

# New Insights on the Alaskan Chukchi Sea

Operationally challenging, environmentally sensitive and seasonally limited; the vast bounds of the underexplored basins of the Arctic region remain of significant long-term importance to the future of global energy demand. The offshore Chukchi region of Alaska represents significant untapped petroleum resources. The most recent assessment by the USGS suggests a potential 29 billion barrels of recoverable reserves.

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The Chukchi Sea is part of the Arctic Ocean and generally considered part of the Alaskan Arctic Basin. It is bordered to the west by Russia's Wrangel Island and the East Siberian Sea, in the east by the Beaufort Sea, and in the south by the Alaskan mainland (Point Barrow to Cape Lisburn) and the Bering Strait. The Chukchi Sea is dominated by a broad, shallow continental shelf (the Chukchi Shelf) with water depths to 100m (330 ft).

Although oil production on Alaska's North Slope began in 1977 (see *GEO ExPro*, Vol. 7, No. 6), to date it has all been on state lands (North Slope Region) and in state inshore waters of the

Beaufort Sea. The US government began offering oil and gas leases in the Chukchi in the 1980s followed by an initial phase of exploration which identified active petroleum systems; however, there has been no development to date.

While the focus of this article is the Chukchi, it is important to note the global effort (including the USGS in Alaska, DMNG in Russia, Greenland, Norway, Finland, Iceland and Canada) as part of a circumpolar initiative to understand the basin-forming relationships, petroleum systems and hydrocarbon potential of the Arctic region.

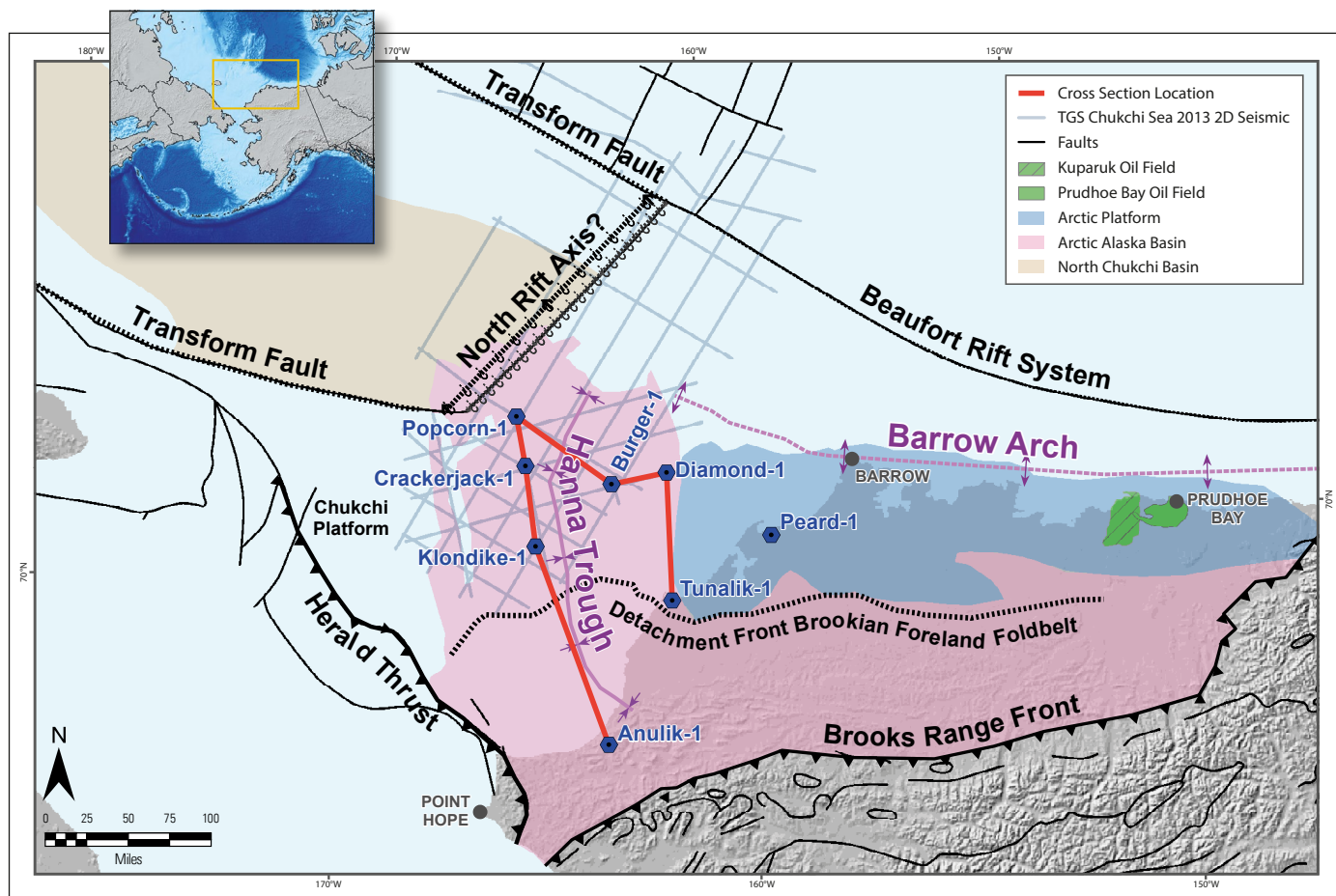
## Geophysics and Leasing Activity

Exploration along Alaska's North Slope (onshore) in the mid-1960s resulted

in the Prudhoe Bay discovery in 1968. Extrapolating these results offshore, early geophysical assessments were made with potential fields' data followed by early 2D seismic. With the advancement of technology, longer offset, higher density 2D data continued to be acquired through the 1970s, 80s and 90s. In the Chukchi Continental Shelf area approximately 160,000 line kilometers of 2D seismic (offsets 6,000m maximum) were acquired between 1988 and 1991 in support of the lease sales and initial drilling activity. These efforts resulted in five exploratory wells (Klondike, Burger, Popcorn, Crackerjack and Diamond), the last of which was drilled in 1991. These early wells validated the presence of an active petroleum system, prospective reservoirs and both oil and natural gas potential, and established initial offshore reserves (Burger was estimated at 5

*The coastline social, environmental and community responsibility are all issues to be dealt with in Arctic exploration.*





General current sedimentary configuration with corresponding major structural elements, with the 2013 Chukchi seismic program and historical well locations.

TCF). Following a hiatus in activity, new longer offset 2D data was acquired in preparation for the 2008 lease round. 3D data was acquired in 2010 following the lease round. Since this time no new data had been acquired until TGS began its Chukchi Sea 2D program in 2013.

Land activity in the Chukchi region has occurred in three activity cycles. During the 1988–1991 period, four lease rounds were held in the Chukchi region which amounted to industry investment of \$512 million on 483 blocks (2.7 million acres), none of which remain active today. Renewed interest followed the USGS assessment update in 2006 resulting in the OCS sale in 2008. The 2008 sale generated \$2.7 bn and a new round of exploration activity. Following this lease round, certain oppositions to oil field activity resulted in a suspension of future lease rounds until agencies could produce a longer term plan for the region. This plan for the OCS region resulted in a five-year plan covering the 2012–2107 period. To enable time for more scientific studies the next lease round for the Chukchi is planned for 2016.

### Structure and Petroleum Systems

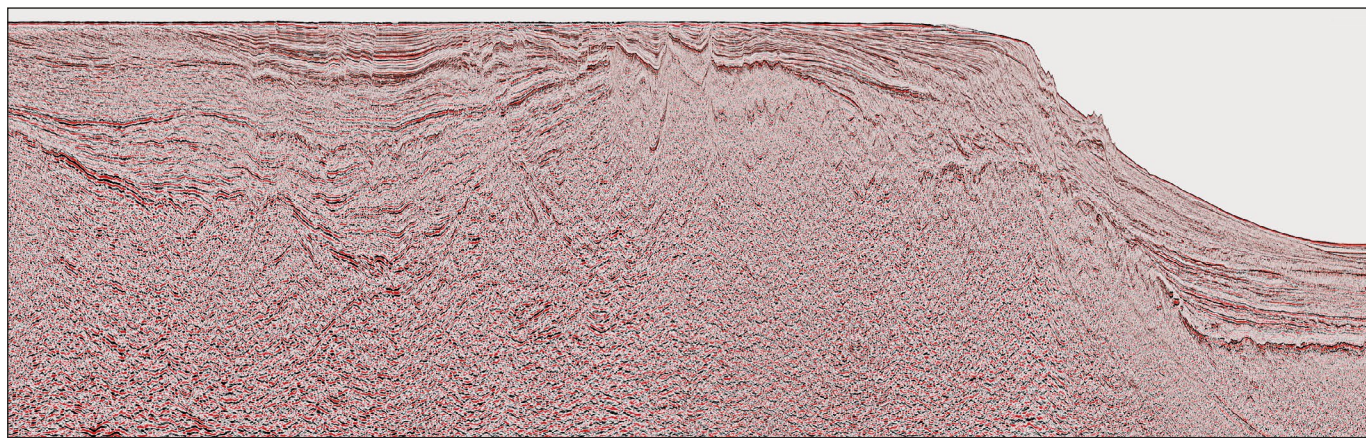
As part of the Arctic Alaskan Basin, the Chukchi Sea region is generally considered a Mesozoic rift style basin consistent with its Arctic analogs: Russian Chukchi, Barents Sea, Greenland, and Beaufort. As identified on the map, the Chukchi is comprised of a number of structural terrains that define the basin/sub basin configurations. As new data is acquired and interpreted, these boundaries and our understanding of the tectonic events and implications to petroleum systems continues to grow. For the purpose of this article we have broken the basin into two regions: the Chukchi Shelf (area covered by current OCS leases bounded to the west by the Herald Thrust Zone and to the east by the Barrow Arch) and the North Chukchi Basin.

With only five offshore wells, understanding of the Chukchi stratigraphy has been constructed through extension of the highly petroliferous systems of the North Slope region with proven source and reservoir rock. The major stratigraphic sequences of the Chukchi are defined by four major unconformities; these sequences are the

Franklinian (pre-Devonian), Ellesmerian (Triassic to Carboniferous), Beaufortian (Late Cretaceous/Jurassic) and Brookian (Cenozoic/Early – Mid Cretaceous). Work done in the late 1990s on Wrangel Island and onshore Alaska (Brooks Range) provides a key outcrop reference to these sequences and aids in our understanding today of the potential for hydrocarbon accumulations. Linking to the key structural events, these intervals may also be categorized as pre-rift sediments (Franklinian and Ellesmerian), rift sediments (Beaufortian) and post-rift sediments (Brookian).

The Franklinian (pre-rift) sequence is characterized from observations in the Brooks Range and Wrangel Island (outcrops) and a number of penetrations on the Alaskan North Slope. In the Chukchi, it is believed to consist of primarily carbonate, sand and shale sequences with areas potentially influenced by mafic intrusives and as yet poorly understood erosional boundaries. Considered a potential source and reservoir rock, true thickness and exploration potential remain to be determined.





Brute stack of 2013 Chukchi seismic – significant hydrocarbon potential can be identified in a complex structural setting, with a thick untested sedimentary section.

The Ellesmerian is the most prolific and understood sequence in the region. Production at Prudhoe Bay (and other fields of the North Slope) is attributable to this sequence, and it is the primary target for the current inventory of offshore wells. Production is generally from the carbonate facies of the Lisburn Group while secondary conventional production is from the interbedded sand/shale sequences in the Triassic interval. It should be noted that considerable unconventional potential exists in the marine shales over this interval, although offshore activity is currently focused on conventional production.

The Beaufortian sequence makes up the major infill from rifting and is largely comprised of marine and terrestrial sand and shale sequences. Understanding of spatial distribution of sands remains in its infancy with the limited offshore control. Many of the existing offshore wells did not encounter or encountered limited reservoir rock. Additional data should provide new information and ongoing prospectivity for this zone.

Brookian rocks make up the dominant section of the proven petroleum systems of the North Slope and Chukchi. Primarily thick marine and terrestrial shale and sand sequences, these sediments are considered excellent reservoir rocks with both structural and stratigraphic implications.

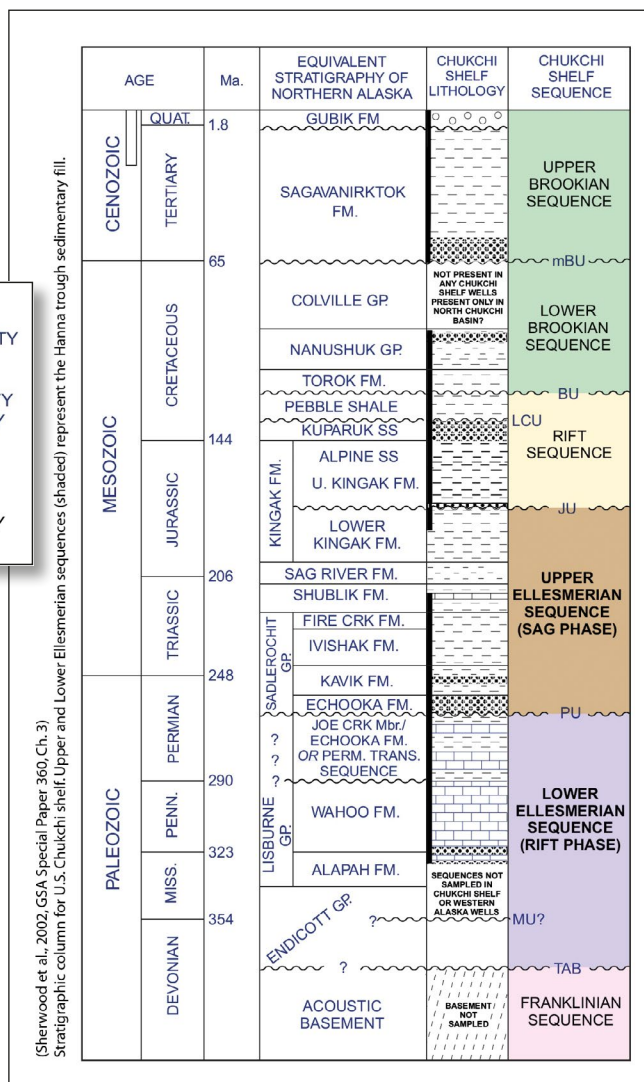
Trapping in the Chukchi is considered combined structural and stratigraphic. As with most early exploration, targets have been focused on large regional structures with four-way or fault-bounded closures. New work to identify AVO class anomalies or estimation of reservoir properties will enhance these interpretations. With new data, additional insight into stratigraphic boundaries may provide advance opportunities for early explorers.

### Exploration Risk Reduction

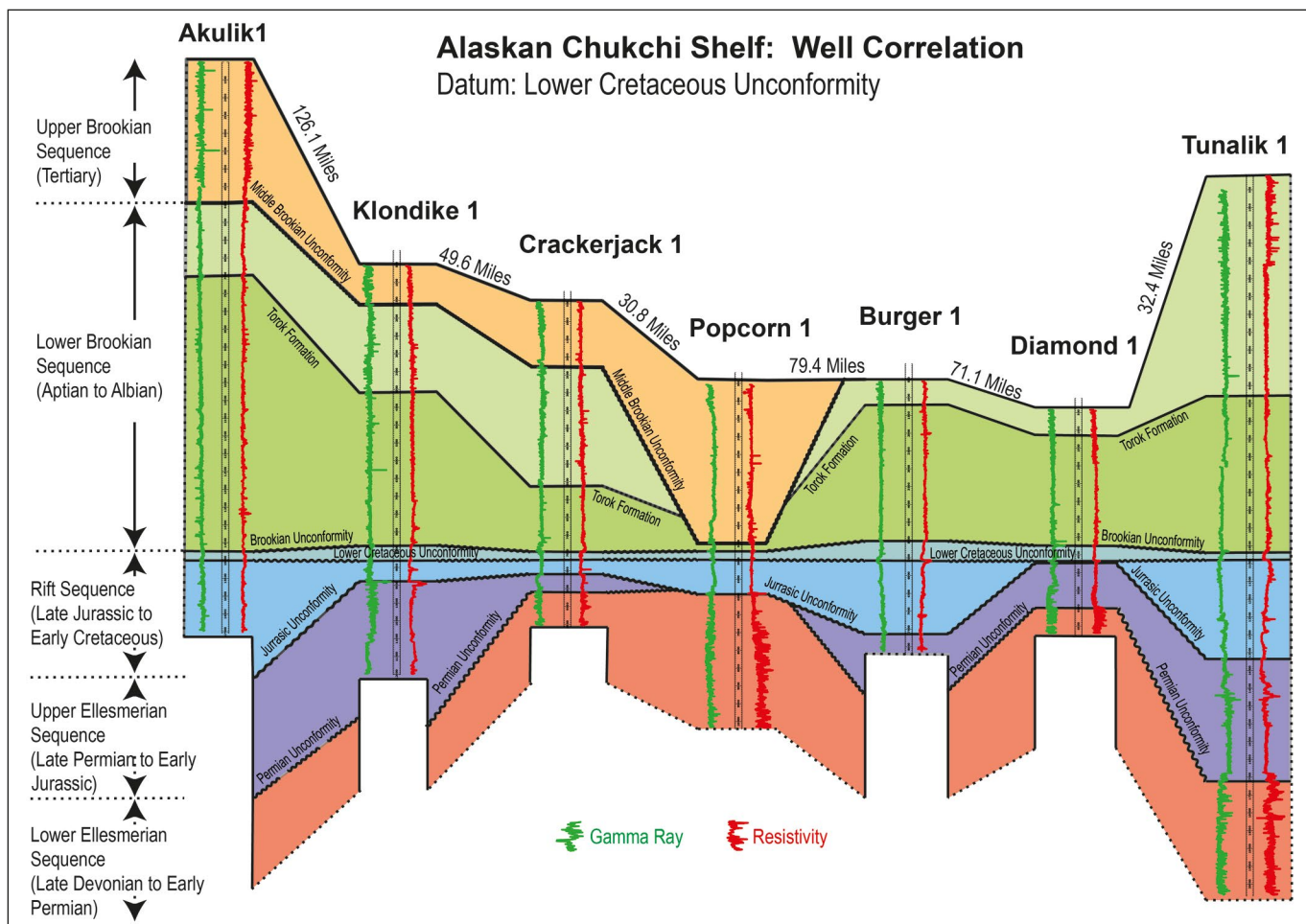
The objective of TGS's 2013/2014 seismic programs is to acquire new high resolution long offset 2D to image both the current OCS blocks in the Chukchi Continental Shelf region and extend our understanding further offshore into new exploration in the North Chukchi Basin.

The 2013 program was acquired during the open water season (July–October), and was conducted in water depths ranging from 100 to 3,500m. Early observations from the 2013 seismic program are provided in the seismic line shown on page 31 (example of data from the Chukchi Shelf). The new information, although preliminary, confirms existing

US Chukchi Shelf stratigraphic column







Representative section of LAS+ well curves extending from onshore to the offshore Chukchi wells. It provides a regional view of the general facies boundaries and the level of structural and stratigraphic. (Cross-section created using TGS data with reference to Sherwood.)

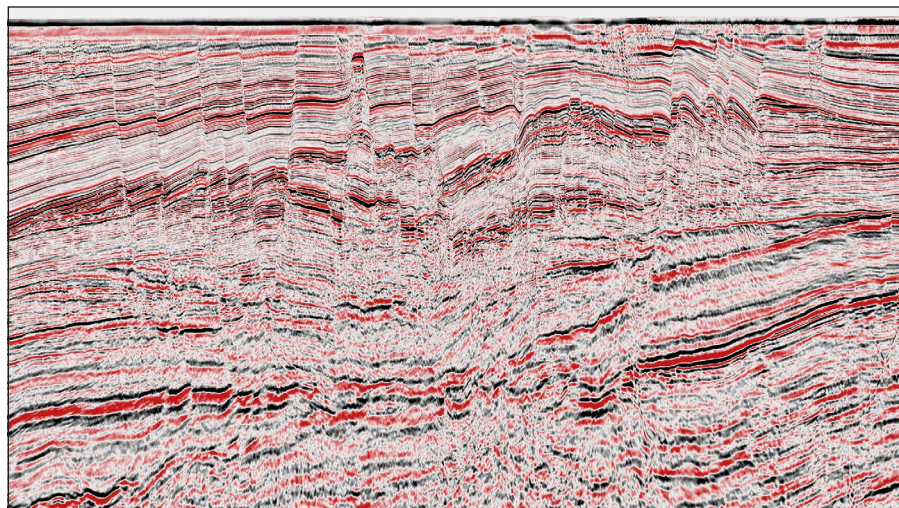
known structural elements and suggests the rift basin fairway may stretch beyond traditional thinking, while syn-rift/pre-rift sediments appear thicker and reach burial depths far in excess of those encountered on the shelf. The quality of the new data also enables advanced structural and

stratigraphic imaging as can be observed in the line below. This level of detail provides new insight to understanding the prospectivity of the region.

Social responsibility remains a cornerstone of exploration activity and requires ongoing commitment to address

and mitigate social, environmental and community impacts to enable the responsible co-existence of all activities. TGS has and will continue to engage local communities and agencies to address the requirements of all stakeholders and ensure sustainability and co-existence of our activities.

The new data reveals advanced structural and stratigraphic imaging.



### Where Next?

The extension of the Mesozoic rift section throughout the survey area has led to the identification of genuine opportunities on the shelf and in the deepwater offshore Alaska. Further acquisition and renewed drilling activity will continue to expand and define the potential of the region.

Ongoing assessment of geotechnical data will advance understanding of petroleum systems in the Chukchi and the regional basin architecture. This information remains critical to the comprehension and prioritization of areas for future development and advancement of exploration in the circumpolar region. ■