

OIL & GAS DEVELOPMENT COMPANY LIMITED



TENDER ENQUIRY NO. PROC-SERVICES/CB/EXPL-5351/2022

A GEOCHEMICAL EVALUATION OF THE PETROLEUM SYSTEM OF THE KOHAT-POTWAR FOLD BELTS (UPPER INDUS BASIN)

Note:

- Bid bond of **USD 10,000/- (US Dollar Ten Thousand Only)** to be submitted with the technical bid.
- The master set of tender documents (services) uploaded on OGDCL website (www.ogdcl.com) is the integral part of this TOR.
 - Following documents must be submitted with the bid: - Bid Bond, Bidding form, Integrity & Ethics undertaking, Affidavit, Data Summary Sheet, Declaration and Draft Contract duly signed & stamped. Please see master set of tender documents services for further detail.

TERMS OF REFERENCE (TOR)
FOR
AGEOCHEMICAL EVALUATION OF THE PETROLEUM SYSTEMS OF THE
KOHAT-POTWAR FOLD BELTS (UPPER INDUS BASIN)

1. Introduction

Oil & Gas Development Company Limited (OGDCL) is the national Oil & Gas Company of Pakistan and a prime body of the country's E&P sector. The Company intends to hire services of reputable firm to conduct a study on geochemical evaluation of the petroleum systems of Kohat-Potwar fold belts in Upper Indus Basin. Kohat-Potwar Fold belt is a part of Indus Basin bounded by MBT in the north, Salt Range Thrust and Trans Indus Ranges in the south, Jehlum Fault and Kurram-Parachinar ranges in the east and west respectively (Fig-1).

The Kohat-Potwar Fold belts covering an area of approximately 42000 km² is prolific hydrocarbon province where exploration was started in 1866 with the drilling of Kundal-1 well. The first hydrocarbon discovery was made by Attock Petroleum Company at Khaur in 1914 from Tertiary aged reservoir. Since then more than 200 exploratory wells have been drilled which resulted 55+ hydrocarbon fields in the fold belt (Fig-2). Hydrocarbons are commonly being produced from stacked Cambrian to Eocene clastic and carbonate reservoirs (Fig-3).

This area comprises a sequence of Precambrian to Tertiary siliciclastics and carbonates that have been intensely deformed by thrusting and folding during the Himalayan orogeny. The area is still active tectonically which has an impact on reservoir compartmentalization and the distributions and orientations of permeable faults and fracture systems. Though, accumulations of oil, gas condensate and gas are known to widespread across the area in stacked reservoirs, however the gaps of knowledge regarding petroleum systems of the region is a key constraint for the area to become a mature petroleum province.

2. Project Aim

The aim of this project is to establish the petroleum system (s) by integrating the oil, gas and source rocks geochemical data. Fixing the source rocks, link those recognized source rocks to known hydrocarbon occurrences through the integration of the geological and geochemical evaluations by using top-down and bottom-up petroleum system analyses approaches, and to assess/model the generated volume of hydrocarbons from each source facie in the study area.

3. Project Work Flow

The proposed project is structured in three stages/phases, with the results of each stage being used to focus the efforts of work to be performed in the next stage.

3.1 Phase-1

The first phase involves the integration and interpretation of all relevant legacy and published source rocks, oil & gas geochemical data. A top-down approach will be used to interpret the fluid properties and their distribution in the geological context. Following tasks will need to be performed during phase-1;

- a) **Data Extraction, Data basing and Quality Controlling:** It includes the evaluation and extraction of all available source rock (s) geochemical, biomarkers, isotopic, oil & gas compositional, PVT data, and required geological information from well logs and reports. All data will need to be placed in a proper integrated database and will be rigorously quality controlled (QC) before interpretation.

- b) **Synthesis and interpretation:** Oil, gas, PVT, hydrocarbon shows, and well data need to be interpreted by using the Top-down petroleum system analysis approach to understand the lateral and vertical distribution of pooled hydrocarbons and their properties. Geochemical data will need to be used to evaluate the occurrence and distribution of potential source rocks along with their characteristics in the area, and restoration of original quantity and quality of organic matter. Source rocks shall be evaluated within a worldwide source rock database which classifies source rocks on the basis of depositional environment and nature of organic matter. Oil composition, biomarker and isotopic data will be used to assess oil families, oil-oil and oil-source correlation, age, depositional environment, parent kerogen nature/organo-facies, maturity of oil, and possible effects of migration fractionation, mixing of oils in main reservoir formation, biodegradation, water washing etc. Geochemical data belonging to hydrocarbon seepages/leakages will need to be used to identify the origin of their source-rocks as well as their maturity and migration effects.
The oil and gas properties will need to be reviewed in the context of available source rock analysis to determine oil to source rock correlation. Conventional well logs, mud logs and other related data will need to be used to fix, correlate, and to map the source rock thickness and organo-facies variations.

- c) **Data Gap Analysis:** The syntheses and interpretation will be followed by a data gap-analysis to identify the key missing/required data to fine-tune the interpretation and models.

- d) **Presentation & Interim Report:** The adopted workflows and key findings of phase-1, along with the requirement of new analyses will be presented to OGDCL management through an online workshop. An interim report of phase-1 having the interpretation and illustrations, shall be submitted.

3.2 Phase-2

Second stage of the study will involve geochemical analysis of rock, oil and gas samples, identified during the data gaps analysis. The most cost effective analytical program will be formulated by the consultant for this phase.

- a) The contractor will communicate number of oil, gas and rock samples by specifying the wells, reservoir and the source rocks along with the nature and type of analyses. Contractor will also provide the justification that how and why required analyses are important to accomplish the study. Final number of samples (oil, gas & rocks) and type of analyses will be decided by OGDCL with the consent of contractor.
- b) Required samples will be collected by OGDCL following the SOPs as defined by the consultant/lab, and will be shipped to the consultant designated geochemical lab.
- c) The consultant and OGDCL representative both will liaise with analytical geochemical services provider (laboratory), however it will be the sole responsibility of consultant to ensure the quality of the newly-produced geochemical data.

3.3 Phase-3

Third stage will involve to conclude the study along with basin and petroleum system modeling. Following tasks will need to be performed in this phase;

- a) Integration of newly acquired data with phase-1 data, and to complete/fine tune the interpretation and models;
- b) Basin and Petroleum System Modeling: After sound integration / interpretation and correlation of source rock(s) and oil(s) & gas data, and having confidence in the type of organo-facies present in source rock beds and the lateral and vertical distribution of source beds/organo-facies in the study area and their thickness, 1&2 D basin and petroleum system modeling will need to be carried out at well locations, kitchen areas, and along 2D seismic lines parallel to main tectonic stress to model the generation, migration and distribution of hydrocarbons in the area. Hydrocarbon generation potential, volume of generated and expelled hydrocarbons will also need to be assessed/modeled. For thermal and maturity modeling, heat flow model shall need to be used which must be based quantitatively on the tectono-stratigraphic evolution of the sub-basins, and related variations of the heat flow. Hydrocarbon generation modeling shall need be realistic, based on the experimentally determined kinetics of the main source rock formations.

4. Data Sets

Following data are available and will be used to accomplish the phase-1 of the tendered study:

Nature of Data	Description
Source rock (s) Geochemical data	TOC & Rock Eval Data of 40 wells
Optical Analysis Data	VKA & VR Data of 12 wells
Biomarker Analysis Data	GC & GCMS Data of 20 wells
Outcrop's data	TOC, RE, and VKA & VR Data of 40 outcrop locations
Isotopic Data	Stable Carbon Isotope data of gases and EOM of 10 wells
Oil Analytical data	40 wells
PVT Data	65 wells

Hydrocarbon composition data	Gas Composition data of 100 wells
Well's data (reports, mud logs, wireline logs etc.)	50 wells
Published data*	Source rock geochemical, oil & gas composition, biomarkers and Isotopic data in the published articles will be part of the data set
Supporting/other Data	<ul style="list-style-type: none"> • Depositional Facies Maps • Interpreted seismic lines of the structures • Geothermal gradient map of the area • BHT & DST temperatures of the wells • Geoseismic transects representing the structural geometry of the area • Published literature

Note:

- All data is in soft form i.e. scanned, pdf etc.

5. DURATION

The total project duration is 10 (ten) months starting from the complete data handing over to the contractor and its acceptance by the contractor. Breakup of the duration is as under:

Phase-1	4 months
Phase-2&3	6 months

- The duration of samples collection and shipment for 2nd phase will be excluded from the above period.

6. DRAFT REPORT

The consultant will submit a draft report to OGDCL for review, allowing reasonable time to complete the review. Final report should incorporate the inputs recommended by OGDCL as agreed by the consultant.

7. DELIVERABLES

Deliverables of the study includes;

- a) A thorough report (text, illustrations, maps etc.) integrating the results of the geochemical and modelling studies, identifying and characterizing the main petroleum systems of the region (05 hard copies + 01 CD having the same report in pdf format);
- b) A comprehensive petroleum and source rock geochemistry database encompassing carefully quality-controlled legacy and published data as well as data acquired for the purpose of the study, in a suitable format to load on OGDCL machines.
- c) Working data and software exported files of 1-D basin and petroleum system models (digital) in suitable format to load in modeling software.
- d) A CD containing all presentations

8. Participation of OGDCL Professionals

A team comprising 03 professionals will participate in this study for two weeks as counterparts to share the local knowledge and experience, and to witness the use of work flows as per TOR of the study. During the participation, OGDCL professionals will review and discuss the major findings of the study with the consultant's team. One (01) professional will participate as a counterpart with lab during analysis of the samples.

9. BID EVALUATION

All bids/proposals will be evaluated technically and financially. Technical proposal shall be reviewed first to determine its technical responsiveness and conformity with the requirement of TOR. After completion of technical evaluation, the financial proposal of only the technically responsive / qualified bidder(s) shall be opened and evaluated. The bids requiring substantial modifications to make it responsive shall be rejected out rightly.

10. TECHNICAL EVALUATION

The technical evaluation shall be carried out according to bellow mentioned evaluation criterion. 100 credit points have been assigned for technical conformity of the bid, out of which the qualifying marks are 80% in each category. The bidders obtaining less than 80% points in each category will be declared non-responsive.

All bidders are requested to submit their bid considering the evaluation criteria. The technical evaluation will be based on the following criteria.

Total Marks = 100		
S#	Description	Allocated marks/points
01	<p>Number of Similar Studies Conducted</p> <p>Number of similar studies ⁽¹⁾ conducted/ completed (including studies in hand) by the bidding firm / company during the last 05 years. Bidders are required to submit the title, year and duration of similar studies conducted during the last five years.</p>	<p>Maximum Marks = 25</p> <p>1) ≥ 15 Studies =25</p> <p>2) Studies 10 to 15 =20 + one mark for each study above 10 studies</p> <p>3) Studies < 10 = 0</p>
02	<p>Professional's experience</p> <p>A team ⁽²⁾ of highly experienced professionals in the field of geochemistry/petroleum system evaluation / petroleum and basin modeling will need to be required to conduct the study. Experience of each participating professional should not be less than 10 years ⁽³⁾. However, the experience of only team lead /project manager will be marked as per given criteria. Project manager ⁽⁴⁾ should have vast experience of conducting and monitoring petroleum system evaluation projects/studies on regional level.</p> <p>Bidders are required to provide the CVs of the professionals describing their experience along with their rule in this study</p>	<p>Maximum Marks = 25</p> <p>Project Manager:</p> <p>1) Experience ≥ 25 years =25</p> <p>2) Experience 20 to 25 Years =20 + one mark for each year of experience above 20 years</p> <p>3) Experience < 20 years = 0</p>
03	<p>Technical Approach</p> <p>Describe and provide the detailed methodology and workflows ⁽⁵⁾ to accomplish the study along with availability and Software applications (i.e.</p>	<p>Maximum Marks = 40</p> <p>1) Methodology and work flows fully describing the given scope of work with latest concepts, applications, equipment / technology = 40 marks</p>

	databasing, mapping, interpretation, petroleum system modeling, analyses etc.)	<p>2) Methodology and work flows not fully describing the given scope of work but covering more than 90% of the scope of work with latest concepts, applications and equipment/technology = 32 marks</p> <p>3) Methodology and work flows not fully describing the given scope of work and without latest concepts, applications and equipment / technology = 0 marks</p>
04	<p>Geochemical/Analytical Lab</p> <p>The bidders have either their own laboratory for analytical geochemical services or to have association/alliance with reputable laboratory providing all required geochemical/analytical services.</p> <p>The laboratory should be well equipped with state of the art technology, using the latest techniques in analyses and following the analytical SOPs.</p> <p>Bidders are required to provide the proof of ownership/association/alliance ⁽⁶⁾ with analytical lab, and details on services of lab along with equipment /machines, and CVs of the analysts engaging for this study.</p>	<p>Maximum Marks = 10</p> <ul style="list-style-type: none"> • Fulfilling all requirements as mentioned and providing required documents = 10 • Bidders failed to provide the required documents = 0

⁽¹⁾ The tendered study is a geochemical evaluation of the petroleum system of two sub-basins which includes the interpretation of various geochemical data sets including PVT, Oil analytical, oil & gas composition, oil & gas isotope, TOC&RE, VR, pyrolysis-GC, biomarkers source rock modeling, etc. at sub-basin scale. In this context, any study appraised to be “similar” shall include the synthesis and interpretation of at least 3 to 4 aspects of the above mentioned data sets at sub-basin scale. Further, unconventional and non-hydrocarbon evaluation studies, reservoir studies, sedimentology, basic geochemical analysis (TOC/RE, lab work, oil and gas analysis) and their stand-alone interpretation, data management, One-D modeling, prospect/lead/block/well level studies, and short duration (<4 months) studies shall not fall in the category of “Similar “studies w.r.t. the scope of the tendered study. Studies conducted by lab shall not be considered in case of association/alliance with laboratory.

⁽²⁾ A team of not less than 4 professionals excluding lab personnel, having proved experience w.r.t tendered study

(3) Any of team members having irrelevant experience and or length of experience < 10 years shall not be entertained

(4) A petroleum system analyst/Geochemist shall lead the study, and shall have vast experience of conducting and monitoring petroleum system evaluation projects/studies on regional level

(5) Elaboration and applications of Top-Down and Bottom-Up Petroleum System Analysis approaches to accomplish the study, methodology and work flows on assessing hydrocarbon potential, generated volume etc. along with the availability and application of software i.e. data-basing, quality controlling, data visualization and mapping, and interpretation & modeling.

(6) In case of association/alliance with laboratory, a consent letter from the associated laboratory shall be required, clearly mentioning the title of this study and willingness to conduct the required analyses. Purchase Orders (POs) of previous work done will not be acceptable as consent letter.

10.1.Financial Evaluation

Financial proposal of only technically responsive bidders shall be opened and evaluated.

10.2.Final Evaluation and Contract Award

Financial evaluation will be carried out on lump sum cost of the study. For final bid evaluation, 80% weightage would be given to technical evaluation and 20% for financial evaluation. The Financially lowest bidder will secure maximum marks/points in financial evaluation and other would be ranked on sliding scale. The points obtained in technical evaluation and financial evaluation will then be combined, and the contract will be awarded to the bidder obtaining maximum points.

11. Financial Bid Format

Phase-1

	<i>Work/Assignments</i>	<i>Lump Sum Charges (US\$)</i>
<i>A</i>	Data Extraction, databasing and Quality Controlling	
<i>B</i>	Data Synthesis, Interpretation, data gap analysis etc.	
<i>C</i>	Interim Report & Online Workshop	
	<i>Sub-Total (A+B+C)</i>	

Phase –II

Number of rock, oil & gas samples, and modeling points/transects may vary. The current numbers are for financial evaluation only, and to book a budget for this study.

	<i>Description of analysis</i>	<i>Number of samples</i>	<i>Unit Rate (US\$)</i>	<i>Sub-Total (US\$)</i>

	<i>Rock Samples (cuttings, core, outcrop)</i>			
1	<i>Total Organic Carbon (TOC) Analysis including carbonate content</i>	200		
2	<i>Rock-Eval. /Hawk Pyrolysis</i>	150		
3	<i>Pyrolysis Gas Chromatographic (PYGC) Analyses</i>	150		
4	<i>Vitrinite Reflectance Analysis (Coal & carbonaceous samples)</i>	50		
5	<i>Isotopic analysis of Kerogen</i>	50		
	<i>Rock's Extracts (EOM)</i>			
6	<i>Soxhlet extraction of cuttings, core and outcrop samples</i>	50		
7	<i>High Resolution Gas Chromatography (HRGC) analyses</i>	50		
8	<i>Medium Performance Liquid Chromatography (MPLC) separation</i>	50		
9	<i>Saturate GCMS (biomarkers) Analyses</i>	50		
10	<i>Aromatic GCMS (biomarkers) analyses</i>	50		
11	<i>Saturates and Aromatics Carbon isotope analysis</i>	50		
	<i>Oil Seep Samples</i>			
12	<i>High Resolution Gas Chromatography (HRGC) analyses</i>	10		
13	<i>Medium Performance Liquid Chromatography (MPLC) separation</i>	10		
14	<i>Saturate GCMS (biomarkers) Analyses</i>	10		
15	<i>Aromatic GCMS (biomarkers) analyses</i>	10		
16	<i>Saturates and Aromatics Carbon isotope Analysis</i>	10		
17	<i>API & Elemental (S, V & N) Analysis</i>	10		
	<i>Reservoired Oil Samples</i>			
18	<i>High Resolution Gas Chromatography (HRGC) analyses</i>	40		
19	<i>Medium Performance Liquid Chromatography (MPLC) separation</i>	40		
20	<i>Saturate GCMS (biomarkers) Analyses</i>	40		
21	<i>Aromatic GCMS (biomarkers) analyses</i>	40		

22	<i>Saturates and Aromatics Carbon isotope Analysis</i>	40		
23	<i>API & Elemental (S, V & N) Analysis</i>	40		
	<i>Gas Samples</i>			
24	<i>Molecular composition of natural gas samples</i>	30		
25	<i>C and H isotopic composition of methane in natural gas samples</i>	30		
26	<i>C isotopic composition of C2 to C5 in natural gas samples</i>	30		
27	<i>Isotopic analysis of sulfur</i>	10		
28	Sub-Total (serial 1 to 27)			

Phase-III

	Work/Assignments	Unit cost (US\$)	Sub-Total (US\$)
a	<i>Integration of lab data & finalizing the interpretation</i>	<i>% of analysis cost at serial #28, phase-II</i>	
b	1-D / Multi-Layer Basin and Petroleum System Modeling (05 locations)	Charges/location	
c	2-D Modeling (05 transects)	Charges/transect	
d	Hydrocarbon resource estimation i.e. generated, expelled, and discovered etc. etc.		
e	<i>Final Report & Online Workshop</i>		
f	<i>Charges/rent of bottle, ampule, tube for collection and shipment of oil and gas samples</i>	Unit charges/rent	<i>Lump sum charges for 50 oil, and 30 gas samples</i>
	Sub-Total (a+b+c+d+e+f)		

Lump sum cost of the project (US\$)= phase-1+phase-2+phase-3	
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Note:

- Rates/cost must be inclusive of all applicable taxes, duties, levies etc. except PST/ICT taxes on services in Pakistan;
- Rates/cost must be inclusive of samples handling, preparation etc. charges;
- Number of samples, analyses and modeling points are not firm. Actual number of samples, analyses and modeling points will be finalized after Phase-1;

- The financial quotation of the study strictly be followed as per above mentioned format.

12. Payment Schedule

Payment shall be made against invoices for actual tests/ analyses/ work done, verified by OGDCL. Payment will be made in two stages:

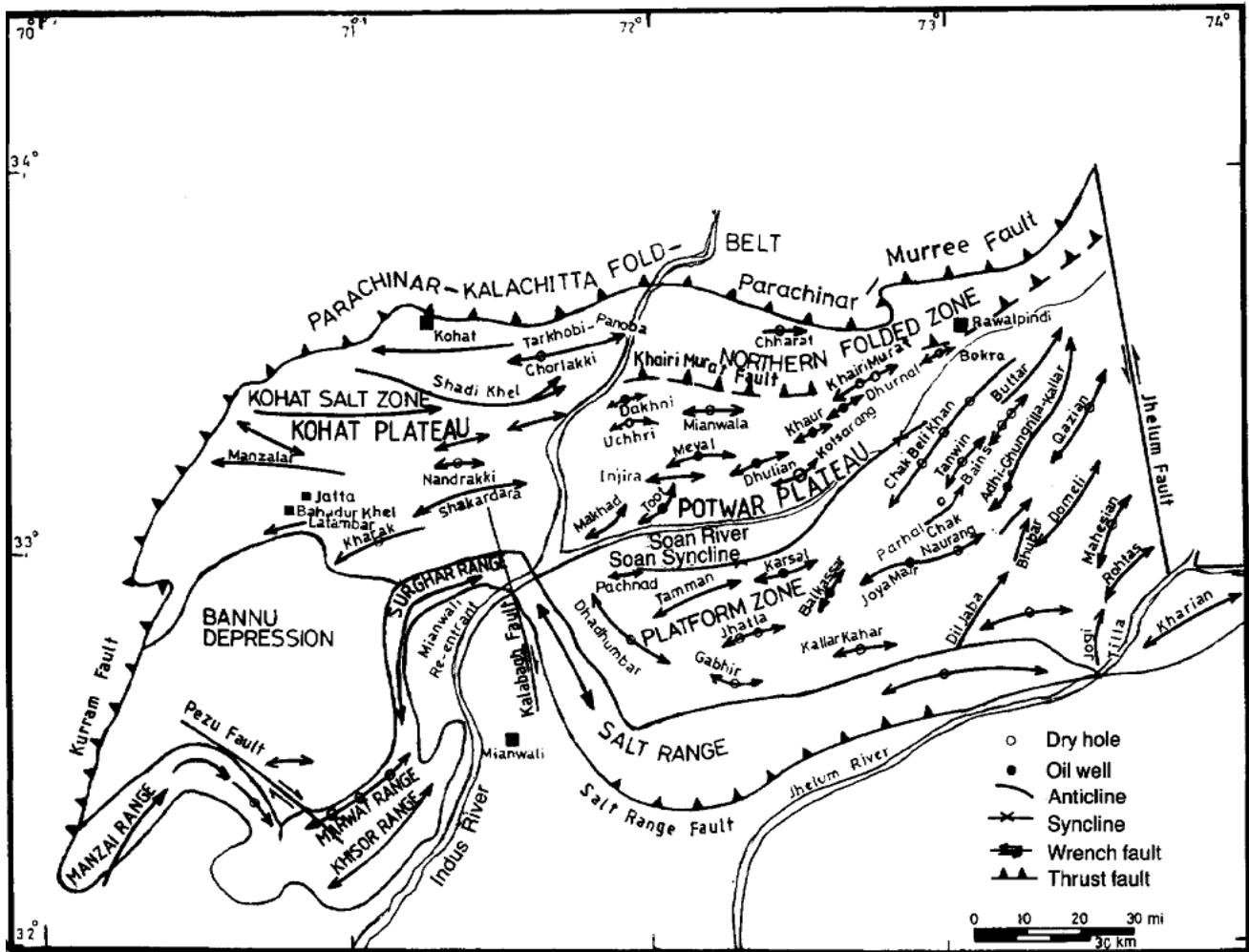
- i. 1ST payment will be made after completion of phase-1 and fulfilling the requirements as mentioned in this TOR;
- ii. The payment of phase-2&3 will be made after completion of the project in all aspects, acceptance of the report by OGDCL and fulfilling the requirements as mentioned in this TOR.

13. Other Terms & Conditions

- i. The bidder should submit the study program, shown in Gantt chart for time duration;
- ii. Consultant will provide the bottles/ampules/tubes for collection and shipment of oil and gas samples;
- iii. Collection, transportation of samples and supporting study material from Pakistan to consultant office (abroad) will be responsibility of OGDCL.
- iv. During the course of synthesis and interpretation phase, missing data or any data which will be required for interpretation will need to be timely notified.
- v. All data/reports/interpretations will remain the property of OGDCL. The consultant will treat all data and information supplied by OGDCL and those acquired by him during the implementation of the study with utmost confidentiality
- vi. Expenses (visa, air tickets, boarding & lodging) regarding the visit of OGDCL professionals to consultant's main project center will be borne by OGDCL;
- vii. Contractor shall provide office space, computers, internet facility and international telephone/fax facilities and local traveling to the OGDCL visiting professionals;
- viii. OGDCL shall not be held liable for any expenses incurred with the preparation or submittal of the proposals or any subsequent discussion and / or negotiations.
- ix. OGDCL reserves the right to increase, decrease or omit any study/ task/ service/ number of samples related to above scope of work.

Published data*

1. Ahmed, W., Alam, S., 1990. Organic geochemistry of crude oil from Potwar-Kohat region. *Pakistan Journal of Hydrocarbon Research*, V. 2, 1–15.
2. Ahmed, W., Alam, S., 1992. Stable Carbon and Deuterium Isotope Composition of Natural Gases in Pakistan. *Pakistan Journal of Hydrocarbon Research*, V. 4, No. 1, 41–49.
3. Ahmed, W., Alam, S., 2007. Organic geochemistry and source rock characteristics of Salt Range Formation, Potwar Basin, Pakistan. *Pakistan Journal of Hydrocarbon Research*, V.17, 37–59.
4. Arif Nazir., 2013. Biomarkers and Pyrolysis Parameters to Investigate Hydrocarbon Generating Potential of Cretaceous Sequences, Indus Basin, Pakistan. PhD thesis, UET Lahore, Pakistan.
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6. Asif, M., Fazeelat, T., 2012. Petroleum geochemistry of the Potwar Basin, Pakistan: II – Oil classification based on heterocyclic and polycyclic aromatic hydrocarbons. *Appl. Geochem.* 27 (8), 1655–1665.
7. Asif, M., Grice, K., Fazeelat, T., 2009. Assessment of petroleum biodegradation using stable hydrogen isotopes of individual saturated hydrocarbons and polycyclic aromatic hydrocarbon distributions in oils from the Upper Indus Basin, Pakistan. *Organic Geochemistry* 40.
8. Asif, M., Fazeelat, T., Jalees, M.I., 2014. Biomarker and stable carbon isotopic study of Eocene sediments of North-Western Potwar Basin, Pakistan. *Journal of Petroleum Science and Engineering* 122, 729-740.
9. Asim Shahzad., 2006. Identification of Potential Hydrocarbon Source Rocks Using Biological Markers in Kohat Plateau, North Pakistan. A PhD thesis submitted to Center of Excellence in Geology, University of Peshawar.
10. Fazeelat Tahira, 2006. Chemical composition and Geochemical Applications of Waxes Isolated from Pakistani Crude Oil. *Jour.Chem.Soc.Pak.* Vol. 26, No. 6, 187-190.
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13. Fazeelat, T., Jalees, M.I., Bianchi, T.S., 2010. Source Rock Potential of Eocene, Paleocene and Jurassic deposits in the subsurface of the Potwar basin, northern Pakistan. *Journal of Petroleum Geology* V.33, 87–96.
14. Raza, H.A., Alam, S, Khan. A., Iqbal, M., 1993. Source Rock Potential of Oil Shale Deposits in Kohat Basin, Pakistan. *Pakistan Journal of Hydrocarbon Research* V. 5, N 1&2, 1-14.
15. Yasin, G., Bhangar, M.I., Ansari, T.M., Naqvi, S.M.S.R., Ashraf, M., Ahmad, K., Talpur, F.N., 2013. Quality and Chemistry of Crude Oils. *JPT and Alternative Fuels*, V 4(3), 53-63.
16. Any other reports/publications relevant to this study.



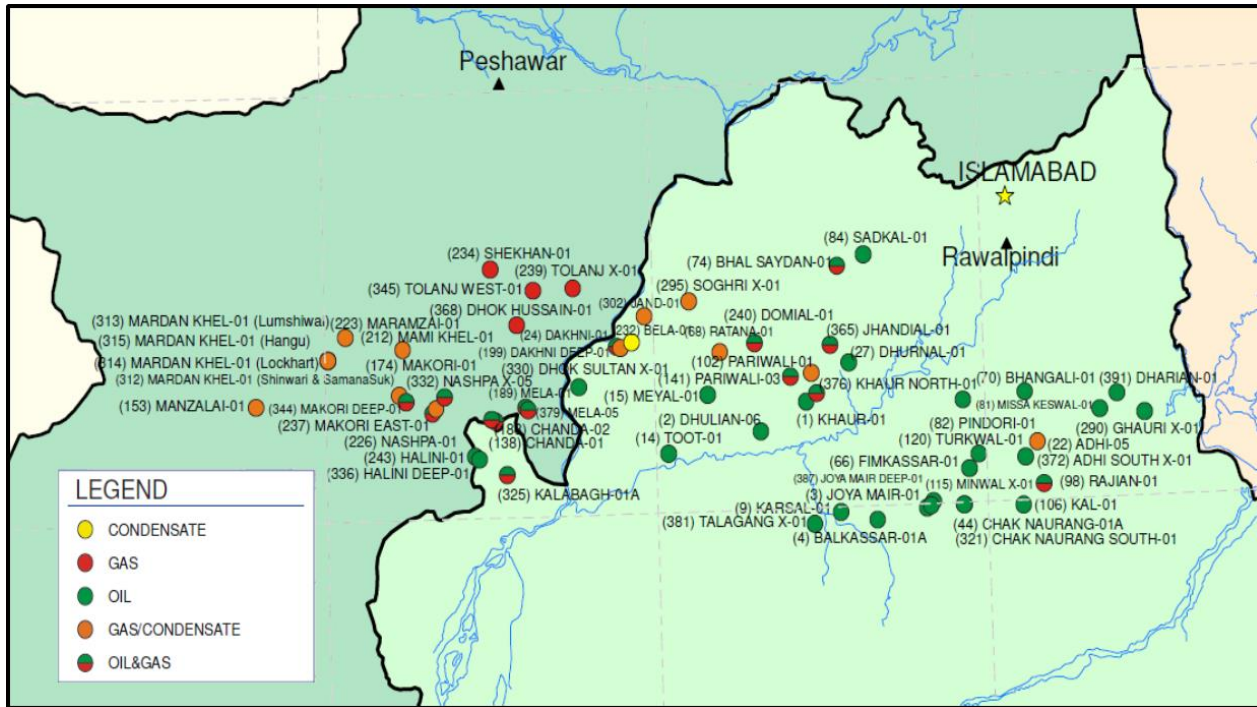


Figure-2: Showing the distribution of hydrocarbon fields and lateral variation of nature of hydrocarbons of Kohat-Potwar fold belts

