A FEASIBILITY STUDY FOR AN INFORMATION MANAGEMENT AND CARTOGRAPHY SERVICE FOR THE PETROLEUM EXPLORATION INDUSTRY IN DENVER, COLORADO.

by

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Scope and Method of Study: A telephone survey of exploration companies in the Denver, Colorado area was conducted to determine the degree of computer usage, how it varied between the majors and independents, and between on-site, remote and batch access to the computer using Chi-Square analysis.

Findings and Conclusions: A few companies have developed the technology to effectively use the computer in exploration, but a majority of companies only use the computer for land lease data and economic analysis in conjunction with the accounting department. The most significant differences are displayed by access to the computer, ranking Denver, Remote and Other. Some differences were also seen between major and independent oil producers.

Adviser's Approval ____________________

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Report Approved:

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INTRODUCTION

Oil price increases have accelerated the search for petroleum in almost every area of the world. Drilling activity has picked up in producing fields, but by far the greatest percentage increase has come in unexplored territory (Oil and Gas Journal Newsletter, December 10, 1979). The U.S. active rig count, a measure of industry activity, is at 2,669. This figure is a 23-year high and is up 35.8% from last year. (Hughes Tool Count, Week ending March 24, 1980).

Between now and the turn of the century, many of these rigs will be making hole for enhanced recovery which the Department of Energy believes will rise 300% by 1990. (Oil and Gas Journal Newsletter, March 24, 1980).

Another measure of activity is the seismic crew count compiled by the Society of Exploration Geophysicists. The latest available count is for November, 1979, which shows a 19% increase over November 1978. Seismic activity in the U.S. more than doubled since 1970. (Geophysics, March, 1980).

Petroleum exploration has been likened to a sampling problem without replacement. Every time a new field is discovered, the population yet to be found decreases by one. The remaining fields continue to get smaller, deeper, stratigraphically and structurally more complex, and geographically located in more remote areas such as the overthrust in

Wyoming, the North Slope in Alaska, the Arctic Ocean, and the North Sea.

Society has also made it tougher to find oil through legislation such as the Environmental Protection Act, the Wilderness Lands Bill, the Windfall Profits Tax, and the Outer Continental Shelf Act. Also included here could be the demand for a corporate social conscience, the easy access to the courts to delay projects, the acceptance of absolute liability, and the burgeoning permit process.

All of these factors combined, demanding and resulting in a greater quantity, higher quality, and more diverse data which must be integrated into the exploration decision making process.

To intensify the problem, the oil industry is faced by a shortage of earth scientists. An employee turnover study by Rath & Strong, Inc. for the Conoco Exploration Department documented this problem.

In the mid-sixties and early seventies, there was an abundant supply of cheap foreign oil and the domestic industry was saddled with price controls which resulted in a de-emphasis on domestic exploration and a cut back in manpower and hiring.

Then in the mid- to late seventies, the price of foreign oil began to increase rapidly and supply became less stable. This resulted in an easing of restrictions on domestic production. In the ensuing expansion, aggressive independents "pirated" experienced personnel from the major oil companies. For Conoco domestic exploration, this resulted in the staffing patterns of many long and short-term employees with few mid-range experienced personnel. See figure one.

Given this environment, the company I propose, Petro-Land Information Systems, would assist the explorationist by collecting, storing, categorizing, manipulating, retrieving, and displaying data. In short, an exploration information management system. Properly utilized, this system would give the explorationist data in a more interpretable form, saving him time and effort.

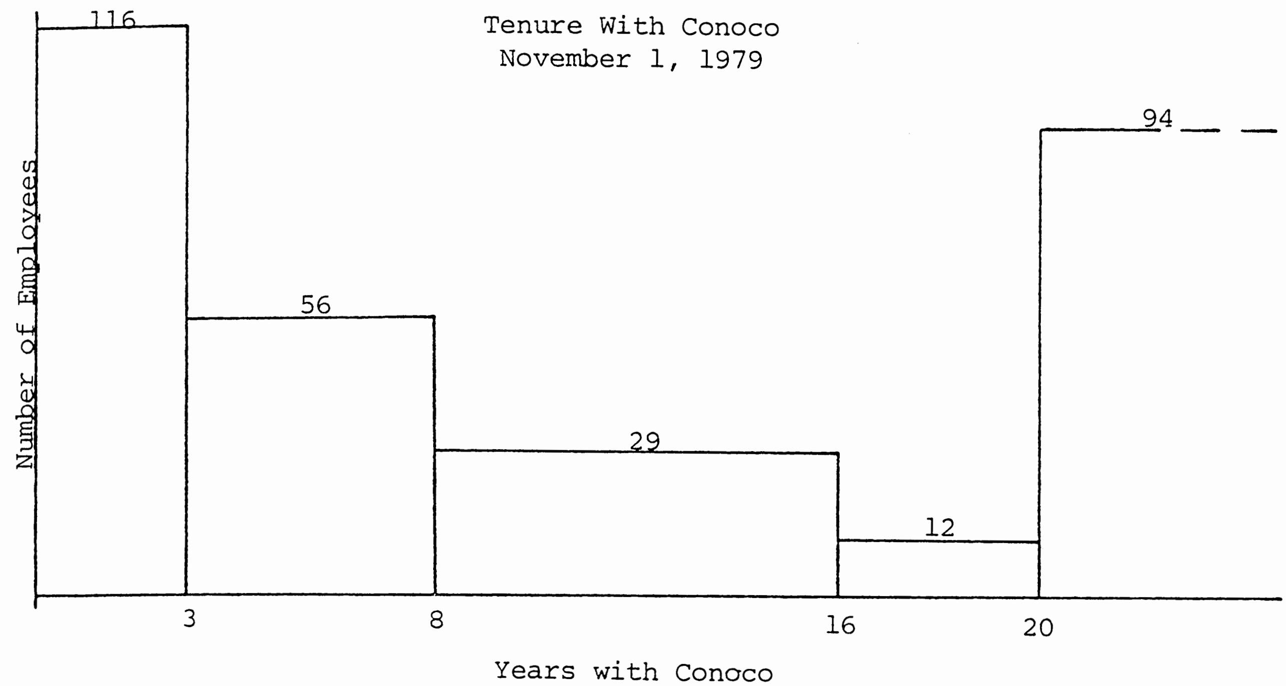
Data bases are available from commercial companies, universities, state and federal agencies, and company proprietary files. Acquisition of this data is prohibitively expensive even for the major oil companies; however, a service company can spread the cost to several clients making it attractive.

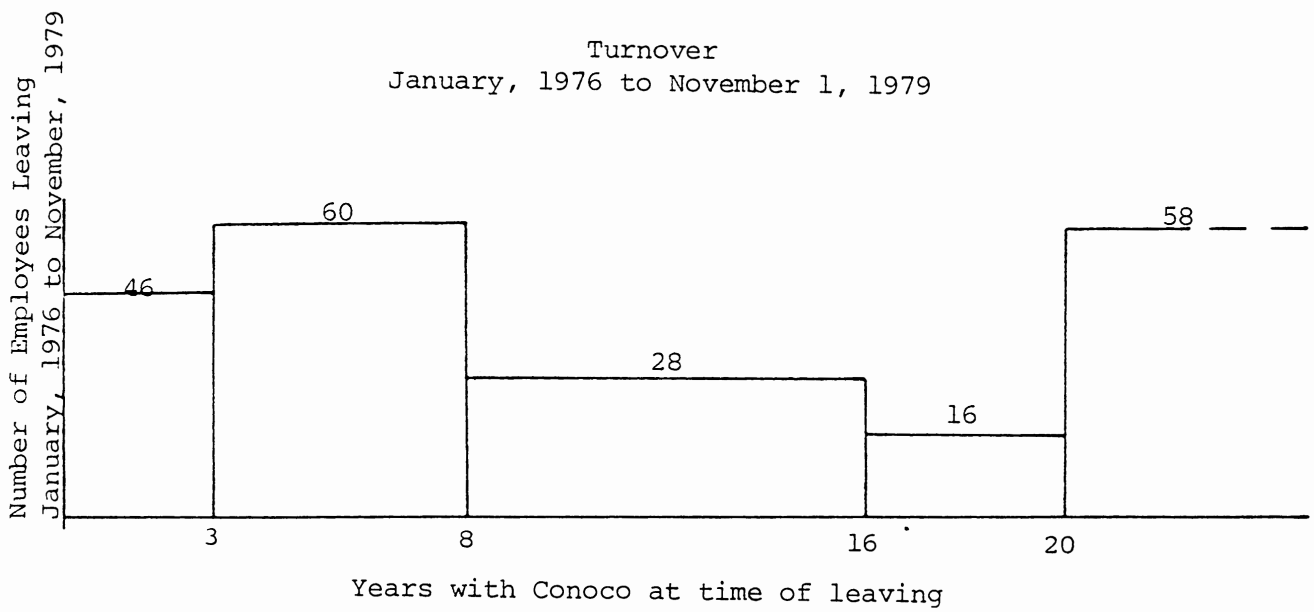
I became interested in establishing Petro-Land while doing a study for the special processing group of Conoco. This involved evaluating hardware and software for digitizing purposes.

In March, 1979 at the Mid-Western Society of Exploration Geophysicists meeting in Denver, I saw Computer Research Corporation's (CRC) Exploration Information Management System. The CRC system was the most attractive in cost, availability of peripheral equipment, flexibility, and ease of adding custom software to the system. The CRC brochure is

Figure 1

Results of Rath and Strong Turnover Study for Conoco Inc.





Conclusion: Every four years there is a 100% turnover rate of personnel with 3 to 20 years experience.

included as Appendix A. Table 1 lists the names and addresses of companies which supply similar systems.

Table 1
Suppliers of Computer Graphics and Data Management Systems

Auto-trol Corporation 5650 N. Pecos Street Denver, Colorado 80221	Calma Company 4230 L.B.J. Freeway, Suite 125 Dallas, Texas 75234
Computer Research Corporation 5161 Ward Road Wheat Ridge, Colorado 80033	M & S Computing P. O. Box 5183 Huntsville, Alabama 35805

Another boost came in September, 1979, when I met Joe Cornelson of the Pelton Company and described the CRC system and how I felt it could be used. Joe thought the Pelton Company might be interested in financing such a venture, but wanted a market survey and sales brochure completed before a final decision was made.

Denver, Colorado was chosen for the market survey due to the large number of exploration companies located in a geographically compact area, an adequate labor supply, and a technical base to support the proposed operations.

This paper is a report on the design and results of the market survey. Chapter One starts with a description of the specific services Petro-Land can offer the industry, followed by a brief discussion of the organization.

Chapter Two is a literature review on predicting demand for new products, predicting demand for new services, and design of marketing surveys.

Chapter Three describes the design of the survey with Chapters Four and Five presenting the results and conclusions respectively.

CHAPTER ONE - Petro-Land Information Systems

Petro-Land Information Systems is organized around Computer Research Corporation's system for exploration information management. With this system, Petro-Land can store, retrieve, manipulate, and display exploration information in its most useable form to do planning and resource inventorying. This requires a computerized data base which can be created from in-house data, data collected by universities or state and federal agencies, or commercially available data bases such as Petroleum Information's Well History Control System.

The following are examples of just a few of the many types of data that can be processed:

- Legal descriptions of areas or point locations
- Lease data
- Right of way easements
- Geological (soil types, outcrops, fault lines, flood planes, etc.)
- Geophysical (seismic sections, gravity, electrical, etc.)
- Topographical
- Oil and gas well locations and associated data

The primary service Petro-Land would offer would be the formation and maintenance of the data bases. These can then be used to create contour maps, or innumerable calculations and conversions performed to generate the desired output. Maps can have a township/range grid superimposed for better perspective, and data can be plotted using only the legal description.

Some of the many applications possible are:

INITIAL POTENTIAL MAP

An initial potential map is used to indicate distribution and quality of production in an area. Formation, oil and/or gas initial potential rates and depth of production, can be annotated for all wells. For many purposes, it is convenient to make both a non-producing zone map and an initial potential map to indicate favorable stepout and recompletion opportunities in old producing trends.

PENETRATION MAP

A penetration map shows all wells that penetrated a given formation. This type of map is an excellent base map for geologic studies, particularly for deeper horizons in a multiple pay zone area.

STRUCTURE AND SHOWS MAP

A map of this type is useful as a beginning point in the study of an area. Oil and/or gas shows, structure, and isopach values can be posted for the most prospective formations.

The following is an example of how the system has been used in the Williston Basin, North Dakota:

A structure and shows map was generated for the Mission Canyon and Red River Formations in Divide and Williams Counties, North Dakota from Petroleum Information's Well History Control System. This indicated where more control was needed to determine prospective areas.

Regional seismic control was acquired for the area. The shotpoint maps were digitized while the geophysicists correlated and picked the horizons of interest. These were then digitized, adjusted to agree at tie points and contoured. An Ordivician-Devonian isochron was also generated to show time thins which are associated with production in this area.

These time maps were then converted to depth and adjusted to the well control by a least-squares fit. This produced a structure map and isopach which indicated where detailing was needed for specific prospects and drilling locations.

As more information is obtained, it can be readily incorporated into the area data base and new maps generated.

This reconnaisance project was completed in 1/3 of the expected time by letting the computer sort and display the available information allowing the geologists and geophysicists more time to interpret the data and generate prospects.

This is a brief description indicating the types of services that can be offered.

The initial staff would consist of myself doing the marketing, management and technical supervision, a full-time secretary/supervisor to manage the office, and graduate students from the Colorado School of Mines to operate the computer. This should provide a quality staff at minimum cost until Petro-Land is well established.

CHAPTER TWO - Literature Review

Three areas of the marketing literature were studied: predicting demand for new products, how to design survey questionnaires, and the non-response problem.

Predicting Demand for New Products.

The development of a new product generally follows several of the following steps: (1) idea generation, (2) concept testing, (3) prototype construction and evaluation, (4) marketing-mix formulation, (5) market testing, and (6) production.

Development of a new service goes through an abreviated set of these steps, with the first two steps being common to both product and service development. If the concept testing proves encouraging, then the next step is to begin operations. This is the only way to test the technical feasibility and limits to growth of the service.

The major problem is generating enough confidence in the idea to start operations. The start-up decision is made with only soft data, respondents stated intentions (Green and Tull, 1978).

According to Tauber (1977, p. 80) "Sales can be defined by four major elements: trial, first repeat, adoption, and frequency of purchase. The key to predicting on-going sales is to be able to predict adoption."

Four survey or test methods will be looked at: Concept and product tests, historical data regression models, laboratory test markets and sales wave experiments. For this comparison, new products can be divided into three categories (Tauber, 1977):

- Type 1: Line extensions and me-too items.
- Type 2: New products that are not easy to classify into existing product categories, but require no change in consumer usage habits.
- Type 3: New products requiring a change in consumer behavior.

Petro-Land fits the innovative or Type 3 product, so this point of view will be used in reviewing the four systems.

Concept and product tests present the consumer with an idea or physical product and measure purchase intention at an early stage of exposure.

For products of Type 3, people are very poor predictors of their own future behavior. Discontinuous products diffuse slowly through the population because they often require changes in values and habits. In addition, this method is unable to measure adoption and frequency of purchase.

Regression models take past new products, and use regression methods to identify the variables that could explain the variance in trial, first repeat, adoption, and frequency of purchase for various categories of products.

For a Type 3 product, it is difficult to classify the product into a known category, and to understand the dynamics of the adoption process.

Laboratory test markets offer the advantage of using current behavior as a measurement tool vs. the less reliable measures of intention or past behavior. The laboratory test market only measures the trial phase, other methods must be used to determine adoption and frequency of purchase, such as an historical data regression model.

Not knowing the dynamics of adoption for a type 3 product again causes difficulties.

Sales Wave experiments measure repeat purchase dynamics by observing current behavior for a sample of consumers who receive the product through a concept/product placement and then are offered a series of chances to purchase it at a special price.

Type 3 products generally have such slow adoption that a behavioral experiment of a few months is not representative of what can happen when consumer interaction allows adoption and frequency of purchase to grow over time (Tauber, 1977).

Crawford (1977, p. 51) asks an interesting question, "Why has the rate of new products success not climbed as a result of the many advances in marketing research technology over the past 25 years?"

He presents nine hypotheses for this failure rate, of which the ninth is most damning. "Predicting new product sales and profits is an inherently impossible task."

Why? Because every "new product" can succeed only as persons or firms in the market place modify their behavior. And, the hypothesis holds, we will be unable to forecast the milieu within which that behavior operates to a degree which permits more than a very low order of accuracy in decision making.

This literature indicates that even a well designed survey will give only tentative results of the market potential. Quite possibly "expert" opinions would be as useful.

Questionnaire Design

The Professional Mail Surveys book by Paul L. Erdos is a good "how-to book" for designing surveys. It provided these six guidelines:

1. The questionnaire must include questions on all subjects which are essential to the project, but none which are not purposeful.

2. The questionnaire should be brief and easy to complete.
3. The respondent must be made to feel that he is participating in an important and interesting project.
4. The form should not contain any question which could bias the answer.
5. It must be designed to elicit clear and precise answers.
6. Phrasing, structure, and layout must be designed with the problem of tabulation in mind.

Two studies have concluded that the more questions asked about specific subjects, the more accurate the results (Lansing, Ginsberg and Braaten, 1961; Sudman, Seymour and Bradburn, 1974). It has also been reported that telephone respondents are more reluctant to divulge information than in personal interviews (Schmiedeskamp, 1962).

Problems of Non-response/Non-contact

Due to my relationship with the oil industry, as a competitor to the companies contacted, the nonresponse problem is difficult to relate to other studies. Two reasons noncontact might occur are respondent's phone number busy and respondent's phone number unlisted, unpublished, or disconnected (Wiseman and McDonald, 1979). Deming (1953) suggests a smaller sample with multiple callbacks may be better than a large sample without callbacks.

One reported technique of eliciting cooperation is the use of peers as sponsors of the survey. It can be accomplished by informing potential respondents of the names of their peers who already have been interviewed, by asking those who have been interviewed to arrange appointments with potential respondents with whom they are acquainted, or by enlisting the aid of peers outside the survey sample.

Peer sponsorship is a technique appropriate only when the web of interpersonal relationships within the population to be surveyed is fairly elaborate (Forsythe, 1977).

CHAPTER THREE - Methodology

Two approaches were taken to assess the demand for Petro-Land's services as previously described. One was the opinions I formed from informal conversations with people in the industry and the second was a formal survey conducted in the Denver area.

I include some of the more pertinent comments here as they were used in designing the questionnaire:

Mr. Dick Pelton, Pelton Company, Ponca City, October, 1979: called three independent producers/drillers who agreed the basic idea sounded good. They indicated one problem was that computer service companies promised more than they could deliver, hence prices were higher than anticipated. This lack of confidence in service companies ability to deliver what was promised was a recurring theme.

Mr. Don Green, Petroleum Information, Oklahoma City: Mr. Green's opinion was that P.I.'s Services Group did not offer individuals in Oklahoma a viable exploration information management system, and the service company I described would be complimentary to P.I.'s marketing effort in the state. Mr. Green referred me to Mike Thacker, Vice-president of Petroleum Information in Denver.

Mr. Thacker was concerned that Petro-Land would compete directly with P.I.'s technical services group in the Denver area, but could also see that it was a different marketing approach to P.I.'s efforts and how it might increase P.I.'s sales. To quote Mr. Thacker, "The market is there, the problem is reaching it." Mr. Thacker has been most encouraging and helpful in presenting ideas to Mr. Bill Good, P.I.'s CEO. Discussions are continuing to work out details, and advantages and disadvantages to P.I. and Petro-Land.

In addition I had extensive talks with both John Kane of Bartlesville and Vic Cockrell of Red Rock in designing Petro-Land and its services to meet the needs of the independent producer in Oklahoma.

These initial contacts and the literature on innovative or Type 3 products (Tauber, 1977) lead me to believe that I should test for the potential market, not the probable market. This conclusion is drawn from the lack of correlation between respondents stated intentions and their actual actions for Type 3 products, as reported in the literature, and the opinions of both John Kane and Vic Cockrell.

I defined a potential user of Petro-Land's services as any company, division office or individual engaged in exploration for hydrocarbons who does not have access to a high speed line printer and plotter in the Denver area, i.e. on-site computer facilities or using a service company.

This definition overcomes several operational problems in conducting the survey:

1) asking the respondents what their intentions are,
2) describing an exploration information management system over the telephone, and
3) convincing the respondent that such a service is possible.

My personal experience has shown that I/O devices have to be conveniently located to the users if extensive use is expected, hence the inclusion of "in the Denver area" in the definition.

Therefore, the potential market is those exploration companies not currently using an exploration information system.

The following questionnaire was used to gather the needed information.

1) Does your company own a computer which the petroleum exploration department can use?

2) Is it located in Denver?

3) If no, do you have remote access to it?

4) Do you use the computer for:

GEOLOGIC	GEOPHYSICAL	GEOCHEMICAL
Basemaps	Basemaps	Data Bases
Well Control	Shot Points	Mapping
Contouring	Seismic Picks	Land Lease data
Data Bases	Modeling	Well Log Analysis
Cross Sections	Contouring	Economic Evaluations

5) Do you use any of the Denver data processing houses?

6) For:

GEOLOGIC	GEOPHYSICAL	GEOCHEMICAL
Basemaps	Basemaps	Data Bases
Well Control	Shot Points	Mapping
Contouring	Seismic Picks	Land Lease Data
Data Bases	Modeling	Well Log Analysis
Cross Sections	Contouring	Economic Evaluations

A telephone survey was conducted to gather the data as quickly as possible and still allow respondents to express opinions not specifically asked for.

Mr. John Greene, Conoco Denver Division Manager, provided the membership list for the Denver Exploration Manager's Association, Appendix B. This is not a complete list, but he felt this covered the spectrum of exploration companies in the Denver area, although favoring the larger operations. He also requested that because of my relationship with Conoco, I limit my questions to those about computer useage.

The membership list of the Denver Exploration Manager's Association represented 123 organizations consisting of 49 majors (>= 1000 Barrels of oil per day or equivalent production), 71 independents and 3 geological consultants. An attempt was made to contact the exploration manager for all these organizations, except Conoco, the only constraint being the time limit to have this paper in for your review by mid-March, and revisions submitted before the end of the spring semester, 1980.

The objective of the survey was to determine the computer usage as applied to exploration problems, and given this usage and the operational environment, draw conclusions as to the likely success of a service company as has been described.

CHAPTER FOUR - Results

Conoco, Phillips, Cities Service and Mobil have large computer systems dedicated to exploration applications. These systems are located in Ponca City, Bartlesville, Tulsa and Dallas respectively, where they are used extensively by special applications groups. Their applications include seismic data processing, mapping and data base storage and manipulation. The Denver exploration offices have direct lines to these systems via remote terminals, but do not have high speed I/O devices and do not use them as an integrated information management system, although the capability is there.

In contrast, Amoco has a large computer center in Denver and uses the system extensively for maintaining lease records, well histories, formation tops, well locations, seismic picks, and other geological and geophysical information in the Rocky Mountain area. This information is available to the explorationist through terminals or line printers and plotters. Same day turn around is provided for all except the largest jobs, and most work is accomplished by the explorationist using interactive routines.

It is this convenience that makes a computer system a valuable tool instead of a toy to be used for special problems.

Of the 123 organizations represented, I could not find phone numbers for ten of them, and one was being liquidated. The remaining 112 names were randomized. Between January 21 and February 28 I attempted to contact 69, and succeeded in completing 38 calls. None of the three geological consultants could be reached due to the phone being busy or no-answer. The Fillon corporation was the only organization using an answering service and did not return my three calls. The remaining non-contacts were due to the phone being busy (10), and return calls not being made or my being away at the time they came in (17).

The final result is a 55% contact rate which falls within the range suggested by Wiseman and McDonald, (1979). The 38 contacted consist of 20 majors and 18 independents.

Of the 38 companies, 22 owned a computer which the petroleum exploration department could use. Of these 22, five are located in Denver. Of the remaining 17, six have remote access to the computer.

The 11 companies that have direct access to the computer are the ones utilizing it in exploration. Amoco, Arco and Tenneco were using or had the capability to do all the operations in question 4. These are three of the five companies with computers in Denver. The remaining companies used the computer for land lease data and economic evaluations in conjunction with their accounting departments.

Twenty-seven companies indicated that they used the Denver data processing houses for seismic processing, and one used a consultant for well log analysis.

Table Two is a summary of the results of the survey.

Table Three is a tabulation of results by major vs. independent and Chi-Square analysis.

Table Four summarizes the Chi-Square analysis by major vs. independent.

Table Five is a tabulation of results by access to the computer. Denver indicates the computer facilities are located in Denver and readily available. Remote means access to the computer is gained through phone lines. Other indicates an off-site staff with no direct communication to the computer.

Table Six summarizes the Chi-Square analysis by access to the computer.

Table Seven is a tabulation of access to the computer by majors and independents.

$$\text{Expected Value} = E_{ij} = \frac{(\sum_i A_{ij})(\sum_j A_{ij})}{\sum_i \sum_j A_{ij}}$$

$$\text{Chi-Square} = X^2 = \sum_i \sum_j \frac{(A_{ij}-E_{ij})^2}{E_{ij}}$$

Table 2

Tabulation of Results

1) Does your company own a computer which the petroleum exploration department can use? 58%

2) Is it located in Denver? 23%

3) If no, do you have remote access to it? 27%

4) Do you use the computer for:

Geologic	Geophysical	Geochemical
a) Basemaps 23%	f) Basemaps 23%	k) Data Bases 14%
b) Well Control 14%	g) Shot Points 14%	l) Mapping 27%
c) Contouring 36%	h) Seismic Picks 14%	m) Land Lease Data 91%
d) Data Bases 14%	i) Modeling 50%	n) Well Log Analysis 41%
e) Cross-sections 18%	j) Contouring 36%	o) Economic Evaluation 91%

5) Do you use any of the Denver data processing houses? 71%

Table 3

Tabulation of Results by Majors and Independents

OWN A COMPUTER (QN. 1)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	14	6	20
INDEPENDENT	8	10	18
	22	16	38

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	11.6	8.4	20
INDEPENDENT	10.4	7.6	18
	22	16	38

CHI-SQUARE = 2.53813

LOCATED IN DENVER (QN. 2)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	2	6	8
	5	17	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	3.2	10.8	14
INDEPENDENT	1.8	6.2	8
	5	17	22

CHI-SQUARE = .0369748

REMOTE ACCESS (QN. 3)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	7	4	11
INDEPENDENT	1	5	6
	8	9	17

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	5.2	5.8	11
INDEPENDENT	2.8	3.2	6
	8	9	17

CHI-SQUARE = 3.43792

GEOLOGIC BASEMAPS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	2	6	8
	5	17	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	3.2	10.8	14
INDEPENDENT	1.8	6.2	8
	5	17	22

CHI-SQUARE = .0369748

GEOLOGIC WELL CONTROL (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	0	8	8
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	1.9	12.1	14
INDEPENDENT	1.1	6.9	8
	3	19	22

CHI-SQUARE = 1.98496

GEOLOGIC CONTOURING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	6	8	14
INDEPENDENT	2	6	8
	8	14	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	5.1	8.9	14
INDEPENDENT	2.9	5.1	8
	8	14	22

CHI-SQUARE = .701531

GEOLOGIC DATA BASES (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	0	8	8
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	1.9	12.1	14
INDEPENDENT	1.1	6.9	8
	3	19	22

CHI-SQUARE = 1.98496

GEOLOGIC CROSS-SECTIONS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	4	10	14
INDEPENDENT	0	8	8
	4	18	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	2.5	11.5	14
INDEPENDENT	1.5	6.5	8
	4	18	22

CHI-SQUARE = 2.79365

GEOPHYSICAL BASEMAPS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	2	6	8
	5	17	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	3.2	10.8	14
INDEPENDENT	1.8	6.2	8
	5	17	22

CHI-SQUARE = .0369748

GEOPHYSICAL SHOT POINTS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	0	8	8
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	1.9	12.1	14
INDEPENDENT	1.1	6.9	8
	3	19	22

CHI-SQUARE = 1.98496

SEISMIC PICKS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	0	8	8
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	1.9	12.1	14
INDEPENDENT	1.1	6.9	8
	3	19	22

CHI-SQUARE = 1.98496

GEOPHYSICAL MODELING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	8	6	14
INDEPENDENT	3	5	8
	11	11	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	7.0	7.0	14
INDEPENDENT	4.0	4.0	8
	11	11	22

CHI-SQUARE = .785714

GEOPHYSICAL CONTOURING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	6	8	14
INDEPENDENT	2	6	8
	8	14	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	5.1	8.9	14
INDEPENDENT	2.9	5.1	8
	8	14	22

CHI-SQUARE = .701531

GEOCHEMICAL DATA BASES (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	3	11	14
INDEPENDENT	0	8	8
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	1.9	12.1	14
INDEPENDENT	1.1	6.9	8
	3	19	22

CHI-SQUARE = 1.98496

GEOCHEMICAL MAPPING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	6	8	14
INDEPENDENT	0	8	8
	6	16	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	3.8	10.2	14
INDEPENDENT	2.2	5.8	8
	6	16	22

CHI-SQUARE = 4.71429

LAND LEASE DATA (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	14	0	14
INDEPENDENT	6	2	8
	20	2	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	12.7	1.3	14
INDEPENDENT	7.3	0.7	8
	20	2	22

CHI-SQUARE = 3.85

WELL LOG ANALYSIS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	7	7	14
INDEPENDENT	2	6	8
	9	13	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	5.7	8.3	14
INDEPENDENT	3.3	4.7	8
	9	13	22

CHI-SQUARE = 1.31624

ECONOMIC EVALUATION (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	14	0	14
INDEPENDENT	6	2	8
	20	2	22

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	12.7	1.3	14
INDEPENDENT	7.3	0.7	8
	20	2	22

CHI-SQUARE = 3.85

USE DENVER DATA PROCESSING HOUSES (QN. 5)

ACTUAL FREQUENCIES

	YES	NO	
MAJOR	15	5	20
INDEPENDENT	12	6	18
	27	11	38

EXPECTED FREQUENCIES

	YES	NO	
MAJOR	14.2	5.8	20
INDEPENDENT	12.8	5.2	18
	27	11	38

CHI-SQUARE = .319866

Table 4

Summary of Chi-Square Analysis, Majors vs. Independents

Probability of finding the calculated X^2 with one degree of freedom is between P_1 and P_2, as determined by looking at an X^2 table.

Question	Calculated X^2	P_1	P_2
1	2.5	greater than .1	
2	0.037	not in table	
3	3.4	.1	.05
4 a)	0.037	not in table	
b)	2.0	greater than .1	
c)	0.7	not in table	
d)	2.0	greater than .1	
e)	2.8	.1	.05
f)	0.037	not in table	
g)	2.0	greater than .1	
h)	2.0	greater than .1	
i)	0.8	not in table	
j)	0.7	not in table	
k)	2.0	greater than .1	
l)	4.7	.05	.025
m)	3.8	.1	.05
n)	1.3	not in table	
o)	3.8	.1	.05
5	0.3	not in table	

Table 5

Tabulation of Results by Access to Computer

GEOLOGIC BASEMAPS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	0	8	8
OTHER	0	9	9
	5	17	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	1.1	3.9	5
REMOTE	1.8	6.2	8
OTHER	2.0	7.0	9
	5	17	22

CHI-SQUARE = 22

GEOLOGIC WELL CONTROL (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	3	2	5
REMOTE	0	8	8
OTHER	0	9	9
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	0.7	4.3	5
REMOTE	1.1	6.9	8
OTHER	1.2	7.8	9
	3	19	22

CHI-SQUARE = 11.8105

GEOLOGIC CONTOURING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	2	6	8
OTHER	1	8	9
	8	14	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	1.8	3.2	5
REMOTE	2.9	5.1	8
OTHER	3.3	5.7	9
	8	14	22

CHI-SQUARE = 11.6766

GEOLOGIC DATA BASES (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	3	2	5
REMOTE	0	8	8
OTHER	0	9	9
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	0.7	4.3	5
REMOTE	1.1	6.9	8
OTHER	1.2	7.8	9
	3	19	22

CHI-SQUARE = 11.8105

GEOLOGIC CROSS-SECTIONS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	3	2	5
REMOTE	0	8	8
OTHER	1	8	9
	4	18	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	0.9	4.1	5
REMOTE	1.5	6.5	8
OTHER	1.6	7.4	9
	4	18	22

CHI-SQUARE = 7.95803

GEOPHYSICAL BASEMAPS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	0	8	8
OTHER	0	9	9
	5	17	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	1.1	3.9	5
REMOTE	1.8	6.2	8
OTHER	2.0	7.0	9
	5	17	22

CHI-SQUARE = 22

GEOPHYSICAL SHOT POINTS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	3	2	5
REMOTE	0	8	8
OTHER	0	9	9
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	0.7	4.3	5
REMOTE	1.1	6.9	8
OTHER	1.2	7.8	9
	3	19	22

CHI-SQUARE = 11.8105

SEISMIC PICKS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	3	2	5
REMOTE	0	8	8
OTHER	0	9	9
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	0.7	4.3	5
REMOTE	1.1	6.9	8
OTHER	1.2	7.8	9
	3	19	22

CHI-SQUARE = 11.8105

GEOPHYSICAL MODELING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	4	4	8
OTHER	2	7	9
	11	11	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	2.5	2.5	5
REMOTE	4.0	4.0	8
OTHER	4.5	4.5	9
	11	11	22

CHI-SQUARE = 7.77778

GEOPHYSICAL CONTOURING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	2	6	8
OTHER	1	8	9
	8	14	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	1.8	3.2	5
REMOTE	2.9	5.1	8
OTHER	3.3	5.7	9
	8	14	22

CHI-SQUARE = 11.6766

GEOCHEMICAL DATA BASES (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	3	2	5
REMOTE	0	8	8
OTHER	0	9	9
	3	19	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	0.7	4.3	5
REMOTE	1.1	6.9	8
OTHER	1.2	7.8	9
	3	19	22

CHI-SQUARE = 11.8105

GEOCHEMICAL MAPPING (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	4	1	5
REMOTE	0	8	8
OTHER	2	7	9
	6	16	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	1.4	3.6	5
REMOTE	2.2	5.8	8
OTHER	2.5	6.5	9
	6	16	22

CHI-SQUARE = 10.1241

LAND LEASE DATA (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	7	1	8
OTHER	8	1	9
	20	2	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	4.5	0.5	5
REMOTE	7.3	0.7	8
OTHER	8.2	0.8	9
	20	2	22

CHI-SQUARE = .656945

WELL LOG ANALYSIS (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	4	1	5
REMOTE	3	5	8
OTHER	2	7	9
	9	13	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	2.0	3.0	5
REMOTE	3.3	4.7	8
OTHER	3.7	5.3	9
	9	13	22

CHI-SQUARE = 4.49924

ECONOMIC EVALUATION (QN. 4)

ACTUAL FREQUENCIES

	YES	NO	
DENVER	5	0	5
REMOTE	7	1	8
OTHER	8	1	9
	20	2	22

EXPECTED FREQUENCIES

	YES	NO	
DENVER	4.5	0.5	5
REMOTE	7.3	0.7	8
OTHER	8.2	0.8	9
	20	2	22

CHI-SQUARE = .656945

Table 6

Summary of Chi-Square Analysis by Access to Computer

Probability of finding the calculated X^2 with two degrees of freedom is between P_1 and P_2, as determined by looking at an X^2 table.

Question	Calculated x^2	P_1	P_2
4 a)	22.0	less than .005	
b)	11.8	less than .005	
c)	11.7	less than .005	
d)	11.8	less than .005	
e)	8.0	.025	.01
f)	22.0	less than .005	
g)	11.8	less than .005	
h)	11.8	less than .005	
i)	7.8	.025	.01
j)	11.7	less than .005	
k)	11.8	less than .005	
l)	10.1	.01	.005
m)	0.66	not in table	
n)	4.5	.1	
o)	0.66	not in table	

Table 7

Access to Computer by Major and Independent

ACCESS TO COMPUTER BY MAJOR AND INDEPENDENT

ACTUAL FREQUENCIES

	MAJOR	INDEPENDENT	
DENVER	3	2	5
REMOTE	7	1	8
OTHER	4	5	9
	14	8	22

EXPECTED FREQUENCIES

	MAJOR	INDEPENDENT	
DENVER	3.2	1.8	5
REMOTE	5.1	2.9	8
OTHER	5.7	3.3	9
	14	8	22

CHI-SQUARE = 3.42986

The cross tabulations of majors vs. independents indicates where a significant difference occurs. This difference tends towards a greater utilization by the majors than the independents. Significant differences occured in owning a computer, remote access to the computer, geologic well control, geologic data bases, geologic cross-sections, geophysical shot points, seismic picks, geochemical data bases, geochemical mapping, land lease data, and economic evaluation.

The cross tabulations of computer usage vs. access to the computer showed significant differences for all questions except land lease data and economic evaluation. The ranking by computer usage is: first - located in Denver; second - remote access via phone lines; and third - specialized staff for computer applications.

The final cross tabulation, majors and independents vs. access to the computer is inconclusive.

CHAPTER FIVE - Implications

The general conclusion from the survey is that independents and Denver division offices of major oil companies are not very sophisticated in using computers to solve exploration problems. Further, this lack of sophistication is due to inconvenience, not opportunity or knowledge.

This survey did not answer the question, as originally hoped, which exploration companies would be interested in a service company providing an exploration information management system. The survey even failed in indicating how many companies might be interested in such a service.

It did document that hardware and software exist and are being used by some companies. The survey also demonstrated a mistrust of computers and service companies due to a lack of ability to deliver what was promised at the quoted price.

This implies there is room in the Denver market for a service company as has been described. However, acceptance and adoption would be slow, requiring other work and/or excellent financing to see such a company through startup. Therefore, this service is probably best left to an established company, such as a seismic data processing house.

Some of the constraints placed on such a service company are that it must be physically located close to its customers to provide good communication and rapid turnaround, excess capacity to enhance response time, and a knowledgable staff to bridge the two technologies.

Another opportunity would be to work for the exploration companies as an intermediary to the service companies to insure that they get the best possible services for the lowest cost. This is one way of overcoming the distrust of service companies while raising the sophistication of the exploration companies. The problems are learning the capabilities and limitations of the various service companies, and then convincing the exploration companies that my knowledge, background, and experience are useful to them.

This relationship would also be useful to the service companies, providing them with a clearer understanding of what exploration companies want and expect of them.

It would appear that on the S-curve of adoption of exploration information management systems, the exploration industry as a whole is still down at the foot. The pioneering work has been going on for some time, recently recieivng a boost from a changing environment. The trick is to predict when the rapid increase in adoption will occur, and be ready to satisfy the demand.

CHAPTER SIX - Post-Mortem

The formal survey is not ideal, but it does provide useful insights into the industry. It does indicate there is room for improvement in the way the industry operates, but there are problems of selling new services to a conservative industry.

The results of this work and difficulties in obtaining financing have caused me to re-evaluate Petro-Land's short term objectives. The companies that have already established information management systems have an ongoing need for information input to their systems. One of these inputs is digitized graphics data.

Starting out by doing custom digitizing reduces the initail capital outlay, and the market is better defined, without precluding growth in the future along the lines described in Chapter One. This building block approach has the advantage that it allows growth to occur as investment funds are available and at a rate that can be managed.

BIBLIOGRAPHY

Crawford, C. Merle. "Marketing Research and the New Product Failure Rate", Journal of Marketing, Vol. 41, pp. 51-61, (April, 1977).

Deming, W. E. "On a Probability Mechanism to Attain an Economic Balance between the Resultant Error of Response and the Bias of Nonresponse", Journal of the American Statistical Association, Vol. 58, pp. 766-83 (December, 1953).

Erdos, Paul L. Professional Mail Surveys, McGraw-Hill, Inc., 1970.

Forsythe, J.B. "Obtaining Cooperation in a Survey of Business Executives", Journal of Marketing Research, Vol. 14, pp. 370-73 (August, 1977).

Green, P.E. and Tull, D.S. Research for Marketing Decisions, Fourth Edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1978.

Lansing, J. B., Ginsberg, G. P., and Braaten, K. "An Investigation of Response Error", Bureau of Economic and Business Research, University of Illinois, 1961.

Oil and Gas Journal Newsletter, (March 24, 1980).

Schmiedeskamp, Jay W. "Reinterviews by Telephone", Journal of Marketing, Vol. 26, pp. 28-34, (January, 1962).

Sudman, Seymour and Bradburn, Norman. Response Effects in Surveys. Chicago: Aldine Publishing Co., 1974.

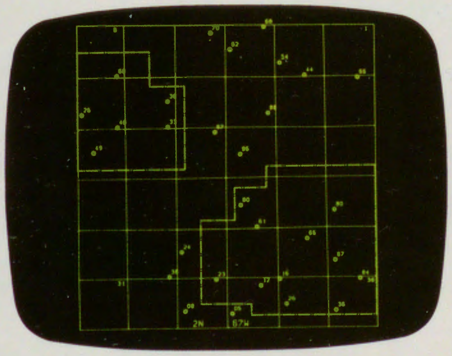
Tauber, Edward M. "Forecasting Sales Prior to Test Market", Journal of Marketing, Vol. 41, pp. 80-84, (January, 1977).

Wiseman, F. and McDonald, P. "Noncontact and Refusal Rates in Consumer Telephone Surveys", Journal of Marketing Research, Vol. 16, Pg. 478-84, (November, 1979).

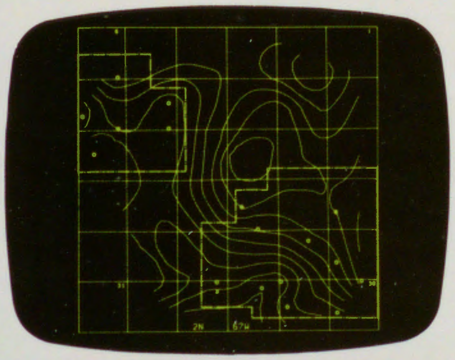
APPENDIX A

Here's the simplest way to analyze your petroleum data.

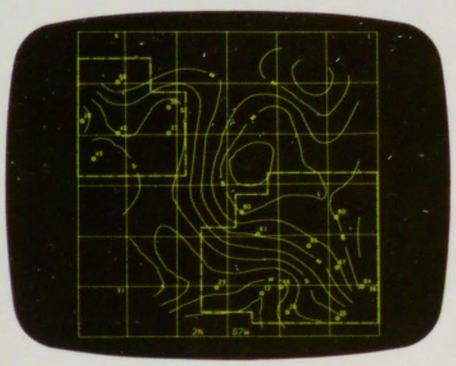
Here's how it works.



You might start by placing a basemap of the area of interest on the digitizer tablet. The tablet resembles a drafting board, up to 44" x 60" in size, but it has a fine electrical grid embedded under the surface. Once your map is on the tablet, you then press buttons on the cursor and on the operator's console to set up your X-Y coordinates and scale. Then you can enter the complete map into the computer...or any geographical, geological or geophysical features or data...by simply tracing them with the cursor. Well locations, leases, formation tops, seismic sections, well logs, production data, you enter all your data with just a few keystrokes of the cursor or console keyboard.



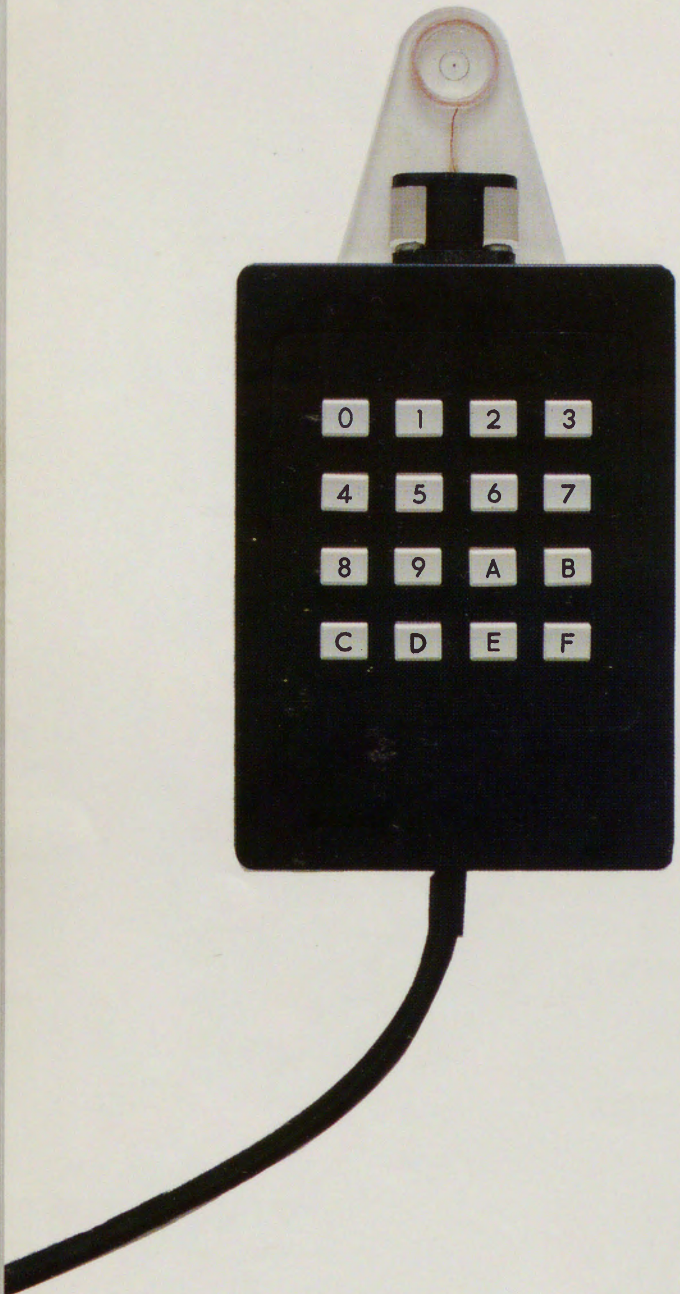
Any data that you enter can be simultaneously displayed on both the graphics and operator's terminals. So let's suppose your graphics terminal now displays the geographic boundaries, contours and well locations of the lease area.



As you look at your screen, you decide that you'd like to know more about the production history of the wells that are shown. So you command the system to call up the desired information from the computer data base: rates of flow, well depths, geophysical data, or whatever is on file. Similarly, legal or property information concerning the lease can also be called up and added to the display: lease description, land owner, lease holder, lease expiration date, and other pertinent information.

See your data in the most appropriate format.

A major advantage of the CRC system is that it lets you massage your data with unsurpassed ease. You can add, delete, merge, rearrange or edit any of the data in the computer file. You can generate contours and produce a wide variety of graphic representations of your data. You can also overlay displayed information for better analysis, or isolate and enlarge portions of the display for a closer look at details. And to do all this, you don't have to be a computer programmer. All the software you need has already been developed by people with more than a decade of experience out in the oil patch.



Topographic data, well logs, maps, seismic sections... who'd believe the amount of raw data you process to derive a few valid answers about oil and gas deposits? If you analyze all this input manually, you face hours of tedious calculations. But if you send it back to your corporate data processing center, you wait days, sometimes weeks, for your answers. Either way, you lose valuable time. And with today's intense competition for oil and gas, lost time can mean lost opportunities for you and your company.

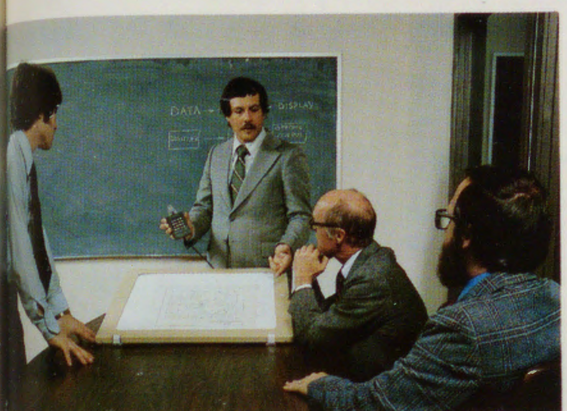
These 16 keys can save you hours of drudgery.

Imagine how the quality of your work would improve if you had both the time and the computational tools you needed to **really** analyze your results, to explore alternative solutions, to play your hunches. That's exactly what CRC's computer graphics system allows you to do. It gives you a way to enter your data directly into a powerful minicomputer. The computer will then manipulate your data, as you command, to extract the maximum amount of useful information from it. And finally, the system automatically displays, plots, or lists your results. But perhaps most surprising of all, **you don't need a computer background to do any of this. The system does it all . . . automatically.**

Now let's get back to that cursor with the 16 keys and see how you would use the CRC system to solve a typical problem, estimating the oil recovery possibilities for a particular lease.

A system that grows to meet your needs.

By taking a straightforward, modular approach to the design of our system, we've produced a graphics system that solves the greatest number of geological, geophysical and petroleum engineering problems in the simplest way possible. It's a system that offers all the capability your job requires, but no expensive extras that you'd rarely . . . perhaps never . . . use. You get, and pay for, just the components and software programs you need. But since the system is modular, it can be expanded easily and economically to keep pace with your changing needs.

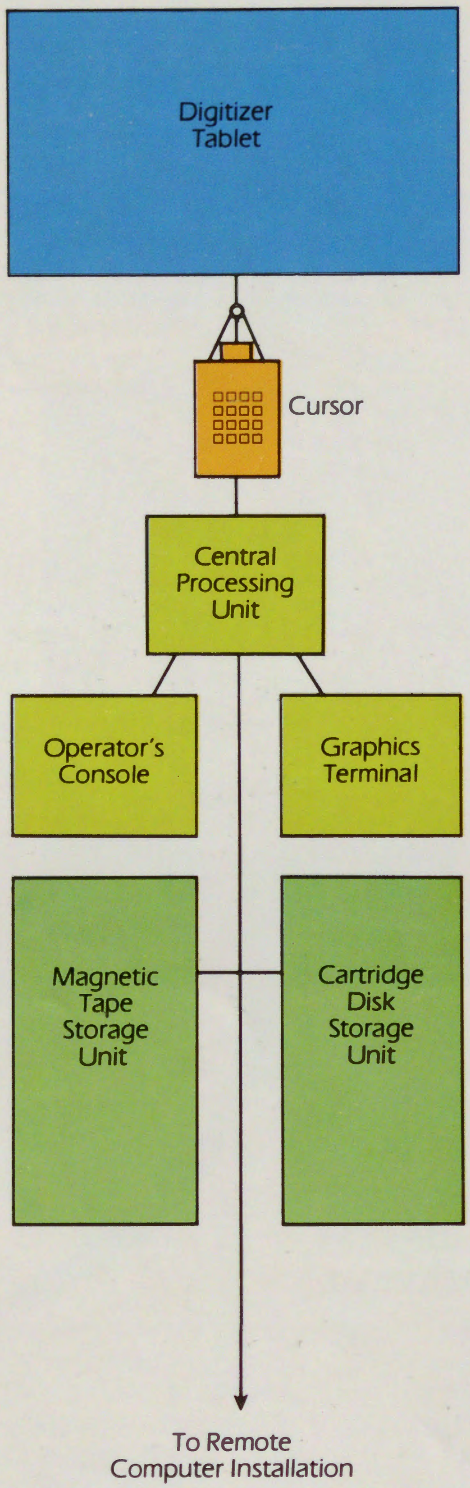


You can count on CRC's support.

Since CRC's success is closely tied to that of our petroleum industry clients, we recognize the importance of establishing helpful, ongoing relationships. And it starts with pre-sale counseling. When you tell us your data requirements, we'll help you select the equipment that will do the job in the shortest time and at the lowest cost. If your application requires the development of special software programs, we'll provide those, too. In fact, if it appears that the programs you require might also be useful to other clients, we will prepare them for you at no charge.

Once your system is installed, a CRC instructor with an extensive background in petroleum exploration and production will teach you how to use the system to its fullest capability. And you'll learn by processing your real-world data, not by going through theoretical exercises. If additional training seems warranted, you may receive additional instruction at CRC headquarters in Denver. Since satisfied customers are so important to us, you can be sure that we'll keep in close touch to see that the system continues to perform as you expect.

Periodic maintenance or emergency service of your system is usually handled by a CRC representative in your area. But if we don't have someone stationed in your locality, we'll provide support from our Denver facility. When service is needed, your system will be back in operation within hours. Even major repairs are usually just a matter of removing and replacing the defective module. Software support is provided from Denver via telephone, or if you prefer, by data link.



The CRC computer graphics system does more than analyze and store data.

Geologists and other petroleum specialists soon come to regard the computer graphics system as a quick and easy way to analyze large volumes of data. But the system can also transmit data to remote computer installations, or give you instant access to data on file at other locations. And you don't have to worry about compatibility problems because the CRC system uses industry standard programming languages and software systems to assure a smooth match with your existing data systems.

For maximum flexibility, a CRC graphics system would consist of these components.

To enter graphical data into the system, you require the 16-button cursor and the digitizer tablet. Alphanumeric data is entered by means of the keyboard on the operator's console. Both the operator's console and the graphics terminal are also used for controlling the system and viewing data.

The heart of the CRC system is a powerful and dependable central processor. Several models are available to ensure that the CRC system you choose will have all the data processing and data transfer capabilities your applications demand.

The system also offers you a choice of storage mediums: cartridge disk or magnetic tape storage units. The disk unit gives you fast random access, while the tape unit offers an economical means of permanently storing large volumes of information.

The graphics terminal provides a fast, simple way to plot your data. But if you need a hardcopy record of the graphic data shown on your terminal, a high-speed plotter offered by CRC will quickly produce it for you, in various line widths and colors, to any scale you select.

For immediate information on our hardware and software, call today:

(303) 421-0644

Who uses the CRC graphics system?

Large producers like Phillips Petroleum. Small companies like American/Canadian Stratigraphic. Some have been using their CRC system for years, while others received delivery just last week. But large or small, new clients or old, all these companies have one thing in common . . . they shopped around and then decided that our CRC system was their best choice. A representative sample of companies using the CRC system includes:

Phillips Petroleum
Litton Aero Service
Superior Oil Co.
American/Canadian Stratigraphic Co.
Intrasearch

Why not see what our system can do for you?

If you'd like factual, no-nonsense information about how our system might help solve your data problems, just call Computer Research Corporation at (303) 421-0644. Describe your applications and we'll tell you if we have the hardware and software needed to do your job. But remember, the sooner you call the sooner we can help. Or if you prefer, send in the enclosed card and we'll contact you.

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C. R. C. MODULAR SYSTEMS

COMPLETE HARDWARE AND SOFTWARE SYSTEMS FOR COMPUTER-GRAPHICS APPLICATIONS

CRC's Interactive Modular Graphics System is composed of hardware and software modules providing a complete range of computer-graphics operations. The hardware modules are expressly designed to be combined in a number of ways so that a variety of system configurations may be formed. Modules may be interconnected with each other for independent operation, or connected as an RJE terminal to IBM 370 or CDC systems. In general, a configuration consists of a central computer and one or more graphic work stations each of which may be intelligent or slaved to the central computer. Up to 30 remote or local intelligent stations, with or without rotating memories, and up to four slave stations may be included in any configuration.

A graphic work station may consist of a digitizer, a plotter, a single CRT, or it may contain several peripherals to perform more complex functions. Stations are generally equipped with an alphanumeric CRT display terminal, which continually monitors the status of the system and provides information feedback. The CRT can also be used as the system terminal or a general purpose terminal to perform non-graphic functions or execute any of the CRC software modules. A graphics CRT is often included for the plotting of data, and it too may be used as a general purpose terminal if needed.

The graphic work station also frequently contains a digitizer. A convenient and versatile device, the digitizer is operated from a 16-button floating keypad cursor, a mobile menu system providing up to 256 selections. The selections are grouped into system and user programmable pages each having up to 16 available functions. The detachable keypad crosshair is interchangeable with a small target-type cursor or a pen-type stylus which is particularly useful for entry of lines or well logs where tracing is performed. The keypad is buffered; the system remembers up to 12 consecutive keystrokes.

Besides CRT's and digitizer, devices that may be configured in graphic work stations include, among others, cartridge disks and magtapes of various sizes, digital incremental plotters, line-printer, and teletypes. CRC designs custom interfaces for devices according to the selected configuration.

Software and hardware functions are controlled by a real-time multiprogramming operation system offering a wide range of services and utilities. The system supports several programming languages such as MACRO assembler, FORTRAN IV, COBOL and BASIC, and can manage the concurrent operation of both real-time and less time-dependent programs. Multiprogramming is realized since tasks often utilize peripheral devices, which releases the CPU for other processing needs. The execution of all tasks is coordinated to achieve efficient use of system resources and rapid response to real-time demands. Status of each task is defined by priority, checkpointing, round-robin scheduling, swapping, and significant events. Available utilities, including Line Text Editor, Source Language Input Program, Task Builder, Librarian, and On-Line Debugging tool further enhance the capability of the system.

Data is stored in named files cataloged in a User File Directory. Files are protected from read, write, extend and delete functions according to four user designations: system, owner, group, world. Manipulation of files (copy, delete, rename, list, etc.) is accomplished by means of file utilities and user-written tasks. File control is device independent. A program performs operations on Logical Unit Numbers (LUN's), which are assigned to specific devices before program execution. If a device fails, an operator can quickly change the LUN to another device and continue processing.

A large-application software library complements the highly modular hardware of the CRC system. A short description of each software module is given below. Modules may be used independently or in conjunction with others to obtain the desired product.

S O F T W A R E   S Y S T E M S

DIGITIZING SYSTEM

A versatile interactive system, based on a 256-entry floating menu keypad cursor. Functions are grouped into 16 entry modes, each having up to 16 operations selected with keypad pushbuttons. The keypad is also used to enter numeric parameters and attributes. The CRT display provides constant information feedback to eliminate guesswork during operation. The display includes mode identification, current parameters (symbol type and size, line type, scale, etc.), sequence number, the last 10 digitized entries, point count, error messages and prompts when specific data is required. Functions currently available include:

SET digitizer origin, map rotation, map offsets, scale and sequence identification, SAVE data and map parameters for later restart, RESTART saved job, RESTART previously digitized file from disk or magnetic tape (ASCII or EBCDIC), TURN on or off the graphics CRT, REPLOT the current file, ZOOM in on selected portions of the plotted map, RESTORE original map plot, UPDATE parameter default table (i.e. scale, offset, plot limits, etc.), SELECT symbol, line type, or letter font type, ENTER attribute data using up to 40 characters of variable and 10 characters of constant data, FORWARD space or backspace within digitized file, RECORD, RECORD and add to XY stack, RECORD using substitution from XY stack, FIND a point using cursor, DELETE a point, FIND and delete a point, RECOVER deleted points, TRACK digitizer cursor on graphics CRT plot, TURN off alphanumeric CRT, ENTER numeric attribute data from keypad, RECORD in stream mode by delta X and delta Y, or delta distance modes, INSERT user-defined pen-up code for disconnection, CLOSE polygon, CONSTRUCT circle using three points, COMPUTE circumference, COMPUTE area, SAVE digitized file on disk or magnetic tape (ASCII or EBCDIC), LIST data to teletype or line-printer, SELECT letter size, CREATE label between two digitized points, CREATE label by size, REPOSITION label, EDIT label text, DELETE or recover label, INSERT new point before or after current point, DELETE sequence of points, REPLACE current point, RECORD in special chart and log mode having 16 user-defined, selectable amplitude scales.

Special functions also available include the following:

RIGHT, left or center justify labels, CREATE curved labels, INSERT digitized record segment into current record, REPEAT polygons, lines, etc., ROUND-off digitized XY data to any user-selected grid system, GENERATE curve for hyperbola, parabola, spiral, etc., ACCESS graphic macros, SPLINE fit line data, CREATE automatic square, rectangle and other geometric shapes, GENERATE symbol types, line types and letter font, AUTOMATICALLY insert dimension lines, CREATE isometric and perspective drawings, CONSTRUCT parallel lines, SELECT various graphics CRT cursors (round, square, etc.), and INCORPORATE software hooks for user interface.

CRC EXPLORATION SYSTEM

-SOFTWARE-

GEOLOGICAL/MAPPING SOFTWARE MODULE

*GRIDDING/GRID OPERATIONS

*CONTOURING

*CONTOUR EDITING

*REGIONAL, RESIDUAL ANALYSIS

*DATA SMOOTHING

*STATISTICS

*VOLUMETRICS

*BASEMAP CONSTRUCTION

*LEGAL WELL LOCATION CONVERSIONS

*LEASE MAP CONSTRUCTION

*DATA STORAGE/RETRIEVAL

*CARTOGRAPHIC DISPLAY/PLOTTING

*MAP PROJECTIONS/COORDINATE CONVERSIONS

*LOG ANALYSIS

*DATA EDITING

GEOPHYSICAL/MAPPING SOFTWARE MODULE

*SEISMIC MODELING

*SEISMIC LINE INTERSECTIONS

*SEISMIC MIGRATION

*SYNTHETIC SEISMOGRAMS

*VELOCITY INTEGRATION

*VELOCITY PLOTTING

*CROSS SECTIONS/FENCE DIAGRAMS

*SHOT POINT PLOTTING

COMPUTER RESEARCH CORPORATION
5161 WARD ROAD
(303) 421-0644
WHEAT RIDGE, CO. 80033

BASEMAP SYSTEM

Designed to provide fast and accurate visual display of any digitized township-range-section data, and to plot and annotate point data with user-generated symbol and letter font libraries. The system also computes location information in linear or lat-long coordinates from quarter-quarter or footage descriptions. Digitized township-range data is readily available from CRC for most of the Rocky Mountain states and the Mid-West.

CARTOGRAPHIC SYSTEM

A versatile map drafting system with a generous selection of mapping options. Graphical data is accepted in lat-long or linear units, and each entry may include up to 720 characters for attributes and map identification. A large library of map symbols for representing point features, line types for linear features (rivers, roads, etc.) and font types for labeling provide a complete and flexible mapping environment. Map symbols may be of any size or position, and map scales may be freely changed as needed. Label text, size, position, and slant are user-defined with selected attribute data used as text if desired. Attractive title and border options are also available. The terminal crosshairs make insertion, deletion, or replacement of points easily achieved when needed.

MINING AND PETROLEUM SYSTEM

Designed to produce accurate contour maps from randomly spaced groups of points having known information (as, for example, elevation points, well locations with sub-sea elevations, chemical analysis in water wells, etc.). In addition, the system will perform many needed calculations on the information given or that produced in the contouring process. Computations include: surface area and volume between two known elevation values, arithmetic operations on gridded or random data values, and trend analysis. The system also provides division of contoured areas for volume computations (unitization mining, etc.), cross-section construction, and 3-dimensional representation of surfaces.

FILE HANDLING AND RETRIEVAL SYSTEM

Retrieves selected information based on location within a polygon, attribute data, or combination of both. Selection is accomplished by simple comparison techniques. Attribute selection is performed by comparing file contents to one or more specific conditions. Up to 40 criteria may be used, individually or in combination, to determine selection. Each specifies a data field to be tested, the relationship, and a value or string to be used in the comparison test. Relationships include equality or inequality for alpha and numeric comparison, and greater than, less than, greater than or equal to, and less than or equal to for numeric comparisons only. Selected data is provided in an output file or defined by an area outline. A deletion option is also available allowing retrieval of all features not passing comparisons tests.

STATISTICAL SYSTEM

Covers a wide range of operations. Computations are performed on mapping features, attribute data, or grid information. Some of the options available are: calculate minimum, maximum, delta, mean, standard deviation, sum of samples, and sum of squares for X, Y, and Z data; two-way classification of the frequency, percent frequency, and other statistics for any two selected variables; means, standard deviations, sums of cross-products of deviations, and correlation coefficients; multiple linear regression, polynomial regression, canonical correlation, analysis of variance, factor analysis, and more.

COMMON AREA SYSTEM

Particularly useful in facilitating land project planning. This system defines the relationship of different attributes, such as soil conditions, vegetation, natural hazards, ground water level, ownership claims, etc.,in a given area. Up to sixteen areas may be selected, each according to the presence or lack of up to ten attributes. The system then provides a color-coded map with shaded areas showing either inclusion or exclusion of each selected area. Overlapping portions are easily visible. Coordinates of both inclusive and exclusive areas are saved for additional common area selections.

LEGAL/PROPERTY/ ENGINEERING SYSTEM

A unique system designed to translate complex property descriptions into usable coordinate form. This interactive system accepts information from both legal documents (deeds, lease agreements, tax records, bills of sale, engineering notes, surveys, etc.) or actual maps, and converts property boundaries into convenient X, Y coordinate form. Each legal or map entry is immediately plotted on the graphics CRT for verification. Input description types include quarter-quarter, compass traverse, interior angle traverse, curves (circular, parabolic, hyperbolic, spiral, etc.), intersection of two lines, intersection of line and curve, etc. This flexible engineering macro package provides easy solutions to intersection, traverse adjustment, and other surveying problems.

DATA ENTRY SYSTEM

A versatile, easy to use data entry system for the encoding of general attribute data. Operator procedures are grouped into three major functions — data entry, verification, and modification. The system is used interactively, and provides several alternative procedures for performing each function. Verification, for example, may be performed in one of three ways: (1) the system displays each field and automatically proceeds to the next, (2) the system displays each field and waits for carriage return before continuing to the next, or (3) the operator re-enters each field and if the entry matches the original contents, the system then proceeds to the next field. Data entry may be provided in any prespecified format, with a variety of mechanisms available to simplify the entry process.

For more information on hardware or software systems, contact:

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DIGITIZING/DATA CAPTURE SOFTWARE MODULE

*POINT/LINE/STREAM/LABEL DIGITIZING

*LOG/CHART DIGITIZING

*TOWNSHIP DIGITIZING

*SEISMIC SECTION DIGITIZING

*TEXT ENTRY

*SYMBOL/CHARACTER FONT/LINE TYPE GENERATION

*EDITING

*SCALING/MULTI-POINT SCALING

*OFFSETTING/ROTATION

*REAL TIME/INTERACTIVE DATA DISPLAY

*MIXED LEGAL/DIGITIZER INPUT

UTILITIES

*COPYING/DELETING

*APPENDING/MERGING

*SORTING

*EDITING/UPDATING

*VARIABLE FORMATTING OF INPUT DATA

*ZOOMING/WINDOWING/CLIPPING/OVERLAY

*SCALING/OFFSETTING

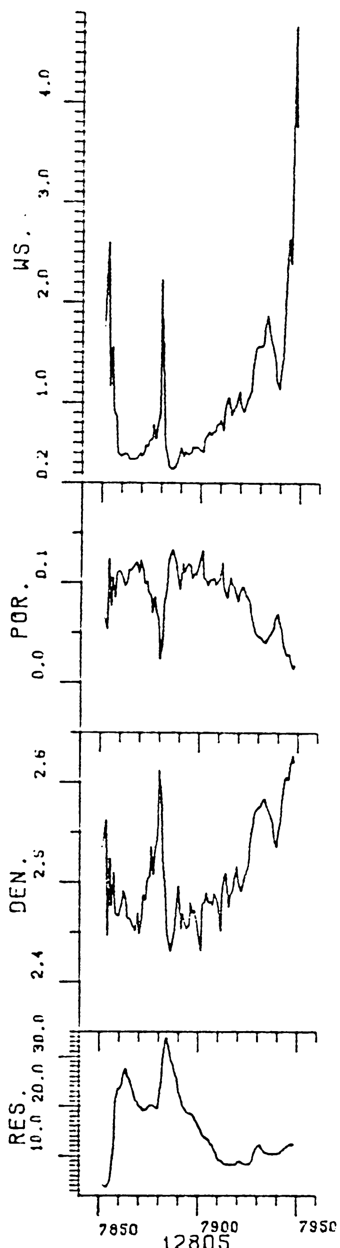
*TITLE/BORDER DISPLAYS

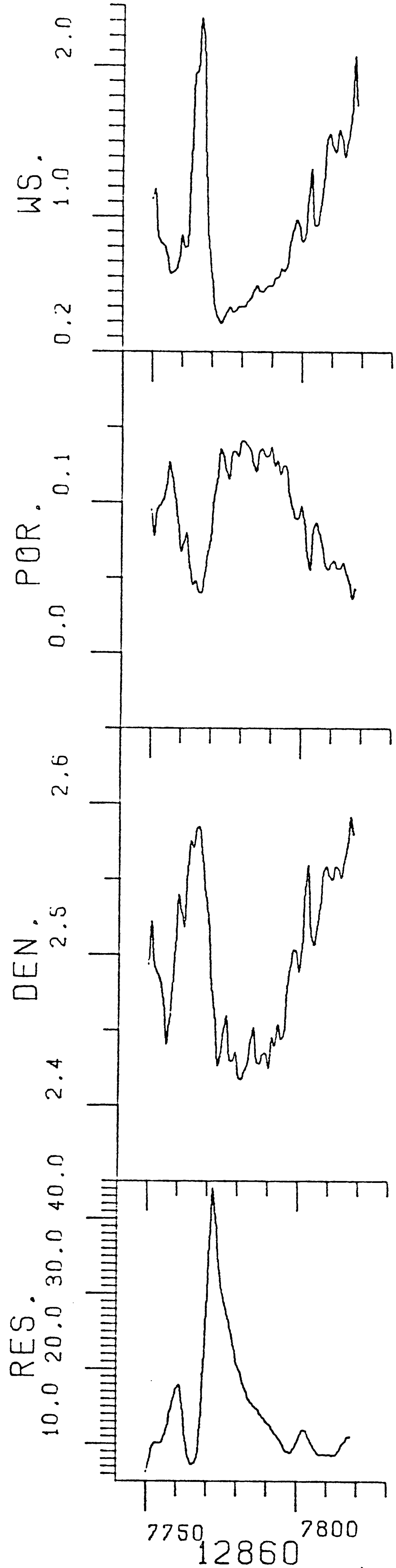
*FORMAT CONVERSIONS

*ASCII/EBCDIC TRANSLATIONS

LOG ANALYSIS

Resistivity
Bulk Density
Porosity
Water Saturation

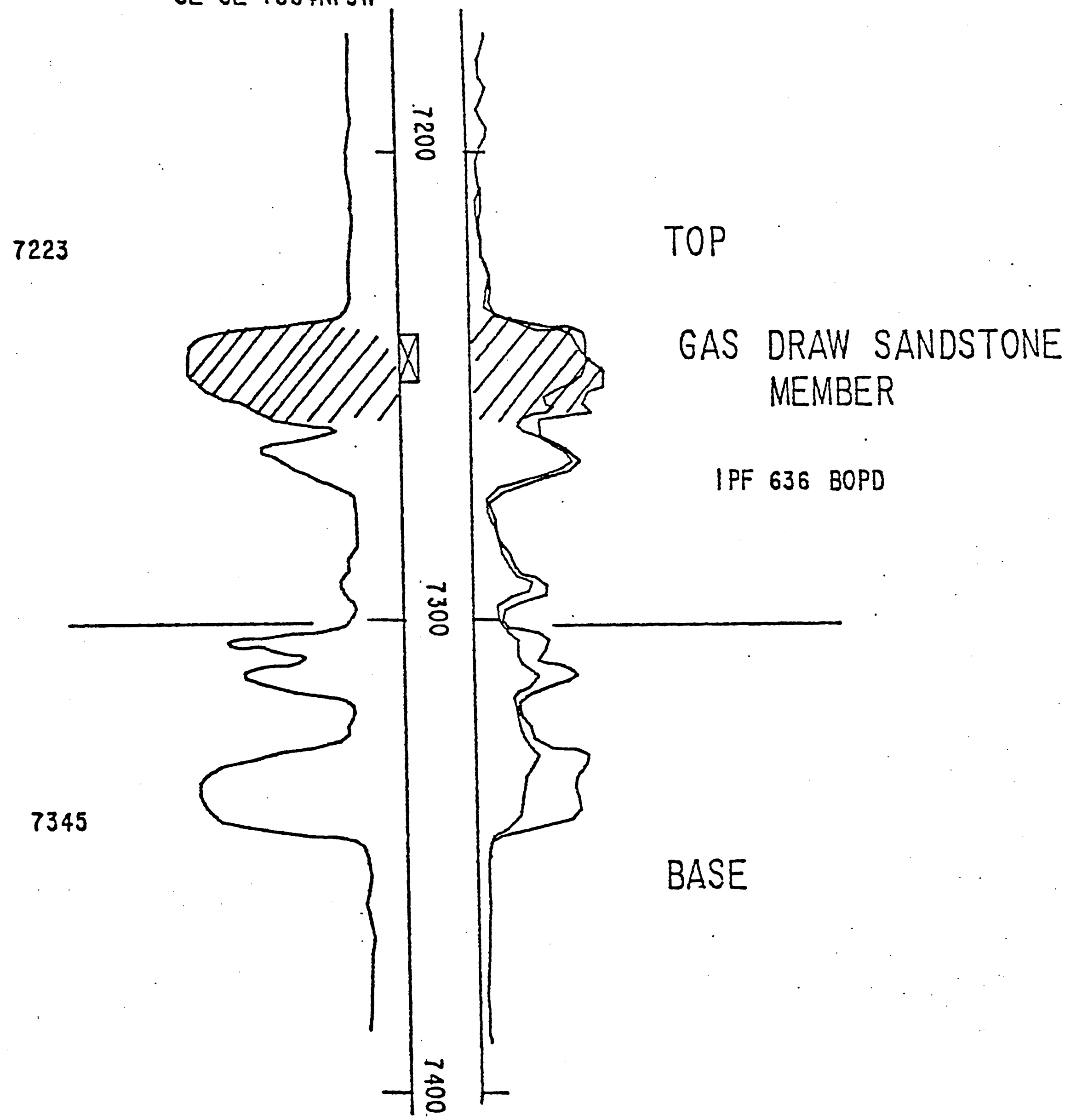




DAVIS OIL COMPANY

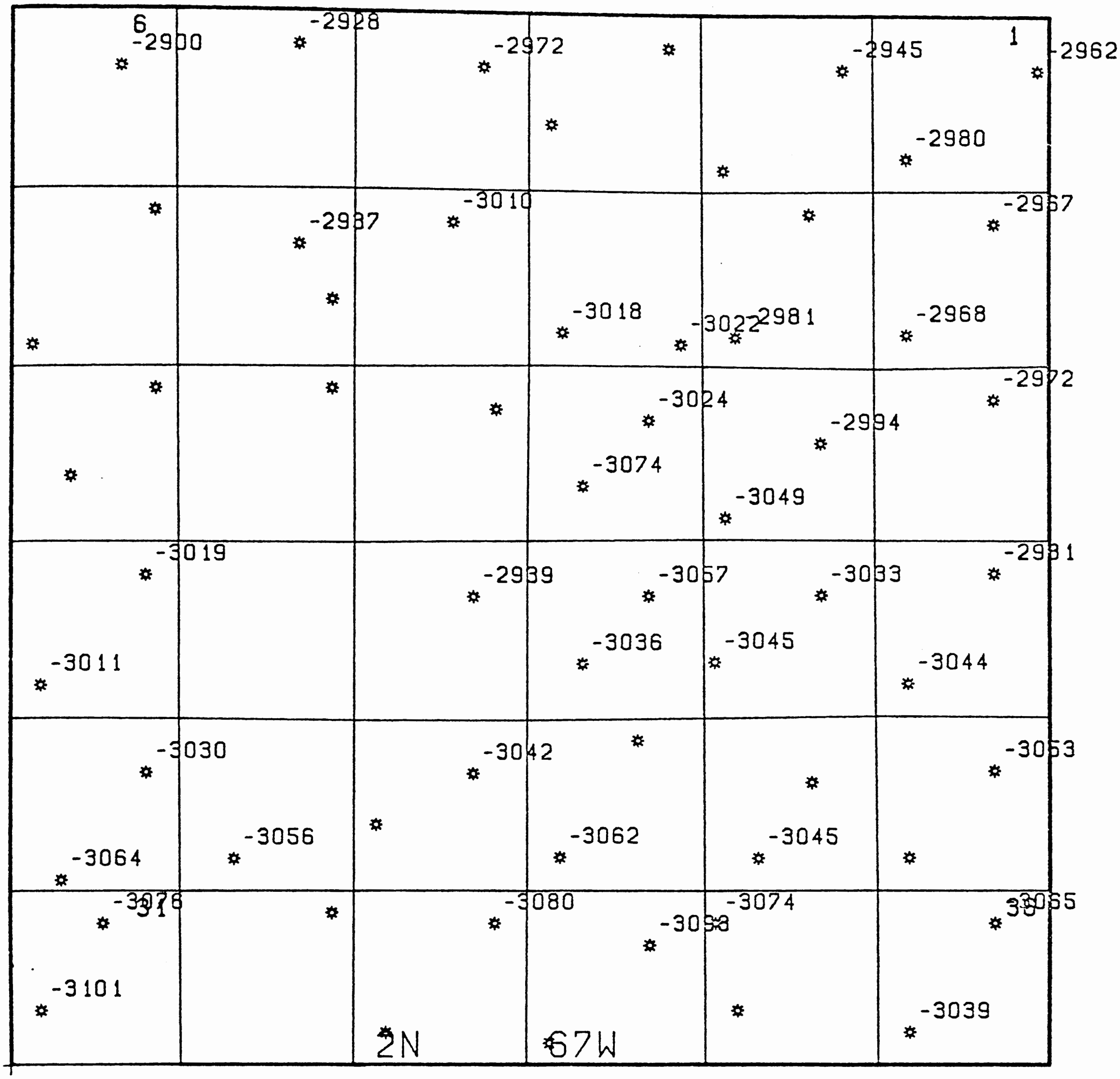
MERRITT FEDERAL 2

SE SE 1354N73W



TYPE MUDDY FORMATION LOG

GAS DRAW FIELD

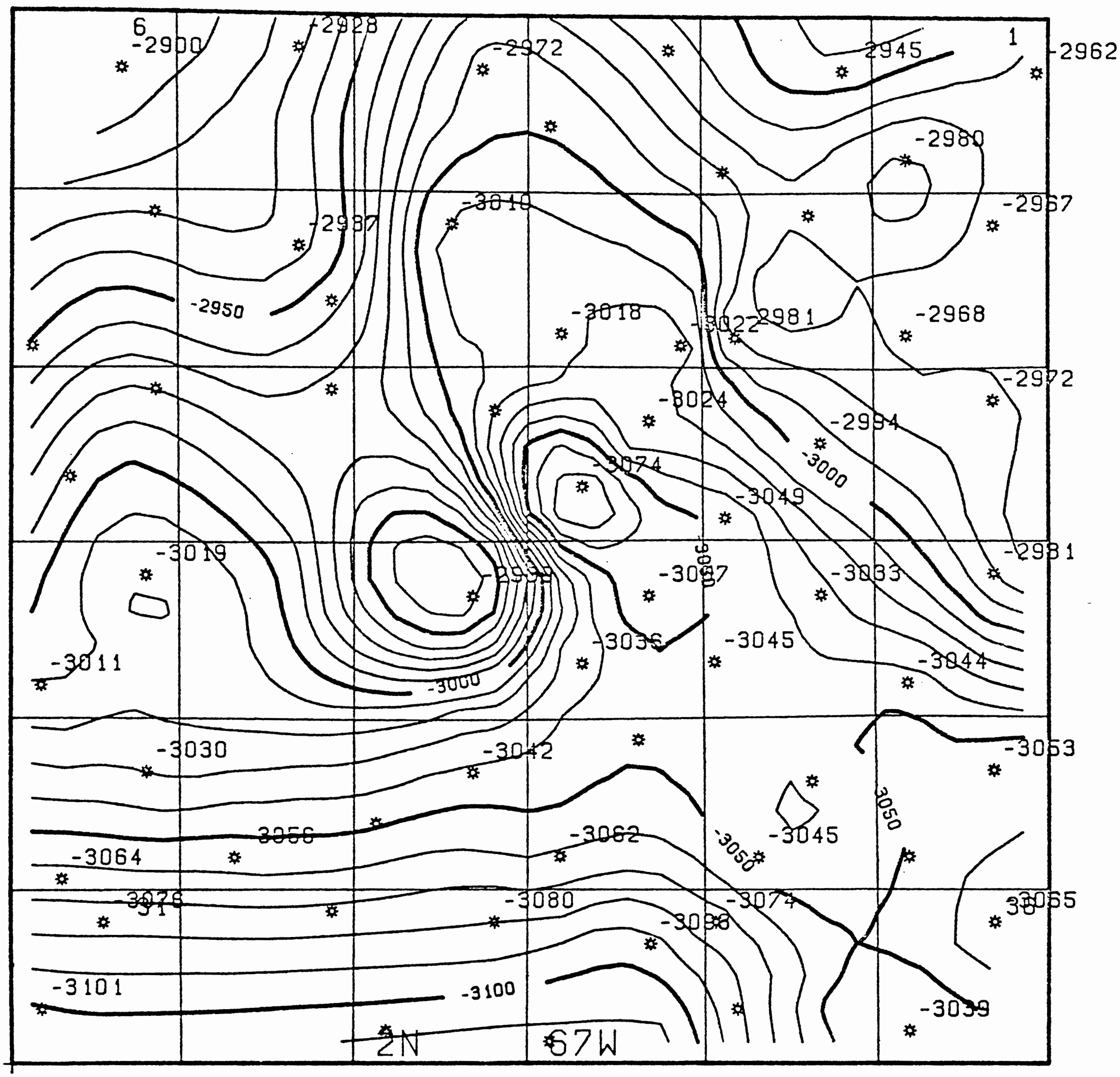


SUBSEA WELL ELEVATIONS

(SAMPLE MAP)

SCALE - 1":3000'   CONTOUR INTERVAL - 10'

PREPARED BY
XYZ CORPORATION



SUBSEA WELL ELEVATIONS

(SAMPLE MAP)

SCALE - 1":3000'   CONTOUR INTERVAL - 10'

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