

# OILS 2006

---

An Internet Enabled, Global Oil Geochemical  
Database, GIS Mapping System, and Associated  
Analytical Service Program

**RFD**base  
RESERVOIR FLUID DATABASE

**OILS**<sup>TM</sup>  
OIL INFORMATION LIBRARY SYSTEM

**GeoMark Research**  
Houston, Texas

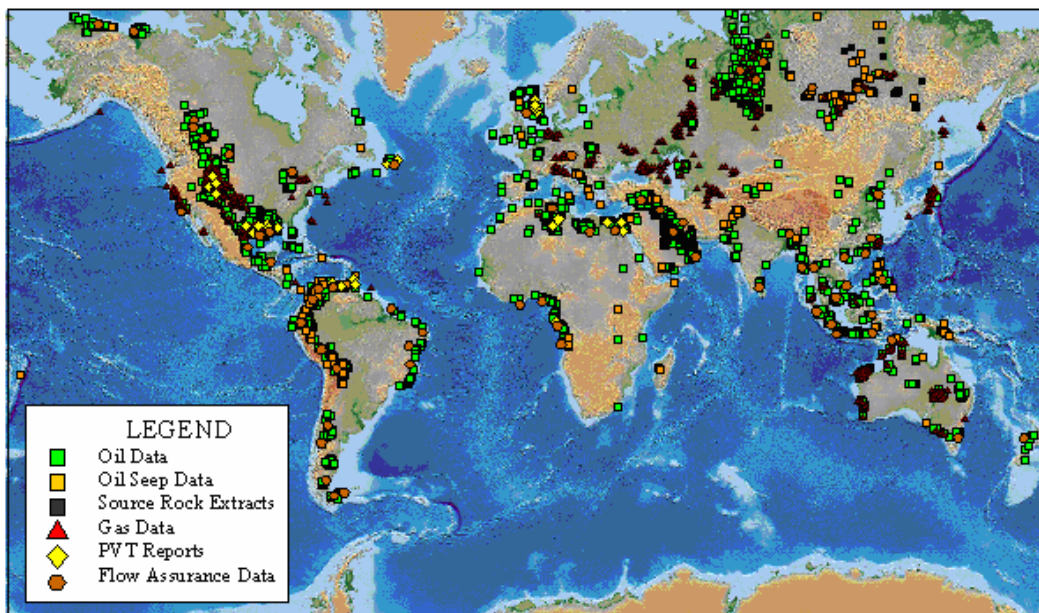
**GEO**MARK

**RFD**base  
RESERVOIR FLUID DATABASE

**OILS**™  
OIL INFORMATION LIBRARY SYSTEM

With the release of the **OILS**™2006 GeoMark's oil database begins now holds the detailed analyses of over 7,000 crude oil, seep, or source rock extract samples. The **OILS** Database is available online via the **RFD**base internet-enabled database for the storage, review and manipulation of all petroleum fluid analyses. Web accessibility allows anyone in your company to use the **OILS** Database, regardless of geographical location. Also, it allows immediate updates of new analytical results and permits an easy integration of any data in any of the other **RFD**base modules (gas analyses, PVT reports, etc).

The various modules within **RFD**base can be viewed at [www.RFDbase.com](http://www.RFDbase.com). The website contains a demonstration routine allowing visitors access to all search and display functions on a limited set of selected samples. Please contact GeoMark for a full demonstration of the entire **RFD**base program.



**Figure 1. Distribution of samples in the RFDbase Database.**

All features of the past **OILS** releases continue. Each participating company still has the right to submit up to thirty (30) samples per year for crude oil analyses at no cost. The interpretive coding (see Appendix A) is contained in the web available tables. Participating companies still have the right to analyze oil samples from the GeoMark collection of 17,000 oil samples, and any new data performed on **OILS** samples (C7, GC/MS/MS, etc.) is routinely added to the database. In addition, the **OILS** Database is linked with modules containing over 17,000 gas analyses, and 1000 PVT reports.

We invite you to review this proposal, visit the website, and either renew your existing subscription to **OILS**, or if you are not a member, consider participation.

## OBJECTIVES

Delivering the **OILS** database via the **RFDbase** website provides a number of useful advantages. All data modules are contained in an integrated location. The detailed search function can identify data for all types, and the mapping interface may be used to search for specific oil analyses or to locate similar fluids (based on geochemical and bulk characteristic classifications) in different geographic regions. These “similar” fluids may be further utilized in estimating fluid properties or parameters, and in linking to commercial or in-house simulation programs.

Some of the specific functions of **RFDbase** are listed below.

- Electronic or hardcopy reports can be generated directly from the database. The reports are exported into standard Excel or Access files.
- Raw HP data files can be downloaded for any oil sample.
- An important feature allows for extensive data searching by fluid properties, field information, etc. Additionally, a web enabled Geographical Information System (GIS) mapping application provides for data searching and comparative analyses in a more visual environment.
- The program allows for real time plotting of selected summary data sheets or data sets.
- With the mapping interface, comparisons of multiple fluids on a geographical basis can be made.
- GC and GC/MS plots are easily viewable online.
- Data are easily exported to Excel or Access for individual samples or entire data sets.
- Geographical searches can identify all types of data (oil, seep, gas, PVT, solids, etc.) available in an area of choice.

The broadband capabilities of **RFDbase** will handle multiple simulations users, and there is unlimited password access to any/all users within a company. All web based functions are straightforward and easy to follow, and a user manual is provided and can be downloaded in PDF format.

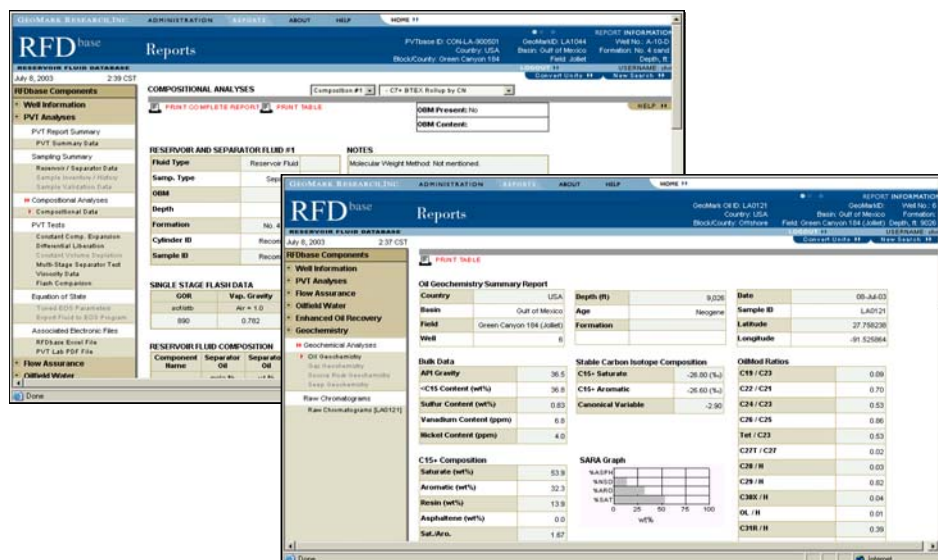


Figure 2. Typical headliner report compilation pages.

## DATABASE DESIGN

**RFDbase** has been developed as an interactive web interface overlaying a Microsoft SQL Server database populated with the petroleum fluid data. The database applications are hosted off-site offering electronic and physical security, as well as broadband access for member companies.

It is important to note that GeoMark has previously constructed geochemical database modules; much of that data was generated using consistent methods in our laboratory. However, portions of the remaining modules are populated with data from other laboratories where inconsistencies may exist between experimental methods and processing techniques. Where available, these variations are recorded and quantified in the database.

In the next section of this proposal we list each of the modules that are active, or being developed, as part of the **RFDbase** database.

## DATA SEARCH & MAPPING FUNCTIONS

All types of data can be identified by multiple search functions. A “Quick Search” function allows a user to search on a series of common sample identifiers such as Country, Basin, or Well Name. A more comprehensive “Custom Search” can be accomplished applying a user-defined attributes search within a single module (oils only), or within multiple modules (oils plus gases). Since all samples in **RFDbase** are coded with latitude and longitude values for placement on the internet-enabled map, a Geographical Information System (GIS) mapping application provides for a “Map Search” function identifying samples in a more visual environment.

The screenshot displays the RFDbase web interface. The top navigation bar includes 'ADMINISTRATION', 'REPORTS', 'ABOUT', and 'HELP'. The main content area shows search results for 'PVT Reports' with two entries. Each entry includes a table of well information and properties.

**Search Results:**

1. PVT Report ID: KMG-TX-000301, PVT Lab Report: 16332-26216-18

WELL INFORMATION		PROPERTIES		PROPERTIES	
Country	USA	Reservoir Pressure	7411 psia	Reservoir Density	0.701 g/cm <sup>3</sup>
Basin	Gulf of Mexico	Reservoir Temperature	80 °C	API Gravity	38.2 °API
Block/County	East Breaks 602	Saturation Pressure	7411 psia	OBM Present	Minor
Field Name	Nansen	Single-Stage GOR	1187 scf/stb	OBM Content	w/o STD
Well Number	3	Single-Stage PVT	1.522 sat-wt%		
Depth #	13216	Reservoir Viscosity	0.890 cP		

2. PVT Report ID: KMG-TX-000302, PVT Lab Report: 16339-26216-14

WELL INFORMATION		PROPERTIES		PROPERTIES	
Country	USA	Reservoir Pressure	7802 psia	Reservoir Density	0.880 g/cm <sup>3</sup>
Basin	Gulf of Mexico	Reservoir Temperature	80 °C	API Gravity	30.2 °API
Block/County	East Breaks 602	Saturation Pressure	7215 psia	OBM Present	No
Field Name	Nansen	Single-Stage GOR	1804 scf/stb	OBM Content	w/o STD
Well Number	3	Single-Stage PVT	1.725 sat-wt%		
Depth #	13404	Reservoir Viscosity	0.481 cP		

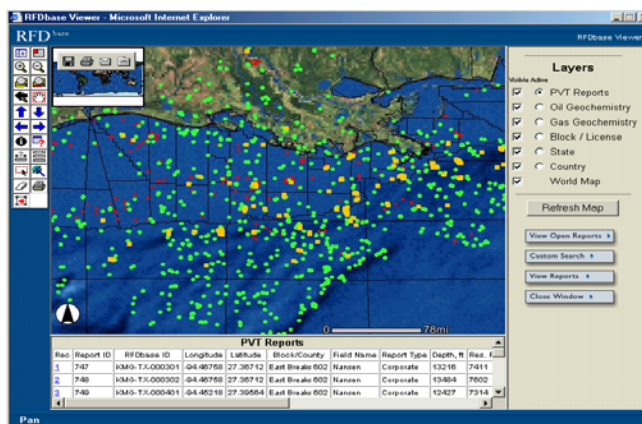
The interface also features a map view showing the geographical location of the wells, with a 'Layers' panel on the right for toggling data layers like 'PVT Reports', 'Oil Geochemistry', and 'Gas Geochemistry'. A 'PVT Reports' table at the bottom provides a summary of the search results.

Row	Report ID	RFDbase ID	Longitude	Latitude	Block/County	Field Name	Report Type	Depth #	Res
1	747	KMG-TX-000301	-94.46758	27.38712	East Breaks 602	Nansen	Corporate	13216	7411
2	748	KMG-TX-000302	-94.46759	27.38712	East Breaks 602	Nansen	Corporate	13404	7802
3	749	KMG-TX-000481	-94.48218	27.39294	East Breaks 602	Nansen	Corporate	12427	7314

Figure 3. Typical headliner report compilation and map view screens.

## DATA INTEGRATION

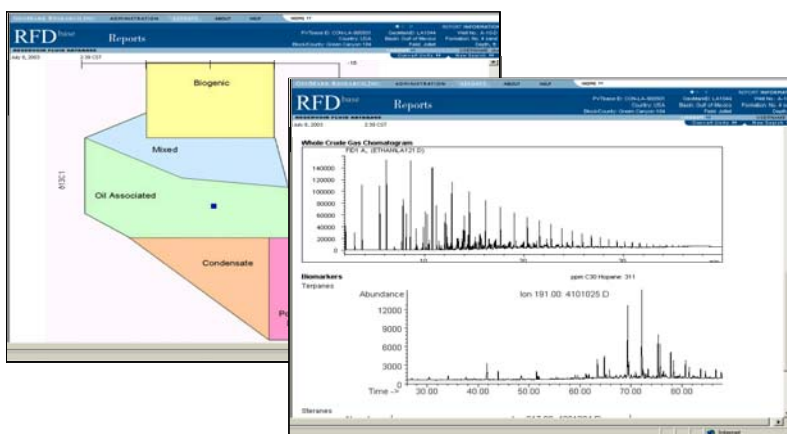
All types of reservoir fluid data are to be stored in the **RFDbase** Database. The Database currently holds modules for oil, oil seep, gas, gas seep, PVT, flow assurance (wax and asphaltene), water analyses, and source rock extract analyses.



**Figure 4.** Gulf of Mexico image showing distribution of all data types. Oil and oil seep data in shown in green, gas and gas seep data in red, and PVT reports are shown in yellow.

## DOWNLOADING DATA

Users have a number of options for printing and/or downloading data. GeoMark’s standard Geochemical Summary sheet can be viewed on screen or printed. Data tables can be downloaded in several format types, including Microsoft Excel or Microsoft Access. Graphical data can be viewed on screen, or downloaded in report format. Raw GC and GC/MS data is also downloadable from the website.



**Figure 5.** Graphical data can be viewed on screen or downloaded.

## PRICING

The price for the **OILS** database is US \$50,000.00/per year. There is no additional cost for web access.

### For Additional Information Contact:

GEO-MARK RESEARCH, INC.  
 9748 Whithorn Drive  
 Houston, Texas 77095

Tel: 281/856-9333  
 Fax: 281/856-2987  
 e-mail: [info@geomarkresearch.com](mailto:info@geomarkresearch.com)

## Appendix A Interpretive Coding

Since most of the oil samples included in the database were appropriated from GEOMARK'S regional crude oil studies, the petroleum systems to which the oils belong can be coded into the database. The corresponding source rock type, age, and level of thermal maturity are provided for each oil sample when this information is available. The degree of biodegradation is indicated as well. Also, a confidence level for the source rock predictions is furnished with available references or GEOMARK studies.

**Depositional Environment** - The oils are indexed as to source rock type into one of eight categories listed below. This enables users to query for source types within any basin, or selectively evaluate facies compatible oils from a global or super-regional set. We also provide reference back to the GEOMARK report from which the interpretation was derived.

### Source Rock Type Categories

- Distal Marine Shale (Type II kerogen)
- Paralic/Deltaic Marine Shale (Type III kerogen)
- Coal/Resinitic Terrestrial Source
- Marine Carbonate (Type II/IIS)
- Hypersaline/Restricted Source
- Marine Marl
- Lacustrine Fresh (Type I/II)
- Lacustrine Saline (Type I/II)

**Geologic Age** - The geologic age of the corresponding source rocks is divided into thirteen (13) divisions shown below. Although source/oil correlations were not performed in most cases, these age-based classifications have come from GEOMARK'S regional studies, and in most cases are undisputed. Confidence ratings are again provided for all interpreted samples.

### Source Rock Age Divisions

- |                        |                         |
|------------------------|-------------------------|
| • Precambrian/Cambrian | • Lower/Middle Jurassic |
| • Ordovician           | • Upper Jurassic        |
| • Silurian             | • Lower Cretaceous      |
| • Devonian             | • Upper Cretaceous      |
| • Carboniferous        | • Paleogene             |
| • Permian              | • Neogene               |
| • Triassic             |                         |

**Thermal Maturity** - With respect to the thermal maturity of the source rock, four general divisions are made based on the triaromatic sterane and/or terpane biomarker parameters of the corresponding crude oils. The first three (M1, M2, M3) are for oils containing sufficient biomarkers and correspond to low, moderate, and high maturities within the oil generation window (~0.5 to 1.0% Ro vitrinite reflectance equivalent). For condensates/high gravity oils without biomarkers, the designation 'M4' is used.

### Source Rock Thermal Maturity Divisions

(Based on crude oil biomarkers)

- |             |                    |                             |
|-------------|--------------------|-----------------------------|
| • <b>M1</b> | Low Maturity       | (~0.50-0.67% VRE)           |
| • <b>M2</b> | Moderate Maturity  | (~0.67-0.83% VRE)           |
| • <b>M3</b> | High Maturity      | (~0.83-1.0% VRE)            |
| • <b>M4</b> | Very High Maturity | (>~1.0% VRE; no biomarkers) |

## Appendix A (cont.). Interpretive Coding

**Biodegradation** - The oils are also coded as to degree of biodegradation. A biodegradation scale modified from the publications of Volkman *et al.* (1983) and Peters and Moldowan (1993) is used.

### Levels of Crude Oil Biodegradation

		<u>Peters and Moldowan (1993) Scale</u>
• <b>B0</b>	Nondegraded Oil	0
• <b>B1</b>	Light Biodegradation	1-4
• <b>B2</b>	Moderate Biodegradation	5-7
• <b>B3</b>	Heavy Biodegradation	8-10

### Addition of Source Rock Extract Analyses

GEOMARK now includes the *Xtrax* source rock module in the OILS™ Database. *Xtrax* is a database of source rock results performed by GEOMARK, thus retaining the analytical similarity characteristic of the OILS™ Database. The *Xtrax* Database holds the analytical data listed below. Sufficient pedigree data is also provided to enable correlation to basin, field, well, zone, etc.

- Total Organic Carbon (TOC)
- Rock Eval Pyrolysis
- Spore Color Index (SCA)
- Vitrinite Reflectance (Ro)
- Liquid Chromatography (SARA Analysis)
- Gas Chromatography of saturate fraction, or whole extract
- GC/MS of both saturate and aromatic fractions
- Stable carbon isotope analysis of both saturate and aromatic fractions

## Appendix B RFDbase Modules

### *PVT Data* \_\_\_\_\_ [PVT Module](#)

The PVT module is fully functional for the storage, review and manipulation of complete PVT reports. The database is divided into a “closed” section for the storage of confidential reports, and a large “open” section for the storage of non-exclusive reports accessible to all participants. This database stores all data in a standardized format for easy comparison of data, and also house all reports in original formats.

### *Gas Analyses* \_\_\_\_\_ [Gas Analysis Module](#)

GeoMark currently maintains two separate gas analysis databases (Global and Gulf of Mexico) that hold a total of 4,300 gas analyses worldwide. Over 95% of these analyses have compositional and carbon isotope measurements. Both of these databases are accessible via the [RFDbase](#) website.

### *Oil Analyses* \_\_\_\_\_ [GOMOIL & OILS™](#)

Through the **OILS™** (Oil Information Library System) and GOMOIL (Gulf of Mexico OILS) databases GeoMark provides access to over 6,700 crude oil geochemical analyses. Participating companies have access to the databases and can contribute oil samples for free analysis by GeoMark. The results of these analyses will be held confidential by GeoMark for a negotiated period of time and are then added to the databases. This provides an analytical source for the participants and populates the databases with new samples. During each year GeoMark will also add new samples to the databases from its' collection of regional study samples, thus assuring that the databases grow substantially each year.

### *Source Rock Analyses* \_\_\_\_\_ [XTRAX](#)

GeoMark is now offering the Xtrax™ (Source Rock Extract Analysis Database) as a complement to its existing **OILS™** (Oil Information Library System) program. This database contains all the analytical and complementary data for a selection of source rock samples. All the extract biomarker and isotopic analyses have been performed by GeoMark, thus assuring compatibility to the **OILS™** data.

### *Flow Assurance* \_\_\_\_\_ [Flow Assurance Module](#)

Over the past 2 years GeoMark has performed a series of geochemical studies designed to establish a baseline understanding of flow assurance problems. These “problematic” studies were performed to investigate the relationship between different oil types (i.e. different source environments, thermal maturities, and degrees of biodegradation) and paraffin and asphalt stability. The results from these studies form the bases for the flow assurance module.

## Appendix C

### Experimental Procedures and Analytical Program

#### Experimental Procedures

**Elemental Analysis.** Sulfur concentration was determined by x-ray fluorescence while nickel and vanadium were determined by atomic adsorption techniques.

**Liquid Chromatographic Separation.** Subsequent to determining the <C15 fraction (light ends) by evaporation in a stream of nitrogen for 30 min, and asphaltene precipitation using n-hexane (overnight at room temperature), the C15+ deasphalted fractions were separated into saturate hydrocarbon, aromatic hydrocarbon, and NSO (nitrogen-sulfur-oxygen compounds or resin) fractions using gravity-flow column chromatography employing a 100-200 mesh silica gel support activated at 400° C prior to use. Hexane was used to elute the saturate hydrocarbons, dichloromethane to elute the aromatic hydrocarbons, and dichloromethane/methanol (50:50) to elute the NSO fraction. Following solvent evaporation, the recovered fractions were quantified gravimetrically. The C15+ saturate hydrocarbon fraction was subjected to molecular sieve filtration (Union Carbide S-115 powder) after the technique described by West *et al.* (1990) in order to concentrate the branched/cyclic biomarker fraction.

**Stable Isotope Analyses.** Stable carbon isotopic compositions (<sup>13</sup>C/<sup>12</sup>C) of the C15+ saturate and aromatic hydrocarbon fractions were determined using the combustion technique of Sofer (1980) and a Finnigan Delta E isotope ratio mass spectrometer. Results are reported relative to the PDB standard.

**Gas Chromatography.** Whole crude oils were injected (split mode 70/1) on a 30 m x 0.32 mm J&W DB-5 column (0.2 µm film thickness) and temperature programmed from -60° C to 350° C at 12°/min using a Hewlett Packard 5891 Gas Chromatograph. Helium was used as the carrier gas.

**Gas Chromatography/Mass Spectroscopy (GC/MS).** GC/MS analyses of C15+ branched/cyclic and aromatic hydrocarbon fractions (in order to determine sterane and terpane biomarker distributions and quantities) were performed using a Hewlett Packard (HP) 5890 GC (split injection) interfaced to a HP 5971 mass spectrometer. The HP-2 column (50 m x 0.2 mm; 0.11 µm film thickness) was temperature programmed from 150° C to 325° C at 2°/min (branched/cyclic) and 100° C to 325° C at 3°/min for aromatics. The mass spectrometer was run in the selected ion mode (SIM), monitoring ions m/z 177, 191, 205, 217, 218, 221, 231 and 259 amu (branched/cyclic) and m/z 133, 178, 184, 192, 198, 231, 245, and 253 (aromatics). In order to determine absolute concentrations of individual biomarkers, a deuterated internal standard (d4-C29 20R sterane; Chiron Laboratories, Norway) was added to the C15+ branched/cyclic hydrocarbon fraction. Response factors (RF) were determined by comparing the mass spectral response at m/z 221 for the deuterated standard to hopane (m/z 191) and sterane (m/z 217) authentic standards. These response factors were found to be approximately 1.4 for terpanes and 1.0 for steranes. Concentrations of individual biomarkers were determined using the equation shown below:

$$\text{Conc. (ppm)} = [(\text{ht. biomarker})(\text{ng standard})] / [(\text{ht. standard})(\text{RF})(\text{mg b/cy fraction})]$$

#### Standard Analytical Program

- Physical property data (API gravity, % Sulfur, ppm Ni and V)
- C<sub>15+</sub> fraction versus <C<sub>15+</sub> fraction
- Deasphalting
- Liquid chromatography (% Saturates, % Aromatics, and % NSO's)
- Capillary gas chromatography of whole crude oil
- Stable carbon isotopic composition of C<sub>15+</sub> saturate and aromatic hydrocarbons
- Quantitative GC/MS analysis of C<sub>15+</sub> saturate hydrocarbons for terpane and sterane distributions
- GC/MS of aromatic hydrocarbon fraction