Islamic Republic of Afghanistan

Ministry of Mines and Petroleum

TERMS OF REFERENCE

FOR

Conducting a high resolution Airborne Magnetic and Gravity surveys of Helmand Basin

LUMP SUM CONTRACT

DATE: 9/6/2021

TABLE OF CONTENTS

1.0 Background

The long-term goals of the Ministry are establishing an effective governance of natural resources, providing jobs, growing the economy, as well as encouragement of private investments in hydrocarbon sectors, and raising the level of revenue and improving the capacity of the Government.

The Ministry of Mines and Petroleum has taken a series of actions to ensure Afghanistan's financial independence. The development of hydrocarbon resources and infrastructure corridors require the extraction of hydrocarbons. The interest will be increased for exploration, exploitation and development of hydrocarbon areas by identifying these resources. Such development will play an important role in long-term economic and social stability. The Afghan Ministry of Mines and Petroleum took some unique steps for development of these resources and has planned a series of development programs. Ministry of Mines and Petroleum based on the national development policy has plan to conduct Airborne Magnetic and Gravity surveys over the Helmand Basin, to acquire sufficient high-quality data for further hydrocarbon exploration efforts.
The Helmand Basin dominates the southern part of Afghanistan and extends into eastern Iran and western Pakistan. The region is structurally enclosed, bordered on four sides by mountain ranges. The Hazarajat Mountains, part of the Karakoram-Himalayan mountain chain, form the northern border of the Helmand region and are the main source of sediments deposited in the basin (Fig. B) (Whitney, 2006). To the south, the Chagai Hills border the basin. In the west, the basin is bordered by the eastern Iranian highlands (Fig.B). The eastern margin of the basin is defined by the edge of the Registan Plateau rising up abruptly to the east of the Helmand River. The Helmand Basin can be divided into five geomorphological regions: the Sistan Depression the Dasht-i Margo Plateau, the Registan Desert, the Hazarajat Mountains, and the Helmand River itself (Fig. B). The Helmand Basin formation reflects a long tectonic history of interactions between continental plates and microplates (Shiel, 2017). The Helmand Basin lies within the Afghan microplate, formed from the collision of several microplates in the Mesozoic (Whitney, 2006; Shiel, 2017). In the early Cretaceous, the Afghan microplate collided with the Eurasian plate, forming the northern margin of the basin marked by the Hazarajat Mountains. Within the Eocene, the Indian plate collided with the Eurasian plate and converged westward against the Afghan plate (Aitchison et al., 2007; Shiel, 2017). With increased crustal shortening the Hindu Kush Mountains formed, and the Afghan plate was forced to the southwest along a series of wrench faults (Whitney, 2006). The two most important microplate-bounding faults are the 1100-km long Herat fault within the Hazarajat Mountains (Wheeler et al., 2005) and the 800-km long Chaman fault on the eastern edge of the Afghan plate (Fig. B). Both faults show active displacement rates of 0.4 mm/y and 33.3 ± 0.3 mm/y respectively (Wheeler et al., 2005; Ul-Hadi et al., 2013). A number of smaller faults with a similar strike to the Herat and Chaman faults are recognized across the basin but have lower estimated displacement rates (Ruleman et al., 2007). The fault systems bordering the Helmand Basin are still active (Wheeler et al., 2005; Whitney, 2006; Ruleman et al., 2007; UlHadi et al., 2013; Fattahi and Amelung, 2016). The eastern and southern margins of the Helmand Basin are related to the movements of the Arabian plate with the opening of the Red Sea (Reilinger and McClusky, 2011). The still seismically active eastern mountains of Iran that border Helmand Basin are related to the distributed deformation as the Arabian Shield moves NNE at about 3 cm/y. To the south of the basin, subduction of the Arabian plate sea floor has developed a wide zone of

deformation (the Makran subduction zone). Opening of the Red Sea initiated about 24 ± 2 my (Reilinger and McClusky, 2011). Collision of the Arabian craton with the Eurasian plate to form the mountain barriers on the eastern and southern margins of the Helmand Basin started in the late Miocene. In the late Eocene, volcanism formed the Chagai Hills along the southern boundary of the Helmand Basin (Perelló et al., 2008). In the Miocene, a number of volcanoes formed along the western edge of the Sistan Depression; the youngest being the Koh-i-Chekab at 8.2 ± 6.0 Ma and an isolated basalt flow dated at 7.3 ± 2.0 Ma forming a mesa within the Hamun-e Helmand playa and placing age constraints on the younger sediments in the basin (Jux and Kempf, 1983).
Aeromagnetic surveys suggest 3-5 km of sedimentary infill lie above the Precambrian basement in the Sistan region (Schreiber et al., 1972). Neogene and Quaternary sediments are estimated to be up to 1000 m thick with only the top 250 m exposed along the edge of the Helmand River (Whitney, 2006). The sediments are described as conglomerates, sandstones, and mudstones deposited by fluvial, aeolian, and lacustrine processes (Smith, 1974). The sequence is flat-lying except close to the borders of the Iranian and Pakistan mountain ranges where the deposits have minor southward or westward tilting respectively, suggesting minor tectonic movements (Jux and Kempf, 1983). The exposed sequence along the edge of the Dasht-i Margo Plateau is divided into two units. A lower unit, the Sistan Beds (>250 m thick), consists of cross-bedded fluvial and aeolian sandstones with occasional lacustrine mudstones. The sediments fine towards the western edge of the Dasht-i Margo Plateau into predominantly laminated lacustrine mudstones, suggesting a large lake or several smaller lakes within the Sistan Depression in the past (Smith, 1974). The Sistan beds are the predominate sediments through which the later geomorphic features cut. This unit is overlain throughout the region by a flat-lying erosional disconformity covered by gravels and coarse sands with thickness varying from 15 m (Smith, 1974). These coarse deposits interfinger with alluvial fans along the edge of the basin toward the Hazarajat Mountains (Smith, 1974). Several gypsum and calcretepalaeosols are present at the surface and at shallow depths of 15-30 cm (Smith, 1974; Doebrich et al., 2006). The age of the sediments in the Helmand Basin is poorly constrained. Along the Helmand River, lacustrine sediments overly volcanic units from the 0.61 Ma Koh-iKhannesin volcano, supporting a late Pleistocene age for these sediments. Because the exposed sections here represent only a third of the total sediment thickness, the observations are consistent with sedimentation in the Miocene and Pliocene into the late Pleistocene. Within the centre of the Sistan Depression in Lake Hamun, a small mesa (~3 km2) called the Kuh-I Khwaja (Fig. 3) is comprised of 55-60 m of lacustrine sediments capped by basalt (50 m) dated at 7.3 ± 2.0 Ma (Jux and Kempf, 1983). Within 3 km of the base of the mesa, two cores through lake sediments (Several studies proposed that the Sistan Depression hosted a large megalake in the Quaternary (>12,000 km2), accounting for the widespread deposition of lacustrine sediments in the region (Huntington, 1905; Smith, 1974; Jux and Kempf, 1983; Whitney, 2006; Hamzeh et al., 2016). Huntington (1905) documented two former shorelines at 3 and 10 m above the playa lakes, which he interpreted as lake highstands in the late Pleistocene.

2.0 Objectives of the assignment

The primary objective of Airborne Magnetic and Gravity survey, covering an area of 131,000 km^2, is to find and identify exploration targets and properly delineate the basin in the absence of exclusive seismic data aiming to map lithology and structural trends in both hard rock environment and basement. The survey will further search depth to basement and delineate structural settings with more accuracy for application topetroleum exploration in sedimentary basin. These properties

are essential information that is only possible with high resolution aeromagnetic and aero-gravimetric surveys. Both surveys are to find a subsurface geological information within the project area, in as such detail as possible, to provide a basis for the assessment of hydrocarbon potential as well as the mineral occurrences of the region and guide in planning of follow-on exploration effort in selected localities for especially seismic survey design. The survey will commence after necessary permits is obtained from Afghan Authorities.
The aforementioned features are expected to be seen on magnetic data which supports distinct physical properties of the assessment unit. The overall sediment thickness should be evaluated by the Consultant.

3.0 Scope of Services

High resolution geophysical equipment shall be installed on an airborne platform and is flown over the target area. The integrated data package is obtained from the survey area using gravimeter and magnetometer and is then returned to Consultant for processing and interpretation.
The Consultant shall provide;

- A detailed survey design of the mentioned area for the approval of the Client before the data acquisition.
- A survey aircraft including experienced pilots, technical personnel and mechanics to support
- Necessary geophysical equipment with industry standard to carry out the survey
- Onsite QC and Daily Report
- Spare part to ensure proper maintenance
- Basic Processing Sequence, Data transcription and the provision of the raw and processed data package with such data processing to be performed at Consultant's processing center.
- A complete package of the unprocessed (raw) data acquired from the survey.
- A Comprehensive interpretation of the Magnetic and Gravity Data for hydrocarbon exploration.
- A detailed comprehensive report specifically mentioning the favorable hydrocarbon prospects for further exploration from the result of interpretation of the Magnetic and Gravity Data.
- Detailed final location coordinates of survey area.
- The Consultant should focus mainly over the valleys and plain areas (including low peaks and foothills) and is not obligated to fly over the high peaks of the mountains.
- All survey logistics, including aircraft fuel and lubricants, airport and navigational charts, crew accommodation, crew meals, crew transport and any other related services or expenses should be included in the prices and should be on Consultant's account, the Ministry will provide the flight permits and other required facilities.
- Emergency response support.
- All damages claimed by local farmers to live stock, due to the low-level survey, will be on the Consultant's account.

Map indicating assignment area with coordinates is attached to this TOR as annex 1.

3.1 AIRBORNE MAGNETIC AND GRAVITY SURVEYS

3.1.1 Equipment Summary

Aircraft or helicopter shall be operational and technically capable of flying over the survey area at an altitude of 400 m to 600 m above average terrain and shall have periodic inspections and checks (500-600 flights hours, monthly and yearly check) for last few years provided with a report given by Aviation Authorities of the country. The primary airborne geophysical equipment required are high sensitivity latest version magnetometer, with ancillary support a single sensor fluxgate magnetometer, CD recorder, radar altimeter, and barometric altimeter, GPS receiver with a real time correction service, navigation system, flight path verification system and gravity measurement system. Ground based processing equipment with full suite of software for in-field processing and other peripherals including plotter and data archive unit are required. Equipment specifications with maintenance record shall be provided to the Company for the tender process.

3.1.2 Test and Calibration for Magnetic Survey

Magnetic Compensation Test

Compensation tests will be undertaken to determine the magnetic influences of aircraft maneuvers and the effectiveness of the aircraft compensation method. The aircraft will fly a square pattern in the four survey directions at a high altitude over a magnetically quiet area and perform pitches, rolls and yaws. The sum of the maximum peak-to-peak residual noise amplitudes in the total compensated signal resulting from the many maneuvers is referred to as the Figure of Merit Index (FOM). The FOM index for the Tail Stinger sensor should be less than 1.2 nT. The results shall be presented to the client's technical representative prior to starting the production flights. This test will be repeated if any major component of the data acquisition system or aircraft is modified or replaced during the course of field operations.

Magnetic Lag Test

A lag test will be undertaken to verify directional parallax in the acquired magnetic readings. The test will consist of precise flying over a distinct magnetic anomaly (or group of anomalies) in reciprocal directions. A lag factor is then determined based on apparent positional shift in the two directions. The results of the lag test will be presented to the client's technical representative prior to the first production flight.

Radar Altimeter Calibration

The radar altimeter will be calibrated by over flying the runway, or known elevation point, at altitudes from 100 feet to 800 feet at 100 feet increments. The field results will be presented to the client's technical representative.

3.1.3 Data Acquisition

During the operations instrumentation calibration tests (Radar altimeter test, lag test, Static and In-flight noise level test, heading error tests, GPS Positioning test) as explained above should be carried out and results are to be provided to the MoMP. Total Magnetic Intensity is to be measured and reduced to pole magnetic data will be a final product along with all standard deliverables as stated below.

Consultant shall provide service for acquisition of Airborne Magnetic and Gravity Survey along with field processing service. The acquisition program will comprise of 131,000 km². Line spacing

for magnetic survey shall be 500 m and for gravity survey the line spacing shall be 1000 m, control line spacing will be 5 or 10 times of the traverse line spacing, and the flight elevation shall be 400m-600m above average ground elevation (above mean terrain). According to the international best practice, a 40-50-kilometer repeat line should be selected and flown on an average of once a week for the comparison and ensuring that the gravimeter is operating consistently. The flown survey line shall not deviate, more than International standard, from the planned flight line. Mean terrain level clearance will not continuously exceed a drape surface agreed by company and Consultant by more than (+/-25) meters for distance of more than 2000 meters. Aircraft speed is 65 m/s, or 234km/h or 126 knots. The aircraft speed tolerance is limited to +/- 10.0 m/s. We would expect Consultant to undertake and complete the necessary HSE evaluation needed in order to provide the best acquisition design to meet the project objectives.

3.1.4 Processing of Magnetic Field Data

The aeromagnetic data is to be processed to ensure that data is within contract specifications and to facilitate the analysis of the data in respect to stated objectives of the survey program.
Processing will include but not limited to the following steps;

1. Transferring raw data files to field processing computer, loading the aeromagnetic and base station data into standard database format. Merging and synchronization of various data sources into a single database.
2. Verifying all channel data including diurnal and GPS and review of individual channel statistics.
3. Examining of diurnal record to verify compliance with activity specification.
4. Differential correction of GPS positions and integration of these corrected positions back into the database on a flight basis.
5. Flight path generation on the map based on corrected GPS positions.
6. If 6 or less common satellites (i.e. simultaneously available to both rover and base GPS receivers) are available at any point on a line, the affected section of the line should be re-flown.
7. Generation of QC multichannel stacked profiles showing the processed magnetic data and its 4th difference, diurnal variation, altimeter data, 60Hz monitor data and aircraft speed for all flight lines.

- Processing shall include elimination of interference generated by maneuvering of the aircraft flying in the Earth's magnetic fields and filtering.
- Reduction to pole from Total Magnetic Intensity data. All of the in-field processing efforts shall prove the high quality of data resulting in high quality of interpretations.

3.1.5 Processing of Gravity Data

The pre-processing of the gravity survey data consists of several independent steps such as filtering (low pass) and cross over adjustment to minimize miss-tie at intersecting lines and gridding. Each of these steps may introduce errors that accumulate in the course of processing which affects accuracy and resolution of the gravity field. For the inversion of the gravity data at flight level into gravity functional at Earth's surface, several approaches can be used such as integral and least square methods.

3.1.6 Airborne Magnetic and Gravity Data Interpretation

Basic objective of the interpretation is to obtain subsurface geological and geophysical information within the Concession area in as much detail as possible to provide the MoMP with guide and assist in designing 2D seismic or other follow on survey to delineate prospective areas. Total field magnetic map along with multiple anomaly parameter profile and forward modelling are required. Bouguer gravity map with forward model studies along with upward and downward continuation for regional – residual gravity separation is also expected from Consultant to supply within the report.

4.0 Liaison with Ministry of Mines and Petroleum

The Consultant shall maintain close liaison with *Mr. Ahmad Ghani Ghani* as appointed by the Client for the sole purpose of the services *ahmad.ghani@momp.gov.af* shall be the primary point of contact from Client.

5.0 Additional Responsibilities of the Consultant

In addition to the other responsibilities the Consultant is also responsible for the following;

- Over all security of the staff, crew, aircraft, equipment, data, reports, etc. at the Consultant's own cost. The cost for security must be included in the lump sum bid price in the Consultant's financial proposal.
- Obtain the approval of the Civil Aviation Authority (CAA) for the flight paths and schedules.
- Obtain the CAA approvals for the use of nearest airports.
- All the works should be done in accordance to the international standards and best practice.
- Liaison with the local population.

6.0 Obligation, Duties and Responsibilities of the Client

The Ministry of Mines and Petroleum "the Client" will provide reasonable assistance and facilitation to the Consultant to secure necessary licenses, visas, work permits, flight permits and other documentations necessary for its operation in connection with the works. All the flight schedules and paths will be determined according to the civil aviation authority procedures and approvals. The Consultant can use any of the following airports (detailed information related to airports will be provided at the contract signing):

1.OASA-SHARANA- ACAA Operational Airport (ARP 330733N0685019E)
2.OAQA-QALAT/Zabul – ACAA Operational Airport (ARP 320802N0665356E)
3.OAKS-KHOST- ACAA Operational Airport (ARP 331704N0694826E)
4.OAKN-Kandhar – ACAA/US Base Operational Airport (ARP 313021N0655052E)
5.OASH –Shank – US Base (ARP 335519N0690441E)
6.Ghazni – Airport – No data available with ACAA
7. OAHR-Herat – Airport - Khawaja Abdullah Ansari International Airport.
8. OABT/BST-Helmand Airport -Bost Airport.

The Client shall supply or otherwise make available to the consultant;

- All geological, geophysical, geographical, and other information relating to the Contract Area in the possession of the Client or coming into its possession and which it has the right to disclose to the Consultant.
- The Government will assist in facilitating the required security within the Contract Area at the sole cost of the Consultant.

7.0 Duration of the Services

The duration of the Services is to extend from the date of effectiveness of the Contract for a period of approximately twenty-four (24) months.

8.0 Equipment to be provided by the consultant

As detailed under Section 5 herein above, the Consultant should arrange all facilities required for the consultancy service and the cost of such provision should be included in the lump sum price in the Consultant's financial proposal.

9.0 Deliverables and Reporting

The Consultant should provide the following list of deliverables and reports in the below mentioned time frame after the effective date:

- Mobilization/Demobilization/Security plan and survey design – Three (3) months
- Data acquisition – Eighteen (18) months
- Processing, Interpretation report and final report – Two (2) months
- Three (3) weeks after the submission of final report the Consultant should present the findings of the survey in details to the client.

9.1 Magnetic Survey Deliverables

- Data correction required, and leveling procedure shall be followed, GPS positioning with several sets for stationary GPS stations.
- Satellite altimetry to provide topographic imaging that shall be recorded in proper format to be utilized for seismic program. Latest flight path verification systems and radar-barometric altimeters.
- Conventional navigation output.
- Total Magnetic Intensity (TMI) and Derivatives of Magnetic Fields (2^{nd}-4^{th}) and Power Spectrum Map

- Depth to Basement and to the level/horizon picked on seismic (Upward-Downward Continuation)
- Quality control of measurement: QC procedure shall be followed at each stage of data acquisition in which status of the equipment shall be checked on daily basis.
- Date and weather condition should be noted in daily reports
- Coordinates and geographic system and local datum shall be enclosed in report
- 2nd order sediments and veining / alteration zone and recognition of the fault hierarchy possible modified stress fields in relation to regional structures inferred time of faulting.
- Interpretation of depth to basement with all faults and lineaments.
- Coherent framework of structural and stratigraphic principles supported by magnetic data and derived maps.
- Identifying/marking hydrocarbons favorable/prospective zones. (further exploratory zones).

9.2 Gravity Survey Deliverables

High quality airborne gravity data shall be acquired and processed with the state of art technology which is standard in oil industry to find faults dipping, relationship among all characteristics and timing of the faults helping to develop tectonic models in searching of HC potential by giving the answer for following questions related to structural analysis and planning of follow on exploration efforts in choosing areas to be delineated.

The deliverables are expected to include the digital data, daily acquisition reports including HSE reporting and basic interpretation as standard. Please provide a list of likely data deliverables and if reproduction costs for multiple copies are required.

> Flight path, flight high, control lines will be same with those of aeromagnetic gathering simultaneously
> Gravity measurement and diagnostic output to be made
> Corrections to be applied (Terrain, free air and others) to get free air gravity
> Equipment with reliable technology, accurate acceleration sensors
> Low noise and drift; Dynamic behavior of the aircraft has a direct impact on both noise and productivity

- Operational and safety consideration for speed of aircraft
- Gyro stabilized platform
- Identifying/marking hydrocarbons favorable/prospective zones. (further exploratory zones).
- Provide CVs for field personnel comprising the administrative and technical staff on the site during the field acquisition phase of program

10.0 Staffing and Skill Mix Needed

The successful team will be comprised of both local (if possible) and international experts with the specific experience and background. It is suggested that in putting together its team, the Consultant should consider designating individuals with high skills, competency and qualifications for the convenience of the client.

The core staff to be evaluated will include:

a) Position K-1: Project Manager
b) Position K-2: Geophysicist
c) Position K-3: Geophysicist /Processor
d) Position K-4: Crew Leader /Geophysical Engineer
e) Position K-5: Geologist

S. No.	Staff Position	Number	Estimated Person Month
Key Professional Staff			
1	Project Manager	1	24
2	Geophysicist	2	24/18
3	Geophysicist /Processor	1	20
4	Crew Leader /Geophysical Engineer	1	18
5	Geologist	1	15
Estimated Person Months for Key Staff			**119**
Support Staff*			
1	Pilot	2	18/18
2	Aircraft Engineer	1	18
3	Other support staff		60
Estimated Person Months for Support Staff			**114**

The Minimum Qualification Required for Key Experts:

The Consultant will comprise a team, managed by a Project Manager. The members of the team will have the skills and experience necessary to undertake the range of tasks set out in this term of reference.

Key staff include:

Position K-1: Project Manager

The proposed candidate should have prior experience of leading team and project management. The Project Manager should possess at least Master's degree or its equivalent in MS Engineering, MSC or any other relevant field with ten or more year's relevant technical expertise and project structuring and management;
A minimum of seven years of experience will be required in the management of similar projects with demonstrated ability to work with government officials. Work experience in related computer software's, good communication skills, fluency in English and proven satisfactory record of similar contracts would be preferred.

- Position K-2: Geophysicist

The proposed candidate should have bachelor or higher degree in Geophysics /Geology and/or any other relevant field and additional training with five or more years' relevant technical expertise. Experience in Afghanistan or in countries with challenging political and security situations would be highly preferred. Work experience in related computer tools, good communication skills, fluency in English and proven satisfactory record of similar contracts would be highly preferred.

- Position K-3: Geophysicist/Processor

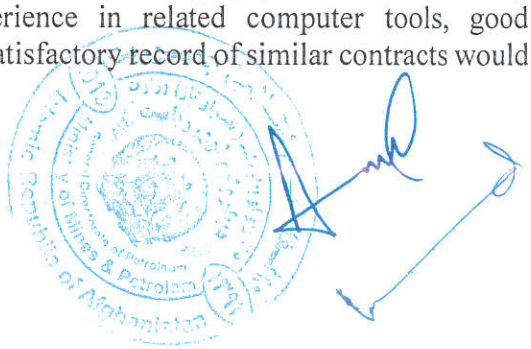
The proposed candidate should have bachelor or higher degree in Geophysics and/or any other relevant field and additional training with five or more years' relevant technical expertise. Experience in Afghanistan or in countries with challenging political and security situations would be highly preferred. Work experience in related computer tools, good communication skills, fluency in English and proven satisfactory record of similar contracts would be highly preferred.

- Position K-4: Crew Leader/Geophysical Engineer

The proposed candidate should have bachelor or higher degree in Engineering, or any other relevant field, Geophysical Field Logistics and QC data processing training and additional training with five or more years' relevant technical expertise. Experience in Afghanistan or in countries with challenging political and security situations would be highly preferred. Work experience in related computer tools, good communication skills, fluency in English and proven satisfactory record of similar contracts would be highly preferred.

- Position K-5: Geologist

The proposed candidate should have bachelor or higher degree in Geology/Earth Sciences and/or any other relevant field and additional training with five or more years' relevant technical expertise. Experience in Afghanistan or in countries with challenging political and security situations would be highly preferred. Work experience in related computer tools, good communication skills, fluency in English and proven satisfactory record of similar contracts would be highly preferred.



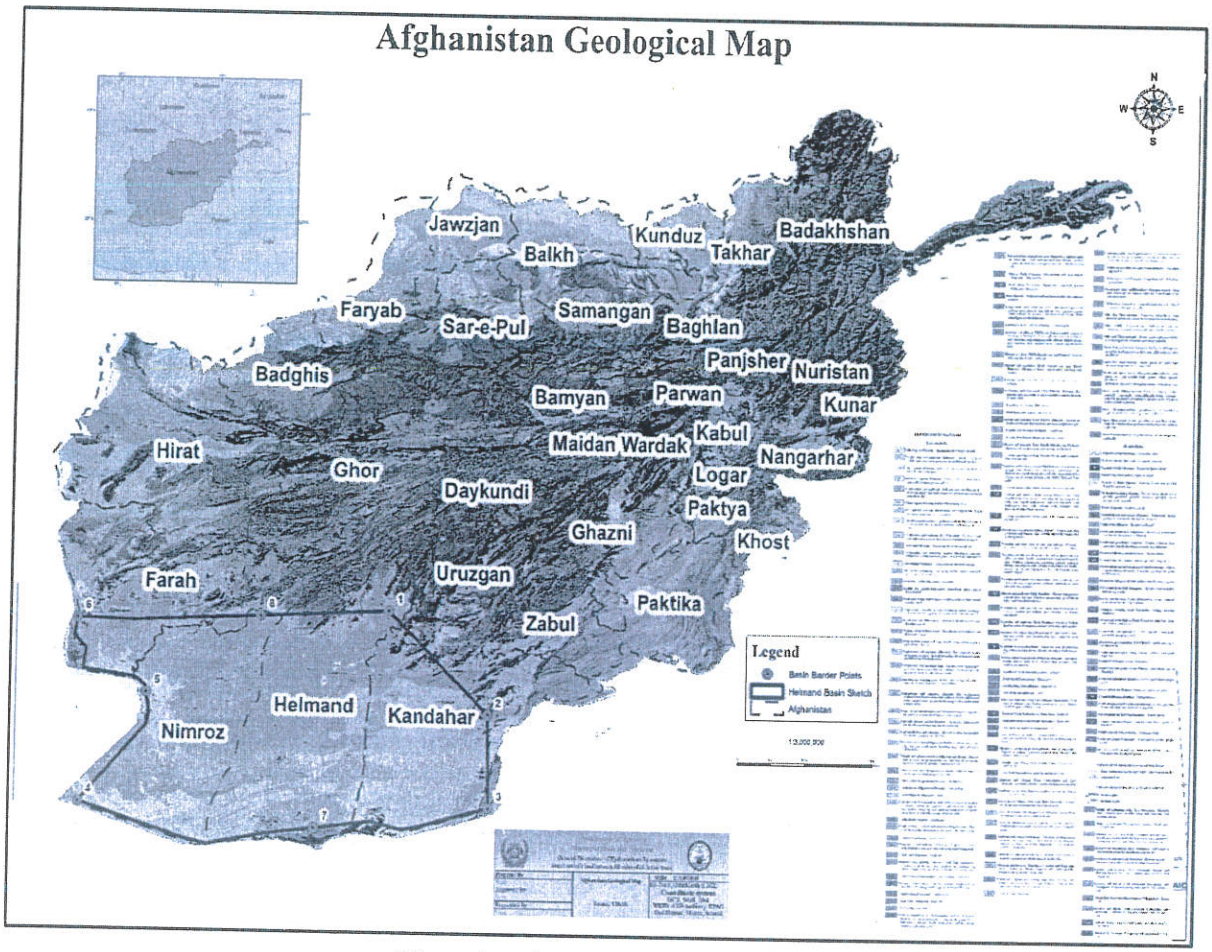
11.0 PAYMENT SCHEDULE

In consideration of the Services performed by the Consultant, the Client shall make such payments to the Consultant based on the following Activities performed:

No	Description	Payment
1	Submission and approval of security plan and survey design by client	10%
2	Mobilization of aircraft, associated equipment's and personnel to the contract site	15%
3	Submission of data acquisition report: for both raw and absolute data, and final approval by the Client.	40%
4	Submission of Data processing report and approval by client	10%
5	De-Mobilization from project side	5%
6	Submission of interpretation report and approval by client	10%
7	Final presentation for identifying hydrocarbons favorable/prospective zones. (further exploratory zones).	10%

The Payment will be made in USD Currency.

Note: *Advance payment option of 10% is available against the provision of Bank Guarantee from acceptable bank to the state Bank of Afghanistan.*

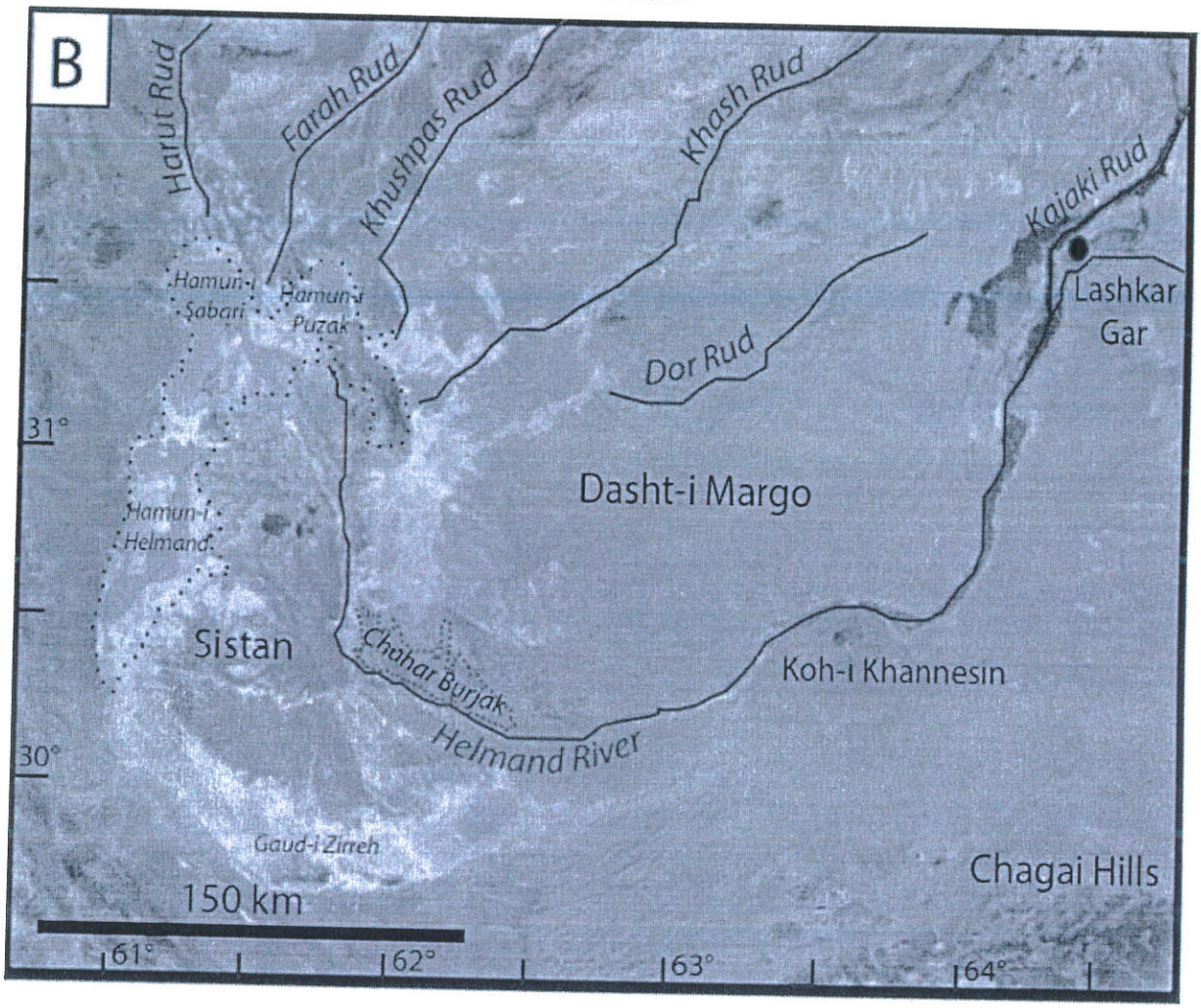


Map showing assignment area.

Helmand Basin Survey Proposed Coordinates

Helmand Basin Coordinate		
Point #	N	E
1	32.26578083	64.95487639
2	31.01589889	66.27320167
3	29.87938222	66.30400417
4	29.88990028	60.90264278
5	31.23219722	61.78787556
6	32.13464222	60.86148972
7	29.61070028	64.01491056
8	32.19025778	63.28223556

FIGURE.B


B
Harut Rud
Farah Rud
Khushpas Rud
Khash Rud
Kajaki Rud
Lashkar Gar
Hamun-i Sabari
Hamun-i Puzak
Dor Rud
31°
Dasht-i Margo
Hamun-i Helmand
Sistan
Chahar Burjak
Koh-i Khannesin
Helmand River
30°
Gaud-i Zirreh
Chagai Hills
150 km
61°
62°
63°
64°