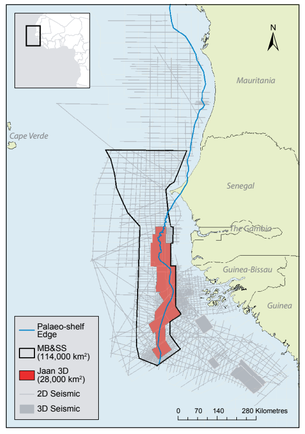
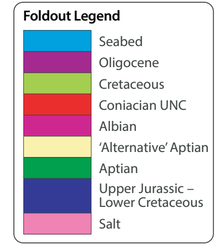
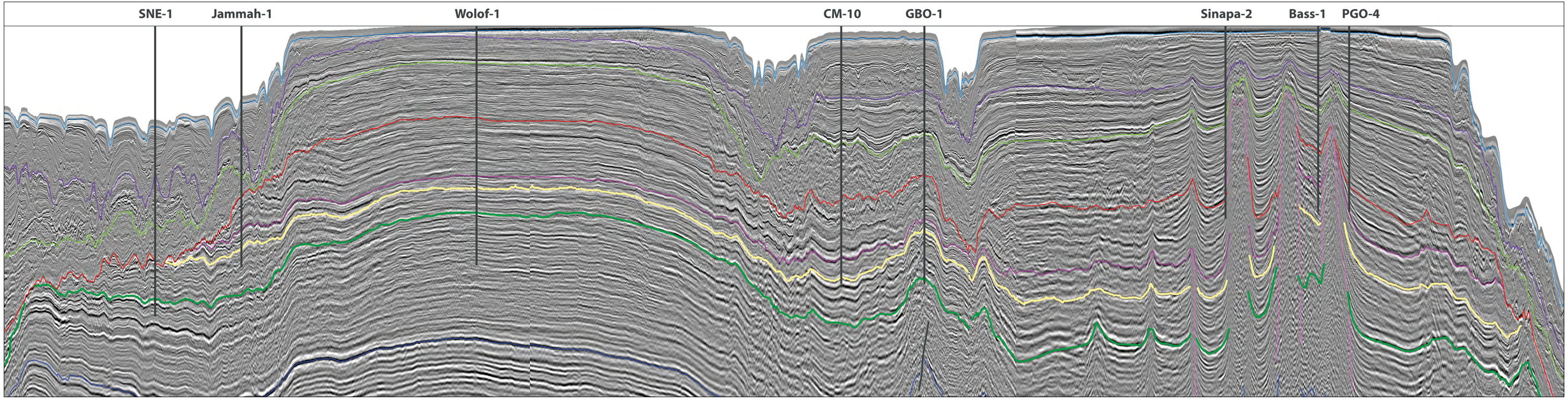
TGS in the MSGBC Basin

Aiding the next steps in exploration

The Mauritania, Senegal, Gambia, Guinea-Bissau and Guinea Conakry (MSGBC) Basin is home to several recent high-profile oil and gas discoveries, both on and off the shelf. The palaeo-shelf edge carbonate trend extending south of the SNE field and the expanse of prospective area outboard of this to the north and south have led many explorers to the region. TGS has recently completed the acquisition of its 3D Jaan survey, which, following completion of the processing, will have a depth migrated volume of over 28,000 km². To complement this – and gain vital information on the petroleum system(s) in a cost-effective manner – TGS is undertaking a multi-beam and seafloor sampling (MB&SS) project. It will cover an area of approximately 114,000 km² and will incorporate approximately 230 targeted cores with state-of-the-art geochemistry to follow. These data will be crucial to the understanding and de-risking of the basin, which is an area of active and planned exploration.







MSGBC Basin: An Integrated Approach to New Exploration

TGS

The MSGBC Basin, located on the North West Africa Atlantic Margin (NWAAM), comprises a collection of sub-basins within Mauritania, Senegal, The Gambia, Guinea-Bissau and Guinea Conakry (Republic of Guinea). Offshore exploration began in the 1960s in southern Senegal and AGC, the maritime zone established in 1993 between Senegal and Guinea-Bissau. Up to a billion barrels of bio-degraded heavy oil was found in Dome Flore (1967) and Dome Gea (1971), while others – namely CM-7 (1967) and CM-10 (1970) – showed excellent total organic carbon (TOC) and hydrogen index (HI) values. Crucially for exploration potential in the region, in 1975, DSDP-367 was drilled in ultra-deepwater (4,768m) on the Senegal-AGC border. It contained an excellent quality source interval from Upper Aptian/Lower Albian to Turonian over 100m thick, described in the official report as "a black, carbonaceous shale, which burns when ignited" and with TOCs of up to 28%.

Despite these early signs pointing towards a prospective hydrocarbon province, it took a further 50 years before the first major commercial discovery. In 2014, Cairn (along with ConocoPhilips, FAR and Petrosen) drilled FAN-1, 110 km south-west of Dakar in Senegal, and discovered oil in stacked Albian slope fan sandstones. The same consortium quickly announced the nearby SNE-1 oil discovery, an Albian sandstone shelf-edge play and the world's largest oil discovery of 2014. Further appraisal wells put the 'SNE development' 2C contingent oil resource at 563 MMb.

In 2015, Kosmos made the industry's second largest discovery of the year with the Tortue-1 gas well just across the northern border of Senegal in Mauritania. With the addition of Guembeul-1 and Ahmeyim-2 in 2016, the Greater Tortue Complex, spanning the Senegal-Mauritania border, stands at 25 Tcf. Two further gas discoveries were made by Kosmos in Senegal, roughly 80 km north-west of Dakar. Teranga-1 (2016) and Yakaar-1 (2017), reported to be the largest gas discovery of 2017 at 15 Tcf, tested the basin floor fan fairways outboard of the proven slope channel trend of the Greater Tortue Complex.

2D and 3D Seismic

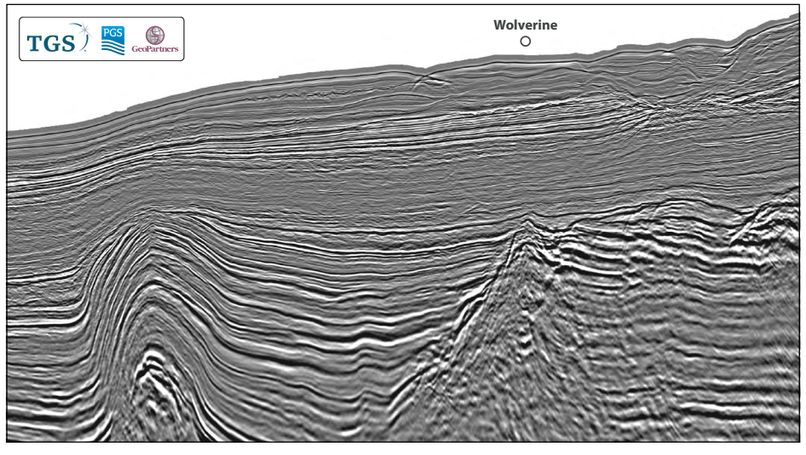
The SNE development is an instantly recognisable play of sand reservoirs sitting on a carbonate platform margin, while off-shelf, slope floor fans provide the FAN play. South of the SNE and FAN discoveries, the palaeo-shelf edge carbonate trend stretches over 550 km before meeting the Guinea Transform Fault and has attracted many exploration companies to the area as they chase similar plays.

The TGS 2D seismic library in the MSGBC Basin has been instrumental in many of the discoveries and comprises over 52,000 km in time and depth, acquired in two phases in 2012 and 2017. A further 20,000 km has been added to this library through TGS' recent acquisition of Spectrum. TGS has been present in the basin since 2010, when it acquired a 3D dataset in The Gambia. This survey now forms part of the recently completed Jaan 3D, which comprises 11,135 km² of new acquisition, complemented by the reprocessing and full pre-stack merging of existing multi-client 3D. The final depth-migrated volume will be over 28,000 km² and will completely capture the prospective palaeo-shelf edge carbonate trend, and therefore over 550 km of potential SNE and FAN plays. Fast track processing is ongoing and final deliverables will be available early 2020.

MB&SS Project

TGS has extensive experience of multi-beam, coring and geochemical analysis programmes, including projects in the Gulf of Mexico, Brazil and Indonesia. With acquisition running in parallel to the Jaan 3D, TGS have been undertaking a Multi-beam and Seafloor Sampling (MB&SS) project in the MSGBC Basin which, when complete, will cover an area of approximately 114,000 km² and incorporate around 230 cores. The footprint covers the entire Jaan 3D and continues north from SNE to the Senegal-Mauritania border, south to the Guinea Transform Fault and outboard to water depths up to 3,500m. MB&SS studies enable the mapping of hydrocarbon occurrences on the seabed and, through geochemical analysis of the cores, offer detailed information about the maturity and source of petroleum system(s).

Figure 1: Planned well location of CNOOC International carbonate platform edge 'Wolverine' prospect.



The initial stage is a multi-beam survey to identify targets (as well as providing detailed bathymetry and information on seabed geo-hazards). It is conducted quickly over vast areas and proves to be an extremely cost-effective method to gain information on a regional scale. Targets for coring are identified as 'hard' seafloor features from the backscatter (the strength of the returned pings). Backscatter anomalies can be due to hydrocarbons migrating naturally to the seabed, which feed chemo-synthetic bacteria and consequently provide nutrition for other larger organisms, with other seabed structures forming as a result.

As of end of August 2019, a total of 105,234 km² of multi-beam bathymetry had been acquired in addition to 23 jumbo piston cores (20-metre barrels), 23 heat flow measurements and 71 anomaly-targeted six-metre cores, which are currently being analysed in the TDI Brooks laboratory in College Station, Texas. Oil samples have been recovered which are yielding exciting results. The integrated application of seismic surveys and MB&SS is a major benefit to future exploration in such a large area where there is a lack of modern wells and information about petroleum systems.

Jaan 3D and MB&SS Applications

The MSGBC Basin is an area of active exploration where two high-profile wells have recently been drilled within the area covered by the MB&SS. Samo-1 (2018), set ~30 km south of and on the same geological trend as the SNE field, and Jamm-1XB (2019), an off-shelf wildcat ~80 km north-west of the SNE field, both proved to have non-commercial oil shows. As operators release more information, it looks likely that several wells will be spudded in 2020. FAR stated in late 2018 (before the Samo-1 disappointment) that the "Samo-1 well result will not effect [sic] CoS for Soloo", a prospect situated between Samo and SNE in The Gambia. In July 2019 FAR stated the "Atum and Anchova (Greater Atum) were high-graded for follow-up drilling". These Albian prospects sit on the shelf edge ~250 km south of the SNE field in the AGC zone. Should they be drilled, the completed Jaan 3D survey will prove useful for further evaluation of migration routes, as the supposed source pinches out against shelf edge. Covered by the Jaan 3D within the AGC zone ~60 km north-west of the Atum prospect lies the recently published CNOOC International 'Wolverine' carbonate platform edge prospect (Figure 1), which may be drilled in 2020.

Another application of the final 28,000 km² 3D depth-migrated volume, over and above prospect and lead mapping, will be the regional interpretation of the margin, since it will tie many of the on-shelf wells. There are several factors which make the on-shelf interpretation difficult. These include: lack of existing wells and shallow penetration depths (particularly below Albian), sparse legacy data from older wells, i.e. checkshots and reliable palaeo-data, and the fact that many wells were drilled into the flanks of salt diapirs. TGS performed an interpretation using the entire 2D dataset south of the Senegal-Mauritania border, integrating all available well information, press releases and publications. Despite the excellent coverage and large amount of well information available, the TGS Aptian interpretation was particularly troublesome since the wells in the north of the Jaan 3D (SNE-1, Jammah-1 and Wolof-1) did not tie with those in the south (CM-10, GBO-1, Bass-1 and PGO-4). This issue may affect the new wells in the area with regard to mapping of reservoir and source.

The foldout seismic image shows the official TGS interpretation of the Aptian (dark green) and the shallower Alternative Aptian (lemon yellow), highlighting the discrepancy. TGS believe the shallower Aptian, tying the southern wells, may have been picked on regional massive limestones without supporting palaeo-data. However, interpretation of the final 3D volume will shed light on this, if one of the upcoming wells doesn't first! ■

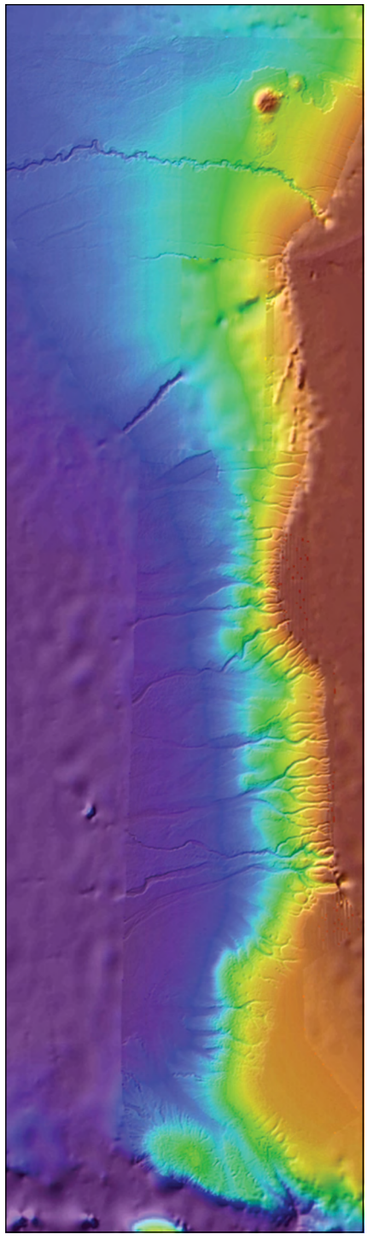


Figure 2: Recently acquired bathymetry, merged with existing public data (SRTM Ver 3), showing the seabed in unprecedented detail.