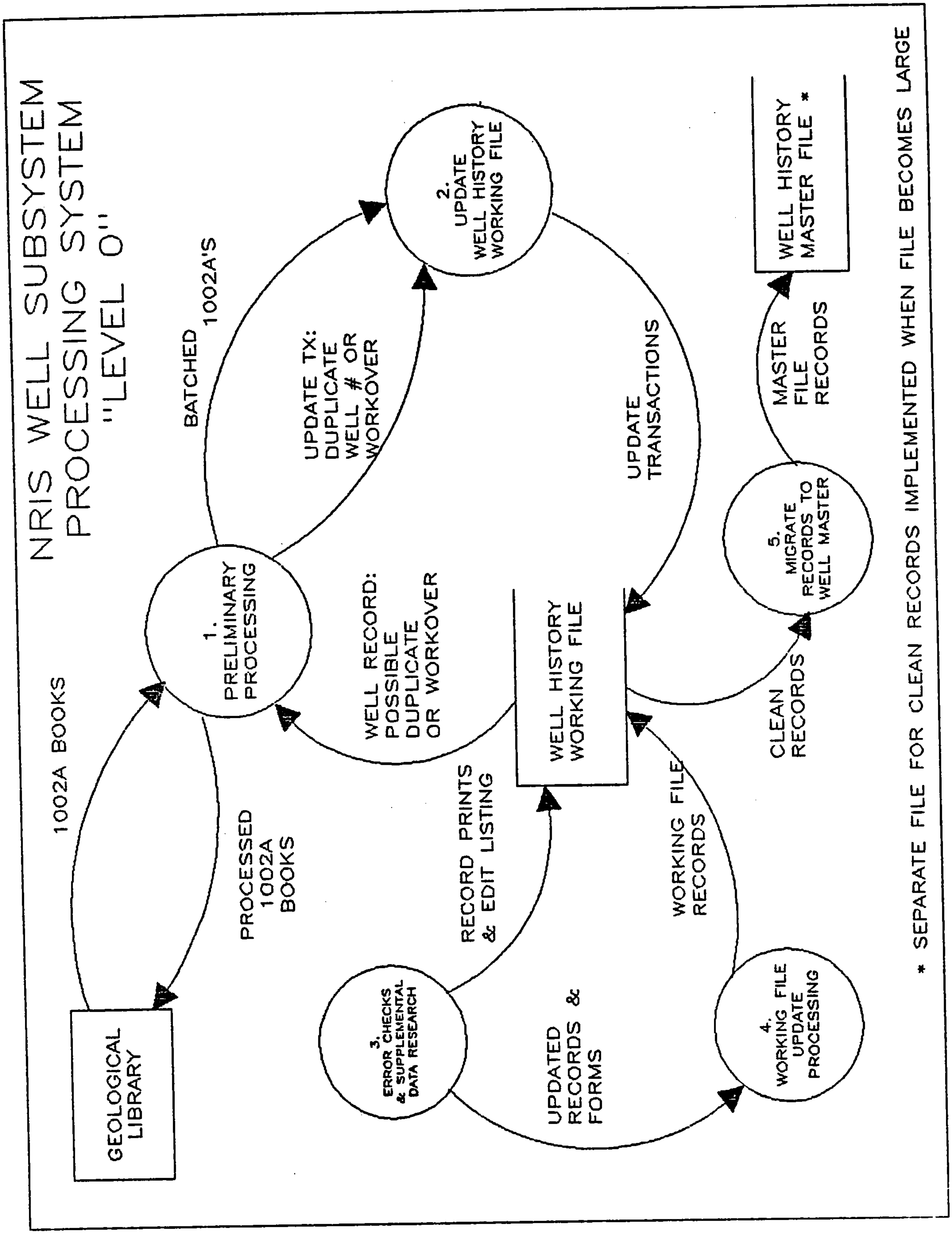
Was H_2S encountered? ______ ______ (YES / NO). If so, at what depth(s) ____________

25. Direct. Survey: True Vertical Depth: ____________ 26. Horizontal Projections: ____________ (N/S) ____________ (E/W)

27. Were unusual drilling circumstances encountered? Yes ______ No ______ If yes, briefly explain: ____________

Other Remarks ____________

ATTACHMENT 4



NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - LEASE MASTER FILE

DESCRIPTION

Record Type:
Lease Header Record

POSITIONS BEG	END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 1; Lease Header Record	N
2	7	6		Field Code	N
8	21	14		Production Unit Number (PUN) PUN breakdown:	N
		3		County Code	
		6		Lease No.	
		1		Sub No.	
		4		Merge No.	
22	27	6		Filler	
28	53	26		Lease Name	A
54	77	24		TRSQ1 TRSQ breakdown:	N
		3		Township	
		3		Range	
		2		Section	
		4		NE Quarter	
		4		SE Quarter	
		4		SW Quarter	
		4		NW Quarter	
78	101	24		TRSQ2	N
102	125	24		TRSQ3	N
126	149	24		TRSQ4	N
150	150	1		Filler	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - LEASE MASTER FILE

DESCRIPTION

Record Type:
Lease Formation Record

POSITIONS BEG	END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 2; Lease Formation Record	N
2	7	6		Field Code	N
8	21	14		Production Unit Number (PUN) PUN breakdown:	N
		3		County Code	
		6		Lease No.	
		1		Sub No.	
		4		Merge No.	
22	23	1		Filler	
24	28	5		Formation Code 1	N
29	53	25		Formation Name 1	A
54	58	5		Formation Code 2	N
59	83	25		Formation Name 2	A
84	88	5		Formation Code 3	N
89	103	25		Formation Name 3	A
104	108	5		Formation Code 4	N
109	143	25		Formation Name 4	A

DATA TYPE LEGEND:A = ALPHA/NUMERIC,N = NUMERIC,B = BINARY,P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - LEASE MASTER FILE

DESCRIPTION

Record Type:
Lease Formation Record (cont.)

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
144	149	6		Transaction Date	N
150	150	1		Filler	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - LEASE MASTER FILE

DESCRIPTION

Record Type:
Lease Production Record

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 3; Lease Production Record	N
2	7	6		Field Code	N
8	21	14		Production Unit Number (PUN) PUN breakdown:	N
		3		County Code	
		6		Lease No.	
		1		Sub No.	
		4		Merge No.	
22	25	4		Filler	
26	27	2		Production Year	N
28	28	1		Product Code	N
29	38	10		Monthly Production 01 January	N
39	48	10		Monthly Production 02 February	N
49	58	10		Monthly Production 03 March	N
59	68	10		Monthly Production 04 April	N

DATA TYPE LEGEND:A = ALPHA/NUMERIC,N = NUMERIC,B = BINARY,P = PACKED

ISP-140

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - LEASE MASTER FILE

DESCRIPTION

Record Type:
Lease Production Record (cont.)

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
69	78	10		Monthly Production 05 May	N
79	88	10		Monthly Production 06 June	N
89	98	10		Monthly Production 07 July	N
99	108	10		Monthly Production 08 August	N
109	118	10		Monthly Production 09 September	N
119	128	10		Monthly Production 10 October	N
129	138	10		Monthly Production 11 November	N
139	148	10		Monthly Production 12 December	N
149	150	2		Filler	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Header Record

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type	N
				1; Field Header Record	
2	7	6		Field Code	N
8	25	18		County Codes 1-6	N
				County Code breakdown:	
		3		County Code 1	
		3		County Code 2	
		3		County Code 3	
		3		County Code 4	
		3		County Code 5	
		3		County Code 6	
26	28	3		Filler	
29	54	26		Field Name	A
55	78	24		Discovery/Abandoned Info.	N
				Breakdown:	
		8		Discovery Date	
		8		Discovery Well API No.	
		8		Abandoned Date	
79	95	17		Alias Information	N
				Breakdown:	
		1		Alias Type	
		4		Alias Year	
		6		Cross Ref Field Code	
		6		Current Field Code	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Header Record (cont.)

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
96	143	48		Comments	A
144	149	6		Oklahoma Nomenclature Committee Date	N
150	150	1		Filler	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Location Record

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 2; Field Location Record	N
2	7	6		Field Code	N
8	25	18		County Codes 1-6 County Code breakdown:	N
		3		County Code 1	
		3		County Code 2	
		3		County Code 3	
		3		County Code 4	
		3		County Code 5	
		3		County Code 6	
26	27	2		Subtype	A
28	29	2		Filler	
54	77	24		TRSQ1 TRSQ breakdown:	N
		3		Township	
		3		Range	
		2		Section	
		4		NE Quarter	
		4		SE Quarter	
		4		SW Quarter	
		4		NW Quarter	
78	101	24		TRSQ2	N

DATA TYPE LEGEND:A = ALPHA/NUMERIC,N = NUMERIC,B = BINARY,P = PACKED

NATURAL RESOURCES INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Location Record (cont.)

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
102	125	24		TRSQ3	N
126	149	24		TRSQ4	N
126	149	24		TRSQ5	N
150	150	1		Filler	

DATA TYPE LEGEND:A = ALPHA/NUMERIC,N = NUMERIC,B = BINARY,P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Production Record

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 3; Field Production Record	N
2	7	6		Field Code	N
8	25	18		County Codes 1-6 County Code breakdown:	N
		3		County Code 1	
		3		County Code 2	
		3		County Code 3	
		3		County Code 4	
		3		County Code 5	
		3		County Code 6	
26	27	2		Production Year	N
28	28	1		Product Code	N
29	38	10		Monthly Production 01 January	N
39	48	10		Monthly Production 02 February	N
49	58	10		Monthly Production 03 March	N
59	68	10		Monthly Production 04 April	N

DATA TYPE LEGEND:A = ALPHA/NUMERIC,N = NUMERIC,B = BINARY,P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Production Record (cont.)

POSITIONS BEG	END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
69	78	10		Monthly Production 05 May	N
79	88	10		Monthly Production 06 June	N
89	98	10		Monthly Production 07 July	N
99	108	10		Monthly Production 08 August	N
109	118	10		Monthly Production 09 September	N
119	128	10		Monthly Production 10 October	N
129	138	10		Monthly Production 11 November	N
139	148	10		Monthly Production 12 December	N
149	150	2		Filler	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - FIELD MASTER FILE

DESCRIPTION

Record Type:
Field Cumulative Production Record

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 4; Field Cum Prod Record	N
2	7	6		Field Code	N
8	25	18		County Codes 1-6 County Code breakdown:	N
		3		County Code 1	
		3		County Code 2	
		3		County Code 3	
		3		County Code 4	
		3		County Code 5	
		3		County Code 6	
26	28	3		Filler	
29	43	15		Cumulative Oil	N
44	58	15		Cumulative Gas	N
59	73	15		Cumulative Associated Gas	N
74	88	15		Cumulative Non-Associated Gas	N
89	90	2		Source	A
91	150	60		Filler	

DATA TYPE LEGEND:A = ALPHA/NUMERIC,N = NUMERIC,B = BINARY,P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - COUNTY MASTER FILE

DESCRIPTION

Record Type:
County Production Record

POSITIONS BEG	POSITIONS END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
1	1	1		Record Type 3; all production records	N
2	7	6		Filler	
8	10	3		County Code	N
11	25	15		County Name	A
26	27	2		Production Year	N
28	28	1		Product Code	N
29	38	10		Monthly Production 01 January	N
39	48	10		Monthly Production 02 February	N
49	58	10		Monthly Production 03 March	N
59	68	10		Monthly Production 04 April	N
69	78	10		Monthly Production 05 May	N

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

NATURAL RESOURCES
INFORMATION SYSTEM

3.0 - COUNTY MASTER FILE

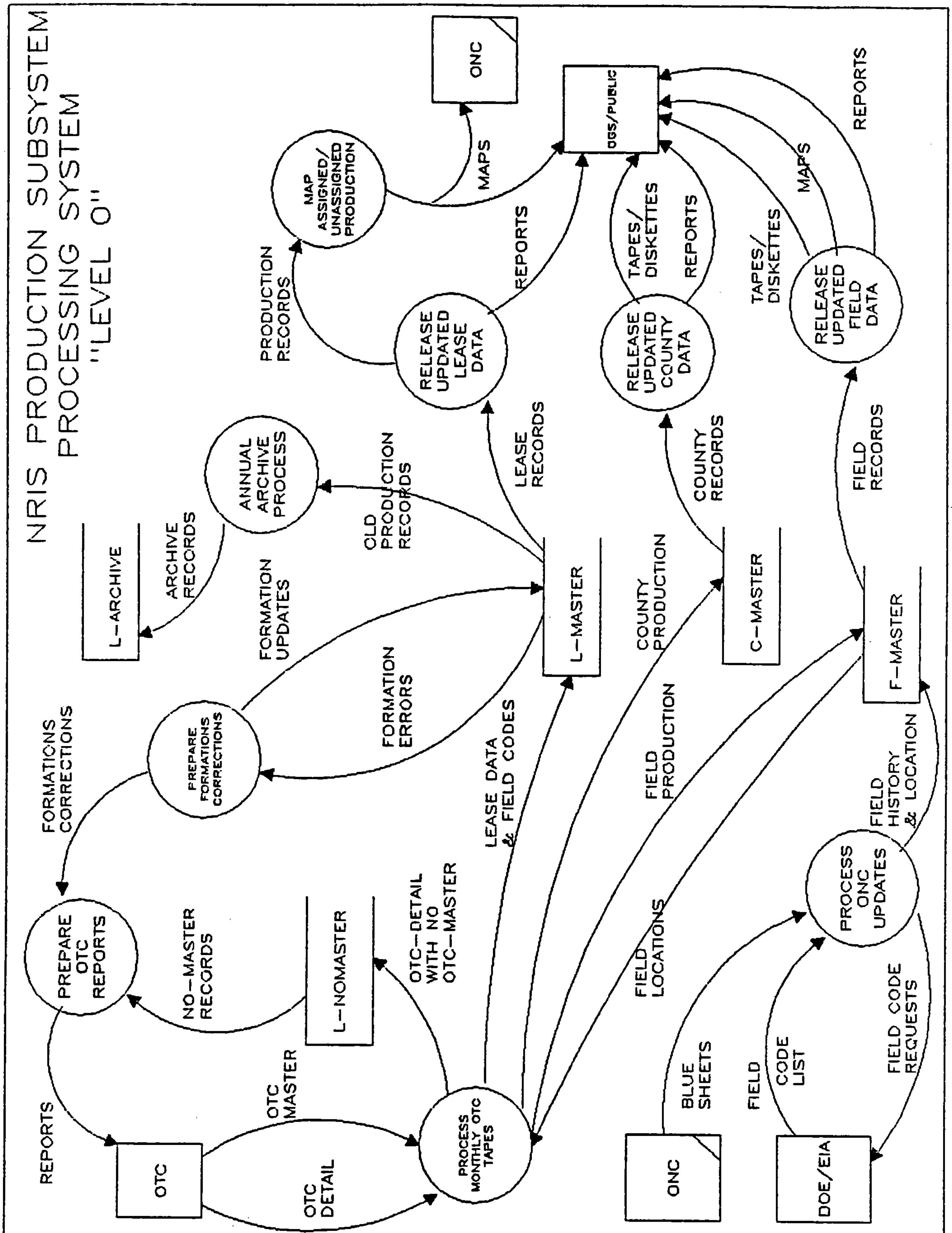
DESCRIPTION

Record Type:
County Production Record (cont.)

POSITIONS BEG	END	LENGTH	ITEM NUMBER	DESCRIPTION	DATA TYPE
79	88	10		Monthly Production 06 June	N
89	98	10		Monthly Production 07 July	N
99	108	10		Monthly Production 08 August	N
109	118	10		Monthly Production 09 September	N
119	128	10		Monthly Production 10 October	N
129	138	10		Monthly Production 11 November	N
139	148	10		Monthly Production 12 December	N
149	150	2		Filler	

DATA TYPE LEGEND: A = ALPHA/NUMERIC, N = NUMERIC, B = BINARY, P = PACKED

ATTACHMENT 6



OIL- AND GAS-WELL INFORMATION SYSTEMS, PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES

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INTRODUCTION

It is common knowledge that Pennsylvania is the birthplace of the modern oil and gas industry. In 1859 "Colonel" Edwin L. Drake drilled the first commercial oil well in Venango County, just south of Titusville, in the northwestern part of the state. Drake drilled his well only 69.5 feet using the spring-pole method commonly used in the salt-well operations of the day, but the production, estimated at eight to 10 barrels of oil per day, spurred others to attempt similar efforts within just a few short months. By the 1870's much of northwestern Pennsylvania looked like a giant forest of wooden derricks, many within a few feet of each other. Until the early 1880s, Pennsylvania led the world in oil production, producing more than 80 percent of the world's supply. The natural gas "boom" followed shortly after, and until the turn of the century Pennsylvania's thriving oil and gas industry continued to drill thousands of wells each year. Despite several bursts of excitement caused by sporadic new discoveries, however, drilling and production essentially subsided throughout the 1900s until the "energy crisis" began in 1973. Today, despite the economic downturn of recent years, Pennsylvania's operators are still drilling a large number of wells (an average 2,700 well per year over the last 10 years); and Pennsylvania's oil and gas production has increased significantly since the founding of OPEC.

The total number of wells drilled in Pennsylvania since Drake has been estimated at between 250,000 and 350,000. The Pennsylvania Department of Environmental Resources has available, in several separate bureaus, well information for over 100,000 of these, and new information on both new and old wells is added daily. This information is in great demand by other government agencies, industry, and the general public, yet the current disparate systems of processing and handling data files critically restricts the Department's capabilities of manipulating and utilizing this large store of information. It became apparent during the early 1980s that these oil and gas data files were in need of automated storage and retrieval capabilities, and an early, unsuccessful attempt was made to develop an automated data-base-management system. A more recent attempt has made use of existing mainframe software to develop an automated permit application-tracking and well-inventory system, and plans are being made for additional automated data-management facilities. These systems, when finally developed and installed, will hopefully provide the Department and the citizens of Pennsylvania with the rapid and ready access to pertinent well information already in demand.

STRUCTURE OF THE DEPARTMENT

The Pennsylvania Department of Environmental Resources (DER) is the main governmental body dealing with Pennsylvania's oil and gas industry (the Department of Commerce and the Public Utility Commission also share in some Commonwealth responsibilities). DER consists of two deputates (Offices) as well as the requisite administrative and legal offices. The Office of Environmental Protection strives to protect the environment by regulating potentially harmful land-use practices, and the Office of Resources Management promotes the utilization and conservation of the Commonwealth's natural resources.

The Bureau of Oil and Gas Management (BOGM), a bureau within the Office of Environmental Protection, is responsible for regulating oil and gas drilling activities, granting drilling and operating permits, monitoring operations for compliance with applicable state and federal regulations, ensuring proper well plugging, and site restoration. BOGM is also responsible for processing applications for higher gas prices under the Natural Gas Policy Act. BOGM conducts its activities under the authority of several statutes, including the

Oil and Gas Act of 1984, the Oil and Gas Conservation Act of 1961, the Clean Streams Law of 1937, and the Gas Operations, Well Drilling, Petroleum and Coal Mining Act of 1984. BOGM is also responsible for collecting well records and production information from Pennsylvania's operators.

The Bureau of Topographic and Geologic Survey, more commonly known as the Pennsylvania Geological Survey, serves the citizens of the Commonwealth as a Resources Management bureau. The Survey's general mission is to gather, analyze, interpret, and disseminate information on topography, geology, ground water, and minerals resources for the entire Commonwealth, so as to provide essential information needed for the understanding, wise use, and conservation of these resources. The Oil and Gas Geology Division of the Survey handles data pertaining specifically to oil- and gas-well drilling, production, exploratory and development activity, and subsurface geology. The Division publishes an annual statistical and narrative report of the previous year's activities based on data received from numerous sources, including BOGM, other DER bureaus, the Department of Commerce, and industry.

PRESENT CAPABILITIES

Because BOGM and the Survey are separate entities within DER, each organization has its own capabilities, resources, and future plans. These aspects are addressed below.

Bureau of Oil and Gas Management

The three offices of BOGM (located in Harrisburg, Pittsburgh, and Meadville) currently communicate directly with DER's Burroughs mainframe computer in Harrisburg via terminals linked with dedicated phone lines. A few Sperry IT personal computers are also hard-wired into this system, giving bureau personnel the capability of moving data to be manipulated by microcomputer-based programs. The primary data-management system is LUMIS, a Cobol-language program developed by McDonnell-Douglas Corp. LUMIS (Land-Use Management Information System) was originally designed for tracking permit applications for the Bureau of Solid Waste Management and the Bureau of Mining and Reclamation, but it has since been modified for use by several other agencies in DER (at present, nine DER bureaus use one or more LUMIS components or "modules"). BOGM came on-line in LUMIS in September of 1986. Of all the components available in LUMIS, BOGM uses seven of them, including Application Tracking, Well Inventory, Inspections, Violations, Enforcements, Complaint Tracking, and Compliance-Self Monitoring. Application Tracking and Well Inventory are the most extensively used components at this time.

Application tracking

BOGM staff enter permit-application data directly into LUMIS as the permit applications are received in the bureau. The system is menu-driven for ease of data entry; a menu appears on the screen, and the operator keys the data into the appropriate spaces (Figure 1). Many of the entries, such as county and municipality, are coded to reduce entry time and storage space and to reduce operator error. All applications are given unique identifying numbers. At any time during the labyrinthine application process, bureau personnel may determine the status of a particular application (e.g., has bonding been approved, has a geologist examined the proposed location for coal-mine or storage field problems, etc.) by entering the application-tracking number in the query format. The application-tracking number is a "key-field", i.e., the information on an application is stored in LUMIS by this number. A number of on-line inquiry functions exist to obtain this number, along with a number of "Disposed Applications" reports showing finished applications. At present, however, this number is the only means the system has of identifying a particular application, and batch commands are non-existent.

Well inventory

The BOGM well inventory presently contains information on more than 132,000 wells and permit locations in Pennsylvania. Completed wells consist of two categories: (1) permitted wells drilled since enactment of the original Oil and Gas Law in 1956; and (2) registered wells, i.e., pre-1968 wells which were not required to be permitted but which have been given permit-type registration numbers. Permit locations are undrilled (cancelled or expired) permits. Prior to enactment of the new Oil and Gas Act in 1984, the Department required only processing fees for permit applications, and then only for a small number of specially designated wells (covered by the Oil and Gas Conservation Act). Because permits were essentially free, most well operators applied for permits on more wells than they could or were willing to drill, and the well-inventory file contains large numbers of these. The new law requires not only processing fees, but also bonding fees and other out-of-pocket expenses for all applications. There has been an expected and understandable concomitant decrease in undrilled permit applications unrelated to the present economic climate.

The well-inventory data consist mostly of demographic information such as operator name and serial number, farm name and number, location, drilling dates, well type, current status, and permit or registration number. Well data are entered directly on a menu similar to that for application tracking (Figure 2), and retrieved information is shown on three separate screens (Figures 3 to 5). All inventory numbers are in the API format, and these numbers constitute the "key field" of the Well Inventory. The Well Inventory also uses the API number to interconnect with other LUMIS components such as Inspections, Violations, Self Monitoring, and Application Tracking. As with the application-tracking system, wells and permits are accessible only through the unique identifying number, and batch commands are non-existent (there are a number of hard-copy batch reports available, however). Although LUMIS also has the capability of running the annual well-production reports against the Well Inventory, and will check all the active wells in the Well Inventory to make sure production reports have been submitted, there are no production, geologic, or engineering data in the system, and BOGM has no plans at this time for including these data.

Bureau of Topographic and Geologic Survey

The Survey currently commands a number of IBM and Sperry personal computers which are assigned to the individual programs. The Oil and Gas Geology Division uses three Sperry IT personal computers, and applications for each are assigned to different projects.

A small oil- and gas-well data base was designed and implemented in 1986 by the division's statistician using Enable, a business-oriented commercial software package pre-installed on the computers. This data base currently contains well data for 1986 and 1987, approximately 4,500 completed wells. The statistician uses the data base mainly to create statistical tables that are the main thrust of the division's annual report of oil and gas developments of the previous year. The data entered into the system consist mostly of demographic information similar to that entered in BOGM's well-inventory system. As well records are received in the Division office, they are processed for the additional technical information, such as producing formations, formation at total depth, deepest producing interval, field and pool, and well classification (Figure 6), that will make them useful to the Survey and to the industry. The well is also relocated on a 7-1/2-minute topographic map by footage to the nearest 2-1/2-minute quadrangle. Division geologists and draftsmen mark these items directly on the well records during the processing phase. Much of this information is not available in any manual or automated files at BOGM or anywhere else in DER.

The statistician has also created a production data base using Enable (Figure 7), but this data base is in its early stages. There are approximately 50,000 producing wells in Pennsylvania, and the initial phase of inputting the basic data (operator, permit/registration number, etc.) has just begun. The annual production amounts and days in production for each well will constitute this eventually enormous file.

CURRENT STATUS OF SURVEY REQUIREMENTS

The Survey is presently engaged in compiling the final revisions to a requirements study for the automated data base needs of the bureau as a whole. The study indicates that the electronic data-processing requirements of the Survey involve the analysis of very large amounts of data in both two and three dimensions, and that the most efficient method for handling these requirements is a bureau-wide geographic information system (GIS). Each division of the Bureau has identified its particular data-handling procedures and the requirements for achieving an effective automated data-management system. Emphasis is given to the particular need to obtain a data base-management system for the Oil and Gas Geology Division, which currently maintains a data base of oil and gas information containing over 100,000 well records and location plats, with the annual addition of 2,000 to 3,000 records. Details on this study and its implications for the future of the Oil and Gas Geology Division are given below.

OUTLOOK FOR FUTURE DATA BASE ACQUISITIONS

The Bureau of Oil and Gas Management plans for future improvements in its data base system, but most of these are directly linked with future improvements in LUMIS. One direction that LUMIS will be going is toward easier modification, so that other programs within DER will be able to more readily adapt the software to their own needs. LUMIS will also be modified to make it easier to access information. At present a well file can be accessed only by the permit/registration number. If this number is unknown, it is actually easier to find the required record manually than to hunt for it in the system. The eventual modification of LUMIS will allow access to a well file by other identifier information, such as operator code, farm name, or location. Batch commands will also be set up so that such queries can be made. There are no BOGM plans for developing a production data base, or for upgrading the demographic data in the well inventory with geologic and engineering data.

The Bureau of Topographic and Geologic Survey will follow through with its requirements study advocating the need for a geographic information system or, at least, a data-base-management system for the Oil and Gas Geology Division. The study makes specific recommendations for both hardware and software.

The Survey's requirements study recommends that the Survey acquire (1) one or more minicomputers with a (collective) minimum capacity of one gigabyte of memory to serve as the Bureau's data-storage and data-manipulation system; and (2) a sophisticated package of software that will satisfy the Bureau's needs for a three-dimensional geographic-information system. As the primary alternative, the study recommends the acquisition of a single minicomputer with a minimum capacity of 250 megabytes of memory, and the recommended software, exclusively for use by the Oil and Gas Geology Division. This alternative should not be implemented unless the recommendation for a bureau-wide system cannot be realistically implemented, or if that implementation requires a long-term study that would effectively put the division's and the bureau's needs on hold for an extended period. Any software developed for the bureau as a whole would need to be integrated with software for U. S. Geological Survey coal and water-well data bases.

Because the Survey recognizes the primary importance of developing an automated data-base-management system for the Oil and Gas Geology Division, the study suggests two possible, though less-than-satisfactory, secondary alternatives. These include (1) acquisition of applicable GIS software that can be operated in the microcomputer environment; and (2) acquisition of a relatively sophisticated, non-GIS, PC-based data-base manager that would be used simply as an "electronic filing cabinet", without the benefit of mapping and other programs. In alternative (1) above the software would need to be adapted or exchanged if a mainframe or minicomputer becames available in the near future.

Acquisition of the hardware and software would only be the beginning. Other needs would arise as system became operative--the need for mass entry of well data, for integrating the data base with LUMIS to make full use of information already keyed into that system, for converting the division's Enable data files to fit the new system. The need for integrating with LUMIS is especially applicable--BOGM, like other Environmental Protection offices, is in the business of regulating industry, not providing information services. Although the information in their system is of basic importance to oil and gas operators in Pennsylvania, it is relatively inaccessible to anyone outside of DER. In addition, the expected adoption of revised Environmental Protection policy on access to public documentation will continue to make it difficult for industry to obtain this information through BOGM. The Survey, on the other hand, is primarily an information agency, and the Oil and Gas Geology Division will improve its commitment to service when the Survey is allowed access to BOGM data.

The Oil and Gas Geology Division estimates that it will take approximately three years to enter all existing well records into a data base, assuming that at least two full-time and several part-time (e.g., student) key-entry employees can be made available once the data-base system is developed and installed. This estimate assumes that other aspects have been satisfied: (1) the personnel are fully familiar with the wide variety of information and well-record types in the division's files (see Figures 8 to 11 for just a few examples of the wide variety of records on file); or (2) that the data from the more than 100,000 records have been reduced to a common format for data entry. The Division presently has 11,600 completed data-entry forms waiting for mass entry into a data-base system. The cost to the Survey for such data entry will probably be phenomenal. The following is offered as an actual example of the time and money involved in such an undertaking. In July of 1987, BOGM concluded a data-conversion contract in which only 30 years worth of files, consisting only of the demographic data from the records and permits, were reduced to input forms and keypunched to tape. Approximately 25 tapes were run into LUMIS to create the BOGM Well Inventory. The time involved was one year, and the cost was $150,000 (approximately $1.00 per record). The keystrokes alone amounted to about 25,000,000. BOGM provided support mainly in training and problem consultation, thus keeping the staff personnel free to do their regularly assigned duties.

LIST OF FIGURES

Figure 1

```
PRINT 359.          ]                  LUMIS                                    ]
                           --- APPLICATION TRACKING MENU ---

                      ------ ENTER -------
[AT]                  COMPONENT IDENTIFIER  ---REQUIRED---
[  ]                  FUNCTION  IDENTIFIER  ---REQUIRED---
[              ]      ID #
[  ]                  PAGE #
[      ]              COORD #/COUNTY
[      ]              BUREAU CODE
[      ]              APPLICATION TYPE

FUNC---------INQUIRY(OF)---------------------FUNC--------UPDATE(OF)-------------
AI    APPLICATION BY ID #                      AU    APPLICATION BY ID #
CI    COORDINATED APPLICATIONS BY COORD #      CU    COORDINATION BY ID #/COORD #
CT    APPLICATIONS BY COUNTY/BUREAU CODE/      SU    APPLICATION STATIONS BY ID #
        OPTIONAL APPLICATION TYPE
LI    APPLICATIONS BY ADDITIONAL ID #

FUNC---------CREATION(OF)--------------------FUNC--------DELETION(OF)-----------
AC    APPLICATION BY OPTIONAL ID #/            AD    APPLICATION BY ID #
        APPLICATION TYPE                       SD    APPLICATION STATIONS BY ID #
CC    COORD # BY ORIGINAL APPLICATION ID #
BR    BATCH
```

Figure 2

```
PRINT 359
                             --- WELL INQUIRY ---

ID # [         ]    SUFFIX [  ]     FARM  [                                      ]
OPERATOR [             ]                                          WELL # [       ]
AGENT    [             ]                                        SERIAL # [       ]
PROJECT  [             ]
STORAGE FIELD  [             ]

COUNTY [   ] [              ] MUNIC [   ]
USGS MAP # [    ] LATITUDE  [       ]  OFFSET [       ]  DIRECTION [ ]
MAP SECTION # [ ] LONGITUDE [       ]  OFFSET [       ]  DIRECTION [ ]

WELL TYPE [  ]           DATE PERMITTED [       ]     DATE REGISTERED [       ]
TOTAL DEPTH [     ]      SURFACE ELEV  [      ]       CONSERVATION WELL [ ]
STATUS: ACT 223 [  ]     ACT 214 [  ]                 PMT/REG [  ]

           DATE-COMMENCED   DATE-COMPLETED   YEAR
DRILLING:     [      ]        [      ]     [    ]
RE-DRILL:     [      ]        [      ]     [    ]
DRILL DEEPER: [      ]        [      ]     [    ]                 CERTIFICATE
ALTERED:      [      ]        [      ]     [    ]  TYPE OF PLUG    RECEIVED
PLUGGING:     [      ]        [      ]     [    ]   [ ]              [ ]
ACTION [ ] NEXT FUNCTION [OG][WC][            ][  ][      ][      ][      ]
```

Figure 3

PRINT 359

--- WELL INQUIRY ---

ID # 129-20952 SUFFIX P FARM ALBERT MCMURRAY WELL # 1
OPERATOR OGO-23467 FOX OIL & GAS, INC. SERIAL # 89]
AGENT
PROJECT
STORAGE FIELD

COUNTY 65 WESTMORELAND MUNIC 001 HEMPFIELD TWP.
USGS MAP # 1609 LATITUDE 40:17:30 OFFSET 10,900 DIRECTION SOUTH
MAP SECTION # 8 LONGITUDE 79:32:30 OFFSET 5,240 DIRECTION WEST

WELL TYPE GS GAS DATE PERMITTED 09/24/85 DATE REGISTERED
TOTAL DEPTH 3,983 SURFACE ELEV 1,112 CONSERVATION WELL
STATUS: ACT 223 ACT 214 PMT/REG

	DATE-COMMENCED	DATE-COMPLETED	YEAR	TYPE OF PLUG	CERTIFICATE RECEIVED
DRILLING:	06/01/77	06/07/77			
RE-DRILL:					
DRILL DEEPER:					
ALTERED:					
PLUGGING:	08/26/85	08/26/85		U UNKNOWN	X

ACTION [ ] NEXT FUNCTION [OG][II][129-20952][01][ ][ ][ ]

Figure 4

```
PRINT 359
                              --- WELL INQUIRY ---

ID # 129-20952     FARM  ALBERT MCMURRAY                               WELL # 1
COAL INFORMATION:              COAL AREA X                        MINED THROUGH
--- COAL-SEAM-PENETRATED ---      - MINE-ID --                 PILLAR-PERMIT

ALTERNATE METHODS: CASING       PLUGGING      VENTING      EQUIPPING
SPECIAL CAUTION AREA       SPECIAL PERMIT CONDITIONS     WATERSHED
BOND ID 50846IC          (BLANKET COL)        OPERATOR TRANSFER DATE

NGPA INFOR4MATION:   CLASSIFICATION     DOCKET #
   MARKER WELL

RELATED PERMITS:
   PART II PERMIT #                    UIC ID #
   EPA CLASS/TYPE                      VOLUME INJECTED          (BBLS)
ACTION [ ] NEXT FUNCTION [OG][II][129-20952   ][02][      ][      ][       ]
```

Figure 5

```
PRINT 359
         --- COMPLIANCE MONITORING REQUIREMENTS INQUIRY ---

ID # 129-20952       NAME ALBERT MCMURRAY                      WELL # 1

NUMBER OF UNRESOLVED VIOLATIONS    0            SPECIAL REPORT

       TYPE              DUE-DATE   FREQ          TYPE              DUE-DATE   FREQ
---------------------    --------   ---    ---------------------   --------   ----
INACTIVE STATUS                            MECH. INTEGRITY
DISPOSAL WELL                              MISCELLANEOUS




ACTION [ ] NEXT FUNCTION [OG][II][129-20952   ][03][       ][       ][       ]
```

Figure 6

1987 WELL STATISTICS

Sys:Date: _______ Deep?: Logs?:

County Code: __ County: _____________

Permit No: ________ RDP: _____ Project: _________

Quadrangle: ___________________ Township: ___________________

Latitude: __________________ Longitude: __________________

Field Name: ___________________ Pool Name: ___________________

Company No: ____

Company: _______________________________

Farm Name/No: ___________________ Serial Number: ______

Elevation: ___ Completion Date: _______ Date Received: ____

T.D.	D.D.	D.P.I.	Class	Type
_____	___	_____	_________	______

MCF: _____ BBL: _____ Rock Pressure: ___ Hrs. __

T.D. Formation: ___________ Producing Formation: _________

Comments: ____

Figure 7

WELL PRODUCTION STATISTICS

Completion Date: _______

County Code: __ County: _____________ Permit: ________

Field Name: ___________________ Pool_Name: ___________________

Quadrangle: ___________________ Township: ___________________

Company No: ____ Company: _______________________________

Farm Name/No: ___________________ Serial Number: ______

Producing Formation: _ Deep? Discovery Well?:

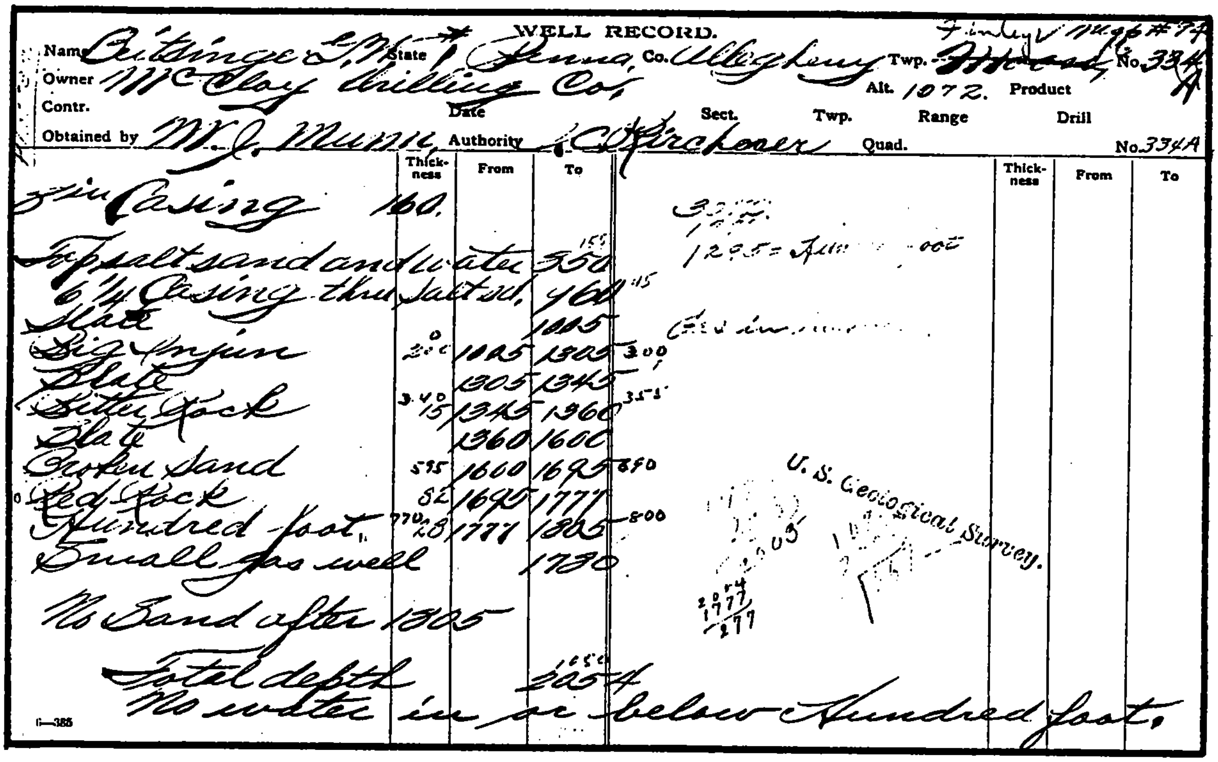
	Gas Prod. 85	GDays85	Oil Prod. 85	ODays85
1985	_________	--	________	--

	Gas Prod. 86	GDays86	Oil Prod. 86	ODays86
1986	_________	--	________	--

	Gas Prod. 87	GDays87	Oil Prod. 87	ODays87
1987	_________	--	________	--

Abandoned/Yr: ___

Figure 8



WELL RECORD.

Name Bitinger L. M. #1 State Penna. Co. Allegheny Twp. Findlay No. 334A
Owner McClay Drilling Co.
Contr. Alt. 1072. Product
Obtained by W. J. Munn Authority Date Sect. Twp. Range Drill Quad. No. 334A

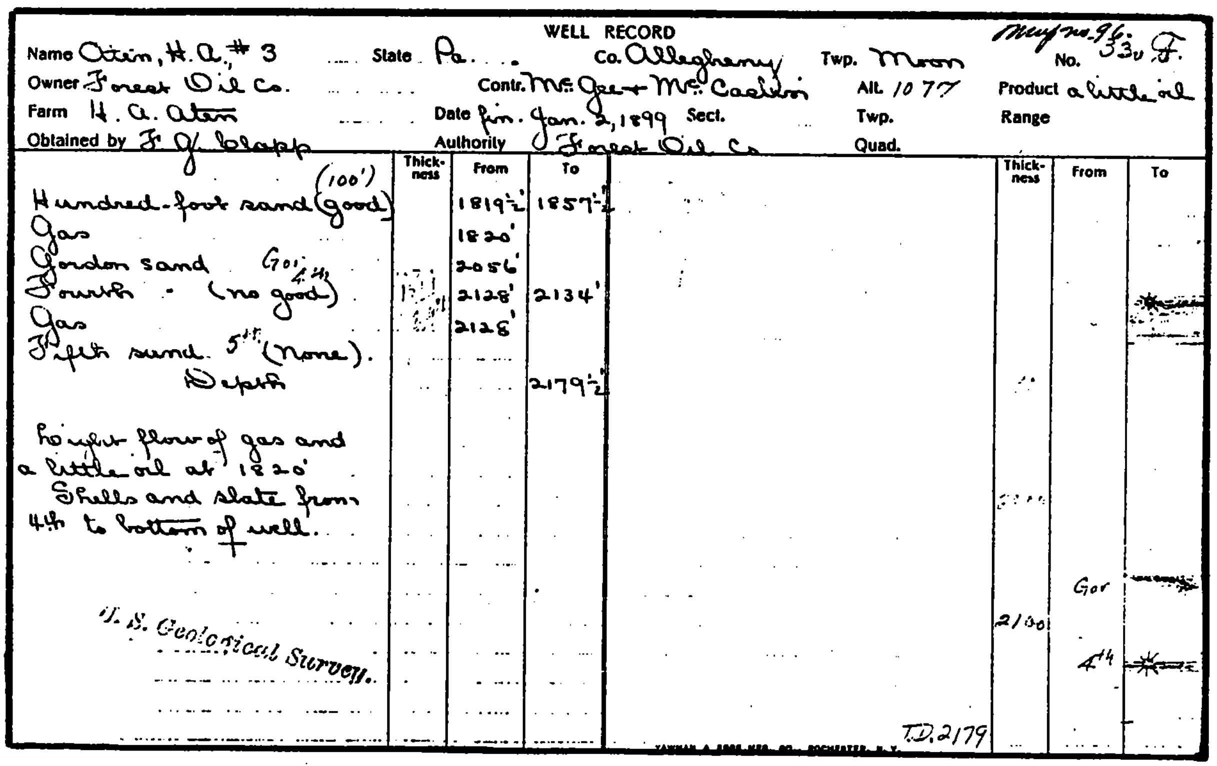
	Thickness	From	To
8 in Casing	160.		
Top salt sand and water			550
6 1/4 Casing thru Salt sd.			460
Slate			1005
Big Injun		1025	1305
Slate		1305	1345
Bitter Rock	15	1345	1360
Slate		1360	1600
Broken Sand		1600	1695
Red Rock	82	1695	1777
Hundred foot	28	1777	1805
Small gas well			1730

No Sand after 1805

Total depth 2054

No water in or below Hundred foot.

U. S. Geological Survey.



WELL RECORD

Name Aten, H. A. # 3 State Pa. Co. Allegheny Twp. Moon Map no. 96. No. 330 F.
Owner Forest Oil Co. Contr. McGee & McCaslin Alt. 1077 Product a little oil
Farm H. A. Aten Date fin. Jan. 2, 1899 Sect. Twp. Range
Obtained by F. J. Clapp Authority Forest Oil Co. Quad.

	Thickness	From	To
Hundred-foot sand (good) (100')		1819½	1857½
Gas		1820'	
Gordon sand		2056'	
Fourth - (no good)		2128'	2134'
Gas		2128'	
Fifth sand 5th (None).			
Depth			2179½

Light flow of gas and a little oil at 1820'.
Shells and slate from 4th to bottom of well.

U. S. Geological Survey.

T.D. 2179

Figure 9

2

ER-OG-4: Rev. 10/82

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF OIL AND GAS REGULATION
PITTSBURGH, PENNSYLVANIA 15222

Office Use Only

WELL RECORD

PERMIT NO. 37-111-20147 PROJECT NO. TYPE OF WELL GAS

WELL OPERATOR: Ashtola Production Company
TELEPHONE NO.: 215-337-1000
ADDRESS: P. O. Box 858, Valley Forge, PA
ZIP: 19482
FARM NAME: Commonwealth of PA. Tract No. 280
FARM NO.: 1
SERIAL NO.:
ACRES:
TOWNSHIP: Elk Lick
COUNTY: Somerset
DRILLING COMMENCED: 9/11/85
DRILLING COMPLETED: 10/14/85
ELEVATION: 3087
QUADRANGLE: Markleton ☒ 7½' ☐ 15'

CASING AND TUBING RECORD

PIPE SIZE	AMOUNT IN WELL	MATERIAL BEHIND PIPE: CEMENT (SKS.)	MATERIAL BEHIND PIPE: GEL (SKS.)	PACKER: TYPE	PACKER: SIZE	PACKER: DEPTH	DATE RUN
16"	11'						9-11-85
11 3/4"	321.7'	200 sks.Class A +3% CACl 2	1/4#sk Flocele	Guide Shoe	11 3/4"	332'	9-17-85
8 5/8"	2383.85'	390 sks 50/50 pozmix +2% gel;	1/4#sk Flocele	Guide Shoe	8 5/8"	2394'	9-26-85
		130 sks Class A +3% $CACl_2$	1/4#sk Flocele				

PERFORATION RECORD: DATE	INTERVAL PERFORATED: FROM	TO	STIMULATION RECORD: DATE	INTERVAL TREATED	AMOUNT FLUID	AMOUNT SAND	INJECTION RATE
		NOT	APPLICABLE				

NATURAL OPEN FLOW — NATURAL ROCK PRESSURE — HRS. DAYS

AFTER TREATMENT OPEN FLOW — AFTER TREATMENT ROCK PRESSURE — HRS. DAYS

REMARKS:

Installed cement basket at 67'

OIL & GAS MANAGEMENT
RECEIVED
NOV 14 1985

1-2-86
[signature]

(FORMATION ON REVERSE SIDE)

20147

Figure 10

ER-OG-4: Rev. 10/82
(pg 2)

COMMONWEALTH OF PENNSYLVANIA - TRACT NO. 1
TRACT #280

FORMATIONS

NAME	TOP	BOTTOM	GAS AT	OIL AT	WATER AT (FRESH OR SALT WATER)	SOURCE OF DATA
Shale	0'	4'				
Sand	4'	57'				
Shale	57'	113'				
Sand	113'	121'				
Shale	121'	138'				DRILLER'S LOG
Sand	138'	150'				
Shale	150'	160'				
Sand	160'	200'			@197' 1/2" stream H_2O	
Red Rock & Sand	200'	286'				
Sand	286'	379'			@294' 2 1/2" stream H_2O	
Sand & Shale	379'	385'				
Red Rock & Shale	385'	468'				
Sand & Shale	468'	1007'				
Red Rock	1007'	1017'				
Sand	1017'	1022'				
Shale	1022'	1030'				
Red Rock	1030'	1046'				
Shale	1046'	1051'				
Sand	1051'	1061'				
Sand & Shale	1061'	1254'				
Red Rock	1254'	1262'				
Sand & Shale	1262'	1275'				
Red Rock	1275'	1325'				
Shale & Sand	1325'	1330'				
Red Rock & Shale	1330'	1445'				
Shale	1445'	1835'				
Sand	1835'	1944'				
Shale	1944'	1980'				
Red Rock	1980'	1997'				
Red Rock & Sand	1997'	2593'				
Sand	2593'	2615'				
Sand & Shale	2615'	8790'				
Marcellus Shale	8790'	9087'				
Onondaga Limestone	9087'	9100'				
Huntersville Chert	9100'	9170'				
Needmore Shale	9170'	9210'				
Oriskany Sand	9210'	9435'				
TD	9435'					

October 31, 19 85
DATE

APPROVED BY David L. Matz

Division Engineer
TITLE

Figure 11

BEAVER COUNTY

API/ Registration #	Municipality	Farm Name	Well#	Serial # Optional	Date Drilled	Type Well	T.D.	Date Register.	Date Granted Inactive Status	Blanket Bond	Fee in Lieu of Bond	Years Prod. Rpts. Filed	Operator
00007	ALIQUIPPA	J. + L. STEEL CORP. ALIQUIPPA WKS.	1	LS-BEA-1	9-12-1960	DISPOSAL		11-1-85				PLUGGED	J. + L. STEEL CORP.
00008	HANOVER	W.B. COOLEY	5	1	1888	OIL	1779	6-19-86		1986			JAMES M. CASSIDY
00009	"	J. COOLEY	4		1904	GAS	1720	"		"			"
00010	ECONOMY	DUNN HEIRS	600161		7-13 1900	"	1274	7-17-86		"			COLUMBIA GAS TRANS.
00011	"	"	600163		2-23 1923	"	1285	"		"			"
00012	HOPEWELL	McCARTNEY	1	CCW 30	N/A	GAS	1520	3/15/37		1937	B		CC WHARTON
00013	"	A P MORROW	1	CCW 31	"	[illegible]	1800	"		"			"
00014	"	"	2	CCW 32	"	"	1800	"		"			"
00015	"	"	3	CCW 33	"	OIL	1800	"		"			"
00016	"	"	4	CCW 34	"	"	1750	"		"			"
00017	"	W MORROW	5	CCW 35	"	"	1700	"		"			"

OIL & GAS INFORMATION IN SOUTH DAKOTA

A PROGRESS REPORT

by

Fred V. Steece 1/

1/ Supervisor of Oil and Gas
Department of Water and Natural Resources
Western Field Office-Oil and Gas
36 E. Chicago, Rapid City, South Dakota 57701

INTRODUCTION

By industry standards South Dakota is a small oil and gas state. Since the first oil test was drilled shortly after the turn of the century, there have been only about 1,500 test borings drilled in the state. This drilling has resulted in approximately 200 producing oil wells and 50 natural gas wells. During 1986 the total oil production was 1,586 thousand barrels and the gas production was 2,475 million cubic feet.

Even though the number of borings is low, still there has been a considerable amount of data generated by these efforts. The information has been and is filed with the South Dakota Department of Water and Natural Resources in two separate places: (1) the Western Field Office of oil and gas in Rapid City, and (2) the South Dakota State Geological Survey on the campus of the University in Vermillion, at the opposite ends of the state. In addition, the sample cuttings and cores from wells and borings are saved and stored for future use at the "core barn" in Vermillion. Although no accurate count has been kept, it is estimated that more than 5,000 uses have been made of the oil and gas files and/or samples and cores since the materials began to be systematically filed more than 40 years ago. Even though we are a "johnny-come-lately" state, we are very much aware of the importance of collecting good data and seeing that this is preserved for future use.

HISTORY

After Dr. E. P. Rothrock became South Dakota State Geologist in 1925, the South Dakota State Geological Survey assumed jurisdiction of oil and gas affairs from the office of the State Engineer, which ostensibly had regulated the little activity up to that time. Thereafter, the Survey was the oil and gas regulatory agency. In 1973 the Survey lost its status as a separate department of state government, when complete reorganization consolidated the 50 or so autonomous agencies into 16 cabinet-level departments, each headed by an Administrative Secretary (Figure 1). The Survey became a division of the Department of Natural Resource Development, which later became the current Department of Water and Natural Resources. Departmental reorganization in 1981 transferred oil and gas, along with all other regulatory programs, to the Division of Water and Natural Resource Management. This Division later underwent a name change to the Division of Environmental Quality, which is its present nomenclature (Figure 2). Although originally a part of the State Geological Survey, the oil and gas program at the Western Field Office, is not now technically within the Survey. Information and samples are filed in the Western Field Office and then transferred or shared with the Survey's Vermillion office.

FACILITIES

The Survey offices have been located on the University of South Dakota campus since its creation in 1893. The present home of the Survey is in the Akeley Science Center, which also houses the Department of Earth Science and Physics. A subsurface laboratory and a core barn, along with a vehicle-storage building, are located off campus about two miles from the main office.

The Western Field Office of oil and gas is located in Rapid City a short distance from the South Dakota School of Mines and Technology campus. Although technically not connected with the School of Mines, the writer is Adjunct Associate Professor of Geology and Geological Engineering.

Paper information files, arranged by county, section, township and range, are maintained at both offices, supplemented by microfiche and microfilm (cassettes) at the Western Field Office. Facilities at both offices are available for in-office study and for duplicating from the paper files. Photocopy facilities are available both in Rapid City and Vermillion for page size, legal, 11 X 17 and for 8 1/2- of 11-inch-wide strip copies. The microfiche, produced by MJ Systems, can be viewed on readers, but copies can be made only from the paper files.

All data from producing wells are posted on a monthly basis and entered into an AT&T 6300 PC. The information can be called up at any time and is compiled semiannually, showing oil, gas, and water and number of producing days on individual wells, by field. Cumulative totals are kept current on a semiannual basis, but this information can be called up on demand.

INFORMATION REQUIREMENTS

Rules regulating oil and gas activities in South Dakota have been in effect since 1939. These early rules were not specific about the kinds of information to be filed; in fact many early drilling operations had little to show but a driller's log. With the advent of more and more sophisticated logging and testing equipment came the resulting technical reports, and the rules were modified to require the filing of this type of data, along with all the other routine information.

All operators are now required to file an organization report showing an administrative breakdown on the company along with their South Dakota agent. This allows the state an avenue of approach to the operator in case any problems arise during the exploratory or production phases of oil and gas development. In additon, a plugging and performance bond is required not only to assure that a well or test hole is properly plugged and the surface reclaimed, but also to ensure that all other regulatory requirements have been met, including the filing of all geologic and engineering information.

Two copies of all logs and reports are required by the Western Field Office. Typical of the types of information filed are electrical well surveys, well-site geologic reports, drill-stem-test reports, core analyses, and occasionally even water analyses, gas analyses, and oil analyses. South Dakota does not require the filing of seismic data. All information is to be filed with the Western Field Office within 30 days of completion or plugging the well, except that cores and samples must be filed within six months. Information can be held confidential by the operator, if requested in writing, for a period of six months. This period can be extended if good cause is shown.

An example of tracking information from the first contact by the operator until release of bond is as follows:

1) The operator makes contact; he declares his intent to drill in South Dakota.
2) Rules are sent along with a "Proceedure" sheet (Figure 3), which outlines step-by-step the process of obtaining a permit to drill.
3) The application is received and has the following components:

   a) Organization Report (Form 1; Figure 4).
   b) Application for Permit to Drill, Deepen or Plug Back (Form 2; Figure 5).
   c) Surety Bond (Form 3): \$5,000 single or \$20,000 blanket (Figure 6).
   d) Bond Information Sheet showing details regarding the principal and surety and instructions on whom to contact with the bond release (Figure 7).
   e) Surveyor's Plat showing the accurate location of the well and the surface elevation (Figure 8).
   f) Additional Surface Restoration Bond (Form 10): \$2,000 single or \$10,000 blanket (Figure 9). This bond is required when the surface and mineral estates have been severed and the surface owner is not a party to the oil and gas lease.
   g) Certificate of Negotiation (Form 9), which shows that the operator and the surface owner have negotiated a settlement for surface damages or are presently negotiating (Figure 10).
   h) A copy of the lease when evidence is needed that the surface and mineral estates have or have not been severed.

When a well becomes productive the operator must file the following information:

i) A Completion or re-Completion Report (Form 4) showing the completion details of the well (Figure 11).
j) Monthly Report of Operations and Well Status (Form 5) on which is listed oil, gas, and water produced during the previous month and the number of days produced (Figure 12).
k) Monthly Report of Injection Wells (Form 5a) showing the amount of water, gas, or air injected during the previous month and the number of days injected (Figure 13).
l) Any additional information or new data not called for elsewhere is filed on a Sundry Notice (Form 6; Figure 14).
m) After a well has been plugged and abandoned the operator files a Plugging Report (Form 7) which is an affidavit showing how and with what material the well or test hole was plugged (Figure 15).

The State Geologist himself supervised the plugging of wells in the early days of the Survey (E. P. Rothrock promulgated this practice through the 1930s, '40s, and '50s). His purpose was to emphasize the importance of of protecting the water resources contained in the subsurface rock column. A second important purpose was to prevent accidental water flooding of oil-bearing strata. He would glean as much information as was possible and enter this in the Scout Report (Figure 16). The only information collected on some of the very old wells was what showed on the Scout Report. The Scout Report is still used today but the emphasis has shifted somewhat from primarily geological to include reclamation information (Figure 17).

UTILIZATION OF INFORMATION

A wide variety of uses are made of the data obtained from the oil and gas industry in South Dakota. One of the most useful and sought-after publications is the semiannual report on production of oil, gas, and water by well, by field in the state (Figure 18). In addition, a series of county oil and gas maps are updated at least once a year (Figure 19). These maps, covering all of western South Dakota (no production and only a small amount of exploration has taken place in the eastern half of the state), show all producing wells, dry holes, injection wells, and oil and gas shows in wells (Figure 20). A large number of publications using oil and gas information and statistical data have been issued by the Survey and by the Western Field Office over the years (Figure 21).

Information obtained from oil and gas exploration, production, and development has a wide range of uses, some of which are listed below.

1) Industrial.--

- Oil company geologists and consultants use the information to find new oil deposits.
- Lease brokers and landmen are interested in ownership and acreage assigned to various wells and units.
- Engineers and building contractors are interested in water-supply wells and in geothermal water for space heating.
- Commercial information companies like Petroleum Information and Dwight's/MJ Systems, for example, seek information for obvious reasons.

2) Agricultural.--

- Farmers and ranchers find application of oil-well information to locating water supplies for their needs, which are for domestic stock watering, for irrigation, and sometimes for geothermal applications, such as space heating or hothouse plant production.

3) State and Federal Agencies.--

- Students and faculty from the institutions of higher learning, such as the School of Mines and Technology in Rapid City, utilize the data for theses and consulting jobs.
- The Department of School and Public Lands and the Department of Revenue are interested in accurate oil and gas production reports for obvious reasons.
- Federal agencies such as USGS, BLM, FERC, and EPA all require correct oil and gas data for their various purposes.

PLANS

In planning for future information management, I like to visualize a system where one would simply enter data into the computer file as it is received, give a command or two, and out comes a time rate/production graph or an isopach map of a particular rock layer. Unfortunately we are not yet at this stage in South Dakota. But this is a capability we look forward to in the future. All historical production data need to be entered into the computer so that they can be retrieved in a logical, systematic, and useable form. Geologic data of many kinds also need to be fed into the computer. This information has its source in geologic reports, which include formation tops, sample and core descriptions, and in drill-stem-test reports. There is a need to have the ability to retrieve this information in the form of maps, bar graphs, and other useable forms. Ideally one would have the ability to map the structure, or the thickness, or the lithofacies of any and all geologic formations in the state, using data that are quickly and accurately available from a data base.

Once all the data are entered for future use, it will be possible to eliminate large volumes of paper files. It is planned, however, to maintain a set of paper files as long as possible for the convenience of file users, who are nearly unanimous in their preference for working from paper as opposed to film or fiche. The most widely used and most strongly defended paper records are the electric logs. Even though these are available on both film and fiche, users still prefer to use and purchase copies of our paper logs.

CONCLUSIONS

There is much work to be done in modernizing our oil and gas information and making it more easily retrievable and efficiently useable. I have no doubt that information from oil and gas exploration, production, and development in South Dakota will continue to accumulate for many years to come.

The potential for future development of oil and gas (particularly gas) I think is good, other factors being equal. Who can say what effect Middle East politics and human behavior will have on world oil production and thus world oil prices? Who can say when a major breakthrough will be made in the economic production of alternate energies such a hydrogen fuel, nuclear fusion, or methanol and ethanol? And who can say when the natural gas "bubble" will burst, resulting in renewed demand for new natural-gas supplies? These few examples of global unknowns point up the complexities of the oil and gas industry; but if we, convened in Norman, Oklahoma, were not optimistic about the future of the oil and gas industry we would all be wasting our time here. I believe that we are not wasting our time here, but that we are doing our best to make the oil and gas information which is available, and that which will be available in the future, work to help in the search for new oil and gas supplies. With these new oil and gas supplies will come new information along with the challenge for its future management.

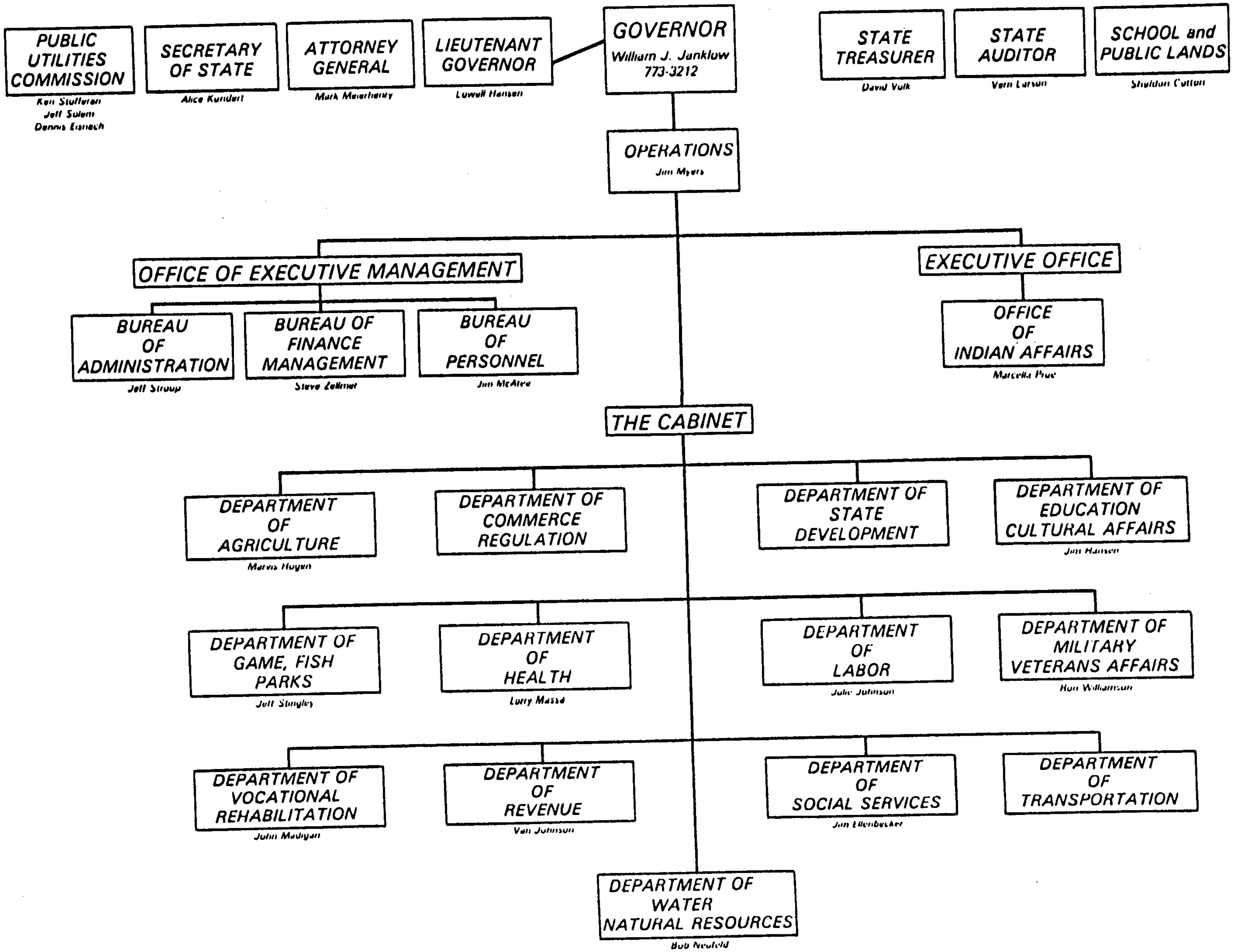


Figure 1: State of South Dakota Organization Chart

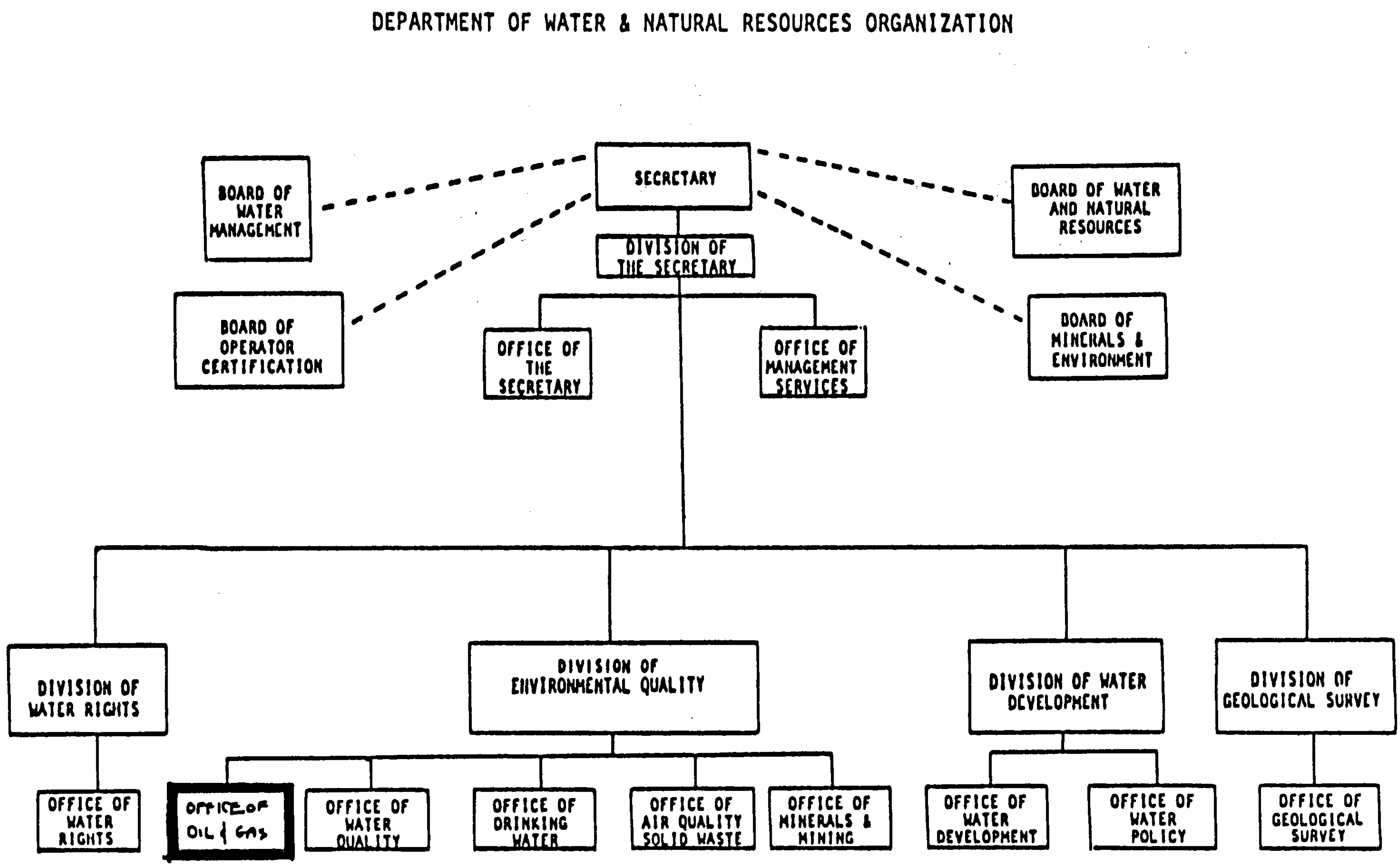
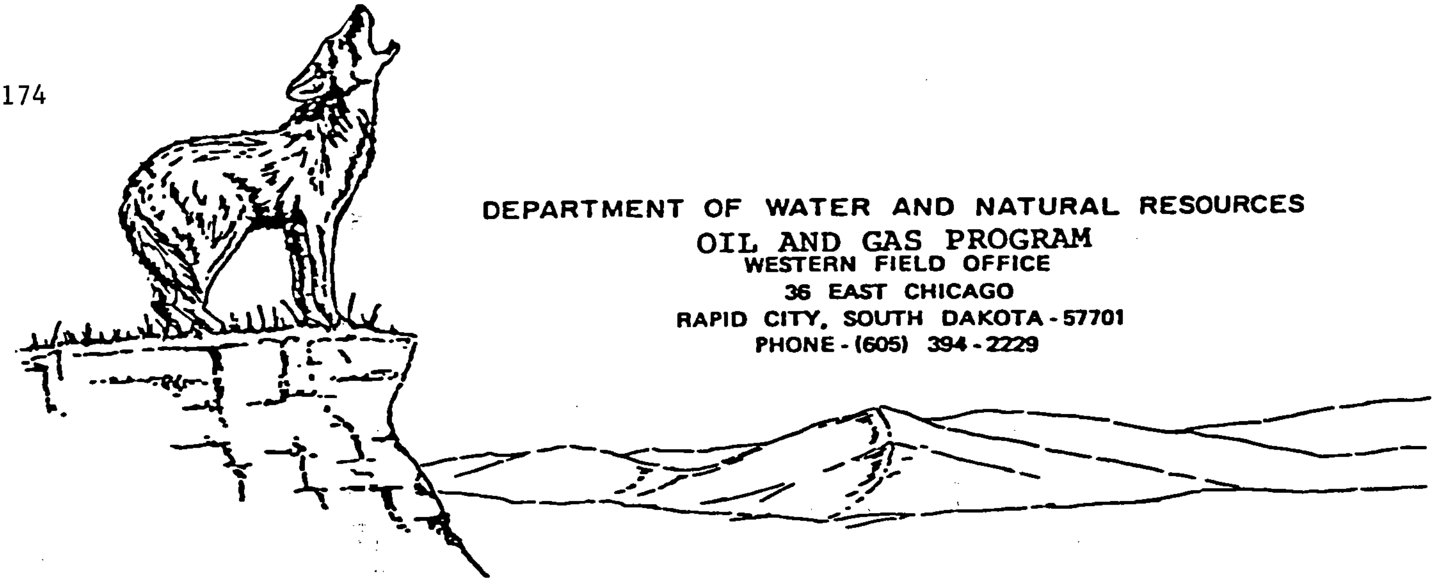


Figure 2: S. D. Department of Water & Natural Resources Organization Chart.



DEPARTMENT OF WATER AND NATURAL RESOURCES
OIL AND GAS PROGRAM
WESTERN FIELD OFFICE
36 EAST CHICAGO
RAPID CITY, SOUTH DAKOTA - 57701
PHONE - (605) 394 - 2229

PROCEEDURE FOR OBTAINING OIL AND GAS DRILLING PERMITS

1. File Application to Drill (Form 2).

2. File a surveyed Plat Map by a registered surveyor.

3. File an Organization Report (Form 1)

4. File a $100 permit fee per well.

5. Plugging and Performance Bond - File a surety bond in favor of the State of South Dakota (Form 3): $5,000 for individual well or $20,000 multiple drilling program; both principal and surety should be acknowledged.

1/

6. Surface Restoration Bond - File a surety bond in favor of the State of South Dakota (Form 10), $2,000 for individual well or $10,000 blanket bond; both principal and surety should be acknowledged.

   Note: The surface restoration bond should be filed when the landowner or lessee is not a party to the oil and gas leasing agreement. This Bond must be executed separately from plugging and performance bond.

7. File a copy of the oil and gas leasing agreement.

8. File a certificate (Form 9) that an agreement with the landowner or lessee is being negotiated regarding compensation for damages to livestock and surface land resulting from drilling operations.

   Address all inquires to:

   Mr. Fred V. Steece, Supervisor
   South Dakota Oil & Gas Program
   Western Field Office
   36 East Chicago Street
   Rapid City, SD 57701

1/ Bonds must be countersigned by a resident South Dakota agent, OR an agent licensed to do business in South Dakota.

Figure 3: Proceedure Sheet

ORGANIZATION REPORT

Full Name of the Company, Organization, or Individual

Post Office Address (Box or Street Address)

Plan of Organization (State whether organization is a corporation, joint stock association, firm or partnership, or individual)

If a reorganization, give name and address of previous organization

(1) If foreign corporation, give State where incorporated	(2) Name and postoffice address of State agent	(3) Date of permit to do business in state

Principal Officers or Partners (if partnership) NAME	TITLE	POSTOFFICE ADDRESS

DIRECTORS NAME	POSTOFFICE ADDRESS

Executed this the ________ day of ________________________, 19____

State of ____________________ }
County of ____________________ }

____
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared ________________________________ known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated herein, and that said report is true and correct.

Subscribed and sworn to before me this ________ day of ____________________________, 19_____

SEAL

____

My commission expires ________________________

Notary Public in and for ________________________________

County, ____________________________

DO NOT WRITE BELOW THIS LINE

Approved ____________________________
Date

Oil and Gas Board of the
State of South Dakota

____________________________, Secretary

Figure 4: Organization Report

State Pub. Co., Pierre

S. Dak. Oil & Gas Board
FORM 2

APPLICATION FOR PERMIT TO:

☐ DRILL ☐ DEEPEN ☐ PLUG BACK

☐ SINGLE ZONE

☐ OIL WELL ☐ GAS WELL ☐ MULTIPLE ZONE

FARM OR LEASE NAME

WELL NO.

FIELD AND POOL, OR WILDCAT

NO. ACRES IN LEASE

¼ ¼ SEC. TWP. RGE

COUNTY

OPERATOR

ADDRESS

LOCATION (In feet from nearest lines of section or legal subdivision, where possible)*

NAME AND ADDRESS OF SURFACE OWNER

ELEVATION

PROPOSED DEPTH

NO. OF WELLS ETC.

ROTARY OR CABLE TOOLS

NAME AND ADDRESS OF CONTRACTOR

APPROXIMATE DATE WORK WILL START

IF LEASE PURCHASED WITH ANY WELLS DRILLED, FROM WHOM PURCHASED (Name and address)

PROPOSED CASING AND CEMENTING PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	NEW OR SECOND HAND	DEPTH	SACKS OF CEMENT

DESCRIBE PROPOSED OPERATIONS. IF PROPOSAL IS TO DEEPEN OF PLUG BACK, GIVE DATA ON PRESENT PRODUCTIVE ZONE AND PROPOSED NEW PRODUCTIVE ZONE. GIVE BLOW OUT PREVENTER PROGRAM IF ANY

SIGNED ______________________ TITLE ______________________ DATE ______________

DO NOT WRITE BELOW THIS LINE

PERMIT NO. ______________

CHECKED BY ______________________
School and Public Lands Date

______________________, Secretary

APPROVAL DATE ______________________

CONDITIONS:

☐ COMPLETE SET OF SAMPLES, AND CORES IF TAKEN, MUST BE SUBMITTED.

☐ SAMPLES, AND CORES IF TAKEN, BELOW __________ DEPTH, MUST BE SUBMITTED.

Figure 5: Application for Permit

Bond No. ______________________

BOND

KNOW ALL MEN BY THESE PRESENTS,

That
we: ____
of the
County of: ______________________ in the State of: ______________________
as Principal,
and ____

of ____

as surety, authorized to do business in the State of South Dakota as surety, are held and firmly bound unto the State of South Dakota in the sum of ($5,000.00; $20,000.00), lawful money of the United States, for which payment, well and truly to be made, we bind ourselves, and each of us, and each of our heirs, executors, administrators or successors, and assigns jointly and severally, firmly by these presents.

The condition of this obligation is that whereas the above bounden principal proposes to drill a well or wells for oil, gas, or stratigraphic purposes in and upon the following described land situated within the State, to wit:

____
(May be used as blanket bond or for single well)

____

____

____

____

____

NOW, THEREFORE, if the above bounden principal shall comply with all of the provisions of the laws of this State and the rules, regulations and orders of the Oil and Gas Board of the State, especially with reference to the proper plugging of said well or wells, and filing with the Oil and Gas Board of this State all notices and records required by said Board, and the restoration of the surface, in the event said well or wells do not produce oil or gas in commercial quantities, or cease to produce oil or gas in commercial quantities, then this obligation shall be terminated by the Board, the same shall be and remain in full force and effect.

Penal sum of

____

Witness our hands and seals, this __________ day of ______________________

____

____
Principal

Witness our hands and seals, this __________ day of ______________________

____

____
Surety

(If the principal is a corporation, the bond should be executed by its duly authorized officers, with the seal of the corporation affixed. When principal or surety executes this bond by agent, power of attorney or other evidence of authority must accompany the bond.)

DO NOT WRITE BELOW THIS LINE

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

______________________, Secretary

Approved ______________
Date

Figure 6: Bond

STATE OF SOUTH DAKOTA

DEPARTMENT OF WATER AND NATURAL RESOURCES

DIVISION OF GEOLOGICAL SURVEY
OIL & GAS FORM 8

BONDING COMPANY INFORMATION SHEET

Information about your bonding company:

Bond No.____________________

Name of Bonding Company:____________________________________

Street Address:____

City, State:____

Phone:____________________ Remarks:_______________________

Information about your South Dakota bonding company agent:

Name of South Dakota Agent:________________________________

Street Address:____

City, State:____

Phone:____________________ Remarks:_______________________

Information about releasing your bond:

When the <u>Principal</u> for whom you are providing <u>Surety</u> has fulfilled all obligations, whom should we contact with our Bond Release?

Name of Contact:____

Street Address:____

City, State:____

Phone:____________________ Remarks:_______________________

Please file this form together with Oil & Gas Form No. 3 with:
Mr. Fred V. Steece, Supervisor, South Dakota Geological Survey,
Western Field Office, 36 East Chicago , Rapid City, SD 57701
PH: (605) 394-2229

Figure 7: Bonding Company Information Sheet

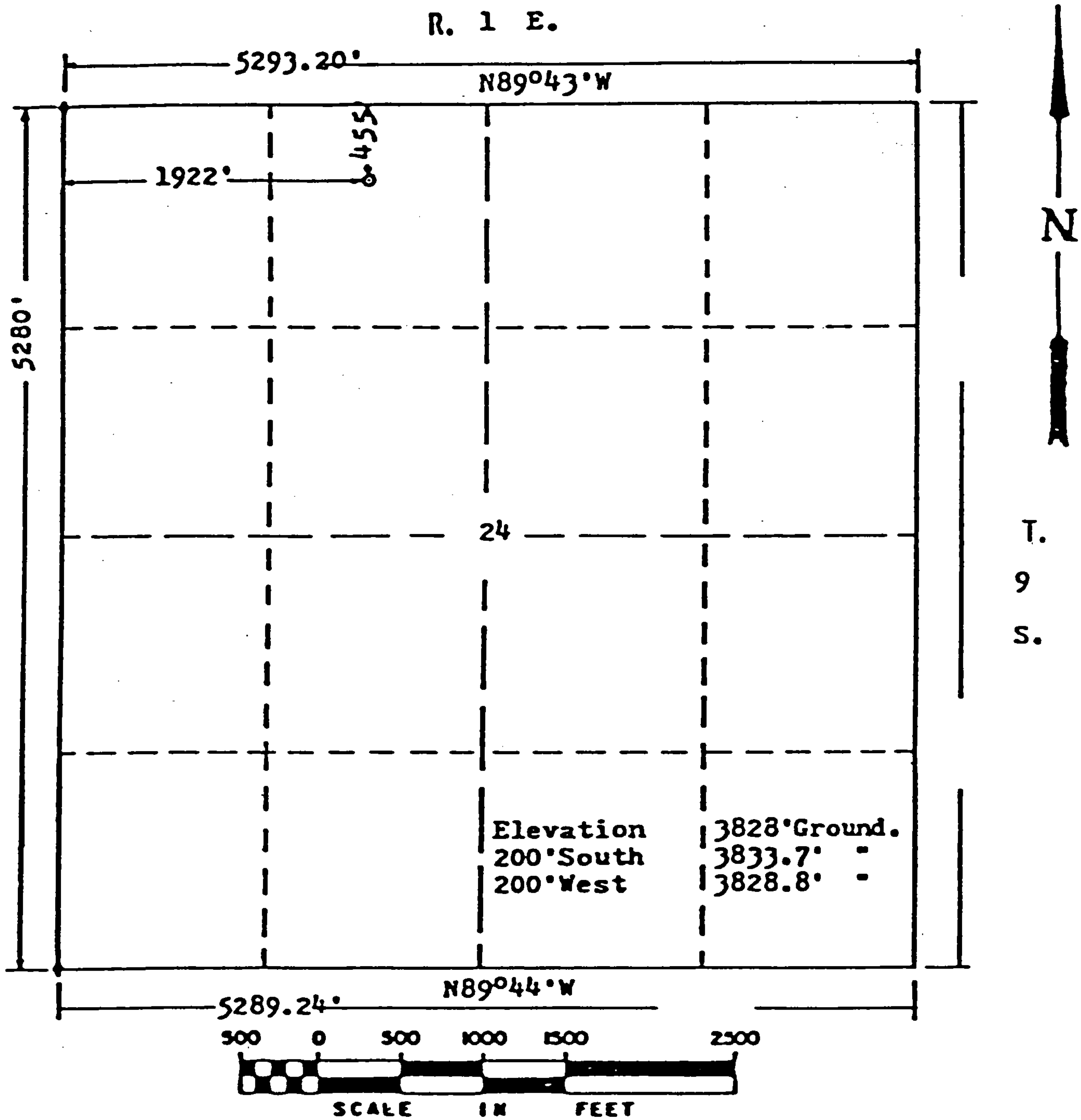


Figure 8: Typical Surveyor's Plat (without affidavit)

State Pub. Co., Pierre

S. Dak Oil & Gas Board
Form 10

Bond No. ____________________

SURFACE RESTORATION BOND

KNOW ALL MEN BY THESE PRESENTS,

That
we: ____
of the County of: ____________________ in the State of: ____________________
as Principal,
and ____

of ____

as surety, authorized to do business in the State of South Dakota as surety, are held and firmly bound unto the State of South Dakota in the sum of $2,000: $10,000), lawful money of the United States, for which payment, well and truly to be made, we bind ourselves, and each of us, and each of our heirs, executors, administrators or successors, and assigns jointly and severally, firmly by these presents.

The condition of this obligation is that whereas the above bounden principal proposes to drill a well or wells for oil, gas, or stratigraphic purposes in and upon the following described land situated within the State, to wit:

____
(May be used as blanket bond or for single well)
____
____
____
____
____

NOW, THEREFORE, if the above bounden principal shall comply with all of the provisions of the laws of this State and the rules, regulations and orders of the Oil and Gas Board of the State, especially with reference to the proper plugging of said well or wells, and filing with the Oil and Gas Board of this State all notices and records required by said Board, and the restoration of the surface, in the event said well or wells do not produce oil or gas in commercial quantities, or cease to produce oil or gas in commercial quantities, then this obligation shall be terminated by the Board, the same shall be and remain in full force and effect.

Penal sum of

____

Witness our hands and seals, this __________ day of ____________________

____
____
Principal

Witness our hands and seals, this __________ day of ____________________

____
____
Surety

(If the principal is a corporation, the bond should be executed by its duly authorized officers, with the seal of the corporation affixed. When principal or surety executes this bond by agent, power of attorney or other evidence of authority must accompany the bond.)

DO NOT WRITE BELOW THIS LINE

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

____________________, Secretary

Approved ______________
Date

Figure 9: Surface Restoration Bond

STATE OF SOUTH DAKOTA

:PARTMENT OF WATER AND
ATURAL RESOURCES

DIVISION OF
GEOLOGICAL SURVEY
OIL & GAS FORM 9

CERTIFICATION OF NEGOTIATION WITH SURFACE OWNER OR LESSEE

I, ______________________________, ______________________
(name of individual) (position)

ith ____________________________, hereby certify that, to the best of my
(company)

iowledge and belief, an agreement regarding compensation for damages to livestock
id surface land resulting from drilling operations on the following property:

______________________________________, has been or is being negotiated
(property for which permit is requested)

.th the surface landowners or lessees, as listed below:

____
(surface owners/lessees)

____
(land area)

ted and signed this ____________day of _______________, 19 _____.

____
(Individual)

for ______________________________
(name of company)

ʒned before me this ____________day of _______________, 19 _____.

____
NOTARY PUBLIC

AL)

Commission Expires: ____________

ʒure 10: Certificate of Negotiation

S. Dak. Oil & Gas Board
FORM 4

STATE PUB. CO., PIERRE

182

WELL COMPLETION OR RECOMPLETION REPORT AND LOG

FARM OR LEASE NAME

WELL NO.

FIELD AND POOL, OR WILDCAT

NO. ACRES IN LEASE

¼ ¼ SEC. TWP. RGE.

COUNTY

TYPE OF COMPLETION

☐ Oil Well ☐ Gas Well ☐ ____________

☐ New Well ☐ Work-Over ☐ Deepen ☐ Plug Back ☐ Same Zone ☐ Diff Zone

OPERATOR

ADDRESS

LOCATION (In feet from nearest lines of section or legal subdivision where possible)*

Surface

Top prod. interval

At total depth

PERMIT NO.	DATE ISSUED	PREVIOUS PERMIT NO.	DATE ISSUED

DATE SPUDDED	DATE T. D. REACHED	DATE COMPL. (Ready to Prod.)	ELEVATIONS (DF, RKB, RT, GR, etc.)*	ELEV. CASINGHEAD FLGE.

TOTAL DEPTH (MD & TVD)	PLUG. BACK T. D. (MD & TVD)	IF MULTIPLE COMPL., HOW MANY*	INTERVALS DRILLED BY →	ROTARY TOOLS	CABLE TOOLS

PRODUCING INTERVAL(S), THIS COMPLETION, TOP, BOTTOM, NAME (MD & TVD)*

DATE DIRECTIONAL SURVEY SUBMITTED

TYPE ELECTRIC AND OTHER LOGS RUN (Circle those filed)

WAS WELL CORED

CASING RECORD (Report all strings set in well)

CASING SIZE	DEPTH SET (MD)	HOLE SIZE	WEIGHT LBS./FT.	PURPOSE	SACKS CEMENT	AMOUNT PULLED

LINER RECORD

SIZE	TOP (MD)	BOTTOM (MD)	SACKS CEMENT*	SCREEN (MD)

TUBING RECORD

SIZE	DEPTH SET (MD)	PACKER SET (MD)

PERFORATION RECORD

DEPTH INTERVAL (MD)	HOLES PER FT.	SIZE AND TYPE	PURPOSE

ACID, SHOT, FRAC., CEMENT SQUEEZE, Etc.

AMOUNT AND KIND OF MATERIAL USED	DEPTH INTERVAL (MD)

PRODUCTION

DATE FIRST PRODUCTION	PRODUCING METHOD (Flowing, gas lift, pumping,—size & type of pump)	WELL STATUS (Prod. or shut-in)

DATE OF TEST	HOURS TESTED	CHOKE SIZE	PRODUCTION FOR TEST →	OIL, Bbls.	GAS, Mcf.	WATER, Bbls. & %	OIL GRAVITY-API (Corr.)

FLOW. TUBING PRESSURE	CASING PRESSURE	CALCULATED 24-HOUR RATE →	OIL, Bbls.	GAS, Mcf.	WATER, Bbls. & %	GAS-OIL RATIO

DISPOSITION OF GAS (Sold, used for fuel, vented, etc.)

TEST WITNESSED BY

LIST OF ATTACHMENTS

I hereby certify that the foregoing and attached information is complete and correct as determined from all available records

SIGNED ______________________ TITLE ______________________ DATE ____________

DO NOT WRITE BELOW THIS LINE

Approved ____________________
Date

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

______________________________ Secretary

Figure 11: Well Completion or Recompletion Report (front)

General: This form is designed for submitting a complete and correct well completion report and log on all types of lands and leases to either a Federal agency or a State agency, or both, pursuant to applicable Federal and/or State laws and regulations. Supplemental instructions by local Federal and/or State offices will govern the use of this form.

If not filed prior to the time this summary record is submitted, copies of all currently available logs (drillers, geologists, sample and core analysis, all types electric, etc.), formation and pressure tests, and directional surveys, should be attached hereto, to the extent required by applicable Federal and/or State laws and regulations. All attachments should be listed on this form, see last blank.

If this well was directionally drilled, show both the location at the surface and at total depth from nearest lines, where possible; also show the locations at the top and at the bottom of any zone for which production data are reported in space 33, and any zone open for injection or disposal. Use this reverse side if more space is needed. (MD-Measured Depth, TVD-True Vertical Depth)

*Indicate which elevation is used as reference (where not otherwise shown) for depth measurements given in other spaces on this form and in any attachments.

If this well is completed for separate production from more than one zone (multiple-zone completion), so state in the correct space and show the producing interval, or intervals, top(s), bottom(s) and name(s) (if any) for only the zone reported in the blanks under PRODUCTION. Submit a separate completion report on this form for each interval (zone) to be separately produced.

"Sacks Cement": Attached supplemental records for this well should show the details of any multiple stage cementing and the location of the cementing tool.

SUMMARY OF POROUS ZONES:
SHOW ALL IMPORTANT ZONES OF POROSITY AND CONTENTS THEREOF; CORED INTERVALS; AND ALL DRILL-STEM TESTS, INCLUDING DEPTH INTERVAL TESTED, CUSHION USED, TIME TOOL OPEN, FLOWING AND SHUT-IN PRESSURES, AND RECOVERIES

FORMATION	TOP	BOTTOM	DESCRIPTION, CONTENTS, ETC.

GEOLOGIC MARKERS

NAME	TOP	
	MEAS. DEPTH	TRUE VERT. DEPTH

Figure 11 (continued): Well Completion or Recompletion Report (back)

S. Dak. Oil & Gas Board
FORM 5

MONTHLY REPORT OF OPERATIONS AND WELL STATUS

FARM OR LEASE NAME

FIELD

Report for the month of ________________________, 19____

COUNTY

OPERATOR

ADDRESS

IDENTIFY POOL OR RESERVOIR AND LEASE SUBDIVISION AS REQUIRED BY FEDERAL OR STATE AGENCY

	WELL NO.	STATUS*	DAYS PROD.	GRAVITY	OIL BBLS.	WATER BBLS.	GAS Mcf	TOTAL OIL ON HAND END OF MONTH

SIGNED ______________________ TITLE ______________________ DATE ______________________

I hereby certify that the foregoing is a complete (unless otherwise indicated) and correct report of operations, disposal of products, and well status for the lease or property for the month shown above.

Figure 12: Monthly Report of Operations

Board of Minerals
and Environment
FORM 5A

MONTHLY REPORT OF INJECTION AND WELL STATUS

FARM OR LEASE NAME

Report for the month of ______________________, 19______

FIELD

OPERATOR

COUNTY

ADDRESS

IDENTIFY POOL OR RESERVOIR AND LEASE SUBDIVISION AS REQUIRED BY FEDERAL OR STATE AGENCY

Well No.	Status*	Days Inj.	Fluid Prod.	Fluid Inj.	Average Press.	Maximum Press.	Total Fluid Injected End Of Month

Signed ______________________ Title ______________________ Date ______________

I hereby certify that the foregoing is a complete (unless otherwise indicated) and correct report of injections, disposal of products, and well status for the lease or property for the month shown above.

Figure 13: Monthly Report of Injection

S. Dak. Oil & Gas Board
FORM 6

STATE PUB. CO., PIERRE

SUNDRY NOTICES AND REPORT ON WELLS

☐ OIL WELL ☐ GAS WELL ☐ ________ ☐ DRY	FARM OR LEASE NAME
OPERATOR	WELL NO.
ADDRESS	FIELD AND POOL, OR WILDCAT
LOCATION (In feet from nearest lines of section or legal subdivision, where possible)	NO. ACRES IN LEASE
	¼ ¼ SEC. TWP. RGE.
ELEVATIONS (D.F., R.K.B., R.T., GRD., etc.; how determined)	COUNTY

INDICATE BELOW BY CHECK MARK NATURE OF REPORT, NOTICE OR OTHER DATA

NOTICE OF INTENTION TO:

- TEST WATER SHUT-OFF ☐
- FRACTURE TREAT ☐
- MULTIPLE COMPLETE ☐
- ABANDON ☐
- SHOOT OR ACIDIZE ☐
- REPAIR WELL ☐
- PULL OR ALTER CASING ☐

SUBSEQUENT REPORT OF:

- WATER SHUT-OFF ☐
- FRACTURE TREATMENT ☐
- SHOOTING OR ACIDIZING ☐
- REPAIRING WELL ☐
- ALTERING CASING ☐

(Note: Report results of multiple completion on Well Completion or Recompletion and Log Form—Form 4)

DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinant dates, including estimated date of starting any proposed work)

I hereby certify that the foregoing as to any work or operation performed is a true and correct report of such work or operation.

SIGNED ________________ TITLE ________________ DATE ________________

DO NOT WRITE BELOW THIS LINE

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

Approved ________________
Date

________________, Secretary

CONDITIONS, IF ANY:

Figure 14: Sundry Notice

PLUGGING RECORD

Operator	Address		
Name of Lease	Well No.	Field & Reservoir	
Location of Well		Sec-Twp-Rge or Block & Survey	County

Application to drill this well was filed in name of	Has this well ever produced oil or gas	Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day)	Dry?

Date plugged:	Total depth	Amount well producing when plugged: Oil (bbls/day)	Gas (MCF/day)	Water (bbls./day)

Name of each formation containing oil or gas. Indicate which formation open to well-bore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used indicate zones squeeze cemented, giving amount cement.

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes

Was well filled with mud-laden fluid, according to regulations?	Indicate deepest formation containing fresh water.

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

USE REVERSE SIDE FOR ADDITIONAL DETAIL

Executed this the ...... day of ...., 19.....

State of ....

County of ....

....
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared .... known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this ...... day of ...., 19......

SEAL

....

My commission expires ....

Notary Public in and for ....

County, ...

DO NOT WRITE BELOW THIS LINE

Approved ______________________
Date

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

______________________, Secretary

Figure 15: Plugging Record

STATE GEOLOGICAL SURVEY

Scout Report

Date scouted..8/15/55....

Designation of well..Shell-Sides #1..............................

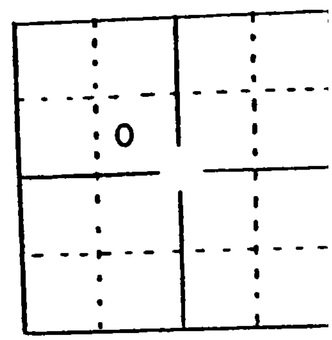
Owner...Shell Oil Company..

Location: Sec. 32 T. 8 N S R. 9 E W .Fall River.....County, S.

Total Depth..2735........feet

Casing Record:

" ______ ft.	4½ " ______ ft.
10 " ______ ft.	4 " ______ ft.
8⅝" 30 ft.	" ______ ft.
7 6 " 131 ft.	



Work in progress at time of visit:

Plugging

0--128	9.5# drilling mud
128--238	cement plug, 25 sacks
238--2390	drilling mud
2390--2550	cement plug, 25 sacks
2550--2735	drilling mud

Developments since last visit:

Spudded in 8/8/55
Drilled to 2735
Cored from 2040 to 2094
Drill stem test 2553 to 2580 recovered 970 feet of fresh water only

Ran Schlumberger log

REMARKS AND RECOMMENDATIONS:

Encountered a little gas in the Niobrara formation. Company geologist thought there might be enough to heat a house. Not commercial.

Will place 10 sack cap plug and marker pipe after rig is removed.

Scouted by:..........

State Geologist

Figure 16: Old Scout Report

SOUTH DAKOTA GEOLOGICAL SURVEY
Western Field Office

SCOUT REPORT

Permit Number______________

API Number______________

ell Name____

______________ Sec.________ T.________ R.________County______________

lev.__________ Est. T.D.________ Actual T.D.________ Spudded__________

ontractor____________________ Geologist____________________

ORMATION TOPS:

LUGGING RECORD: DATE PLUGGED/COMPLETED______________

CASING RECORD

__FROM_____TO_____

__FROM_____TO_____

	DRY HOLE MARKER	ADEQUATELY MARKED	MARKER STURDY	MARKER CAPPED	FENCES UP	MUD PITS FILLED	SITE LEVELED	SITE SMOOTHED	SITE SEEDED	SITE CLEAN	ROADS RECLAIMED	APPROVED	NOT APPROVED	LETTER TO SURFACE OWNER	LTR TO OPERATOR	SCOUTED BY

- Satisfactory 0 - Not satisfactory NA - Not applicable

MARKS:

gure 17: New Scout Report

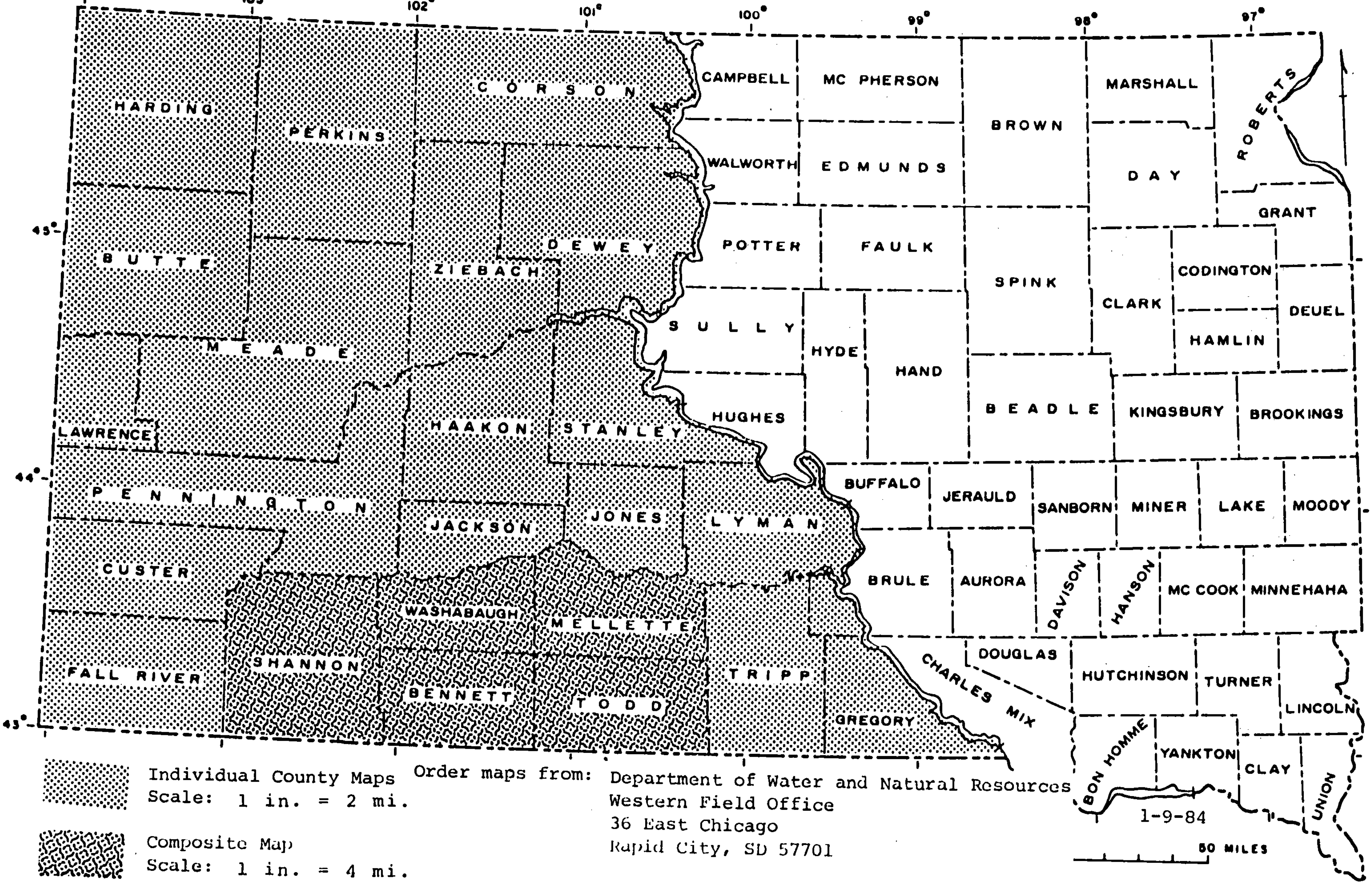
DEPARTMENT OF WATER AND NATURAL RESOURCES
Western Field Office - Oil & Gas
36 East Chicago - Rapid City, South Dakota 57701

OIL, GAS AND WATER PRODUCTION FIGURES FOR SOUTH DAKOTA, FIRST HALF, 1987

Well Name Location API Number		Cuml. Prod. 12-31-86	Jan.	Feb.	Mar.	Apr.	May	Jun.	Cuml. Prod. 6-30-86
ALUM CREEK FIELD: (1981 Fall River County)									
Operator, Placid Oil Company									
Placid #3-9	O	98,932	1,490	1,319	1,429	1,339	1,420	1,555	107,484
Federal	G	58,073	247	220	226	226	235	797	60,024
NESE 3-11S-1E	W	11,804	562	494	461	567	499	479	14,866
40 047 20125	D		31	28	31	30	31	30	181
Placid #2-5		24,161							24,161
Federal		21,703	WI	WI	WI	WI	WI	WI	21,703
SWNW 2-11S-1E		35,496							35,496
40 047 20127									
Placid #3-8		430,564	10,546	9,328	10,307	10,162	14,734	15,002	500,643
Federal		201,976	1,647	1,674	2,067	2,187	3,537	3,737	216,825
SENE 3-11S-1E		684	0	0	104	123	609	841	2,361
40 047 20130			31	28	31	30	31	30	181
Placid #3-15		105,370	3,578	3,153	2,523	3,134	3,075	3,103	123,936
Federal		306,768	816	979	1,248	1,426	2,177	2,357	315,771
SWSE 3-11S-1E		3,166	0	0	0	0	0	0	3,166
40 047 20131			31	28	24	30	31	30	174
Placid #3-16		59,404	568	520	508	503	448	460	62,411
Federal		20,896	116	103	123	96	114	94	21,542
SESE 3-11S-1E		6,443	336	317	318	359	324	490	8,587
40 047 20132			31	28	31	30	31	30	181

Figure 18: Semi-Annual Production Report

INDEX TO SOUTH DAKOTA OIL AND GAS MAPS



Individual County Maps
Scale: 1 in. = 2 mi.

Composite Map
Scale: 1 in. = 4 mi.

Order maps from: Department of Water and Natural Resources
Western Field Office
36 East Chicago
Rapid City, SD 57701

Prices: Butte, Fall River & Harding $5.00; other counties $2.50; Composite Map $2.50
Maps updated periodically

Figure 19: Index Map, Oil & Gas Maps

EDGEMONT FIELD

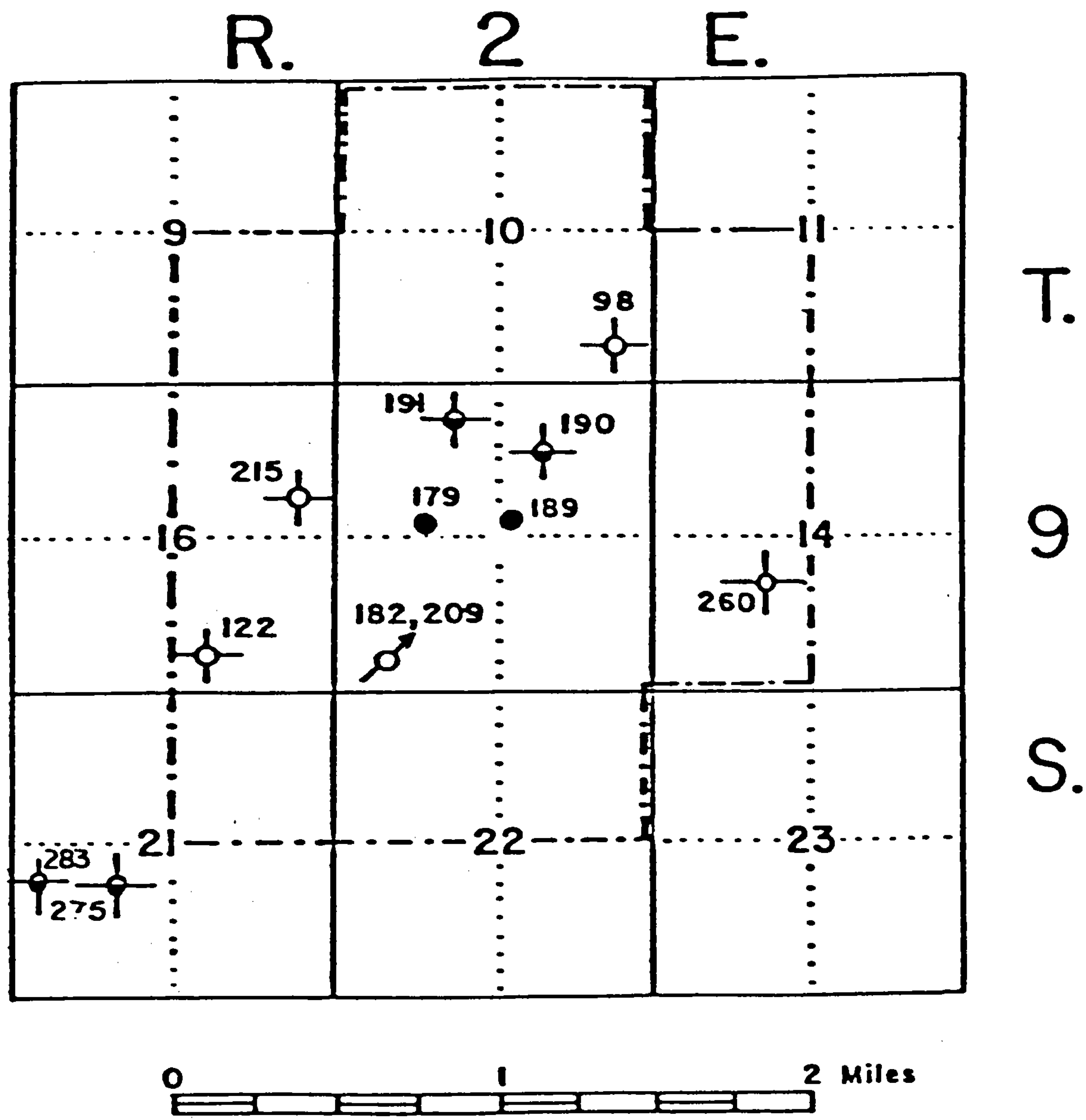


Figure 20: Excerpt from 1986 Fall River County, SD, Oil and gas map.

PETROLEUM AND NATURAL GAS INFORMATION IN TENNESSEE

By

RONALD P. ZURAWSKI
Assistant Supervisor, Tennessee State Oil and Gas Board

The presence of oil and gas in Tennessee has been known since the early 1800s. Early settlers along the Cumberland River in northern Tennessee and southern Kentucky drilled wells in search of brine for salt-making and found indications of oil and natural gas instead. By 1866, the first commercial oil well had been drilled in Middle Tennessee, about 25 miles south of the Kentucky state line. In the years immediately following, many test holes were drilled, due to the presence of oil in many shallow water wells dug in Middle Tennessee, as well as numerous surface shows. Only minor oil production occurred during the next 60 years, however. By the early 1920s, production began to increase, and averaged about 10,000 barrels per year until around 1970.

In 1943 the Tennessee General Assembly established the State Oil and Gas Board, and designated the State Geologist as its Supervisor. Drilling and production activity were still relatively small, however, and the Board remained inactive, promulgated no rules and regulations, and required submission of no specific types of information other than those required by the 1943 law itself. Such information included logs, including electrical logs, drilling records, and such drill cuttings and cores as might be required by the Supervisor. The law also required that all producers of crude petroleum or natural gas in Tennessee keep and preserve suitable records of the amount of petroleum or natural gas produced and sold and the price received, and report such records to the Oil and Gas Supervisor.

By 1968, drilling and production had increased to a point requiring the activation of the State Oil and Gas Board, which issued the first set of rules and regulations. These became effective on April 11, 1968. The rules contained additional information requirements, such as a detailed well-location plat, information about the depth and thickness of all water zones encountered and logged, the depth of all shows of oil or gas, the depth and thickness of any coal seams encountered, and a plugging affidavit, unless the plugging was witnessed by the Supervisor or his representative.

In 1971, the oil and gas law was amended to expand the authority of the State Oil and Gas Board, and additional rules and regulations were promulgated in 1972. These rules required the submission of a Well History, Work Summary, and Completion or Recompletion Report for each well, a detailed casing and perforation record, and detailed information on the well's initial production, if any. The new rules also required that purchasers of crude oil and natural gas submit monthly reports to the Supervisor.

The rules and regulations were amended again in August of 1982, to require that deliverability tests be run on wells to be completed as shut-in gas wells, unless the operator submitted to the Supervisor a copy of a geophysical log run on the well, accompanied by a notarized statement indicating the probable producing zone on the log. In March of 1986 this rule was modified so as to require that the deliverability test be performed only after the well had achieved a stabilized flow rate, or if this could not be achieved, to require a maximum test period of 48 hours. This rule change also eliminated the shut-in gas-well affidavit provision. Since then, no additional information requirements have been imposed.

From the early 1900s until about 1970, most of the oil and gas information submitted or otherwise obtained by the Tennessee Division of

Geology (of which the State Oil and Gas Board is a part) was used in publishing oil and gas reports, charts, and maps. The open-file data were used by few oil and gas industry representatives, because oil and gas activity was still low.

In 1969, discovery of the Oneida West Field in Scott County ushered in an expanded era of oil and gas production in Tennessee. During the next few years, the oil and gas industry grew rapidly and numerous oil and gas fields were discovered in Morgan and Scott Counties in the northern plateau area of Tennessee, part of the larger and better known Appalachian Basin. Production increased to a record of more than 1.2 million barrels of oil in 1982, and 5 billion cubic feet of gas in 1984. Although some oil and gas research took place during these "boom" times, much of the Division of Geology and Oil and Gas Board staff time was required to issue oil and gas test-well permits and to file and record well data and production reports. There was a corresponding increase in the use of open-file data by the oil and gas industry. Division of Geology publications during this period included pipeline maps, a natural-gas-well map for the state, and annual tabulations of oil and gas production.

By 1975, the State Oil and Gas Board had begun to computerize some of the oil and gas data on file with the Division of Geology. The program designed to handle these data was written in COBOL, for use with the state's IBM 370 mainframe computer. As a result of this effort, a subsurface-information catalog of Tennessee was published in 1975. This publication contained information on wells drilled in Tennessee between 1866 and 1974, but provided only basic information such as well name, general location, total depth and deepest formation reached, completion date, initial result, and other types of data available from the well files of the Division. Included in the catalog were data not only from oil and gas tests, but also from water wells in counties where relatively few oil and gas tests had been drilled, and data from mineral core tests, water or hydrologic test wells, and industrial waste-disposal wells.

During the next several years, additional information was added to the computer file for each well, including field name, a more specific location, producing formation, tops, and initial production data. No new catalog has been published since these additional data have been added, but computer printouts have been made available upon request.

Since mid-1986, the subsurface section has been using NCR PC8 computers with Lotus 123 and Microsoft Word to compile open-file reports on oil and gas fields in Tennessee. The Lotus software is used primarily for stratigraphic spreadsheet data and decline curves, while the Microsoft program is used for report-writing. Contour maps, cross sections, etc. were still done by hand. In mid-1987, the Division acquired another NCR PC8 computer with 2mB RAM and a 72mB hard disk that will be dedicated as a mapping computer. A Calcomp 19481 Series digitizer and a Calcomp 1943GT plotter were also purchased for mapping. Radian Corporation CPS\PC mapping software program and Autocad CAN program were purchased to handle computerized mapping. The Division is in the process of integrating these programs and hardware to compile and publish oil and gas field reports. Eventually, all of the existing oil and gas data stored in the IBM 370 will be downloaded to the mapping computer, and the oil and gas files will be in dBase III Plus format. The stratigraphic information will be checked for accuracy and consistency. When this has been done, the Division will be able to produce subsurface maps and cross sections on a regional scale.

Since the early days of oil and gas exploration in Tennessee, the Division of Geology has been the primary agency concerned with collecting, managing, and utilizing oil and gas information. In recent years the Groundwater Protection Division of the Tennessee Department of Health and Environment has become involved with pollution control, including discharges of oil well drilling and production-related fluids to surface streams and freshwater aquifers. They need better information on the location and depth of freshwater aquifers, so that more-effective casing programs can be developed to protect those zones from the effects of oil and gas test-well drilling. To get some of these data, the Division of Geology and the U. S. Geological Survey undertook a cooperative program in 1985 to monitor the drilling of selected oil and gas test wells, to obtain information about the depth, quality, and quantity of fresh water contained in the aquifers penetrated. This effort has provided some useful data, but has been curtailed by funding limitations.

Several other agencies besides the Division of Geology have furnished or made use of oil and gas information. One of these is the National Park Service, which used the data in connection with development of the Big South Fork National River and Recreation Area. There are numerous oil and gas wells, both producing and abandoned, in this area. The Tennessee Department of Economic and Community Development uses the data in monitoring the activity of energy-related industries in Tennessee. The Petroleum Tax Division of the Tennessee Department of Revenue furnishes data on the value of the oil and gas produced in Tennessee each year. The Underground Injection Control program, over which the Tennessee Department of Health and Environment is trying to obtain primacy, also presents an opportunity for sharing data, although to date no real sharing has occurred.

The Division of Geology has been, and will continue to be, the agency primarily concerned with the collection and use of oil and gas information in Tennessee. The Division will continue to report oil and gas activity to Petroleum Information and to submit geophysical and electric logs to Appalachian Well Map Service, as it has done in the past. The Division will continue to develop and expand computer programs dealing with the storage and manipulation of oil and gas information, so that interested parties can share and use that information. At present any of the Division's data sets or programs can be furnished as hard copy, or on tape, to other agencies or organizations upon request. Once the Division's new information systems are more fully developed, even more sharing will be possible.

OIL AND GAS INFORMATION IN TEXAS[1]

by

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[1]Publication authorized by the Director, Bureau of Economic Geology.

INTRODUCTION

The Railroad Commission of Texas (RRC) regulates all oil and gas activity in the State of Texas and therefore collects and manages all Texas oil and gas field information. Distribution of selected parts of these data, particularly production data, is largely undertaken by commercial organizations, such as Dwights Energydata Inc., Petroleum Information Corporation, and NRG Associates. Manipulation and synthesis of oil and gas reservoir data contained in Railroad Commission files has been undertaken by the Bureau of Economic Geology in Reservoir Atlas compilations (Galloway and others, 1983; Finley and others, in preparation) and in several ongoing projects in the oil and gas programmatic research areas. This paper describes the types of data collected by the Railroad Commission of Texas and outlines current and anticipated noncommercial usage of this information.

COLLECTION AND MANAGEMENT

Field Data Required by the Railroad Commission

The Oil and Gas Division of the RRC has 78 forms for which filing may be required. Forms are listed in the Forms and Procedures Manual of the RRC. Sixteen of these 78 forms include geologic and engineering data of practical use in reservoir characterization. These forms are:

W-1	Application to Drill, Deepen or Plug Back
W-2	Oil Well Potential Test Completion or Recompletion
W-7	Bottom-Hole Pressure Report
W-10	Oil Well Status Report
W-12	Inclination Report
W-14	Application to Dispose of Salt Water by Injection into Porous formation not Productive of Oil or Gas
G-1	Gas Well Back Pressure Test Completion or Recompletion Report and Log
G-5	Gas Well Classification Report
G-9	Gas Cycling Report
G-10	Gas Well Status Report
P-1	Producer's Monthly Report of Oil Wells
P-2	Producer's Monthly Report of Gas Wells
P-7	Application for Discovery Allowable and New Field Designation
H-1	Application to Inject Fluid into a Reservoir Productive of Oil or Gas
H-10	Annual Disposal/Injection Well Monitoring Report
L-1	Electric Log Status Report

The W-1 form, Application to Drill, Deepen or Plug Back, must be accompanied by a certified plat of the lease or unitized tract showing the acreage dedicated to the proration unit for the proposed well and the well's location. Geologic and engineering data on the form consist of operator name, well location, total depth, number of continuous acres in the lease, pooled unit or unitized tract, well name, completion depth, spacing pattern, and density pattern. These forms are accessible through the RRC Central Records on film, hard copy, or on computer tape for 1977 to the present. The Subscriptions and Publications department sells the W-1 form in hard copy by district or statewide. The form can be obtained quarterly, but no back issues are available.

The W-2 form, Oil Well Potential Test, Completion or Recompletion report and log, is filed to give a complete well record and to report test results. Useful geologic and engineering data on this form consist of type of electric logs run, completion date, potential test, total number of acres in the lease, top of pay, total depth, plug-back depth, reservoir or reservoirs completed in, casing size, hole size, tubing size and length, production stimulation and completion, and a formation record listing depths of principal geological markers and formation tops. These forms are accessible through the RRC Central Records on film, hard copy, or on computer tape for 1977 to the present.

The W-7 form, Bottom-Hole Pressure Report, is filed annually or semiannually if field rules designate that a W-7 must be filed. Geologic and engineering data consist of top of pay, date tested, shut-in hours, bottom-hole temperature, tested depth, observed pressure, and datum plane. These forms are accessible on film through the RRC Central Records.

The W-10 form, Oil Well Status Report, is an oil-well potential-test report that is used to determine RRC oil-well allowables. It is normally filed once a year to comply with RRC rules. A W-10 retest can be filed at any time to change the RRC allowable. Some commingled wells must be reported twice a year. Geologic and engineering data on this form consist of field name, lease name and number, well number, producing-well data, and nonproducing-well data. Producing-well data consist of lift type, date tested, number of barrels of oil and water produced, and amount of gas (in mcf) produced during 24-hour tests. The gas/oil ratio is also given. Nonproducing-well data specify whether the well is shut-in, is an injector for salt-water disposal, or is plugged or abandoned. These forms are accessible through the RRC Central Records on film.

The W-12 form, Inclination Report, is used to report the results of inclination surveys, which are required for all wells drilled or deepened with rotary tools. The data consist of measured depth, course length, angle of inclination, displacement per 100 feet, course displacement, and cumulative displacement. These forms are accessible through the RRC Central Records on film or hard copy.

The W-14 form, Application for Oil and Gas Waste Disposal Well, allows applicants to seek authorization to dispose of oil and gas waste in nonproductive porous formations. Geologic and engineering data on this form are tubing size, total depth, injection interval, injection formation, and source of fluids. Along with this form a plat map and electric log are required. These forms are accessible through the RRC Central Records on film or hard copy.

The G-1 form, Gas Well Back Pressure Test, Completion or Recompletion Report and Log, is filed upon completion of any gas well, workover, or reclassification of any service wells to be carried on the RRC gas schedule. The form contains four-point back-pressure test data, including wellhead flowing temperature, flow rate, wellhead flowing and shut-in pressures, dry-gas gravity, condensate gravity, GOR, wet-gas gravity, average shut-in temperature, bottom-hole temperature, time of test, calculated absolute open flow, and four-point graph with the inverse of the slope value. Additional data include lease acres, date completed, top of pay, total depth, plug-back depth, completion status, casing size and length, tubing size and length, and producing interval. These forms are accessible through the RRC Central Records on film, hard copy, or on-line for 1977 to the present.

The G-5 form, Gas Well Classification Report, is filed after any gas well completion or reclassification, or as requested by the RRC. If the producing gas/oil ratio is less than 100 MSCF/STB, a distillation-of-liquid test is required to determine if the well is to be classified as a gas well or oil well. The data on the form contain distillation data, separator operating pressure, gravity of separator liquid, stock-tank-liquid gravity, and gas gravity. These forms are accessible through the RRC Central Records on film or hard copy.

The G-9 form, Gas Cycling Report, documents production from wells utilized in gas recycling projects. Data from this form consists of lease condensate production, plant condensate production, gross gas production, gas volume injected, and net gas production. These forms are accessible through the RRC Central Records on film.

The G-10 form, Well Status Report, comes in two formats. One is a computer-generated form used for semiannual surveys. The second is a printed blank form used for retest and new wells. The data consist of field names, lease name, well number, date tested, gas, condensate, and water production for a 24-hour period, gas gravity, condensate gravity, GOR, wellhead shut-in pressure, and wellhead flowing pressure. The form also gives status of nonproductive wells including shut-in, injection, salt-water disposal, and plugged and abandoned wells. Data from these forms are available through RRC Central Records on computer (from 1977 forward) or on film and hard copy (from 1935 to 1984). The G-10 is also available through the Automatic Data Processing Division on computer tape (from 1977 forward).

The P-1 form, Producer's Monthly Report of Oil Wells, is filed by an operator for the leases of each field. The form gives oil and gas information. The oil information contains by-lease data on number of wells and type of lift, oil on hand at the beginning of the month, oil production, disposition volume, and oil on hand at the end of the month. Gas information includes formation production, gas-lift-gas injected and disposition volume. The type of disposition is given for both oil and gas. These forms are accessible through the RRC Central Records on film or through the Automatic Data Processing Division on computer tape.

The P-2 form, Producers Monthly Report of Gas Wells, reports gas and condensate data for individual wells. This form contains gas and condensate data. The gas data include formation production, gas-lift-gas injected, and gas disposition volume. Condensate data include volume on hand at beginning of month, production, disposition volume, and volume on hand at end of the month. The type of disposition is given for both gas and condensate. These forms are accessible through the RRC Central Records on film or the Automatic Data Processing Division on computer tape.

The P-7 form, Application for Discovery Allowable and New Field Designation, is used to show proof that the new completion is in a reservoir separated both vertically and horizontally from adjacent reservoirs. Data on the new well include the name of the producing zone, type of production, top of pay, and perforated interval. Also reported are the field name, reservoir name and depth interval, and distance and direction from the new well to the nearest production and to the nearest comparable production. An area map is also filed with this form. These forms are accessible through the RRC Central Records on film.

The H-1 form, Application to Inject Fluid into a Reservoir Productive of Oil or Gas, is used to obtain authorization to inject fluid into a producing zone. This form is filed for one or more proposed injection wells within a field. The form has six groups of data, reservoir and fluid data on entire reservoir, reservoir and fluid data, production history of reservoir, type of injection project and results expected, injection data, and injection-well data.

The first group, reservoir and fluid data on entire reservoir, contains rock composition, depth of oil-water contact, original bottom-hole pressure, existence of original gas cap, formation volume factor, estimated productive area of the entire reservoir, type of structure, depth of gas-oil contact, current bottom-hole pressure, bubble-point pressure, and type of drive during primary production.

The second group, reservoir and fluid data, contains number of productive acres in lease, average horizontal permeability, average porosity, average depth to top of pay, range of horizontal permeability, oil gravity, average effective pay thickness, connate-water saturation, and oil viscosity.

The third group, production history of reservoir, contains leases, first well-completion date, current average gas/oil ratio, current number of producing wells on each lease in project area, cumulative oil production, current water production, and current average daily oil production per well.

The fourth group, type of injection project and results expected, contains type of injection project, current estimated oil saturation, estimated original oil-in-place, estimated residual oil saturation at abandonment, and estimated ultimate additional oil that will be recovered as a direct result of injection.

The fifth group, injection data, contains type of injection fluid, source of injection fluid, number of injection wells to be approved, total estimated maximum daily rate of injection for all wells and per well in the application, injection pattern and spacing, and maximum injection pressure to be used.

The sixth group, injection well data, contains surface and production casing, tubing information, and injection depth. Hard copy of the H-1 form is available in the Central Records hearing files.

The H-10 form, Annual Disposal/Injection Well Monitoring Report, is filed on each injection well within a field. The geologic and engineering data on this form consist of the average and maximum injection pressure, total liquid volume injected, and minimum and maximum tubing-casing annulus pressure. These data are reported monthly. The depth interval of injection is also given. Use of this form began in April 1983. These forms are available in hard copy through the Underground Injection Control department. They are also being microfilmed for the Central Records department.

The L-1 form, Electric Log Status Report, requires the filing of one wireline survey for obtaining lithology, porosity, or resistivity information. Any operator can request keeping a log confidential for up to 3 years. The requirement to file an L-1 became effective September 1, 1985.

The Bureau of Economic Geology's Geophysical Log Facility (GLF) is the repository for these logs. The GLF has approximately 19,000 logs on file in both paper and microfiche copy. The logs are indexed three ways: (1) by district/county/operator, (2) by district/operator/lease/well number, and (3) by district/county/log total depth. The logs are filed by RRC district number, then by API number. The logs are available in microfiche or paper copy.

Other Sources of Information

Automated Data Management

The Automatic Data Processing Division of the RRC has a computerized compilation of some of the geologic and engineering information from the aforementioned forms on computer tape. This information is found on the Oil Master and Gas Master files, and to a smaller extent on the Oil Detail Well Tape and Well Bore Data Base files. These computer tapes contain data from 1970 to the present, except for the Well Bore Data Base tape, which has historic well data.

Hearing Files

The information described above is housed in the Central Records Division of the RRC. This repository also contains the hard-copy records of open hearings such as MER (maximum efficient recovery) reviews, and data submitted in support of petitions to unitize reservoirs, change field rules, inject fluids, or initiate waterfloods. These data formed the basis for the Bureau's oil and gas reservoir atlases.

Maps

The RRC map department has 900 field maps available in hard copy. An alphabetical index by field name is available. The map department is currently establishing a statewide well-location data base using an automated mapping system. This system has well locations on 7.5-minute USGS quadrangle maps. The maps will be available in three formats: (1) blueline copies at a scale of 1 inch = 1,200 feet, (2) computer pen plots at a scale of 1 inch = 1,200 feet, and (3) digital tape. These maps will have well and API numbers for referencing each spotted well. The maps will be continuously updated as RRC forms giving well activity are submitted to the RRC.

Along with the maps, a well report of spotted wells will be available. This report will have information such as total depth, previous and current operator, type of well, field and reservoir for each well, and completion date.

As of November 1987, computerized base maps had been completed for 19 counties, and 10 counties had been mapped for well locations. The first maps from this new map information-management system will be available in late 1987.

Production Summaries

The RRC maintains gas-production and oil-production ledgers. Both summarize some information found on the aforementioned forms. The gas ledger contains some data from the G-1, G-10, and P-2 forms and lists production allowables and cumulative status of underage or overage production. The oil production ledger contains a P-1 summary as well as production allowable information. Both ledgers give a well status, and operator and gatherer update. Production ledgers are available in RRC Central Records on film from 1933 to the present, or from Subscriptions and Publications on microfiche from 1978 to the present. Production data are also available on computer tape in the Oil Masters and Gas Masters files sold by the RRC Automatic Data Processing Division, or through the Subscriptions and Publications department in hard-copy monthly reports. These reservoir-specific production data are summarized annually in the Annual Report of the Oil and Gas Division of the RRC.

Secondary and Enhanced Recovery

Historically the collection and management of secondary- and enhanced-recovery information have been through a questionnaire sent to operators and the subsequent publishing of the data in a bulletin. This bulletin, titled A Survey of Secondary and Enhanced Recovery Operations in Texas, was published every two years from 1952 to 1982. Data in this bulletin from 1970 to 1982 are available on computer tape through the Automatic Data Processing Division. The H-10 form has replaced the old questionnaire as a source of injection-volume data.

UTILIZATION OF STATE-LEVEL OIL AND GAS INFORMATION

Commercial Utilization and Marketing

Three commercial organizations collect and market Railroad Commission data. Dwights Energydata Inc., Petroleum Information Corporation, and NRG Associates provide oil and gas information in a variety of formats, including computer tapes and/or on-line access to production data, and aggregated reservoir or field information. These services are similar to those offered in other states.

State-Level Data Utilization

In 1981 the Bureau of Economic Geology initiated a review of the 450 largest oil reservoirs in Texas that summarized all the information available from Railroad Commission files and documents outlined above. The product of this review was a compilation titled the Atlas of Major Texas Oil Reservoirs (Galloway and others, 1983). Data collected were reservoir-specific and included physical characteristics, petrophysical information, and reservoir volumetrics. Reservoirs were grouped into plays based on similar reservoir origin and trap style. Forty-seven major oil plays were recognized in Texas. The strength of grouping this reservoir-specific information into geologically based plays is the extrapolation potential, not only within plays but also between different plays of similar origin. This Atlas formed the basis of the Bureau of Economic Geology's ongoing oil-reservoir studies, as it focused attention onto the nature of the remaining Texas resource base (Fisher, 1987), and in particular onto the large volume of unproduced mobile oil that will remain in Texas reservoirs at abandonment. A companion Atlas of Major Texas Gas Reservoirs (Finley and others, in preparation) that reviews almost 2,000 gas pools is currently being compiled from information in Railroad Commission files. This publication will lay the foundation for a focused program of detailed gas-reservoir studies to be initiated in 1988.

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STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS & MINING

AUTOMATED OIL AND GAS INFORMATION SYSTEM

R. J. Firth, Associate Director, Oil & Gas

Introduction

The Division of Oil, Gas and Mining of the Department of Natural Resources is responsible for the management of an automated oil and gas production information system for the reporting of oil and gas production, disposition and sales; recording and maintaining historical well data; generation of various reports; and microfilming. The automated oil and gas information system, a cooperative venture of the Division of State Lands and Forestry, the State Tax Commission, and the Division of Oil, Gas and Mining, serves these agencies in a variety of management and auditing requirements.

Background

The 1983 Utah Legislature passed Senate Bill 157, which effected the repeal and reenactment of the Utah Oil and Gas Conservation Act. The Utah law governing oil and gas development expanded the authority for administering the new Act to include regulatory powers traditionally considered beyond the parameters of conservation statutes. The legislature reassigned the jurisdictional responsibility for collection of the oil and gas production tax from the Division to the State Tax Commission, and the Division's responsibility was enlarged and clarified in other areas, including development of a field inspection program; collection of reports from refineries, oil and gas pipelines, and crude oil and gas trucking companies in order to provide auditing capabilities of those activities; and publication of monthly production, refinery, and transportation statistical data.

Also by special appropriation during 1982, the Utah Legislature established an oil and gas audit program in the State Tax Commission and instructed the Tax Commission to audit for all revenues the state received from its oil and gas production. Subsequent to the passage of the Federal Oil and Gas Royalty Management Act of 1982, the Utah Tax Commission received a delegation of authority from the Secretary of Interior, under Section 205 of the Act, to audit federal royalties within the state. These actions by the legislature apparently resulted from its concerns regarding the shortcomings and improprieties of the federal royalty-management system during the late 1970s.

Oil and Gas Information System

Thus, with the 1983 Legislative mandate, a committee of personnel from the three agencies was formed in mid-1983 to investigate and develop an oil and gas information system that provided details on the production and disposition of oil and gas, as well as providing the management control for internal and external reporting purposes.

It was quickly determined that the Division's outdated manual and automated system were not suitable for such an undertaking. The decision was made to contract for programmer-analysts from the Division of Data Processing to develop a shared data base on the IBM main frame. At the time, the three agencies were using three different Wang systems in two different locations. The volume of data, the amount and quality of printing that would be required, the lack of a Wang data base, and the physical distance between agencies all contributed to the decision to use a mainframe data base.

Following considerable research, a determination was reached to develop a system entirely independent of other agencies' systems, particularly in the area of federal reporting. The first phase of the proposed system was ready to be implemented in April, 1984, after nearly six months of development.

Each agency was assigned responsibility for populating and maintaining the integrity of certain files. The Division of Oil, Gas and Mining enters the well-history data, the field and lease designations, and the monthly production and disposition data. The well-history data include specific data items such as API number, operator, entity (lease) number, location, and producing formation (Attachment 1).

Procedures for Reporting Oil and Gas Production and Disposition

The operator reporting of oil and gas production involves the use of three report forms: (1) Monthly Oil and Gas Production Report; (2) Monthly Oil and Gas Disposition Report; and (3) Producing Entity Action (Attachments 2, 3, and 4). A unique feature of the system is that the Monthly Oil and Gas Production Report is pre-printed with each operator's active wells. This information is obtained from the individual well data base. The pre-printed form (turnaround document) is sent to the operator monthly. The operator completes the report with the appropriate production information and returns the form, along with the Oil and Gas Disposition Report, to the Division no later than 45 days from the end of the report period. The producing entity number is the key data element of the disposition report and may be changed by submitting a Producing Entity Action form.

As the reports are received by the Division staff, the information is grouped into batches and entered into the Wang data collection system. The batches are transmitted to the IBM mainframe, where edits are performed against the information in the data base, and the good data are added to the data base. Data that fail the edit go to a suspense file, where it may be corrected through on-line data entry and reprocessed with the next transmission from the Wang.

When all of the data have been entered and corrected, series of monthly reports is generated. This includes the Monthly Production Report, which consists of the monthly and cumulative oil, gas, and water production for each active well, summary production by county and field, and a report of changes to previous reports. This report is printed and is available for purchase from the Division. Many other useful reports are generated each month, including the Monthly Disposition Report, Monthly Gas Flaring Report, Monthly APD and Completion Report, and a tape for a commercial reporting company. In addition, various inquiry programs are available and are utilized extensively by oil and gas auditing staff in the three agencies and by the public, using terminals available in the well-records area.

Automated System Conveniences

1. The system handles large volumes of data.

2. Selected data elements can be automatically compared for audit and management information purposes.

3. Messages which alert for reporting non-compliance are provided.

4. Essential reports which would otherwise be labor-intensive are easily generated.

5. The format of reporting forms standardizes and organizes the information provided to the agency.

6. The pre-printed-form (turnaround-document) concept for production reporting controls the accuracy of well-identification data, and ensures up-to-date operator information for accountability of each well. It also provides a regular system of communication for both the operator and the agency.

7. The automated system provides for convenient reference to the manual records system.

8. Microfiche of the monthly report series are created directly from a computer file generated simultaneously with the printed reports.

9. Automated reports provide convenient visual editing of questionable data.

Automated System Inconveniences

1. Special skills are necessary to use system.

2. A manual system must still be maintained.

3. Mainframe response time and system down time are sometimes excessive. Batch runs to the mainframe data base during off-hours aids to alleviate these problems.

4. Many more points of coordination are required, including coordination with and dependance on the professional data-processing staff.

5. In some cases, automation has raised user expectations beyond the system's capabilities.

The Future

Use of the oil and gas information system in the development and enhancement of the other projects continues in areas such as:

1. Oil and gas inspection and enforcement reporting.

2. Information inquiry and requests.

3. Gas-processing-plant reporting.

4. UIC-program reporting.

5. Automated Geographic Reference (mapping) development in coordination with State Lands for use in well spacing, pooling. etc.

6. Specific field studies, including decline curves, secondary recovery, etc.

As with the development of the original oil and gas information system, industry involvement is necessary to minimize problems in the development of these projects. The Division continues to improve upon the gains of the past few years, and intends to anticipate particular regulatory requirements and concerns. The goal is to develop a regulatory framework that can be in place at the proper time, and that can support the policy of fostering, encouraging, and promoting development of oil and gas resources in Utah.

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 11/05/87  D E T A I L   W E L L   D A T A   B Y   A P I      MENU: OPTION 00
API NUMBER: 4304715462   PROD ZONE: GRRV            SEC   TWNSHP   RANGE   QR-QR
ENTITY: 5265 (WONSITS VLY U(59785)               )  11    08.0 S   21.0 E  SWNW
WELL NAME: WVU #34
OPERATOR:  N0210 (CHEVRON USA INC                 )        MERIDIAN: S
FIELD:       710 (WONSITS VALLEY                  )
CONFIDENTIAL FLAG:     CONFIDENTIAL EXPIRES:               ALT ADDR FLAG:
    * * * APPLICATION TO DRILL, DEEPEN, OR PLUG BACK * * *
TYPE OF WELL (OW/GW/OT) OW            LEASE NUMBER: U-0806    LEASE TYPE: 1
SURFACE LOC:   2092 FNL 0682 FWL      UNIT NAME: WONSITS VALLEY
PROD ZONE LOC: 2092 FNL 0682 FWL      DEPTH: 5700        PROPOSED ZONE:
ELEVATION:                            APD DATE: 650423   AUTH CODE:
    * * * COMPLETION REPORT INFORMATION * * *            DATE RECD: 0
SPUD DATE: 650427                     COMPL DATE: 650901  TOTAL DEPTH: 5535
PRODUCING INTERVALS: F-2 5315-5333, F-4 5372-5387, G 5452-5466
BOTTOM HOLE: 2092 FNL 0682 FWL        DATE PROD: 650901   WELL STATUS: POW
24HR OIL:  60      24HR GAS:    0     24HR WTR: 100       G-O RATIO:    0
   * * * WELL COMMENTS * * *                              API GRAVITY: 31.07
  850730 OPER CHG FROM GULF N1590 EFF 850701:860130 ACIDIZED PERFS 5315-33';
  5370-97';5416-23';5452-70'

 OPTION: 21 PERIOD(YYMM):    0 API: 4304715462 ZONE: GRRV  ENTITY:     0
```

UTAH NATURAL RESOURCES
Oil, Gas & Mining
/est North Temple, 3 Triad Center, Suite 350, Salt Lake City, Ut
-1203. ●(801-538-5340)

MONTHLY OIL AND GAS PRODUCTION REPORT

Operator name and address:

Utah Account No. __________

Report Period (Month/Year) __________

Amended Report ☐

l Name Number	Entity	Location	Producing Zone	Days Oper	Production Volume Oil (BBL)	Gas (MSCF)	Water (BBL)
				TOTAL			

ıents (attach separate sheet if necessary) __________

reviewed this report and certify the information to be accurate and complete. Date __________

__________ Telephone __________
ized signature

PLEASE COMPLETE FORMS IN BLACK INK

ATTACHMENT 2

PRODUCTION REPORT INSTRUCTIONS

OPERATOR NAME AND ADDRESS:
Name and mailing address of company operating the well(s).

UTAH ACCOUNT NUMBER:
Enter the Utah Account Number of the company operating the well(s). The number is assigned by the Utah Division of Oil, Gas and Mining.

REPORT PERIOD:
The report period covers one calendar month from 12:01 AM of the first day to 12:00 PM of the last day. This report is due not later than the 15th day of the second month following the report period.

AMENDED REPORT:
Check if this report is changing or updating information previously submitted. Enter well identification and all data on the entire line correctly. Circle the amended data.

WELL NAME:
Well name as it appears on official State records

API NUMBER:
API Number assigned by the Utah Division of Oil, Gas & Mining.

PEN:
Producing Entity Number.

LOCATION:
Township, Range, and Section.

PRODUCING ZONE:
Use the abbreviations published by the Utah Division of Oil, Gas, & Mining to enter the formation from which the well is producing. Production from multiple formations of a single well should be reported by using a separate line for each producing formation.

DAYS OPERATED:
Number of days the well was operated during this report period for purposes of production.

PRODUCED OIL:
All oil and condensate produced from the well during this report period. Quantity should be reported in BBLS, and should have been corrected to standard conditions at 60° F and adjusted for the exclusion of impurities (BS&W) which do not constitute a natural component of the oil.

PRODUCED GAS:
All gas produced from the well during this report period. (MCF adjusted to standard conditions at 60° F/14.73 PSIA).

PRODUCED WATER:
All water produced from the well during this report period (BBLS).

PAGE TOTALS:
Total each column on each page. Page totals are used to verify accuracy of data entry for automated processing of the report.

DATE:
Date the report was prepared.

AUTHORIZED SIGNATURE:
Signature of person preparing the report.

TELEPHONE NUMBER:
Telphone number of the person preparing the report.

NOTE:
Corrections, additions, and deletions to the preprinted information should be made by the operator, and should be supported by attached explanation. Companies are encouraged to make a copy of the completed report for their own records.

UTAH NATURAL RESOURCES
Oil, Gas & Mining

DOGM 56 64 22
7/85

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Page ____ of ____

MONTHLY OIL AND GAS DISPOSITION REPORT

Operator Name ____________________ Utah Account No. ____________
Address ____________________ Report Period (Month/Year) ____________
City ____________ State ____________ Zip ____________ Amended Report ☐

Producing Entity No.	Prod. Type*	API/ BTU	Beginning Inventory	Volume Produced	Product Disposition: Transported	Used on Site	Flared/Vented	Other	Ending Inventory
	OL								
	GS								
	NL								
	OL								
	GS								
	NL								
	OL								
	GS								
	NL								
		TOTAL							

Comments (attach separate sheet if necessary) ____________________

I have reviewed this report and certify the information to be accurate and complete

Date ____________

____
Authorized Signature

Telephone ____________

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ATTACHMENT 3

INSTRUCTIONS

OPERATOR NAME AND ADDRESS
Name and mailing address of company operating Producing Entity.

UTAH ACCOUNT NUMBER
Enter Utah Account Number of Entity operator. Number is assigned by Utah Division of Oil, Gas and Mining.

REPORT PERIOD
Report period covers one calendar month from 12:01 a.m. of the first day to 12:00 midnight of the last day. **REPORT IS DUE** not later than the 15th day of second month following report period.

AMENDED REPORT
Check box if this report is changing or updating information previously submitted. Correctly enter all data on line containing amendment, and circle amended data.

PRODUCING ENTITY
Enter number assigned to Producing Entity by Utah Division of Oil, Gas and Mining.

PRODUCT TYPE
Use the following codes for product type: OL – Oil; GS – Gas; NL – NGL.

API/BTU
API gravity of oil being reported. BTU of gas being reported.

BEGINNING INVENTORY
Producing Entity inventory at beginning of report period for type of product being reported.

VOLUME PRODUCED
Sum of oil and/or gas production as reported on production report of same period for all wells assigned to Producing Entity. NGL volume will appear here for the first time and should be reported in gallons.

PRODUCT DISPOSITION
Transported: Products physically removed from Producing Entity which are not accounted for in one of the other disposition columns (typically sales).

Used on Site: Product used for operation of on site equipment, re-injection, or other valid on site purposes.

Flared/Vented: Gas wasted in accordance with applicable state rules and regulations.

Other: Disposition of products not accounted for in one of the other disposition columns. Such disposition should include unavoidable loss such as spillage, leakage, or theft which may have occurred at Producing Entity or between Producing Entity and well. *Shrinkage must be reported* in this column when NGL is also reported for Producing Entity. An attachment of explanation is required for all entries in *Other* column.

ENDING INVENTORY
Producing Entity inventory at end of report period. Inventory should be physically verified and reconciled on report form as follows: beginning inventory + volume produced – disposition = ending inventory.

PAGE TOTAL
Total figures in each column regardless of units of measurement. Page totals are used to verify accuracy of data entry for automated processing of report.

NOTE
All oil and gas volumes should be corrected to standard conditions (60°F – 14.73 PSIA) and adjusted for exclusion of impurities (BS&W) not constituting a natural component part of the oil.

Units of measurement:
OIL & CONDENSATE – BBLS
GAS – MSCF
NGL – GAL

Companies are encouraged to make a copy of completed report for their records.

UTAH
NATURAL RESOURCES
Oil, Gas & Mining

7/85

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PRODUCING ENTITY ACTION

Operator Name ____________________
Address ____________________
City ____________ State ________ Zip ________
Utah Account No. ____________________

Authorized Signature ____________________
Effective Date ____________ Telephone ____________

ACTION CODE

- **A** Establish new entity for new well(s).
- **B** Add new well(s) to existing entity.
- **C** Delete well(s) from existing entity.
- **D** Establish new entity for well(s) being deleted from existing entity.
- **E** Change well(s) from one entity to another existing entity.
- **F** Other. (Specify using attachments if necessary.)

BRACKET WELLS TO BE GROUPED TOGETHER.

(Use black ink or typewriter ribbon.)

Action Code	Current Entity No.	New Entity No.	API No.	Well Name	Well Location Sec.	T	R	Q/Q	County	Producing Formation

Explanation of action:

Action Code	Current Entity No.	New Entity No.	API No.	Well Name	Sec.	T	R	Q/Q	County	Producing Formation

Explanation of action:

Action Code	Current Entity No.	New Entity No.	API No.	Well Name	Sec.	T	R	Q/Q	County	Producing Formation

Explanation of action:

Action Code	Current Entity No.	New Entity No.	API No.	Well Name	Sec.	T	R	Q/Q	County	Producing Formation

Explanation of action:

an equal opportunity emplc

ATTACHMENT 4

INSTRUCTIONS

ACTION CODE
Describes requested action.

CURRENT ENTITY NUMBER
Number of entity to which wells affected are currently assigned. Leave blank if not applicable.

NEW ENTITY NUMBER
Number of entity to which wells affected are being assigned. Leave blank if Entity Number has not been assigned.

API NUMBER
Number assigned to well by Utah Division of Oil, Gas and Mining.

WELL LOCATION
Section, township, range, quarter/quarter and county of well affected.

PRODUCING FORMATION
Enter Division of Oil, Gas and Mining abbreviation for producing formation. If wells have more than one producing formation, each should be listed on a separate line of report.

NOTE
Use black ink or typewriter ribbon to facilitate microfilming.

DOGM 56 64 23

OIL AND GAS ACTIVITY AND DATA COMPUTERIZATION, COMMONWEALTH OF VIRGINIA *

BY

FRANK H. JACOBEEN, JR.

VIRGINIA DEPARTMENT OF MINES, MINERALS AND ENERGY

DIVISION OF MINERAL RESOURCES

1987

INTRODUCTION

The Virginia Department of Mines, Minerals and Energy in Richmond, O. G. Dishner, Director, administers activities concerning mining and drilling in the Commonwealth through four of its six Divisions. The regulation and monitoring of the drilling for hydrocarbons and geothermal energy is the responsibility of the Division of Gas and Oil, and the gathering and handling of the geologic data generated are done by the Division of Mineral Resources (Figure 1).

The Division of Gas and Oil, in Abingdon, through the Gas and Oil Inspector, B. T. Fulmer, and two Assistant Inspectors, is responsible for regulating oil and gas drilling in Virginia. The Inspectors assure compliance with the laws, process drilling applications, monitor active drilling, and supervise the plugging, completion, and reclamation of the drill sites. The Division of Gas and Oil also collects, processes, and disseminates data about the industry and maintains complete well files, including petrophysical logs. The Division is required to investigate complaints and encourages public participation in the regulatory process through meetings. A list of the forms used by the Division is included as Appendix I of this report.

The Division of Mineral Resources in Charlottesville, R. C. Milici, Commissioner and State Geologist, is responsible for the geologic aspects of oil and gas exploration and production within the Commonwealth. Two people are currently assigned responsibilities related to these activities. The Division of Mineral Resources cooperates with the Division of Gas and Oil by collecting and processing drill cuttings from wells and maintaining a sample repository. This repository, in Charlottesville, is available to the public. The Division of Mineral Resources also maintains a set of well records and compiles summaries on all wells (Figures 2 and 3). An important duty of the Division is to process the geologic data and, as funds are available, prepare and publish geologic reports.

DRILLING AND PRODUCTION

A small amount of oil is produced from rocks of Mississippian, Silurian, and Ordovician ages in Virginia; substantial quantities of gas are produced from rocks of Mississippian and Devonian age (Figure 4). In 1986, the total oil production from 50 wells was 18,342 barrels, and total gas production from 573 wells was 15.4 billion cubic feet. It is estimated that proven producible reserves are more than 260 billion cubic feet of gas. Undrilled probable producible gas from known productive areas is estimated to be between 1 and 1.5 trillion cubic feet.

To date, more than 1150 wells have been drilled in Virginia in the search for hydrocarbons. More than 600 of these are currently producing. Most of the drilling activity has been concentrated in the southwestern part of the state. Thirty wells have been drilled in Rockingham County in the west-central part of the State, and a few wells, all non productive, were drilled in the Richmond and Taylorsville Triassic basins in eastern Virginia (Figure 5). Scattered wells have been drilled on the Coastal Plain and in the Valley and Ridge provinces, but none are productive. It is anticipated that to fully develop the currently productive areas, more than 2,500 additional wells will be drilled.

DATA MANAGEMENT

In order to handle the oil and gas data more efficiently, a computerized master file of all wells that have been drilled for hydrocarbons in Virginia has been started by the Division of Gas and Oil in Abingdon and the Division of Mineral Resources in Charlottesville. When complete, this file will contain drilling, completion, and geologic data on all wells that have been drilled in Virginia, and will list the petrophysical logs that are in the Commonwealth's files. This master file currently lists well data in Buchanan, Dickenson, and Wise counties by county name, quadrangle name, Division of Gas and Oil number (originally Division of Mines and Quarries - DMQ) and API number. Data can be recovered under these headings, and by well name (operator and farm), permit number, location (latitude and longitude and/or Universal Transverse Mercator system), elevation, projected depth, type of log, and the repository site (Abingdon or Charlottesville) for each log. The depth intervals covered by each type of log are listed for each well. Examples of typical printouts are included as Figures 6 through 10.

Future work will expand these files to include data on all wells, the engineering and completion data as reported by the operators to the Division of Gas and Oil, and the geologic data as reported to or as originated by the Division of Mineral Resources. Plans include additional development of computer capabilities to plot wells and manipulate the broad range of available data.

The computer-equipment components available at the Division of Mineral Resources in Charlottesville are an IBM-AT, an Epson printer, an Altek digitizer, and a Hewlett-Packard 7475A plotter. The equipment at the Division of Gas and Oil in Abingdon consists of a Prime Personal Computer, an Epson printer, and a Hewlett-Packard 7475A plotter. Currently, the program used for this data processing is PC-INFO by Henco, which is compatible with the IBM and Prime systems. Expansion of the system in the future will be dependent upon the availability of funding.

DEPARTMENT OF MINES, MINERALS AND ENERGY

GENERAL ORGANIZATIONAL STRUCTURE

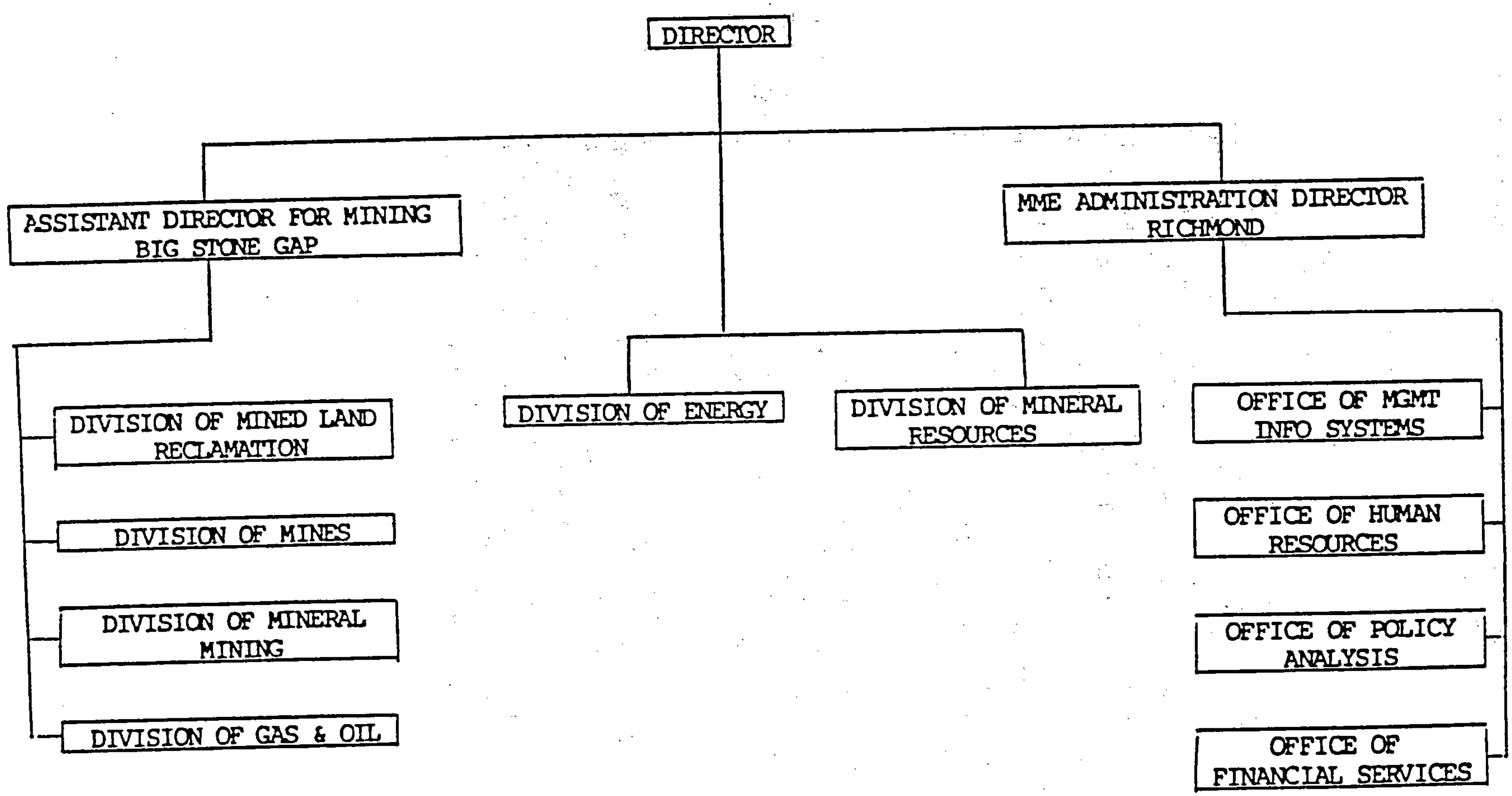


Figure 1

OIL AND GAS WELL SUMMARY REPORT

API No. ______________________ VDMR Well Rep. No. __________

DMQ File No. __________

Operator ______________________________

Farm ______________________________

Co.·Well No. ______________________________

County ______________ Quadrangle ______________

Location (UTM) ______________ UTM Zone ________

(Lat. and Long.) ______________________________

Field ______________ Province ______________

Elev. (specify) ________ TD ________ Form. at TD ________

Age ________

Date compl. or abandoned ______________________________

Result ______________________________

Gas Shows ______________________________

Gas Pays ______________________________

Main Production ______________ Prod. Form. ______________

Age ______________

Treatment: ______________________________

____

____

Initial Production ______________________________

____

Oil shows ______________________________

Water FW ______ at ______ ______ at ______ ______ at ______

SW ______ at ______ ______ at ______ ______ at ______

Coal ______________________________

Plat ________ Plotted ________ Completion Report ______________

Drillers Log ________ Geologic Log ______________

Samples ________ Interval Sheet ________

Sample Interval ______________________________

Remarks ______________________________

Geophysical Logs S.P. ______ Res ______ Gamma ______ Neutron ______

Density ______ Sonic ______ Other ______________

____

____

Figure 2

SUMMARY REPORT BACK

Stratigraphic Data Source ______________________

Formation	Top	Datum (Subsea)	Thickness

Remarks ______________________

References ______________________

Released to Open File: Completion ______________________

Samples ______________________

(Note: UTM measurements in meters, all others in feet)

Figure 3

OIL AND GAS IN VIRGINIA

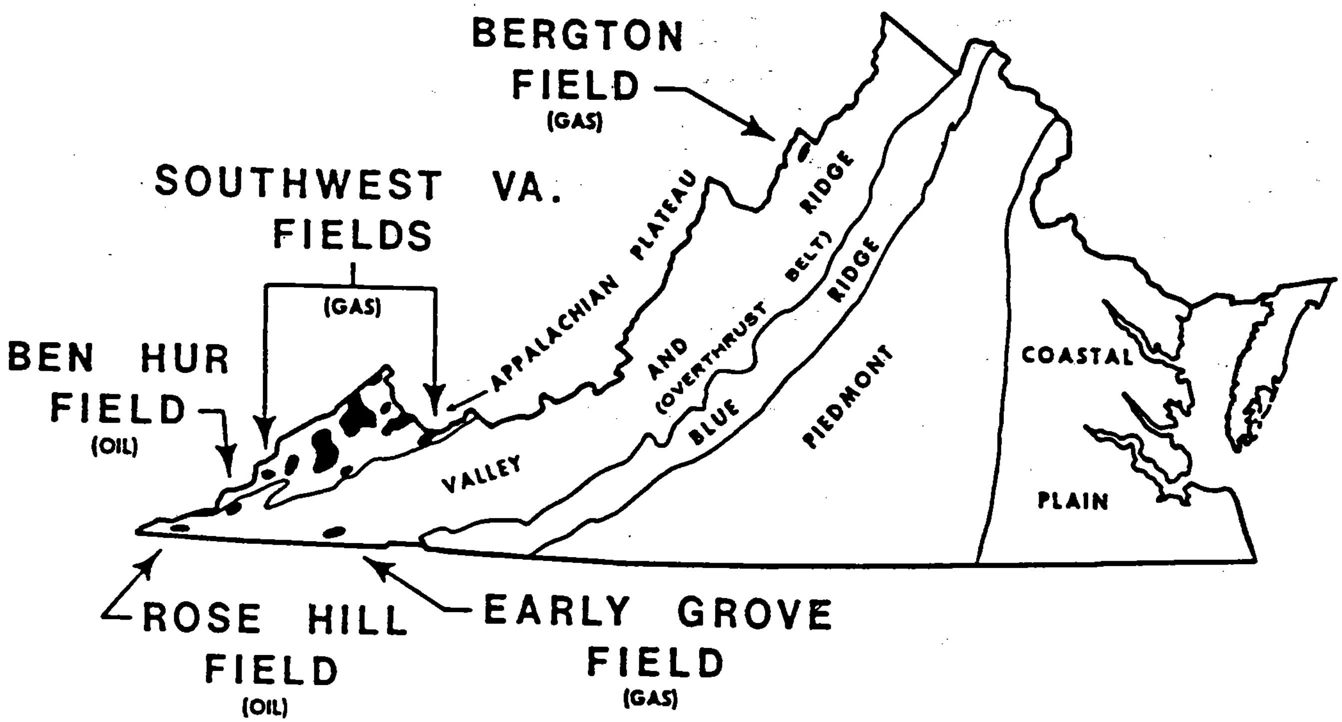
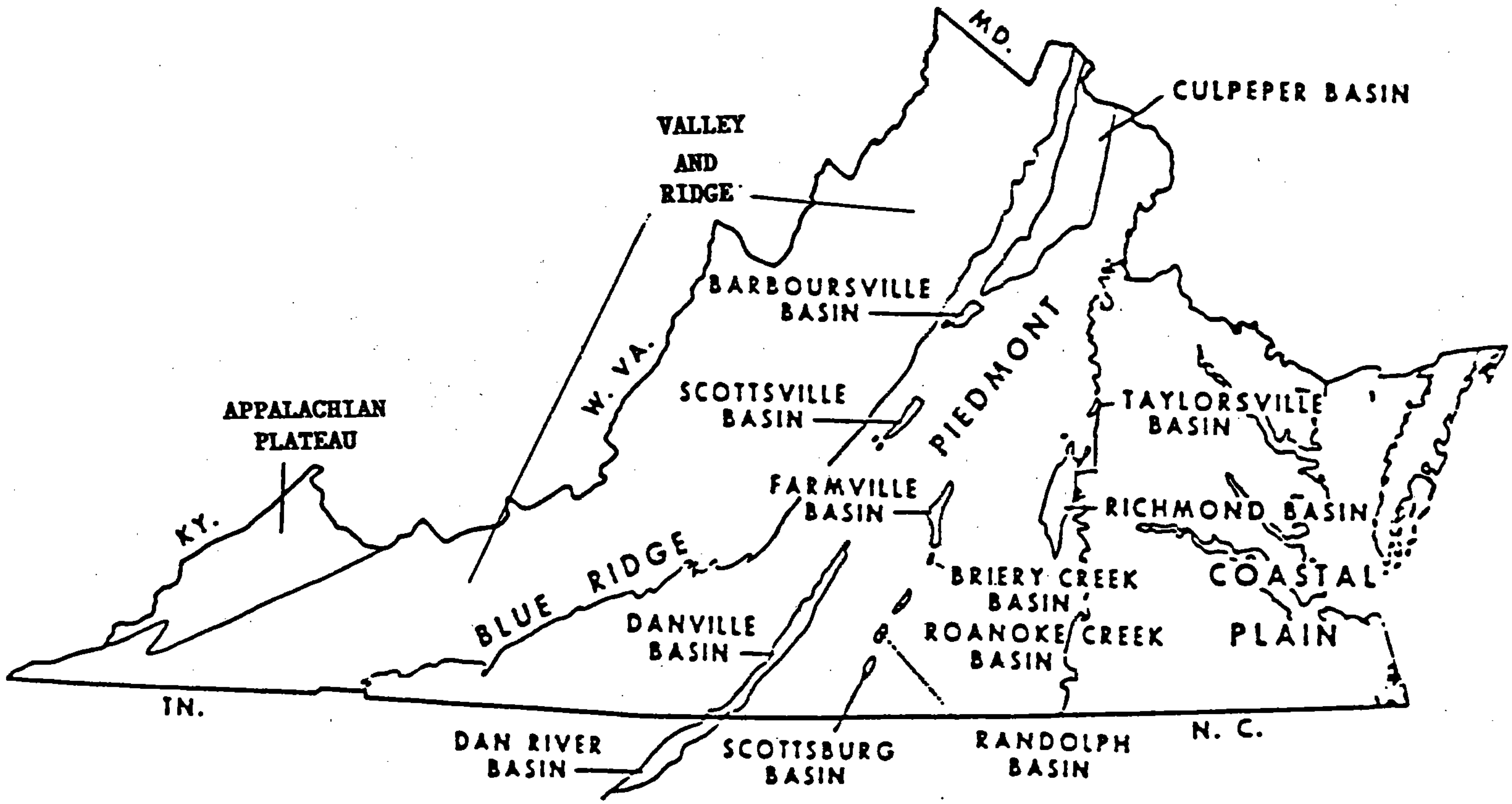


Figure 4



PHYSIOGRAPHIC PROVINCES
AND MESOZOIC BASINS IN
VIRGINIA

Figure 5

ITEMS
DATAFILE NAME: MASTER.NEW
18 ITEMS: STARTING IN POSITION 1

10/ 7/1987

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	ALTERNATE NAME .
1	COMPANY	25	25	C	-	
26	WELL	25	25	C	-	
51	FILE	7	7	C	-	
58	API	13	13	C	-	
71	DATE(REC)	8	10	D	-	
79	DATE(ISSUED)	8	10	D	-	
87	PERMIT	5	5	I	-	
92	FARM	25	25	C	-	
117	DISTRICT	15	15	C	-	
132	QUADRANGLE	25	25	C	-	
157	LATITUDE	20	20	C	-	
177	LONGITUDE	20	20	C	-	
197	ELEVATION(FT)	9	9	C	-	
206	DEPTH(PROJECTED)	8	8	C	-	
214	TARGET	15	15	C	-	
229	COUNTY	15	15	C	-	
244	JURISDICTIONAL	5	5	C	-	
249	STATUS	10	10	C	-	

ENTER COMMAND >

Figure 6

RECNO	FILE	GR	NEU	DEN	LAT	RES	VEL	CBL	SONIC	TEMP	AUDIO	OTHR
28	BU-092	X		X	X			X				
30	BU-094	X		X	X							
64	BU-129	X		X				X		X		X
67	BU-132	X		X						X		
72	BU-137	X		X				X		X		
73	BU-138	X		X				X		X		
75	BU-140	X	X	X			X	X		X		
78	BU-143	X		X				X		X		
81	BU-146	X		X				X		X		
83	BU-148	X		X				X		X		
95	BU-162	X		X						X		
104	BU-173	X		X				X		X		
105	BU-174	X		X				X		X		
185	DI-087	X		X						X		
228	DI-131	X		X						X		
229	DI-132	X		X				X		X		
341	DI-259	X	X	X						X	X	
357	DI-278	X	X	X						X		
358	DI-279	X	X	X						X		
365	DI-286	X	X	X						X	X	
537	DI-301	X	X	X						X	X	

Figure 7

LOCATION AND AVAILABITY OF OIL & GAS WELL LOGS

API NO.: 45-027-20042 DMQ FILE NO.: BU-092
DMR MAP REFERENCE NO.: PR3-1 DMR WELL REPOSITORY NO.:

COUNTY: BUCHANAN QUAD: PRATER

COMPANY: UNITED FUEL GAS CO.
COMPANY WELL NUMBER: 9587

** LOCATION **

LATITUDE: 0 LONGITUDE;
NORTHING: 04118540 EASTING: 00392240 UTM ZONE: 0017

** LOG DESCRIPTIONS **

SAMPLE LOG STRIP?
SAMPLE LOG DESCRIPTION:

TOTAL NUMBER OF E-LOGS: 4 LOCATIONS OF LOGS: A&C

LOG DESCRIPTION:
G/IND/LAT 1922-4564 @A; GD(5") 1917-4567; PERF(5") 4000-4444; CBL(5") 4000-4435 @A&C

G GAMMA RAY:	X	V VELOCITY:	
N NEUTRON:		B BOND (CBL):	X
D DENSITY:	X	P PERFS.:	X
C COLLARS:		A AUDIO:	
I INDUCTION:	X	T TEMP	
L LATEROLOG:	X	S SONIC:	
R RESIST.:		Sm SAMPLES:	
OTHER:			

Figure 8

FILE NUMBER	API NUMBER	COMPANY	WELL NAME/NUMBER	QUADRANGLE	STATUS
A10BU	45-027-19881	CLINCHFIELD COAL CO	125	PRATER	P & A
A23BU	45-027-19894	CLINCHFIELD COAL CO	102	PRATER	P & A
A23DK	45-051-19814	PINE MTN O & G	113	PRATER	PRODUCING
BU-024	45-027-19939	COLUMBIA GAS	9552	PRATER	P & A
BU-092	45-027-20042	COLUMBIA GAS	9587	PRATER	PRODUCING
BU-094	45-027-20046	COLUMBIA GAS	9586	PRATER	PRODUCING
BU-129	45-027-20117	COLUMBIA GAS	9722-T	PRATER	P & A
BU-132	45-027-20147	COLUMBIA GAS	9781-T	PRATER	P & A
BU-137	45-027-20164	COLUMBIA GAS	20009	PRATER	PRODUCING
BU-138	45-027-20172	COLUMBIA GAS	20005	PRATER	PRODUCING
BU-140	45-027-20205	COLUMBIA GAS	20212	PRATER	P & A
BU-143	45-027-20213	COLUMBIA GAS	20006	PRATER	PRODUCING
BU-146	45-027-20250	COLUMBIA GAS	20343	PRATER	PRODUCING
BU-148	45-027-20252	COLUMBIA GAS	20301	PRATER	PRODUCING
BU-162	45-027-20279	COLUMBIA GAS	20467	PRATER	PRODUCING
BU-173	45-027-20298	COLUMBIA GAS	20554	PRATER	PRODUCING
BU-174	45-027-20305	COLUMBIA GAS	20553	PRATER	PRODUCING
DI-087	45-051-20139	COLUMBIA GAS	9835	PRATER	PRODUCING
DI-131	45-051-20216	COLUMBIA GAS	20016	PRATER	P & A
DI-132	45-051-20222	COLUMBIA GAS	20008	PRATER	PRODUCING
DI-259	45-051-20849	PHILADELPHIA OIL CO	P-213	PRATER	PRODUCING
DI-277	45-051-20885	PHILADELPHIA OIL CO	P-228	PRATER	
DI-278	45-051-20886	PHILADELPHIA OIL CO	P-229	PRATER	PRODUCING
DI-279	45-051-20887	PHILADELPHIA OIL CO	P-232	PRATER	PRODUCING
DI-286	45-051-20895	PHILADELPHIA OIL CO	P-230	PRATER	PRODUCING
DI-291	45-051-20901	PHILADELPHIA OIL CO	P-231	PRATER	
DI-295	45-051-20906	PHILADELPHIA OIL CO	P-234	PRATER	
DI-297	45-051-20908	PHILADELPHIA OIL CO	P-284	PRATER	
DI-301	45-051-20917	PHILADELPHIA OIL CO	P-287	PRATER	PRODUCING
DI-321	45-051-20945	PHILADELPHIA OIL CO	P-292	PRATER	

Figure 9

QUADRANGLE	FILE NUMBER	API NUMBER	COMPANY	WELL NAME/NUMBER
PRATER	A10BU	45-027-19881	CLINCHFIELD COAL CO	125
PRATER	A23BU	45-027-19894	CLINCHFIELD COAL CO	102
PRATER	A23DK	45-051-19814	PINE MTN O & G	113
PRATER	BU-024	45-027-19939	COLUMBIA GAS	9552
PRATER	BU-092	45-027-20042	COLUMBIA GAS	9587
PRATER	BU-094	45-027-20046	COLUMBIA GAS	9586
PRATER	BU-129	45-027-20117	COLUMBIA GAS	9722-T
PRATER	BU-132	45-027-20147	COLUMBIA GAS	9781-T
PRATER	BU-137	45-027-20164	COLUMBIA GAS	20009
PRATER	BU-138	45-027-20172	COLUMBIA GAS	20005
PRATER	BU-140	45-027-20205	COLUMBIA GAS	20212
PRATER	BU-143	45-027-20213	COLUMBIA GAS	20006
PRATER	BU-146	45-027-20250	COLUMBIA GAS	20343
PRATER	BU-148	45-027-20252	COLUMBIA GAS	20301
PRATER	BU-162	45-027-20279	COLUMBIA GAS	20467
PRATER	BU-173	45-027-20298	COLUMBIA GAS	20554
PRATER	BU-174	45-027-20305	COLUMBIA GAS	20553
PRATER	DI-087	45-051-20139	COLUMBIA GAS	9835
PRATER	DI-131	45-051-20216	COLUMBIA GAS	20016
PRATER	DI-132	45-051-20222	COLUMBIA GAS	20008
PRATER	DI-259	45-051-20849	PHILADELPHIA OIL CO	P-213
PRATER	DI-277	45-051-20885	PHILADELPHIA OIL CO	P-228
PRATER	DI-278	45-051-20886	PHILADELPHIA OIL CO	P-229
PRATER	DI-279	45-051-20887	PHILADELPHIA OIL CO	P-232
PRATER	DI-286	45-051-20895	PHILADELPHIA OIL CO	P-230
PRATER	DI-291	45-051-20901	PHILADELPHIA OIL CO	P-231
PRATER	DI-295	45-051-20906	PHILADELPHIA OIL CO	P-234
PRATER	DI-297	45-051-20908	PHILADELPHIA OIL CO	P-284
PRATER	DI-301	45-051-20917	PHILADELPHIA OIL CO	P-287
PRATER	DI-321	45-051-20945	PHILADELPHIA OIL CO	P-292

Figure 10

PUBLIC OIL AND GAS INFORMATION SYSTEMS IN WEST VIRGINIA

Mary C. Behling

West Virginia Geological and Economic Survey
P.O. Box 879
Morgantown, WV 26507-0879

Three State agencies in West Virginia independently maintain computerized well-specific oil and gas data bases and are continuing to develop these comprehensive data systems, but for different purposes.

Why does a state support three comprehensive computerized oil and gas data systems? In West Virginia, the varied responsibilities, needs, and the geographic location of the agencies involved all played a part in the development of these systems. Future development of two of the three systems (if not all three) will continue.

This paper will discuss how these three systems arose and will summarize the organization of two of the systems. Further, it will concentrate on the structure and organization of the third system, which is maintained by the West Virginia Geological and Economic Survey.

Approximately 65,000 wells have been drilled in this State since permitting became required on June 29, 1929, and supposedly 60,000 wells were drilled prior to that time; the oldest well in the Geological Survey's data base was completed in 1884. Natural gas and/or oil wells have been drilled in 53 of the 55 counties in the State. Figure 1 shows the occurrence of oil and gas fields in the State, concentrated in the Appalachian Plateaus physiographic province; in the Valley and Ridge physiographic province, Early Devonian Oriskany gas fields occur in the so-called "Eastern Overthrust." Of this total number of wells, the Federal Energy Regulatory Commission (FERC) estimated a few years ago that approximately 40,000 wells were still producing; annual production data received by the State from the operators since 1979 place the number of producing wells closer to 30,000.

Two of the data systems were developed from copies of data tapes provided by the West Virginia Geological and Economic Survey (WVGES). With extensive work begun in 1966, the Survey developed a computerized card-image, fixed-format file of well-completion records as part of a national cooperative effort with the American Association of Petroleum Geologists/Committee on Statistics of Drilling (AAPG/CSD). Located in Morgantown, the Survey (which is an autonomous State agency) purchased time on West Virginia University's computer system for the development of the first and second versions of its Oil and Gas Data System. A minicomputer was purchased in the mid-1970s, and when it was later upgraded to a VAX-11/750 in the early 1980s, the current version of the Survey's Oil and Gas Data System was written for that computer.

In the mid-1970s, the Survey generated a comprehensive tape for the Oil and Gas Conservation Commission (OGCC) to install on the State government computer network in the State Capitol in Charleston, 150 miles to the south. Numerous problems occurred on this system over the next decade, and the OGCC finally obtained its own Wang VS15 system in 1986. Despite problems with the organization of the very large oil and gas data system on the locally written data-management software system, the OGCC nevertheless is continuing to work toward on-line availability of the entire post-1929 file of well completions.

In the early 1980s, the OGCC gave a tape copy of their file to the West Virginia Department of Energy (WVDOE), Office of Oil and Gas, the regulatory agency for oil and gas activity in the State. WVDOE now maintains a modified version of this file on a VAX-11/780 computer system, on which it buys time.

WVDOE SYSTEM

Regulatory responsibilities for oil and gas drilling in the State of West Virginia rest with the WVDOE, Office of Oil and Gas. They issue permits to drill, inject, and plug wells, inspect all phases of drilling activities, issue citations for violations, and administer the UIC program. They also manage the acquisition of production data from operators. In addition, they maintain basic data on well completions, stratigraphy, and pays and shows of hydrocarbons, although they currently have no plans to utilize these data.

Data are organized into 47 files, some of which contain basic information, while others are summary report files created from the basic data in other files. Because they are not integrated, individual files contain all of the information necessary to generate any specific report. However, this also results in duplication of certain data fields in a number of files.

WVDOE buys computer time on a VAX-11/780 computer system and stores and manages the data through POISE data-management software. This information system is used primarily to manage the regulatory responsibilities of the agency. The basic data on well completions, stratigraphy, and pays and shows are obtained from the Geological Survey or entered by WVDOE staff as time permits.

OGCC SYSTEM

The Oil and Gas Conservation Commission is responsible for deep wells drilled in the State, for unitization or forced pooling with respect to deep wells within units, and for some secondary-recovery projects if there is a need to force pool; they also provide comments on UIC proposals. Despite their responsibility solely for deep wells (currently defined as a well that penetrates at least 20 feet below the top of the Middle Devonian Onondaga Limestone), this agency maintains a comprehensive system on all wells drilled since permitting became required in 1929, because of the numerous requests for information which they receive and their desire to continue to meet them.

Residing on a Wang VS15 computer under a unique locally written data-management software system, this file is characterized by a fixed-format record structure which consists of a single 796-byte record per well. Within this record is space for recording up to six completion intervals and up to 14 stratigraphic units. Also stored in this record are operator code, well location (in degrees/minutes/seconds as well as in direction and feet from latitude and longitude), quadrangle, field name, IPs, rock pressure, monthly oil and/or gas volume for the previous year, and up to 11 of the most recent years of cumulative gas or oil production.

WVGES SYSTEM

The Geological and Economic Survey has no regulatory responsibilities, but is mandated in its charge from the Legislature to conduct applied geological assessment of mineral and water resources and to provide for the dissemination of that information. For the past two decades, the Survey has been fortunate to have the leadership of a Director who had the foresight to emphasize and support computerization of basic data in the agency, despite the varying amount of annual budgets. As a result, the Oil and Gas Data System was the first of six major geological data systems developed and now residing on-line on the agency's minicomputer; administrative data systems now reside on a separate microcomputer network.

For the past two decades, WVGES staff have routinely utilized the data in the Oil and Gas Data System for numerous research projects and publications, quarterly and annual reports of current drilling activity, and response to requests for information from the public. This data system is an integral part of the daily work of the staff in both research and information services. It will be discussed in considerable detail because of its sophisticated data structure and because of its extensive and varied use by so many people in the agency.

File Residency:

The Survey's Oil and Gas Data System is organized differently from that of the other two agencies, using a dictionary-based structure under two proprietary software products from Digital Equipment Corporation (DEC), the "Common Data Dictionary" and "DATATRIEVE" data-management software. These software packages run under the VAX/VMS v.4.6 operating system on a VAX-11/750 computer system with 12 MB of memory and 1 GB of disk storage capacity. Much of this capacity was obtained through very recent upgrades; for several years, though, limited storage capacity and memory were at a premium. Although the Survey essentially utilizes only its own system, an RJE line is maintained to the West Virginia Network for Educational Telecomputing (WVNET) for access to additional statistical and mathematical software; Survey staff have occasionally accessed the Gas Research Institute's (GRI) Eastern Gas Data System, which currently resides at Lewin and Associates.

WVGES staff have access to 21 CRTs and five hard-copy terminals, three color-graphics terminals, and eight IBM PC/AT and compatible microcomputers. Other computer peripherals available include two digitizers, a Bruning ZETA 5400 digital incremental plotter, and a Tektronix ink-jet color copier.

Domains:

Within DEC's fourth-generation language "DATATRIEVE", the word "domain" represents the relationship between a record definition and a data file. It is a broader use of the term than the stricter definition of domain as a field or column in a relational data base. Usage of the term in this paper follows that of the DEC software and is essentially synonymous with file type or record type.

In the Survey's Oil and Gas Data System, a total of 12 domains can be linked via common fields which include the county and permit portion of the API number. The combined county/permit number creates a unique number; therefore, well numbering starts with "1" in each county. Six of the 12 domains are the so-called "basic" well-completion data files, and the other six are subsidiary files (Figure 2). So, for each well completion which operators report to the State, the "basic" domains are routinely stored, including: OWNERS, LOCATIONS, COMPLETIONS, STRATIGRAPHY, PAYS and OGWATER. The subsidiary domains include

PLUG, Mechanical Log Catalog, Well Sample Catalog, OG1 permit applications, monthly/annual PRODUCTION, and GRI completion-by-stage; data in these domains are stored as they become available.

Data Structure:

The primary considerations in the design of this data system were the most efficient possible storage on the disk drive and the fastest possible retrieval. It may sound trite, but for a number of years, these were the overriding concerns because of insufficient resources on the VAX. Data retrieval will be discussed later; storage techniques and the files themselves will be addressed first.

Each episode of drilling is recorded as if it were a separate well, so that the drilling history of a well can be reconstructed. Each record type is no larger than it needs to be, with a minimum of duplication of fields from record type to record type. Therefore, there is a minimum of space wasted on the disk. DATATRIEVE software is used both for its ability to manage data and also for its ability to enable users to query the system in English commands (e.g., "Find COMPLETIONS with Deepest_Formation_Encountered > 460 and Total_Depth > 5999 and Gas > 25" would have retrieved productive deep wells in a particular region, under a previous definition of "deep well"). But because DATATRIEVE allocates space in each domain for each field in each record in that domain, whether or not that space is utilized, it was important to be as conservative as possible in reserving that disk space.

For some record types (such as OWNERS), there is one comprehensive record per episode of drilling. For other record types (such as STRATIGRAPHY), each unit is stored as a separate record. Examples of how that is accomplished will be described shortly.

Data Management:

It was learned early that, for all of its good points, DATATRIEVE can be very slow for the routine entry and editing of basic data (which can involve a large portion of anyone's work with data and can be quite cumbersome). Therefore, it was decided to move data entry and editing out of DATATRIEVE and into locally written FORTRAN programs for formatted screens on CRTs. These customized FORTRAN programs run much faster and speed up the basic data tasks.

Formatted screens and the programs behind them control the entry of character versus numeric data types, the size of data fields, validation of codes by accessing look-up tables, and checking certain data values for valid ranges in the data entered.

Staff Usage and Training:

The Oil and Gas Data System is routinely accessed by seven of the eight staff in the Oil and Gas Section and nine of the 10 staff in the Geologic Data Section (which is the computer-services group in the agency).

Formal in-house training courses are conducted by the Geologic Data Section when needed. These courses include: "Introduction to VAX/VMS" (one-day), "Oil and Gas Data System" (four-days, hands-on), and "Introduction to DATATRIEVE Queries and Reporting" (half-day, with follow-up consulting).

Domain Descriptions:

A. Basic Well Data:

During this discussion, a particular well (Lincoln 2542) will be tracked through the basic data domains.

1.) OWNERS: In OWNERS, name of surface owner, farm number, company number (if available), and operator are stored. The formatted screen for modification of these data is shown in Figure 3; the screen for entry of these data is similar. There is one record per episode of drilling. The operator code is that of the company which was involved in the drilling episode; the Survey does not monitor the sale of wells or keep track of ownership changes. However, in another domain, PRODUCTION, the operator who reported production for a given year is stored, giving some handle on recent ownership.

This record is 61 bytes long, much of it in text fields for farm name and operator name. For a variety of reasons, both a text field and a code for the operator are maintained.

2.) LOCATIONS: Only one record per well is stored in the LOCATIONS domain, because the surface well location doesn't change. If revisions are submitted at a later time, the original LOCATIONS record is modified. The formatted screen for the modification of location data is shown in Figure 4; the screen for the entry of data is similar, with the well location plotted on the right side of the screen as a validation tool after data have been keyed-in, but before they have been stored. LOCATIONS contains the tax district, 7.5' and 15' quadrangles, and 7.5' and 15' locations in miles south and west of latitude and longitude. Universal Transverse Mercator coordinates are calculated from the latitude-longitude coordinates and also are stored in the system, transparent to the user.

Well coordinates are entered in a form of latitude and longitude that is easy for a person to measure and visualize; however, all subsequent processing and applications access the UTM coordinates, which are given in meters north of a baseline and east of a meridian on a rectangular grid. UTMs are used in all processing applications because they represent continuously increasing coordinate values in a single zone with no zonal boundaries bisecting the state; additionally, because they increase in the same direction (up and to the right) as plots do from the origin on the plotter, no reverse imaging procedures are necessary in the plotting software.

Within the FORTRAN program which manages the formatted screen for LOCATIONS, a validation is performed prior to storage of the data. The boundary coordinates of the quad and section are stored in an array in the program and are compared with those of the well, to ensure that a quad code that initially passes through the look-up table as a valid code is actually the quad within whose boundaries the well is situated. As a result, coordinates entered this way are fairly reliable.

3.) COMPLETIONS: Basic well-completion data are stored in the COMPLETIONS domain, with one record per episode of drilling. The formatted screen for the entry and modification of data in this domain is shown in Figure 5. These data include spud and completion dates, elevation and elevation type, field, initial and final classifications, well type, completion method, rig type, deepest formation, total depth, new footage, exploratory footage, IPs of gas and oil (both natural and after treatment), and rock pressure (natural or treated).

WVGES defines the "official" oil and gas fields in the State. Fields are not yet automatically delimited, but consideration is being given to how to accomplish this through a combination of graphics programs and an expert system.

A series of quarterly reports is produced for staff to use in monitoring current drilling activity in the State. Among these are summary reports for exploratory and development drilling by county, deepest formations penetrated by county, deepest pay formations by county, drilling by field and by well classification, and a summary by actual year completed (rather than the current year reported). In these times of limited new drilling activity, after a drilling boom in the early 1980s, the paperwork on older wells has been flowing in from the operators.

4.) STRATIGRAPHY: Efforts were made to optimize the STRATIGRAPHY domain because of the variability in the amount of data available from well to well. There is one record per stratigraphic unit, regardless of episode of drilling. The API number has been repeated for each of these records, but that is a small concession for accommodating the immense variability in the amount of data available per well. Figure 6 illustrates the formatted screen for the display of stratigraphic data. Entry, modification, and deletion of these data occur through additional screens embedded within this program and accessed from the menus at the bottom of this screen and elsewhere in this program.

Stratigraphic interpretations recorded in the system are those of Survey staff; that is, geologists interpret stratigraphic sequences from mechanical logs or verify/reinterpret stratigraphy reported on the driller's log.

For some wells, little of the stratigraphy described on a driller's log makes sense; for other wells, especially some fairly shallow wells, few stratigraphic units are identifiable. For wells like these, few (or no) records are stored in the STRATIGRAPHY domain. For wells with mechanical logs, and especially for basement tests, many units may be identifiable, resulting in as many as 30 records stored in order to adequately describe the stratigraphic section. The majority of wells have stratigraphy only from driller's logs, with an average of 10 to 12 units coded.

The modification screen shown in Figure 7 illustrates the detail stored in each record in this domain. These fields include datum and datum type (because they are occasionally different from the datum stored in the COMPLETIONS domain, and because stratigraphic tops interpreted from different sources are occasionally stored), formation code, depth from the surface datum to the top of the unit, and thickness of the unit; codes can be used to indicate the quality and source of the data. Because most of the contouring performed in the agency until recently was of structure maps on the top of a unit, or isopach maps, and because it was prudent to limit processing costs when using other computer systems to keep costs down, storage of tops and thicknesses of units resulted in the least amount of subsequent processing before mapping. The various types of maps currently produced and owning a plotter no longer make storage of these types of data such an important criterion in the structure of the data system. Because calculation of subsea depths or the calculation of the bottom of a formation for mapping that horizon is easily done within DATATRIEVE whenever needed, there is no compelling need to change the structure of the domain.

Alternatively, tops and bottoms of units could be stored for structure mapping, and thicknesses could be computed for isopach mapping. The formatted screen for entry of stratigraphic data contains an option for the entry of tops and bottoms, with the program calculating the thicknesses, which are then stored.

5.) <u>PAYS:</u> Like STRATIGRAPHY, records in the PAYS domain are among those which were optimized in design because of variability in the amount of data available from well to well. As a result, there is one record per pay or show interval or interval of activity, regardless of episode of drilling. The formatted screen for the display of PAYS data is shown in Figure 8.

While the Survey operated under its first two oil and gas data-base structures, it was unable to answer numerous questions which were received about storage intervals, intervals of injection, and, most importantly, the stratigraphic position and depths of shows of hydrocarbons. Survey staff were determined to resolve those inadequacies in the current structure.

Figure 9 illustrates the formatted screen for modifications in the PAYS domain; the screen for entry of data is similar. Data stored include activity and product codes for the pay/show/horizon of gas/oil/water/storage/salt water or brine/injection, the stratigraphic interval of the activity, the formation at the top and also at the bottom of the interval, and the natural and stimulated IPs (if known) for a specific interval. This structure permits the capture of data not only on completed (i.e., "pay") zones, but also on the position of shows of gas or oil, dry completion intervals (which are few in number and of general interest), storage intervals, intervals of injection or disposal of industrial waste, and the position of production of natural salt water and Salina salt brine. The PAYS domain now provides much more information than in the past, and this detail is being recorded for all current wells and all older wells which are part of current research projects. The only problem is the lack of time and personnel to systematically work on entering these new data fields for several thousand older wells.

The structure of this domain was recently modified to include formation codes for both the top and the bottom of an interval. With 1,000-foot (or more) completion intervals common in older as well as more recent Devonian shale wells, it became necessary to discriminate the formations completed through such a large interval.

6.) <u>OGWATER:</u> This domain is similar in design to PAYS and STRATIGRAPHY, with one record per occurrence of water encountered in the drilling process, regardless of episode of drilling. Entered are the type of water (essentially, "fresh" versus "salt"), the depth from the surface datum of the well to the top of the water, and a now-unused field for quantity of water in bailers. There is a formatted screen for this domain, also, although it is not shown here.

B. Subsidiary Well Data:

1.) PLUG: Among the fields recorded in this subsidiary file on the plugging of a well are the plugging date, the depth to which the well was plugged (generally zero in the case of a plugging and abandonment), and the year the plugging was reported to the State. Various summary reports are produced by crossing this information with certain data from the basic data domains.

2.) MECHANICAL LOG CATALOG: Known within the agency as MLC, this domain contains data on over 12,000 wells with mechanical logs on file at the Survey. Log traces are not currently digitized, but that is being considered for future work in log analysis.

MLC is the first domain for which a split formatted screen (Figure 10) was developed. MLC-specific data appear on the left, and data extracted from other basic data domains appear on the right. As the well number is entered on the top line on the left, the program retrieves and displays certain data from OWNERS, LOCATIONS, COMPLETIONS, and WELL SAMPLE CATALOG (WSC - which will be discussed next), for comparing the data that appear on the log with the data stored in the basic data domains. Data unique to MLC include the available range of intervals logged, the deepest formation logged, the types of logs available, the microfilm roll number(s) on which logs for this well appear, and comments (which definitely are needed in this domain).

A related domain, MLC-BYFARM, was devised for those pre-1929 wells for which logs are available but for which no permit numbers exist. These wells could not be entered into the main data files, because they do not have permit numbers by which the data are indexed. This related domain, then, contains the MLC-specific data plus all of the basic well data needed for the publication. Recent efforts to establish artificial numbering schemes for these wells are mentioned later in this paper.

MLC and WSC are the only two domains which contain comments fields, and the only two in which they are really needed. There are plans for several major enhancements to the MLC domain in the future, including digitization of log traces and providing greater detail about each specific log. However, the file will be published before any further organizational or compositional changes are made. For the publication, data from several of the basic data domains and also from WSC are retrieved into a program which sorts the data by permit number, translates all of the codes, and formats all of the data in a listing.

3.) WELL SAMPLE CATALOG: Known in the agency as WSC, this companion file to MLC was computerized and published 10 years ago, but little work on updating it has been done until recently. WSC now contains information on approximately 4,000 wells with samples and cores in the Survey's sample library.

Redesign of the WSC domain with a program for a split formatted screen similar to that for MLC has recently been completed. In the process, several changes were made to the data structure for this domain. It now resembles MLC and contains only the unique information on the intervals of the samples or cores. WSC will be published in a style similar to that of MLC.

4.) OG1 (PERMIT APPLICATIONS): This domain grew out of the continuous requests from the public for information on forecasting drilling trends in the State. Well-completion records, often filed months or years after the fact, are not useful in forecasting in the short term. When a staff member foresaw the use of information on the previously unexamined permit application forms (formerly known as form number "OG1" in this State) to meet these requests, this domain was created.

Unique data captured in this record include an operator code, projected target formation, projected depth, and projected well type (this filed only for injection wells), along with other miscellaneous data. Among the quarterly cumulative reports generated each year are summaries by operator within county, by target formation within county, and by county and permit number. An increase in permitting activity for Devonian shale targets in northwestern West Virginia in 1980 and 1981 that was shown in these reports helped staff see the beginning of an exploratory boom in that area and enabled them to prepare preliminary information as they began to be deluged with requests for information from all over the country.

A secondary domain related to this one contains operators' addresses as they appear on the permit applications. These current addresses are not used by the Oil and Gas Section per se, but are captured nonetheless on a second embedded formatted screen for OG1 and are utilized directly with OG1 data for the generation of the oil and gas portion of the agency's annual "Mineral Producers and Processors Directory."

5.) PRODUCTION: The PRODUCTION domain has evolved continuously over the past six years and by now has become probably the least-efficient of the data structures in the system. The monthly or annual gas and/or oil volumes and monthly or annual days-on-line that were obtained from a variety of sources contain exceptions to every rule that was established for this domain.

Some cooperative effort has occurred among the WVDOE, OGCC, and WVGES on the entry of well-specific annual production data. Each agency has been working on the entry of specific years of data from paper records and computer-readable media and is sharing the resulting computer files as they are completed.

The formatted screen shown in Figure 11 is the second screen for this domain. The first screen summarizes the data available for a well by year, listing annual volumes and days-on-line, similar to the screen for the display of data in the PAYS and STRATIGRAPHY domains. This second screen illustrates the detail contained in the record, along with a well-status code to qualify the data.

Aside from the large amount of production that may be unreported by some operators, the biggest problem with this domain is the ambiguity of the data provided, especially where production data from multiple wells are recorded on the same meter. A few operators provide information about metering, but most do not. The effect of this is probably an over-inflation of the volumes reported, with the same large volume listed for each well on the meter. Sometimes this is noticed by staff, many times not.

6.) GRI COMPLETION-BY-STAGE: This domain, used in research currently supported by the Gas Research Institute, was designed to provide detailed information on each stage of completion in a well penetrating the Devonian shales. Among the detail stored in this record are completed interval, rock pressures before and after stimulation, IPs before and after stimulation, and stratigraphic zones completed. One record is completed for each stage of well completion.

Previously, this record contained far more detailed information on the completion episode per se: amounts and types of solids and fluids used, the various pressures recorded, length of shut-in, etc. However, because there seemed to be little interest among operators cooperating with GRI in the Appalachian Basin in the detail available in this record, and because the detail was very time-consuming to capture and interpret, the Survey has abandoned the detail for a summary version of the record.

Currently, these data are being entered only for wells completed in the Devonian shales. In the future, these data may be available for all wells drilled, regardless of completion target.

Important Organizational Factors:

The Survey's computerized Oil and Gas Data System is divided into two subdirectories, CURRENT and PAST. In the CURRENT subdirectory are data for well completions reported to the State during the current year. These completions must be less than five years old; otherwise, they are entered into the PAST subdirectory. All other wells from all previous years (or wells reported during the current year but with a completion date older than five years) are stored in the PAST subdirectory.

Within the PAST subdirectory, county data are organized into 10 "regions" (Figure 12), with each region consisting of two to 15 counties containing between 1,600 and 10,000 wells. The purpose of this subdivision into smaller groups of counties is to make sequential searches more efficient. This size is not too small to encumber us with too many regions and to make crossing of domains among the regions unwieldy when analyzing data on a regional scale, yet not too large to slow down queries and retrievals.

In defining each region, care was taken to combine contiguous counties with similar physiographic, stratigraphic, structural, and production characteristics into logical groupings. The largest geographic region consists of 15 counties covering the entire Valley and Ridge physiographic province of the State, with a total of approximately 1,600 wells. The smallest geographic region consists of two counties, containing approximately 7,500 wells.

Within each domain, files are indexed by permit number rather than county code. There are far more permit numbers than county codes within each region; therefore, the search is far more efficient, because a specific permit number/county code combination can be located far more quickly than a county/permit combination.

Data Utilization:

Most current applications and programs utilizing the Oil and Gas Data System are VAX-based. PC applications are data-base and graphics-oriented.

For various VAX applications, users write DATATRIEVE procedures which cross domains to extract the fields desired from each domain into subfiles. These subfiles then are used as input into other DATATRIEVE procedures, statistical programs, geostatistical programs, mapping software, or FORTRAN programs.

For either the production of reports of basic data or for the input of data into other application programs, data are accessed through DATATRIEVE queries and procedures or FORTRAN programs written to retrieve and format basic data. Among the standard reports produced in the agency are: nine tables describing quarterly cumulative drilling summaries for currently reported well completions, five tables describing permit applications (including summaries of operator activity and target formations), and several other reports generated routinely in the data-entry and data-editing tasks. Also, staff routinely write procedures for specific retrievals and reports for use in their own work.

Retrievals for service requests for the public are still customized, although that policy is in a state of flux. DATATRIEVE procedures and FORTRAN programs are written to extract the specific data requested and to format the data into computer-processible files on magnetic tape or floppy diskette or into formatted listings.

For mapping, subfiles are created for input into SURFACE-II or locally written kriging programs. Standard well postings by well type, isoline, isopach, and structure-contour maps are produced via SURFACE-II, with pre-processor programs which call in files of digitized county outlines and files containing quad boundaries. Locally written kriging programs are used to generate maps of kriged estimates of initial potential of gas, cumulative production of gas, structure, thickness, and probability of IP greater than specified values (e.g., 100 MCF, or 1,000 MCF).

Other applications include analysis of production data and the generation of production-decline curves, stratigraphic correlation via graphics programs, estimation of stratigraphic tops in driller's logs, and formatting data for publication ("Mechanical Log Catalog", "Well Sample Catalog", "Mineral Producers and Processors Directory", etc.).

Research Activities:

Recent contracts with the Gas Research Institute of Chicago, Illinois, have supported research into the development of a stratigraphic framework for the Devonian shales in the State (and the Appalachian Basin) and the analysis of the relationship between Devonian shale stratigraphy, completion methods, and production in this State (and others in the Basin). Better understanding of the stratigraphic framework of the 3,000- to 7,000-foot-thick wedge of Devonian shales in the State and the relationships between stratigraphy and completion methods and between stratigraphy and production will provide operators with information to more efficiently complete smaller intervals within the shale sequence and at reduced well-completion costs.

These projects are a cooperative effort of the Oil and Gas and Geologic Data Sections at the Survey and have resulted in the publication of three oil and gas reports and the presentation of several papers. Work in progress and scheduled to be completed in 1988 includes the production of oil and gas reports for three additional areas, regional maps of probability of drilling success in the Devonian shales, and an atlas of Devonian shale gas fields and pools showing contoured IPs.

This work stemmed from cooperative research of the two Sections in the early 1980s on the designation of tight sands in the State using computerized methods and subsequent work studying gas fields and pools using geostatistical methods. Other current research utilizing the Oil and Gas Data System and automated evaluation techniques includes evaluating gas IP and cumulative production in resource estimation, using conditional simulation for assessing risk from gas IP and production data in Devonian shales, and work on quantitative stratigraphic correlation.

The contracts with GRI also have driven the development of graphics software in the agency and investigations into the ways in which expert systems can be utilized to help geologists make better interpretations of the basic data. Figure 13 shows a menu of operations for a graphics system developed in-house that assists in estimating tops and thicknesses of Devonian shale units in the western part of the State. This system has application throughout the stratigraphic sequence, and extension of the algorithms both up and down the stratigraphic section is anticipated in the future.

In this example, Lincoln 2542 is a so-called "unknown" well in which Devonian-shale stratigraphy will be estimated from stratigraphy in the nearby wells which has already been interpreted from mechanical logs. The locations of the wells used in making the estimates are shown on the accompanying map on this screen. Declustering techniques have been employed to minimize the effect of clustering of wells. These programs can be run either interactively at a graphics terminal or in batch mode with graphic output printed on a Tektronix 4631 or 4695 copier or with estimated values printed on a line printer.

Figure 14 illustrates a cross section drawn through this area, with the stratigraphic sections of all of the mechanically logged wells and the estimated stratigraphy for Lincoln 2542; the estimated stratigraphy for the "unknown" well is repeated to the right of the cross section. The numbers on the left side of the isolated estimate are the stratigraphic codes for the units; the numbers on the right side are the estimated tops for those units. Geologists then compare these estimated tops with lithologic tops provided by the driller and choose the driller's tops closest to the estimates; the estimates themselves are not entered, but depths provided by the driller are interpreted with the aid of this technique and then entered into the system.

<u>Compatibility:</u>

The WVGES system was designed and written at the Survey to meet the information and research needs of that agency. It is a dynamic, evolving system. Inasmuch as it is distinctive because it is a function of local use, compatibility with other systems on a dynamic basis probably cannot be attained. With the Survey's ability to rewrite files or subfiles at will, however, data that represent a snapshot in time on the system can be copied to another system without much difficulty. The DATATRIEVE and dictionary structure have made it easy to write files to magnetic tape for use on other mainframes or to diskette for use on a PC with data-base-management software such as dBASE III PLUS.

SUMMARY EVALUATION OF THE WVGES SYSTEM

Problems:

The major problems encountered within the past few years with this DATATRIEVE-based system have been primarily software- or hardware-related and no longer are strictly a function of incomplete or unreliable data, as they were in the past. DATATRIEVE proved to be slow and awkward for data entry and data modification. It was imperative that these functions be moved to formatted screens written in FORTRAN to speed up this entire process.

Inadequate computing capacity was a continuing problem for a long time. However, recent disk and memory upgrades have reduced the impact of those problems. Also, the recent purchase of graphics terminals and PCs with color-graphics monitors have spread responsibilities (and facilities) for data management and data analysis out of the Geologic Data Section and further into the section with the greatest stake in the data.

Future hopes for some terminals/monitors with 19-inch screens, to permit simultaneous windowing of several domains onto the screen, remain on the horizon. Currently, except for aspects of Mechanical Log Catalog and Well Sample Catalog, multiple domains cannot be examined at the same time. Therefore, users must make a correction in one domain, move out of that screen and into another domain or another program altogether, and then make other related changes. It would be a luxury to have the ability to view several domains concurrently and to have the option to permit a correction in one to automatically trigger related corrections in other domains.

Other problems that have been encountered in an effort to maintain and manage an oil and gas information system are somewhat out of the control of this agency. It is constantly evident that a new well-completion form needs to be formulated by the WVDOE, Office of Oil and Gas, in order to make it more obvious to the operators what data need to be reported and how. The Survey's efforts to get such a modification in the form, even so far as twice designing new forms, have not been taken seriously.

In the Survey's system, the next major update will include a modification of the IPs in the COMPLETIONS domain, so that three volumes will be recorded: natural, after stimulation but before shut-in, and after stimulation after shut-in. Data recorded in these fields then will be less ambiguous. But a major problem then becomes how to correct data for the 65,000 older wells with some various interpretations already in the system. Another limitation that is being addressed is the current inability to analyze log traces. Staff are looking for software to manage both the digitization and the analysis of these data.

Because this entire system was written in-house, it is a series of constantly expanding, interrelated programs and procedures which are not currently integrated directly with any digitizing/mapping software. Some graphics routines are available but they are utilized as a separate step in the entire analysis process, outside the data-management realm.

Advantages:

The Survey's Oil and Gas Data System is fairly comprehensive and designed to capture much of the information available. Because of this, it is useful for a variety of research and information programs, not just currently active projects. It is flexible enough to handle the exceptions and was not just designed for the so-called "average" well (if there is such a thing).

Through the consistent use of formatted screens for entry and modification of data by the staff and fairly comprehensive data-validation programs, the creeping entry of "bad data" which had plagued the system for the first 14 years has been eliminated for the most part. Screens which contain menus to guide the users along, which provide on-the-spot verification and translation of codes, and which check the compatibility and validity of data have brought the Survey a long way from the extensive manual verification procedures that were used (or totally ignored) in the past into an era of far greater data reliability. Batch programs that are run after data entry provide additional checks in this entire procedure, as data are checked across domains for compatibility.

The interconnection of the subsidiary domains with the basic domains has provided far greater potential to utilize and analyze the data and greater capacity to edit the data by viewing a well in its totality rather than in an isolated record-by-record/domain-by-domain setting.

With an artificial internal numbering scheme, wells drilled prior to June 1929 which exist without permit numbers can now be accommodated within the computer system. Artificial numbering schemes have been devised for wells known only by farm name or by alphabetical (rather than numerical) permits, for pre-1929 abandoned wells, and for pre-1929 fractured wells. All of these wells can now be managed and processed in a comprehensive single series of files (domains) on a computer.

Probably the best part is that, because this entire system was generated internally, the source code for the programs and procedures that manage and analyze the data is available and can be modified as necessary. As a result, the system is dynamic and reflects the increasingly complex well analysis that the staff continue to perform; it is customized both to needs of the agency and the data which are available. The cost involved only the salaries of the staff who have worked on it for years. For an autonomous State agency constantly fighting budget battles, this was the ONLY way for the Survey to accomplish what has been done to date; no large allocations for commercial software packages have found their way into the agency's budgets over the past several years and probably never will. This shoestring budgeting has driven the Survey to develop an efficient and useful Oil and Gas Data System in-house.

FUTURE PLANS

Each of the agencies involved in the development and management of oil and gas data in the State has specific ideas about what the future should hold for their systems. The primary pitfalls faced by each of the agencies are inadequate funding to reach these goals in a meaningful time frame and too many wells with too few people to handle the work load.

The primary goal of the Oil and Gas Conservation Commission is to remove all of the bugs from their system (both software and data) in order to reach a position in which they will be able to analyze the available engineering data and adequately respond to requests for information from the public.

The WVDOE, Office of Oil and Gas, is attempting to automate data collection from the operators by encouraging electronic transfer of data directly into their system. Also of importance to them is the registration of all operators for the purpose of determining current well ownership. Their environmental division wants to obtain and manage information on produced fluids.

Staff at the Geological Survey are working on the application of expert systems into the routines for basic data entry and data evaluation, in order to improve the quality of the data which have been amassed and interpreted over the past two decades. As part of a cooperative project planned with the WVDOE, Survey staff will be working on the completion of the data base by gathering and interpreting data on the pre-1929 (i.e., non-permitted) wells. Through this project, maps of truly abandoned (i.e., not currently producing and not formally abandoned/plugged) wells will be generated for WVDOE's area reviews of UIC permits and to provide direction in their continuing effort to identify and plug these wells. Additional work at the Survey is being considered in petrophysical-log analysis and expansion of previous work analyzing fields and pools.

Geological Survey staff also are reassessing the agency's policy for providing basic well data in computer-processible form to the public. Among the options being considered are: (1) providing data for oil-and-gas-related publications in ASCII files on floppy diskettes optionally available to the purchaser, and (2) no longer customizing data requests, but selling selected sets of information in a fixed format. Additionally, Survey staff are considering the development of a menu-driven program for use by the public for the retrieval of basic data at our site.

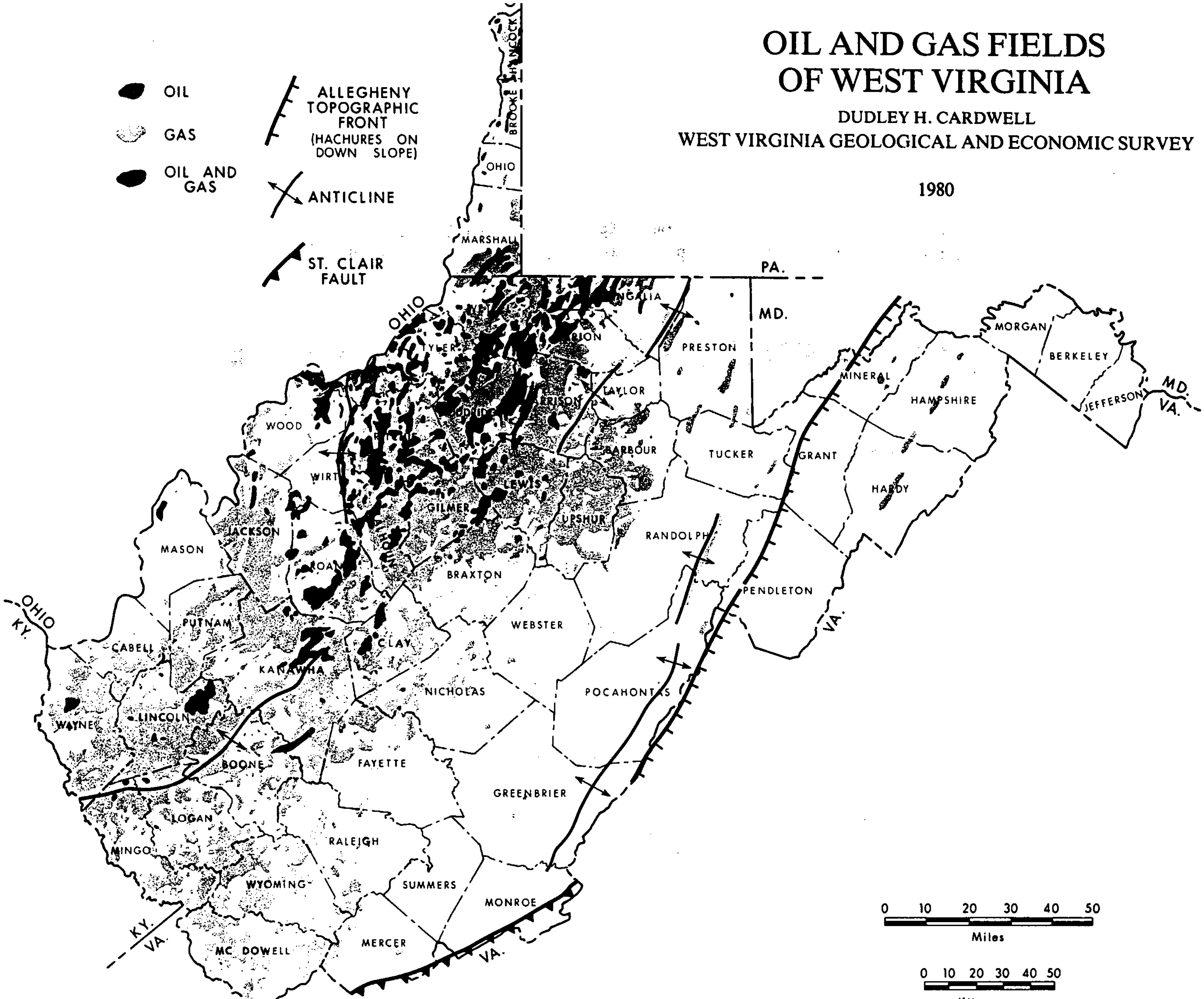


Figure 1. Oil and Gas Fields Map of West Virginia.

```
WVGES OIL AND GAS FORMATTED SCREEN
            MAIN MENU

1 COMPLETIONS screen
2 LOCATIONS screen
3 OWNERS screen
4 PAYS screen
5 STRATIGRAPHY screen
6 OGWATER screen
7 PLUGGINGS screen
8 MLC screen
0 WSC screen
9 Exit

Select the formatted screen you wish to use:
```

Figure 2. Main menu for accessing formatted screens for most domains in the WVGES Oil and Gas System.

OWNERS MODIFICATION

01) COUNTY 043   02) PERMIT 2542   03) SUFFIX 0

04) COMPLETION DATE:03/25/1982

05) STATUS C Completed

06) FARM NAME J C Cartwright 1

07) OPERATOR CODE 0518

08) OPERATOR Lincoln Prod

ANY MISTAKES (Y/N)? _

Figure 3. Formatted screen for modification of OWNERS data.

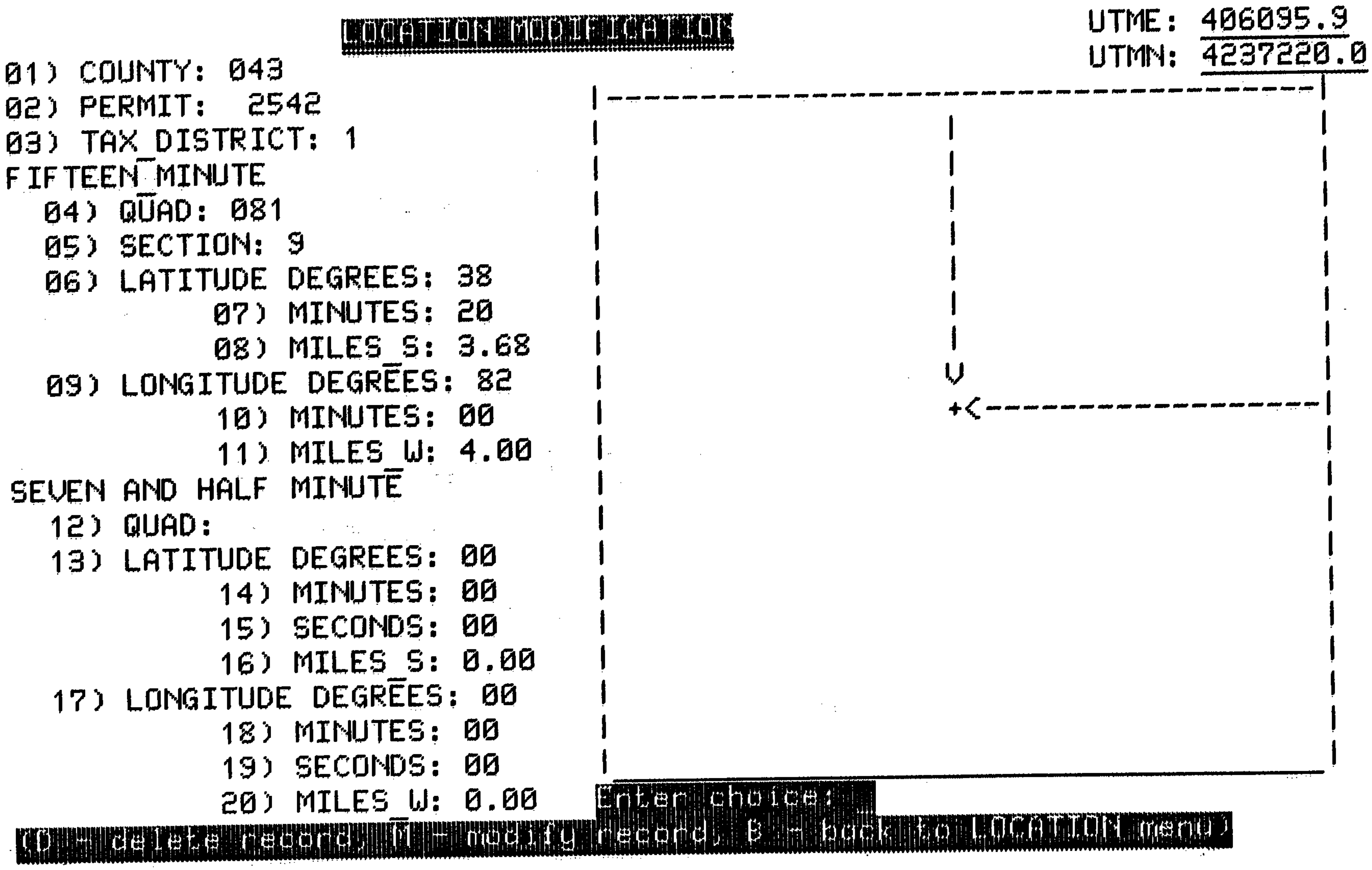


Figure 4. Formatted screen for modification of LOCATIONS data.

```
01) COUNTY: 043   02) PERMIT:  2542  03) SUFFIX: 0  04) YEAR_REPORTED: 1983

CLASSIFICATION:  05) INITIAL: 6   06) FINAL: 6   07) FIELD: 209

08) ELEVATION: 0675  09) ELEVATION TYPE: G  10) SPUD DATE: 02/09/1982(M/D/Y)

11) LEASE TYPE: 1   12) RIG TYPE: 3         13) COMP DATE: 03/25/1982(M/D/Y)

OPEN FLOW:                      GAS:                               OIL:
               14) BEFORE TREATMENT: 000160   15) BEFORE TREATMENT: 0000
               16) AFTER TREATMENT: 000103    17) AFTER TREATMENT: 0000

ROCK PRESSURE:  18) NATURAL: 0000   19) TIME (NATURAL, IN HOURS): 000
                20) TREATED: 0000   21) TIME (TREATED, IN HOURS): 000

22) EST ULT YLD: _   23) BATCH DATE: __/__/1983(M/D/Y)    24) WELL TYPE: 1

25) COMPLETION METHOD: 5   26) TOTAL DEPTH: 03774   27) NEW FOOTAGE: 03774

28) EXPLORATORY FOOTAGE: 00000   29) DEEPEST FM ENCOUNTERED: 830

ANY MISTAKES (Y/N)? _
```

Figure 5. Formatted screen for entry and modification of COMPLETIONS data. There is no title on the screen because the data fields fill the screen.

STRATIGRAPHY UNITS for COUNTY = 043 PERMIT = 2542

RECORD	SUF-	FORMATION		DEPTH TO TOP		THICKNESS		DATUM	
NO.	FIX	CODE	QUAL	FEET	QUAL	FEET	QUAL	ELEV	TYPE
1	0	340		1295		192		678	D
2	0	345		1295		192		678	D
3	0	375		1487		15		678	D
4	0	383		1502		43		678	D
5	0	394		1979		20		678	D
6	0	395		2006	E	22	E	678	D
7	0	404		2026	E	1020	E	678	D
8	0	813		3046	E	326	E	678	D
9	0	822		3372	E	122	E	678	D
10	0	825		3494	E	177	E	678	D
11	0	830		3671	E	0		678	D

Enter choice _
D - delete record M - modify record S - store new record
C - change to brief screen B - back to STRAT menu

Figure 6. Formatted screen for the display of STRATIGRAPHY data.

```
                  STRATIGRAPHY MODIFICATION

ID:  01) COUNTY 043     02) PERMIT  2542    03) SUFFIX O

04) ELEVATION OF DATUM  678   05) TYPE OF DATUM D
                                  (Derrick Flr)
06) FORMATION CODE 813        09) QUALITY CODE
    (Lower Huron)                 (Driller's Pick)
07) DEPTH TO TOP  3046        10) QUALITY CODE E
                                  (INVALID CODE)
08) THICKNESS   326           11) QUALITY CODE E
                                  (INVALID CODE)



ANY MISTAKES (Y/N)? _
```

Figure 7. Formatted screen for the modification of STRATIGRAPHY data.

PAYS records for COUNTY = 043 PERMIT = 2542

REC. NO.	CNTY	PERMIT	SUF-FIX	COMP DATE	ACT	PROD	TOP	PFT	BOTTOM	PFB	BEFORE	AFTER
1	043	2542	0	03/25/1982	N		0		1468	345	0	0
2	043	2542	0	03/25/1982	N		0		3290	813	0	0
3	043	2542	0	03/25/1982	N		0		3305	813	0	0
4	043	2542	0	03/25/1982	G	2	2800	404	3773	830	160	103

Enter choice M   Enter record number 4

D - delete record   M - modify record

C - change to brief screen   B - back to PAYS menu

Figure 8. Formatted screen for the display of PAYS data.

```
                      PAYS MODIFICATION

ID:

01) COUNTY 043      02) PERMIT  2542    03) SUFFIX 0

04) COMPLETION DATE 03/25/1982(MM/DD/YYYY)

05) ACTIVITY G                          06) PRODUCT 2

07) DEPTH TO TOP     2800               08) PAY FORMATION TOP 404 .
                                            (Total Green-grey Shale)
09) DEPTH TO BOTTOM  3773               10) PAY FORMATION BOTTOM 830
                                            (Black Shale (Rhinestreet))
11) VOLUME BEFORE TREATMENT    160      12) VOLUME AFTER  TREATMENT    103

ANY MISTAKES (Y/N)? _
```

Figure 9. Formatted screen for the modification of PAYS data.

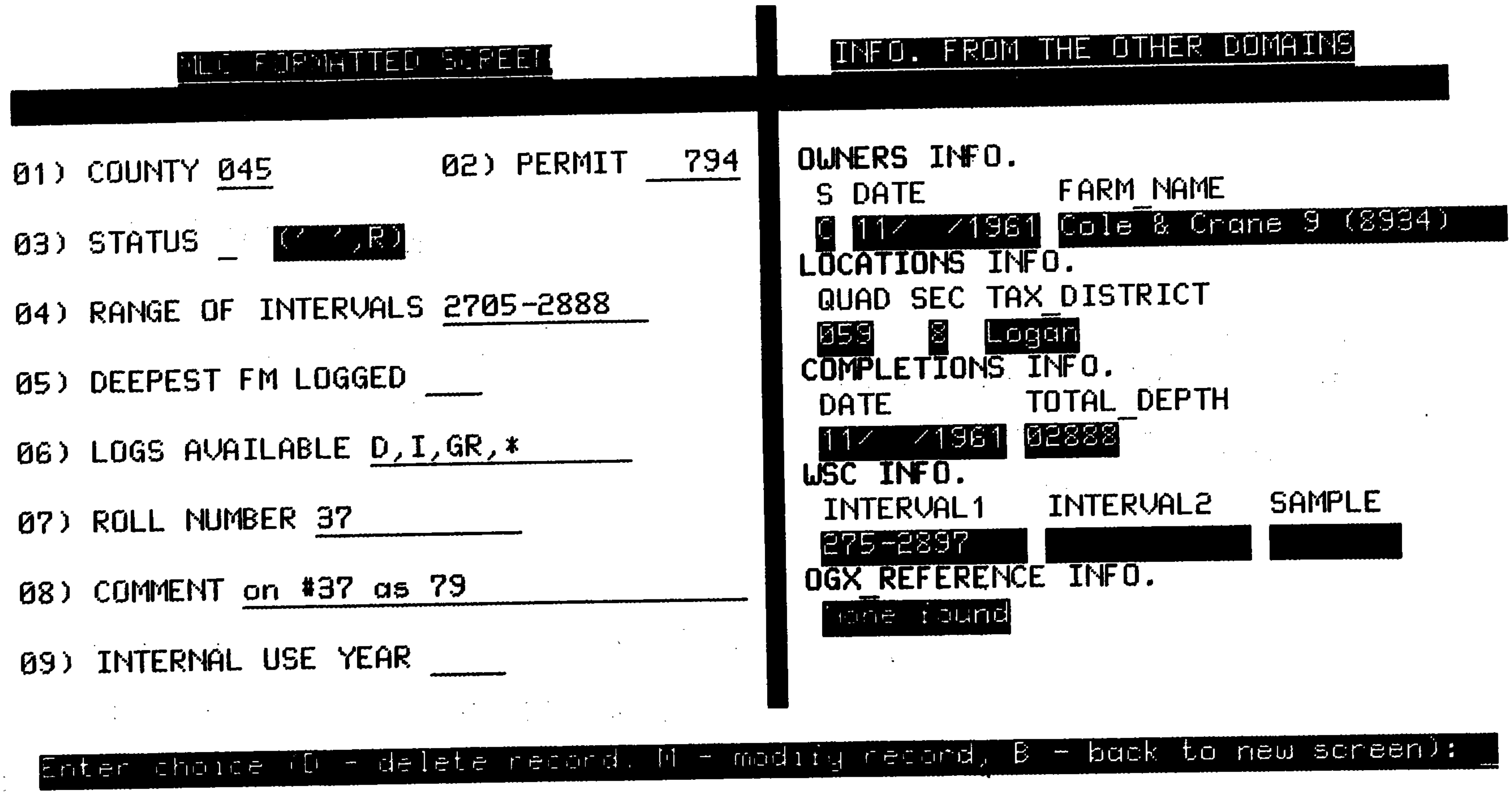


Figure 10. Formatted screen for entry and modification of MECHANICAL LOG CATALOG data.

```
                    PRODUCTION MODIFICATION

ID:    01) COUNTY 061          02) PERMIT   332
INFO:  03) YEAR 1981           04) OPERATOR 0179        05) WELL STATUS _

       06) FLOW PRESSURE    0       07) SHUT IN PRESSURE    0

  ANNUAL:
       08) DAYS ON LINE   0    09) GAS   24203          10) OIL       0
  MONTHLY:
       11) D_JAN ?             23) G_JAN  2052          35) O_JAN      0
       12) D_FEB ?             24) G_FEB  1082          36) O_FEB      0
       13) D_MAR ?             25) G_MAR  3700          37) O_MAR      0
       14) D_APR ?             26) G_APR  2506          38) O_APR      0
       15) D_MAY ?             27) G_MAY     0          39) O_MAY      0
       16) D_JUN ?             28) G_JUN  3885          40) O_JUN      0
       17) D_JUL ?             29) G_JUL  3640          41) O_JUL      0
       18) D_AUG ?             30) G_AUG  2767          42) O_AUG      0
       19) D_SEP ?             31) G_SEP  1720          43) O_SEP      0
       20) D_OCT ?             32) G_OCT     0          44) O_OCT      0
       21) D_NOV ?             33) G_NOV     0          45) O_NOV      0
       22) D_DEC ?             34) G_DEC  2851          46) O_DEC      0
 ANY MISTAKES (Y/N)? _
```

Figure 11. Formatted screen for the modification of PRODUCTION data.

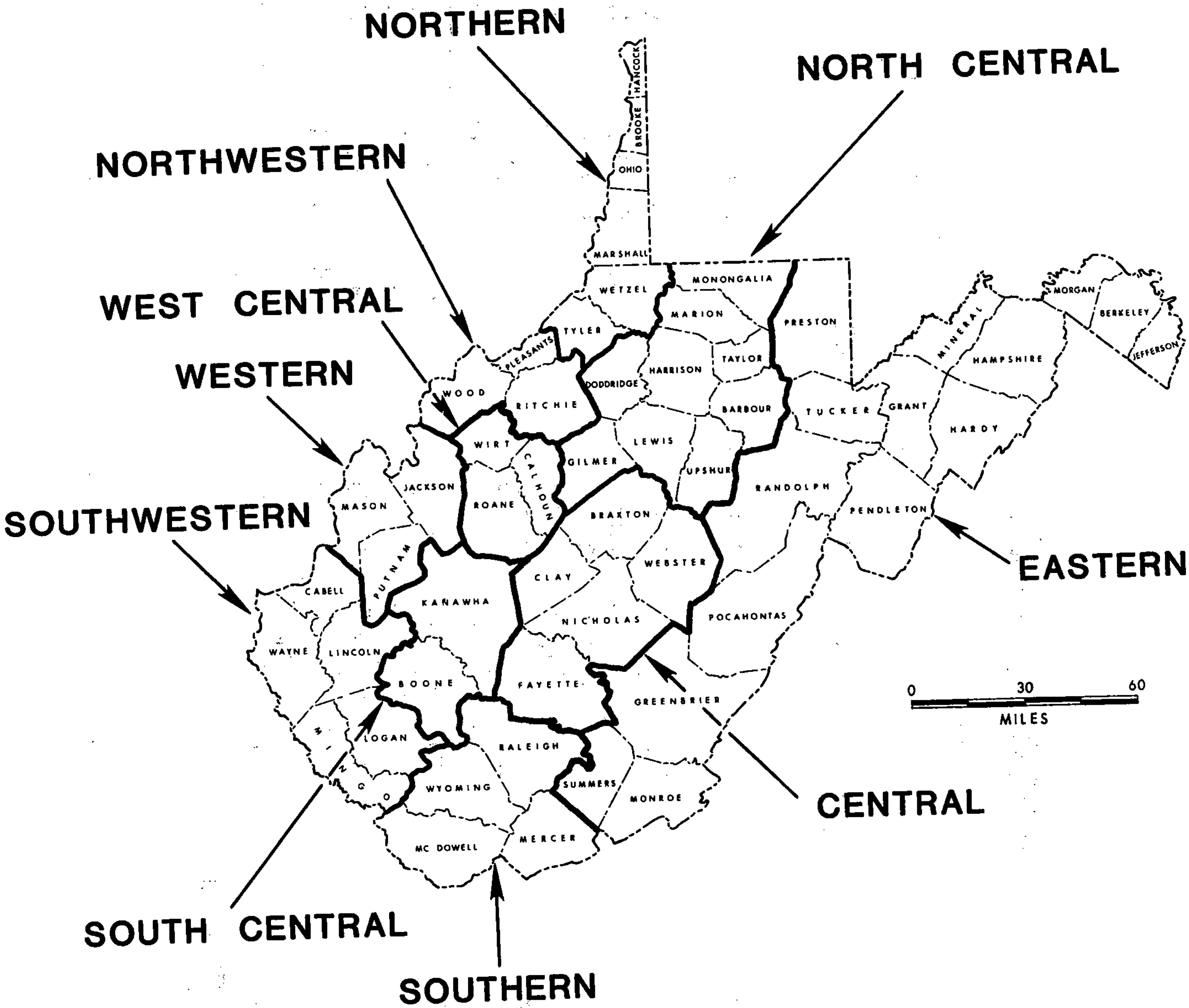


Figure 12. WVGES Oil and Gas Sys

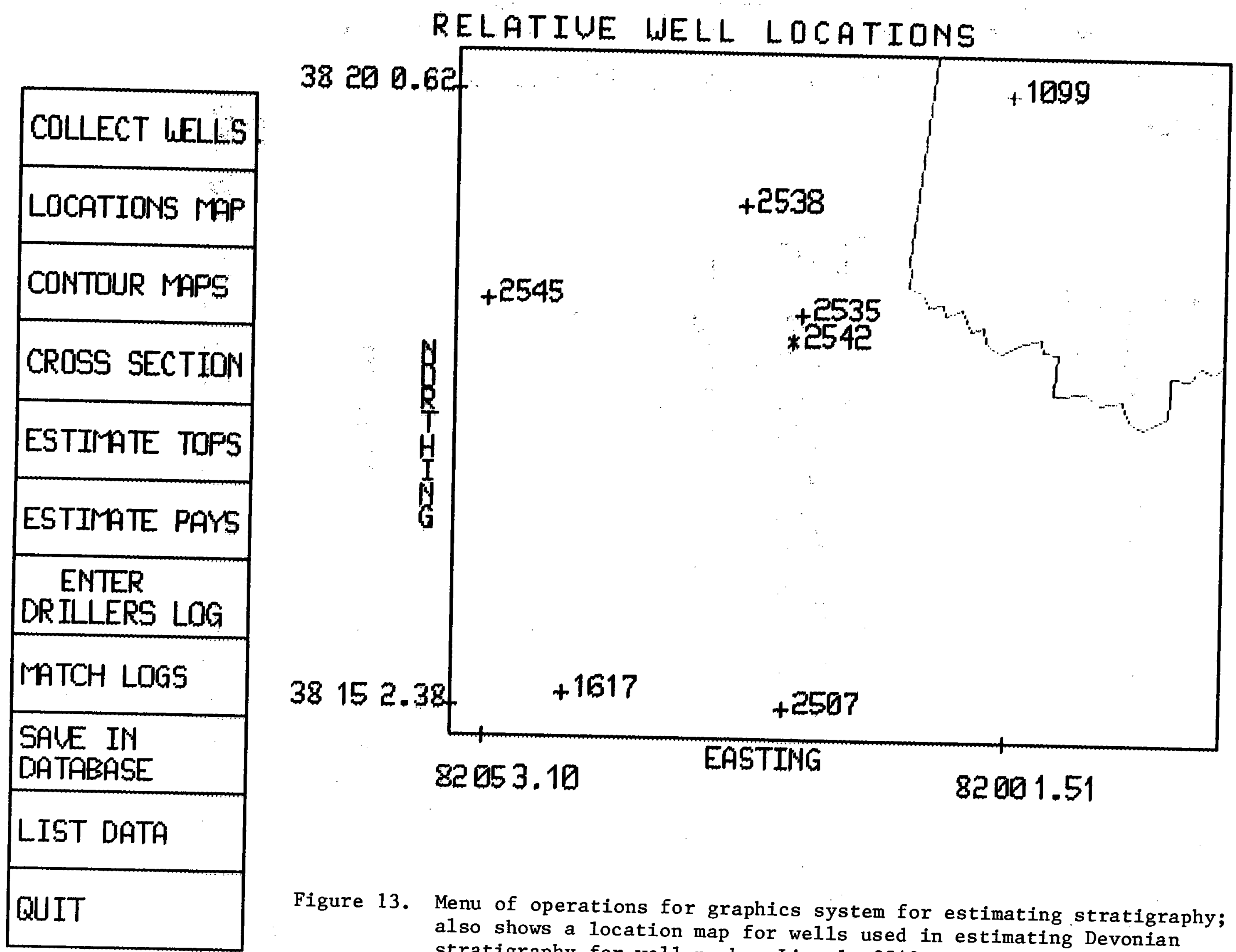


Figure 13. Menu of operations for graphics system for estimating stratigraphy; also shows a location map for wells used in estimating Devonian stratigraphy for well number Lincoln 2542. See also Figure 14.

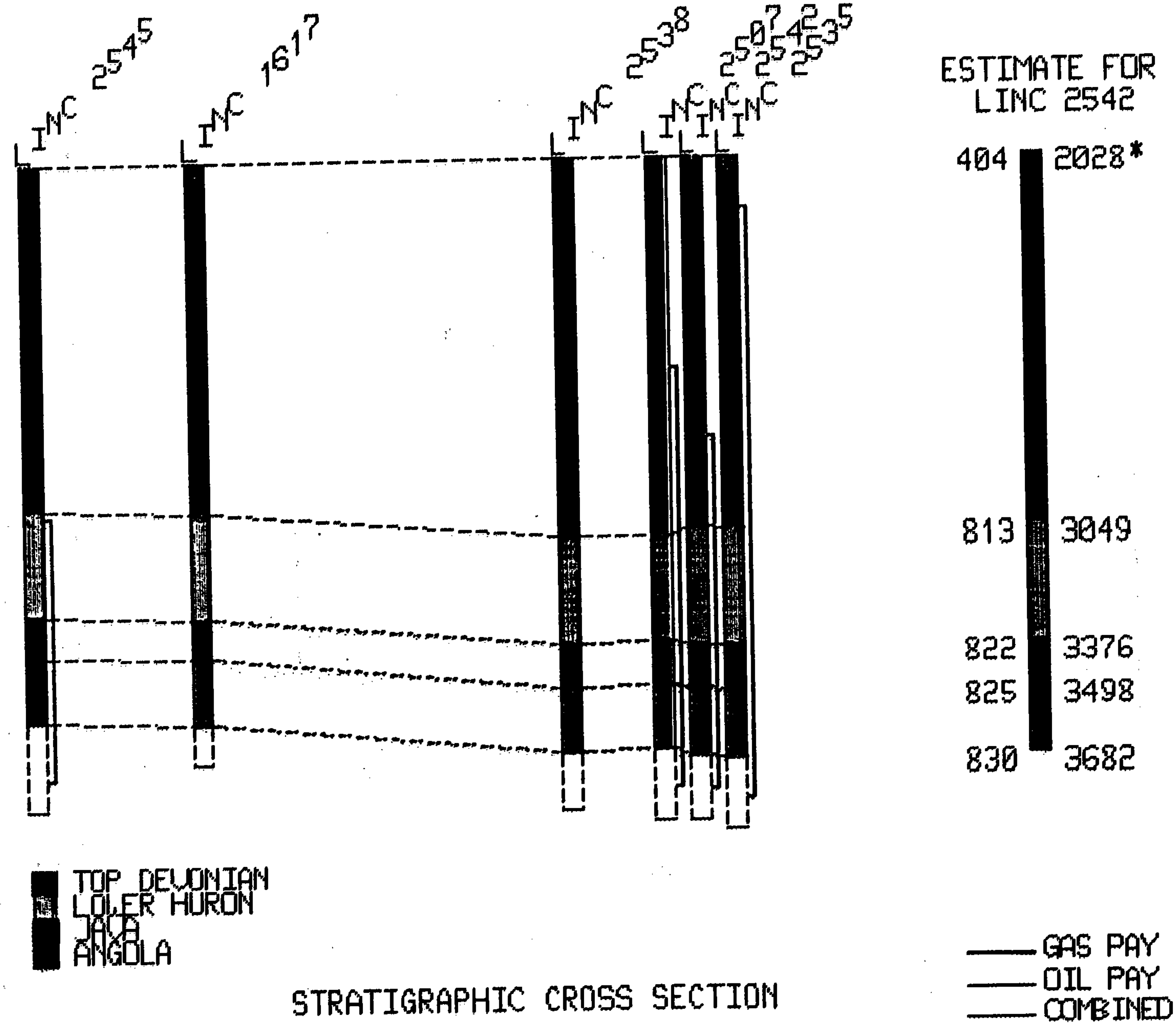


Figure 14. Cross section of Devonian shale correlations, for wells shown on map in Figure 13. Section on the right shows the estimated stratigraphic sequence for Lincoln 2542, with stratigraphic codes on the left side and estimated tops on the right side.

OIL AND GAS INFORMATION SYSTEMS IN WYOMING

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Geological Survey of Wyoming

A discussion of Wyoming's efforts to computerize oil and gas information should include an explanation of the way the State system of data processing is organized (Figure 1). The Data Services Division of the Department of Administration and Fiscal Control is responsible for approving access to the State's IBM 3090 mainframe computer. Data Services also provides programmers and operators for the mainframe computer. In addition, all personal computers, other hardware, and software requested by a State agency must be approved and purchased by Data Services. Presently most of the State's hardware and software are IBM or IBM-compatible.

The Geological Survey of Wyoming, the Royalty Division of Public Lands, the Oil and Gas Conservation Commission, and the Ad Valorem Tax and the Mineral Severance Tax Divisions of Revenue and Taxation are all presently working with computerized oil and gas information. The Geological Survey, Royalty Division of Public Lands, and the Oil and Gas Conservation Commission are using IBM personal computers and dBase III or dBase III Plus software for a large share of the work they are doing. The Oil and Gas Conservation Commission, Ad Valorem Tax Division, and Mineral Severance Tax Division all use the IBM mainframe computer for their large data bases.

Current activity in Wyoming with respect to the collection, management, and utilization of oil and gas information is focused on production data and on revenue to the State generated by that production. Production statistics for 1986 show that 122.4 million barrels of oil and 587 billion cubic feet of gas were produced from 15,480 wells in 982 fields (Wyoming Oil and Gas Conservation Commission, 1987a). Revenue is collected in the form of ad valorem taxes, State severance taxes, and royalties. The 1986 valuation on mineral production of $5.5 billion was approximately 70 percent of the State's total valuation (Department of Revenue and Taxation Ad Valorem Tax Division, 1986). In 1986, the oil and gas industry paid $271 million in ad valorem production taxes, $138 million in State severance taxes, and $40 million in State royalties and rentals.

One of the major concerns of the State at the present time is that the budget for a biennium does not exceed available funds. The Revenue Estimating Group was formed four years ago in an attempt to develop projections of General Fund revenue which could be used by the Legislature and the Governor. Severance taxes on mineral production contribute between 20 percent and 30 percent of total revenue to the General Fund. Severance taxes on oil and gas production contribute over 50 percent of the total severance taxes that are collected. The Geological Survey of Wyoming, the Wyoming Oil and Gas Conservation Commission, and the Ad Valorem Tax Division of Revenue and Taxation are responsible for predicting oil and gas production and prices for the Revenue Estimating Group.

Since the Geological Survey is one agency responsible for projecting oil and gas production and average yearly prices, there is an ongoing effort to enter and update historical and current production figures for all fields in the State. The production information for each field along with the discovery date and geographical location for the field is entered into a dBase III Plus file. By using the information in this file, production from fields discovered in a particular year can be related to rig count, number of wildcat wells, and total completions in that year, as well as to the amount of production those discoveries contribute to present production. In recent years, the Legislature passed a number of bills which gave severance-tax breaks to oil and gas producers. These bills provide a broader definition of "stripper" production, reduce severance taxes on tertiary production, and cut severance taxes on production from wildcat wells drilled and completed between January 1, 1987, and December 31, 1989. These bills all have the effect of reducing severance taxes that go into the General Fund. Therefore, it is important to predict the amount of production affected by these bills, especially as older fields become "stripper" or tertiary producers.

A service provided by the Geological Survey for the Public Land Commissioner is the evaluation of State-owned land eligible for competitive-bid lease sales. Between 300 and 500 tracts are evaluated every two months. The tracts with the highest ratings are selected by the Public Land Commissioner's office, and 200 tracts are auctioned off bimonthly. This service helps to maximize income to the State in the form of bonus bids and yearly rentals. By exposing the best parcels of land to the oil and gas industry, the State is also likely to realize more royalty, severance tax, and ad valorem tax revenues on production from these leases.

All parcels of State land rated by the Geological Survey have been entered into a dBase III Plus file. The file currently contains 7,500 records (Figure 2) and is updated six times a year.

The Wyoming Oil and Gas Conservation Commission keeps monthly production statistics on the State's IBM 3090 mainframe computer. Monthly production for all oil and gas wells in the State is reported to the Commission on their Form 2. Yearly and cumulative totals of oil and gas production are published by the Commission. Total production is listed by field, by county, by operator, and by formation.

The Commission is currently downloading production data from the State's mainframe computer to disks. The data to be used in various projects are then transferred to dBase III Plus files with an IBM personal computer. A decline-curve study on the 20 largest oil fields in the State was just completed. These 20 largest fields presently account for 55 percent of all oil production. Decline curves are also being plotted for fields which produce oil from the Minnelusa Formation. The Minnelusa Formation accounted for 15.6 percent of 1986 oil production (Wyoming Oil and Gas Conservation Commission, 1987b) and is a prime candidate for tertiary recovery projects. After the Minnelusa study is completed, decline curves will be plotted for fields which produce oil from other formations. Production from gas plants is also being entered into a data base so gas production at the wellhead can be reconciled with taxable-gas-production totals. Other data entered on the Commission's personal computers are Federal drilling units, applications for permit to drill, spacing orders, and seismic permits.

Much of the activity in computerization of oil and gas information by the Commission is related to their predictions for oil and gas production and to matters which come before the Commission at their monthly hearings.

The Royalty Division of Public Lands uses an IBM personal computer and an accounting program in dBase III to monitor State royalty payments. The Royalty Division has plans to access the Oil and Gas Conservation Commission's production data base to verify that the correct royalties are being paid.

The Ad Valorem Tax Division of Revenue and Taxation monitors the operators and the taxable production for each well in the State. Ad Valorem credits tax payments to the correct tax district. They also calculate total taxable oil and gas production and the average price of that production. These figures are then used to predict taxable production and price.

The Mineral Severance Tax Division of Revenue and Taxation tabulates severance tax payments by individual operators. They use Ad Valorem's data to verify that the correct amount of severance tax has been paid by each operator.

References Cited

Department of Revenue and Taxation Ad Valorem Tax Division, 1986, Annual Report: Department of Revenue and Taxation Ad Valorem Tax Division, Cheyenne, Wyoming, 232 p.

Wyoming Oil and Gas Conservation Commission, 1987a, Wyoming oil and gas statistics 1986: Wyoming Oil and Gas Conservation Commission, Casper, Wyoming, p. 1-87.

Wyoming Oil and Gas Conservation Commission, 1987b, Wyoming oil and gas 1986: Wyoming Oil and Gas Conservation Commission, Casper, Wyoming, 49 p.

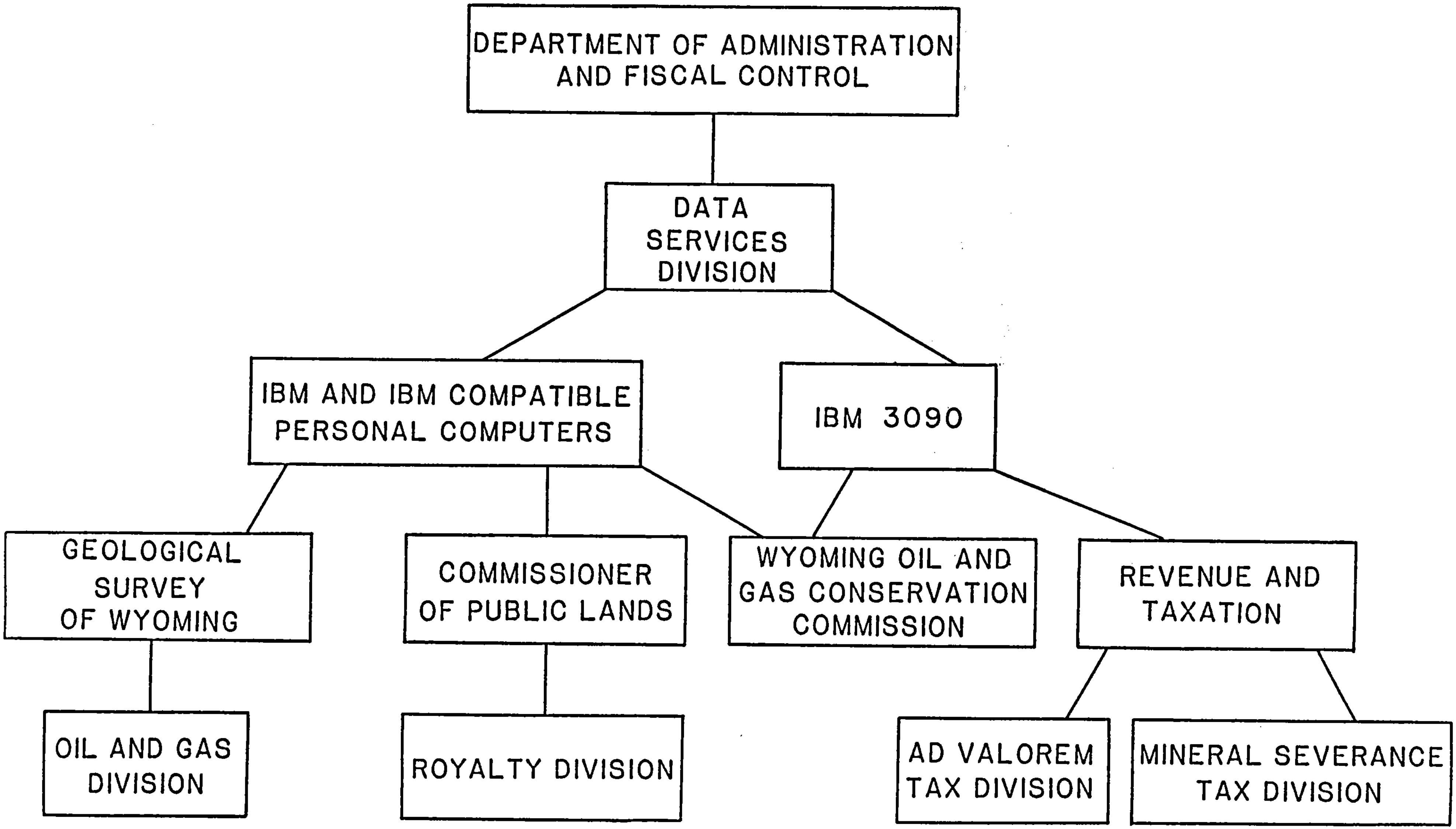

Figure 1. Generalized flow chart of Wyoming's data processing organization for oil and gas information.

LOCATION	RANK	COUNTY	AREA	DATE	FUND	COMMENTS
4407236	Excellent	Campbell	Powder River Basin	7/87	Common School	9/87 $50/acre Exxon

Figure 2. Typical record in dBase III Plus file for the Public Land Commissioner.