

Providing new insights into the Browse basin

Broadband acquisition reveals valid structural and stratigraphic traps able to charge offshore Australia.

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The Browse basin offshore Australia's Northwest Shelf, currently one of the world's exploration hot spots, is a geologically challenging area where imaging and mapping of deep Lower Cretaceous and Jurassic intervals remains difficult using conventional seismic data. PGS' GeoStreamer technology has delivered solid results through its new Aurora MultiClient 3-D survey, the first GeoStreamer multiclient 3-D project in Australia. Nearly 8,000 sq km (3,090 sq miles) of high-quality broadband data were acquired in 2011 and 2012 within a proven oil and gas fairway along the southeastern flank of the Browse basin that includes both licensed and open acreage.

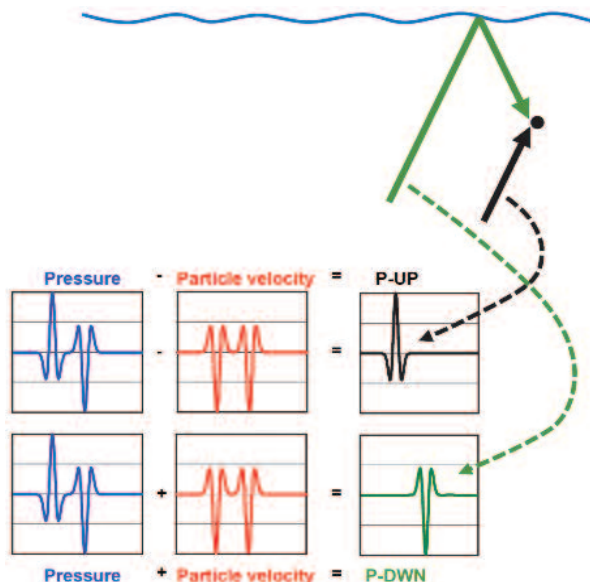


FIGURE 1. This schematic illustrates how combining the measurements from pressure and particle velocity sensors cancels out the reflection from the sea surface to the receiver to deliver a sharper, broader-bandwidth, ghost-free wavelet in the upgoing-only separated wavefield. (Images courtesy of PGS)

The dataset demonstrates a substantial improvement in resolution and penetration compared to existing datasets, so much so that an additional 200 sq km (77 sq miles) of 3-D data were acquired over the Gwydion oil discovery east of the Aurora survey. In addition, several proprietary surveys were acquired on the Northwest Shelf of Australia during the same period due to the uptake of broadband seismic in this area.

Technology advantages

GeoStreamer is a towed dual-sensor streamer technology using colocated hydrophones and velocity sensors to explicitly measure both the pressure wavefield and the vertical component of the particle velocity wavefield. That makes it possible in subsequent processing to separate both the upgoing and downgoing pressure and particle velocity wavefields (Figure 1).

The four resulting wavefields provide several unique opportunities for subsequent data processing and interpretation. The upgoing pressure wavefield does not contain the receiver ghost that is present in conventional (total pressure) seismic data. Thus, the reflection events are sharper and richer in both low- and high-frequency content and have better resolution and event continuity. The ability to remove the ghost prestack means that all subsequent stages of processing benefit.

Operationally, the GeoStreamer is towed at a depth of at least 15 m (50 ft), which means acquisition is much less affected by operational/environmental noise and typically records higher signal-to-noise (S/N) ratios. In contrast to conventional streamer data, towing GeoStreamers at 15 m not only produces optimal data quality and resolution but also allows optimal operational performance and efficiency. And with wavefield separation removing the receiver ghost, unwanted interference is reduced at all target levels.

This technology translates into significant interpretation benefits: enhanced resolution for improved imaging of thin units and stratigraphic traps, better penetration for imaging deep targets, enhanced multiple attenuation, more accurate determination of attenuation, and higher

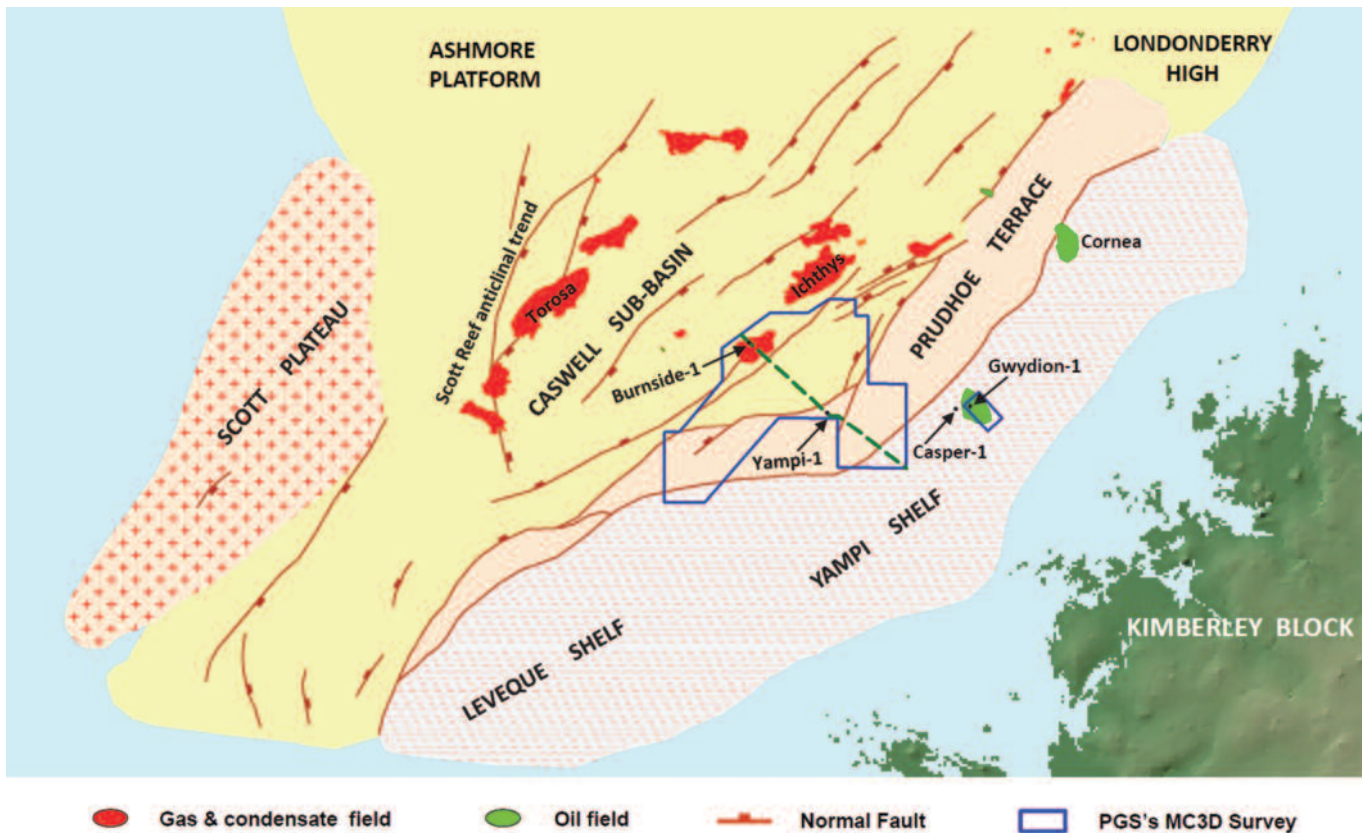


FIGURE 2. This regional structural map of the Browse basin shows the location of the composite seismic line.

S/N ratios. The extended bandwidth of the data is essential for inversion and detailed reservoir characterization, with the additional low frequencies “filling the gap” and providing a more data-driven inversion. The system enables a more stable estimation of velocity ratios and subsequent fluid discrimination and litho-fluid analysis.

Regional geological setting

The Aurora and Gwydion 3-D surveys are located on the Prudhoe terrace and Yampi shelf within the northeast trending Browse basin, which covers approximately 140,000 km (54,054 sq miles) of Australia’s western continental shelf/slope (Figure 2). The area is one of a series of rift/extensional basins that form one contiguous Western Australian Super-basin primarily filled with pre-rift Permo-Triassic intracratonic sediments overlain by Jurassic to Cenozoic synrift and post-rift successions. The Yampi shelf forms the southeastern margin of the Browse basin and is underlain by shallow basement with a distinct erosional palaeo-topographic relief. The basinward boundary of the Yampi shelf is characterized by a change in dip of basement from relatively flat-lying to gently basinward-

dipping. The Yampi shelf extends westward into the fault-bounded Prudhoe terrace, beyond which lies the Caswell sub-basin with up to 15,000 m (49,215 ft) of sedimentary section. The Caswell sub-basin is bounded to the west by the Scott reef anticlinal trend, which itself passes westward to the deepwater Scott plateau.

The regional geology of the basin is shown by the northwest to southeast composite line that highlights the distinction between the highly faulted pre-Jurassic succession associated with the rifting phase and the overlying largely progradational succession of Jurassic to Cenozoic age.

New exploration opportunities

The giant Ichthys Field (13.5 Tcf recoverable) is just 10 km (6 miles) to the north of the Aurora survey area. The new survey covers the Burnside discovery with a 65-m (213-ft) gas column that is currently being appraised by Santos and is on trend approximately 40 km (24 miles) to the southwest of Ichthys. Evidence of the oil potential of the Yampi shelf was demonstrated by discoveries at Gwydion-1 and Caspar-1 in the mid-1990s, which chal-

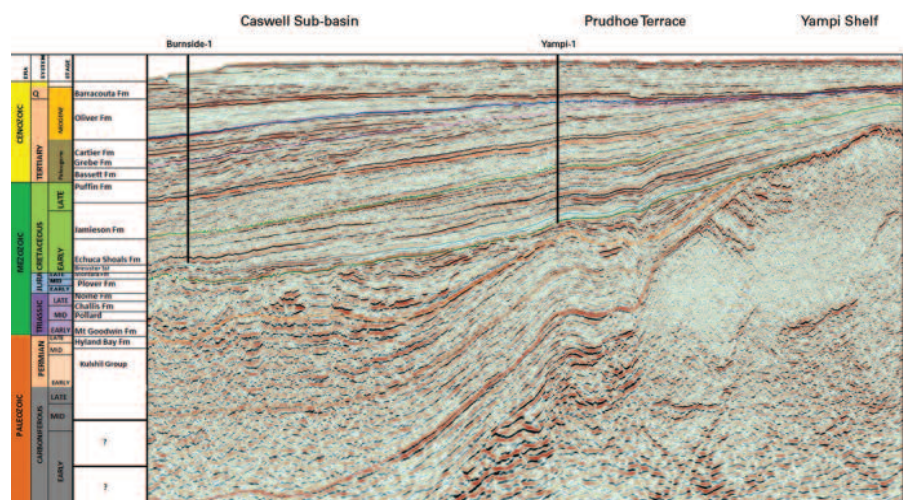


FIGURE 3. The Aurora MC3D composite line spans the Caswell sub-basin, Prudhoe terrace, and Yampi shelf, tying the Burnside-1 and Yampi-1 wells.

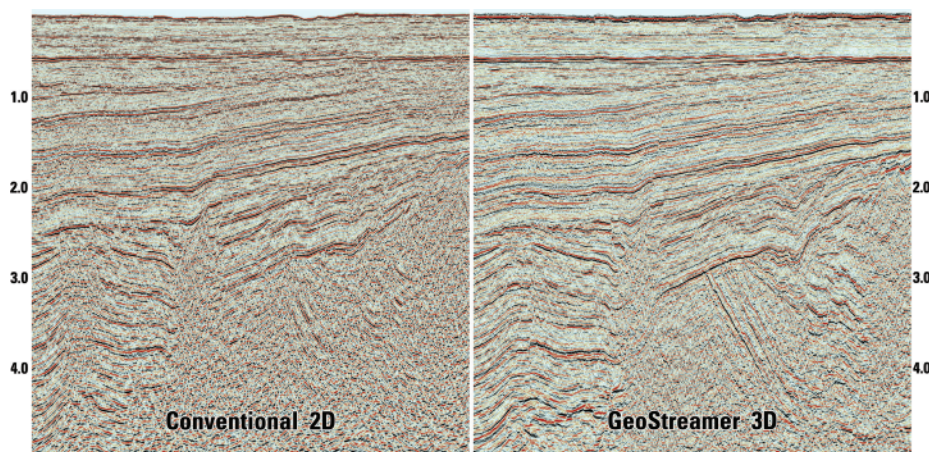


FIGURE 4. A comparison of conventional and GeoStreamer broadband full-stack seismic data shows improved imaging in the broadband data.

lenged the previous perception that the basin was a gas-prone province. These discoveries proved long-distance migration from the mature kitchen areas in the Browse basin depocenter.

The majority of the gas is sourced from Early to Middle Jurassic Plover formation pro-delta shales and coastal plain shaly coals, whereas most of the oil-prone source potential is associated with Late Jurassic to Early Cretaceous transgressive marine shale sequences. Good-quality reservoir sands are known to occur within the fluvial-deltaic Plover formation as well as in shallow marine sandstone reservoirs within the Late Jurassic to Early Cretaceous Vulcan and Echuca Shoals formations. High-quality Early Cretaceous stacked sandstone reservoirs were encountered in wells drilled on the basin's

shallow eastern margin.

Hydrocarbon accumulations have been encountered in both structural and stratigraphic plays within Jurassic horsts/tilted fault blocks and associated drape features as well as late Jurassic to early Cretaceous drape of erosional basement highs on the eastern margin of the Yampi shelf. Other potential play types include shallow marine Tithonian to Berriasian sandstone onlap/pinchout plays on the Prudhoe terrace and Yampi shelf. Late Jurassic to early Cretaceous claystones within the Vulcan and Echuca Shoals formations provide regional seals throughout much of the basin.

Although a working petroleum system and migration have both been established on the Yampi shelf and adjoining Prudhoe terrace, the area still is relatively lightly explored and offers good potential for new discoveries. High-quality 3-D seismic surveys provide a key exploration tool for identification of additional valid structural and/or stratigraphic traps with access to charge (Figure 4). GeoStreamer

broadband technology, with increased resolution and deeper penetration, has enabled detailed reconstructions of the migration pathways and recognition of more prospective play fairways.

Previously poorly imaged stratigraphic plays along the basin margin benefit from the higher bandwidth. Also, improved penetration and high-resolution imaging of the thick Palaeozoic section underlying the main breakup unconformity, particularly the superior imaging of deeper Permo-Triassic fault blocks, will assist in evaluation of these deeper untested plays. In addition, a high-quality deghosted prestack dataset calibrated to wells and suitable for quantitative attribute analysis can support a new phase of stratigraphic exploration around the Browse basin's eastern margin. **ESP**