

PETROLEUM SYSTEMS OF SOUTH CENTRAL ASIA

**REGIONAL PETROLEUM GEOCHEMISTRY
OF CRUDE OILS FROM PAKISTAN, INDIA,
NEPAL, BANGLADESH, AND MYANMAR**

**GEOMARK
RESEARCH, INC.**

PROSPECTUS

EXECUTIVE SUMMARY

GEO-MARK RESEARCH has performed a regional assessment of southern Central Asia by geochemically analyzing a suite of 91 crude oils. Samples include an extensive set of oils from Pakistan, India, and Bangladesh, plus selected oils from Myanmar and a single oil from Nepal. The oils selected for analysis are listed in Table I and shown in Figure 1.

Each oil has been characterized by a detailed analytical program that includes bulk compositional data, quantitative biomarker analysis of terpanes and steranes, and determination of stable carbon isotope composition of saturate and aromatic hydrocarbon fractions. Using data from the oils and cluster and principal component analyses, we have accomplished the following:

- Determined the number of genetically distinct oil families in each producing region.
- Mapped the stratigraphic and geographic distribution of the oil families and degree of mixing. Compare families among basins and distinguished 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 depositional 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 migrational directions by comparing oil family and mixing distributions with the location of known depocenters.
- 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 country as a whole.
- Evaluated the effects of secondary oil alterations (migration, biodegradation, etc.) on oil composition, producibility and economic value.

All of the analytical data generated from the oils has been issued in a set of data volumes and on magnetic media. The final interpretive report includes full color, wall-size maps showing the distribution of oil families and associated petroleum systems.

The cost of the study is US \$35,500.

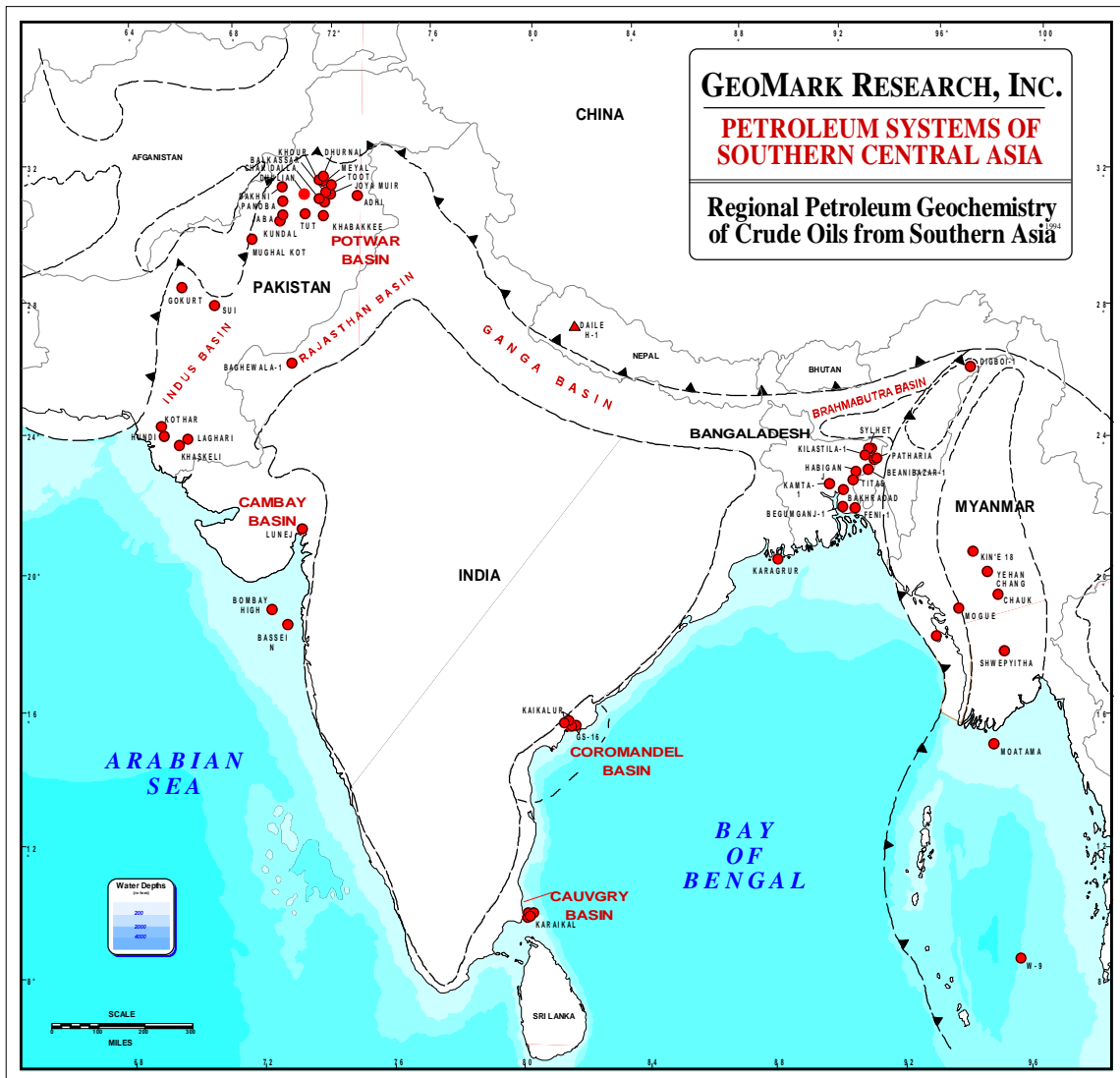


Figure 1. Location Map Showing Samples Selected for Analysis.

METHODOLOGY AND EXPLORATION APPLICATIONS

In areas such as southern Central Asia where a substantial number of fields have been discovered, a regional oil study is an excellent way of identifying, evaluating and comparing the various petroleum systems that have contributed to reserves. A regional oil study approach is particularly useful for comparing the remaining potential of various basins and for predicting the distribution of particular hydrocarbon plays.

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 using multivariate statistical techniques. The source facies of each oil family can be deduced from the oil geochemistry (e.g., Moldowan, *et al.*, 1985; Peters, *et al.*, 1986; and Zumberge, 1987). A variety of parameters based on molecular and bulk composition can be used to make inferences regarding source lithology, anoxicity, salinity, organic input (marine, non-marine or marginal marine) and thermal maturity. In many cases it is possible to bracket the age of the source from the oil data.

The predicted source facies has been compared to the stratigraphy, sedimentology, and burial history of each basin to determine the most probable source units. The aerial extent and burial depth of the source units, combined with the geographic and stratigraphic distributions of their associated oil families and degree of mixing have been used to determine the location of the various oil generating depocenters and the most probable migration directions.

The relative potential of the petroleum systems in each basin has been ranked by incorporating geological information on source thickness and sedimentary environment, and source potential of the various source units. The results have been evaluated in an effort to identify areas where petroleum systems may exist but have been overlooked or poorly tested.

ANALYTICAL PROGRAM

The following techniques have been used on each of the oil samples:

- API Gravity
- % Sulfur
- Nickel/Vanadium concentration
- C15+ vs. <C15
- Deasphalting
- Liquid Chromatography (%Sat %Aro %NSO)
- Capillary GC of Whole Crude Oils
- Stable Carbon Isotopes for both Sat and Aro Hydrocarbon Fractions
- GC/MS of branched/cyclic fraction 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. All of the analytical data are provided in hard copy and on magnetic media.

Analytical data are presented within **Basin Data Volumes**, and 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 will be presented in a comprehensive **Final Report**, which will include sections for:

- regional geology
- differentiation of oil families/
mixing by multivariate statistics
- inferred oil/source correlations
- oil generation and migration
- interpretation of oil characteristics

The final interpretive report will include wall-sized, full color maps/montages showing the distribution of oil families and associated petroleum systems.

PARTICIPATION

The cost of the study is US \$35,500.

TIMING

The study is completed and available for immediate delivery.

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Table I - Crude Oil Samples Analyzed for this Study

Country	Basin	Field	Country	Basin	Field
Bangladesh	Bengal	Bakhrabad-1	Pakistan	Indus	Dabhi
Bangladesh	Bengal	Begumgonj-1	Pakistan	Indus	Hundi
Bangladesh	Bengal	Feni-1	Pakistan	Indus	Khaskeli-1
Bangladesh	Bengal	Feni-1	Pakistan	Indus	Kothar
Bangladesh	Bengal	Kamat-1	Pakistan	Indus	Laghari-1
Bangladesh	Bengal	Titas	Pakistan	Indus	Sari
Bangladesh	Surma	Benibazar-1X	Pakistan	Indus	Tarai-1
Bangladesh	Surma	Habigonj 1/2	Pakistan	Potwar	Adhi-7
Bangladesh	Surma	Habigonj-4	Pakistan	Potwar	Ahdi-5
Bangladesh	Surma	Harargag Seep	Pakistan	Potwar	Balkassar-1
Bangladesh	Surma	Kailas Tila-1	Pakistan	Potwar	Balkassar-7
Bangladesh	Surma	Patharia Seep	Pakistan	Potwar	Balkassar
Bangladesh	Surma	Sylhet	Pakistan	Potwar	Bhangali-1
Bangladesh	Surma	Sylhet-7	Pakistan	Potwar	Chharat Seep
Bangladesh	Surma	Sylhet	Pakistan	Potwar	Chharat Seep
India	Tripura Foldbelt	Badarpur-8	Pakistan	Potwar	Dhulian
India	Tripura Foldbelt	Badarpur-16	Pakistan	Potwar	Dhurnal-1
India	Assam	Digboi	Pakistan	Potwar	Dhurnal-2
India	Bombay High	LR-30819	Pakistan	Potwar	Dhurnal-2
India	Bombay High	Bombay High-1	Pakistan	Potwar	Fimkassar-1X
India	Bombay High	Bassein-1	Pakistan	Potwar	Jabba Seep
India	Cauvery	Karaikal-10	Pakistan	Potwar	Joya Mair
India	Cauvery	Paravakottai	Pakistan	Potwar	Joya Mair-1
India	Cauvery	Karaikal-1	Pakistan	Potwar	Khabbaki Seep
India	Cauvery	Karaikal-1	Pakistan	Potwar	Khairi Murat Seep
India	Cauvery	Karaikal-10	Pakistan	Potwar	Khairi Murat Seep
India	Cambay	Lunej Cambay	Pakistan	Potwar	Kundal Kaiser Seep
India	Coromandel	GS-16-5	Pakistan	Potwar	Meyal-1
India	Coromandel	GS-16-1	Pakistan	Potwar	Missa Kaswal-1
India		P-II-C1	Pakistan	Potwar	Missa Kaswal-1
India	Rajasthan	Baghewala-1	Pakistan	Potwar	Missa Kaswal-1
Myanmar		Mogue	Pakistan	Potwar	Mughal Kot Seep
Myanmar	Chindwin	Yehan Chang	Pakistan	Potwar	Mughal Kot Seep
Myanmar	Prome Embayment	Shwepyitha-17	Pakistan	Potwar	Panoba Seep
Myanmar	Salin	Chauk-967	Pakistan	Potwar	Pariwali-1
Myanmar	Salin	Kin'e 18	Pakistan	Potwar	Pariwali-1
Myanmar	Andaman Sea	3CA-2	Pakistan	Potwar	Qazian
Myanmar		Burma-7 (OC4-6)	Pakistan	Potwar	Qazian-1X
Myanmar	Arakan	Leduang	Pakistan	Potwar	Ratana-1
Nepal		Dailekh-1	Pakistan	Potwar	Ratana-1
Pakistan	Central	Dadhar Bibi Nari Seep	Pakistan	Potwar	Rodho
Pakistan	Central	Gourkurt-1 Seep	Pakistan	Potwar	Toot-3
Pakistan	Central	Khattan-1 Seep	Pakistan	Potwar	Toot-4
Pakistan	Central	Sanni Sulfur Mine Seep 1	Pakistan	Potwar	Toot-7
Pakistan	Central	Sanni Sulfur Mine Seep 2	Pakistan	Potwar?	DBR
Pakistan	Central	Sui			