

# 2018 Highlights

## Offshore Data Library

### Europe

- Entered a collaboration with Axxis Geo Solutions (AGS) for multi-client ocean bottom node projects in the North Sea. The area of mutual interest covers the core part of the central North Sea up to and including the Utsira area. Under this agreement, the parties will work together to develop opportunities to co-invest in multi-client ocean bottom node projects, the first being a 1,500 km<sup>2</sup> project in Utsira where acquisition is ongoing.
- Acquired the new Erlend Wild West multi-client 3D seismic project, covering 1,815 km<sup>2</sup> in the UK West of Shetland region and tying into TGS' existing EW12 3D data.
- Completed the second season of the Atlantic Margin multi-client program in mid-Norway, which now comprises a total of 46,400 km<sup>2</sup> of 3D seismic data over a variety of play models with stratigraphic and structural traps in Paleocene and Cretaceous turbidite/fan deposits.
- Acquired the Hammerfest Basin 3D multi-client project in a JV with PGS in the Barents Sea, Norway. The survey is covering 4,034 km<sup>2</sup> in the active APA area of the Hammerfest Basin.

### North & South America

- Partnered with Spectrum to acquire the Santos 3D program over the prospective southern Santos Basin offshore Brazil. The survey covers a 15,000 km<sup>2</sup> area south of the high-profile discoveries of the Santos Basin. Acquisition of the survey continues in 2019.
- Partnered with PGS to acquire a new 3D multi-client project, Lewis Hills 3D, spanning approximately 3,400 km<sup>2</sup> in East Canada.
- The TGS/PGS JV also acquired approximately 2,700 km<sup>2</sup> of additional data on the 2017 Harbour Deep and Cape Broyle 3D surveys in East Canada.
- Commenced a new 3D multi-client project with PGS in Canada, Tablelands 3D covering approximately 8,000 km<sup>2</sup> in an active Newfoundland area of the Flemish Pass and Orphan Basins. Bids for acreage covered by Tablelands 3D will close in November 2020.
- Commenced the Brazil Southern Basins SeaSeep Project in the Campos and Santos Basins, offshore Brazil. The project covers existing TGS surveys and includes coring and geochemistry.

### Africa & Middle East

- Began acquisition of the Jaan 3D multi-client seismic project in the North West Africa Atlantic Margin, in partnership with PGS and GeoPartners. The program comprises a fully harmonized multi-client dataset in the southern portion of the MSGBC Basin. Approximately 11,135 km<sup>2</sup> of new acquisition is complemented by the reprocessing and full pre-stack merging of existing multi-client 3D. Once complete, the final depth migrated volume will be over 28,300 km<sup>2</sup>.
- Commenced acquisition of the first regional offshore MSGBC Multibeam and SeaSeep Project in the North West Africa Atlantic Margin. The program covers an area of more than 113,500 km<sup>2</sup>.
- Partnered with Western Geco to complete the acquisition of 11,625 km of 2D data in the Egyptian part of the Red Sea. Completed data will be available ahead of the licensing round announcement in 2019.

## Onshore Seismic Library

- Continued to build on our position in the prolific part of the SCOOP/STACK portion of the Anadarko basin with the addition of the 793 km<sup>2</sup> Hackberry Complex 3D.
- Commenced acquisition on two additional projects in the SCOOP/STACK, Canton 3D (1,400 km<sup>2</sup>) and Gloss Mountain 3D (1,507 km<sup>2</sup>). Acquisition on both projects started in 2018. When complete, these two projects will increase TGS's footprint to over 6,850 km<sup>2</sup> in this prolific play.
- Completed the 464 km<sup>2</sup> Sanderson 3D located along the eastern flank of the Delaware Basin predominantly in Pecos County, Texas.
- Completed the Quail Ridge East 3D in collaboration with Fairfield Geotechnologies. The project is covering 330 km<sup>2</sup> in Western Lea County, New Mexico. Additionally, TGS and Fairfield Geotechnologies entered into an agreement to jointly explore opportunities for new projects in the Permian Basin. The Area of Mutual Interest (AMI) encompasses 5,400 km<sup>2</sup>.
- Added an additional 460 km<sup>2</sup> to our data library in the Montney Shale area of the Western Canadian Sedimentary Basin, by acquiring the Dawson 3D and Dawson 3D Phase II multi-client seismic surveys in early and late 2018, respectively.
- Increased reprocessing efforts in the Southern Basins of Mexico.

## Geological Data Library

- Expanded the world's largest library of digital well log data, including approximately 52,000 new digital Log ASCII Standard (LAS) wells, 9,300 new enhanced digital LAS+ well logs, 418,000 new Validated Well Headers, 209,000 raster images, as well as directional surveys, production data and multiple interpretive products.
- Updated multi-client interpretation studies in Norway, UK, Canada, Mexico, U.S. Gulf of Mexico and U.S. Onshore and continued with ongoing multi-client projects geared towards supplying customers with information on stratigraphy, structure, basin maturity and prospectivity.
- Enhanced our US Well Performance Database with Well Completion Data to enable correlation with well performance.
- Commercially released Mexico Well Performance Data providing the industry's only monthly production data, including production forecast and EURs on all active Mexico wells.

## Imaging Technology

- Applied leading-edge 3D image-domain least-square reverse time migration to gathers to preserve amplitude for AVO analysis.
- Completed one of the industry's largest orthorhombic depth imaging projects (18,686 km<sup>2</sup>) for the Fusion 3D survey in the U.S. Gulf of Mexico. This orthorhombic depth imaging uses full waveform inversion (FWI) and RTM COR gathers to update the subsalt velocity and dirty salt and greatly improve the image around and below the salt.
- Applied interwoven passes of multilayer tomography, full waveform inversion (FWI) and image-guided tomography to generate a geologically reasonable, data-driven model for depth imaging in the northern Atlantic margin and North Sea.
- Applied full waveform inversion (FWI) to update the salt and subsalt velocity models using a sparse-node decimated version of OGO 3D.
- Applied hybrid 3D inversion-based deblending and denoise-based deblending to simulated heavily blended data up to 8 Hz with a maximum offset of 30 km. The study shows that it is possible to reveal the signals required for an FWI workflow to build a velocity model. This process was applied to 3D seismic in offshore Europe.
- Developed and applied onshore FWI and innovative onshore denoise such as MMF filter to more effectively isolate and attenuate seismic noise based on shape differences. The study shows its effectiveness for suppression of both coherent and incoherent noise that results in an improved signal-to-noise ratio.
- Processed leading-edge TopSeis style acquisition for improved near-offset and multiazimuthal streamer seismic.
- Applied high-end depth imaging technologies: tomography using common-offset RTM (COR) gathers, and least-squares RTM to resolve sub-basalt prospectivity.

- Applied advanced depth imaging technology in the Permian Basin, onshore USA. Improved gather flattening results from the application of differential statics which represent the difference in vertical travel times between the refraction-based velocity estimate and the perturbed shallow velocity model.
- Processed coil-shooting data for broadband, long-offset, full-azimuth illumination using 5D regularization of dual-coil shooting full azimuth data. Tilted orthorhombic (TORT) imaging produced flat gathers in the shallow with Kirchhoff PSDM. Subsalt, the velocity is further updated using COR tomography, resulting in more continuous and interpretable events below salt.

## Data & Analytics Technology

- Gathered and standardized TGS's multi-client data, integrated it into a new TGS Data Lake structure and developed software for querying and extracting of metadata and data from the Data Lake.
- Began research on dozens of analytical solutions to geoscience problems and developed commercial solutions for salt identification in seismic (SaltNet) and missing log curve prediction (ARLAS).
- Utilized crowd-sourcing to develop an AI solution to a geoscience problem as one of the first oil & gas service companies. Over 4,000 data scientists competed in a "Salt Identification Challenge" that was hosted on the Kaggle platform. TGS utilized the winning entries along with its own research work to develop its SaltNet solution quickly and economically.
- Developed a data management solution that is being offered to clients.