Call for Bids NS25-1P: Acreage above the 'Sable Delta' and its deepwater stratigraphic equivalents

Mark E. Deptuck — mdeptuck@cnsoer.ca
Kristopher L. Kendell — kkendell@cnsoer.ca

Canada-Nova Scotia Offshore Energy Regulator, Dartmouth, Nova Scotia, Canada

Overview

Canada-Nova Scotia Offshore Energy Regulator (CNSOER) Call for Bids NS25-1P includes thirteen nominated parcels on the central Scotian Shelf and Slope. Positioned mainly over the shallow to deepwater parts of the Sable Subbasin, several recent geoscience studies highlight the stratigraphic character (e.g. Deptuck and Kendell 2020, 2022; Beicip-Franlab et al. 2023), salt tectonic development (Deptuck and Kendell 2017), and exploration potential (Beicip-Franlab et al. 2023; Deptuck et al. 2024) of the call region. Drawing mainly from that earlier work, this report provides a brief overview of known hydrocarbon occurrences, their geological setting, and additional exploration potential in the Sable Subbasin and its deepwater stratigraphic equivalents.

Parcel summary

Call for Bids NS25-1P consists of thirteen nominated parcels on the central Scotian Shelf and Slope, in water depths ranging from < 100 to > 4,000 m (Figure 1a). Deepwater Parcels 1 to 8 are located on the Scotian Slope, over the easternmost parts of the Shelburne Subbasin and seaward parts of the Sable Subbasin (Figure 1b). Shallow water (< 200 m) Parcels 9 to 13 are located on the outer Scotian Shelf over the landward parts of the Sable Subbasin, adjacent to several decommissioned and abandoned gas and condensate fields and numerous undeveloped hydrocarbon discoveries (Figure 2b).

Exploration history and hydrocarbon occurrences

Since the late 1960s, oil and gas explorers have collected widespread 2D and 3D multichannel seismic datasets across the central Scotian Shelf and Slope (Figure 2a, 2b). Seventy-two exploration wells were drilled in the call area to test a variety of Mesozoic targets, with twenty-three significant discoveries declared (Figure 3); all but two are in the NS25-1P call area. Eight of these discoveries were developed into three separate commercial projects (Cohasset-Panuke, Sable Offshore Energy Project [SOEP], and Deep Panuke), with production of natural gas, condensate, and oil from both siliciclastic and carbonate reservoirs (Smith et al. 2014; Belghiszadeh et al. 2023) (Figure 3). Numerous other proven gas, condensate, and oil discoveries remain undeveloped on the continental shelf, where modern seismic data has not been acquired in more than two decades. These include the Marmora, Penobscot, and Eagle discoveries, containing in-place resources of 148 Bcf of natural gas, 65 Million barrels of oil, and 1.25 Tcf of natural gas, respectively (Kendell et al. 2013; Smith et al. 2015, 2016, 2018).

Further seaward, sparse drilling on the continental slope to date has failed to identify commercial volumes of hydrocarbons. However, gas or condensate encountered in Cretaceous turbidite reservoirs at Newburn H-23 (Parcel 4), Aspy D-11/D-11A (boundary between Parcels 3 and 4; see BP 2019), and Annapolis G-24 (Parcel 7), demonstrate that a working petroleum system exists seaward of the sand-prone Late Jurassic to Cretaceous Sable Delta (Figure 3b) (Kidston et al. 2007; Deptuck 2008; Deptuck and Kendell 2020).

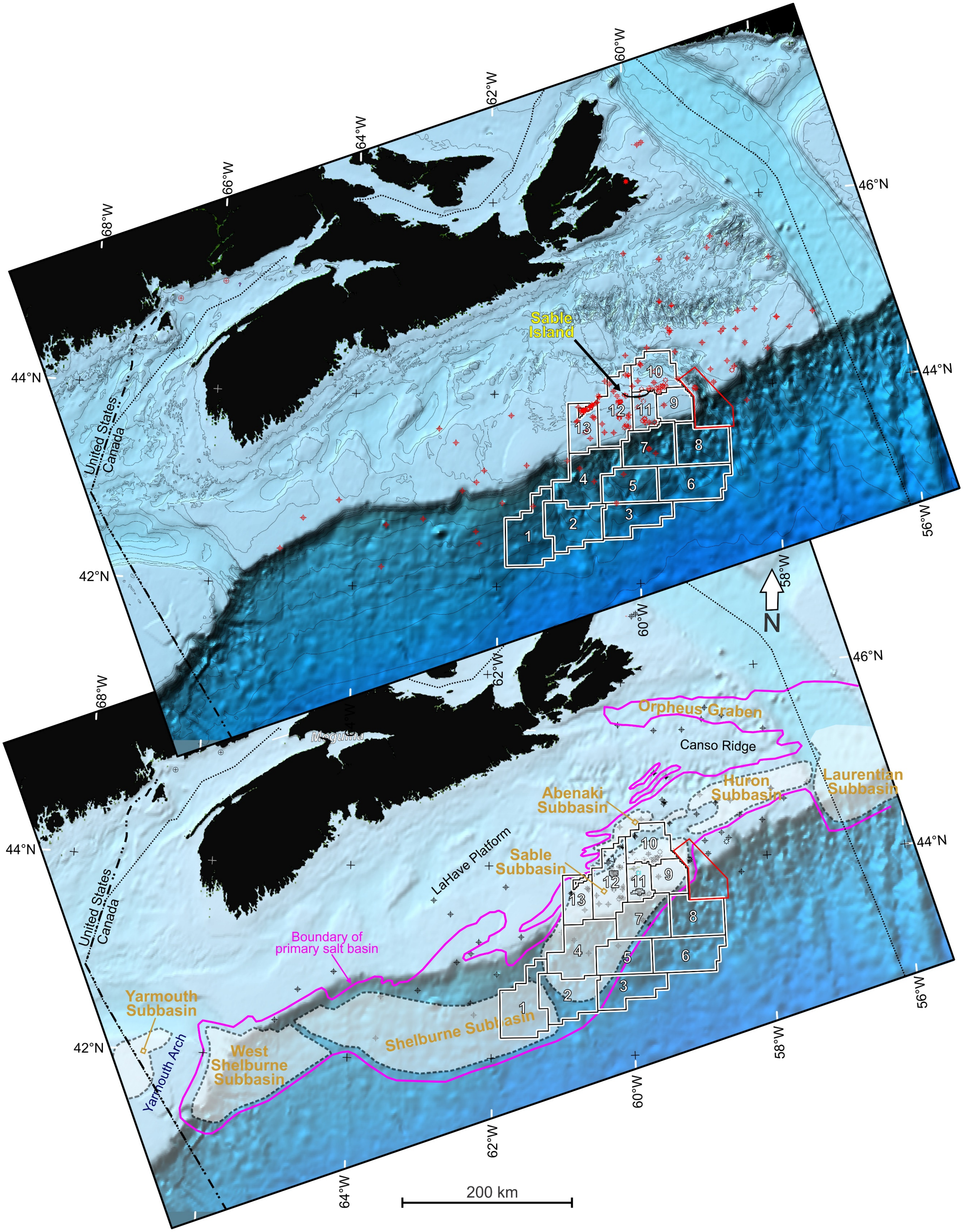


Figure 1. **(a)** Basemap showing NS25-1P parcel locations and well locations (red) on the Scotian Shelf and Slope; **(b)** Parcel locations relative to main subbasins associated with sedimentation above the primary salt basin (outlined in pink).

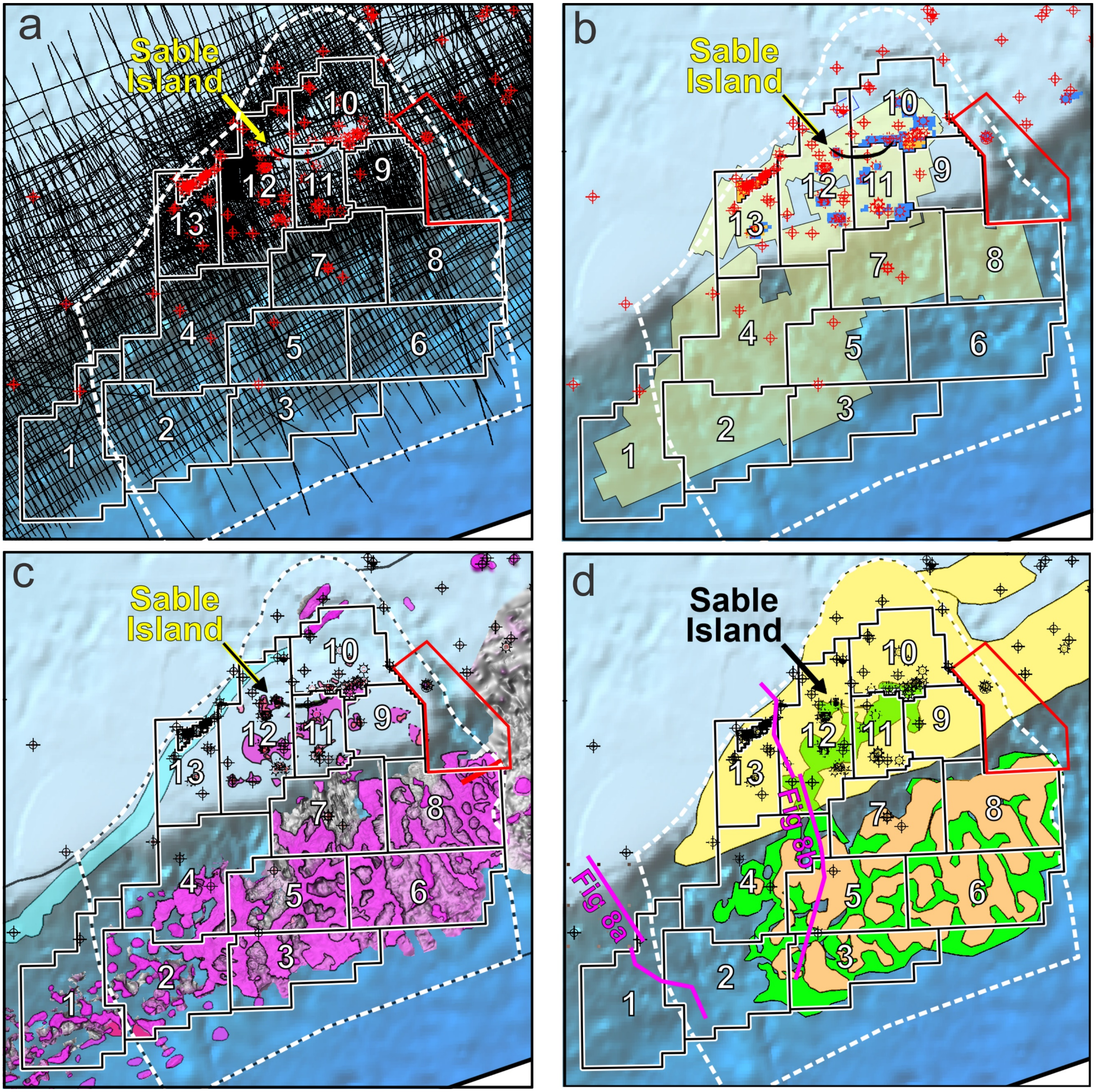


Figure 2. NS25-1P parcel locations relative to **(a)** 2D seismic profiles; **(b)** 3D seismic surveys with the location of remaining Production Licences (orange) and Significant Discovery Licences (blue); **(c)** the distribution of allochthonous salt bodies on the shelf and slope (pink), as well as the carbonate bank edge (light blue); **(d)** examples of play areas in the NS25-1P call area, with Figure 8 line locations shown in pink (*yellow* - listric fault plays; *green* – sub-salt canopy cut-off plays (shelf and slope); *orange* – supra-canopy turtles and folds). Note that the white bold dashed line shows the location of "Region D" of Deptuck et al. (2024). See text for details.

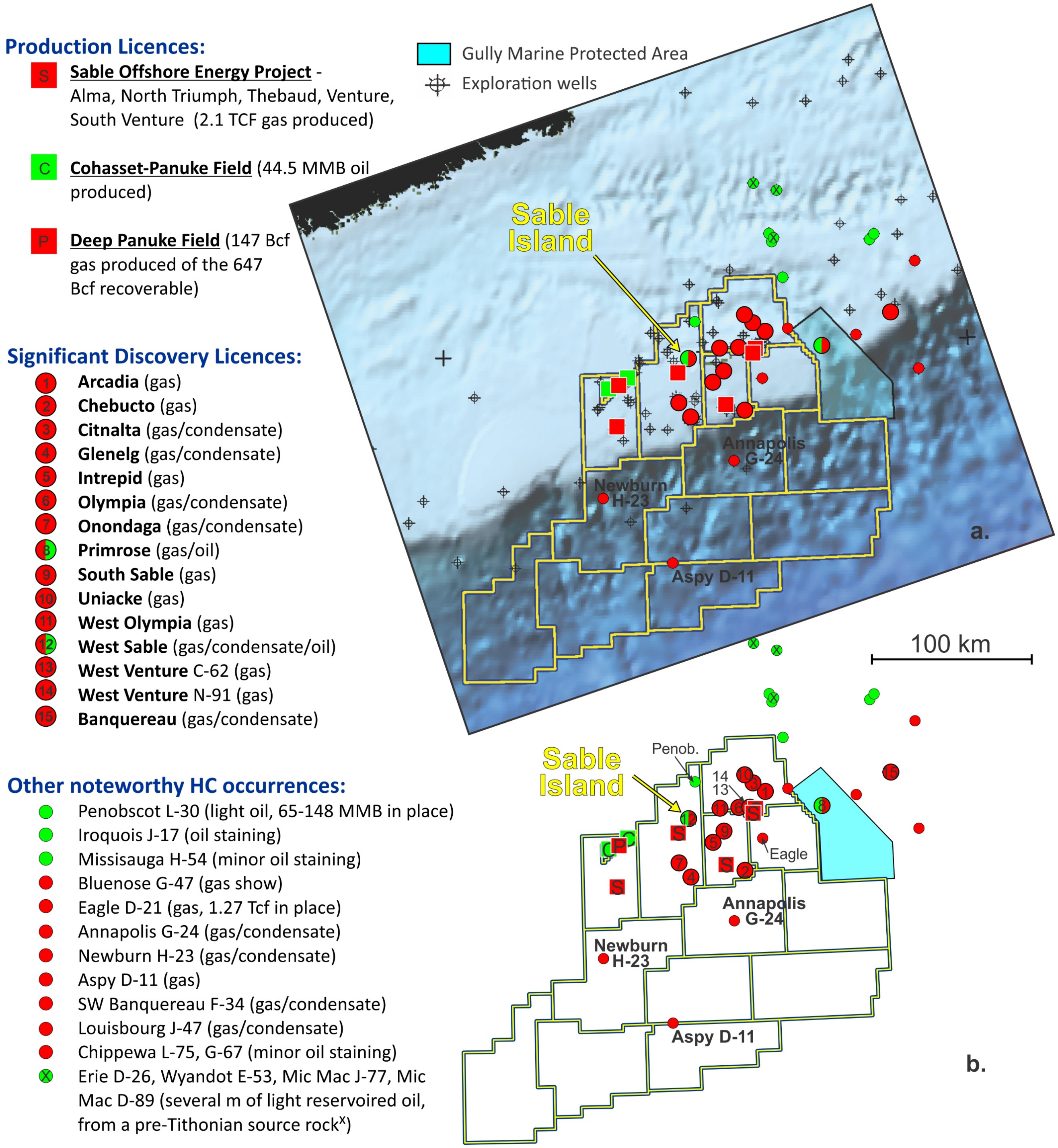


Figure 3. Summary of hydrocarbon occurrences near the NS25-1P Call for Bids area (red – natural gas; green – oil).

Exploration potential

Figure 4 schematically illustrates the diverse range of potential hydrocarbon traps on the shelf and slope in the call area. Most hydrocarbon traps formed in response to salt-related deformation as voluminous sediment was supplied by rivers to the Sable Subbasin in the Late Jurassic and Cretaceous. Accumulation of fluvial, deltaic, and deepwater sediments above Argo Formation evaporites took place sequentially as the Sable Delta prograded and simultaneously migrated westward (Wade and MacLean 1990; Cummings and Arnott 2005; Cummings et al. 2006; Deptuck and Kendell 2020). The successive migration of Jurassic through Paleogene depocenters is shown in the sediment thickness maps in Figure 5, closely tracking changes in the timing, style, and location of salt-related deformation (see Shimeld 2004; Deptuck and Kendell 2017, 2020; Deptuck et al. 2024).

Shelf –

In Parcels 9 to 13 on the shelf, high sedimentation rates lead to thin-skinned extension and the development of listric growth faults (Figure 4). Successive northeast-trending bands of listric faults developed as the Late Jurassic to Cretaceous Sable Delta and associated coarser-grained siliciclastics prograded south and west, intermittently interrupted during periods of higher sea level that allowed thicker shale or carbonate successions to accumulate above the shelf. Traps are dominantly *rollover anticlines* with mainly gas- and condensate-bearing fluvial-deltaic reservoirs (Smith et al. 2014; Steele et al. 2011).

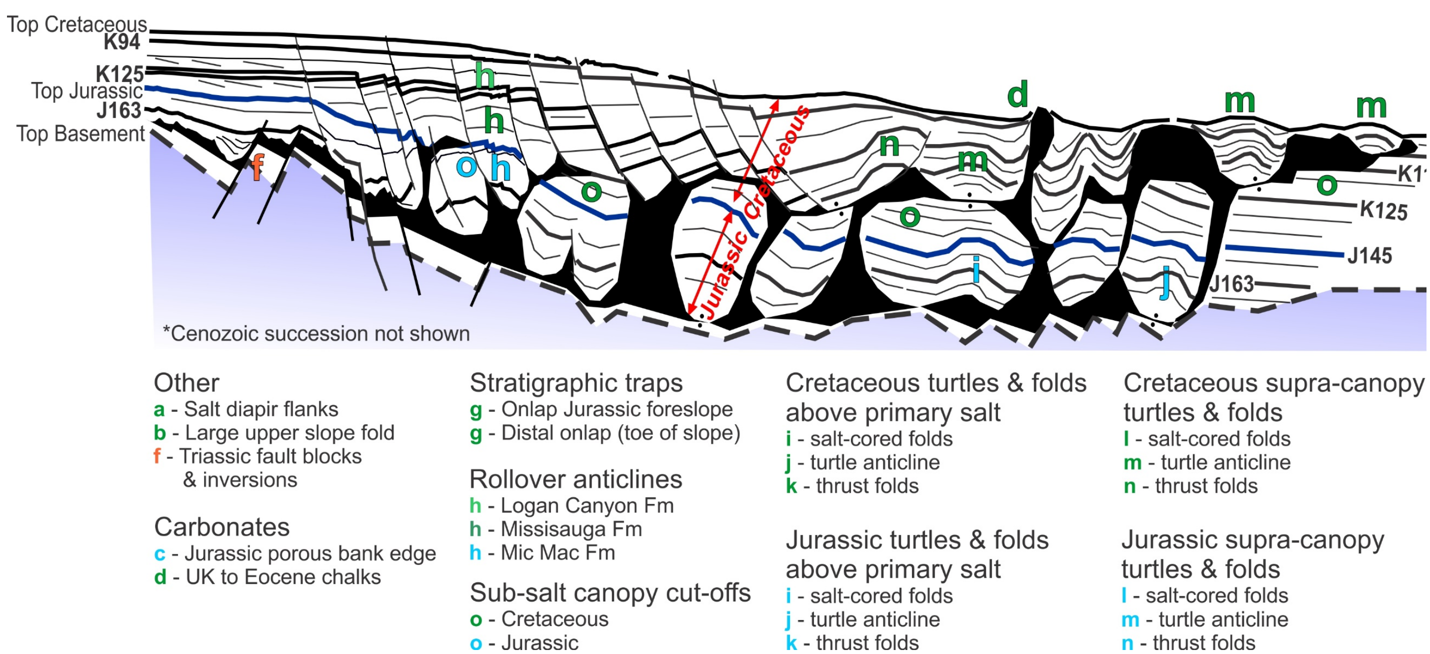


Figure 4. Schematic dip section across the continental shelf and slope showing play types and examples of the range of potential traps in the NS25-1P Call for Bids area. Green – Cretaceous traps; Blue – Jurassic traps; Orange – Triassic traps

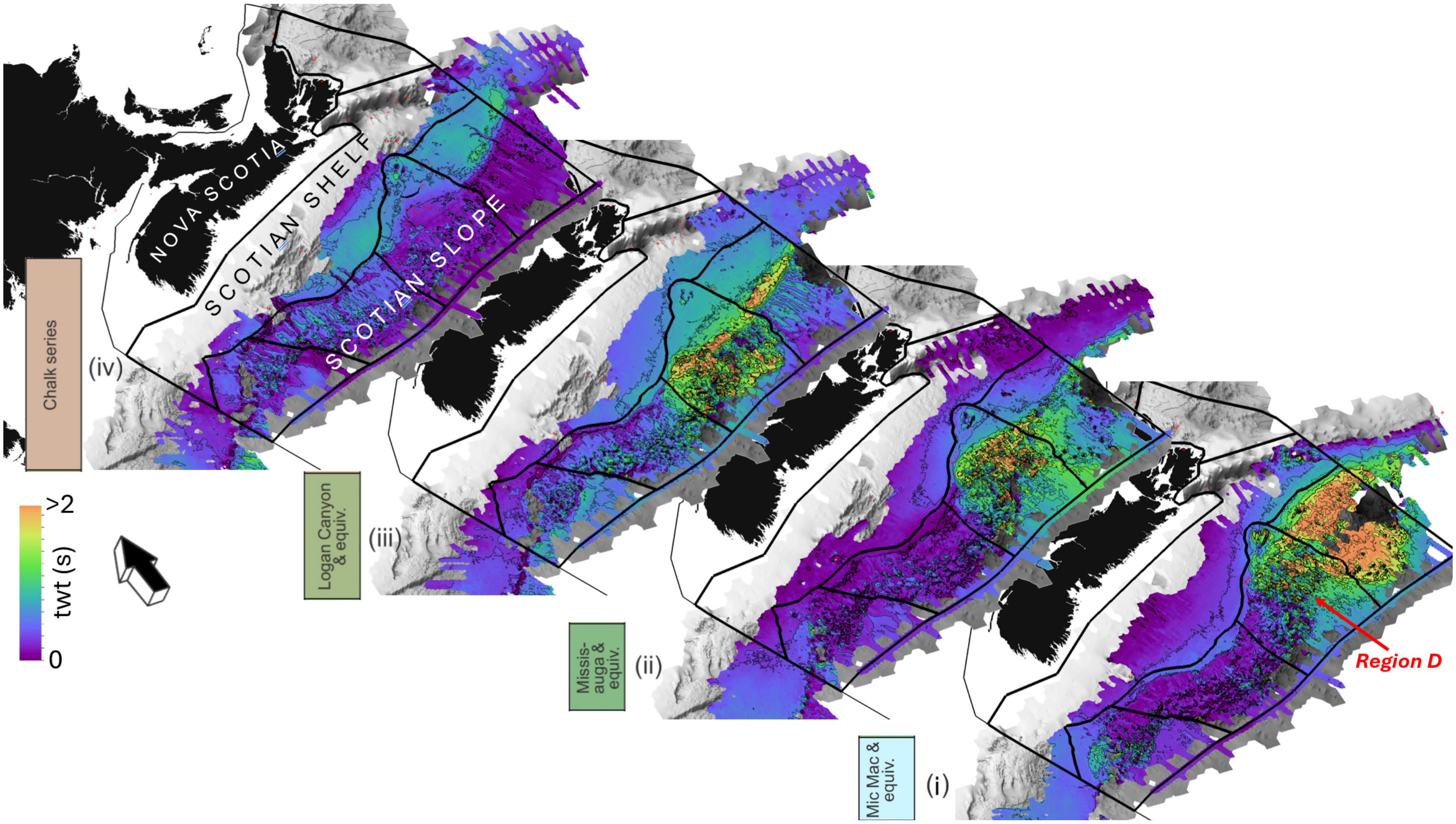


Figure 5. (i) to (iii) Successive time-thickness maps showing the westward and seaward migration of the thickest parts of the Mic Mac/Abenaki, Missisauga, Logan Canyon formations and their lateral equivalents. (iv) Thickness map of the Petrel to Eocene succession comprises the *chalk series*; increased siliciclastic composition contributes to its thickest parts on the shelf, where shelf-perched deltas interfinger with chalks between the K94 and T40 markers. Note that the vertical length of the rectangular stratigraphic label on each map scales according to the amount of time each unit represents, with the chalk series representing a prolonged period of condensed sedimentation, in contrast to the much higher sedimentation rates in (i) and (ii). The bold black lines delimit the distinct geographic regions defined by Deptuck et al. (2024). Region D most closely coincides with the NS25-1P call area.

A recent margin-wide petroleum resource assessment (Deptuck et al., 2024) examined two rollover plays in the call area: a deeper play involving the upper part of the Mic Mac Formation and the Missisauga Formation, and a shallower play involving the younger Logan Canyon Formation (Wade and MacLean 1990) (Figure 2d; Table 1). The results of this study suggest that significant exploration potential remains in the Sable Subbasin (see also Steele et al. 2011), with a mean potential resource of ~8.5 Tcf of *risked* and *recoverable* gas in rollover anticline plays (in addition to the roughly 4.1 Tcf of gas already recovered or recoverable from proven discoveries).

Both fault-seal dependent three-way traps and four-way dip closures are possible in Parcels 9 to 13, with the former being effective only where there is sufficient shale in the succession (Smith et al. 2014). The Aptian Naskapi Member (shale) of the Logan Canyon Formation is the primary seal, with secondary seals corresponding to Albian to Cenomanian Sable Member (of the Logan Canyon Formation), the Turonian to Santonian shale of the

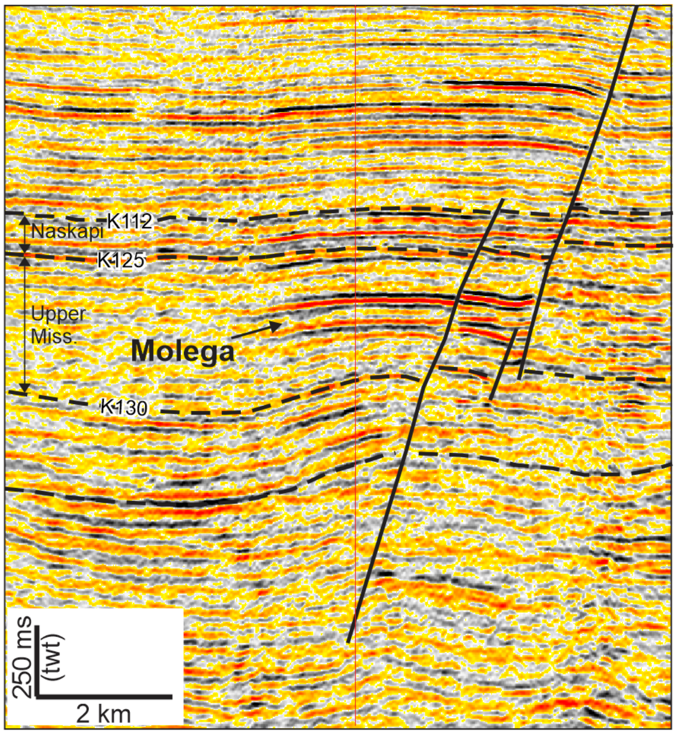


Figure 6. Seismic line through the Molega structure, an Upper Missisauga rollover anticline with elevated amplitudes (from Kendell et al. 2012)

Dawson Canyon Formation, and numerous thinner intra-formational shales within shelf-margin delta successions. Lack of fault seal associated with very high net-to-gross fluvial-deltaic successions is a primary failure mechanism for these traps on the shelf, with seal risk increasing in the landward direction where the Naskapi Member thins (Smith et al. 2014).

Parcels 9 to 13 include several undrilled leads identified on vintage 2D and 3D seismic data-sets. These include 'Molega' (Figure 6), 'Dolphin', 'Propeller', and 'South Marmora' (described in Smith et al. 2018), as well as 'Poplar', 'North Eagle', 'West Australia', 'Hemlock', and 'Larch' (described in Smith et al. 2016). Several additional leads were identified by Steele et al. (2011). Like most known hydrocarbon occurrences on the shelf, all of these leads correspond to structural traps associated with rollover anticlines, with the primary reservoirs corresponding to fluvial-deltaic to shoreface sandstones associated with the Sable Delta.

Like the Cohasset-Panuke oil field, there is also potential for trapped hydrocarbons in subtle forced folds that developed through differential compaction above basement highs or the well-indurated Jurassic carbonate bank edge. Likewise, there is untested potential for subsalt traps beneath early amalgamated salt sheets on the shelf (e.g. areas of Parcel 9, 11, and 12, see Figure 7). These untested traps are commonly > 800 m deeper than most existing well penetrations on the Scotian Shelf. As such, strata in this shelf play are likely to be overpressured, and both reservoir quality and lateral trap integrity are key geological risk factors.

In addition to Late Jurassic and Cretaceous siliciclastic reservoirs, younger Upper Cretaceous to Paleogene chalk reservoirs are also possible in the call area (e.g. Wyandot Formation or 'Acadia Chalk';

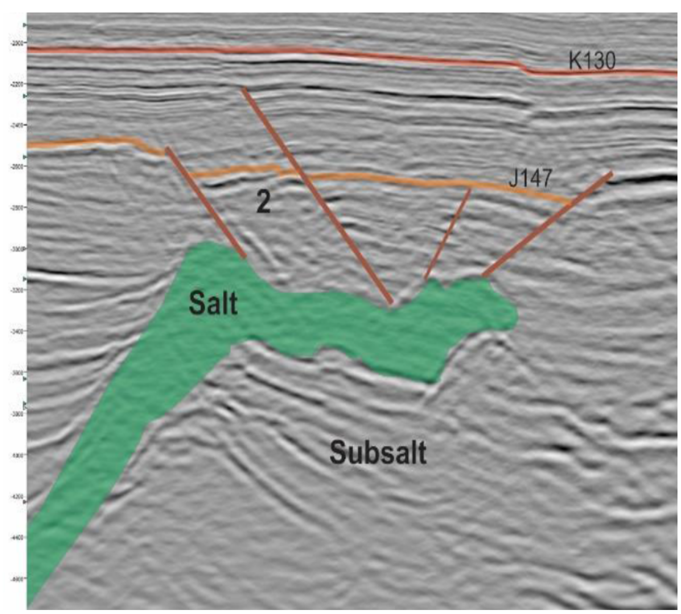


Figure 7. Seismic profile across the Propeller Lead (above salt tongue), illustrating additional potential in the deeper succession beneath the salt (profile from Smith et al. 2018).

see Weston et al. 2012). For example, the undeveloped ~1.25 Tcf Eagle discovery in Parcel 9 is a shallow fault-related fold with the main reservoir corresponding to porous pelagic chalks with 52 m of pay (in the Wyandot Formation), sealed above by Paleogene shale (Smith et al. 2016). Likewise, 50 m of net gas pay was found in Wyandot chalks folded above a salt diapir in the Primrose Significant Discovery just east of Parcel 9 (in the Gully Marine Protected Area; Smith et al. 2014) (Figure 3). Horizontal drilling and well stimulation like fracking may be required to successfully produce gas from these low-permeability reservoirs (Smith et al. 2016). Improvements in reservoir permeability, however, may exist in areas more favourable for the accumulation of resedimented chalk (e.g. in areas down-slope from mass failures or regions affected by intense bottom-current reworking).

Slope –

On the slope, Parcels 1 to 8 cover a region of complex structural deformation driven by progradation of the Sable Delta that delivered sediment to the slope (Wade and MacLean 1990; Cummings and Arnott 2006; Piper et al. 2010). Wide variations in the shape, size, distribution, and timing of expelled salt bodies reflect the more complex salt-sediment interactions in deepwater compared to the shelf. Parcels 1 and 2 mainly contain vertically rising salt stocks or walls with minor salt overhangs that formed around the perimeter of minibasins that loaded the primary salt layer (e.g. Figure 8a). Similar Jurassic to Lower Cretaceous minibasins – up to several kilometer thick – developed above the primary salt layer in Parcels 3 through 8. Structures above the primary salt layer include minibasins with up-turned flanks, turtle anticlines (Mauduit et al. 1997), early expulsion rollovers, and salt-detachment folds developed in response to shortening (see Hudec and Jackson 2011 for salt tectonic definitions; see Deptuck et al. 2009; Deptuck and Kendell 2012 for Scotian Slope examples).

Table 1. Summary of fully risked in-place and recoverable gas and oil (Mean) for each of the 12 play types defined by Deptuck et al. 2024 in Area D (Abenaki-Sable Corridor). Region D roughly coincides with the NS25-1P Call for Bids area. Note that this study assumes a gas-prone type II/III source rock, which directly influences the proportion of gas versus oil.

	Gas		Oil	
	Fully Risked GIP (Bcf) Mean	***Fully Risked Recov. (Bcf) Mean***	***Fully Risked OIP (MMBbls) Mean***	***Fully Risked Recov. (MMBbls) Mean***
D. Abenaki-Sable Corridor				
a. Pre-salt Triassic syntectonic rotated fault blocks & inversions	13	10	4	1
b. Upper Mic Mac to Missisauga listric rollovers & folds	10,669	8,004	802	281
c. Logan Canyon listric rollovers & folds	3,743	2,805	385	135
d. Jurassic porous carbonate bank edge (e.g. like Deep Panuke)	958	258	333	117
e. Upper Jurassic to Cretaceous stratigraphic onlap traps	66	49	0	0
f1. Upper Jurassic subsalt canopy cut-off (shelf)	89	53	0	0
f2. Cretaceous subsalt canopy cut-off (slope)	5,031	3,763	0	0
g. Jurassic slope turtles & folds (above primary salt)	1,024	615	0	0
h. Cretaceous slope turtles & folds (above primary salt)	7,093	5,331	0	0
i. Cretaceous supra-canopy turtles & folds	6,587	4,936	0	0
j. Cretaceous three-way traps on diapirs flanks	364	273	0	0
k. Chalk Play - closures at T50	3,269	879	0	0

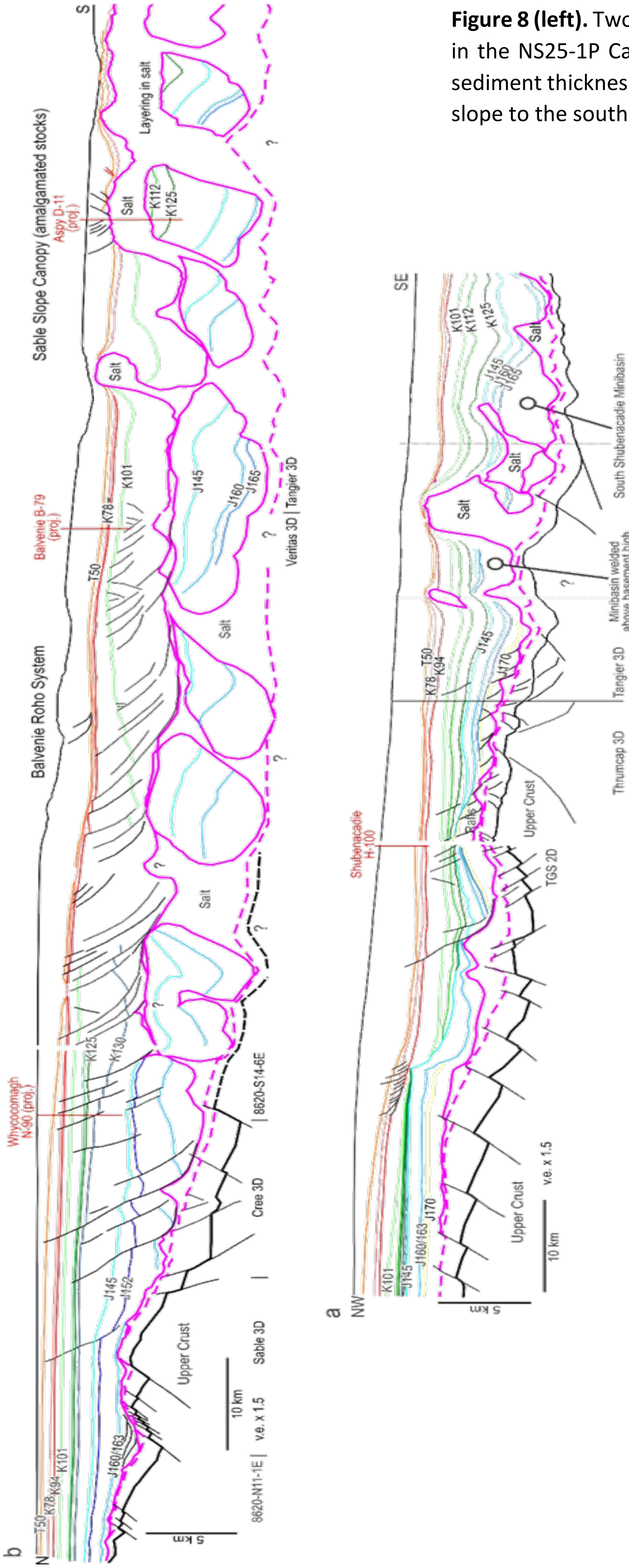


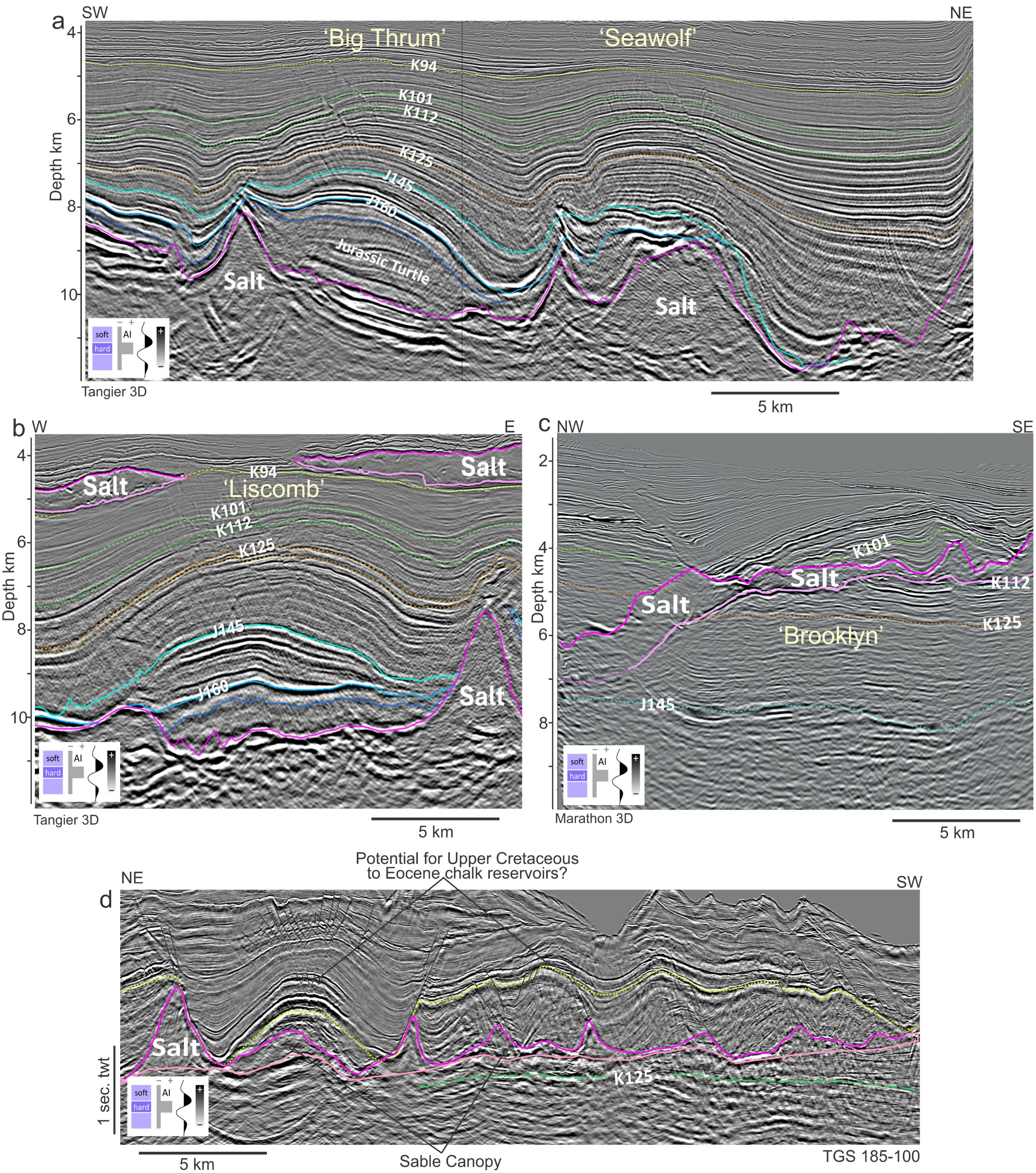
Figure 8 (left). Two composite seismic depth sections across the continental shelf and slope in the NS25-1P Call for Bids area, showing the wide variations in salt tectonic style and sediment thickness across the Sable Subbasin **(b)** and the more sediment-starved shelf and slope to the southwest **(a)**. Adapted from Deptuck and Kendell (2022).

Figure 9 (next page). Seismic examples across the **(a)** 'Big Thrum' and 'Seawolf' leads above the *primary* salt layer; **(b)** 'Liscomb' lead above the *primary* salt layer; **(c)** 'Brooklyn' lead below canopy salt; **(d)** turtles or half-turtles above the eastern parts of the Sable Slope Canopy. See Deptuck et al. (2024) for line locations and details.

Salt expulsion in Parcels 3 to 8 was extensive, with seaward-leaning salt feeders (stocks) supplying large allochthonous salt bodies. These salt bodies were emplaced within younger stratigraphic intervals and range from salt tongues to amalgamated salt-stock canopies to salt nappes (Hudec and Jackson 2007; Deptuck and Kendell 2017; 2020).

Most of the resulting allochthonous salt bodies were later reactivated during Cretaceous and Cenozoic sedimentation, producing a wide array of salt-related structures *above* allochthonous salt sheets. These include shallower minibasins, turtle structures flanked by younger rim-synclines, half-turtles, and roho systems (e.g. Figures 3c-d, 8b).

Except for Parcel 1 located along the eastern Shelburne Corridor, parcels 2 through 8 are located mainly within the Sable-Abenaki Corridor of Deptuck et al. (2024), who defined eight different slope play types in the call area. These plays can generally be separated into traps located *(i)* above the primary salt layer or adjacent to primary salt feeders, (ii) beneath canopy salt, or (iii) above canopy salt or secondary salt feeders. The total risked mean recoverable hydrocarbon resource potential in the deepwater parts of the Sable Subbasin exceeds 15 Tcf (Region D of Deptuck et al. 2024).


a
SW
NE
'Big Thrum'
'Seawolf'
K94
K101
K112
K125
J145
J160
Jurassic Turtle
Salt
Salt
Depth km
4
6
8
10
soft
hard
AI
Tangier 3D
5 km
b
W
E
Salt
Salt
'Liscomb'
K94
K101
K112
K125
J145
J160
Salt
Depth km
Tangier 3D
5 km
c
NW
SE
K101
Salt
Salt
K112
K125
'Brooklyn'
J145
Depth km
Marathon 3D
5 km
Potential for Upper Cretaceous
to Eocene chalk reservoirs?
d
NE
SW
Salt
K125
1 sec. twt
5 km
Sable Canopy
TGS 185-100

The largest *fully-risked* volumes are associated with:

(a) Cretaceous turtles and folds located above the primary salt layer (with mean recoverable gas exceeding 5.3 Tcf);
(b) Cretaceous supra-canopy turtles and folds (with mean recoverable gas exceeding 4.9 Tcf); and
(c) Cretaceous subsalt canopy cut-off traps (with mean recoverable gas exceeding 3.7 Tcf).

Parcels 1 through 8 include numerous undrilled leads identified in previous work from both 2D and 3D seismic data-sets. Leads identified immediately above the primary salt layer include turtle structures like 'Big Thrumb' and 'Liscomb' (Figure 9a, b), compressional salt-cored or salt-detachment folds like 'Big Tancook' and 'Seawolf' (Figure 9a), as well as potential three-way closures or hybrid structures against salt flanks like 'Crows Nest' and 'Piscatiqui' (see Deptuck 2008; Beicip-Franlab et al. 2023, and Deptuck et al. 2024).

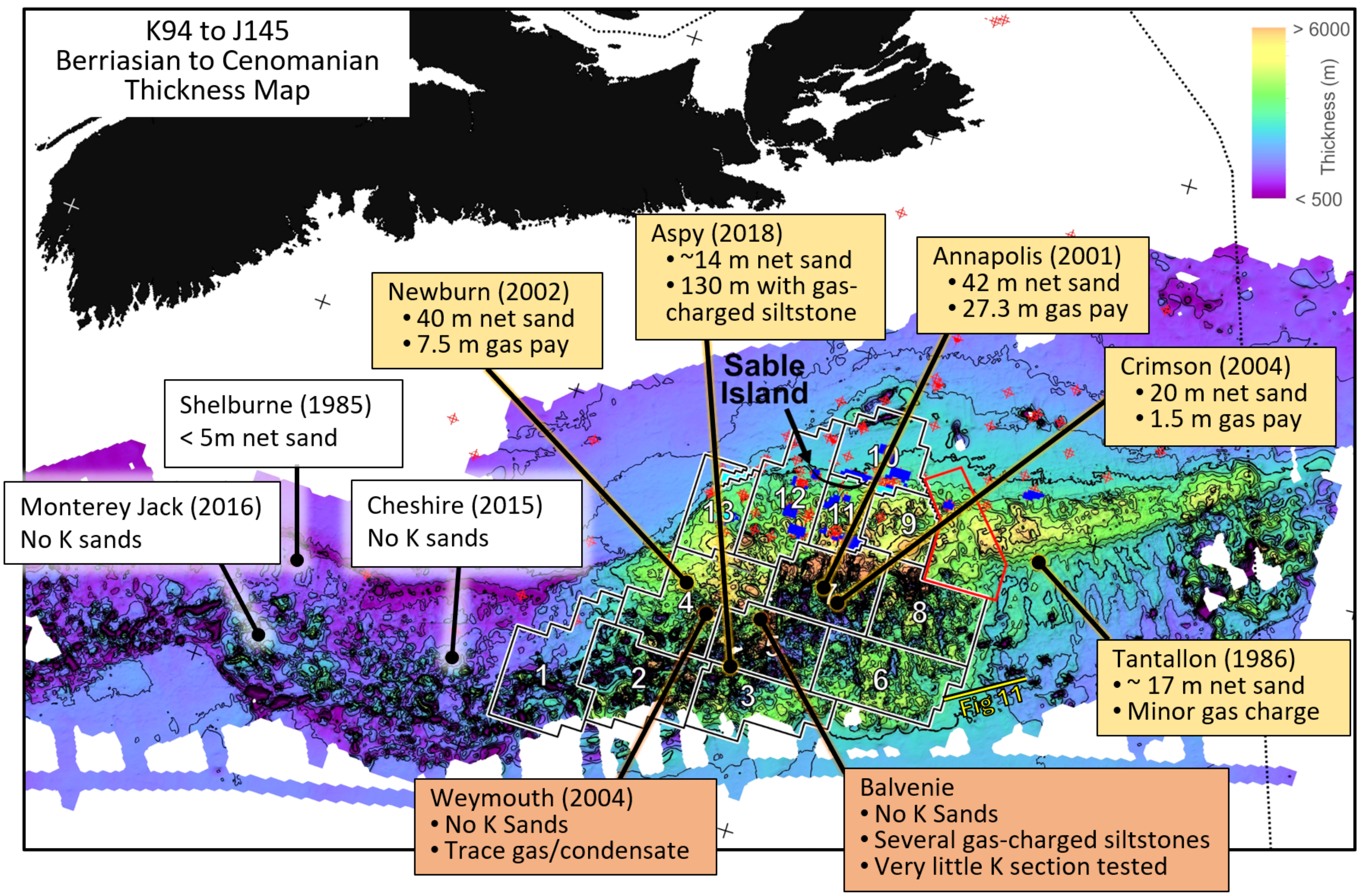


Figure 10. Berriasian to Cenomanian sediment thickness map (K94 and J145 markers) on the Scotian Shelf and Slope, showing net Cretaceous sand and charged Cretaceous reservoirs in key slope wells. Note that the canopy salt thickness was removed from this isopach. Velocity model from Beicip-Franlab et al. (2023) used for the depth conversion.

Sub-canopy cut-off traps like 'Brooklyn' (Figure 9c), located beneath the eastern parts of the Sable Slope Canopy, are characterized by several stacked "hard-over-soft" reflections. These amplitude anomalies are consistent with turbidite reservoirs sealed above by canopy salt. Potential traps above canopy salt include three-way or four-way closures against salt flanks or diapir crests and inverted turtle structures like 'Thorburn' and 'Belleisle' (see Kendell et al. 2016, Beicip-Franlab et al. 2023, and Deptuck et al. 2024).

These potential exploration targets are likely to be gas- or condensate-prone (Fowler 2020), with reservoirs consisting of Cretaceous deepwater turbidite sandstones (turbidite channels and lobes). Deepwater wells like Newburn H-23, Annapolis G-24, Crimson F-81, and Aspy D-11/D-11A encountered turbidite sands with average net pay porosity ranging from 14 to 19% (Kidston et al. 2007; Kendell et al. 2016) (see also Figure 10).

Detailed loop-scale interpretations from 2D seismic profiles seaward of the Sable Slope Canopy (southeast of Parcel 6) show evidence for both channel belts flanked by levees and more laterally extensive acoustically soft reflections interpreted as sheet sands (submarine lobe deposits) (Deptuck and Kendell 2020; Deptuck et al. 2024) (Figure 11). Some of these depositional features continue beneath canopy salt, where poor seismic imaging, due to legacy acquisition shortcomings and salt interference, precludes mapping.

Finally, like the shelf, Upper Cretaceous to Eocene strata on the slope in the call area also contain widespread chalk deposits that could form viable hydrocarbon reservoirs. Upper Cretaceous and early Paleogene chalks are commonly folded above salt diapirs, producing numerous shallower buried closures (Deptuck et al. 2024). Unlike the shelf (e.g. the Eagle gas discovery), there is increased potential for resedimented chalk on the slope, which could have more favourable permeability (Megson and Tygesen 2005). Timing of burial and maximum burial depth (compaction) compared to the timing of hydrocarbon generation are key considerations. Reservoir quality is a key geological risk factor.

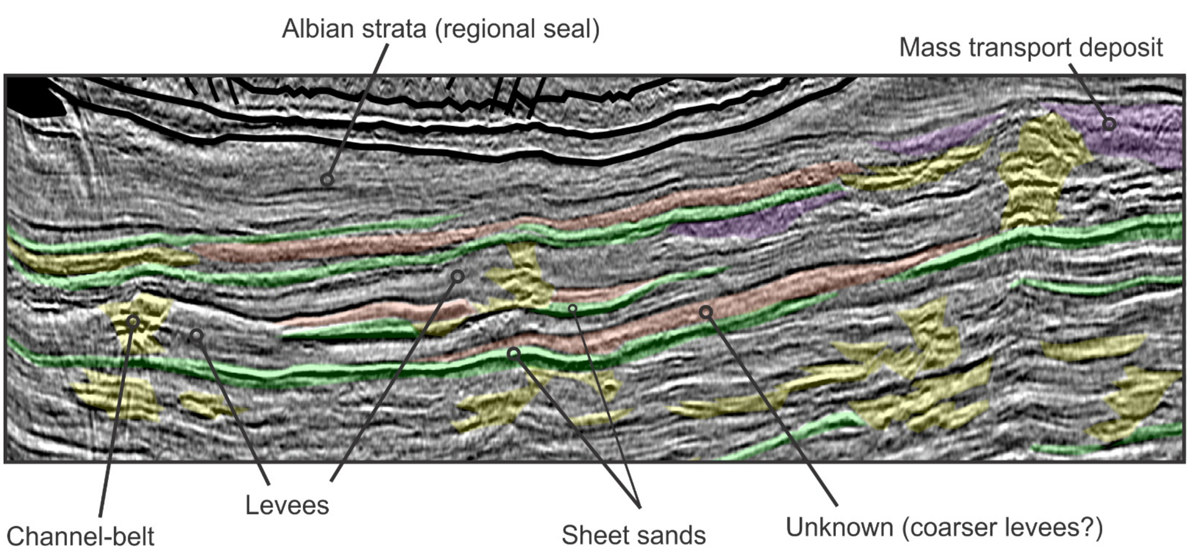


Figure 11. Representative strike-oriented 2D seismic profile located seaward of the Sable Slope Canopy, where the absence of salt overhangs substantially improves seismic imaging. Coloured overlays show the different deepwater seismic facies and interpreted submarine fan architectural elements recognized seaward of the Sable Delta and Sable Salt Canopy, where the absence of overlying salt improves seismic imaging (from Deptuck et al. 2024).

Acknowledgments: We thank Brian Altheim for his invaluable technical help during this project, Carl Makrides and Brent Smith for their pre-retirement contributions, and Matteo Niccoli for helpful review comments.

References:

BP Canada Energy Group ULC (2019) Subsurface Well History Report – Aspy D-11/D-11A. Canada-Nova Scotia Offshore Petroleum Board File No. D406.

Beicip-Franlab et al. (2023) Scotian Basin Integration Atlas: A collaborative study of stratigraphy, architecture, evolution, and geological prospectivity; A technical collaboration with direct and indirect input provided by Canada-Nova Scotia Offshore Petroleum Board (CNSOPB), Leptis E&P, Stratum Reservoir, Weston Stratigraphic, APT (Canada) Ltd, Andrew MacRae, Bill Richards, and others. Atlas submitted to the Offshore Energy Research Association (OERA), and available online here: Scotian Basin Integration Atlas 2023 | Nova Scotia Offshore Energy Research Association (oera.ca)

Belghiszadeh, E. Kendell, K., Makrides, C., Rhyno, S. (2023) Sable Offshore Energy Project – Resource management study, CNSOPB Report, available at Geoscience Publications | CNSOER

Cummings, D.C., and Arnott, R.W.C. (2005) Growth-faulted shelf-margin deltas: a new (but old) play type, offshore Nova Scotia. Bulletin of Canadian Petroleum Geology, 53: 211-236.

Cummings, D.C., Hart, B.S., and Arnott, R.W.C. (2006) Sedimentology and stratigraphy of a thick, areally extensive fluvial-marine transition, Missisauga Formation, offshore Nova Scotia and its correlation with shelf margin and slope strata. Bulletin of Canadian Petroleum Geology, 54: 152-174.

Deptuck, M.E. (2008) NS08-2 Call for Bids - Sub-regional geology and exploration potential for Parcels 1 and 2, Central Scotian Slope. 40 p. Geoscience Publications | CNSOER

Deptuck, M.E. and Kendell, K. (2012) Contrasting salt tectonic styles on the western versus central parts of the Scotian Margin, offshore Nova Scotia, CNSOPB Geoscience Open File Poster 2012-001PF, 2 panels Geoscience Publications | CNSOER

Deptuck, M.E. and Kendell, K.L. (2017) Chapter 13 – A Review of Mesozoic-Cenozoic Salt Tectonics Along the Scotian Margin, Eastern Canada. In: Soto, J.I., Flinch, J.F., Tari, G. (Eds.), Permo-Triassic Salt Provinces of Europe, North Africa and the Atlantic Margins. Elsevier, p 287–312.

Deptuck, M.E. and Kendell, K.L. (2020) Atlas of 3D seismic surfaces and thickness maps, central and southwestern Scotian Slope. CNSOPB Geoscience Open File Report 2020-002MF – 2020-006MF, 59 panels Geoscience Publications | CNSOER

Deptuck, M.E. and Kendell, K.L. (2022) Geology of the central Scotian Shelf and Slope - Call for Bids NS22-1. CNSOPB Geoscience Open File Report 2022-001MF, 24 p. Geoscience Publications | CNSOER

Deptuck, M.E., Kendell, K., and Smith, B. (2009) Complex deepwater fold-belts in the SW Sable Subbasin, offshore Nova Scotia. Extended Abstract, Canadian Society of Petroleum Geologists Annual Convention, Calgary, 4 p. Geoscience Publications | CNSOER

Deptuck, M.E., Kendell, K.L., Makrides, C., and Altheim, B. (2024) Quantitative petroleum resource assessment in the Canada-Nova Scotia Offshore Area (Scotian Shelf, Scotian Slope, and Sydney Basin), CNSOPB Geoscience Open File Report 2024-001MF, 111 p. Geoscience Publications | CNSOER

Fowler, M. (2020) Review of geochemical evidence for multiple source rocks on the Scotian Shelf, OERA Report pp 254 (downloaded from OERA.ca in September 2021)

Hudec, M.R. and Jackson, M.P.A. (2007) Terra infirma: Understanding salt tectonics. Earth-Science Reviews, 82, p. 1-28.

Hudec, M.R. and Jackson, M.P.A. (2011) The salt mine: a digital atlas of salt tectonics: The University of Texas at Austin, Bureau of Economic Geology, Udden Book Series No. 5; AAPG Memoir 99, 305 p.

Kendell, K.L. (2012) Variations in salt expulsion style within the Sable Canopy Complex, central Scotian margin. Can. J. Earth Sci. 49(12), 1504–1522. https://doi.org/10.1139/e2012-069

Kendell, K. and Deptuck, M.E. (2012) Lower Cretaceous shelf-edge trajectories, shelf-indenting canyons and the potential transfer of coarser clastics into deeper water, Sable Subbasin, offshore Nova Scotia, CNSOPB Geoscience Open File Poster 2012-002PF, 2 panels Geoscience Publications | CNSOER

Kendell, K.L., Smith, B.M. and Brown, D.E. (2013) Geological context and parcel prospectivity for Call for Bids NS13-1;

seismic Interpretation, source rocks and maturation, exploration history and potential play types of the central and eastern Scotian Shelf. Call for Bids NS13-1 Summary Document, 64 p. Geoscience Publications | CNSOER

Kendell, K., Deptuck, M., Smith, B. and Brown, D. (2016) Call for Bids NS16-1 - Exploration history, geological setting and exploration potential of the central Scotian Slope. Geoscience Open File Report 2016-002MF, Canada-Nova Scotia Offshore Petroleum Board, 42 p. Geoscience Publications | CNSOER

Kidston, A.G., Smith, B.M., Brown, D.E., Makrides, C., Altheim, B. (2007) Nova Scotia deepwater post-drill analysis 1982-2004. Halifax, Nova Scotia, Canada, Canada-Nova Scotia Offshore Petroleum Board, 182 p. Geoscience Publications | CNSOER

Mauduit, T. Gaullier, v., and Brun, J.P. (1997) On the asymmetry of turtle-back growth anticlines. Marine and Petroleum Geology, 14, p. 763-771

Megson, J. and Tygesen, T. (2005) The North Sea Chalk: an underexplored and underdeveloped play. In: DORE ´, A.G. and VINING, B. A. (eds) Petroleum Geology: North-West Europe and Global Perspectives—Proceedings of the 6th Petroleum Geology Conference, 159–168. Petroleum Geology Conferences Ltd. Published by the Geological Society, London.

Piper, D.J.W., Noftall, R. and Pe-Piper, G. (2010) Allochthonous prodeltaic sediment facies in the lower Cretaceous at the Tantallon M-41 well: Implications for the deep-water Scotian Basin, AAPG Bulletin, v. 94, p. 87-104

Shimeld, J. (2004) A comparison of salt tectonic subprovinces beneath the Scotian Slope and Laurentian Fan, 24th Annual GCS-SEPM Foundation Bob F. Perkins Research Conference, Houston, p. 291-306

Smith, B., Makrides, C., Altheim B. and Kendell K.L. (2014). Resource Assessment of Undeveloped Significant Discoveries on the Scotian Shelf. Canada-Nova Scotia Offshore Petroleum Board, 182p. Geoscience Publications | CNSOER

Smith, B.M., Makrides, C. and Kendell, K. (2015). Call for Bids NS15-1 – Exploration history, geologic setting, and exploration potential: Eastern Region. Geoscience Open File Report 2015-002MF, Canada-Nova Scotia Offshore Petroleum Board, 32p. Geoscience Publications | CNSOER

Smith, B.M., Kendell K., Makrides, C., Brown, D.E. (2016). Call for Bids NS16-1 – Exploration history, geologic setting, and exploration potential: Sable Subbasin Region. Geoscience Open File Report, 2016-001MF. Canada -Nova Scotia Offshore Petroleum Board, 19p. Geoscience Publications | CNSOER

Smith, B.M., Kendell K., Makrides, C., Brown, D.E. (2018) Call for Bids NS18-3 – Seismic Interpretation, well summaries, source rock, and exploration leads in the Central Scotian Shelf, Sable Subbasin. CNSOPB Geoscience Open File Report 2018-002MF, 27 p. Geoscience Publications | CNSOER

Steele, D.R., Mulders, J., Crisp, M., (2011) Sable Sub-basin Near-field Exploration Prospectivity. OTC Paper 22028, 9 p.

Wade, J.A. and MacLean, B.C. (1990) The geology of the Southeastern Margin of Canada, Chapter 5, In: M.J. Keen and G.L. Williams (Eds), Geology of the Continental Margin of Eastern Canada, Geological Survey of Canada, The Geology of Canada, p. 190-238