Falcon®

Airborne Gravity Gradiometer and Gravity Survey

Survey Proposal

Mosman Oil and Gas Limited
("COMPANY")

Amadeus Basin, N.T., Australia

Submitted By
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Passion for Geoscience
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CGG

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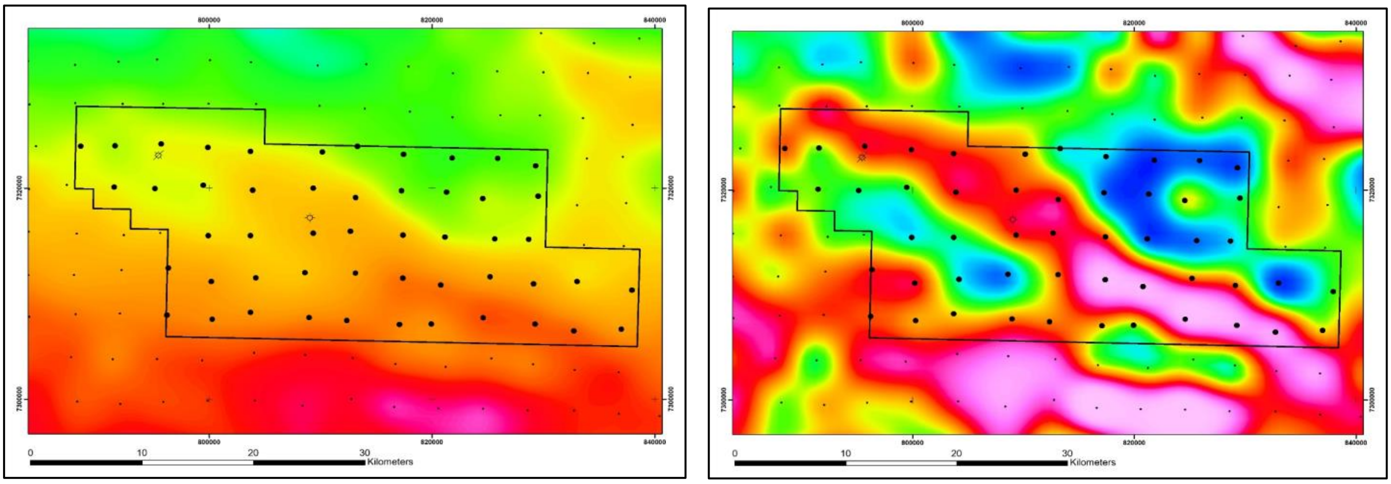
CGG is pleased to submit this proposal to Mosman Oil and Gas for a **Falcon®** Airborne Gravity Gradiometer (AGG), Gravity and Magnetic survey over EP 145 in the Amadeus Basin in the Northern Territory, Australia.

We understand that the requirement for Mosman is to be able to image the known anticline geometry (analogous to the Mereenie field) away from the existing seismic lines, and to better define structure at depth, at or below the Petermann Unconformity. Salt diapirism may be a key control on hydrocarbon accumulation within the block and recent activity in the Amadeus basin has focused on the sub-salt plays (Dukas). Imaging the salt geometry will be a key outcome, and with the density contrasts expected, gravity gradiometry will provide the resolution required to define the presence and extent of the evaporite bodies. To achieve these objectives, CGG provide options for acquisition at 500m and 750m line spacing.

Gravity Gradiometry and Conventional Airborne Gravity

Both ground based and airborne conventional gravity has been widely used in the basin. Gravity images the key structures in the basin at regional scale, however lacks the resolution required to accurately define the structures and help de-risk future seismic planning and/or drilling. Presently, there are 4km spaced ground gravity stations across the survey area, providing ~8km resolution. There are only 55 gravity stations across EP145. Conventional airborne gravity acquisition, even at tight line spacing will only improve that resolution to about 4-5km at best, given the long filters involved in the processing of airborne gravity data.

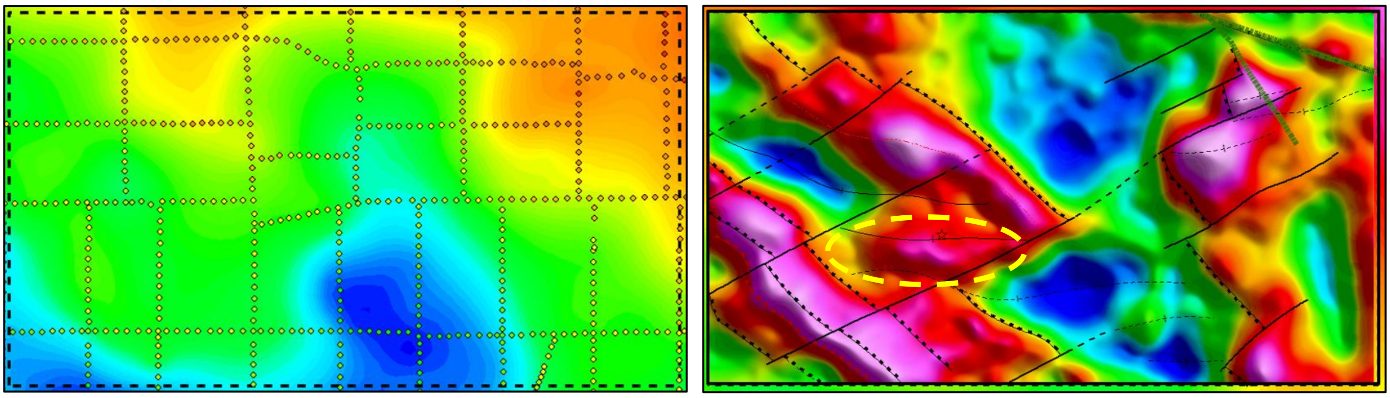
CGG recommend acquiring Falcon AGG at 500m spacing to provide a step-change increase in resolution. The Falcon gradiometry system does not require the long filters needed by conventional gravity systems. As a result, Falcon AGG will provide the lowest noise gravity data at 500m resolution, delivering high quality gravity data throughout the depth range required by Mosman. Falcon will be able to image the shallower anticline hosting the West Walker field and other structures in detail. This Ordovician stratigraphy appears to be conformable above the Petermann Unconformity, where salt tectonics and basement influences control structure. Falcon AGG will retain the ability to image the salt and sub-salt geometry at depth.



Existing gravity stations over EP 145 (55 stations in total) with standard gravity (left) and calculated 1st vertical derivative (right). The resolution is low, and similar to what can be expected from a conventional airborne gravity survey.

The images above show the ground gravity data and its 1st vertical derivative (vertical gravity gradient), and highlight possible erroneous measurements in the ground gravity data and show the low resolution nature of the data.

The images below show a comparison between ground gravity data and Falcon AGG data from the Canning Basin in Western Australia, where the high resolution gravity gradient data (right) is what is measured by the Falcon system. This is a similar size to the proposed EP145 survey, with the images being 50km across.



Comparison of ground gravity and a Falcon AGG survey in the Canning Basin. Image on left is ground gravity (with much higher sampling than EP145), and the 500m spaced Falcon AGG (vertical gravity gradient) result over the same area (right). The Ungani field structure (~2,400m depth) is imaged by the AGG data (yellow ellipse). Survey is comparable in size to EP 145 (50 km survey width).

Traditionally, gravity has been seen as a low-resolution tool, however the higher resolution of Falcon AGG is in line with the scales of structure observed in seismic data. Together, 2D seismic and Falcon AGG provide a powerful exploration dataset. EP145 has relatively sparse 2D seismic coverage and will greatly benefit from the 'plan view' structural information at the resolution provided by the Falcon AGG dataset. The AGG data will allow confident interpretation of structure away from the 'knowns' of the seismic lines and provide more assurance around salt distribution and geometry where seismic imaging is compromised by the salt. This adds immense value to the pre-existing seismic data, while ensuring that any new acquisition is shot in the optimum location to image key structure.

An example of the additional value that AGG provides to seismic data and the comparable resolutions between the two is demonstrated in the images below, looking at the same Canning Basin data example.

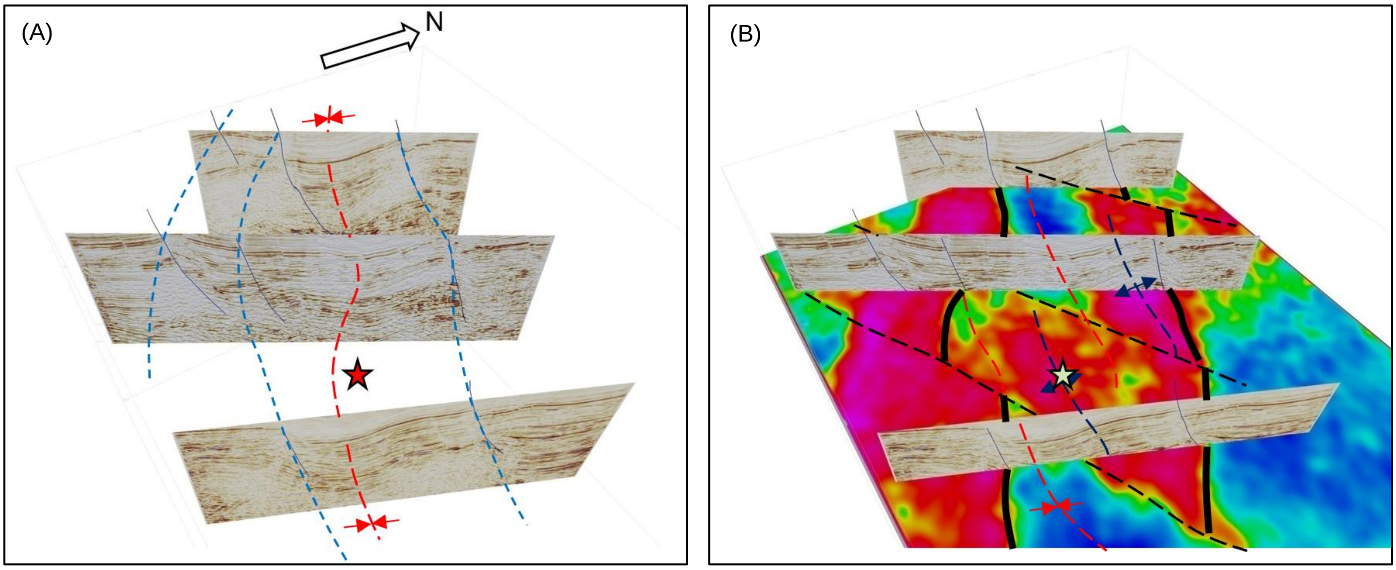
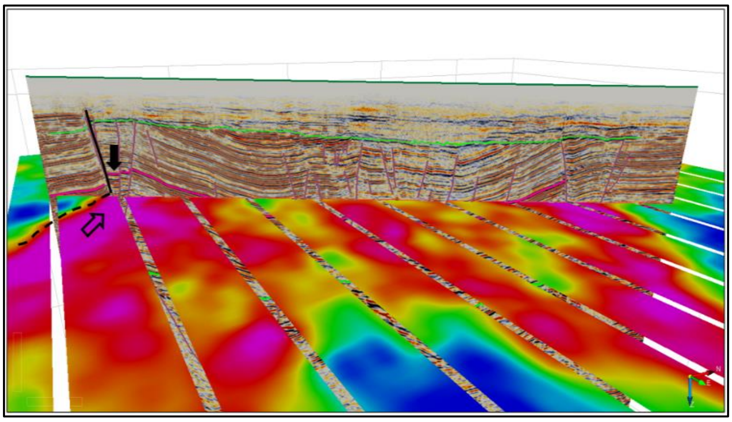
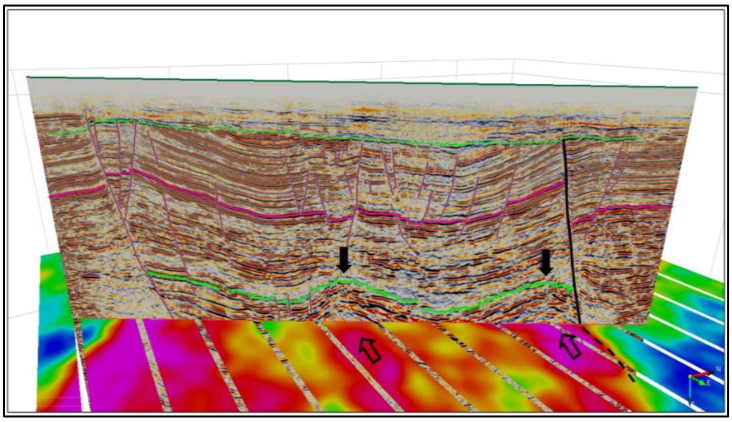


Image (A) shows sparse 2D seismic lines (~10km apart) interpreted in the absence of any other information. Red star shows Ungani field location (anticlinal, 4-way dip closure). Image (B) shows the same seismic data, but now using the AGG data to guide exploration.





The Falcon AGG responds to structure at different depths, depending on the location of the density contrasts. In the examples to the left, a seismic line through the Ungani field is shown. The upper image shows the Falcon response to the shallow fault and inversion structure (LHS) as a clear gravity high, extending for some distance away from the seismic plane.

The lower image shows the same seismic line, but this time with the AGG data pushed much deeper (~2,400m) where the AGG data is imaging the normal fault on the RHS, but also the anticlines of the known oil fields in the basin as clear gravity highs marked by the open arrows.

More information on the Falcon AGG system is provided below.

Falcon

The Falcon AGG technology is the only gravity gradiometer system specifically designed for airborne survey use. This provides a number of key advantages over all other standard Full Tensor Gradiometer (FTG) systems such as:

- **Lower noise** – To mount both complements of accelerometers in a single instrument, a larger baseline (approximately twice the size of a standard FTG gradiometer) is used. This increased baseline between accelerometers and the use of two complements reduces the noise power by a factor of 8. As the accelerometers are aligned horizontally, the instrument is much less sensitive to noise in the vertical direction which accounts for the majority of the acceleration noise in an aircraft. Therefore the Falcon AGG system is much less sensitive to aircraft turbulence than other standard gravity gradiometers.
- **Higher resolution and sensitivity** – By measuring the lowest noise tensor component and using it to recover the vertical component of gravity (gD) and all of the components of the gravity gradient tensor, the lowest noise, highest sensitivity and highest spatial resolution airborne gravity data is obtained.
- **Measured error & redundancy** - Having two independent gravity gradiometers taking measurements at the exact same time and place results in reduction of noise through averaging and also provides redundancy in the event that one complement of accelerometers fails. In addition, taking the difference between the complements provides an estimation of system error across the entire survey area.
- **Highest production rate -** The Falcon AGG system, with horizontally aligned accelerometers, is far less susceptible to turbulence than standard FTG systems. Falcon systems can operate in more turbulent conditions without compromising the quality, sensitivity or resolution of the data. Greater production rates and reduced standby days are achieved, resulting in faster survey completion and reduced overall cost.

Some other features of CGG's offer that will be of particular benefit to you:

- CGG's industry leading quality assurance procedures, highly trained personnel and a commitment to research and development assures the best possible results for your airborne geophysical exploration project. In addition, the flight path will be tightly controlled using advanced GPS electronic navigation.
- The CGG software system used in all of our worldwide airborne data processing centers ensures that the flow of data from the aircraft, through field QC, to final processing and mapping is accomplished seamlessly and efficiently.
- CGG applies a very rigorous Safety Management System to all of its surveys. A complete Project Safety Plan and Risk Analysis will be completed before the survey commences, and ongoing safety meetings will occur throughout the survey.

Survey Timing

Noting your timing requirements for the data, whereby the data be acquired prior to July 2021 so it can be utilized for seismic planning, CGG is able to mobilize to the survey are in mid-June 2021

This proposal is valid for 30 days.

Thank you for the opportunity to provide this proposal and we look forward to working with you on this airborne survey.

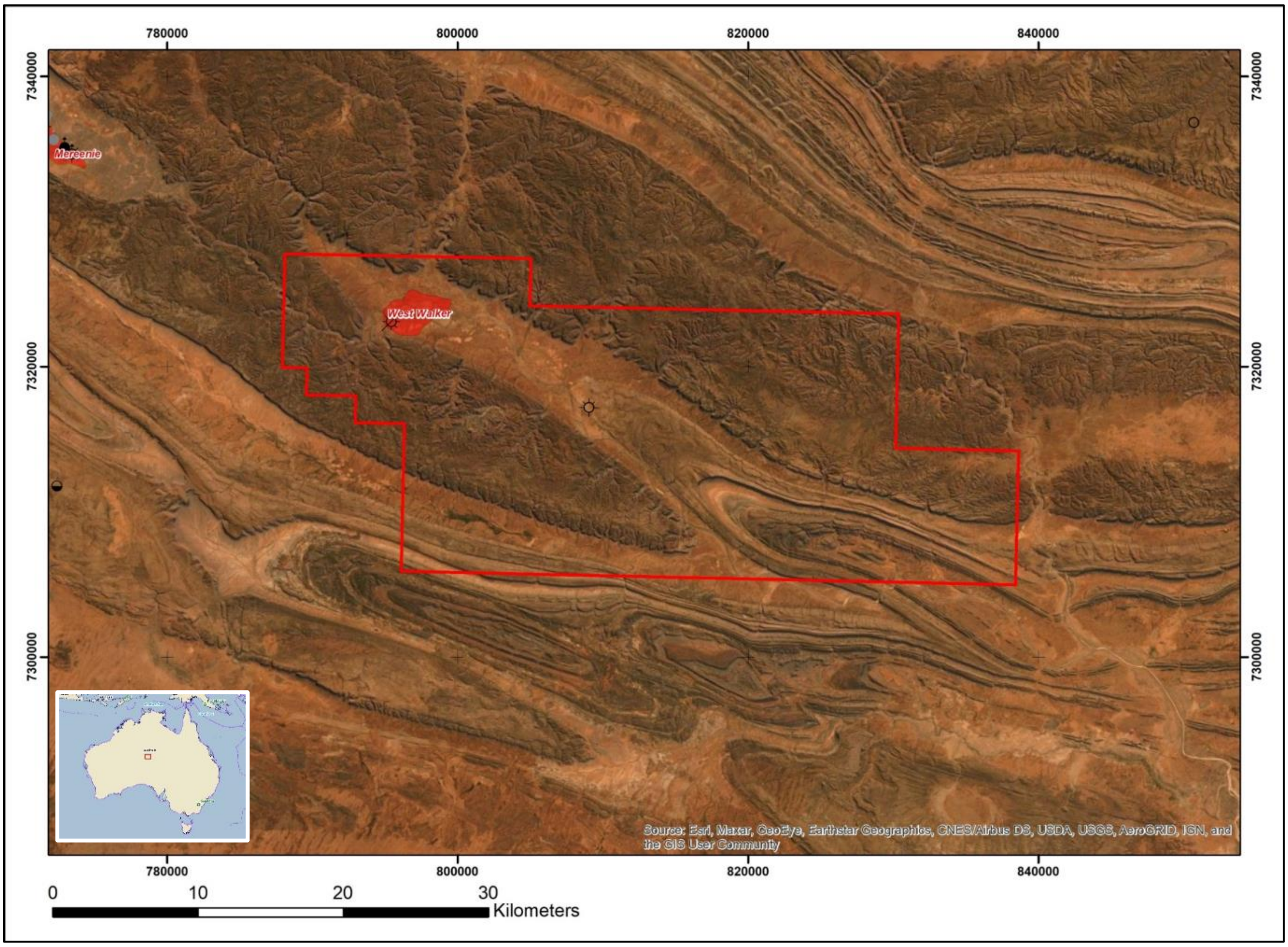
Yours Sincerely

Business Development Manager
CGG Multi-Physics

1 Survey Area and Flight Plan Details

1.1 Survey Area

The Survey Area comprises the area bounded by the coordinates and shown in the map below.



Survey Area plotted over Terrain and topographical map in projection WGS84 Zone 54S.

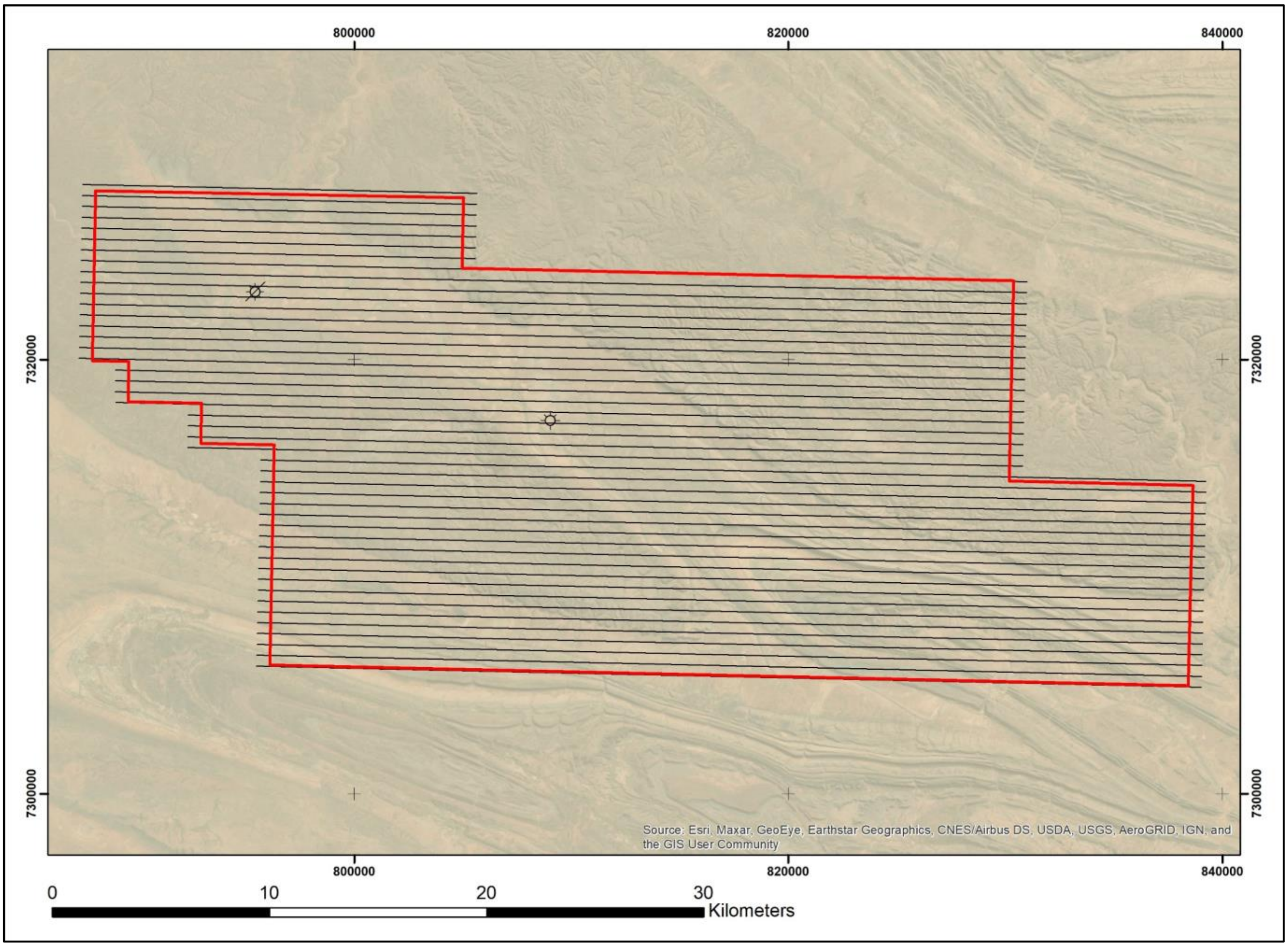
Point	East	North	Point	East	North
1	788088	7327781	8	796108	7305920
2	805037	7327470	9	796322	7316076
3	804967	7324208	10	792934	7316147
4	830387	7323640	11	792972	7317996
5	830172	7314404	12	789585	7318066
6	838641	7314204	13	789623	7319919
7	838420	7304967	14	787930	7319953

Coordinates of the SURVEY AREA in WGS84 Zone 54S.

Note that the planned number of line kilometers is an estimate at this stage and may vary with flight plan optimization. It includes sufficient overfly past the boundary supplied in order to process and deliver line data to the boundary.

1.2 Flight Plan

The calculated distance required to complete the survey the survey is 1,755 line kms at 500m line spacing, or 1,181 line km at 750m spacing.

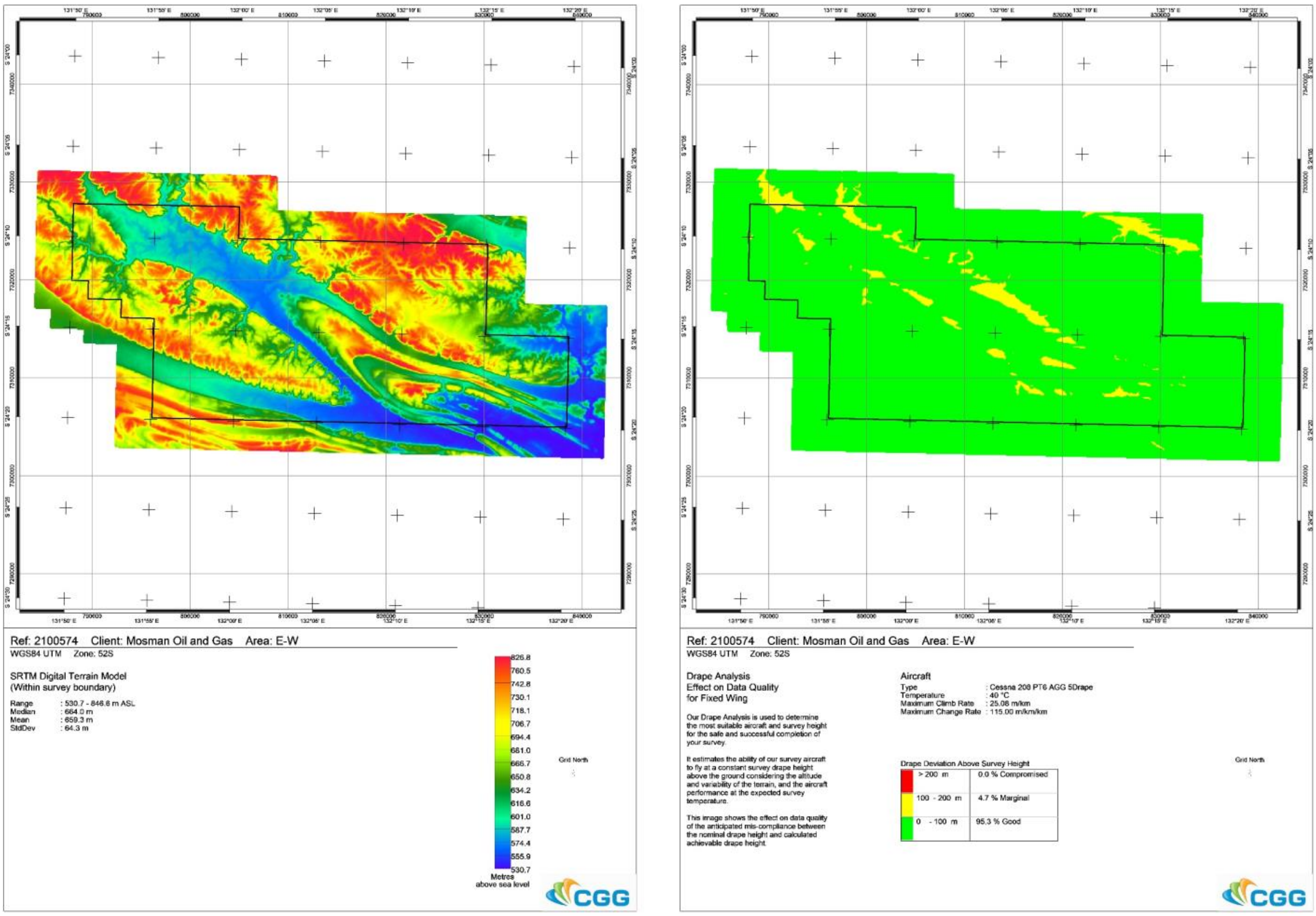


Flight Plan (500m spacing) plotted over Terrain and topographical map in projection WGS84 Zone 54S.

Area Name	Traverse Line Spacing (m)	Traverse Line Direction	Tie Line Spacing (m)	Tie Line Direction	Chargeable Survey Distance Line Km
EP145	500m	091	NA	NA	1,755
EP145	750m	091	NA	NA	1,181

Flight Planning Parameters.

1.3 Terrain Analysis



Terrain (left) and Drape Compliance (right) WGS84 Zone 54S.

The survey area has an elevation range of approximately 300m and includes some rugged breakaways which form parts of Kings Canyon. The terrain is close to ideal for aerial survey operations and 95% of the survey area can be flown within 100m of the proposed survey altitude. The remaining 5% is associated with the steep breakaways, will be acquired well within 200m of plan, resulting in excellent data throughout the survey area.

2 Equipment and Personnel

2.1 Aircraft

CGG will supply a survey Aircraft that will efficiently and safely conduct the survey. The aircraft will be deployed with the following survey equipment, and ground support systems as required:

2.2 Instrumentation

2.2.1 Gravity Gradiometer

Falcon Airborne Gravity Gradiometer System, including Lockheed Martin Airborne Gravity Gradiometer (AGG) with single near-vertical spin-axis, dual complement Gravity Gradiometer Instrument (GGI). Detailed specifications restricted under ITAR.

2.2.2 Airborne Magnetometer

A single-sensor magnetometer mounted on a stinger that will provide high precision magnetic data collection. In addition to the airborne magnetometer, a continuously-recording base station magnetometer will be located near the survey area in an area of low magnetic gradient, away from man-made influences. The base station and the aircraft acquisition system clocks will be synchronized. The specifications of the magnetometers are described below.

Description	Specification
Manufacturer \ Model	Scintrex \ CS-3 cesium vapor (or equivalent)
Resolution	0.01 nT
Operating Range	15,000 – 105,000 nT
Sampling Rate	10 Hz

2.2.3 Base Station Magnetometer

A Proton Precession or Cesium Vapor magnetometer ground station for diurnal corrections with a 0.01nT resolution, cycle at 1-second intervals. The base station magnetometer will be run during flying hours to monitor the diurnal field.

2.2.4 Fluxgate Magnetometer

One three-axis fluxgate magnetometer with each sensing axis oriented at approximately 90 degrees to the other two and each with a sensitivity of 1 nT or better sampled at the same rate as the aircraft TMI sensor.

2.2.5 Laser Scanner

A laser scanner is used to acquire accurate terrain data for corrections of the AGG data. The laser scanner specifications are listed below.

Description	Specification
Manufacturer/Model	Riegl LMS-Q140i-80 (or equivalent)
Sampling rate	276 samples per line, 20 scans per second
Range	Up to 350 m (depending on target reflectivity)
Accuracy	+/- 2.5 cm (+/- 10 cm worst case)
The laser scanner scans perpendicular to the flight path +/- 40 degrees from vertical.	

2.2.6 GPS Positioning / Navigation Equipment

Will include a dual frequency phase measurement GPS system suitable for real-time position accuracy of 5m and post-processed accuracy of 1m and a GPS ground station for phase-smoothed pseudo-range differential correction of flight position data.

Description	Specification
Manufacturer/Model	NOVATEL OEMV-3G 14 Channel (or equivalent)
Resolution	0.00001 degrees
Accuracy	0.6-1.8 m
Sampling Rate	1 Hz

2.2.7 Radar Altimeter

Description	Specification
Manufacturer/Model	King KRA-405B (or equivalent)
Accuracy	3%
Sampling Rate	10 Hz

2.2.8 Data Acquisition System

A digital acquisition system will be used for recording all geophysical and ancillary data. A minimum of two external hard drives will be provided to the field crew for duplicate backups of data acquired.

2.2.9 Pilot survey line guidance system

Providing the pilot with indication of deviation from planned survey line and logging of survey compliance.

2.3 Field Personnel

CGG will supply experienced operators/technicians and data processing personnel as required.

The data is transmitted to the office for processing, where a geophysical data processor will process the survey data and monitor data quality on a flight by flight basis.

3 Specifications and Quality Control

3.1 Survey Specifications

Flight Line Spacing	500m / 750m TBC
Flight Line Direction	091 degrees
Tie Line Spacing	NA
Tie Line Direction	NA
Minimum Line Length	11.2 km
Flying Height **(DEPENDENT ON RISK ASSESSMENT / TERRAIN)**	120m
NOTE: FLIGHT SPECIFICATIONS ARE SUBJECT TO RECON FLIGHT AND FINAL ONSITE SAFETY ANALYSIS	

4 Data Processing and Deliverables

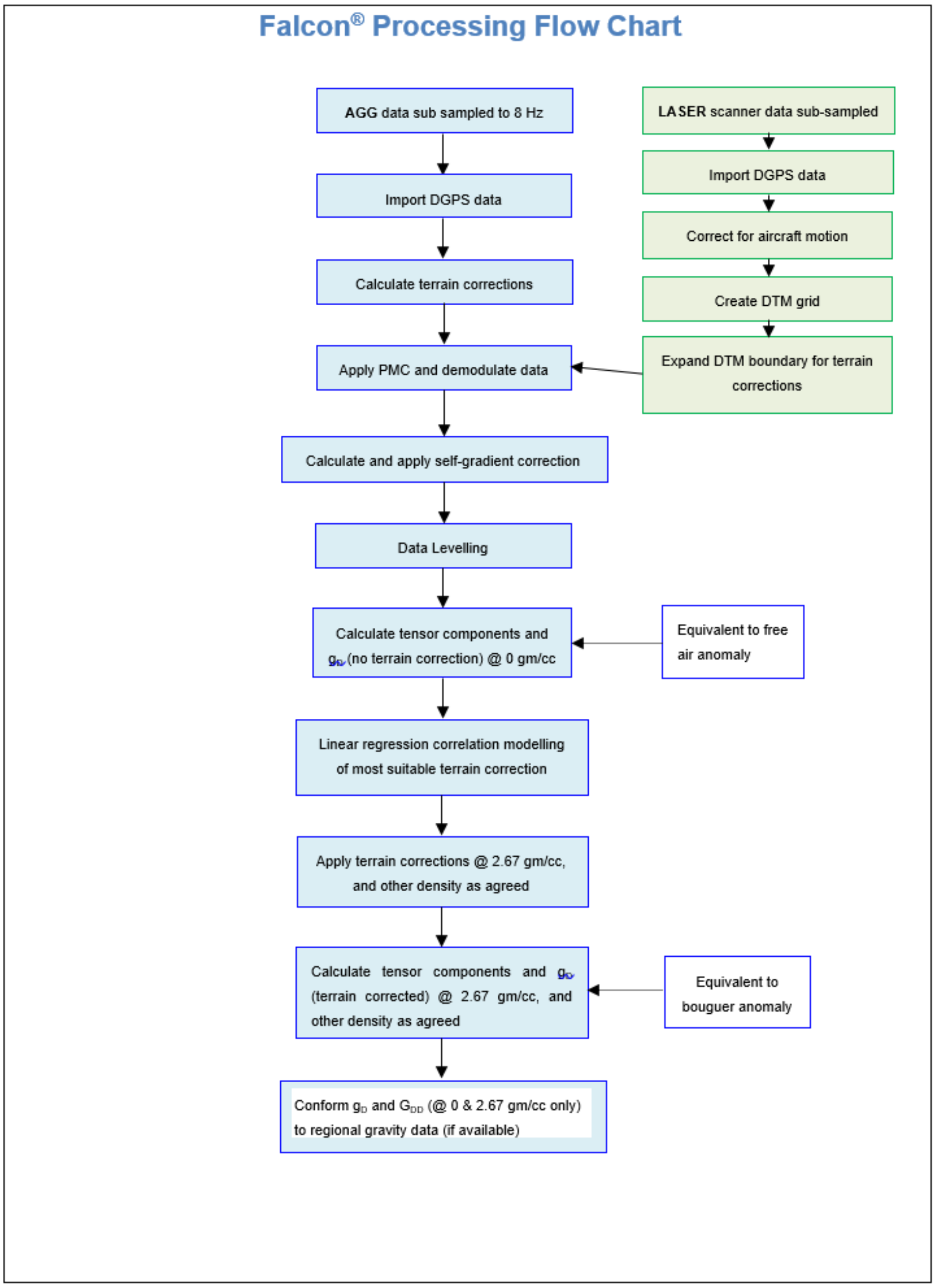
4.1 Data Processing

CGG uses proprietary Falcon AGG processing software for data processing and quality control.

At the completion of each day's flying the raw data will be transmitted to our office processing facility, which enables our office processing staff to immediately conduct thorough data quality checks and start the processing with a minimum duplication of procedures or loss of time.

An experienced geophysical data processor will review all survey data to ensure that the data are of acceptable quality and initiate preliminary and final processing and products.

Final processing workflow is described in the chart below.



4.2 Deliverable Products

All products from the survey are delivered in digital form. Databases are delivered in Geosoft format and grids in Geosoft OR ERMapper format. All data are referenced to the WGS84 datum and are in a UTM projection.

4.2.1 Field Quality Control Products

The following products will be available during data acquisition.

Daily

1. Flight path image
2. Daily QC report (Line Summary Statistics)

Weekly

3. Preliminary grid images
    a. Vertical Gravity Gradient (G_{DD})
    b. Gravity (g_D)

4.2.2 Preliminary Products

The following products will be delivered on a preliminary basis after the acquisition has completed and the field data is consolidated

1. Flight path image
2. Preliminary grids
    a. Digital Terrain Model
    b. Vertical Gravity Gradient (G_{DD})
    c. Gravity (g_D)
3. Digital line archives in Geosoft or ASCII format
4. Other preliminary products may be negotiated

4.2.3 Final Processing Products

4.2.3.1 Standard Products

1. Survey Logistics and Processing Report
2. Grids of;
    a. Vertical Gravity Gradient (G_{DD}) and Gravity (g_D) at 0 & 2.67 gm/cc, and other agreed densities
    b. Digital terrain model
3. Located database of measured & processed line data as listed below