

FTG

Full Tensor Gravity Gradiometry surveys offer exploration alternatives to assist operators 'zero in' on the most prospective regions to shoot their seismic programs

Despite the exploration rush Africa has experienced over the past decade and a half, much of the continent still remains under-explored. During challenging times such as those experienced over the past few years, there is a continued need for innovative and cost effective exploration technologies that meet Africa's unique challenges. One such technology is Full Tensor Gravity Gradiometry (FTG).

FTG Benefits

Full Tensor Gravity Gradiometry, or FTG, is increasingly being utilized across the continent, especially over the past 10 years. FTG offers many advantages to operators who hold massive exploration blocks, often ranging in size from 1,000 sq km and as large as 15,000 sq km. These areas can often consist of complex geology with only poor seismic imaging available. FTG data can play a key role in honing in the most prospective areas to conduct new seismic surveys. Any regional seismic data already present can also be calibrated to the FTG data to provide an initial model for interpretation. Cost wise, FTG is an attractive option in narrowing down seismic area prospects.

According to an article published in *Petroleum Africa's* January 2014 issue by Chris Anderson, "FTG maps subsurface features on the basis of density contrasts; identifying the density variations in underlying rocks by measuring the gradient of the earth's gravity field (variations in density cause variations in the gravity signal). FTG can measure variations of Earth's gravity field with higher resolution utilizing a broader bandwidth. The result is that a more detailed structural map can be derived indicating specific geological features, such as volcanics, salt domes, and major faults."

A key advantage of gradiometry over conventional gravity measurements is the improvement in signal to noise, this being particularly important for efficient airborne surveys. The combination of fast efficient acquisition facilitated by robust signal to noise characteristics and broader bandwidth make a compelling case for frontier exploration.

Anderson continued, "FTG is particularly applicable to African exploration because of the information it generates as a complement to often sparse seismic, the cost effective, efficient and non-invasive way in which it is acquired, and the fact that it is ideally suited to many African geological settings.

"East Africa, in particular, exhibits some significant geological challenges in terms of characterizing the subsurface. The East African Rift,

extending from the Red Sea through Sudan, Uganda, Ethiopia, Kenya, Tanzania and Mozambique, is the most significant regional feature. The presence of rift margins, varied depositional settings, and a raft of Paleocene, Oligocene, and Miocene sedimentary rocks (clastics) with varying levels of maturity, combined with widespread volcanic features, add complexity and complicate the interpretation of any seismic data that is present. Mapping subsurface density in these complex areas where FTG can detect features at a suitably high resolution can bring greater understanding and better interpretation."

FTG Programs in Africa

As mentioned, East Africa holds many regions which can greatly benefit from FTG programs and operators in the continent are increasingly utilizing this technology. Many programs have already been undertaken with others on the drawing board; here we look at just a few.

Ethiopian company SouthWest Energy, in partnership with the now defunct ARKeX, completed the acquisition, processing and interpretation of 17,906 km of FTG, magnetics and Lidar data in **Ethiopia's** Gambella Basin over a 136-day period in 2015. In total 156 structures and 48 lead concepts were identified from the FTG interpretation. The new 3D inversion work revealed morphology of the basement top and other horizons in great detail and sediment thickness reaching 9 km was estimated. According to SouthWest, "in an area such as this with a proven and prolific petroleum system and sufficient sediment thickness, a huge opportunity exists for oil to form and migrate upwards to charge the plethora of identified structures."

Also in Ethiopia, GPB Ethiopia Resources B.V. awarded the contract for the provision of Airborne FTG & Magnetic Surveys in the Gewane-El Wiha Block,



Image 1 shows the survey grid layout and the high and low grid densities which were designed based on SWE's assessment of basin's prospectivity

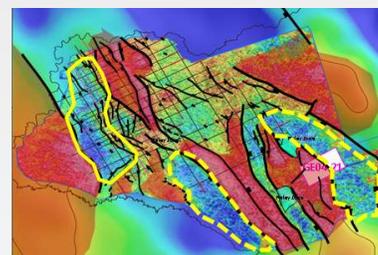


Image 2 shows two isolated basins indicated by dashed yellow polygons, and a northwestern basin (solid yellow polygon) that is closed in the SWE block.

Source: SouthWest Energy



Source: ARKeX/Petroleum Africa January 2014

An Airborne FTG Survey in Kenya

(Afar Area) to Bell Geospace. The survey began in January 2015 with results delivered in September of that same year. Considering the survey results, GPB GR specialists defined prospective areas for the 2D seismic data acquisition and in April 2016, BGP Inc. (CNPC Group) completed the 2D seismic acquisition program. Petrotrace was responsible for the seismic data interpretation works.

Last November, Austin Bridgeporth completed acquisition and processing of its Airborne Full Tensor Gravity Gradiometry survey for Tullow Oil over Blocks 12A and 12B in **Kenya**. The new data added to the over 60,000 sq km of FTG data that Tullow Oil has already acquired in the East African Rift Basin. Austin Bridgeporth says this FTG data is seen as a key exploration tool and has been used extensively to identify and derisk oil resources throughout Tullow Oil's Kenyan and Ethiopian exploration licenses.

Taipan Resources also contracted ARKeX to conduct an FTG survey on Kenya's Block 2B back in 2013, and a well was later drilled.

State companies too are seeing the value in running FTG programs. In **Tanzania**, Tanzania Petroleum Development Corp. (TPDC) contracted CGG to conduct a non-invasive Airborne Gravity Gradiometry Survey over Lake Tanganyika North Block. TPDC said the objective of the survey is to acquire high resolution gravity and magnetic data to map subsurface structural geological framework, thickness and extent of the sedimentary rocks over the Lake Tanganyika Rift Basin.

South Africa's PASA (Petroleum Agency of South Africa) also contracted CGG in January 2016 to run a program across two blocks totaling approximately 78,000 line kilometers. The survey objective was to provide partial coverage of the largely underexplored Western Bredasdorp, Durban and Zululand basins and to assist in mapping crystalline basement and magnetic and density anomalies within the sedimentary section. The airborne survey allows data collection through the "transition zone" from the marine environment to the near-shore.

A comprehensive interpretation, combining this new data set with available geologic and geophysical data, was also undertaken by CGG's in-house interpretation team. Deliverables will include a full geophysical interpretation report, including definition of basement lithology and structure, mapping of sediment fairways and depositional-centers and any intrusives or salt which may be present in the sedimentary section. The final results will be presented in ArcGIS® format for assimilation into the clients' own seismic, geological and well control databases. These survey deliverables will provide significant assistance to exploration and de-risking of prospective areas by oil companies when they become available for licensing in mid-2016.

In January 2016, Oyster Oil and Gas commenced an airborne survey in **Djibouti**. The survey was conducted by Bridgeporth Holdings Ltd. and consisted of a high density gravity and magnetics airborne survey over some 3,350 line km onshore and offshore of southern Djibouti. The contract also included the processing and inversion studies of the data later in 2016.

Results from Oyster's airborne gravity and magnetic survey indicated that the targeted Mesozoic sedimentary basin extends across most of Block 1. This past January it was announced that the company, armed with its FTG survey and other data, would look to move on to Phase III of its exploration campaign, including an onshore seismic campaign.

Moving northwest, ERHC Energy ran a gravity/magnetic program in **Chad** over its BDS 2008 license. The survey was carried out by Bridgeporth who flew the 4,720 line km survey, focusing on the two main areas identified by ERHC's technical team. The two areas under scrutiny were located north of Esso's Tega and Maku discoveries in the Doseo Basin and to the east of and on trend with OPIC's Benoy-1 discovery in the Doba Basin. The Doba and Doseo basins feature active exploration and development projects with discoveries exceeding 1,290 million boe. ERHC also has contracted with Bridgeporth to process and interpret the collected gravity/magnetic data.

The latest FTG contract award came in November 2016. Bell Geospace won a contract with RakGas to acquire just under 15,000 line kilometers of airborne survey data. The contract will see Bell Geospace fly FTG and Magnetics surveys in **Zanzibar**.

The contract with RakGas includes the acquisition of 3D Full Tensor Gradiometry (FTG) data as well as processing and interpretative services. Flights began on March 14 from Abeid Karume International Airport in Zanzibar and is expected to conclude in mid June. Bell Geospace is using a Basler BT-67 flying at low altitude to conduct the survey. The outcome of the surveys is expected to enable RakGas in its exploration efforts in this region and bring understanding of the complex sub-surface geology therein.

Source: Bell Geospace



John Macfarlane Executive Vice President of Bell Geospace commented at the time of the award: “Our client relationship with RakGas is longstanding and this contract represents the next phase in our acquisition of data for the business. This is the first move into oil & gas

exploration in Zanzibar and the results will be unique in developing an understanding of its indigenous resources.”

The RAKGas technical team said its strategy is “to establish a working geologic model and structural framework in the initial exploration phase. The FTG survey provides a very good launching point prior to

2D and 3D seismic acquisition. While the survey time is less than conventional seismic, the other advantages are greater coverage in areas where ground operations may be too sensitive, such as densely populated villages and town sites. The two methods complement each other to improve the geologic interpretation, thereby reducing the time needed to identify the primary drill sites, provide needed time for rig planning, long lead items and with the best of circumstances, improve the success rate.”

In Conclusion

Exploration is inherently a risky business. The use of FTG in the continent can assist operators in narrowing down their targets and significantly de-risking their exploration programs, ultimately saving money that can go toward future seismic programs, and eventually drilling operations. Likewise, state owned oil and gas firms are seeing the advantage of upgrading their exploration packages prior to launching licensing rounds. Further, multi-client programs can be beneficial not only to potential investors, but give services providers an edge in gaining more business. 

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