

**LOWER ARABIAN GULF
GEOCHEMICAL STUDY**

GEO**MARK**
RESEARCH, INC.

PROSPECTUS

EXECUTIVE SUMMARY

The GeoMark Middle East Geochemistry Study of 412 oils and 72 selected source rock samples defined numerous Oil Systems and related Oil Families distributed over the greater Arabian Basin. In that study a limited number of oils and source rocks were available from the southern Gulf Emirates, northern Oman and Rub' al Khali of Saudi Arabia. Analyses of these samples indicated a previously unknown clastic source rock of probable lower Jurassic to Triassic age. In addition, oils derived from Silurian and InfraCambrian sources were detected as well as the generally accepted Middle Jurassic to middle Cretaceous sources.

As a follow-up to the plate-wide study, GeoMark has finalized a more detailed evaluation of the lower Arabian Gulf region. This study, performed in cooperation with Abu Dhabi National Oil Company, provides data on an additional 70 source rock samples and over 150 oils and condensates drawn from all producing horizons from the Permian to Tertiary from fields across the region (see Figure 1, and Appendices A and B). In addition, source rock samples from all known or suspected contributing intervals have been analyzed and correlated back to the defined Oil Families.

The major objective of the Study was to provide a comprehensive characterization of oil systems in the Southern Gulf Region.

- Augment the characterization of distinct Oil Families as defined in the Middle East Geochemical Study, and further refine areal distributions.
- Emphasize deeper zone oils and condensates to further clarify the contribution to hydrocarbon pools from older source rocks of the region.
- Increase the number of samples from fields with stacked reservoirs and multiple zones within defined Oil Systems to assess vertical and lateral migration.
- Identify the major source rocks contributing to the defined Oil Families by direct fingerprinting of rock extracts.
- Identify/confirm the “possible” Triassic sourced clastic oil seen in several locations within the region. Assess the importance of this system.
- Assess the volumetric importance of the InfraCambrian oils detected in northern Oman.

All analytical data generated by the Study will be provided to participants in hard cover volumes and digital format. The interpretive report includes maps summarizing the regional geology, the distribution of Oil Families, source rocks and the associated petroleum systems. The cost of the study is (US) \$ 37,500.00.

INTRODUCTION

The petroleum reserves of the United Arab Emirates, northern Oman and offshore Iran are contained in clastic and carbonate reservoirs ranging in age from the early Permian to the Upper Cretaceous with additional minor accumulations in Tertiary units. From the limited number of oil samples available to the GeoMark Middle East Oil Study, it was possible to determine that pools in the southern Gulf area, northern Oman and the Rub' al Khali of Saudi Arabia were derived from several different source rocks ranging in age from the Late PreCambrian Huqf to the Eocene shales of the Pabdeh Formation. Of particular interest was the definition of a distinct oil family derived from a clastic source which until now has not been recognized in the region. This new source may be of Lower Jurassic to Triassic in age. The discrimination of this possible new source interval and the better definition of the Silurian source shale distribution were primary objectives of this new Study. Other recognized source intervals have been sampled and related to defined oil families through detailed geochemical analyses. The fields included in this Study are listed in Appendices A and B.

METHODOLOGY

The several Petroleum Systems within the Study Area have been outlined by the results of the plate-wide GeoMark Middle East Geochemical Study. The current project presents the analyses and interpretations derived from carefully selected oil and condensate samples drawn from all producing intervals from the Permian to Tertiary and distributed across the entire onshore and offshore areas of the UAE and offshore Iran. Samples from Qatar, northern Oman and the Rub' al Khali augment the regional setting. Source rocks from all identified rich intervals are related to the defined Oil Families. Migration directions and timing are elucidated in the Study.

GIS DATABASE

Results of the study are presented in digital form on an Access™ database. Access™ is a fully relational database running on personal computers under Microsoft Windows. The Access™ held data are displayed via the ArcView™ geographic information system (GIS). ArcView™ is a multiplatform program running on Unix workstations, PC's Microsoft Windows, and the Macintosh. A hard copy of the Access™ output is supplied in Data Volumes.

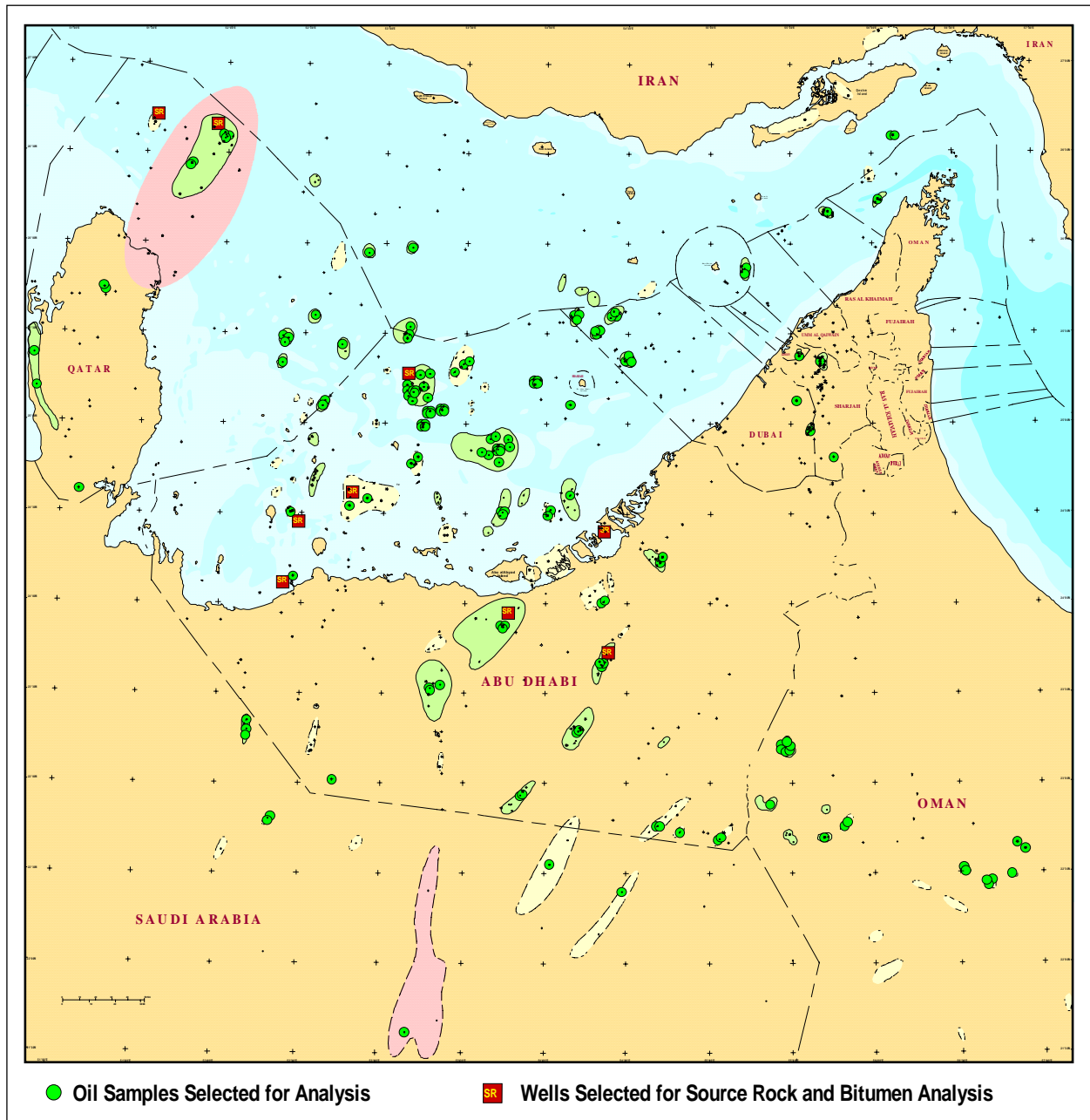


Figure 1. Base map showing sample locations.

ANALYTICAL PROGRAM

SOURCE ROCK SAMPLES

The source rock samples were analyzed by the following techniques:

- Lithological Description
- Total Organic Carbon (TOC)
- Rock-Eval Pyrolysis
- Kerogen Maceral Analysis (TAI)
- Vitrinite Reflectance (% Ro)
- Bitumen Analysis (This includes all the analytical procedures listed below for oils, with the exception of API gravity, Ni/V and %S)

OIL SAMPLES

The following techniques were employed on each of the oil samples:

- API Gravity
- % Sulfur
- Nickel/Vanadium concentrations
- C15+ vs. <C15+
- Deasphalting (% Asph)
- Liquid Chromatography (%Sat %Aro %NSO)
- Capillary GC of Whole Crudes
- Stable Carbon Isotopes for both Sat and Aro Hydrocarbon Fractions
- GC/MS of Saturates for Terpane/Sterane Distributions (quantitative)
- GC/MS of Aromatic Hydrocarbons

All results are available in digital form. This includes tabulated data as well as raw gas chromatograms and mass fragmentograms if desired.

PRESENTATION OF RESULTS

Results of the study are presented in both analytical and interpretive formats to insure that all findings are readily accessible to explorationists and research personnel. All of the analytical data are provided in hard copy and on personal computer disks.

Analytical data are presented within **Regional Data Volumes**, and include the following:

- Source rock data
- Basic Oil Data
 - Physical property oil data
 - Stable carbon isotope data
 - Liquid chromatographic data
- Gas chromatographic results
- GC/MS mass chromatograms

A synthesis and interpretation of all information are presented in a comprehensive **Final Report**. The **Final Report** includes sections for:

- Regional Geology
- Interpretation of Oil Characteristics
- Differentiation of Oil Families
 - Using Multivariate Statistics
- Source Rock Quality Maps
- Inferred Oil/Source Correlations
- Oil Generation and Migration
- Production Histories
- Overall Exploration Potential

PARTICIPATION

The cost of the study is US \$37,500.

TIMING

This project is complete and available for immediate delivery.

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Appendix A

Fields/Wells Selected for Oil Analysis

ID	Country	Field	Age	ID	Country	Field	Age
UE020	Sharjah	Sajaa	Cretaceous	UE080	Abu Dhabi	Bab	L. Cretaceous
UE021	Sharjah	Al Owaid	Jurassic?	UE081	Abu Dhabi	Bab	L. Cretaceous
UE022	Dubai	Margham	L. Cretaceous	UE082	Abu Dhabi	Umm Shaif	U. Jurassic
UE023	Dubai	Al Awir	Eocene	UE083	Abu Dhabi	Umm Shaif	U. Jurassic
UE024	UAE			UE084	Abu Dhabi	Umm Shaif	U. Jurassic
UE025	Abu Dhabi	Qusahwira	L. Cretaceous	UE085	Abu Dhabi	Umm Shaif	Permian
UE026	Abu Dhabi	Bu Hasa	L. Cretaceous	UE086	Abu Dhabi	Umm Shaif	M. Jurassic
UE027	Abu Dhabi	Bu Hasa	L. Cretaceous	UE087	Abu Dhabi	Umm Shaif	M. Jurassic
UE028	Abu Dhabi	Ghasha	M. Jurassic	UE088	Abu Dhabi	Umm Shaif	U. Jurassic
UE029	Abu Dhabi	Ghasha	U. Jurassic	UE089	Abu Dhabi	Umm Shaif	M. Jurassic
UE030	Abu Dhabi	Ghasha	U. Jurassic	UE090	Abu Dhabi	Umm Shaif	U. Jurassic
UE031	Abu Dhabi	Mandous	Miocene	UE091	Abu Dhabi	Umm Shaif	U. Jurassic
UE032	Abu Dhabi	Mandous	Oligocene	UE092	Abu Dhabi	Umm ad Dalkh	M. Cretaceous
UE033	Abu Dhabi	Salsal (Alpha I/I)	L. Cretaceous	UE093	Abu Dhabi	Mender	L. Cretaceous
UE034	Abu Dhabi	Salsal (Alpha I/I)	M. Jurassic	UE094	Abu Dhabi	Mender	L. Cretaceous
UE035	Abu Dhabi	Salsal (Alpha I/I)	U. Jurassic	UE095	Abu Dhabi	Mosadeq	Eocene
UE036	Abu Dhabi	Dholou (Alpha II/I)	U. Jurassic	UE096	Abu Dhabi	Mosadeq	L. Cretaceous
UE037	Abu Dhabi	Dholou (Alpha II/I)	U. Jurassic	UE097	Abu Dhabi	Mubarraz	L. Cretaceous
UE038	Abu Dhabi	Dholou (Alpha II/I)	M. Jurassic	UE098	Abu Dhabi	Mubarraz	L. Cretaceous
UE039	Abu Dhabi	Dholou (Alpha II/I)	M. Jurassic	UE099	Abu Dhabi	Mubarraz	L. Cretaceous
UE040	Abu Dhabi	Sahil	L. Cretaceous	UE100	Abu Dhabi	Umm Lulu	L. Cretaceous
UE041	Abu Dhabi	Sahil	L. Cretaceous	UE101	Abu Dhabi	Shah	U. Cretaceous
UE042	Abu Dhabi	Sahil	L. Cretaceous	UE102	Abu Dhabi	Shah	U. Cretaceous
UE043	Abu Dhabi	Umm Shaif	M. Jurassic	UE103	Abu Dhabi	Abu	U. Jurassic
UE044	Abu Dhabi	Umm Shaif	M. Jurassic	UE104	Abu Dhabi	Bu Hasa	
UE045	Abu Dhabi	Umm al Salsal	M. Jurassic	UE105	Abu Dhabi	Bu Hasa	
UE046	Abu Dhabi	Asab	L. Cretaceous	UE106	Abu Dhabi	Habshan	
UE047	Abu Dhabi	Asab	L. Cretaceous	UE107	Abu Dhabi	Marzouk	M. Cretaceous
UE048	Abu Dhabi	Bu Hasa	L. Cretaceous	UE108	Abu Dhabi	Marzouk	M. Cretaceous
UE049	Abu Dhabi	Bu Hasa	L. Cretaceous	UE109	Abu Dhabi	Marzouk	M. Cretaceous
UE050	Abu Dhabi	Jarn Yaphour	L. Cretaceous	UE110	Abu Dhabi	Marzouk	M. Cretaceous
UE051	Abu Dhabi	Geem	M. Cretaceous	UE111	Abu Dhabi	Marzouk	M. Cretaceous
UE052	Abu Dhabi	Belbazem	M. Jurassic	UE112	Abu Dhabi	Marzouk	M. Cretaceous
UE053	Abu Dhabi	Belbazem	L. Cretaceous	UE113	Abu Dhabi	Marzouk	M. Cretaceous
UE054	Abu Dhabi	Belbazem	U. Jurassic	UE114	Abu Dhabi	Marzouk	M. Cretaceous
UE055	Abu Dhabi	Belbazem	U. Jurassic	UE115	Abu Dhabi	Mushash	
UE056	Abu Dhabi	Shuwaihat	M. Jurassic	UE116	Abu Dhabi	Mushash	
UE057	Abu Dhabi	Rumaiitha	L. Cretaceous	UE117	Abu Dhabi	Umm Shaif	
UE058	Abu Dhabi	Saath al Raaz Boot	U. Jurassic	UE118	Abu Dhabi	Se Dhafara	
UE059	Abu Dhabi	Saath al Raaz Boot	U. Jurassic	UE119	Abu Dhabi	Zayghat	M. Cretaceous
UE060	Abu Dhabi	Hair Dalmah	M. Cretaceous	UE120	Abu Dhabi	Zayghat	M. Cretaceous
UE061	Abu Dhabi	El Bunduq	U. Jurassic	UE121	Abu Dhabi	Zayghat	M. Cretaceous
UE062	Abu Dhabi	El Bunduq	M. Jurassic	UE122	Dubai	Falah	M. Cretaceous
UE063	Abu Dhabi	Abu al Bukloosh	U. Jurassic	UE123	Dubai	Falah	L. Cretaceous
UE064	Abu Dhabi	Abu al Bukloosh	U. Jurassic	UE124	Dubai	Rashid	L. Cretaceous

ID	Country	Field	Age	ID	Country	Field	Age
UE066	Abu Dhabi	Zakum	M. Jurassic	UE126	Dubai	Fateh	L. Cretaceous
UE067	Abu Dhabi	Zakum	M. Cretaceous	UE127	Dubai	Fateh	M. Cretaceous
UE068	Abu Dhabi	Zakum		UE128	Dubai	SW Fateh	M. Cretaceous
UE069	Abu Dhabi	Zakum	L. Cretaceous	UE129	Dubai	Fateh	
UE070	Abu Dhabi	Zakum	L. Cretaceous	UE130	Dubai	SW Fateh	L. Cretaceous
UE071	Abu Dhabi	Zakum	L. Cretaceous	UE131	Dubai	SW Fateh	
UE072	Abu Dhabi	Zakum	L. Cretaceous	UE132	Dubai	Fateh	M. Cretaceous
UE073	Abu Dhabi	Zakum	L. Cretaceous	UE133	Abu Dhabi	Bu Haseer	
UE074	Abu Dhabi	Zakum	L. Cretaceous	UE134	Abu Dhabi	Bu Haseer	
UE075	Abu Dhabi	Zakum	L. Cretaceous	UE135	Abu Dhabi	Meem	
UE076	Abu Dhabi	Nasr	L. Cretaceous	UE136	Abu Dhabi	Meem	
UE077	Abu Dhabi	Nasr	U. Jurassic	UE137	Abu Dhabi	Yaser	
UE078	Abu Dhabi	Nasr	U. Jurassic	UE138	Abu Dhabi	Yaser	
UE079	Abu Dhabi	Bab	L. Cretaceous	UE139	Abu Dhabi	Yaser	

Appendix B
Wells Selected for Source Rock Analysis

Well Name and Number	Number of Samples
Abu Dhabi:	
Bab - 116	22
Sahil - 23	21
Hudairiat - 2	31
Al Dabb'iyah - 4	10
Shuweihat - 4	5
Umm Shaif - 212	4
Umm Shaif - 226	35
Ghasa - 7	7
Hair Daimah - 3	12
Qatar:	
Al Ruyyan	2