FAR EAST
OIL STUDY

**REGIONAL PETROLEUM GEOCHEMISTRY
OF CRUDE OILS FROM
BASINS OF THE WESTERN CIRCUM-PACIFIC**

**GEOMARK
RESEARCH, INC.**

PROSPECTUS

EXECUTIVE SUMMARY

The Far East has long been recognized as a major hydrocarbon province and recent developments, political, economical and geological, will insure that the region retains a high level of exploration activity. To assist future exploration efforts of this prolific area, GeoMark Research has completed a regional geochemical evaluation of the western Circum-Pacific region. This study is based on the geochemical characterization of over 370 crude oil samples using a detailed analytical program which includes the quantitative biomarker analysis of terpanes and steranes and the determination of the stable carbon isotope composition of the C15+ hydrocarbon fractions. With this information, we have accomplished the following:

- Determined the number of genetically distinct oil families in each producing region.
- Documented any similarities in oil families across this geographically broad, but geologically related region.
- Mapped the stratigraphic and geographic distribution of the oil families and distinguish basins/areas with single oil families (single sources) from those with multiple oil families (multiple sources).
- Utilized geochemical characteristics of the oil families to deduce their source facies, thermal maturity level, and degree of preservation.
- Determined the most likely source unit(s) in each basin by comparing the distribution of oil families and their inferred source facies with regional stratigraphy, burial history, and available source rock data.
- Estimated the migrational directions by comparing oil family distributions with the location of known oil kitchens.
- Utilized the geographic, stratigraphic, and structural distribution of source rocks and genetically related oils to identify, map, and rank the petroleum systems in each basin and in the region as a whole.

Due to the large areal extent of the basins of the Western Circum-Pacific and the many oil samples (and associated high cost) necessary to adequately understand the petroleum systems in the Far East, we have subdivided the study into four geographical areas. These four areas are illustrated in the enclosed map and a listing of the oils from each of the areas is also included.

The crude oil geochemical data, interpretive reports, and associated maps can be purchased for any single or combination of the four areas. Cost information is presented in the Participation section of this proposal.

INTRODUCTION

Oil has been produced in the Far East for centuries and the region has long been recognized as a major hydrocarbon province. In spite of this, it is felt that significant reserves remain undiscovered in many basins within the region (Champeny, 1981). However, for both geological and geographical reasons exploration is difficult and expensive. In any region where exploration is difficult because of geological factors it is critical to obtain a thorough understanding of the petroleum systems operating within the region. By understanding the factors controlling a) the source/origin, b) migration pathways and c) reservoir distribution of each separate petroleum system exploration risk is definitely reduced.

A regional crude oil study is perhaps the best method of accomplishing an evaluation of regional petroleum systems. By correlating and characterizing crude oil samples from a statistically broad collection of oils, it is possible to deduce all of the elements listed above (source, pathway, etc.) for each system within a basin or region. Previous investigations have evoked a multiplicity of source types, ages and locations. Some of these basins have been well studied, but no comprehensive analytical study of the entire region has been performed. Consequently, many details of the petroleum systems in most of the basins are poorly understood.

To assist in a further understanding of the region, GeoMark Research has completed a regional crude oil study of the Far East. The study involves the analysis of more than 370 oil samples extending from Japan to New Zealand. (Figure 1) A generalized distribution of the oil samples included in the study is presented in the enclosed map. The samples that were analyzed are listed in Appendix A.

METHODOLOGY AND EXPLORATION APPLICATIONS

The regional petroleum systems within the study area have been evaluated by first determining the number of effective source units within a region by establishing the number of compositionally distinct oil families. The source facies of each oil family were deduced from the oil geochemistry (e.g., Zumberge, 1987; Moldowan *et al*., 1985). Conclusions were reached regarding source lithology, anoxicity, salinity, organic input (marine, non-marine or marginal marine) and thermal maturity using a variety of parameters based on detailed and bulk composition and information obtained from the literature. In some cases it was possible to bracket the age of the source from the oil data.

The predicted source facies was compared to the stratigraphy, sedimentology, and burial history of each basin to determine the most probable source units. The areal extent and burial depth of the source units were combined with the geographic and stratigraphic distributions of their associated oil families to determine the location of the various oil kitchens and the most probable migration directions. The relative potential of the petroleum systems in each basin was ranked by incorporating geological information on source thickness and sedimentary environment, and source potential of the various source units. The results were evaluated in an effort to identify areas where particular petroleum systems exist but have been overlooked or poorly tested.

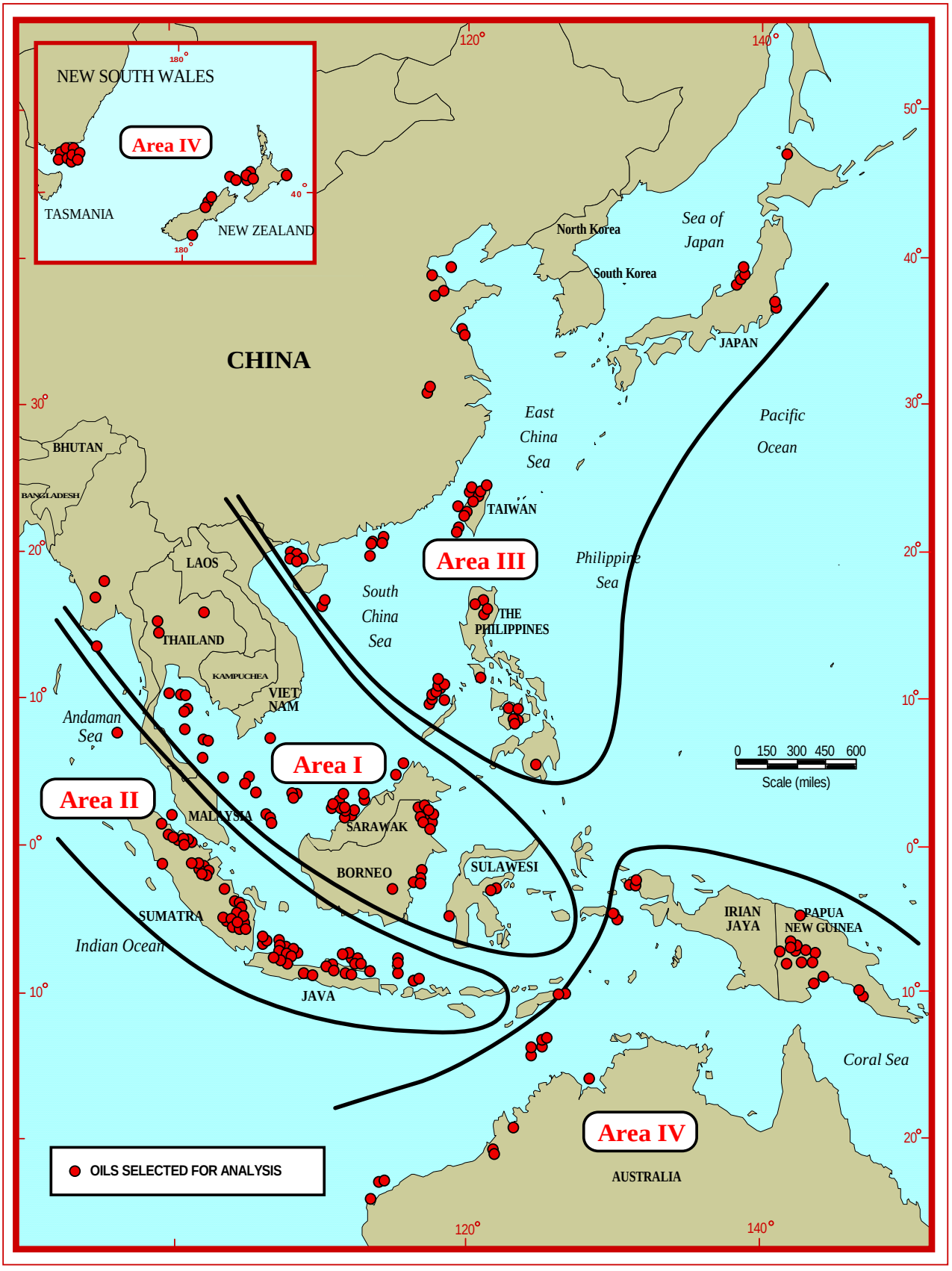

Figure 1. Location map showing distribution of samples analyzed for this study.

ANALYTICAL PROGRAM

All of the oil samples have been analyzed using the following technical program:

- API Gravity
- % Sulfur
- Ni/V Ratios
- C15+ vs. <C15+
- Deasphalting
- Liquid Chromatography (%Sat %Aro %NSO)
- Capillary GC of Whole Crude Oil
- Stable Carbon Isotopic Composition of the C15+ Saturate and Aromatic Hydrocarbons
- Quantitative GC/MS analysis of C15+ Saturate Hydrocarbons for Terpane/Sterane Distributions

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. The analytical data, provided on personal computer disks and within **Area Data Volumes,** include the following:

- physical property data
- liquid chromatographic data
- gas chromatographic results
- stable carbon isotope data
- GC/MS mass chromatograms.

A synthesis and interpretation of all information is presented in comprehensive **Final Reports**. For each of the regions studied, the **Final Report** includes sections for:

- regional geology
- differentiation of oil families by multivariate statistics
- production histories
- inferred oil/source correlations
- oil generation and migration
- interpretation of oil characteristics
- overall exploration potential

PARTICIPATION

The Price of this study is US $65,000. This study is complete and available for immediate delivery.

STUDY AREA	NUMBER OF OILS	COST
1 (MYANMAR TO SULAWESI)	**89**	**$17,000**
2 (SUMATRA TO JAVA)	**122**	**$20,000**
3 (PHILIPPINES TO JAPAN)	**102**	**$17,000**
4 (AUSTRALIA TO N. ZEALAND)	**71**	**$15,000**

FOR ADDITIONAL INFORMATION CONTACT:

Mr. Stephen W. Brown
GEOMARK RESEARCH, INC.
9748 Whithorn Drive
Houston, TX 77095

Telephone: (281) 856-9333
Fax: (281) 856-2987
e-mail: sbrown@geomarkresearch.com

REFERENCES

CHAMPENY, J.D. (1981). Petroleum potential in the Far East. *AAPG Bull*., **65**, 189-194.

MOLDOWAN J.M., SEIFERT W.K., AND GALLEGOS E.J. (1985). Relationship between petroleum composition and depositional environment of source rocks. *AAPG Bull*., **69**, 1255-1268.

ZUMBERGE J.E. (1987). Prediction of source rock characteristics based on terpane biomarkers in crude oils: A multivariate statistical approach. *Geochimica et Cosmochimica Acta*, **51**, 1625-1637.

APPENDIX A
Samples Analyzed for this Study

Sarawak/Sabah
D 18-2
D 18-6
D 18-5
D 18-6
D 35-1
D 21-2
D 21-3
D 35-3
D 35-4
D 30-2
D 34-1
D 41-1
D 41-1
Ketam 1
F23
D 30-2
Laila C
Siwa-5
Siwa-5
St Joseph-2
Patricia-3
Temana-44
Temana-15
Temana-38
Temana-44
Tukau-11
N.W. Bayan-1
Engkabang-1

Malay
Guntong

Myanmar
Mogue
Chindwin
Prome
Salin
Kin'e 18
Moatama

Vietnam
Bach Ho-1
Bach Ho-1

Thailand
Phu Horm 1
Phu Horm 1
Sirikit N. A-1
Esso W-9 B-1
Bung Ya
Bung Muang
16-B 1
15-B 1X
15-B 1X
Kaphong 1
Erawan 12-1
Erawan 12-1
9-492 1X
9-492 1X
5-1-L
17-B 1
Maung Fang Seep
T6-9

Kalimantan
Tanjung 1
Bekapai BH1
Bekapai-9
Bekapai G7
Bekapai-11
Handil HL-275S
Handil HQ-2S
Handil-2

Kalimantan
Kerbau-2
Semanlu-1
Semanlu-1
Sisi-2B
Tambora-11 Bis
Tambora-14
Tambora-19
Tunu-5
Moera Kaeli-3
Apar-1
Sembakung
Batu Kede Seep
Cemba Seep

Malay
Terubuk-1
Terubuk-2
Terubuk-3
Terubuk-3
Anoa

E. Natuna
L-3X
L-3X
L-3X

W. Natuna
E. Udang
Udang-1
Belanak 1
Ikan Pari-2
Kelud-1

Ardjuna
LL-2
UA-6
L-6
UA-1
UB-3
BB-1
XB-3
FF-1
E-10
FZ-1
B-11
XA-2 X-25
VA-1
Cipluk

C. Sumatra
Minas
Bekasap
Pematang
Sago 7
Sago 76
S. Pulai 2
S. Pulai 10
Ukui 12
Ukui 15
Andan 37
Andan 76
PTSI 92
PTSI 81
Caltex Pedada
Pekan
Sabak
Stanvac Langkap
Pelita
Andan
Binio 24
Gemuruh 4
Jurang
Kayurara 15

C. Sumatra
N. Merbau 11
Merbau 2
Molek 8
Pak
Panduk 10
Parum 12
Pekan 43
Talayap 2
Nene 1
Bekasap

Onshore Java
Gondang 1
Sekarkorong 1
Kuti1
Lidah 1
Banyuasin
Gegunung
Wonocolo
Semanggi 7
Nglobo 8
Ledok 229
Ledok 132
Cirebon
Teluk Beran

E. Java Sea
Kawengan 48
JS-20-4
JS-53A-1
JS-20-4
JS-20-4
JS-20-4
JS-20-4
JS-20-4
JS-20-4
JS-44A-1
JS-44A-1
JS-1-1
JS-2-1
JS-14A
JS-18-1
JS-19W-1
JS-19-1
JS-19-1
JS-19-1
Poleng-3
JS-20-1
JS-19W-1
Sepanjang Isle
CN-1
CS-1

Jatibarang
Randegan 44
Haurgeulis 1
Cemara-Timur 2
Kandang Haur-Timur 6
Cemara-Barat 3
Tugu-Barat 7
Jatibarang 44

N. Sumatra
5.8N; 262.7E
NSB-L1

Madura
Arosbaya
Kembar 1

S. Sumatra
Kertegeneh 1
Lerpak 3
Ogan
Tenjung Tiga
Benuang

S. Sumatra
Tempino
Bentayan
Benekat 244
Kembang 1
Ibul 41
Stanvac Jene 1
Kampung Minyak 1
N. Kruh 6
Limau Timur 173
Raja 68
Rambutan 4
Rimbabat 4
Sembatu 2
Tabuan 6
Talang Akar 188
W. Iliran 2

S.E. Kangean
L 46-1
L 46-2

Ombilin
Kolok

Sunda
ZZZ-1
AA-1
AU-1
Widuri Alpha

China
S. China Sea 1
S. China Sea 2
Wan-5
Wan-9
Ying-9
Yellow Sea A
Yellow Sea B
Yellow Sea C
Wei Zhou 6-1-1
Shengli
Daqing
Bohai
(BGCC Bohai) Wan
Liuhua 11-1-2
Liuhua 4-1-1
Liuhua 11-1-3
Liuhua 11-1-5
Liuhua 11-1-5
Pan Zhuang-10
Wang Long Zhuang-15
Ying-9

Japan
Iwaki-1
Aga Oki Si A-13
Aga Oki Si A-6
Aga Oki Si A-4
Aga Oki Si A-13
Shinanogawa Oki Si A1-A
Aga Oki Kita IA-4
Aga Oki Kita IA-6
Kakizaki Oki Tsi-1
Kakizaki Oki Tsi-1
Aga Tobu Oki Si-1
Aga Tobu Oki Si-1
Hokkaido Seep

Taiwan
Formosa-1
Chingtsaohu-14
Taihsil-1
Tiehchenshan-23
Pachangchi-3

Taiwan
CDW-1
Chinshui-53
CDA-3
K; CBA-1
K; CBK-4A
K; CBK-20
K; CBL-1
K; CBS-1
Tiechenshan-39

Philippines
Ipil-1
Ipil-1
Bondoc-3
Reina Regente-2
Reina Regente 1-B
Libagon-6
B.B. Andrada
Amer. Asiatic Corp.
Tayug Seep
S. Mindanao Seep
S. Mindoro Seep
N. Luzon Seep
Cadlao-1
Cadlao-3
Linapacan B1
Linapacan 1A
Custodio-1
Custodio-2
Linapacan B1
Linapacan A-1A
Pandan-1
S. Pandan-1
Libro-1
San Francisco-1
Tara-1
S. Nido-1
S. Nido-1
S. Nido-W1
Galoc-1
Galoc-1
Galoc-1
S. Galoc-1A
S. Galoc-1A
S. Galoc-1A
Matinloc-2
Matinloc-2
Matinloc-1
Matinloc-1
Caluit-1
Malolos-1
Enad-1
Lumpan-5A
West Linapacan-1
Enad-1
San Jose-1
San Jose-1
Sampuguita-1
Cadlao-1
Topac-1
Seep
Maya-11
Libro-1
Gumaca Seep

Indonesia
Nief East 1
Waisian-24
Mogoi-41
Jagiro-4

Indonesia
Paulaca
Aliambata

Papua New Guinea
Seep
Lavani
Seep
Seep
Juha 1X
H. Tege Seep
Erave River Seep
Kagua HW Seep
Upoia Anti. Seep
Lavani Anti. Seep
Omati 1
Puri Anti. Seep
Lake Kutubu Seep
Upoia Seep
Samadan Seep

Australia
Jabiru
Puffin 2
Puffin 3
Halibut 71050
Kingfish 71049
Corbia 1
Dolphin A-1
Halibut A-1
Halibut A-1
Perch A-1
Tuna A-1
Tuna A-1
Mackeral 1
Snapper 1
Tuna 1
Sunfish 2
Luderick 1
Tarwhine 1
Yellowtail 1
Yellowtail 1
Rough Range 1
Seep
Port Campbell 1
Flaxmans 1
Cabawin 1
Tirrawarra
Chinook 1
Griffin 1

New Zealand
HORC 86
Kotoku Field
McKee 4
Todd Maui 1
Kotuka Seep
Waitangi Station 1
Niagara 1
Toetoe 2A, B
Maui 1
Moki
Blackwater 1
McKee 3A
Kaimiro 1
Pouri 1
Tuhua 2
Stratford 1
Ahuroa 2A
Galleon 1

Tonga
2 Seeps