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TITLE: PREPARATION OF NORTHERN MID-CONTINENT PETROLEUM ATLAS

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FOREWORD

Project members and contributors to this report include: Dana Adkins-Heljeson, Saibal Bhattacharya, Tim Carr, Lee C Gerhard, Paul Gerlach, Willard Guy, Robert O'Dell, Ken Stalder and W. Lynn Watney. A digital copy of the report is available through the Digital Petroleum Atlas Homepage (http://www.kgs.ukans.edu/DPA/dpaHome.html).

ABSTRACT

Report covers the fourth year of the Digital Petroleum Atlas (DPA) Project. The DPA is a long-term effort to develop a new methodology for efficient and timely access to the latest petroleum data and technology for the domestic oil and gas industry, research organizations and local governmental units. The DPA is a new and evolving approach to generating and publishing petroleum reservoir, field, play and basin studies. Atlas products are available anywhere in the world using a standard point-and-click world-wide-web interface (http://www.kgs.ukans.edu/DPA/dpaHome.html). In order to provide efficient transfer of the technology for client-defined solutions, all information and technology in the DPA can be accessed, manipulated and downloaded.

The DPA increases and improves online access from data through to "final publication." Until recently petroleum atlases circulated like all scholarly information, through personal exchanges, subscriptions, and libraries. Today, digital scientific information is becoming the norm. The result - a dramatic increase in the international and disciplinary scope of information exchange in the petroleum industry. Digital communication has made traditional collaborative activity more informal, intimate, instantaneous, and continuous. At the present the DPA provides worldwide access to limited but constantly increasing data and interpreted information. For example, data from each of over 300,000 oil and gas wells in Kansas are being accessed online for projects in locations from Chanute, Kansas, to Houston, Texas, to Berlin, Germany. Programs developed through the DPA provide oil and gas operators and the public tools to make exploration and development decisions using seismic data, interpreted well logs, and mapped petroleum information. The DPA provides online access to digital versions of researchers' published bulletins, maps, and reports. Through the DPA, we are working to provide online tools that will permit our colleagues and customers to better query, interpret, map, and display the latest information and research results in earth science databases that could be scattered anywhere in the world. These "published" products are living, created on demand, customized to best address a specific earth science question, and access data that is continuously updated and improved. The DPA has significantly altered the relationship between research results, data access, the transfer of technology, and our relationship with our clients.

The fourth year of the project moved forward to expand the development and integration of relational databases into the DPA. The result is that while the coverage and the detail have increased the number of static pages in the DPA has decreased significantly. The use of relational databases means that previously completed products, such as field and basin studies, are automatically updated with the latest production and well data. In addition raster images such has completion reports are scanned and uploaded into relational databases and can be used for efficient construction of larger scale studies. Over the last year content of the DPA has increased with three additional field studies (Box Ranch, Kismet and Stewart fields), comprehensive regional maps on all major oil and gas producing horizons and several new county scale maps. The DPA Project continues to provide improved access to a "published" product and ongoing technology transfer activity. The DPA remains widely used by oil and gas

producers and other groups interested in natural resources.

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EXECUTIVE SUMMARY

The Digital Petroleum Atlas (DPA) Project is in the fourth year of a long-term effort to develop a new methodology to provide efficient and timely access to the latest petroleum data and technology for the domestic oil and gas industry, public sector research organizations and local governmental units. The goal of the DPA is to provide real-time data access through the Internet, coupled with digital modeling to simulate and visualize petroleum systems. The DPA will enable an improved integrated systems approach to the petroleum exploration and development. The result: projects are far more interdisciplinary than in the past, and are conducted within an environment of rapidly increasing quantities of data, and varieties and modes of dissemination. Data accessibility requires operators to apply not only more data but also different types of data than before to develop, verify, and successfully apply models to exploration and development decisions.

The DPA provides real-time access through the Internet using widely available tools such as World-Wide-Web browsers. The latest technologies and information are "published" electronically when individual project components are completed, removing the lag and expense of transferring technology using traditional paper publication. Active links, graphical user interfaces and database search mechanisms provide a product with which the operator can interact in ways that are impossible in a paper publication. Contained in the DPA are forms of publication that can only be displayed in an electronic environment (for example, relational searches based on geologic and engineering criteria). Improvement in data and technology access for the domestic petroleum industry represents one of the best and cost-effective options that are available for mitigating the continued decline in domestic production.

Year 4 of the project concentrated on increased integration of relational databases that permit automatic updating of all DPA products (e.g., latest production and well data for field studies). Pages containing production data are generated through queries of the most currently available data. In this aspect the DPA is a constantly and automatically updated product that will remain current well beyond the duration of the project. Additional fields added to the DPA bring the total to 11 plays. New fields added to the DPA include: Box Ranch (Comanche County), Kismet (Seward and Meade counties) and Stewart Field (Finney County). Field studies generated in previous years of the project remain, and have been enhanced with updated data and additional maps. These fields include: Chase-Silica Field (Arbuckle) in Rice, Barton and Stanford counties; McKinney Field (Chester, Marmaton, and Morrow) in Meade County; Arroyo Field (Morrowan), Stanton County; Big Bow Field (St. Louis), Grant and Stanton counties; and Gentzler Field (Morrowan), Stevens County; Amazon Ditch and Terry fields (Lansing-Kansas City, Mississippian and Morrowan), Finney County; and Schaben Field (Mississippian), Ness County. Ten counties now contain detailed maps on multiple horizons. Regional maps at the statewide scale cover all the major oil and gas producing intervals. Methodologies developed in year four of the DPA Project provide improved access and increased breath to a continuously "published" product and ongoing technology transfer activity.

Usage statistics and unsolicited feedback show that oil and gas producers are using the DPA on a regular basis to develop prospects, evaluate properties and provide regional background to ongoing and potential projects. In addition, public sector agencies, such as the Kansas Corporation Commission, Kansas Department of Revenue and the US Department of Energy, Energy Information Agency use the data and results available in the Digital Petroleum Atlas.

INTRODUCTION

THE NEED FOR A DIGITAL PETROLEUM ATLAS

The United States obtains 85 percent of its energy from fossil fuels, nearly 40 percent from oil alone (of which half was imported), and 24 percent from natural gas (President's Committee of Advisors on Science and Technology, 1997). U.S. fossil fuel dependence, like that of the rest of the world, will decline only slowly in the future. It has been estimated that fossil fuels will provide two-thirds of all world energy needs in 2030 and half or more in 2100 (EIA, 1997). Petroleum demand is projected to grow from 19.5 million barrels per day in 1999 to 25.8 million in 2020—an average rate of 1.3 percent per year—led by growth in the transportation sector, which accounts for about 70 percent of U.S. petroleum consumption (US Department of Energy, 2000a). U.S. crude oil production is projected to decline at an average annual rate of 0.7 percent from 1999 to 2020, to 5.1 million barrels per day. U.S. oil imports, according to the "reference" forecast of the Department of Energy, would grow from 9 million barrels per day in 1995 to 14 million barrels per day in 2015 and continue to increase for some time thereafter (US Department of Energy, 2000). The Digital Petroleum Atlas program addresses many of the issues of insuring secure U.S. oil and gas supply as outlined by the report of the President's Committee of Advisors on Science and Technology (1997).

The US and the Northern Mid-continent have large remaining oil and particularly gas resources in numerous reservoirs. A higher percentage of original oil and gas in place can be produced if old and new data and knowledge are made available to operators. Basic data and innovative developments in technology need to be directly accessible to assist operators in day-to-day decisions. While technology and information are extremely important to independents, they do not have research departments and must rely on collaborative research and development efforts (US Department of Energy, 2000b). The Kansas Geological Survey is working with the U. S. Department of Energy and oil and gas producers to create a Digital Petroleum Atlas (DPA) to meet information and technology needs. The DPA is unique in that it provides independent petroleum operators on-line digital and hard copy information, digital data bases, new scientific study of typical fields of the region and purposeful technology transfer.

The DPA increases and improves online access from data through to "final publication." Until recently petroleum atlases circulated like all scholarly information, through personal exchanges, subscriptions, and libraries. Today, digital scientific information is becoming the norm. The result - a dramatic increase in the international and disciplinary scope of information exchange in the petroleum industry. Digital communication has made traditional collaborative activity more informal, intimate, instantaneous, and continuous. At present the DPA provides worldwide access to limited but constantly increasing data and interpreted information. For example, data from each of over 300,000 oil and gas wells in Kansas are being accessed online for projects in locations from Chanute, Kansas, to Houston, Texas, to Berlin, Germany. Programs developed through the DPA provide oil and gas operators and the public tools to make exploration and development decisions using seismic data, interpreted well logs, and mapped petroleum information. The DPA provides online access to digital versions of researchers' published bulletins, maps, and reports. Through the DPA, we are working to provide online tools that will permit our colleagues and

customers to better query, interpret, map, and display the latest information and research results in earth science databases that could be scattered anywhere in the world. These “published” products are living, created on demand, customized to best address a specific earth science question, and access data that is continuously updated and improved. The DPA has significantly altered the relationship between research results, data access, the transfer of technology, and our relationship with our clients.

Integrated analysis in the petroleum sector requires large quantities of high-quality current information. A model of a petroleum reservoir or play cannot be more accurate than the description used to create the model. For each grid block within a model, critical attributes such as velocity, porosity, thickness, fluid saturation, and permeability must be accurately specified. If these attributes are incorrect, a reservoir simulation or seismic volume will not accurately model processes. Models (simulations and visualizations) based on simplified information that does not account for complex features and interactions do not provide accurate answers to geologic questions. No single approach can provide complete knowledge concerning a process such as movement of fluids through an oil or gas reservoir. However, integrating technology and large quantities of information from several disciplines has the best chance to successfully understand and exploit petroleum resources. Steadily decreasing cost of computing and communication, enhanced capabilities for collection of digital scientific data, greatly increased network bandwidth, the advent of digital wireless communication, increased access to long-distance communication, growing capabilities of natural language processing, and improved standards in data structures and network communication have had a positive impact on the exchange of digital data and information, and increased collaborative work among domestic operators. The Digital Petroleum Atlas is an attempt to bring these advances in information technology to the independent oil and gas operator. The atlas provides independent US operators easy access to large quantities of high quality information to evaluate technologies that are best suited for additional oil and gas recovery. Information is available when and where operators need it (literally on the operator's desk).

Short of conducting a full-scale reservoir analysis of each producing field, the DPA will provide a tool to enhance Kansas oil and gas production. The demonstration of the digital petroleum atlas will also enable similar projects to be instituted in other petroleum producing areas, so that a geographically broad on-line digital database will be available to domestic operators. The ultimate goal is a national digital petroleum atlas.

An efficient and effective method of communicating key information to operators is by example. For each reservoir type in a producing region, a thoroughly studied and documented analog can illustrate geologic and engineering procedures that are likely to be most successful in increasing ultimate recovery. An analog example provides operators with sufficient information and procedures to study producing fields, and increase production and ultimate recovery by modifying and applying proven methods. One way to accomplish the goal of disseminating information by analog is to provide a digital on-line geological and engineering based, state-of-the-art petroleum atlas that contains not only historical data and descriptions, but technologically advanced syntheses and analyses of "why reservoirs produce" and "how ultimate production may be increased." This is a national need. A digital petroleum atlas is an efficient and effective vehicle to provide access to legacy databases and innovative knowledge that can be used by the operator.

The traditional role of technical publication is to formalize and record scientific and technical results in time, and to transfer technology to potential users (Kerkhof, 1994). The published petroleum atlas is a time-honored approach to illustrating by analog the latest petroleum exploration and development knowledge and application (e.g., Powers, 1929; Galloway, et al., 1983; Bebout, et al., 1993,). Similar proprietary compilations are common at major petroleum companies. The underlying goals of these petroleum atlases have been to:

- Synthesize information on major reservoirs, fields, plays and basins;
- Assist in efficient exploration and development by increasing technical knowledge of trapping, discovery and production of oil and gas;
- Serve as analogs for reservoirs, fields and plays similar to those described; and
- Provide an overview and introduction to the various petroleum basins described.

The traditional published atlas is a time consuming and expensive process that results in a static paper product. Typically, products and data are limited by space and cost considerations to summary information at the field or reservoir level. For each play, field, or reservoir only a relatively small number of author-selected maps, cross-sections, charts and other summary data are included. Typically, the paper atlas does not provide access to well and lease data or to intermediate research products (such as digital geographic and geologic components of maps, interpreted and uninterpreted subsurface data, well test analyses, thin section images, and other traditionally unpublished material). Without access to the data and intermediate products, modifying and updating a published field study to fit a user-defined application or new scientific idea is a difficult and time consuming process.

Today, traditional channels of scientific and technical communication represented by the petroleum atlas are being challenged by the shear volume of publication, the increased unit costs, the relatively decreased resources of academic and industrial library systems, and the rapidity of technical change (Okerson,1992). In addition, the growth of networks, storage servers, printers, and software that make up the Internet are rapidly changing the world from one in which research organizations, publishers and libraries control the printing, distribution, and archiving to a world in which individuals can rapidly and cheaply “publish”, provide access and modify scientific results on-line. These changes offer significant challenges and opportunities both to public and private sector participants and to the traditions of technical publication (Denning and Rous, 1995).

KANSAS PETROLEUM ATLAS

The Kansas Digital Petroleum Atlas (DPA) is on-line publications available on the Internet anywhere in the world using a standard point-and-click world-wide-web interface (Figure 1). The Uniform resource locator (URL) is http://www.kgs.ukans.edu/DPA/dpaHome.html. The DPA consists of studies at reservoir, field, play and basin scales. The DPA is a dynamic, evolving product with

new structure, research results, and data appearing almost daily. Through complete and flexible user access to technology, interpretative products, and underlying geologic and petroleum data, the DPA alters the relationship between interpretative result and data, between technology generation and application. At the present time, the Digital Petroleum Atlas currently contains just over 3,000 static web pages covering 11 counties, 10 fields and two regions of Kansas. "Static" pages, actual HTML text files on the DPA web server showing information to visitors, have decreased significantly since the last report (Carr and others, 1999). Today, most DPA pages do not exist as static pages but are constructed using templates and information (data and images) retrieved from relational databases. A template is used to construct an entire class of pages. For example, for a set of county geology pages (Figure 2), the only differences are the names of the files, the window titles, and the two figures (i.e., map and stratigraphic chart). The navigation is adjusted for each page (assigning a "Previous" page and assigning a "Next" page). As a result, a new set of geologic maps, core photos, etc., for a new play or field can be integrated into the DPA efficiently as a new set of static web pages. In addition, programs that use templates and can query relational database systems containing production, well and electric log data provide web access to data stored in relational databases. The combination of static and dynamic web pages cover Kansas's oil and gas plays at scales from the regional through the single well sample. The DPA also consists of a navigational architecture that permits accessing information by a number of methods.

USAGE OF THE PROTOTYPE DIGITAL PETROLEUM ATLAS

Since the Digital Petroleum Atlas is an electronic publication, on-line access was provided to the public soon after project inception (January 1996). Use of the DPA products was almost immediate and has grown steadily over the last four plus years (Figure 3). This near real-time transfer of technology and information to the client is one advantage clearly demonstrated by the DPA.

The pages that comprise the DPA make up the bulk of the web site for the Petroleum Research Section (PRS) of the Kansas Geological Survey. Usage statistics show that access to these pages has grown to over 65,000 access "hits" per month (Figure 3). In measuring access "hits" on the PRS site, all access to graphics is removed. This eliminates the multiple counting of access hits that result from multiple figures (buttons, bars, arrows, etc.) on a single web page. In addition, all access from the Kansas Geological Survey subdomain (kgs.ukans.edu) is removed. This measurement protocol produces a consistent and conservative measure of external usage. Current usage statistics are collected daily and weekly and are available on the Petroleum Research Section of the Kansas Geological Survey web site (http://www.kgs.ukans.edu/usage/past_stats.html).

Each month a detailed usage report is generated for the oil and gas portion of the Kansas Geological Survey web site. The latest report for December 2000 (http://www.kgs.ukans.edu/usage/2000/dec_wt/DEFAULT.HTM) provides rough quantitative measures for the Digital Petroleum Atlas. In April, the pages of the Digital Petroleum ranked higher among the most requested pages (Figure 4). Other highly requested pages on the Petroleum Research web server are portals that provide general access to the Digital Petroleum Atlas and other oil and gas information. After the user enters the Digital Petroleum Atlas Home Page or DPA-Kansas Page they split off in any number of directions. The Digital Petroleum Atlas Home Page was also the number 2 most popular entry page and the number 3 most popular exit page. This is interpreted to mean that the DPA is book marked and users jump directly to it. The December statistics also show that the Petroleum Research Web Site and the Digital Petroleum Atlas appealed primarily to companies (.com domain with 58 % of total hits) and networks (.net domain with 39%). The .net domain is interpreted as representing the very small independent and consultant who uses a local or national Internet access provider. Statistics for December 2000 measure the most accessed directories on the Petroleum Research web server. The DPA is the most accessed directory with over 30 percent of the total hits for the site (Figure 5).

Other measures of the impact of the Kansas Digital Petroleum Atlas are unsolicited comments and success stories received by users. A selection of comments is provided in Appendix A.

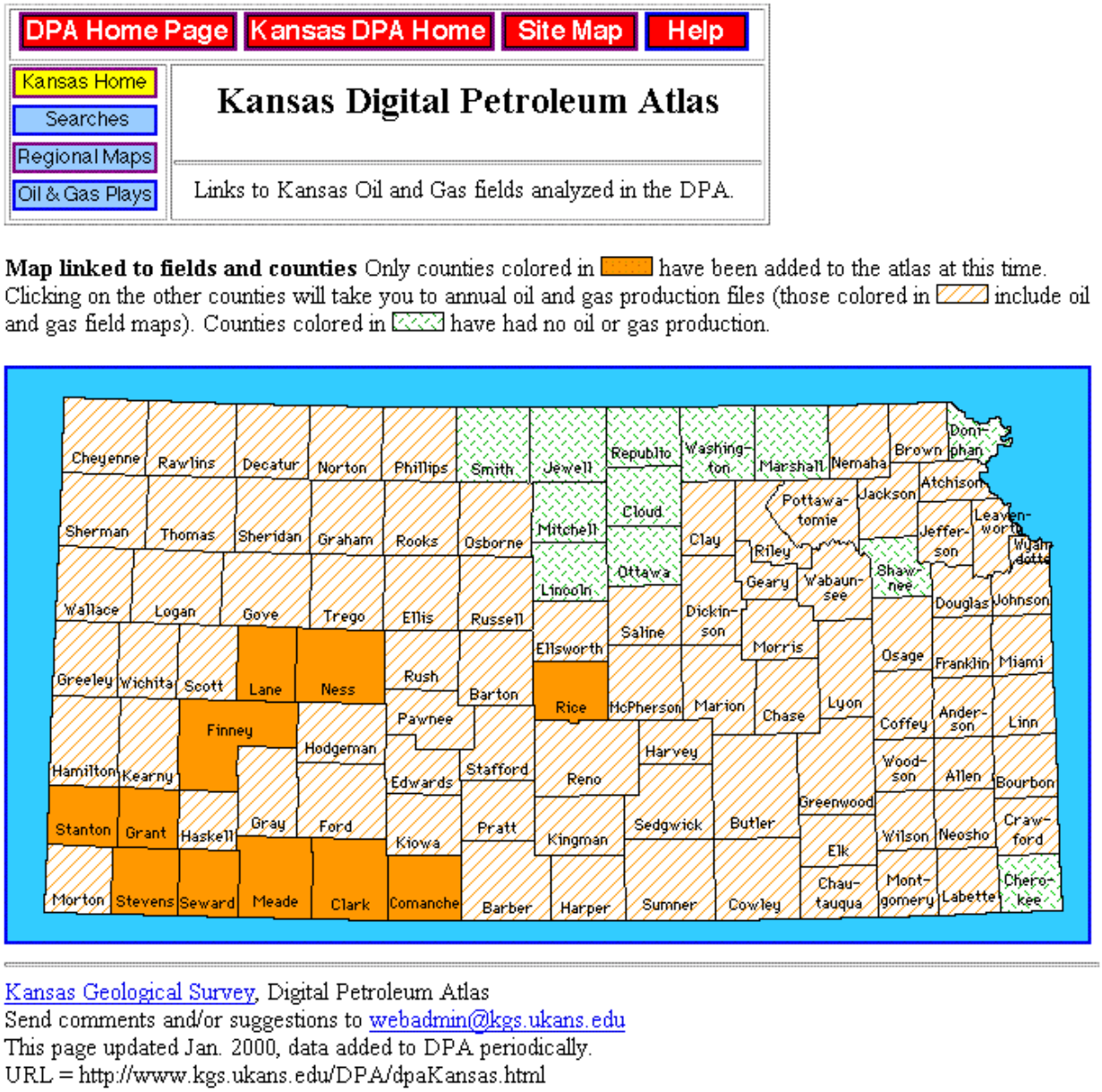


Figure 1. Interactive map of Kansas Digital Petroleum Atlas (DPA) showing counties containing fields and plays that have been added to the DPA. Regional maps on key horizons are available for all highlighted counties. Counties not added to the DPA have oil and gas field maps and links to annual field production. During year four, county-scale maps were added covering Seward, Clark and Comanche counties.

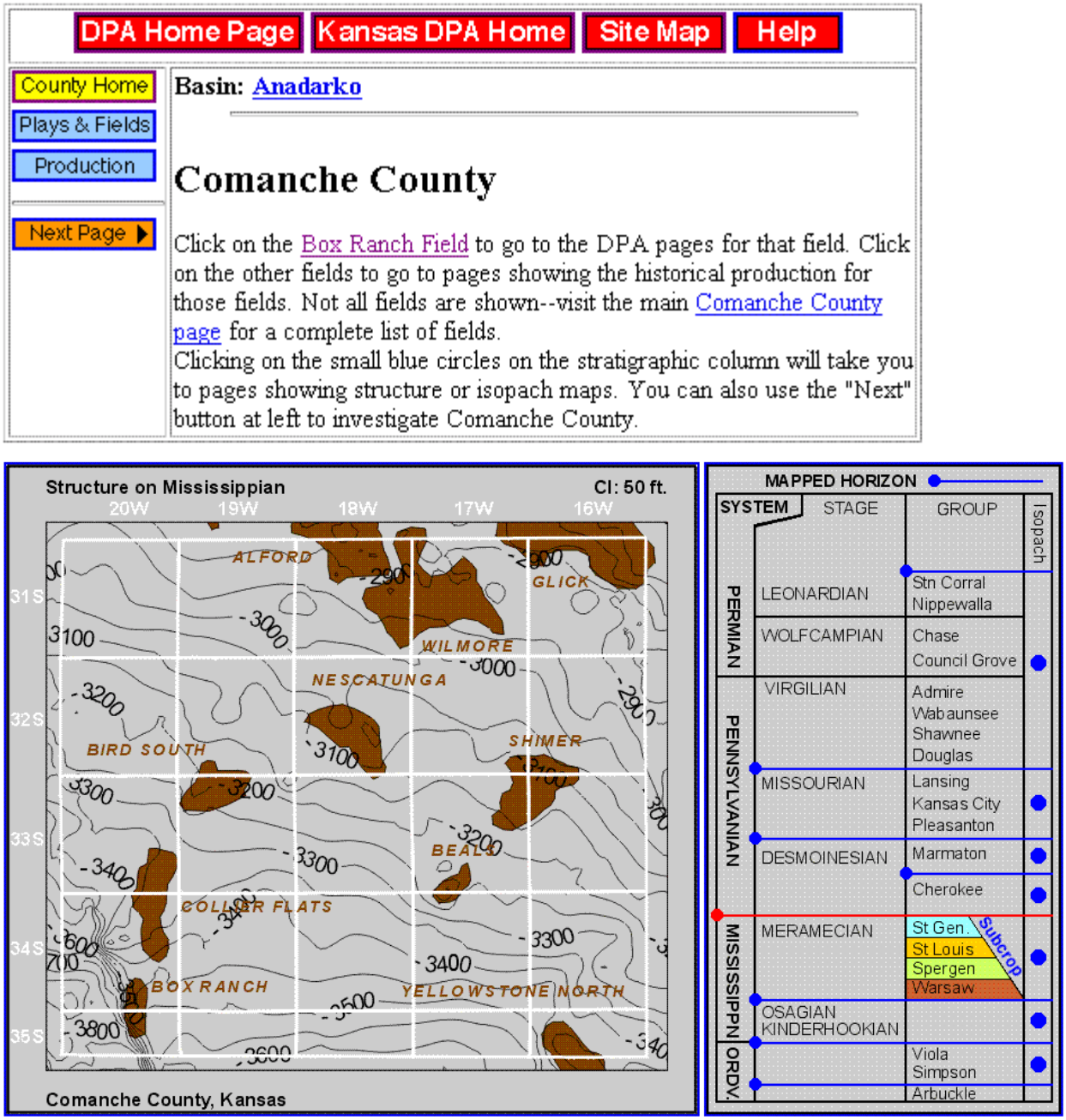


Figure 2. Comanche County, a sample county page added to the Digital Petroleum Atlas in year 4. County page shows structure on top of Meramecian and contains a field study (Box Ranch). Page shows typical navigation buttons and page layout. Map and stratigraphic column are interactive and linked to other county-scale maps and selected field studies. Blue links are active and red horizon is displayed. (http://www.kgs.ukans.edu/DPA/County/abc/comanche.html).

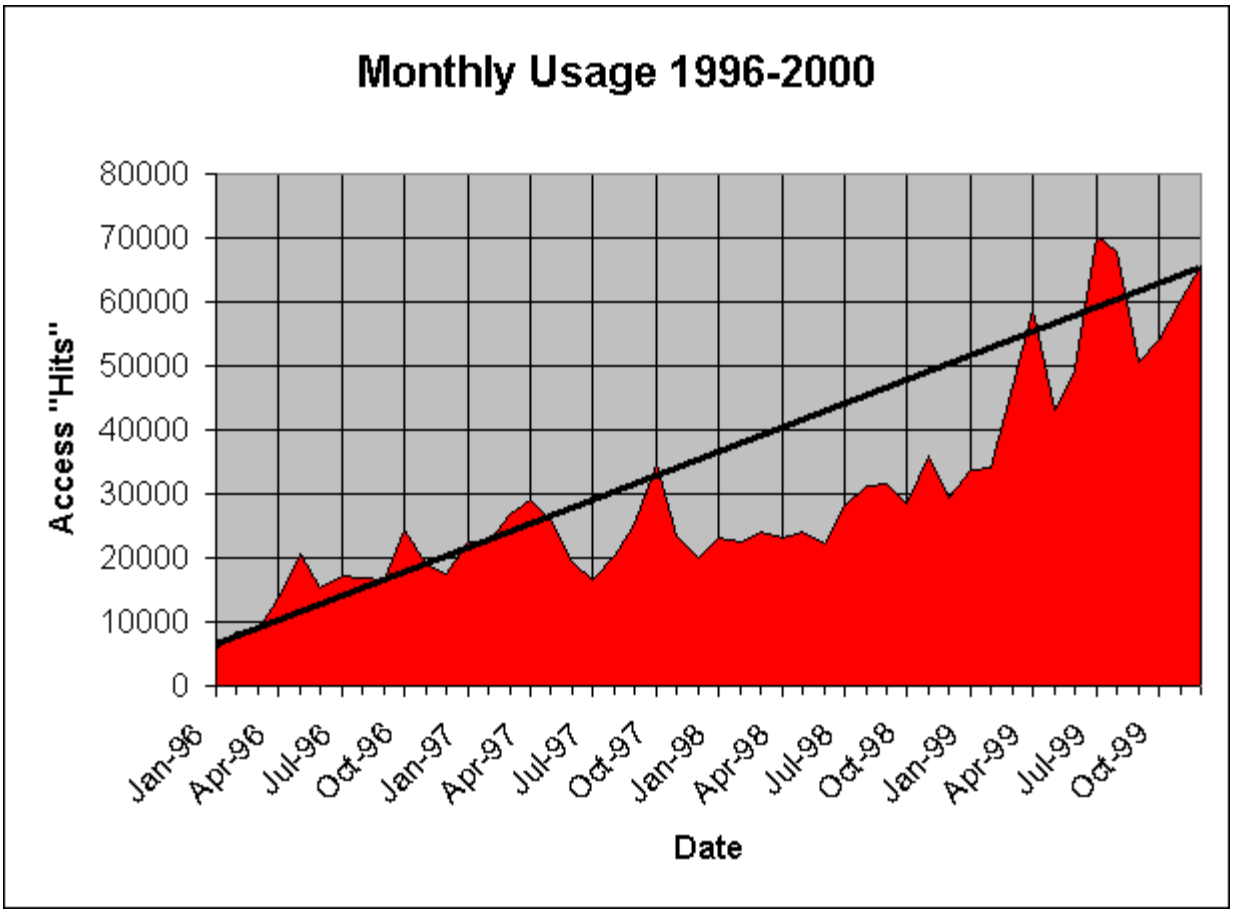


Figure 3. Monthly usage statistics measure separate pages viewed from the Petroleum Research server. Miscellaneous graphics and access from Kansas Geological Survey computers are removed prior to analysis. Current usage statistics are collected daily and are available on the Petroleum Research Section of the Kansas Geological Survey web site (http://www.kgs.ukans.edu/usage/past_stats.html).

Most Requested Pages					
	Pages	Views	% of Total Views	User Sessions	Avg. Time
1	**KGS--Oil and Gas Info** *http://www.kgs.ukans.edu/PRS/petroIndex.html*	1416	2.29%	1295	00:01:28
2	**KGS--Oil and Gas Info** *http://www.kgs.ukans.edu/PRS/petroDB.html*	890	1.44%	819	00:03:32
3	**KGS--Oil and Gas Production** *http://www.kgs.ukans.edu/PRS/petro/interactive.html*	450	0.72%	425	00:00:45
4	**Digital Petroleum Atlas Home** *http://www.kgs.ukans.edu/DPA/dpaHome.html*	415	0.67%	399	00:00:59
5	**KGS--Oil and Gas Info** *http://www.kgs.ukans.edu/PRS/petroPubs.html*	251	0.4%	238	00:01:11
6	**DPA--Kansas** *http://www.kgs.ukans.edu/DPA/dpaKansas.html*	230	0.37%	213	00:01:08
7	**KGS--Oil and Gas Info** *http://www.kgs.ukans.edu/PRS/petroLinks.html*	221	0.35%	211	00:04:26
8	**Northern Mid Continent PTTC Advisory Personnel** *http://www.kgs.ukans.edu/PTTC/*	216	0.34%	201	00:02:05
9	**KGS--Oil and gas map data** *http://www.kgs.ukans.edu/PRS/petroMaps/mapsAvail.html*	191	0.3%	183	00:01:09
10	**Energy Resource Center** *http://www.kgs.ukans.edu/ERC/*	161	0.26%	151	00:01:55
	Sub Total For the Page Views Above	**4441**	**7.18%**	**N/A**	**N/A**
	Total For the Log File	**61775**	**100%**	**N/A**	**N/A**

Figure 4. Statistics measuring most requested pages viewed from the Petroleum Research web server in December 2000. Pages that were part of the Digital Petroleum Atlas were among the most requested pages (positions 4,6). Other highly requested pages on the Petroleum Research web server are portals (positions 1-3, 5, 7, 9) that provide general access to the Digital Petroleum Atlas and other oil and gas information. Complete report for December 2000 is available online at http://www.kgs.ukans.edu/usage/2000/dec_wt/DEFAULT.HTM.

Most Accessed Directories					
Path to Directory	Hits	% of Total Hits	Non Cached %	Non Cached K Xferred	User Sessions
http://www.kgs.ukans.edu/DPA	21639	29.8%	90.43%	84,785K	4700
http://www.kgs.ukans.edu/PRS	20044	27.6%	89.92%	341,896K	5734
http://www.kgs.ukans.edu/WellLogs	13329	18.35%	50.95%	136,115K	253
http://www.kgs.ukans.edu/ERC	4445	6.12%	96.58%	22,151K	1735
http://www.kgs.ukans.edu/CO2	3333	4.59%	96.84%	11,015K	504
http://www.kgs.ukans.edu/Hugoton	2815	3.87%	90.79%	17,245K	397
http://www.kgs.ukans.edu/midcont99	1068	1.47%	98.97%	5,888K	479
http://www.kgs.ukans.edu/PTTC	695	0.95%	89.92%	3,446K	334
http://www.kgs.ukans.edu/Geophysics	660	0.9%	95.45%	169,782K	206
http://www.kgs.ukans.edu/Staff	656	0.9%	96.64%	5,908K	347
http://www.kgs.ukans.edu/Workshops	609	0.83%	57.79%	1,465K	102
http://www.kgs.ukans.edu/KCC	534	0.73%	98.5%	2,179K	256
http://www.kgs.ukans.edu/	409	0.56%	82.64%	750K	356
http://www.kgs.ukans.edu/Hexacoral	280	0.38%	93.21%	5,661K	81
http://www.kgs.ukans.edu/Class2	214	0.29%	99.53%	4,599K	111
http://www.kgs.ukans.edu/Gemini	213	0.29%	93.42%	34,675K	72
http://www.kgs.ukans.edu/KWRC	201	0.27%	100%	736K	34
http://www.kgs.ukans.edu/ExplorationServices	174	0.23%	94.25%	4,085K	8
http://www.kgs.ukans.edu/Climate	165	0.22%	85.45%	717K	98
http://www.kgs.ukans.edu/Hydro	160	0.22%	100%	1K	17

Figure 5. Statistics for December 2000 measure the most accessed directories on the Petroleum Research web server. The DPA is the most accessed directory with 30 percent of the total hits for the site. Complete report for December 2000 is available online at http://www.kgs.ukans.edu/usage/2000/dec_wt/DEFAULT.HTM.

YEAR 4: RESULTS AND DISCUSSION

WEB STRUCTURE

A goal of the Digital Petroleum Atlas (DPA) is to provide users flexible access to the original data and intermediate steps of the study. Results of field studies are fed immediately into the databases. The flexibility of the Web provides access to the data that went into the study at the same time as the results.

To support these technical goals, a design was created for the web site. Several models were drawn up, but the goals were very simple:

1. Display information assembled
2. Allow user to choose path and goals
3. Don't let user get lost.
4. Allow for efficient updating

As the DPA was constructed, there were two obvious "paths" through the digital data. The user could move geographically through several scales of data:

Play → Basin → County → Field → Well

At each geographic scale, the user would be presented with choices and answers.

a. For this county, which field would you like to see?
b. What is the structure of the Morrow in the basin?
c. For this Field, which well are you interested in?
d. For which Play is this field an analog?

As an alternative the DPA could be structured around topical areas. For the DPA the topical areas were broken into following categories:

Regional	General	Geology
Geophysics	Reservoir	Wells

For each field, basin and county, information was structured in terms of both geographic scale and topical area. These two general structural styles of information (pages based on geographical scale and pages based on topical area) result in a grid system. However, in practice this structure becomes rapidly unmanageable. While it would be nice to simultaneously compare the geologic maps of three or four fields (isopach or structure), it is not possible and not desirable to have links from each geology page to every other geology page. As a result, for the DPA we emphasized movement among geographic scales, and worked to maximize the visitor's ability to move from County to Field to Well. Movement between topical areas is limited to within the selected geographic scale (e.g., figures 1, 2).

IMPROVED DATABASE MANAGEMENT

At the present time, the Digital Petroleum Atlas currently contains over 3,000 static web pages covering 11 counties, 10 fields and two regions of Kansas. While during the last year, the DPA coverage has increased with the addition of 3 counties and 3 fields, and the detail has increased to include completion reports and drill stem tests, the number of static web pages has decreased by almost 50 percent from 6000 pages (Carr and others, 1999). Dynamic pages that are constructed on demand have replaced static web pages.

"Static" pages are actual HTML text files on the DPA web server showing information to visitors. Most of DPA pages are very similar--that is, a template can be made and multiple pages extracted from that template. For example, for a set of county geology pages (Figure 2), the only differences are the names of the files, the window titles, and the two figures (i.e., map and stratigraphic chart). The navigation is adjusted for each page (assigning a "Previous" page and assigning a "Next" page).

However, the method of creating static web pages has two problems. The first problem is maintenance of pages containing variable data. Data such as oil and gas production changes monthly, and the pages must be updated periodically. With more and more fields added, the work of creating all the new pages and updating all the previously created pages can take up all available time. The second problem is one of scale. For any small field (25-100 wells), it is easy to create pages for each well and attach scanned well completion forms, digital well logs, and other information. But with larger fields, such as the Chase-Silica field with 10,378 wells, assembling the data is in itself a major task and pages cannot be created by hand. By creating dynamic pages that access a relational data base management system (e.g., Oracle), whatever data is available can be displayed to the visitor. New production data is available immediately. Plus, the database can create lists of wells for the user based on location information, and pages for the wells are created only if the user wants to see detailed information.

The first field added to the DPA was Arroyo, a field with 36 wells needing web pages. These pages were created by hand and links were made from the field map and the web pages. After the well pages were created, pages for completion forms, production, petrophysical analysis, etc. were created as needed and attached by hand to the well pages. Updating the production pages would take only a few hours of student time. Big Bow Field was handled the same way, but Gentzler and Schaben fields added a new challenge. While the number of wells in Gentzler and Schaben fields was reasonable, the geographic scale of these new fields meant that the visitor could not select an individual well of interest because the well spots were too small to resolve on the user's screen. For fields with a larger geographic area, clicking on the main map brings up a map with more detail on the particular quarter of interest.

For Chase-Silica Field (Rice County), simple zooming does not allow a clear picture of all wells without creating several levels of zoom. The Chase-Silica Field covers eight townships (288 square miles). At this scale it is impossible to resolve and select all wells, and only currently producing wells were shown. In addition, the resulting maps and individual well pages required the creation and maintenance of 10,378 additional web pages. With the addition of Chase-Silica Field, the total amount of data to maintain and update was becoming a significant drain on resources. Each month, new production data and well information has to be added for all the fields in the

DPA. A new approach was required to automate the maintenance and enhancement of the DPA.

Relational database tables and procedures

The ImageMap command of HTML can also be used to ask a question of a database. Here is an ImageMap syntax fragment for the map of a portion of Chase-Silica Field (Figure 6, 7):

<area shape=rect coords="408,54,478,124"
href="http://magellan.kgs.ukans.edu/abyss/public/dpa.chase.mainTRS?twn=18&rge=10&
sct=36">

The link shows that the computer called " magellan.kgs.ukans.edu" is asked for a web page. On that computer, the words " abyss/public/" mean that the Oracle database called "abyss" will be called with a publicly available question. The program that will run the database query is "dpa.chase.mainTRS." Finally, the program needs township, range, and section values ("twn=18&rge=10&sct=36"). Even though 36 sections are "imagemapped" for each township scale map, the process uses search and replace functions that are very efficient.

Software provided with relational database management systems, such as Oracle, is used to connect the web pages to the database. This "middleware" receives the parameters from the web browser, formats them, and sends them to the programs stored in the relational database (Figure 8). After each query is executed, the database sends the data back through the middleware. The results appear to the user with a web browser just like any static web page (Figure 8).

A number of separate tables in the relational database are used to support the DPA web pages (figures 9, 10). The main table is the master list of oil and gas wells maintained by the Kansas Geologic Survey. To the user the pages generated from the query to the database appear, and act exactly as the static, hand-created pages. The subsidiary data files accessed by the DPA are often not maintained by project personnel. Kansas Geological Survey personnel, and even other state agencies, provide update the information in the tables as part of other projects (Figure 9). An example would be monthly oil and gas production data obtained from the Kansas Department of Revenue. The DPA structure is used to extract up-to-date data from those external tables and present to the user web pages that look and act just like normal DPA pages. The result is that parts of the DPA are automatically maintained and updated and will continue to be maintained after the project has ended ("a living publication").

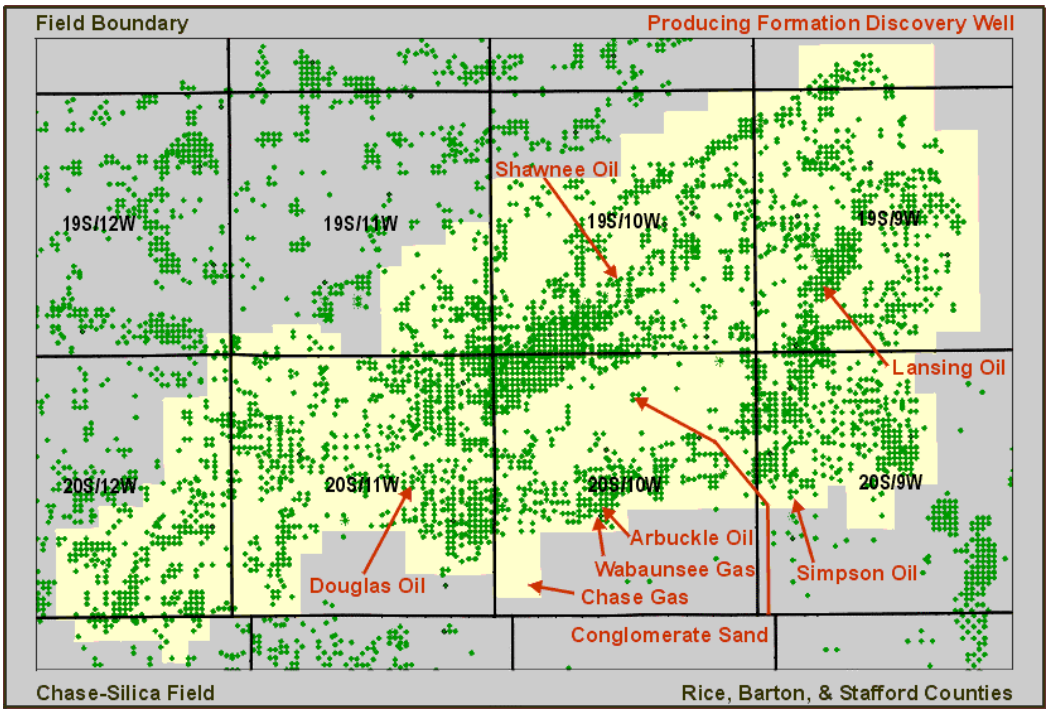


Figure 6. Clicking on any township-range block brings up a more detailed figure of the wells in that block (Figure 7). Page is available online at http://www.kgs.ukans.edu/DPA/Chase/Wells/chaseWell1.html.

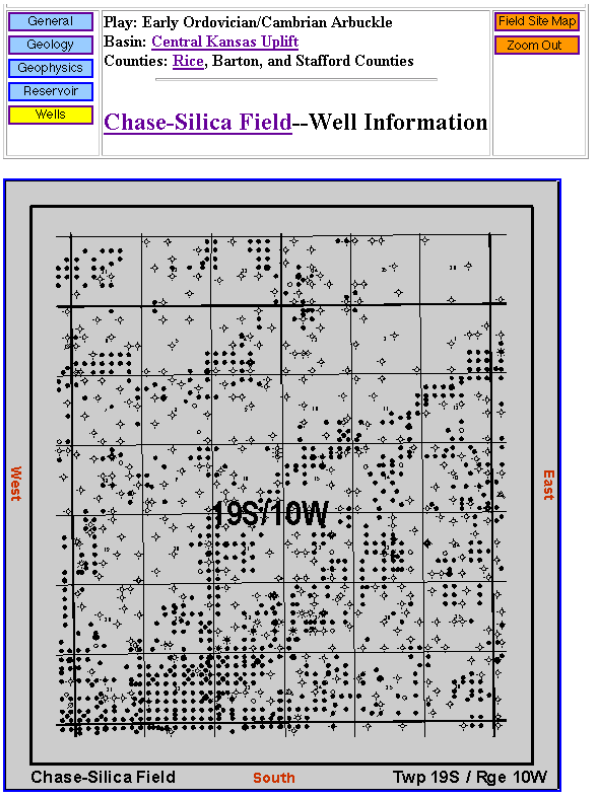


Figure 7. Large fields are split into several sections so that the user can view the wells in greater detail. From this scale of map, the user can select a set of wells from any Township-Range-Section block. The Oracle database can then assemble the set of wells desired, and creates web pages for each well. The user can pan through out the entire field by clicking on the directional controls. Page is available online at: http://www.kgs.ukans.edu/DPA/Chase/Wells/19S10W.html.

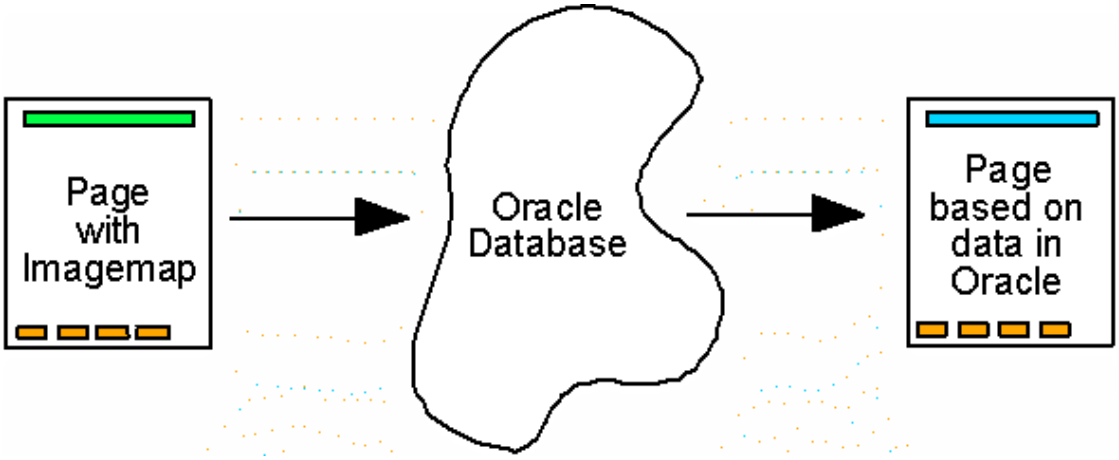


Figure 8. Instead of presenting an existing web page, the imagemap can call a database. The database can be used to create a dynamic web page based on the parameters sent and the data currently stored in the database.

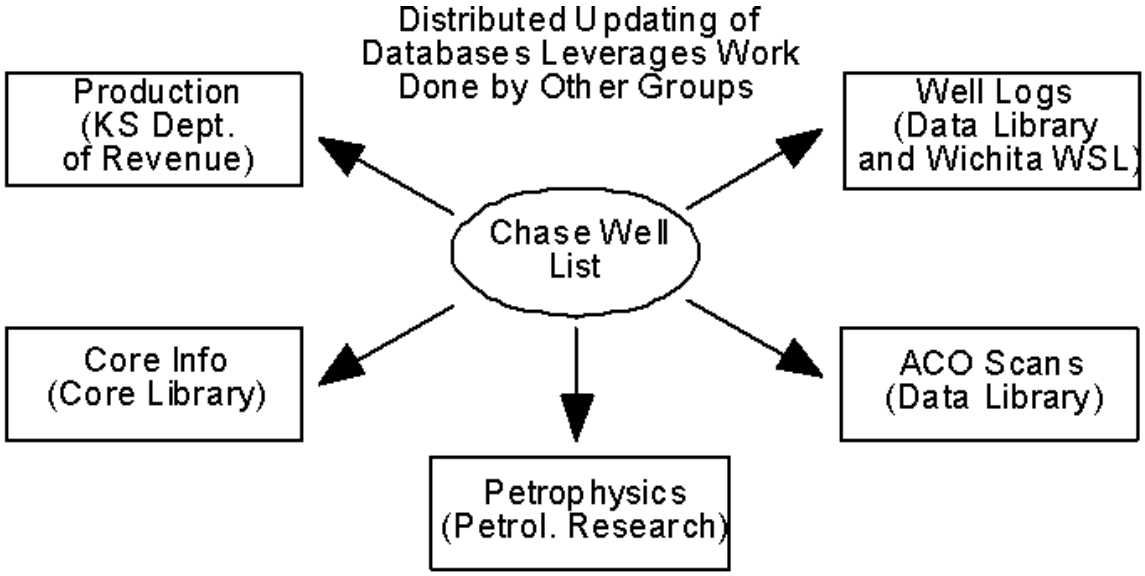


Figure 9. A well query to fields in the Digital Petroleum Atlas accesses numerous relational databases. The DPA personnel maintain the main well list for individual fields in the atlas, but other Kansas Geological Survey staff maintains and updates the other tables. The result is that updated data is automatically available to the user and overhead of maintaining the DPA is significantly reduced.

In year 3, only the Chase-Silica field was using dynamic pages and query to relational databases. In year 4, Kismet and Stewart fields were added to the atlas, and the dynamic well pages were added. While the last DPA annual report stated that older DPA fields would not be moved use dynamic pages and query to relational databases, current plans are to migrate all existing fields to Oracle during the next project year. Because of new drilling in the existing DPA fields, the current pages become out of date and new pages must be added. In addition, the static pages do not benefit from the work done to the main database. For example, all of the LAS (digital wireline log files) have been copied from the DPA to Oracle. Providing access through the relational databases decreases maintenance.

In year four the following relational database tables have been added to the DPA or have been improved:

1. Updated to Digital logs to LAS 2.0 standard
2. Standardized file header layout
3. Missing header values added
4. Database selection of curve types
5. Online presentation of data using Java procedures.

Current Database Layout

The Digital Petroleum Atlas uses a Master List of Oil and Gas Wells to bring together all of the information on oil and gas wells owned, maintained, or generated through the DPA or other efforts in the Kansas Geologic Survey. While the DPA originally maintained all its own database tables, that duplication of effort was not seen to be cost effective. The current database structure and list of tables accessed by the DPA is shown in figures 9 and 10.

With this new design of the atlas using dynamic pages linked to relational databases, DPA project members can concentrate on producing the interpreted maps and assembling data. Other Kansas Geologic Survey staff can proceed on well header maintenance. In addition, detailed geological work on the DPA, Hugoton, Panoma, Schaben, or other projects improves the main oil and gas databases, while work independent of the DPA on the main database improves the files used by the DPA project.

Table name	Level	Usage	Maintained by
WELL_HEADERS	Parent	Well header data such as lease name, well number, location, operator,	KCC data loads, KGS Data Library, KGS Well Sample Library
LOG_HEADERS	Child	Paper wireline log info	KGS Data Library
BOXES	Child	Cuttings	KGS Well Sample Library
LAS.WELL_HEADERS	Child	Digital wireline logs (LAS)	KGS Data Library
WELL_TOPS	Child	Formation tops	Project geologists
ACO_SCAN_URLS	Child	Scans of ACO-1, driller's logs, DST reports	KGS Data Library, project geologists
CORE_DATA_AND_ DESCRIPTIONS	Child	Petrophysical and rock catalog data	Project geologists
DRILL_STEM_TESTS (in prototype)	Child	Digital Drill Stem Test data	KGS Data Library, project geologists
RELATED DOCUMENTS (in prototype)	Child	Links from wells to online reports (core descriptions, open-file reports) that are better represented as a complete set.	Web staff
LEASES	Parent	Oil and gas production data	Dept. of Revenue, KGS staff

Figure 10. A list of current database tables that are accessed through the DPA. The tables are maintained as part of ongoing efforts of the DPA and other groups in the Kansas Geologic Survey. As the scope of the databases has increased more maintenance is performed outside of the DPA.

SUMMARY OF YEAR 4 ADDITIONS TO ATLAS CONTENT

As the DPA began, the primary task was gathering data at the field and well scale and placing this data online. As a home page, we created an interactive map of Kansas linked to all the counties in the state (Figure 1). The Kansas DPA Home Page remains the primary portal, and provides numerous paths to access Kansas petroleum information and technology at the various geographic scales and topical areas. Access is provided to reviews of the regional geological setting, overviews of oil and gas plays and to information and technology at the county, field and well levels. The total number of static web pages exceeds 3,000. This is a 50 percent decrease from previous years, but dynamic pages constructed using programs that access relational databases are replacing static web pages.

The DPA provides access to a number of regional maps, studies and data sets (e.g., gravity and magnetics, and discussions of Kansas oil and gas provinces). The summary of the status of various components of the DPA is summarized on the web (Figure 11, http://www.kge.ukans.edu/DPA/Reports/statusChart.html). As part of fourth

year of the DPA project, studies were undertaken at three Kansas fields and producing areas. These were added to the previously existing field studies. The additions are:

- Box Ranch Field (Multiple Producing Formations: Kansas City Group--multiple zones, Marmaton Group--multiple zones, Pleasanton, Morrow, and Mississippian, Viola, Simpson and Arbuckle) in Comanche County (figures 12-19);

- Kismet Field (Producing Formations: Lansing and Kansas City group--multiple zones, Marmaton Group--multiple zones, Morrow and Mississippian) in Seward and Meade counties.

- Stewart Field (Producing Formations: Pennsylvanian Morrow Formation, waterflood designed as part of DOE funded Class 1 Project, and Mississippian, St. Louis) in Finney County.

The Box Ranch Field is shown as an example of the new approach to generation of dynamic web pages accessing relational databases. The Box Ranch Field is presented within a regional framework (Figure 2), and contains multiple structure and isopach maps covering the field (Figure 12). The maps show the structural nose that forms the trap. Field production data is generated from a query to the production data table. Lease production is summed to generate the most current annual and cumulative production data (Figure 13). A table of lease production data is generated on request (Figure 14). The lease production data contains cumulative production data for oil and gas from each lease. The table can be sorted by multiple parameters. Individual annual and monthly lease production data can be accessed (figures 15, 16). In addition information on individual wells can be accessed from multiple tables (figures 17a-c). Data includes geologic tops used in the structure and isopach maps, list of electric logs available in paper and digital formats and links to data from completion forms (Figure 18) and drill stem tests (Figure 19). New data and research products continue to be added to each field study, as they become available. Publication in the DPA is an ongoing process that continuously updates the data and technology associated with each field study. The addition of the ability to query relational databases increased the efficiency of updating previously completed field studies. Each field study homepage provides a map of the field area, basic field and discovery information, and a standardized set of links to additional geologic, geophysical, engineering and production data.

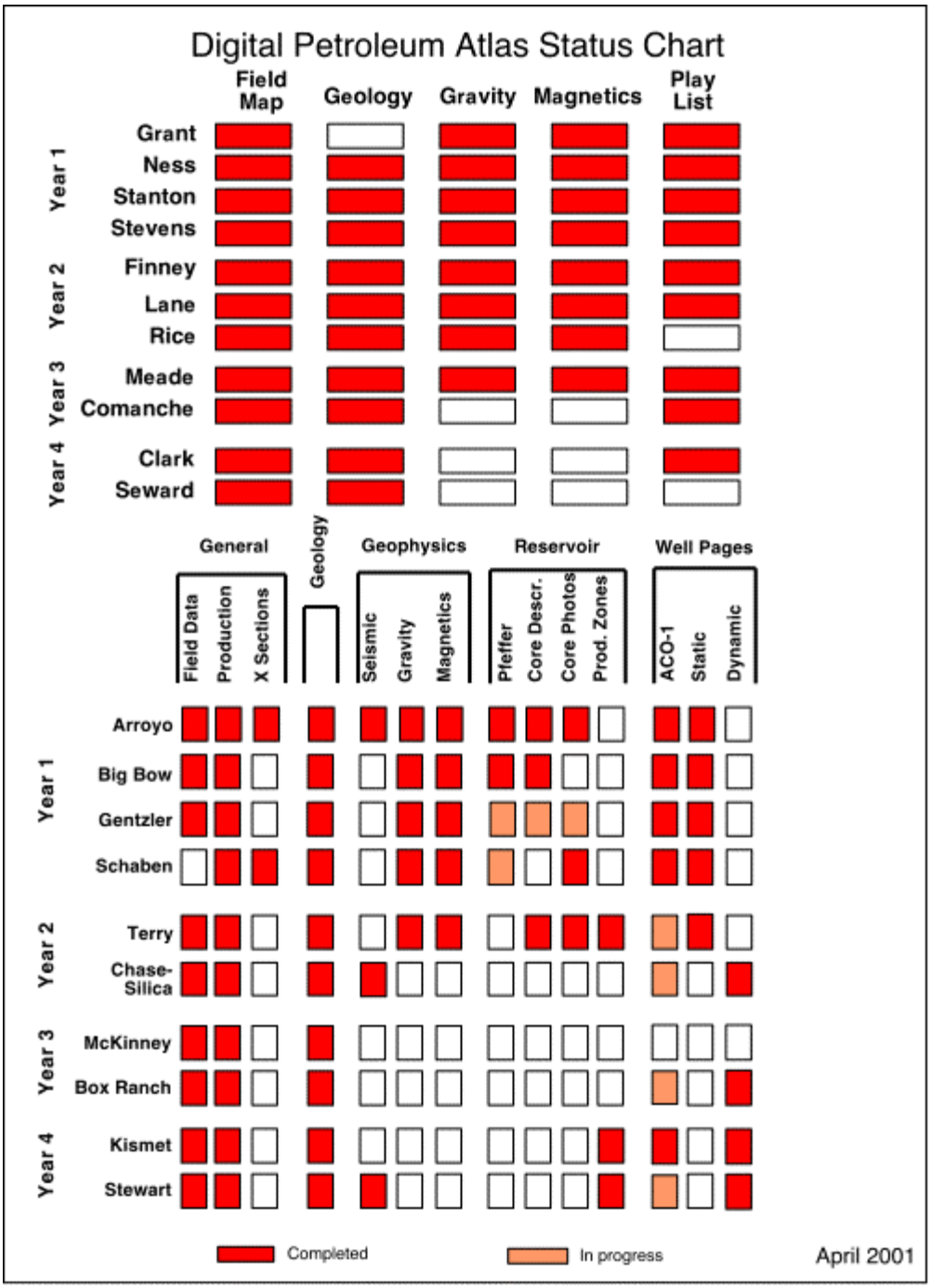


Figure 11. Status chart showing the status of different field and regional studies in the Digital Petroleum Atlas. Current chart is available at http://www.kge.ukans.edu/DPA/Reports/statusChart.html.

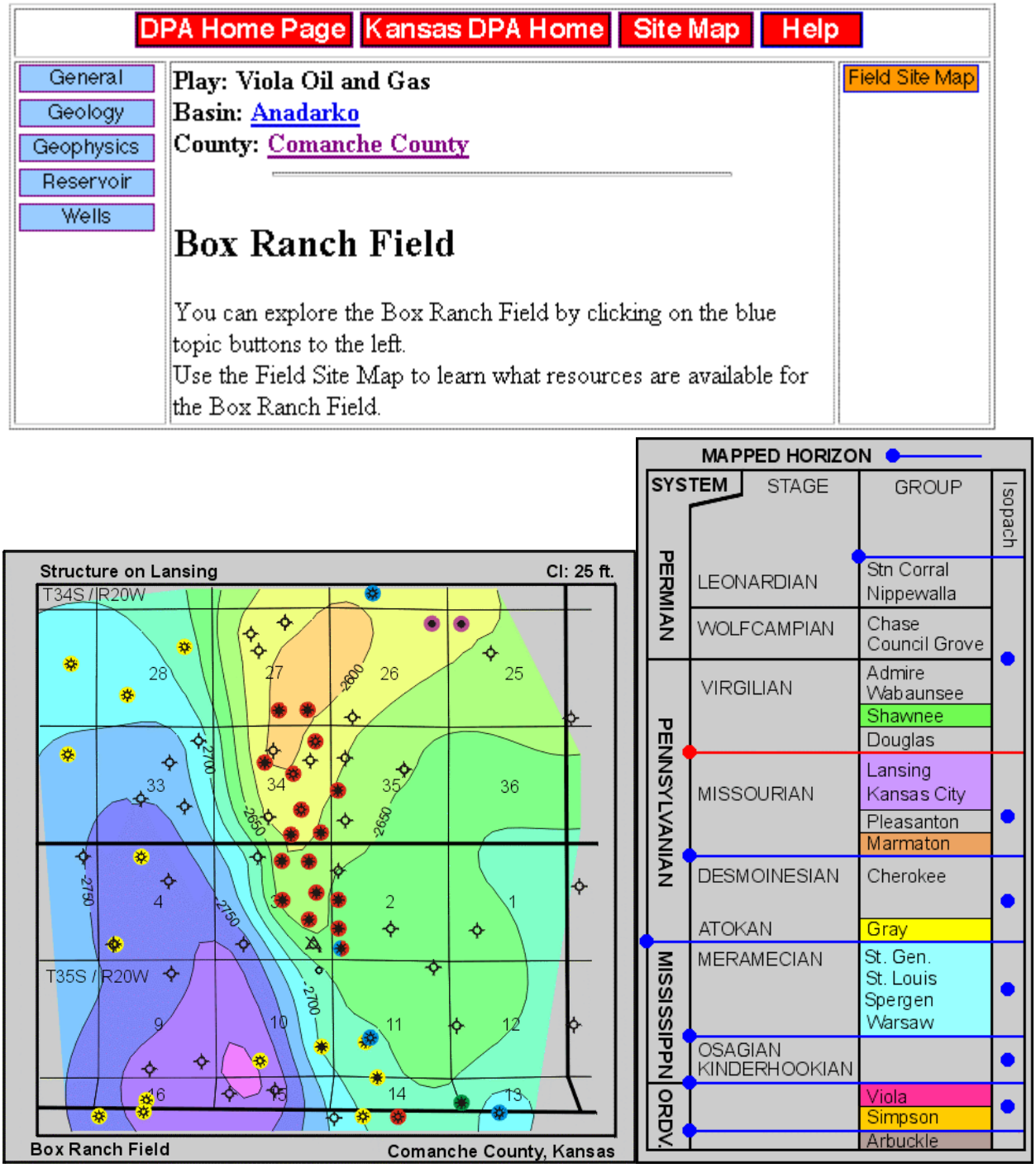


Figure 12. Sample of detailed geologic map covering a portion of Box Ranch Field, Comanche County. Page shows navigation buttons and selection of stratigraphic horizons. Map contains links to topical data, maps, cross-sections, technical discussions, production, data, and detailed lease and well information.

Box Ranch--Oil and Gas Production

Field discovery year: 1988
Field discovery location: 2, T35S, R20W
Counties: Comanche
Leases: View list of leases for this field
Producing Formations

Name	Depth (ft.)	Thickness (ft.)	Oil Grav	Produces
MISSISSIPPIAN	-	-	-	Oil
VIOLA	-	-	-	Oil,Gas

Year	Oil			Gas		
	Production (bbls)	Wells	Cumulative (bbls)	Production (mcf)	Wells	Cumulative (mcf)
1988	-	3	38,356	-	1	21,462
1989	130,758	6	169,114	133,840	1	155,302
1990	155,121	9	324,235	357,312	1	512,614
1991	141,890	9	466,125	332,435	1	845,049
1992	210,302	12	676,427	551,065	1	1,396,114
1993	162,530	12	838,957	621,200	1	2,017,314
1994	127,606	12	966,563	478,602	1	2,495,916
1995	77,523	10	1,044,086	359,326	1	2,855,242
1996	34,430	-	1,078,516	239,693	1	3,094,935
1997	24,157	-	1,102,673	79,193	1	3,174,128
1998	13,213	-	1,115,886	11,448	1	3,185,576
1999	15,603	-	1,131,489	8,463	1	3,194,039
2000*	16,861	0	1,148,350	2,338	1	3,196,377

*2000 data incomplete at this time. 1998-1999 data may still change.

Figure 13. Sample of detailed production and producing well data for the Box Ranch Field, Comanche County. Data is assembled from production data that is maintained in a relational database and is updated monthly. Cumulative data is computed and is current. Production data from individual leases can be viewed by clicking on hot link at top of page.

Kansas Geological Survey | Oil and Gas | Lease Oil & Gas Production | **BOX RANCH Field** | Save Data to File

17 records returned.

Select name of lease to view details. Click on column heading to sort entire set.

Well	T-R-S	Operator	Oil?	Gas?	Cumulative production	Field
Petty 1-27	T34S, R20W, Sec. 27	ROBERTS & MUR	Oil		15502	BOX RANCH
Petty 2-27	T34S, R20W, Sec. 27	ROBERTS & MURPHY INC	Oil		5646	BOX RANCH
1-34 Miller	T34S, R20W, Sec. 34	ROBERTS AND MURPHY	Oil		249835	BOX RANCH
2-34 Miller	T34S, R20W, Sec. 34	ROBERTS AND MURPHY	Oil		29292	BOX RANCH
Kuhns #2	T34S, R20W, Sec. 34	ROBERTS & MURPHY INC	Oil		610	BOX RANCH
Miller 3-34	T34S, R20W, Sec. 34	ROBERTS & MURPHY INC	Oil		89070	BOX RANCH
Kuhns #3	T34S, R20W, Sec. 34	ROBERTS & MURPHY INC	Oil		5078	BOX RANCH
Baker 1-35	T34S, R20W, Sec. 35	ROBERTS AND MURPHY	Oil		54495	BOX RANCH
Box Ranch	T35S, R20W, Sec. 2	ROBERTS & MURPHY	Oil		28396	BOX RANCH
Box Ranch #2-1	T35S, R20W, Sec. 2	ROBERTS & MURPHY INC		Gas	3196377	BOX RANCH
Box Ranch	T35S, R20W, Sec. 2	ROBERTS & MURPHY	Oil		74077	BOX RANCH
Box Ranch	T35S, R20W, Sec. 2	ROBERTS & MURPHY	Oil		55759	BOX RANCH
2-3 Box Ranch	T35S, R20W, Sec. 3	ROBERTS & MURPHY	Oil		277886	BOX RANCH
Box Ranch 4-3	T35S, R20W, Sec. 3	ROBERTS & MURPHY IN	Oil		18644	BOX RANCH
Box Ranch 6-3	T35S, R20W, Sec. 3	ROBERTS & MURPHY INC	Oil		72757	BOX RANCH
Box Ranch 5-3	T35S, R20W, Sec. 3	ROBERTS & MURPHY	Oil		48875	BOX RANCH
Box Ranch 3-3	T35S, R20W, Sec. 3	ROBERTS AND MURPHY	Oil		122427	BOX RANCH

Kansas Geological Survey
Comments to webadmin@kgs.ukans.edu
URL=http://magellan.kgs.ukans.edu/Field/lease.html
Programs Updated March 2001.
Data from Kansas Dept. of Revenue files quarterly.

Figure 14. List of leases in Box Ranch Field, Comanche County, Kansas. Leases are assembled from relational databases and contain current cumulative production data. Leases can be sorted by various criteria (e.g., well name, operator, and cumulative oil or gas production). Clicking on well name can access production from individual leases.

Kansas Geological Survey | Oil and Gas | Lease Oil & Gas Production

Lease 1-34 Miller

Operator: ROBERTS AND MURPHY
Location: T34S, R20W, Sec. 34
Field: Box Ranch

Annual Production

Year	Oil			Gas		
	Production (bbls)	Wells	Cumulative (bbls)	Production (mcf)	Wells	Cumulative (mcf)
1989	-	1	1,137	-	-	0
1990	21,432	1	22,569	-	-	0
1991	36,891	1	59,460	-	-	0
1992	41,833	1	101,293	-	-	0
1993	38,458	1	139,751	-	-	0
1994	42,276	1	182,027	-	-	0
1995	32,189	1	214,216	-	-	0
1996	13,280	-	227,496	-	-	0
1997	8,621	-	236,117	-	-	0
1998	3,469	-	239,586	-	-	0
1999	4,379	-	243,965	-	-	0
2000	5,870	0	249,835	-	-	0

*2000 data incomplete at this time. 1998-1999 data may still change.

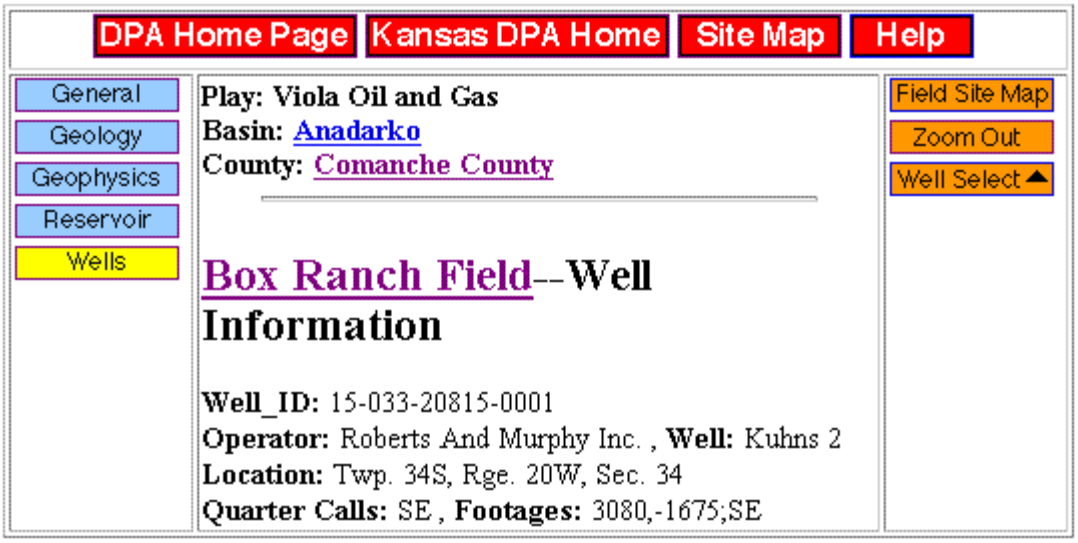
Figure 15. Annual production for an individual lease/well (Roberts and Murphy 1-34 Miller(in the Box Ranch Field, Comanche County, Kansas. Lease data is assembled by query from relational databases and contains the most current annual production data. Following the annual production, monthly production is provided from 1995 to present.

Monthly from 1995 on

Year	Month	Oil		Gas	
		Production (bbls)	Wells	Production (mcf)	Wells
1995	1	4,225	1	-	-
1995	2	3,500	1	-	-
1995	3	3,575	1	-	-
1995	4	3,605	1	-	-
1995	5	3,607	1	-	-
1995	6	2,809	1	-	-
1995	7	231	1	-	-
1995	8	2,192	1	-	-
1995	9	2,082	1	-	-
1995	10	1,573	1	-	-
1995	11	2,329	1	-	-
1995	12	2,461	1	-	-
1996	1	1,533	-	-	-
1996	2	1,339	-	-	-
1996	3	2,035	-	-	-
1996	4	528	-	-	-
1996	5	1,758	-	-	-
1996	6	1,017	-	-	-
1996	7	1,050	-	-	-
1996	8	790	-	-	-
1996	9	1,295	-	-	-
1996	10	533	-	-	-
1996	11	1,032	-	-	-
1996	12	369	-	-	-
1997	1	876	-	-	-
1999	2	700	-	-	-
1999	3	-	-	-	-
1999	4	-	-	-	-
1999	5	344	-	-	-
1999	6	-	-	-	-
1999	7	519	-	-	-
1999	8	359	-	-	-
1999	9	704	-	-	-
1999	10	663	-	-	-
1999	11	187	-	-	-
1999	12	904	-	-	-
2000	1	542	-	-	-
2000	2	177	-	-	-
2000	3	180	-	-	-
2000	4	1,243	-	-	-
2000	5	359	0	-	-
2000	6	715	0	-	-
2000	7	541	0	-	-
2000	8	708	0	-	-
2000	9	523	0	-	-
2000	10	533	0	-	-
2000	11	179	0	-	-
2000	12	170	0	-	-

Kansas Geological Survey
Comments to webadmin@kgs.ukans.edu
URL=http://magellan.kgs.ukans.edu/Field/lease.html
Programs Updated March 2001.
Data from Kansas Dept. of Revenue files quarterly.

Figure 16. Sample of monthly production for an individual lease/well (Roberts and Murphy 1-34 Miller) in the Box Ranch Field, Comanche County, Kansas. Lease data is assembled by query from relational databases and contains the most current annual production data.



Tops Data

Form.	Top	Base	Source	Updated
HEEBNER	4150			15-APR-1999
LANSING	4370			15-APR-1999
MISSISSIPPIAN	5200			15-APR-1999
VIOLA	6150			15-APR-1999
SIMPSON	6350			15-APR-1999
ARBUCKLE	6450			15-APR-1999

Figure 17a. Sample of well data for an individual well (Roberts and Murphy Kuhns 2) in the Box Ranch Field, Comanche County, Kansas. The well data is assembled from multiple individual data tables and includes header information (e.g., location, operator, API number) and geologic tops. Information continues in figures b and c.

Wireline Log Header Data

Logger: Schlumberger **Tool:** Dual Induction SFL **Top:** 667; **Bottom:** 6492 **BHT:** 130F **Gamma Ray:** Y, **Spontaneous Potental:** Y
Logger: Schlumberger **Tool:** Microlog **Top:** 3790; **Bottom:** 6469 **BHT:** 130F **Gamma Ray:** Y, **Spontaneous Potental:**
Logger: Schlumberger **Tool:** Computer Processed Log **Top:** 3790; **Bottom:** 6478 **BHT:** 130F **Gamma Ray:** , **Spontaneous Potental:**
Logger: Schlumberger **Tool:** **Top:** 2800; **Bottom:** 6465 **BHT:** 130F **Gamma Ray:** , **Spontaneous Potental:**
Logger: Schlumberger **Tool:** Continuous Dipmeter **Top:** 5090; **Bottom:** 6497 **BHT:** 130F **Gamma Ray:** Y, **Spontaneous Potental:**
Logger: Schlumberger **Tool:** Compensated Neutron Formation Density **Top:** 3790; **Bottom:** 6495 **BHT:** 130F **Gamma Ray:** Y, **Spontaneous Potental:**

Figure 17b. Continuation of sample of well data for an individual well (Roberts and Murphy Kuhns 2) in the Box Ranch Field, Comanche County, Kansas. The well data is assembled from multiple individual data tables and includes log data. If digital log data is available it can be downloaded. Information continues in figure below.

Cuttings Data

Box Number: D1028
Times Checked Out: 0
Starting Depth: 3800 ; **Ending Depth:** 6500
Skips:

ACO-1 and Driller's Logs

ACO-1 Form

- View form(s) on screen
- Download scan(s)

DST Report

- View form(s) on screen
- Download scan(s)

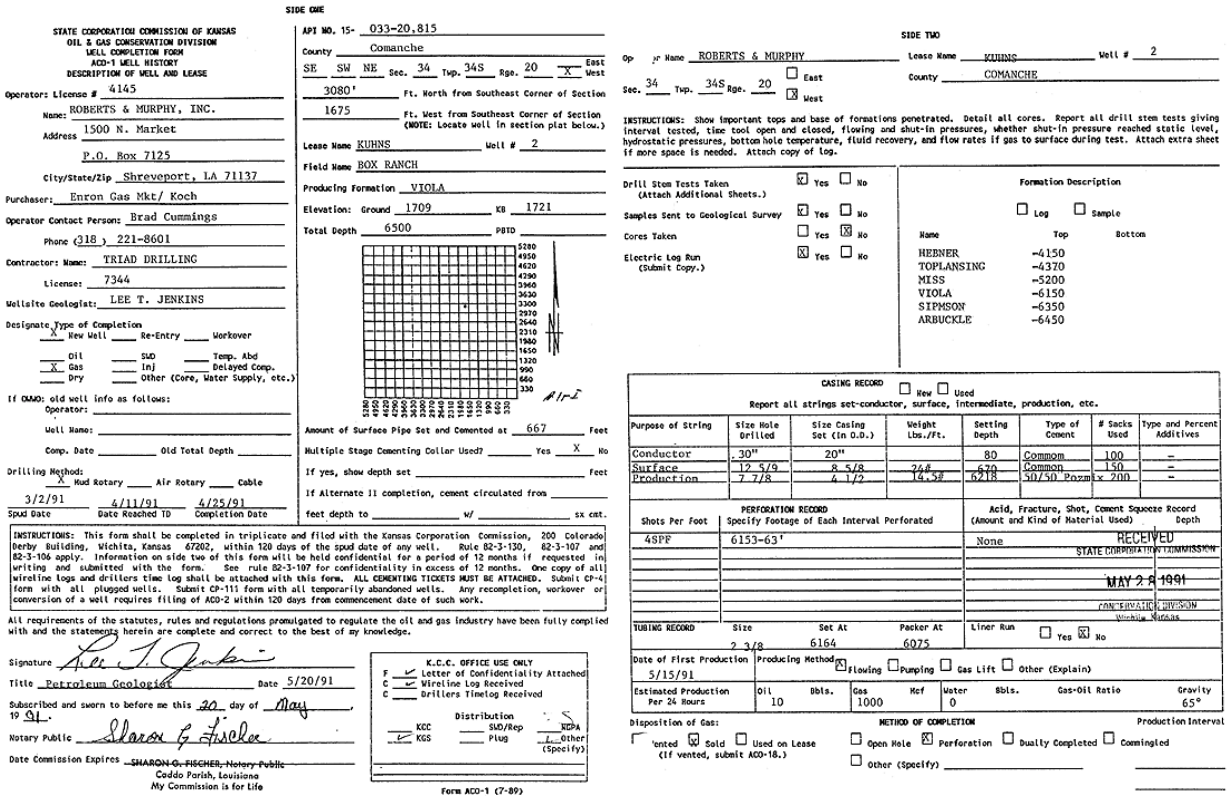
OWWO ACO-1 Form

- View form(s) on screen
- Download scan(s)

The file you download contains one or more TIFF images compressed into a ZIP archive. Your browser may be already set up to decompress these files. Commercial software to perform this is available from PKWARE, Inc., the company that invented the format. A web page from a group of people creating shareware or public domain software is available at Info-ZIP. The TIFFs are 300 dpi archival-quality scans of the WWC5 forms and can be viewed by software like Corel PhotoPaint or Adobe PhotoShop.

Kansas Geological Survey, Digital Petroleum Atlas
Comments to webadmin@kgs.ukans.edu
Program Updated March 2001.
URL=http://www.kgs.ukans.edu/DPA/BoxRanch/boxWell1.html

Figure 17c. Continuation of sample of well data for an individual well (Roberts and Murphy Kuhns 2) in the Box Ranch Field, Comanche County, Kansas. The well data is assembled from multiple individual data tables and includes raster images of completion report, drill stem tests and injection data. Data can be viewed or downloaded. If digital drill stem test data is available it can be downloaded. Information continues in figures below.



SIDE ONE

STATE CORPORATION COMMISSION OF KANSAS
OIL & GAS CONSERVATION DIVISION
WELL COMPLETION FORM
ACO-1 WELL HISTORY
DESCRIPTION OF WELL AND LEASE

Operator: License # 4145
Name: ROBERTS & MURPHY, INC.
Address 1500 N. Market
P.O. Box 7125
City/State/Zip Shreveport, LA 71137
Purchaser: Enron Gas Mkt/ Koch
Operator Contact Person: Brad Cummings
Phone (318) 221-8601
Contractor: Name: TRIAD DRILLING
License: 7344
Wellsite Geologist: LEE T. JENKINS

Designate Type of Completion
X New Well ___ Re-Entry ___ Workover
___ Oil ___ SWD ___ Temp. Abd
X Gas ___ Inj ___ Delayed Comp.
___ Dry ___ Other (Core, Water Supply, etc.)

If OWWO: old well info as follows:
Operator:
Well Name:
Comp. Date ___ Old Total Depth ___

Drilling Method:
X Mud Rotary ___ Air Rotary ___ Cable

3/2/91 Spud Date | 4/11/91 Date Reached TD | 4/25/91 Completion Date

API NO. 15- 033-20,815
County Comanche
SE SW NE Sec. 34 Twp. 34S Rge. 20 X East West
3080' Ft. North from Southeast Corner of Section
1675 Ft. West from Southeast Corner of Section
(NOTE: Locate well in section plat below.)
Lease Name KUHNS Well # 2
Field Name BOX RANCH
Producing Formation VIOLA
Elevation: Ground 1709 KB 1721
Total Depth 6500 PBTD

5280 4950 4620 4290 3960 3630 3300 2970 2640 2310 1980 1650 1320 990 660 330

Amount of Surface Pipe Set and Cemented at 667 Feet
Multiple Stage Cementing Collar Used? ___ Yes X No
If yes, show depth set ___ Feet
If Alternate II completion, cement circulated from
feet depth to ___ w/ ___ sx cmt.

INSTRUCTIONS: This form shall be completed in triplicate and filed with the Kansas Corporation Commission, 200 Colorado Derby Building, Wichita, Kansas 67202, within 120 days of the spud date of any well. Rule 82-3-130, 82-3-107 and 82-3-106 apply. Information on side two of this form will be held confidential for a period of 12 months if requested in writing and submitted with the form. See rule 82-3-107 for confidentiality in excess of 12 months. One copy of all wireline logs and drillers time log shall be attached with this form. ALL CEMENTING TICKETS MUST BE ATTACHED. Submit CP-4 form with all plugged wells. Submit CP-111 form with all temporarily abandoned wells. Any recompletion, workover or conversion of a well requires filing of ACO-2 within 120 days from commencement date of such work.

All requirements of the statutes, rules and regulations promulgated to regulate the oil and gas industry have been fully complied with and the statements herein are complete and correct to the best of my knowledge.

Signature Lee T. Jenkins
Title Petroleum Geologist Date 5/20/91
Subscribed and sworn to before me this 20 day of May, 19 91.
Notary Public Sharon G Fischer
Date Commission Expires SHARON G. FISCHER, Notary Public Caddo Parish, Louisiana My Commission is for Life

K.C.C. OFFICE USE ONLY
F ✓ Letter of Confidentiality Attached
C ✓ Wireline Log Received
C ___ Drillers Timelog Received
Distribution
___ KCC ___ SWD/Rep ___ NGPA
✓ KGS ___ Plug ___ Other (Specify)

Form ACO-1 (7-89)

SIDE TWO

Operator Name ROBERTS & MURPHY Lease Name KUHNS Well # 2
Sec. 34 Twp. 34S Rge. 20 ☐ East ☒ West County COMANCHE

INSTRUCTIONS: Show important tops and base of formations penetrated. Detail all cores. Report all drill stem tests giving interval tested, time tool open and closed, flowing and shut-in pressures, whether shut-in pressure reached static level, hydrostatic pressures, bottom hole temperature, fluid recovery, and flow rates if gas to surface during test. Attach extra sheet if more space is needed. Attach copy of log.

Drill Stem Tests Taken (Attach Additional Sheets.) ☒ Yes ☐ No
Samples Sent to Geological Survey ☒ Yes ☐ No
Cores Taken ☐ Yes ☒ No
Electric Log Run (Submit Copy.) ☒ Yes ☐ No

Formation Description
☐ Log ☐ Sample

Name	Top	Bottom
HEBNER	-4150	
TOPLANSING	-4370	
MISS	-5200	
VIOLA	-6150	
SIMPSON	-6350	
ARBUCKLE	-6450	

CASING RECORD ☐ New ☐ Used
Report all strings set-conductor, surface, intermediate, production, etc.

Purpose of String	Size Hole Drilled	Size Casing Set (in O.D.)	Weight Lbs./Ft.	Setting Depth	Type of Cement	# Sacks Used	Type and Percent Additives
Conductor	30"	20"		80	Common	100	-
Surface	12 5/9	8 5/8	24#	670	Common	150	-
Production	7 7/8	4 1/2	14.5#	6218	50/50 Pozmix	200	-

PERFORATION RECORD
Shots Per Foot | Specify Footage of Each Interval Perforated | Acid, Fracture, Shot, Cement Squeeze Record (Amount and Kind of Material Used) | Depth
4SPF | 6153-63' | None

RECEIVED
STATE CORPORATION COMMISSION
MAY 28 1991
CONSERVATION DIVISION
Wichita, Kansas

TUBING RECORD Size 2 3/8 Set At 6164 Packer At 6075
Liner Run ☐ Yes ☒ No

Date of First Production 5/15/91 Producing Method ☒ Flowing ☐ Pumping ☐ Gas Lift ☐ Other (Explain)

Estimated Production Per 24 Hours	Oil	Bbls.	Gas	Mcf	Water	Bbls.	Gas-Oil Ratio	Gravity
	10		1000		0			65°

Disposition of Gas: ☐ Vented ☒ Sold ☐ Used on Lease (If vented, submit ACO-18.)
METHOD OF COMPLETION ☐ Open Hole ☒ Perforation ☐ Dually Completed ☐ Commingled ☐ Other (Specify)
Production Interval

Figure 18. Raster images of Kansas Corporation Commission Completion report for a selected well in the Box Ranch Field, Comanche County, Kansas. The images for every well in the field are stored in a relational database table. The images are linked and a dynamic well page is constructed on demand for the Digital Petroleum Atlas.

DST #1
30-60-60-120
6104-6132'
IHP 3707
IFP 361-221
ISIP 2440
FFP 221-247
FSIP 2452
FHP 2985
REC. 715' Gas Cut Mud

DST #2
30-60-60-120
6202 -6226'
IHP 3086
IFP 0-31
ISIP 1895
FFP 221-247
FSIP 2364
FHP 2997
Rec. 100' Oil/Gas Cut Mud

DST #3
30-60-60-120
6288 -6314'
IHP 3162
IFP 259-1400
ISIP 2516
FFP 1400 -2450
FSIP 2541
FHP 3066
Rec. 4650' Gas Cut SW

DST #4
6134 -6170
2-10-10-90
IHP 2868
IFP 268-287
ISIP 2476
FFP 213- 241
FSIP 2476
FHP 2878
Rec. Gas

Figure 19. Example of drill stem test (DST) information available for wells in the Box Ranch Field, Comanche County Kansas. DST information is for the Roberts and Murphy, Inc. Kuhns #2. The information is stored in a relational database table and is linked to a dynamic well page that is constructed on demand for the Digital Petroleum Atlas.

TECHNOLOGY TRANSFER ACTIVITIES

The world-wide-web and publish as-you-go design of the Digital Petroleum Atlas Project provides immediate and ongoing technology transfer activities. Based on increased usage statistics and informal industry feedback, the DPA model appears to provide an efficient method of technology transfer to the geographically dispersed high technology petroleum industry (Figure 3 and Appendix A). The pages that comprise the DPA are among the most visited on the Kansas Geological Survey web site and usage continues to grow (figures 3-5). Periodic email updates provided to interested operators and individuals have been well received. As part of technology transfer efforts, formal talks and paper were prepared and presented to local and national meetings (Table 1; Buatois, et. al. 1999; Carr and Adkins-Heljeson, 1999; Luchtel and Carr, 1999; Allisa and Carr, 1999). In addition, the Digital Petroleum Atlas Project has been integrated into the Internet for the Petroleum Professional Course. This is a popular course for oil and gas producers and is taught as part of the North Midcontinent part of Petroleum Technology Transfer Council (For example see online version of the Internet course at http://www.kgs.ukans.edu/General/Tutorial/Internet/findex.html).

Table 1. Presentations undertaken as part of fourth year of the Digital Petroleum Atlas Project.

- Workshops on Kansas Online Resources at Kansas Petroleum Council Environmental Working Group August 3-4, 1999
- Internet for the Petroleum Professional, Sponsored by North Mid Continent Petroleum Technology Transfer Council PTTC and Kansas Geological Survey, Kansas Independent Oil and Gas Association (KIOGA) Annual Meeting, Wichita Kansas, August 30, 1999
- PTTC Workshops on Geologic Aspects of Waterflooding at North Midcontinent PTTC Workshop, Wichita, Kansas November 11, 1999.

PROBLEMS ENCOUNTERED

The Digital Petroleum Atlas was designed to be a dynamic product with the constant addition of new information and ideas. Within this changing environment defined tasks of the year three DPA were completed. In using the DPA, oil and gas operators and the interested public proposed many of the ongoing changes and additions. The prototype DPA project was completed within budget and cost sharing was in excess of 20%.

RECOMMENDATIONS FOR FUTURE WORK

Results from the year four of the Digital Petroleum Atlas Project have met expectations. We continue to expand the breath and depth of plays, fields and reservoirs covered, enhance the included petroleum technology, expand the geographic coverage, and improve the navigation and technology for online access to continuously updated relational databases. Work is progressing to provide interactive programs that can interact with relational databases to provide online tools to map fields, and display and analysis data (e.g., log and production data).

CONCLUSIONS

As the fourth year of a longer-term effort, the Digital Petroleum Atlas (DPA) has developed an improved new methodology to provide efficient and timely access to the latest petroleum data and technology for the domestic oil and gas industry, public sector research organizations and local governmental units. The DPA provides real-time and cost-effective electronic publication of materials typically found in published paper oil and gas atlases. The latest technologies and information are continuously "published" electronically when individual project components are completed, reducing the lag and expense of transferring technology using traditional paper publication. Additional information and technology are constantly being added and older information updated to the DPA increasing its scope and detail. Active links, graphical user interfaces and relational database search mechanisms provide a published electronic product with which the operator can interact in ways that are impossible in a paper publication. Contained in the DPA are forms of publication that can only be displayed in an electronic environment (for example, animated exploration histories through time, and special queries). Through complete and flexible user access to technology, interpretative products and the underlying geologic and petroleum data, the DPA changes the relationship between interpretative result and data, between technology generation and application. Improved access to petroleum data and technology represents one of the best and cost-effective options that available for maintaining domestic production.

REFERENCES CITED

Alisa, Abdulramen M. I., and T. R. Carr, 1999,Sequence stratigraphy of the Lower Morrow and the Arroyo and Gentzler fields of southwestern Kansas, in D. F. Merriam (ed.) Geosciences for the 21st Century, Transactions of the AAPG Midcontinent Section Meeting, Wichita, Kansas, p. 135.

Annual Energy Outlook 1998: Energy Information Agency, U. S. Department of Energy, December 18, 1997. http://www.eia.doe.gov/oiaf/aeo98/homepage.html.

Bebout, D. G., W. A. White, T. F. Hentz, and M. K. Grasmick (editors), 1993, Atlas of Midcontinent Gas Reservoirs; Bureau of Economic Geology, The University of Texas, Austin, Texas, 85 p.

Buatois, L.A., M. G. Mángano, and T. R. Carr, 1999, Sedimentology and ichnology of Paleozoic estuarine and shoreface reservoirs, Morrow Sandstone, Lower Pennsylvanian of southwest Kansas, USA; Kansas Geological Survey, Current Research in Earth Sciences, Bulletin 243, part 1, 35p. http://www.kgs.ukans.edu/Current/1999/buatois/buatois1.html.

Carr, Timothy R., Rex C. Buchanan, Dana Adkins-Heljeson, Thomas D. Mettille, and Janice Sorensen, 1997a, The Future of Scientific Communication in the Earth Sciences: The Impact of the Internet; Computers and Geoscience, 23, p.503-512.

Carr, Timothy R., Rex C. Buchanan, Dana Adkins-Heljeson, Thomas D. Mettille, and Janice Sorensen, 1997b, The Impact of the Internet on the Public Sector: Providing Natural Resource Information and Technology to Kansas, in Barbara J. DeFelice, ed., Expanding Boundaries: Geoscience Information for Earth System Science: Geoscience Information Society Proceedings, volume 27, p. 93-99.

Carr, Timothy R., Dana Adkins-Heljeson, Paul M. Gerlach, Lee C. Gerhard, Joseph M. Kruger, and W. Lynn Watney, 1997c, The Kansas Geological Survey's Digital Petroleum Atlas (DPA) Project, Proceedings Society of Petroleum Engineers 1997 Annual Meeting, SPE 38825, p. 771-778.

Carr, Timothy R., and Dana Adkins-Heljeson, Internet for the Petroleum Professional Short Course Notes, Sponsored by North Mid Continent Petroleum Technology Transfer Council and Kansas Geological Survey, Kansas Independent Oil and Gas Association (KIOGA) Annual Meeting, Wichita Kansas, August 30, 1999, 120 p.

Carr, Timothy R., Dana Adkins-Heljeson, Paul M. Gerlach, Lee C. Gerhard, Willard Guy, Robert O'Dell, and W. Lynn Watney, 1999, Preparation of Northern Mid-Continent Petroleum Atlas Annual Report DE-FG26-97BC15008, May 15, 1999, http://www.kgs.ukans.edu/PRS/publication/OFR99_19/index.html.

Denning, Peter J. and Bernard Rous, 1995, The ACM electronic publishing plan; ACM, Inc.; http://www.acm.org/pubs/epub_plan.html.

Galloway, W. E., T. E. Ewing, C. M. Garrett, N. Tyler, and D. G. Bebout (editors), 1983, Atlas of Major Texas Oil Reservoirs; Bureau of Economic Geology, The University of Texas, Austin, Texas, 139 p.

Kerkhof, B. M., 1994, Journal publishing and the (electronic) future: Expectation challenges and reality, in, C. Wick, (ed., Finding and Communicating Geoscience Information; Proceedings of the Twenty-Eighth Meeting of the Geoscience Information Society, p. 11-19.

Luctel, Kristie L., and T. R. Carr, 1999, Sequence stratigraphy of the upper Kearney Formation (Morrowan Series, Lower Pennsylvanian System) for the Santa Fe Trail, Cimarron Valley and Stirrup fields, Morton County, Kansas, Proceedings 1999 AAPG Presentations, San Antonio, Texas, p. A84.

Okerson, Ann, 1992, Synopsis, in, A. M. Cummings and others, eds., University Libraries and Scholarly Communication: A Study for the Andrew W. Mellon Foundation by the Association of Research Libraries, p. xv-xxiv, gopher://gopher.lib.virginia.edu:70/00/alpha/mellon/synopsis.txt.

Powers, S. (editor), 1929, Structure of Typical American Fields: A symposium on the relation of oil accumulation to structure (3 vols.); American Association Petroleum Geologists, Tulsa, OK, 1806 p.

Report of the Energy Research and Development Panel, Federal Energy Research and Development for the Challenges of the Twenty-first Century: President's Committee of Advisors on Science and Technology, November 1997. http://www.whitehouse.gov/WH/EOP/OSTP/Energy/

US Department of Energy (2000a), Annual Energy Outlook 2001 With Projections to 2020, Report#:DOE/EIA-0383(2001), December 22, 2000, http://www.eia.doe.gov/oiaf/aeo/index.html.

US Department of Energy (2000b), Eighth Annual National Energy Modeling System/Annual Energy Outlook Conference, March 21, 2000, http://www.eia.doe.gov/oiaf/analysispaper/conf_summary.html.

APPENDIX A

SELECTED COMMENTS AND SUCCESS STORIES FROM PRODUCERS
(Names are on file at the Kansas Geological Survey).

Subject: Data Base
Date: Fri, 17 Dec 1999 20:02:08 EST
From: A Geologist at a Small Independent Producer
To: webadmin@kgs.ukans.edu

Absolutely wonderful site. I was afraid I would have to go to “commercial source” to gather the data I needed for Kansas project. This site has been a terrific source.

Thank You !!!!!

Subject: Kansas Geological Data
Date: Sat, 18 Dec 1999 11:32:09 EST
From: A Geologist at a Small Independent Producer
To: webadmin@kgs.ukans.edu

The more I delve into your Web Site the more I am impressed. The KGS is to be commended for compiling a remarkable volume of useful and easily accessible data. Thank you for making my research easy.

Subject: Horizontal Well in McPherson County Update
Date: Thu, 30 Dec 1999 06:21:50 -0600
From: An Independent Producer
To: <rex@kgs.ukans.edu>

Rex:

We plan on drilling out from under surface January 2nd. Will probably be done with the vertical section of the hole on the 5th then drill the curve and have the 7" set by the 8th. Should be horizontal in the chert by the 10th. I'll contact you on the 6th or 7th to set up a time. I'm not sure what part of the well you want to view (I'm guessing the horizontal part using foam). Let me know.

Thanks for the map tip. I picked up the Pratt County 1:100,000 map and it is just the right size. I'll call Lawrence to get the non-folded prints. Thanks again.

By the way you have a good website. The oil/gas production by year is good-free-and fast! Is there a way to access monthly volumes or see what the last month input is? You have the fastest quick look at production cumulatives I've seen yet.

Subject: thanks

Date: Wed, 22 Mar 1999 15:31:55 -0700
From: Professor at Academic Institution
To: tcarr@kgs.ukans.edu

Thanks for the tip Tim. Went right to your excellent webpage and found what I was looking for. Kudos to whoever maintains this site.

Documented comments from personnel at different small independents. Names on request.

“The atlas gave me a start on the geology of producing formations and discerning which wells produce from these deeper formations. It also gave me a start on assessing the volume of oil and gas production per lease and per field. Having this information readily available saved about six weeks of my time.” Using the atlas reduced the time to complete this task by more than 80%.

“The atlas gives me a jump start on an area. I know it’s a time saver.”

“I saved at least three days of searching for literature on the petroleum geology of the area.”

“Utilizing the Atlas prevented me from having to make a trip to Kansas (from Texas) to personally research the data base at the KCC.”