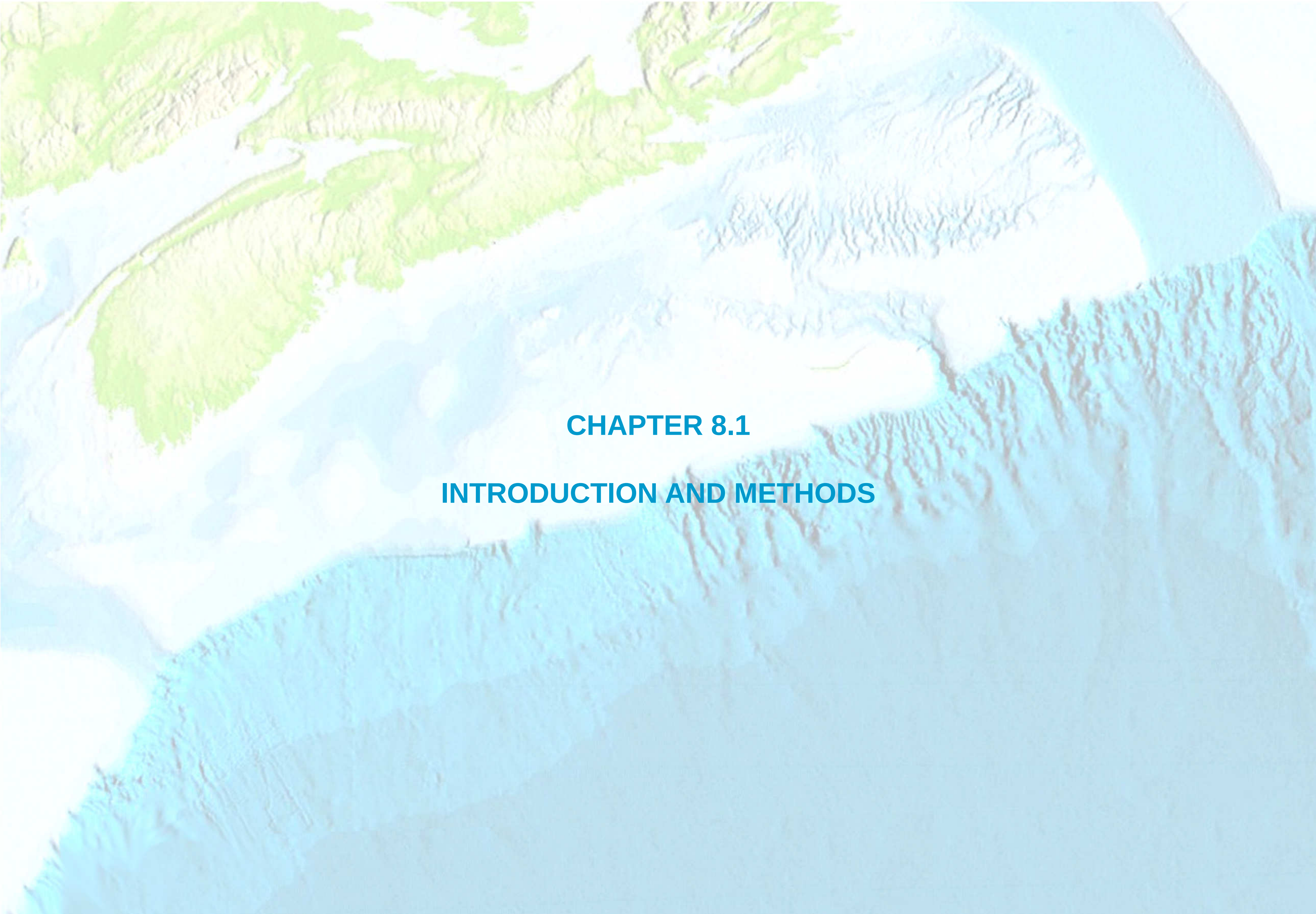
CHAPTER 8

LEAD ASSESSMENT



CHAPTER 8.1

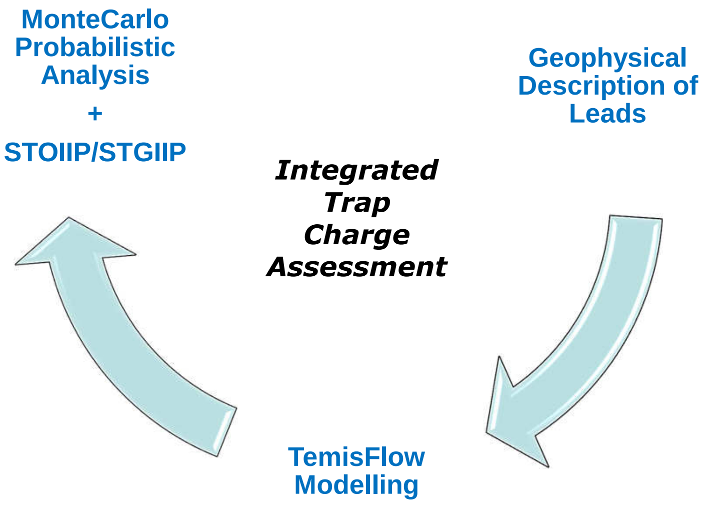
INTRODUCTION AND METHODS

Integrated Trap Charge Assessment

The traditional approach for estimating in place hydrocarbon volumes consists in solving the STOIIP and STGIIP equations. The total volume of rocks inside the lead perimeter, the percentage of that volume that could correspond to reservoir rocks (NTG), the average porosity and hydrocarbon saturation are the main inputs considered in these equations. The main uncertainties of this method are often related to the hydrocarbon charge and composition. There is no simple way to estimate trap charge and hydrocarbon composition without numerical models of expulsion and fluid migration.

For this reason the approach retained for the lead assessment consists in coupling the volumetric approach mentioned above with a numerical model of the petroleum system using TemisFlow™. This integrated method allows first a good approximation to the maximum storage capacity of leads based on seismic interpretation and geological models, and second a good comprehension of the type of hydrocarbons, migration pathways and trapping mechanisms from the TemisFlow results.

The hydrocarbon fractions considered for each lead are extracted from TemisFlow™ allowing the discrimination of gas prone and oil prone accumulations at the different stratigraphic levels. Finally, a number of MonteCarlo probabilistic simulations were generated to take into account uncertainties related to ~~on~~ trapped volumes.



Integrated workflow for trap charge assessment.

The two methodologies for the leads assessment, conventional geophysical methods and the basin modelling approach are described on the following page.

For the basin modelling, migration simulations (calculation of HCs and water movements within the porous media) are performed using Full Darcy capabilities of TemisFlow™ in a 2 km * 2 km grid with a high vertical resolution. The volumetric calculations for the leads results from the redistribution of migrated HC in a 1 km * 1 km grid using the Trap Charge Assessment tool in TemisFlow™. The redistribution is based on topographical analysis (in terms of flow lines and drainage areas – Ray Tracing approach) of the top horizon of the analyzed layer/play (Chapter 7, PL. 7.3.1). A definition of thresholds for hydrocarbon fluids concentration (in terms of masses) is provided, thresholds below which hydrocarbon quantities are discarded from the volumes computation as they are considered as non-pay.

For the geophysical methods, two scenario have been defined, which are detailed on the next page:

- A scenario in which generated hydrocarbons are only Gas and Condensate (Scenario 1)
- A scenario in which generated hydrocarbons are Oil and Gas (Scenario 2)

It is important to note that the geophysical component focuses on what is considered to be the top 11 leads (Figure 1). TemisFlow™ modelling allows for a verification of selected leads and gives volumes of oil and gas for each stratigraphic play within each parcel. It is also important to note that the geophysical approach gives only a partial view of the resource potential, whereas TemisFlow™ results allow assumptions regarding the total trapped volume, as well as the type of hydrocarbon trapped and ratio between the different phases.

A summary of the total volume for the 11 leads is presented in Table 1.

Leads Summary	Gas	Boe Gas	Oil	Boe
	Tcf	*MMbbl*	*MMbbl*	*MMbbl*
Scenario (1) Gas & Condensate	**45**	**7720**	**4334**	**12054**
Scenario (2) Oil & Gas	**52**	**9039**	**2229**	**11267**

Table 1: Summary of the leads Oil and Gas total volume for each scenario.

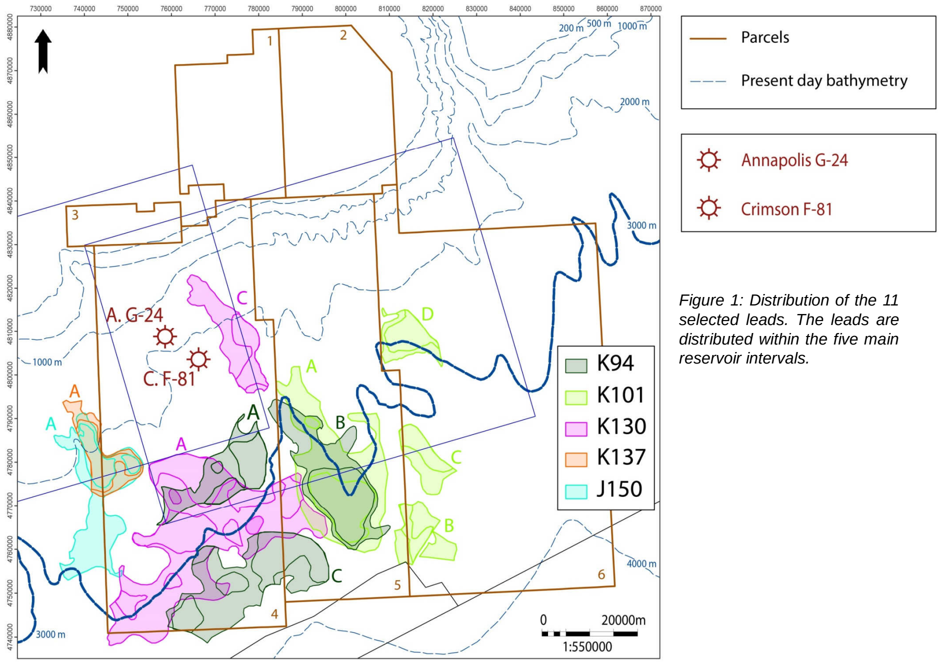
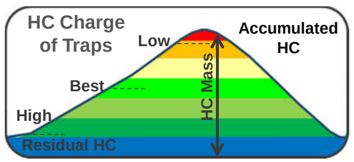
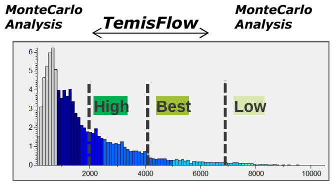


Figure 1: Distribution of the 11 selected leads. The leads are distributed within the five main reservoir intervals.

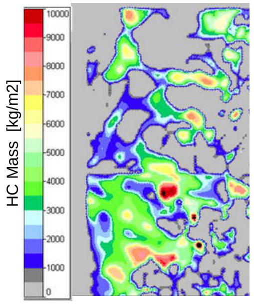
Basin Modelling Methodology for HC Charge Assessment



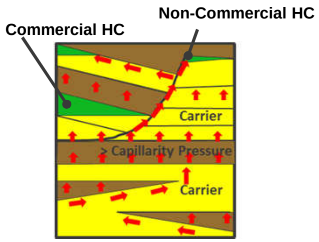


As full Darcy results reproduce the HC migration through porous media HC mass is represented by continuous low to high values. Low values are most frequent but with less probability of having an efficient migration to the trap's top.

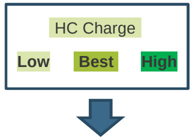
HC mass distribution typically exhibits an exponential decrease in frequency with concentration.



Typical Darcy Flow Modelling Result



The low to high concentration of HC mass includes the spectrum of all the possible HC accumulations in the basin.



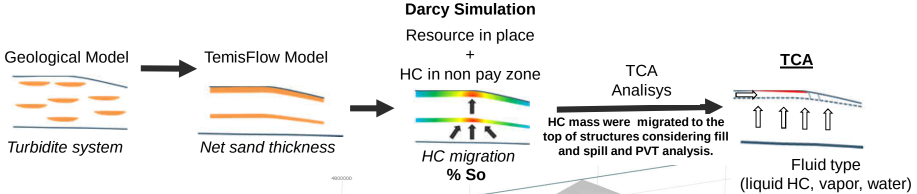
Spectrum of probable HC charge scenarios

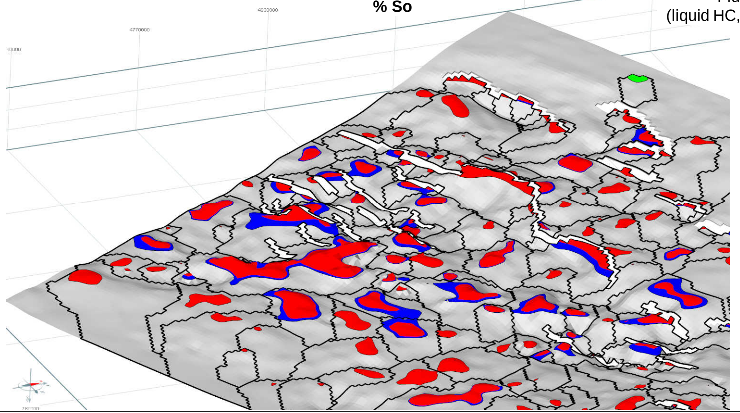
A 3D Darcy migration Temisflow Model was generated as reference for the probable "Best" value of HCs trapped at the different reservoir levels. Results include the hydrocarbon volumes in place as well as:

- A detailed description of the HC composition considering HC cracking through time.
- A tracking analysis of the individual supply of source rocks to reservoir levels.

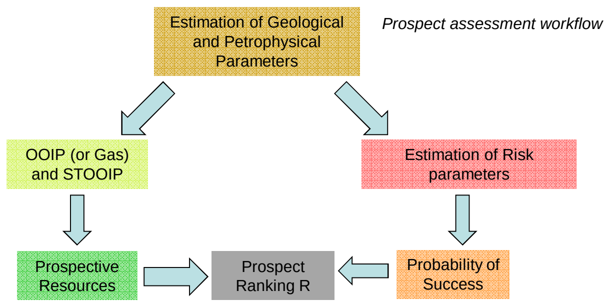
Consequently, raw 3D Darcy migration hydrocarbon quantities trapped within a given layer/play are redistributed using the Trap Charge Assessment tool (TCA) available in TemisFlow. Low and High values were estimated by coupling Temis results with a statistical MonteCarlo analysis.

The HC redistribution is based on a geometric analysis (in terms of flow lines and drainage areas – Ray Tracing approach) of the top horizon of the reservoir layer/play. This allows identification of all the potential traps in the interval including four or three way closure structures. These structures will then be filled by hydrocarbons trapped at drainage areas considering volume and composition calculated by TemisFlow.





Geophysical Methodology for HC Charge Assessment



In order to balance and validate TemisFlow modelling results, a leads assessment was conducted with conventional methods in parallel to the basin modelling stage. Based on the structural maps, 11 large structures within the 5 main reservoir intervals have been identified. They are all located within blocks 4, 5 and 6.

For each lead, two scenarios were simulated: a scenario considering that the lead is filled with gas and associated condensate, and a scenario in which the lead is filled with Oil, Gas and associated condensate. These results are then compared to volumetrics obtained from the TemisFlow modelling results. The convergence of results increases the confidence in the lead prospectivity, whereas values of volume that are different give a range of probability. Volumes estimates are made using the equation and parameters detailed thereafter, however these results do not take into account the recovery factor parameter.

Trap Definition	→	Structural, stratigraphic, mix.	GRV	Range of Uncertainty
Reservoir Volume	→	Extension and thickness.	NTG	Range of Uncertainty
PhiE	→	Sedimentary model, wells.	PhiE	Range of Uncertainty
HC Saturation	→	Petroleum system modelling	So;Sg	Range of Uncertainty
Volumetric Factor	→	Petroleum system modelling	Bo; Bgwet	Range of Uncertainty

$$Gas\ from\ Vapor = \frac{GRVg * NTG * PhiE * Sg}{Bgwet}$$

$$Gas\ from\ liquids = \frac{GRVo * NTG * PhiE * So}{Bo} \times GOR$$

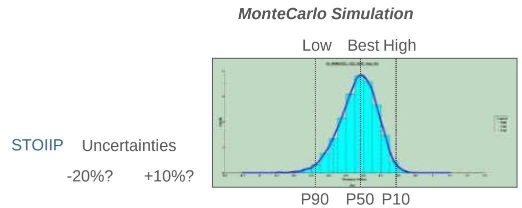
$$Recoverable\ Condensate = \frac{GRVg * NTG * PhiE * Sg}{Bgwet} \times CGR$$

$$Recoverable\ liquid = \frac{GRVo * NTG * PhiE * So}{Bo}$$

Coupled with a probabilistic analysis based on the range of uncertainties of each parameter

Probabilistic methods provide an approach that accounts for the uncertainty in each of the parameters that impact the resources of the individual lead. The resource potential in the success case was calculated using Crystal Ball V2 software employing MonteCarlo simulation. Approximately 5,000 trials were run. Quantitative data were derived from the most likely geological model with a range of uncertainty.

These simulations led to an estimation of the unrisked low estimate (P90), best estimate (P50), high estimate (P10) and mean of the prospective resources.

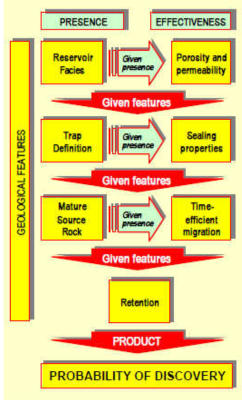


Methodology for Lead Risk Assessment and Risking Volumes

The methodology used for the lead risk assessment is based on the CCOP Guidelines for Risk Assessment of Petroleum Prospects. Four parameters representing the major probability factors of discovery are used:

- ✓ Probability of reservoir
- ✓ Probability of seal
- ✓ Probability of trap
- ✓ Probability of hydrocarbon charge

The probability scale ranges from 0.0 to 1.0 where the end points of the scale: P = 1.0 means 100% certainty and P = 0.0 means 0% certainty.



Schematic overview of the risking procedure (from CCOP Guidelines for Risk Assessment of Petroleum Prospects, 2000)

The major risk identified in the study area is related to the presence/absence of reservoirs, given the uncertainties due to the lack of hard data. Information regarding reservoir effectiveness, saturation and porosity is taken from two CNSOPB reports (Kidson et al., 2002; Kidson et al., 2005) as well as the 2011 PFA study.

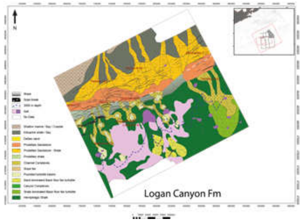
Regarding the probability of seal, overall sealing properties are considered to be acceptable to very good due to:

- the deep water setting of each targeted interval
- the existence of several major MFS such as the Tithonian MFS (J150), the Hauterivian MFS (K130), the Albian/Aptian boundary MFS
- The presence of a well developed salt canopy

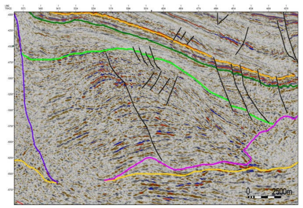
The least risk is attributed to the hydrocarbon charge, based on DHI evidence, discoveries in wells, and most importantly, TemisFlow™ modelling results.

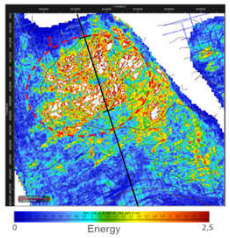
Values and criteria used for the risking are detailed in the tables below.

GDE maps are used for reservoir and seal presence.

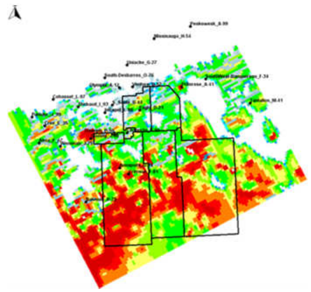


Seismic data are used for identifying traps, closures, reservoirs and seals.





Whenever possible, seismic attributes are used to support hypothesis regarding hydrocarbon charge presence.



Hydrocarbon saturation per play is the primary information used for probability of hydrocarbon charge

Trap: probability of presence of an efficient structural trap

Seismic correlation and mapping \ Data reliability		3D Seismic	2D Seismic: Dense grid size	2D Seismic: Open grid size	2D Seismic: Very open grid
Good corr., nearby wells	Low structural complexity	0.9 - 1.0	0.9 - 1.0	0.8 - 1.0	0.7 - 0.9
	High structural complexity	0.7 - 1.0	0.6 - 0.9	0.5 - 0.8	0.4 - 0.7
	Low relief, uncertain depth conversion	0.6 - 0.9	0.5 - 0.8	0.4 - 0.7	0.3 - 0.6
Uncertain corr, distant wells	Low structural complexity	0.9 - 1.0	0.8 - 1.0	0.7 - 0.9	0.5 - 0.8
	High structural complexity	0.7 - 0.9	0.6 - 0.9	0.4 - 0.8	0.3 - 0.7
	Low relief, uncertain depth conversion	0.5 - 0.8	0.4 - 0.7	0.3 - 0.6	0.2 - 0.5
Unreliable corr. Analogue Model	Low structural complexity	0.9 - 1.0	0.7 - 1.0	0.6 - 0.8	0.4 - 0.7
	High structural complexity	0.4 - 0.7	0.3 - 0.6	0.2 - 0.5	0.1 - 0.4
	Low relief, uncertain depth conversion	0.3 - 0.7	0.2 - 0.6	0.1 - 0.5	0.1 - 0.4

Reservoir: probability of presence of an effective reservoir facies

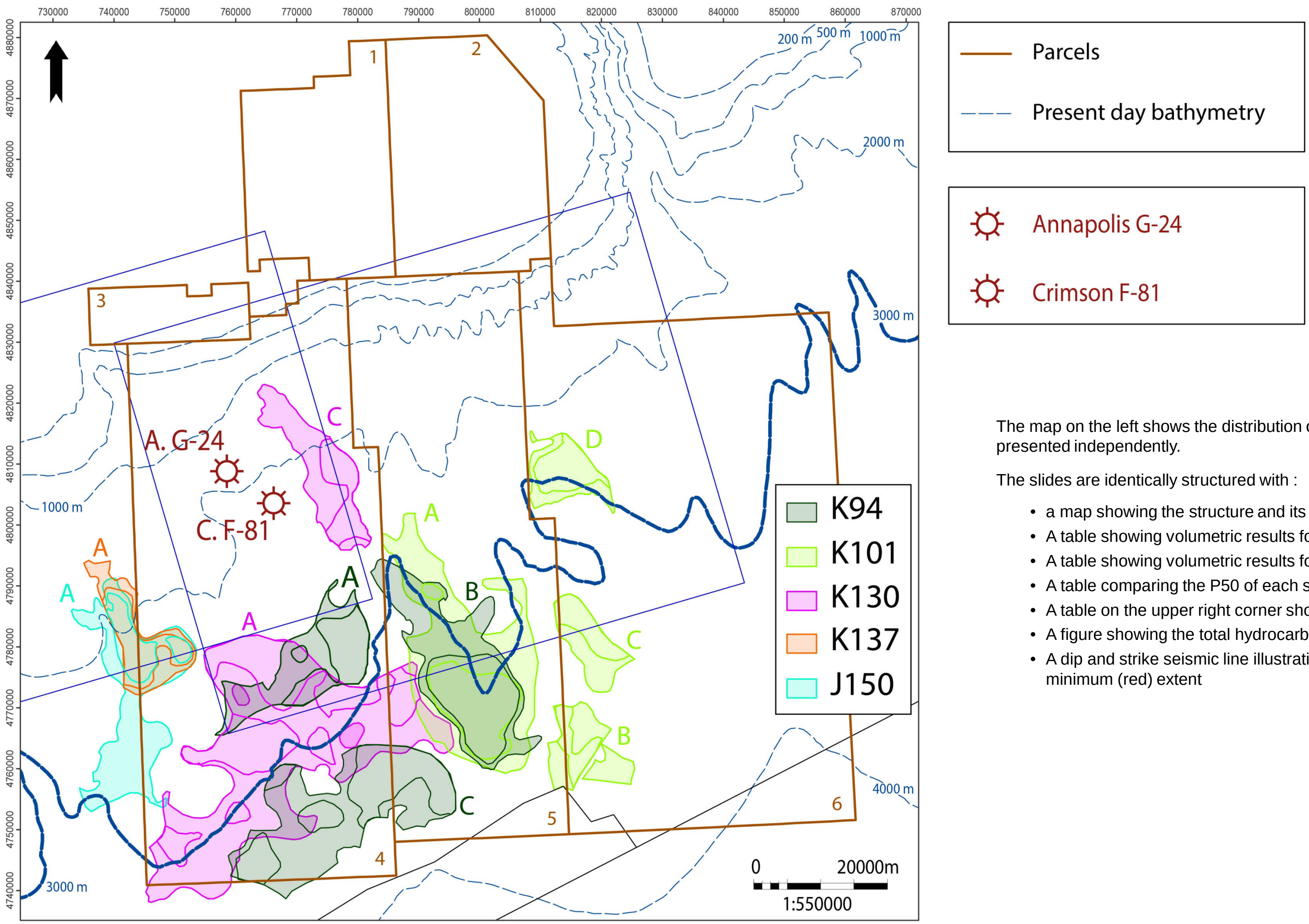
Depositional environment \ Data reliability		Direct data, proximal deposits	Direct data, more distal deposits	Limited data, discontinuous deposits	Indirect data, seismic sequence analysis
Marine	Shallow marine, "blanket"	0.9 - 1.0	0.7 - 0.8	0.6 - 0.7	0.4 - 0.6
	Coastal, deltaic, tidal	0.8 - 1.0	0.7 - 0.8	0.6 - 0.7	0.4 - 0.6
	Submarine fan	0.7 - 0.8	0.5 - 0.6	0.3 - 0.5	0.1 - 0.3
	Carbonates	0.8 - 1.0	0.6 - 0.8	0.5 - 0.7	0.3 - 0.5

Seal: probability of presence of an effective seal mechanism

Seal mechanism \ Seal quality	Top surface	Bottom side	Structural style	Very good	Good	Acceptable	Poor
Simple seal	Conform	N/A	Anticline, buried highs, build-ups, faulted str.	0.9 - 1.0	0.8 - 1.0	0.6 - 0.8	0.4 - 0.6
	Uncon-form	N/A	Faulted structures	0.8 - 0.9	0.7 - 0.8	0.5 - 0.7	0.3 - 0.5
Combined seal	Conform	Uncon-form	Onlap, lowstand wedge	0.5 – 0.7	0.4 – 0.5	0.3 - 0.4	0.1 - 0.3
	Conform	Faults	Downfaulted structures	0.6 - 0.8	0.5 – 0.6	0.3 - 0.5	0.1 - 0.3
	Conform	Facies shift	"shale out"	0.6 - 0.8	0.5 – 0.7	0.4 - 0.6	0.1 - 0.3
	Uncon-form	Conform	Subcrop structures	0.4 – 0.5	0.3 – 0.5	0.2 - 0.4	0.1 - 0.3

CHAPTER 8.2

LEADS ASSESSMENT: Geophysical Methods

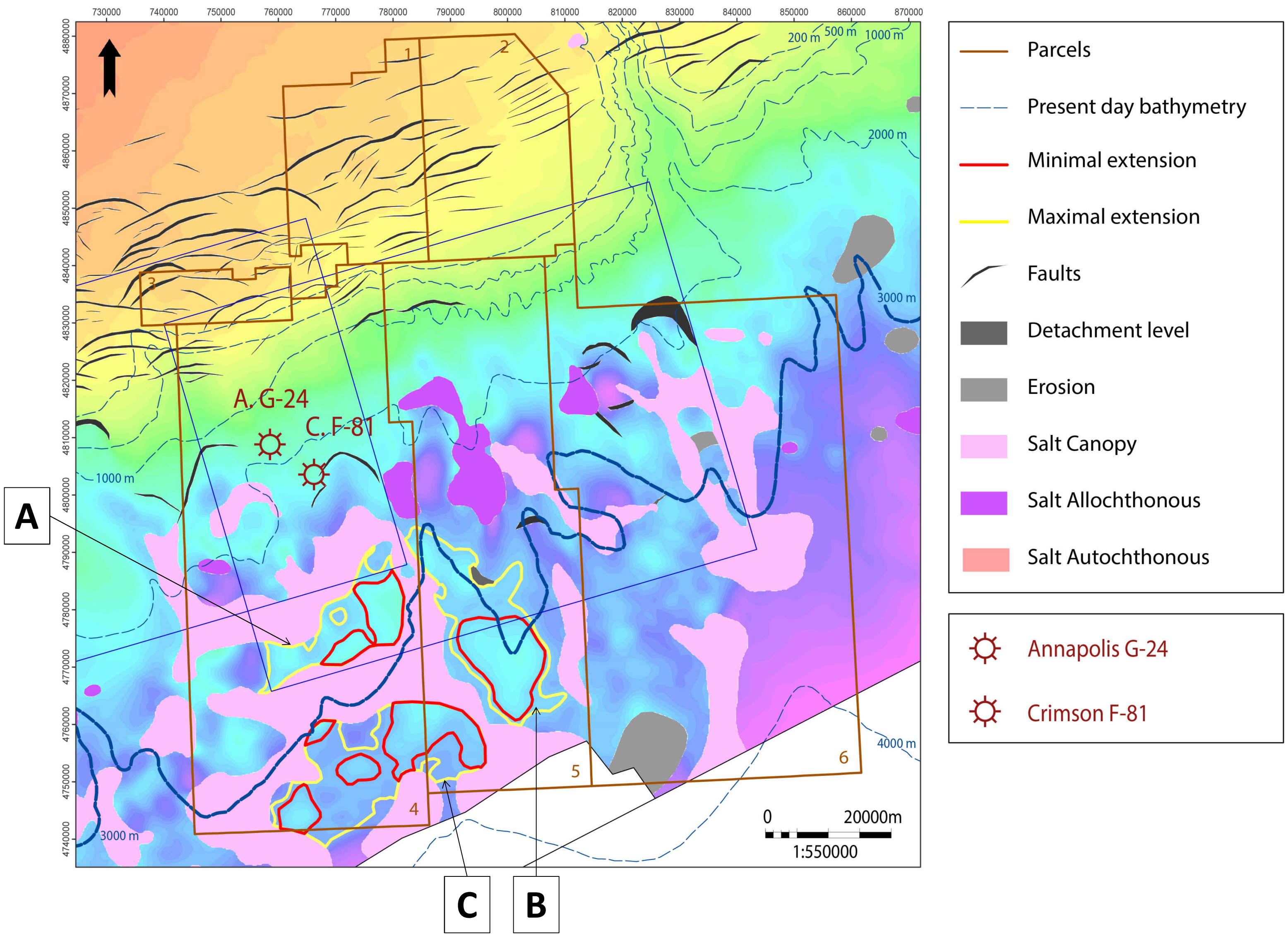


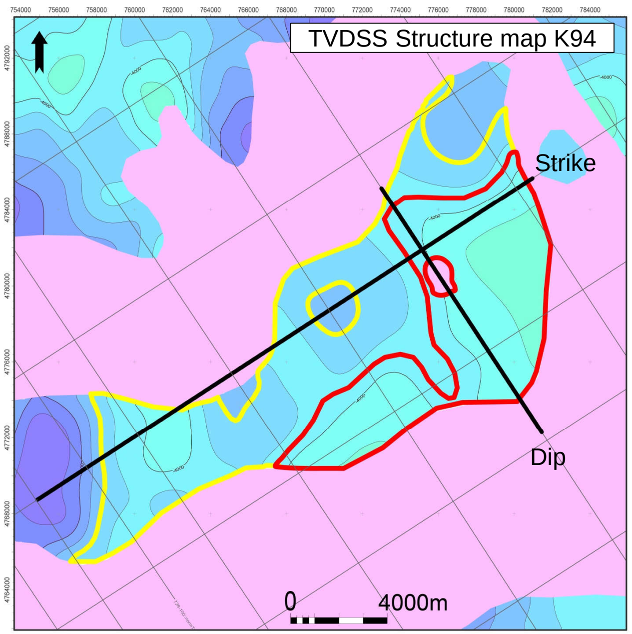
The map on the left shows the distribution of all leads picked for the lead assessment. Each lead is presented independently.

The slides are identically structured with :

- a map showing the structure and its related closure on the upper right corner
- A table showing volumetric results for the Gas and Condensate scenario (S1)
- A table showing volumetric results for the Oil and Gas scenario (S2)
- A table comparing the P50 of each scenario to TemisFlow™ results for the same lead
- A table on the upper right corner showing results from the risk assessment
- A figure showing the total hydrocarbon volume from TemisFlow™ modelling for the related play
- A dip and strike seismic line illustrating the structure, its closure and its maximum (yellow) and minimum (red) extent

ALL LEADS K94





Three-way closure against salt

Percentiles	P90	P50	P10
GAS (Tcf)	0.5	1.4	3.5
LIQUID (MMbbl)	54.2	124.3	259.5

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.5	1.6	4.0
LIQUID (MMbbl)	37.7	136.1	330.2

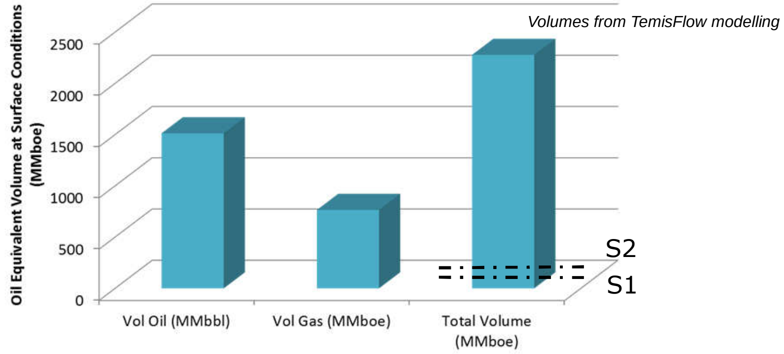
Oil and Gas scenario (S2)

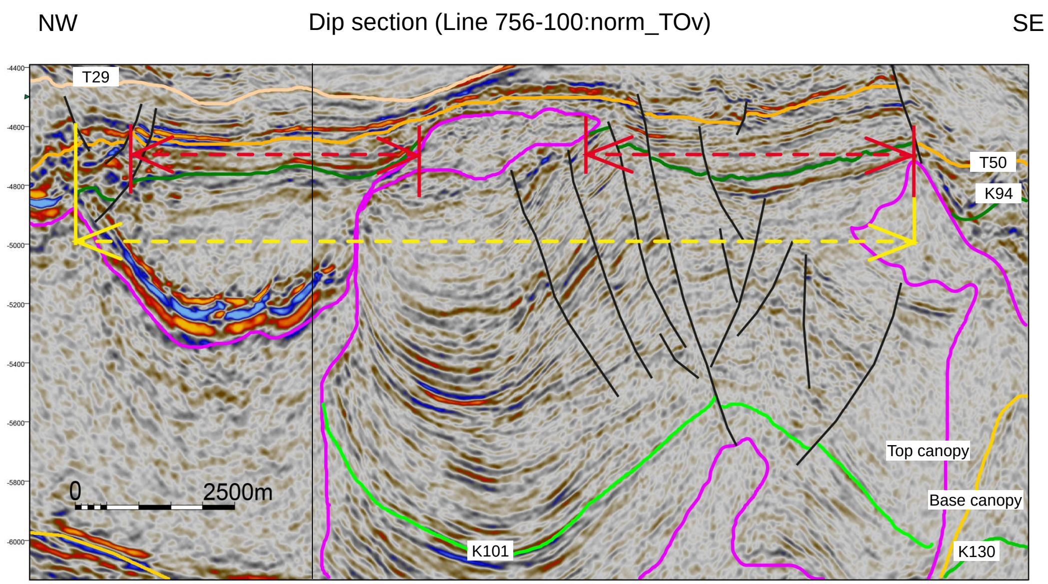
	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	1.4	1.6	1.621
LIQUID (MMbbl)	124.3	136.1	0.652
Total Volume MMboe	365.65	414.59	931.45

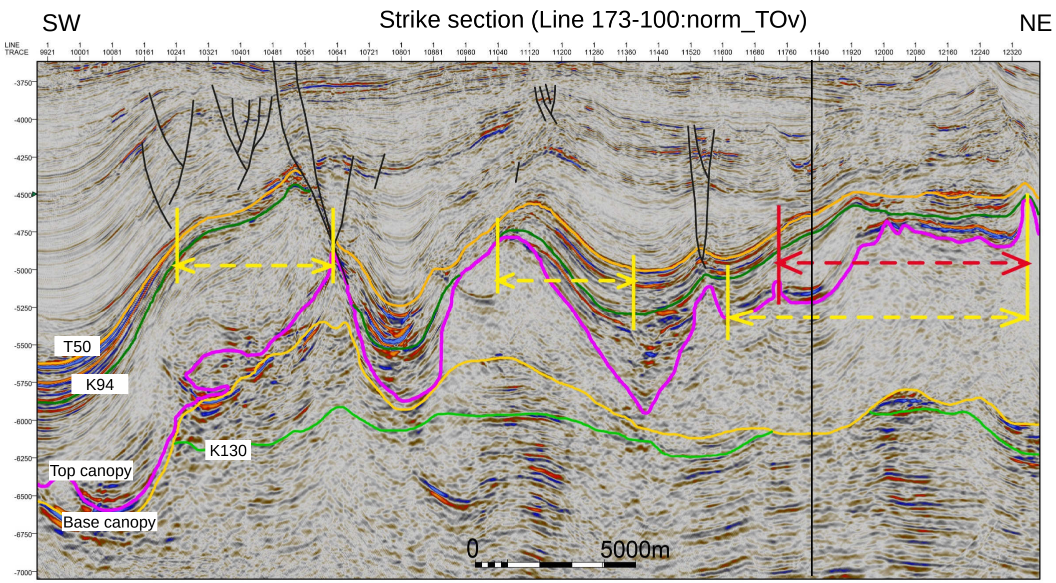
Volume comparison for K94 A

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	Pounded turbidites	0.3
Seal	Dawson Canyon Shale	0.8
Trap	Turtle back and cluster; Closure against salt	0.8
Hydrocarbon Charge	Mature SR and effective migration; Gas	0.9
	Probability of Success	0.17

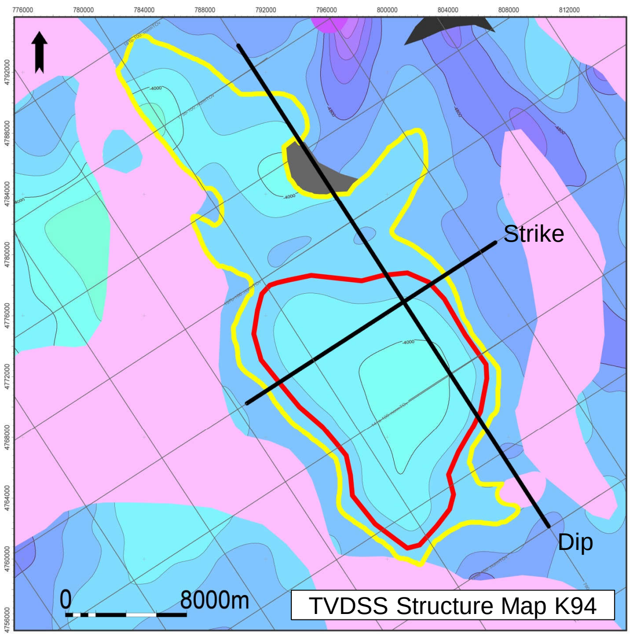
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K94
GRAND TOTAL IN PLACE (UNRISKED)







LEADS ASSESSMENT



Turtle back four-way closure

Percentiles	P90	P50	P10
GAS (Tcf)	0.7	2.4	5.7
LIQUID (MMbbl)	48.8	157.5	401.9

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.7	2.2	5.1
LIQUID (MMbbl)	120.2	370.2	874.3

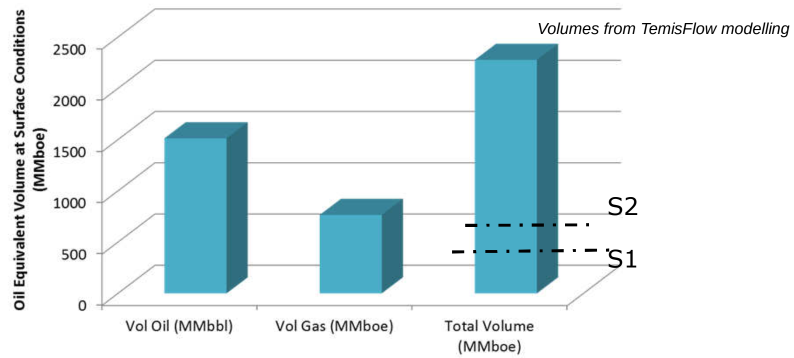
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	2.4	2.2	1.62
LIQUID (MMbbl)	157.5	370.2	0.65
Total Volume MMboe	571.25	743.02	151.44

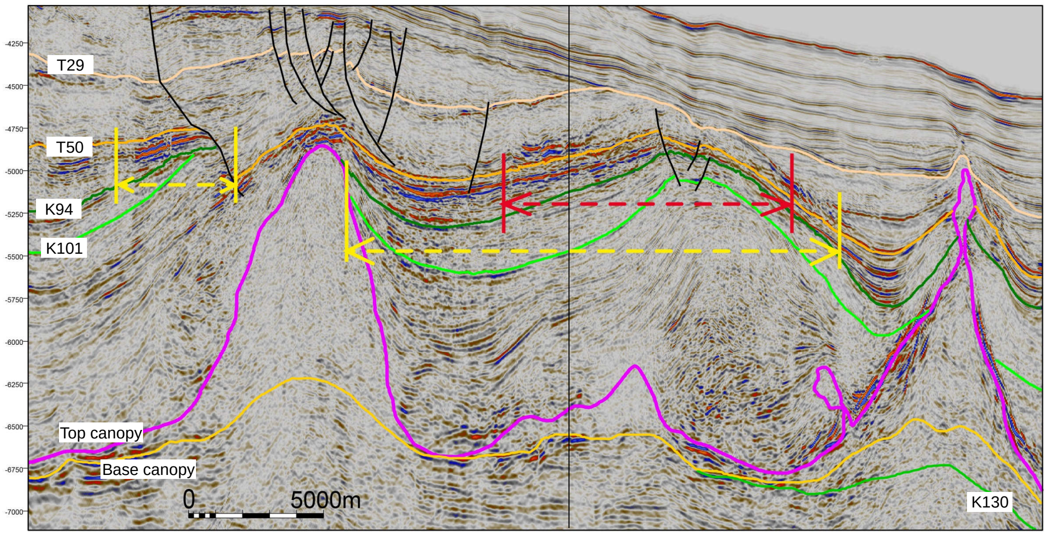
Volume comparison for K94 B

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	Pounded turbidites	0.3
Seal	Dawson Canyon Shale	0.9
Trap	Large faulted turtle back	0.8
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.19

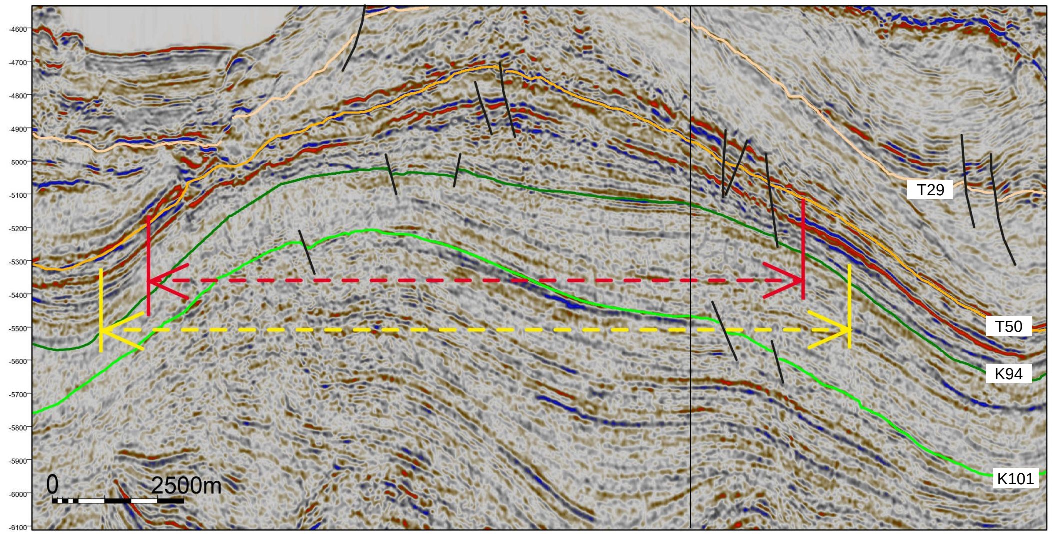
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K94
GRAND TOTAL IN PLACE (UNRISKED)

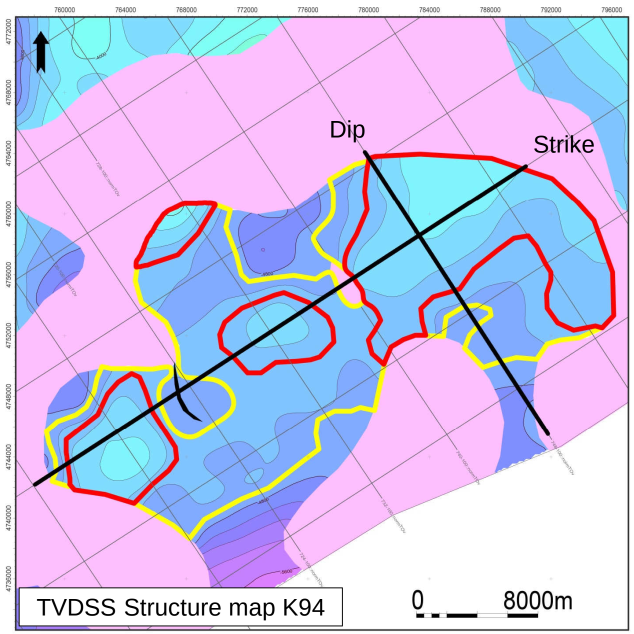


NW Dip section (Line 780-100:norm_TOv) SE



SW Strike section (Line 149-100:norm_TOv) NE





Three-way closures related to salt deformations (anticlines and turtle back)

Percentiles	P90	P50	P10
GAS (Tcf)	0.8	2.9	7.5
LIQUID (MMbbl)	58.4	195.1	496.2

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.8	2.7	6.5
LIQUID (MMbbl)	162.6	469.1	1108.9

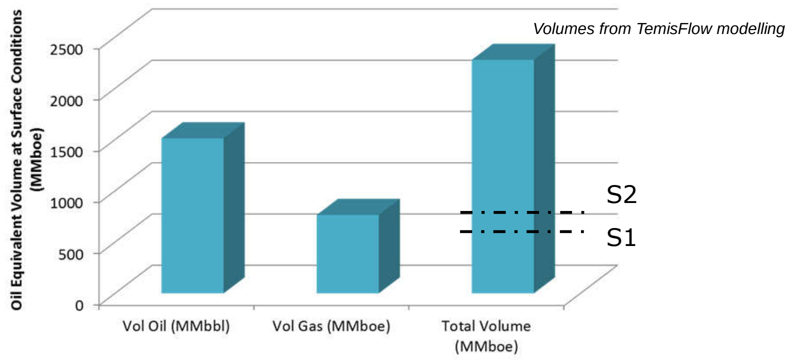
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	2.9	2.7	N/A
LIQUID (MMbbl)	195.1	469.1	N/A
Total Volume MMboe	696.87	930.97	N/A

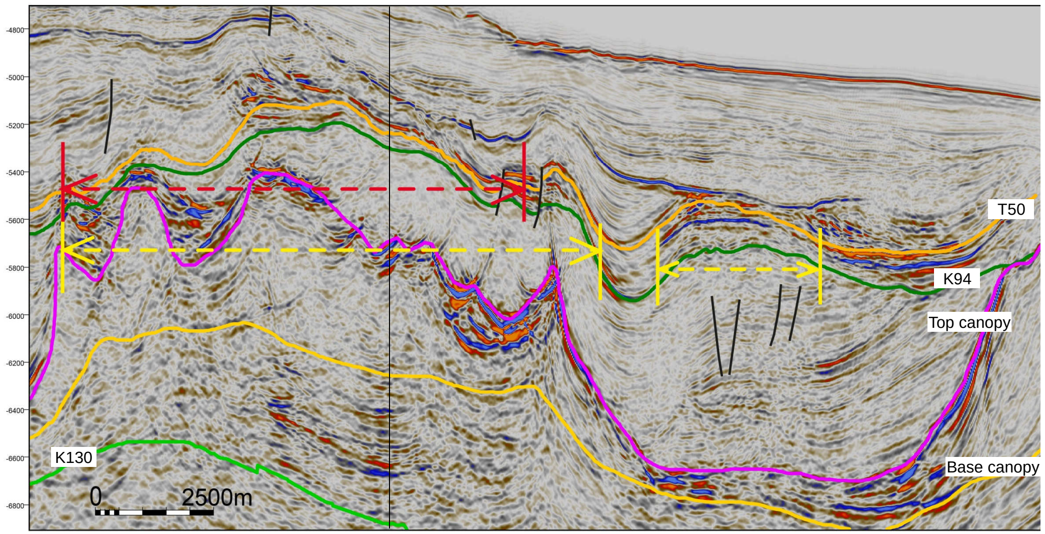
Volume comparison for K94 C

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	Pounded turbidites and turbidite fans	0.3
Seal	Dawson Canyon Shale	0.7
Trap	Anticlines and turtle back; Complex faulted structure	0.7
Hydrocarbon Charge	Mature SR and semi-effective migration; Oil & Gas	0.7
	Probability of Success	0.10

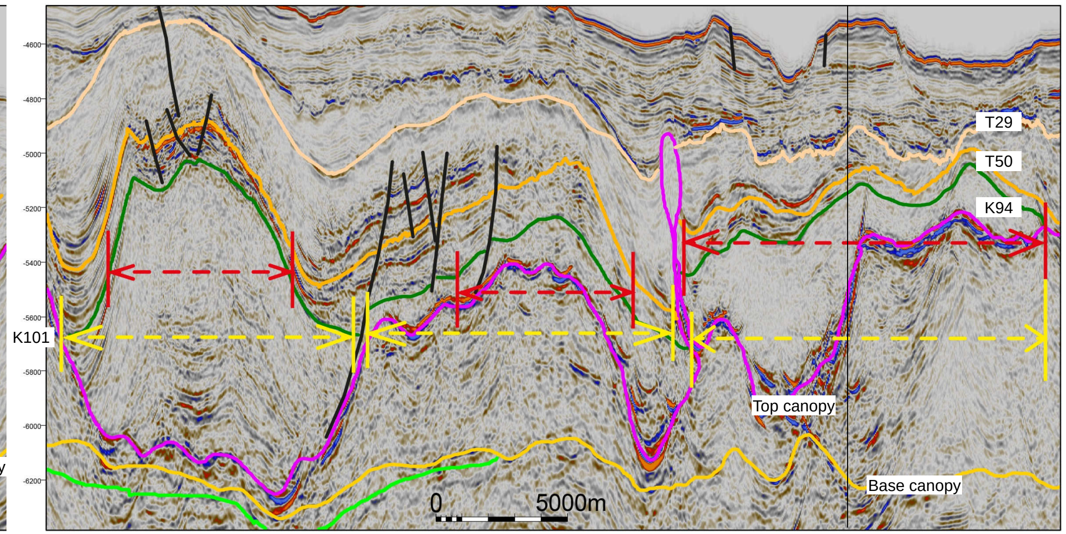
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K94
GRAND TOTAL IN PLACE (UNRISKED)



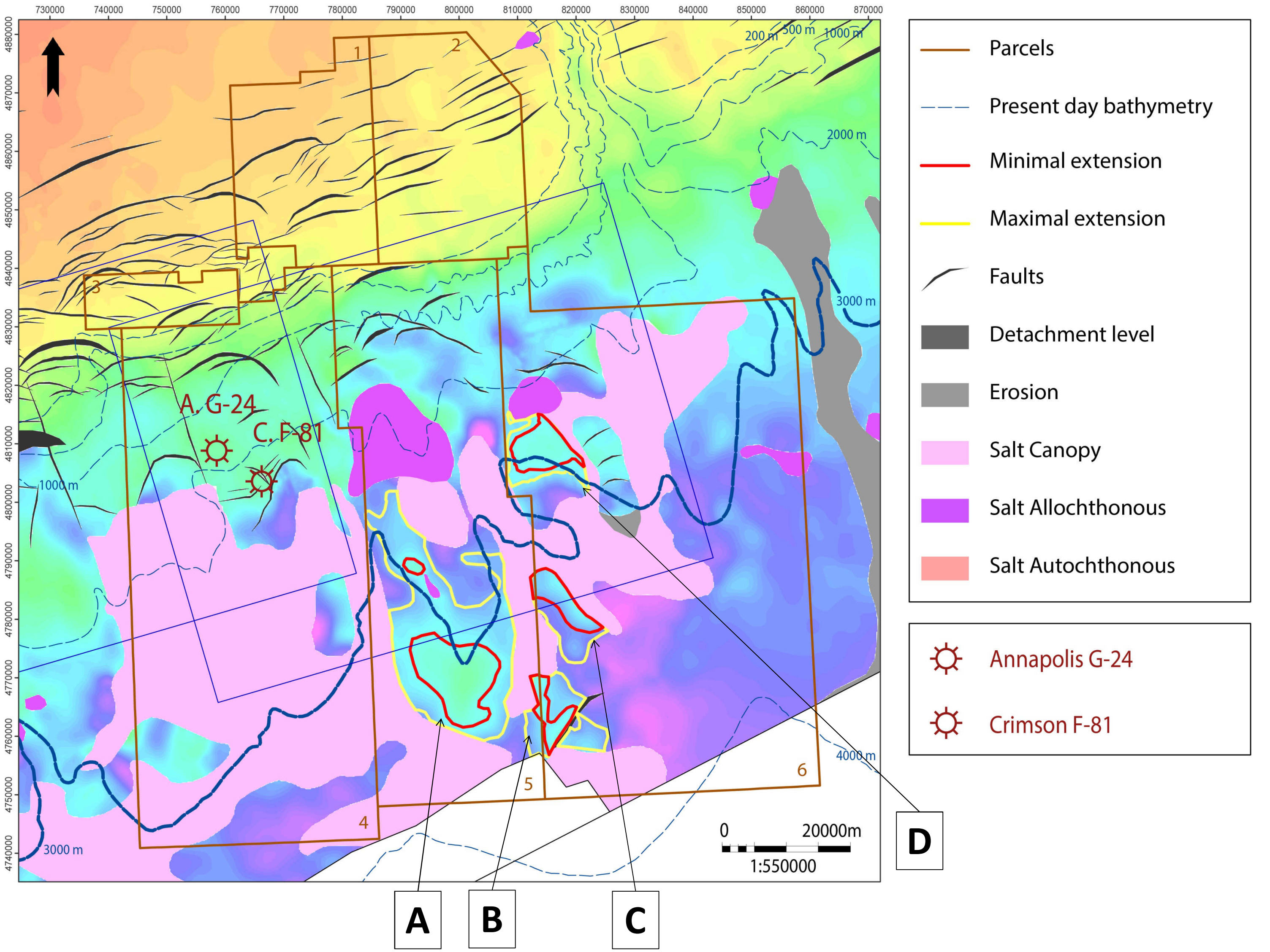
NW Dip section (Line 748-100:norm_TOv) SE

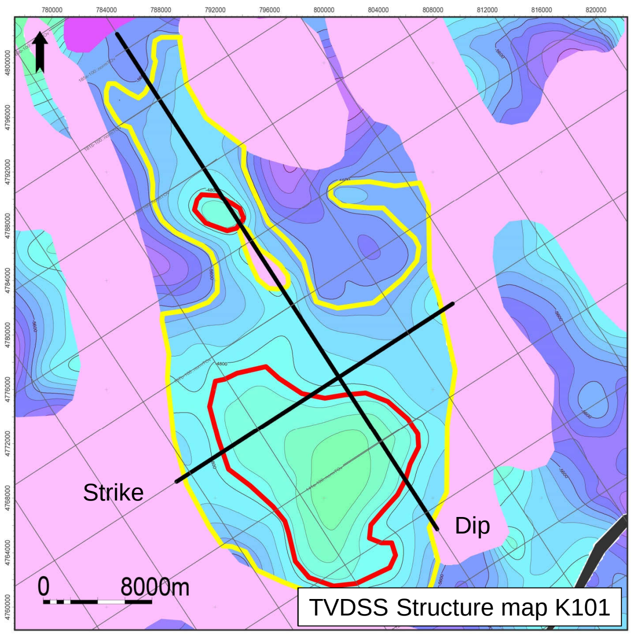


SW Strike section (Line 141-100:norm_TOv) NE



ALL LEADS K101





Turtle back four-way closure

Percentiles	P90	P50	P90
GAS (Tcf)	1.5	5.0	12.3
LIQUID (MMbbl)	99.9	319.8	768.6

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	1.3	4.1	9.9
LIQUID (MMbbl)	271.6	771.9	1802.8

Oil and Gas scenario (S2)

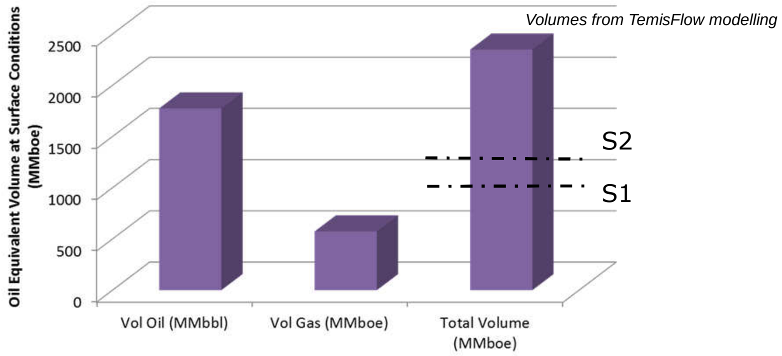
	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	5	4.1	1.535
LIQUID (MMbbl)	319.8	771.9	755.000
Total Volume MMboe	1181.77	1470.36	1019.63

Volume comparison for K101 A

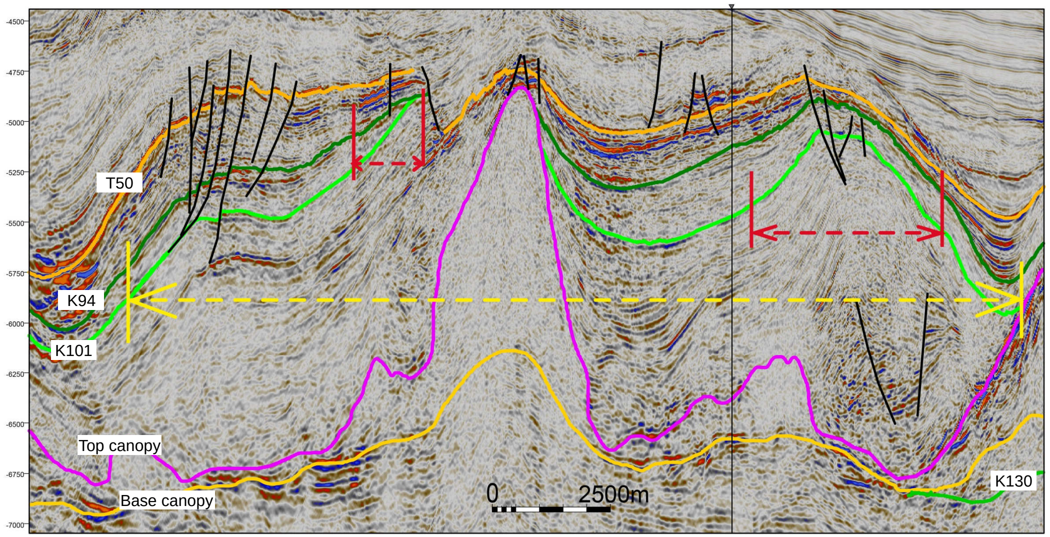
Lead compared with total volume for all leads for K94 from Temis

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	Pounded turbidites and turbidite fans	0.3
Seal	Shortland Shale	0.9
Trap	Large faulted turtle back	0.8
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.19

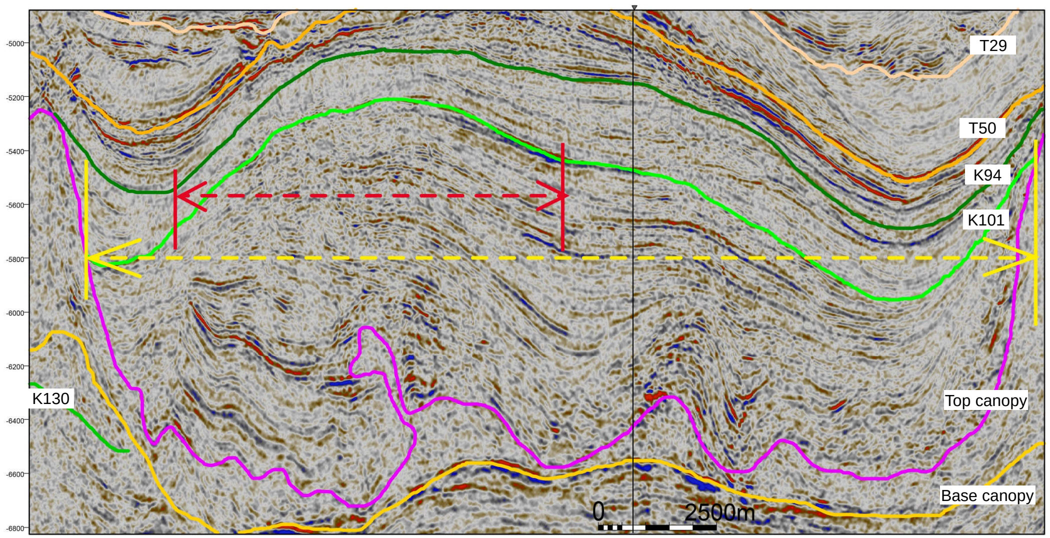
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K101
GRAND TOTAL IN PLACE (UNRISKED)

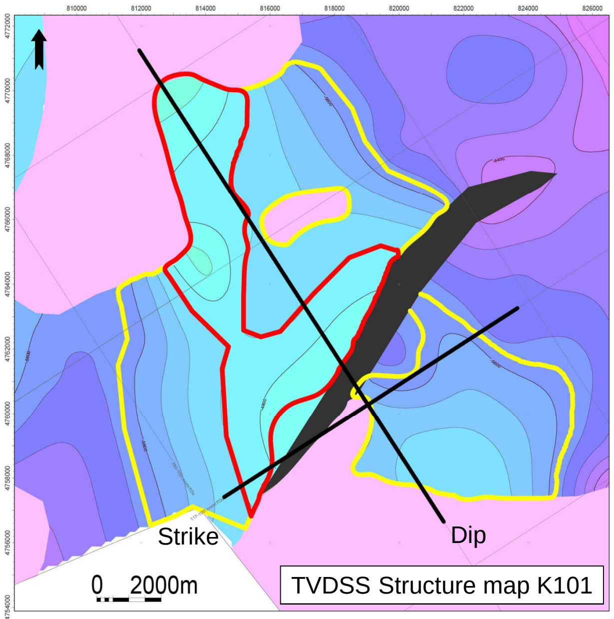


NW Dip section (Line 780-100:norm_TOv) SE



SW Strike section (Line 149-100:norm_TOv) NE





Three-way closure against salt and fault

Percentiles	P90	P50	P10
GAS (Tcf)	0.3	1.0	2.5
LIQUID (MMbbl)	22.9	68.6	168.2

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.2	0.9	2.1
LIQUID (MMbbl)	53.8	163.3	386.0

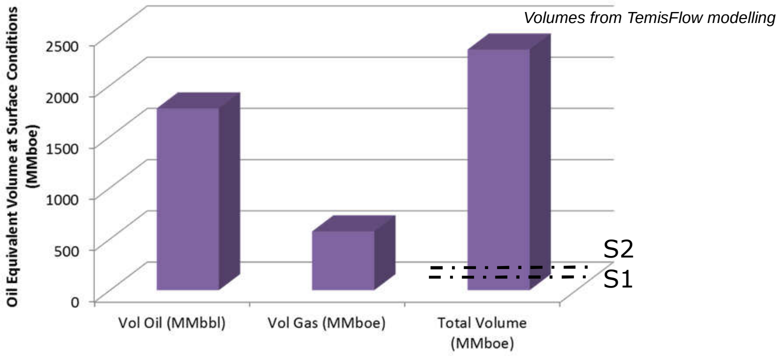
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	1	0.9	N/A
LIQUID (MMbbl)	68.6	163.3	N/A
Total Volume MMboe	246.8	311.93	N/A

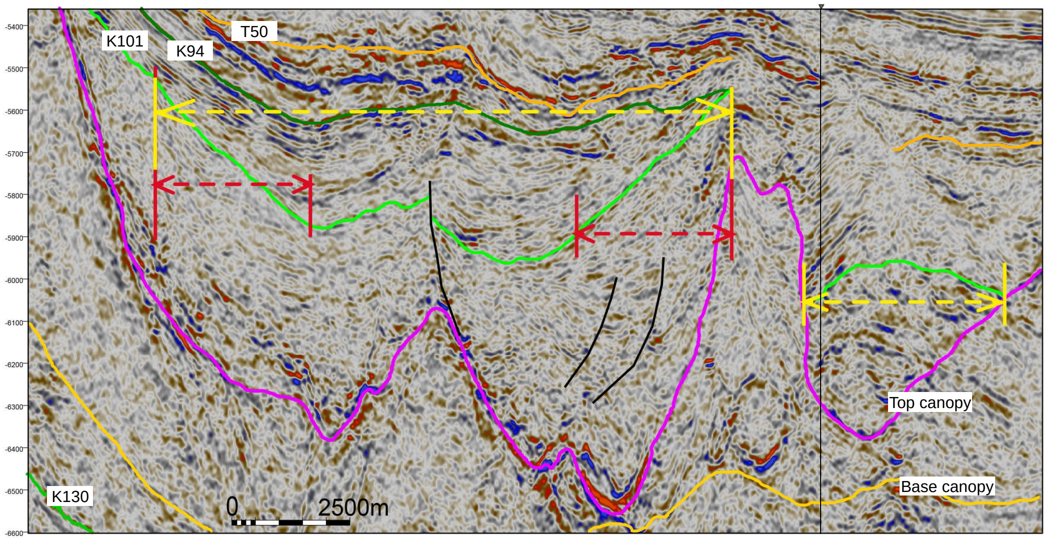
Volume comparison for K101 B

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	turbidite fans	0.3
Seal	Shortland Shale	0.7
Trap	Complex faulted structure and Closure against Salt	0.5
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.09

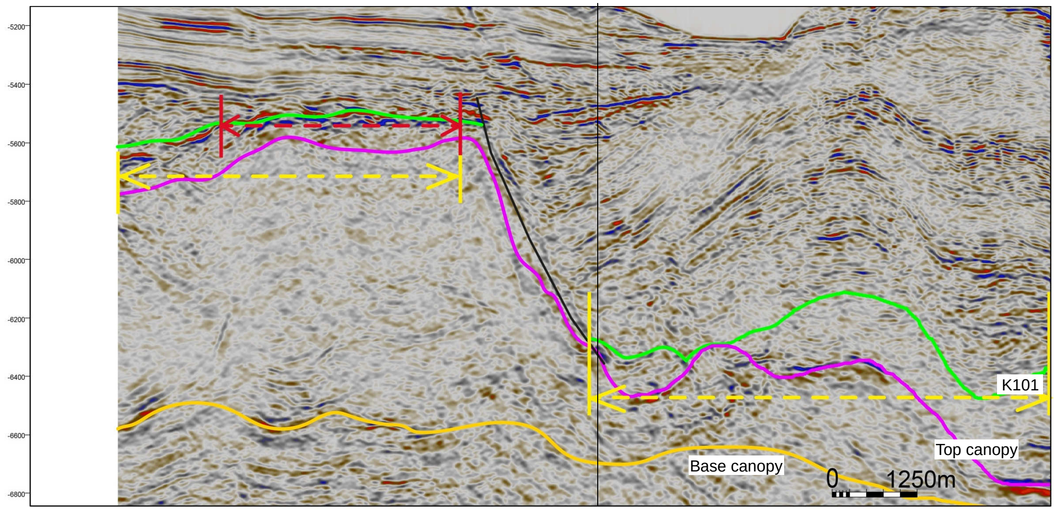
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K101
GRAND TOTAL IN PLACE (UNRISKED)

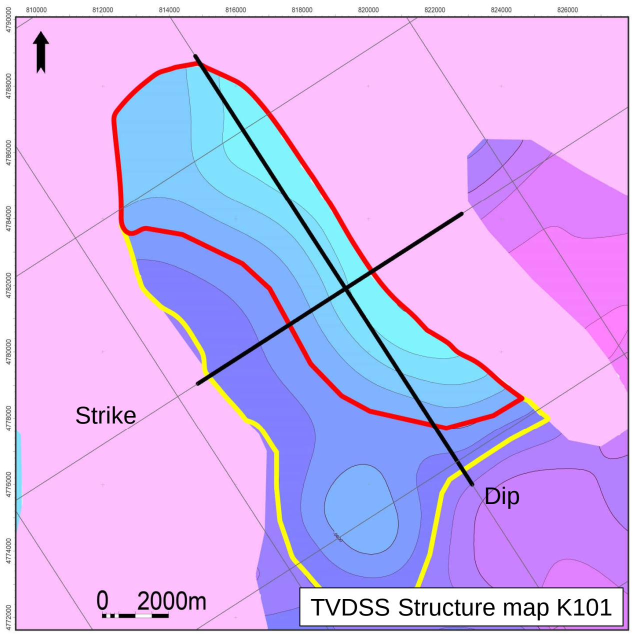


NW Dip section (Line 788-100:norm_TOv) SE



SW Strike section (Line 117-100:norm_TOv) NE





Three-way closure against salt (turtle back)

Percentiles	P90	P50	P10
GAS (Tcf)	0.3	0.9	2.2
LIQUID (MMbbl)	17.2	59.4	148.4

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.2	0.7	1.8
LIQUID (MMbbl)	48.1	138.6	320.5

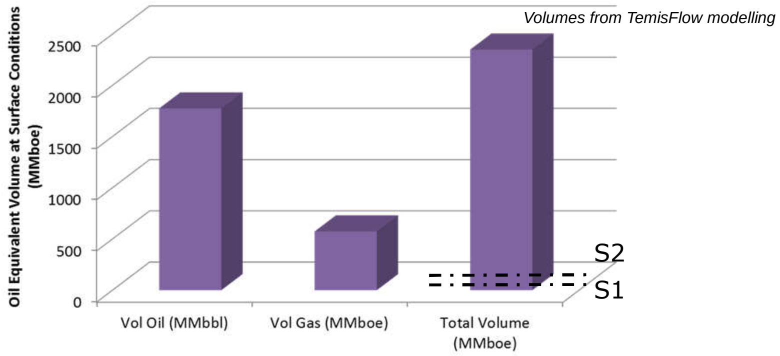
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	0.9	0.7	N/A
LIQUID (MMbbl)	59.4	138.6	N/A
Total Volume MMboe	212.17	264.84	N/A

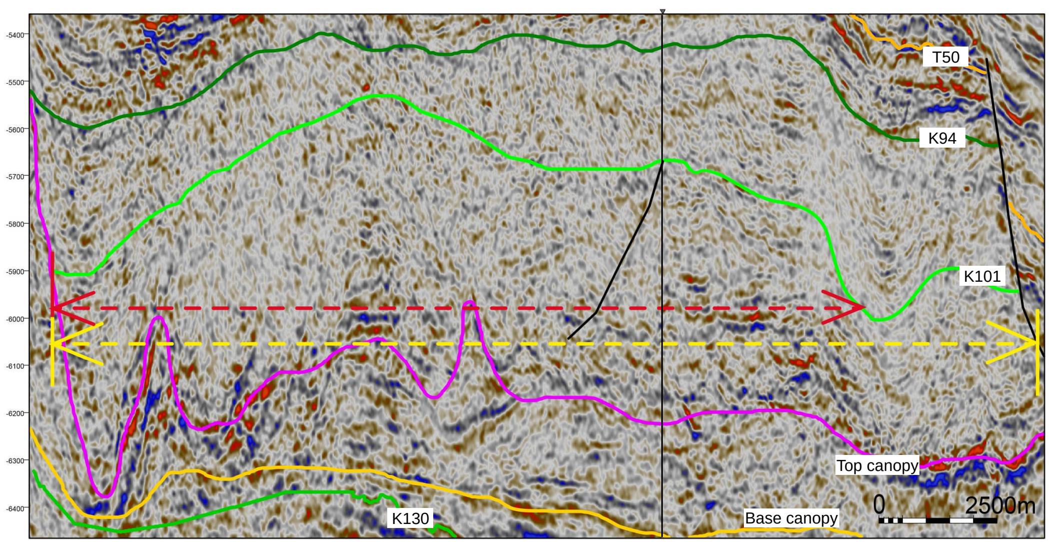
Volume comparison for K101 C

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	turbidite fans	0.4
Seal	Shortland Shale	0.8
Trap	Large faulted turtle back	0.6
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.17

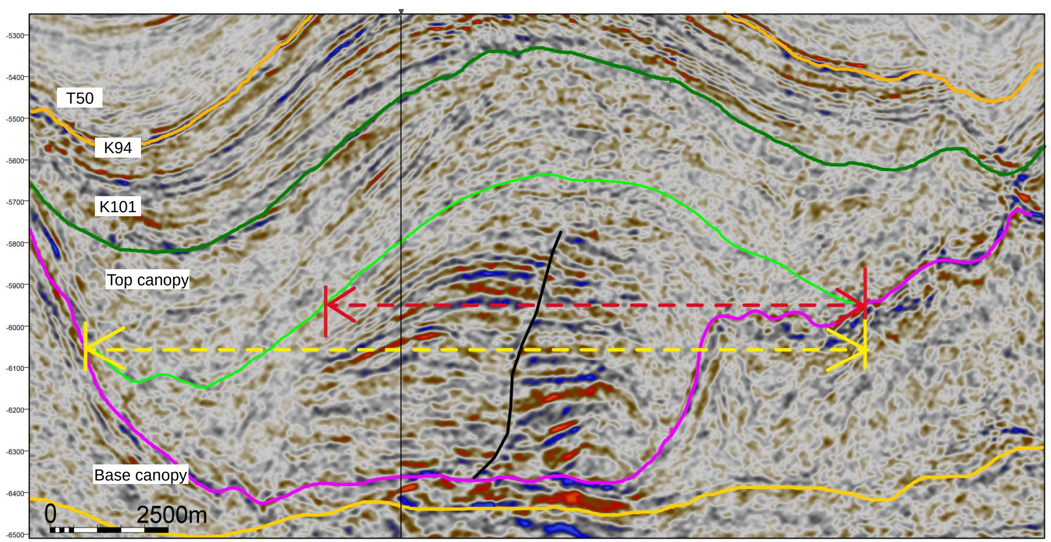
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K101
GRAND TOTAL IN PLACE (UNRISKED)

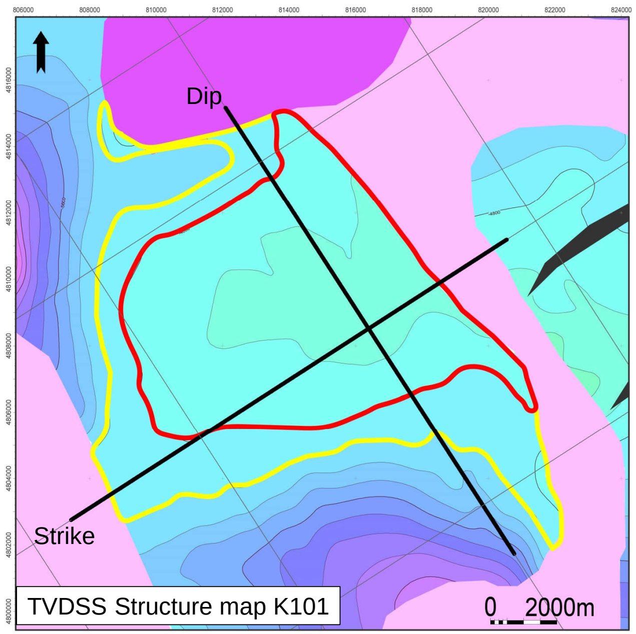


NW Dip section (Line 804-100:norm_TOv) SE



SW Strike section (Line 141a-100:norm_TOv) NE





Three-way closure against salt (turtle back)

Percentiles	P90	P50	P10
GAS (Tcf)	0.3	1.0	2.5
LIQUID (MMbbl)	22.1	66.7	157.8

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.3	1.0	2.4
LIQUID (MMbbl)	31.0	84.7	199.7

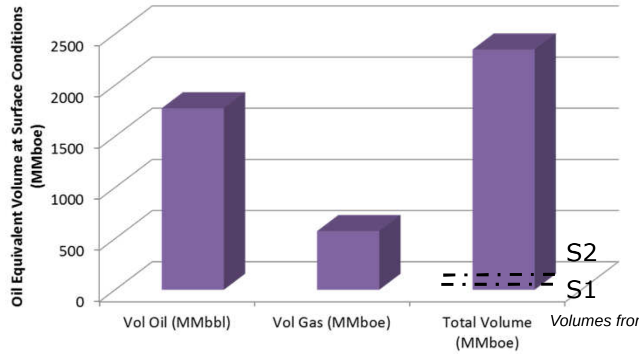
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	1	1	0.114
LIQUID (MMbbl)	66.7	84.7	35.000
Total Volume MMboe	239.1	262.14	54.65

Volume comparison for K101 D

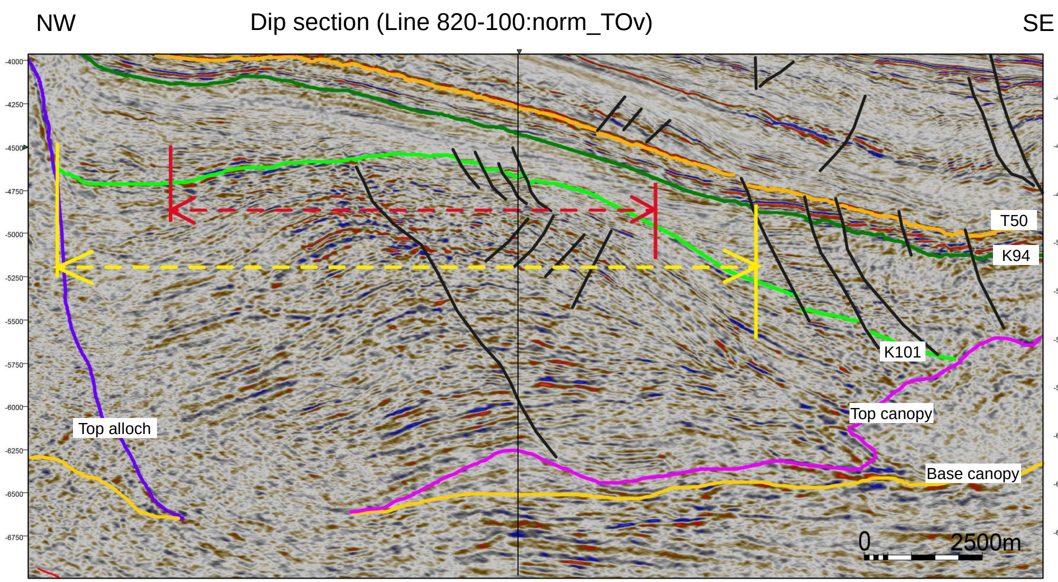
GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	Pounded turbidites	0.4
Seal	Shortland Shale	0.8
Trap	Faulted turtle back structure	0.8
Hydrocarbon Charge	Mature SR and effective migration; Gas	0.8
	Probability of Success	0.20

PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K101
GRAND TOTAL IN PLACE (UNRISKED)

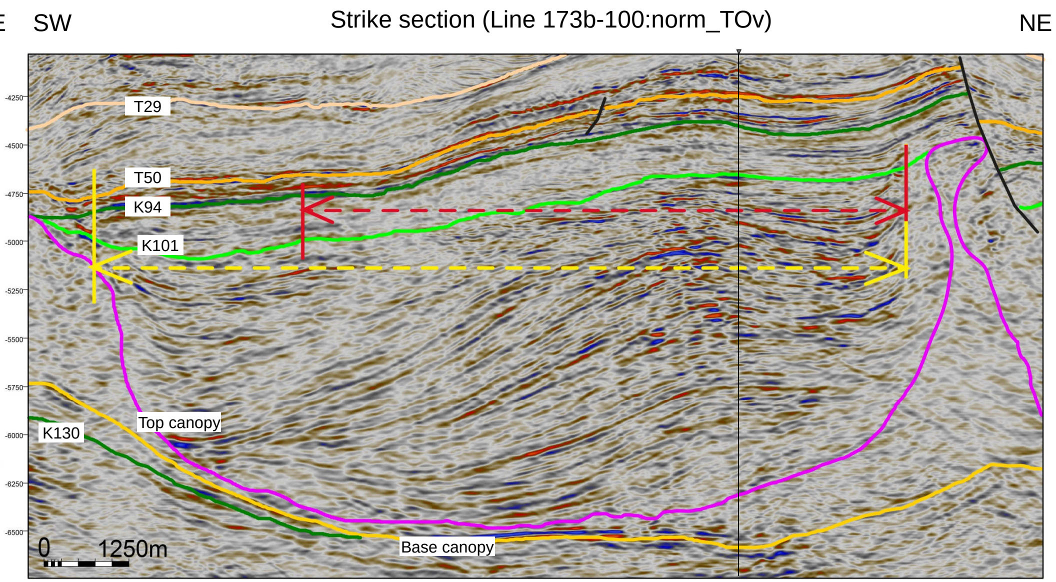


Volumes from TemisFlow modelling

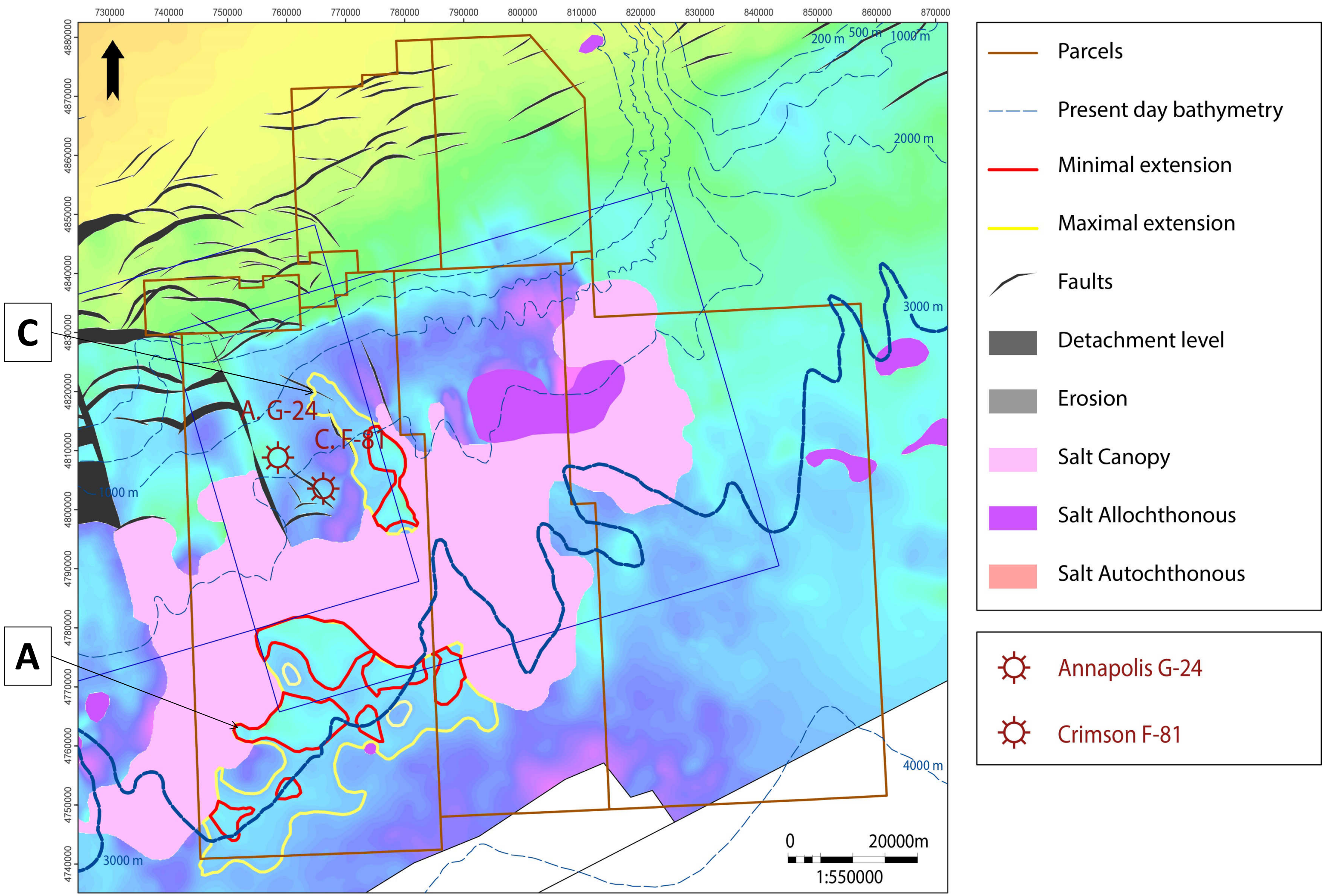
Dip section (Line 820-100:norm_TOv)

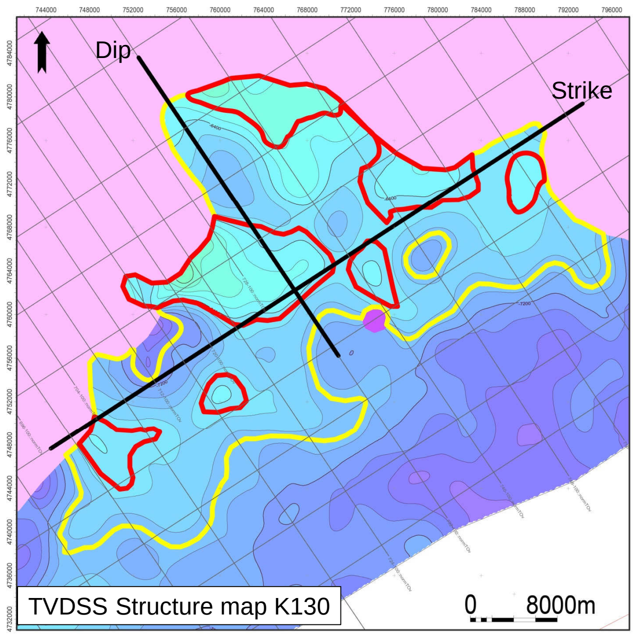


Strike section (Line 173b-100:norm_TOv)



ALL LEADS K130





Three-way closure against salt (anticline)

Percentiles	P90	P50	P10
GAS (Tcf)	8.1	19.7	45.6
LIQUID (MMbbl)	322.4	905.1	2079.9

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	4.6	15.0	34.8
LIQUID (MMbbl)	583.8	1606.2	3655.4

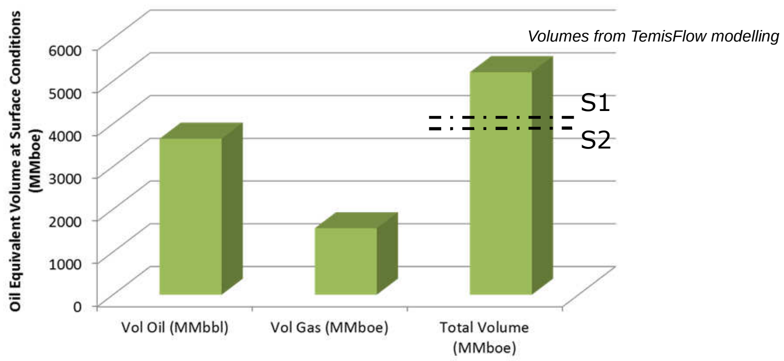
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	19.7	15	2.07
LIQUID (MMbbl)	905.1	1606.2	884
Total Volume MMboe	4301.28	4199.76	1024.45

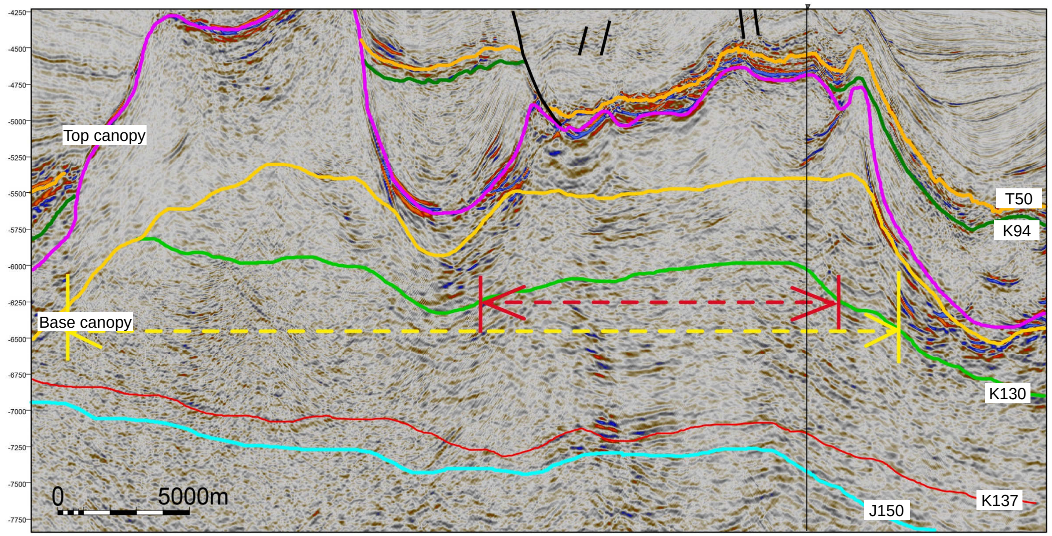
Volume comparison for K130 A

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	turbidite fans	0.3
Seal	Hauterivian MFS and Salt Canopy	0.6
Trap	Subsalt large turbidite fans	0.4
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.06

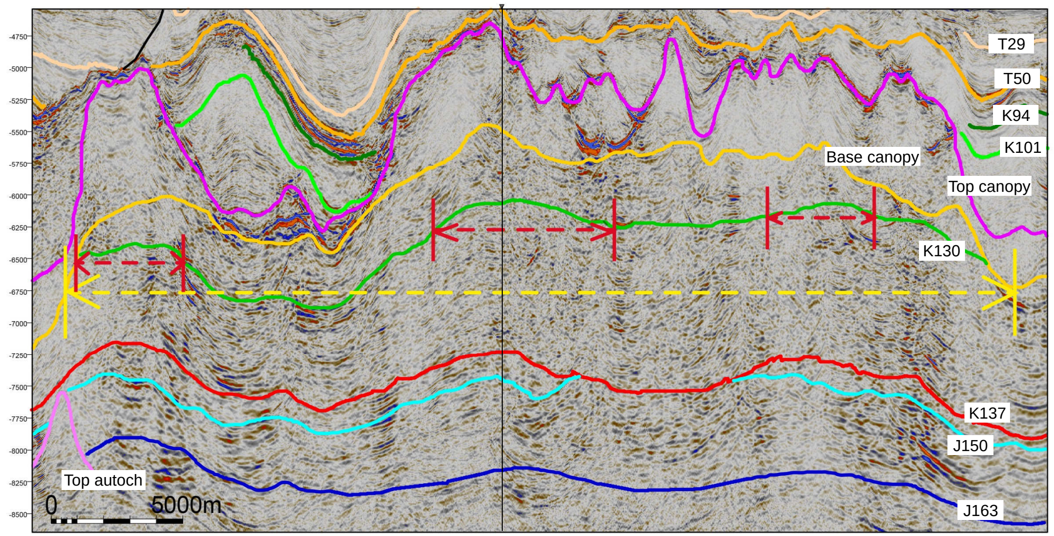
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K130
GRAND TOTAL IN PLACE (UNRISKED)

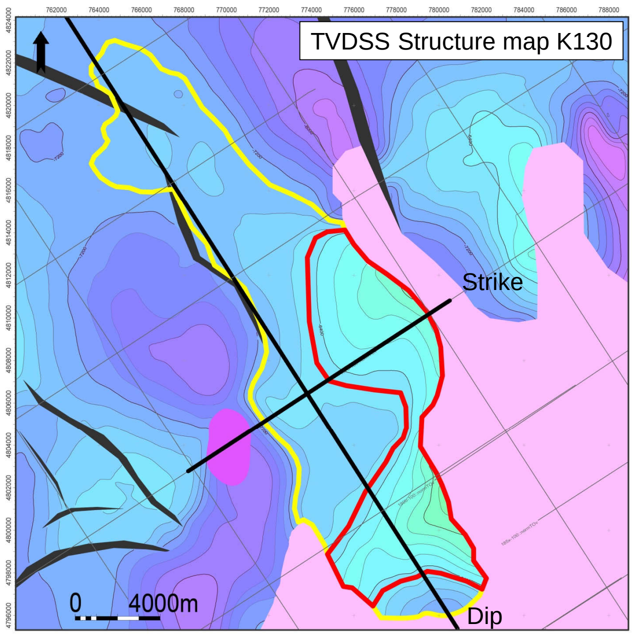


NW Dip section (Line 732-100:norm_TOv) SE



SW Strike section (Line 157-100:norm_TOv) NE





Three-way closure against fault and salt (salt related anticline)

Percentiles	P90	P50	P10
GAS (Tcf)	1.9	4.7	9.8
LIQUID (MMbbl)	83.9	205.5	444.2

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	1.9	4.7	10.4
LIQUID (MMbbl)	111.8	313.0	698.9

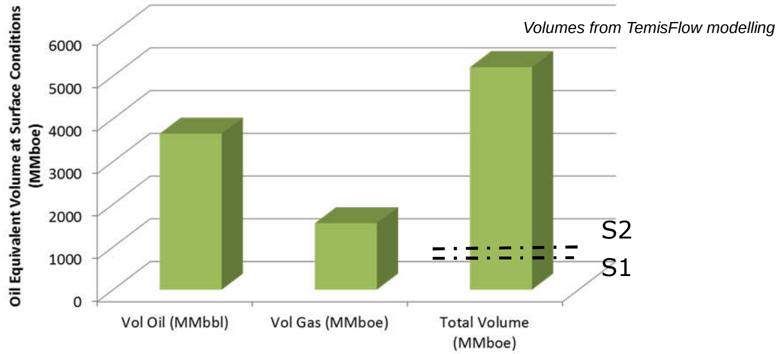
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	4.7	4.7	0.533
LIQUID (MMbbl)	205.5	313	95
Total Volume MMboe	1015.76	1117	186.89

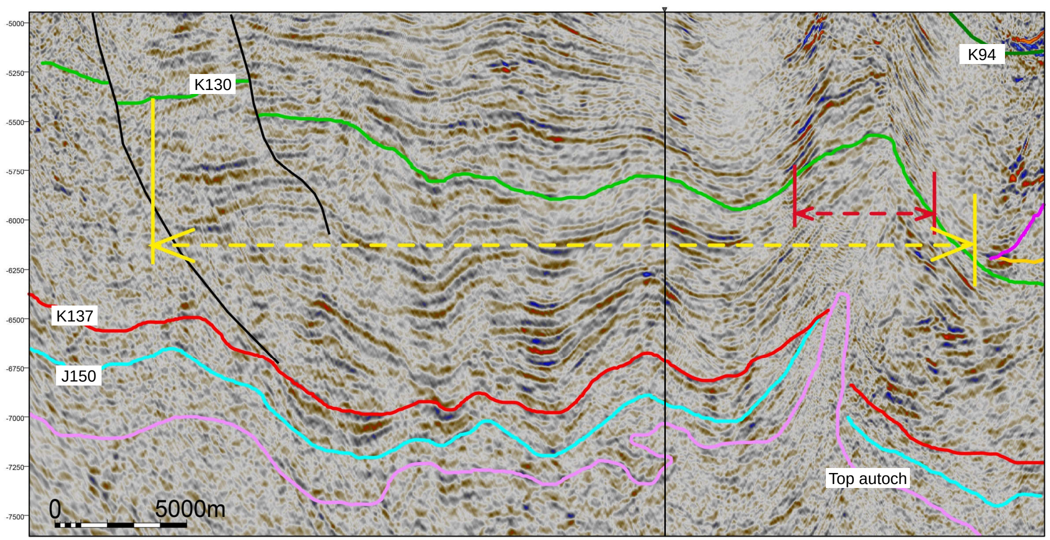
Volume comparison for K130 C

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	Pounded turbidites; Upper fan turbidites	0.4
Seal	Hauterivian MFS and Salt Canopy	0.7
Trap	Subsalt large turbidite fans; Closure against salt	0.7
Hydrocarbon Charge	Mature SR and effective migration; Gas	0.9
	Probability of Success	0.18

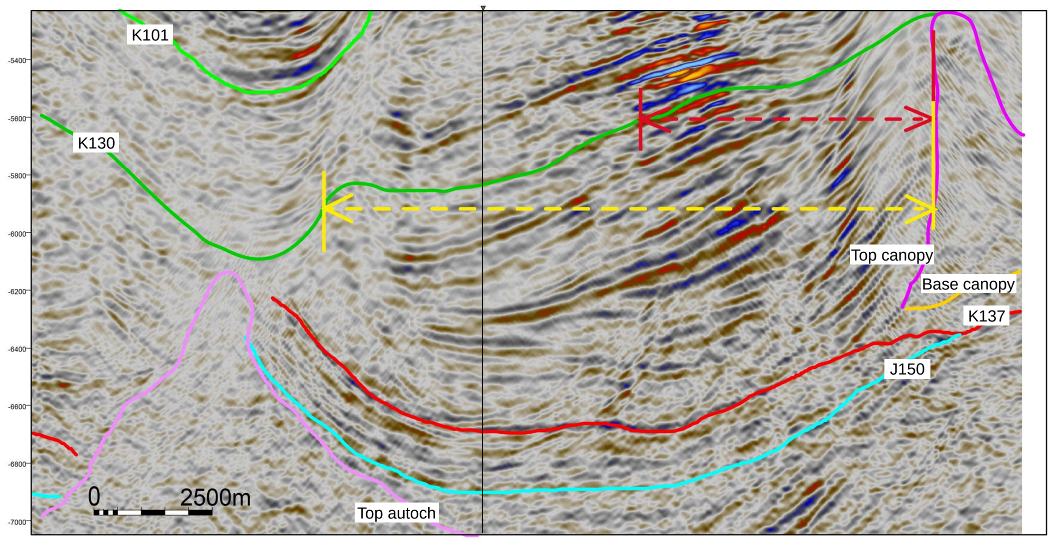
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K130
GRAND TOTAL IN PLACE (UNRISKED)



NW Dip section (Line 772-100:norm_TOv) SE

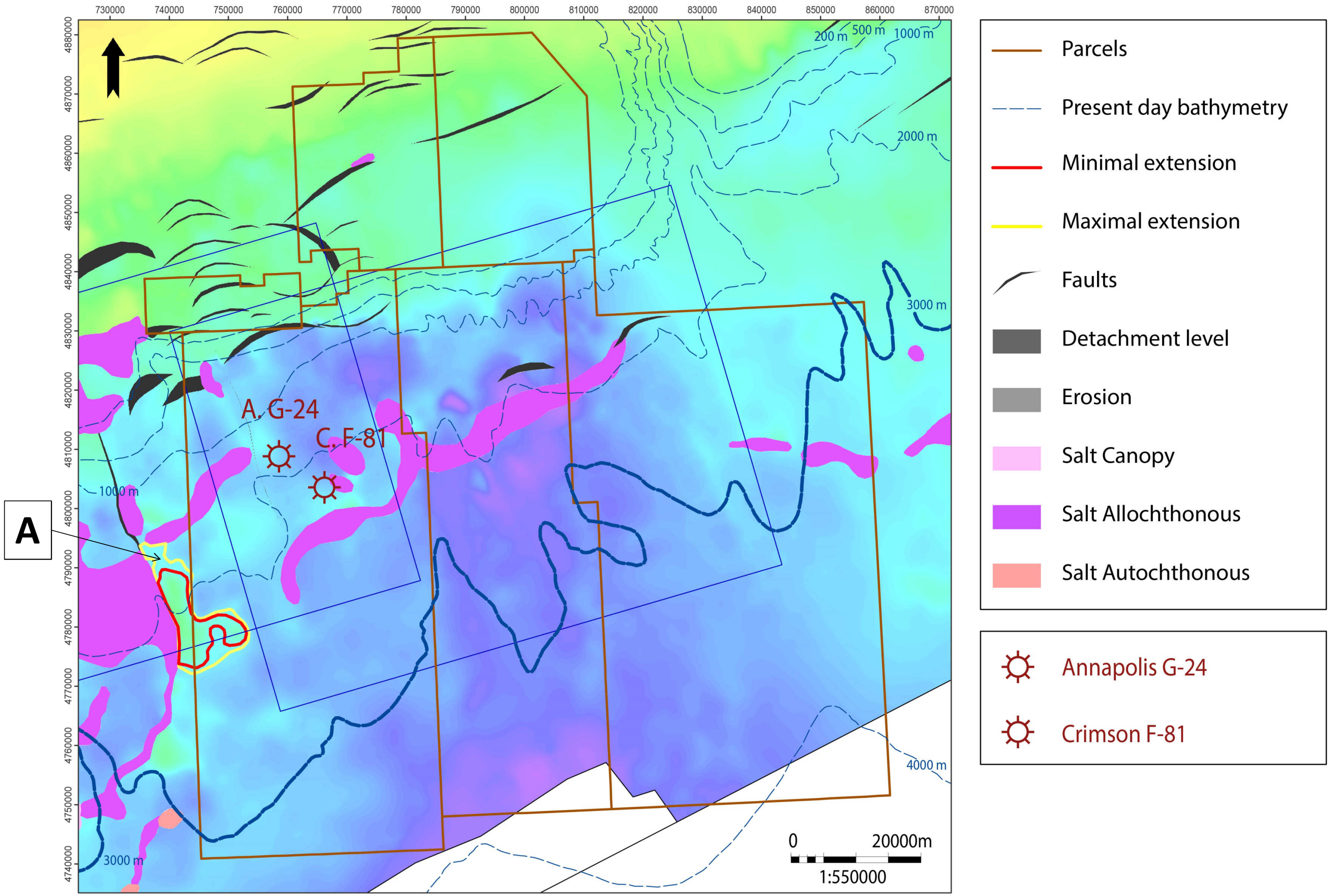


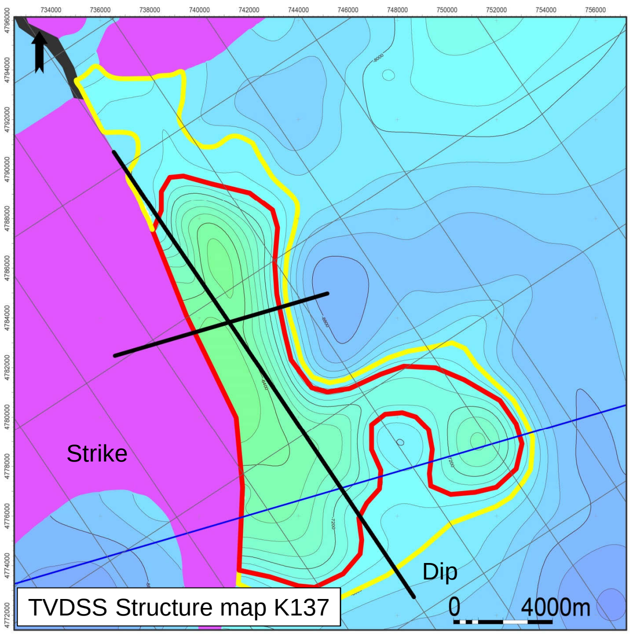
SW Strike section (Line 197-100:norm_TOv) NE



K130-C Lead Summary plate

ALL LEADS K137





Three-way closure against salt (salt related anticline)

Percentiles	P90	P50	P10
GAS (Tcf)	0.1	0.2	0.3
LIQUID (MMbbl)	0.9	2.4	5.2

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	0.1	0.2	0.4
LIQUID (MMbbl)	1.6	4.6	11.0

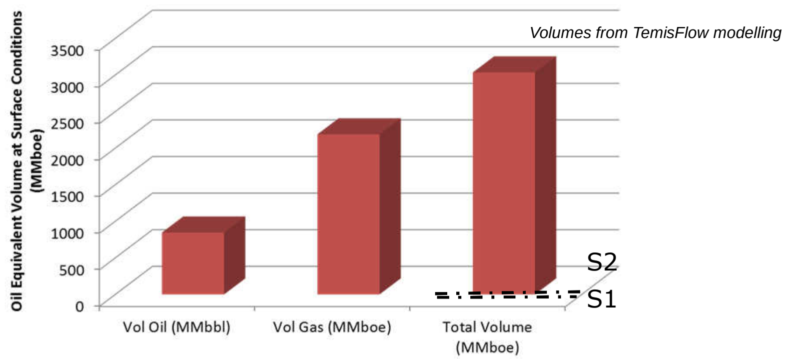
Oil and Gas scenario (S2)

	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	0.2	0.2	0.187
LIQUID (MMbbl)	2.4	4.6	16
Total Volume MMboe	32.22	36.88	48.24

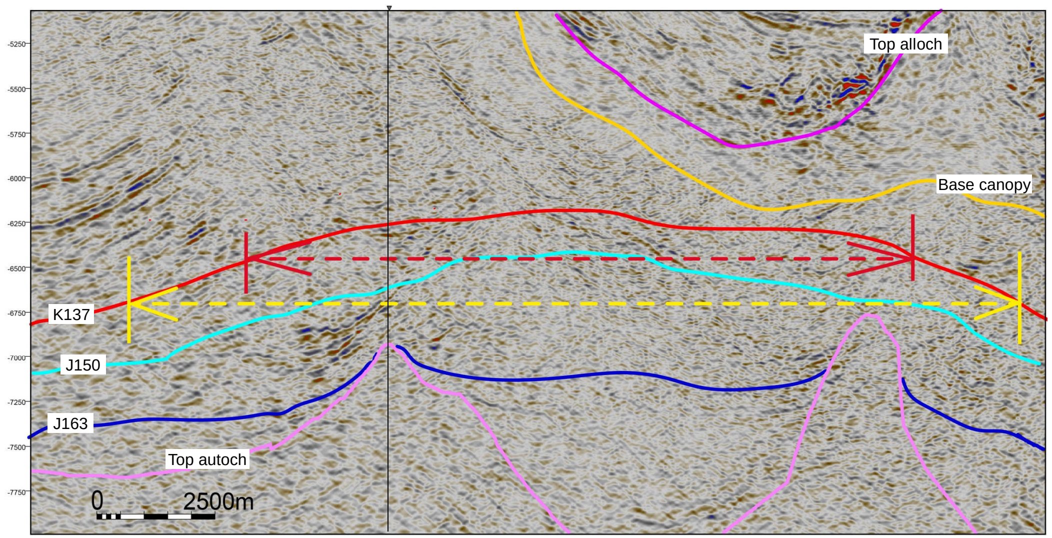
Volume comparison for K137 A

GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	turbidite fans	0.3
Seal	Salt and Berriasian Shale	0.5
Trap	Subsalt turbidite fans; Faulted structure; closure against salt	0.4
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.05

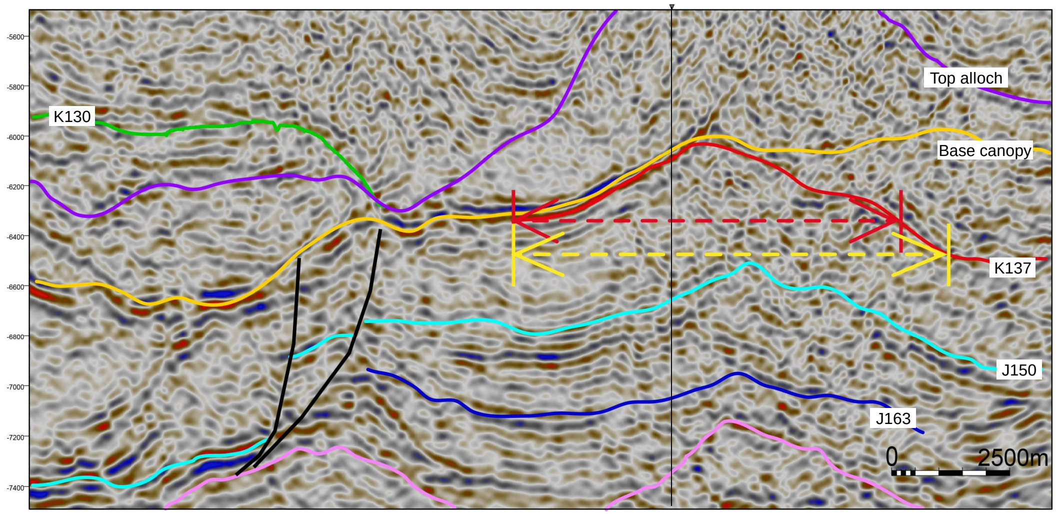
PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY K137
GRAND TOTAL IN PLACE (UNRISKED)



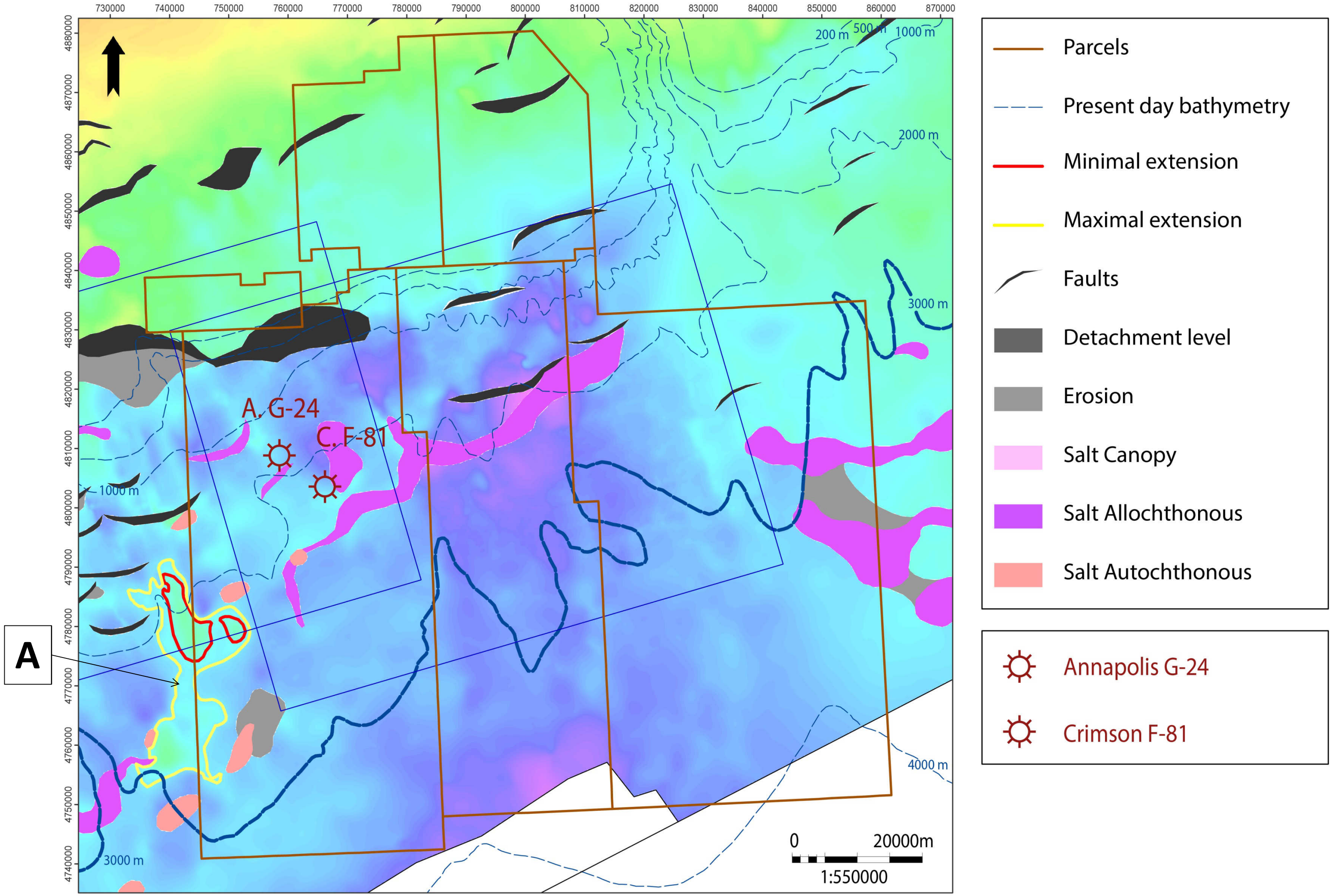
NW Dip section (Line 720-100:norm_TOv) SE

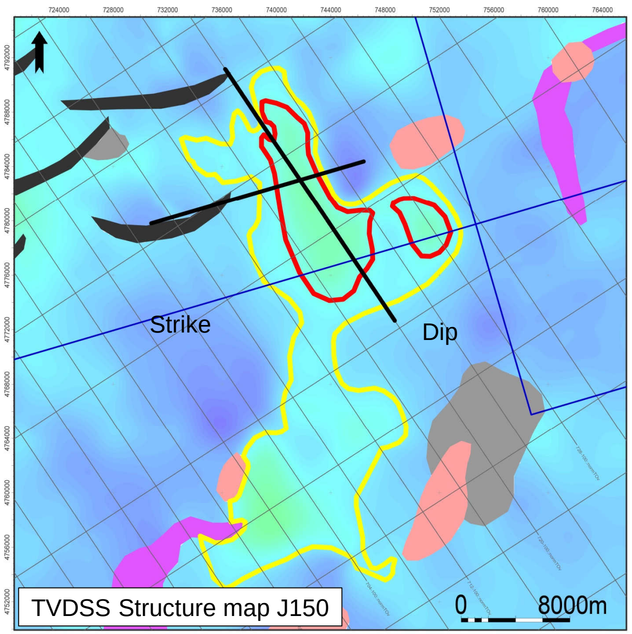


SW Strike section (XLine 5400 Veritas 3D) NE



ALL LEADS J150





Three-way closure against salt (salt related anticline)

Percentiles	P90	P50	P10
GAS (Tcf)	6.1	13.2	26.2
Condensates (MMbbl)	54.2	124.3	259.5

Gas and Condensate scenario (S1)

Percentiles	P90	P50	P10
GAS (Tcf)	5.5	11.8	24.4
LIQUID (MMbbl)	108.5	276.0	595.6

Oil and Gas scenario (S2)

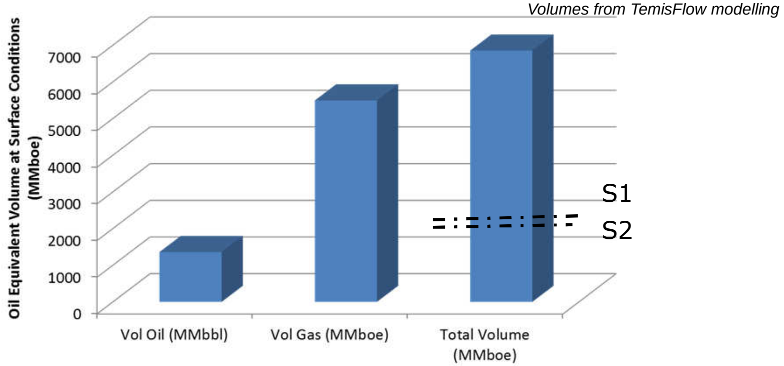
	Scenario S1	Scenario S2	Basin Modelling Volume
GAS (Tcf)	11.8	13.2	5.74
LIQUID (MMbbl)	276	124.3	349
Total Volume MMboe	2399.91	2307.51	1338.55

Volume comparison for J150 A

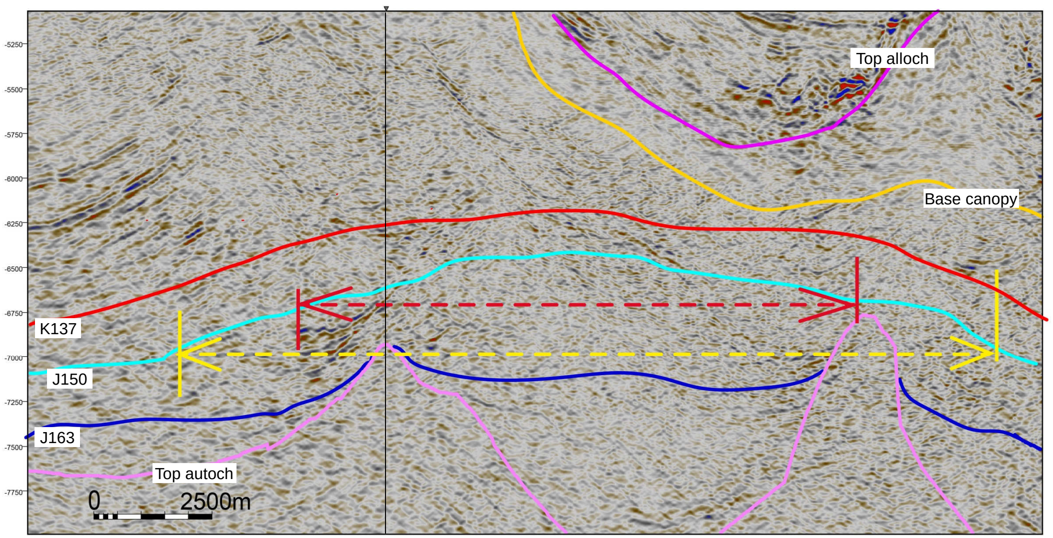
GEOLOGICAL RISKS		
	Comments	Chance Factor
Reservoir	turbidite fans	0.2
Seal	Salt & Tithonian MFS	0.7
Trap	Subsalt turbidite fans; Faulted structure; closure against salt	0.3
Hydrocarbon Charge	Mature SR and effective migration; Oil & Gas	0.9
	Probability of Success	0.04

PARCEL 4, 5 AND 6 TOTAL VOLUME IN PLAY J150
GRAND TOTAL IN PLACE (UNRISKED)

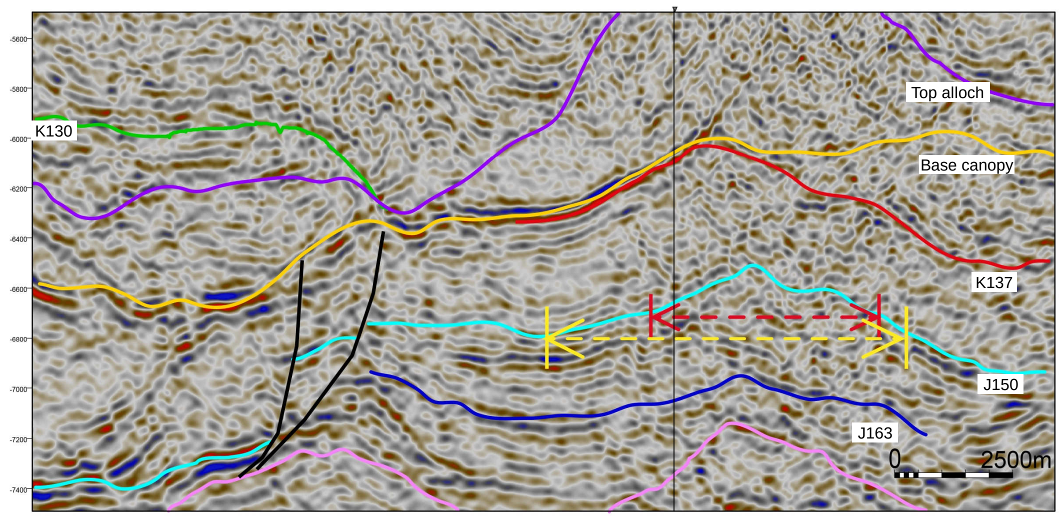
Volumes from TemisFlow modelling



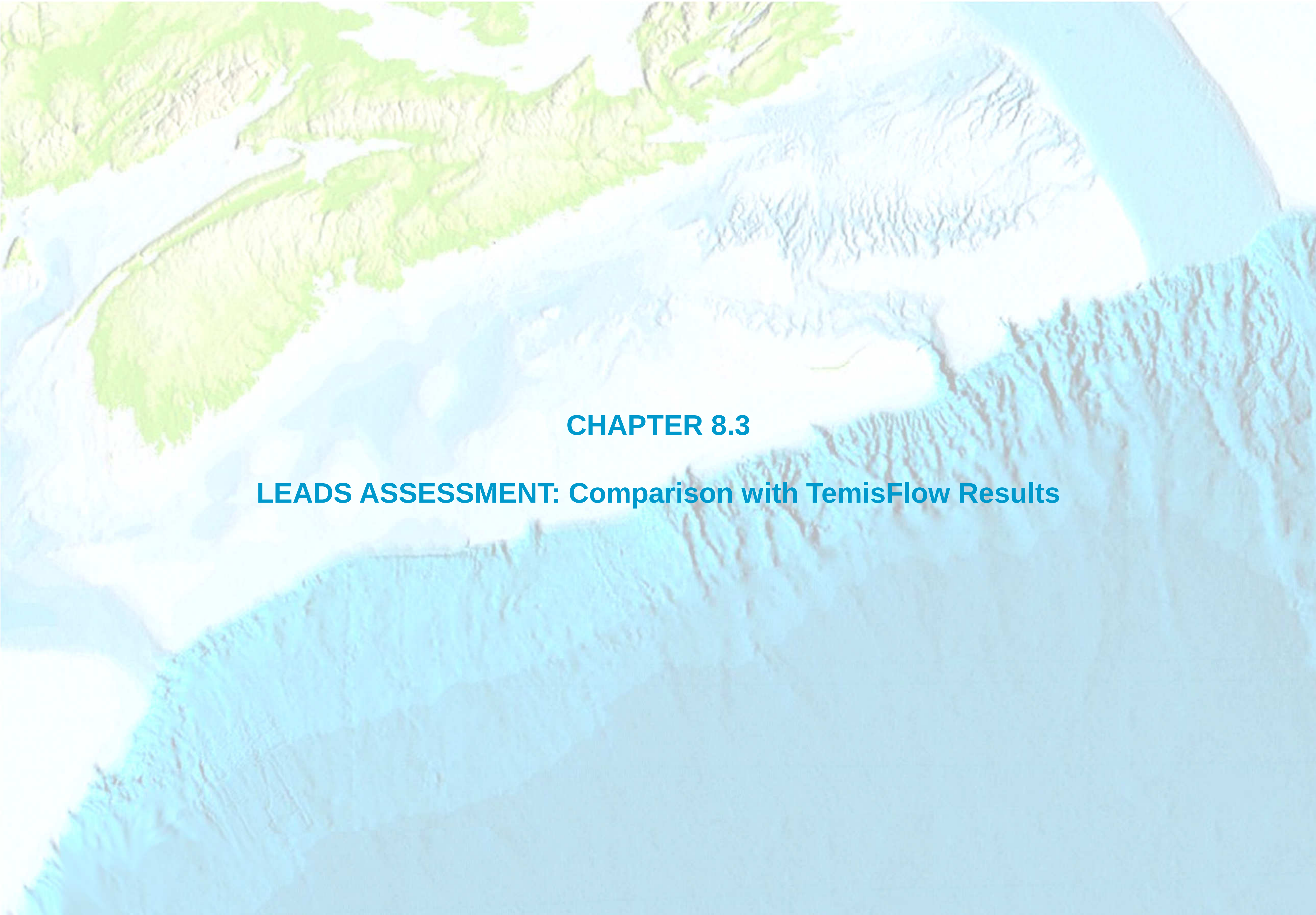
NW Dip section (Line 720-100:norm_TOv) SE



SW Strike section (Line 189-100:norm_TOv) NE

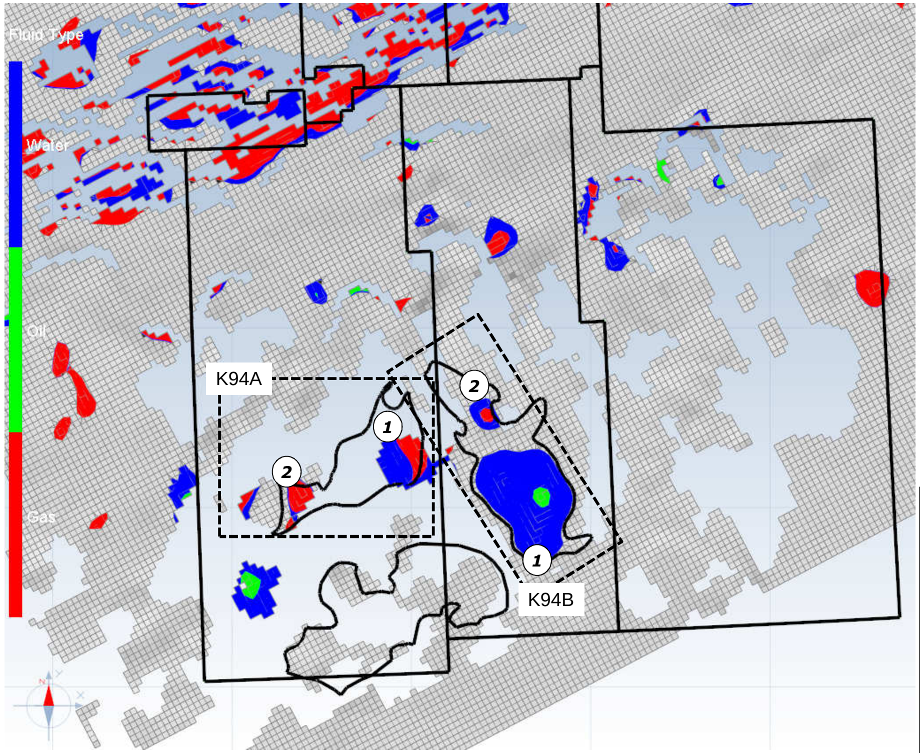


J150-A Lead Summary Plate



CHAPTER 8.3

LEADS ASSESSMENT: Comparison with TemisFlow Results

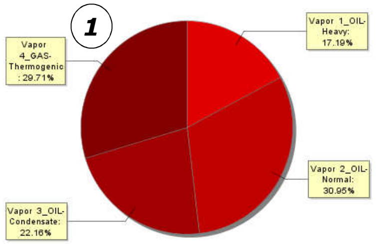


TCA results for K94

The hydrocarbon phase (red for vapor and green for liquid) corresponds to their physical state at reservoir conditions considering environmental conditions of pressure and temperature. The hydrocarbon composition bar at the base of each pie chart provides the components that will be obtained from the reservoir phase at standard conditions.

K94A

HC Phase at bottom conditions

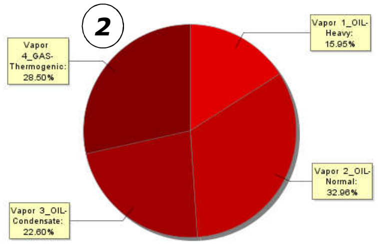


100% vapor with 70.3% HC Liquids.

Heavy Oil – Oil – Condensate - Gas

HC Composition

HC Phase at bottom conditions



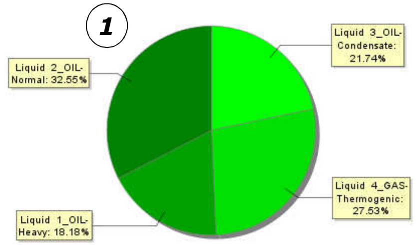
100% vapor with 71.5% HC Liquids.

Heavy Oil – Oil – Condensate - Gas

HC Composition

K94B

HC Phase at bottom conditions

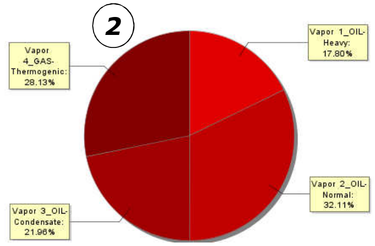


100% Liquids with 27.5% associated Gas.

Heavy Oil – Oil – Condensate - Gas

HC Composition

HC Phase at bottom conditions



100% vapor with 67.8% HC Liquids.

Heavy Oil – Oil – Condensate - Gas

HC Composition

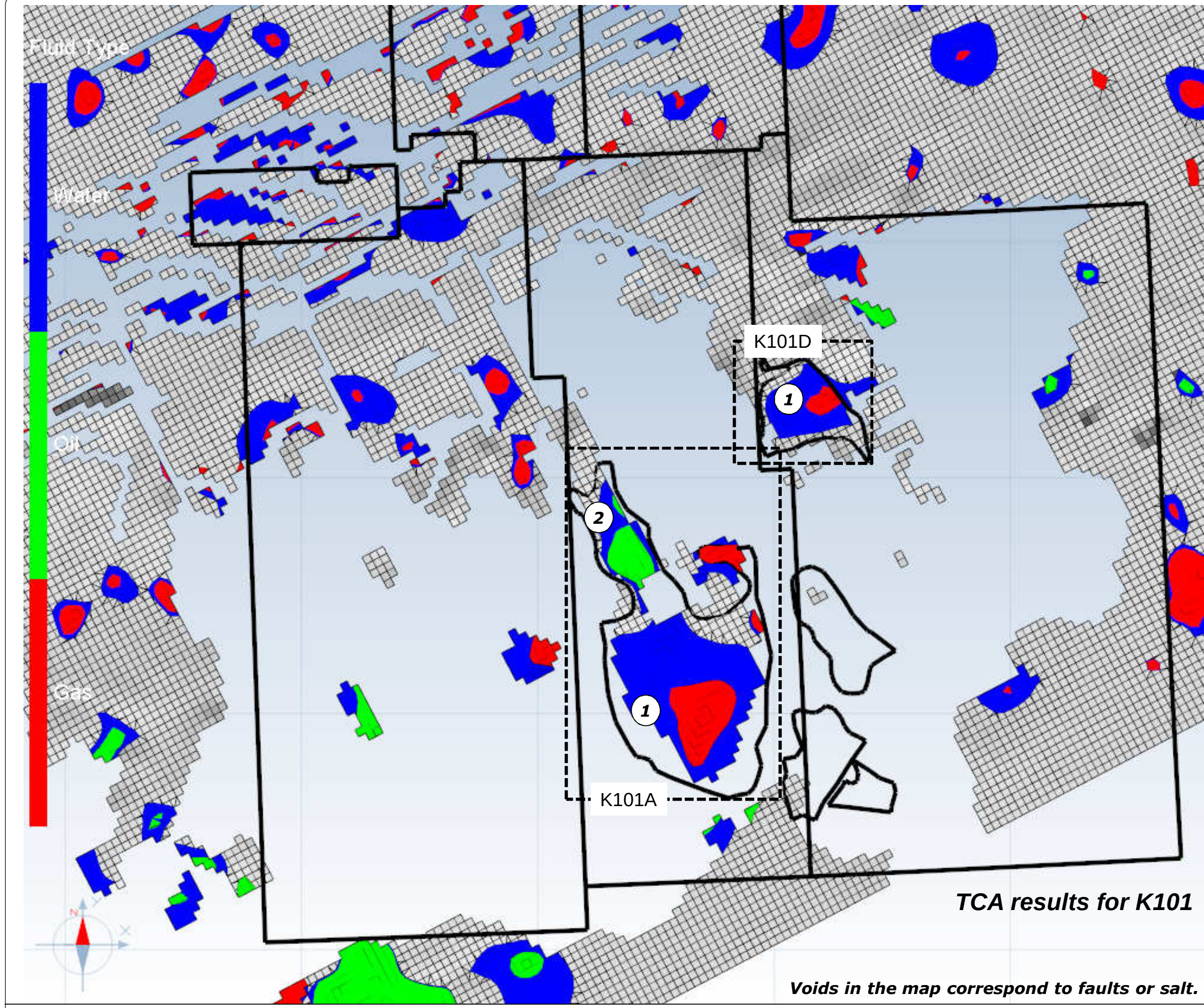
K94A Hydrocarbon Mass by fractions				
	Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]
K94A - 2	6,86E+09	1,42E+10	9,73E+09	1,23E+10
K94A - 1	1,25E+10	2,26E+10	1,62E+10	2,17E+10
	1,94E+10	3,68E+10	2,59E+10	3,39E+10

Hydrocarbons charged at leads K94A and K94B mainly correspond to oil, condensate and gas in vapor or liquid phase at bottom conditions. The gas fraction represents around 30% of trapped hydrocarbons in both leads.

Total Volume of Liquid HC [BBO]	*Total Volume of Gas [TCF]*
0,652	**1,621**

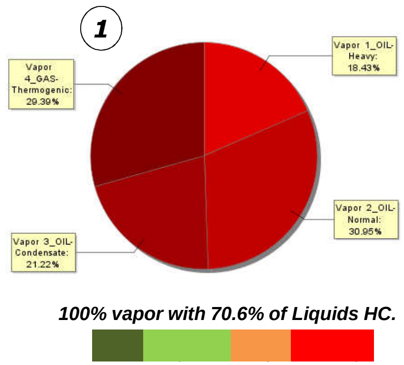
K94B Hydrocarbon Mass by fractions				
	Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]
K94B - 2	1,67E+09	3,01E+09	2,06E+09	2,64E+09
K94B - 1	1,74E+09	3,11E+09	2,08E+09	2,63E+09
	3,41E+09	6,13E+09	4,14E+09	5,27E+09

Total Volume of Liquid HC [BBO]	*Total Volume of Gas [TCF]*
0,108	**0,252**



K101A

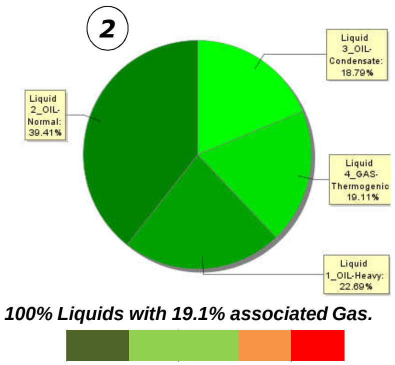
HC Phase at bottom conditions



100% vapor with 70.6% of Liquids HC.

HC Composition

HC Phase at bottom conditions

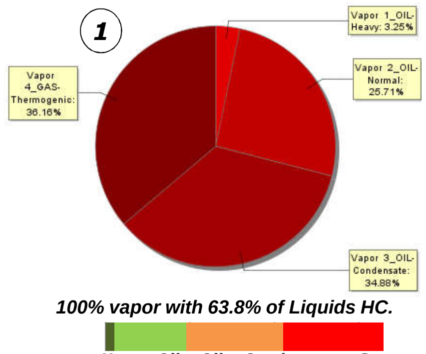


100% Liquids with 19.1% associated Gas.

HC Composition

K101D

HC Phase at bottom conditions



100% vapor with 63.8% of Liquids HC.

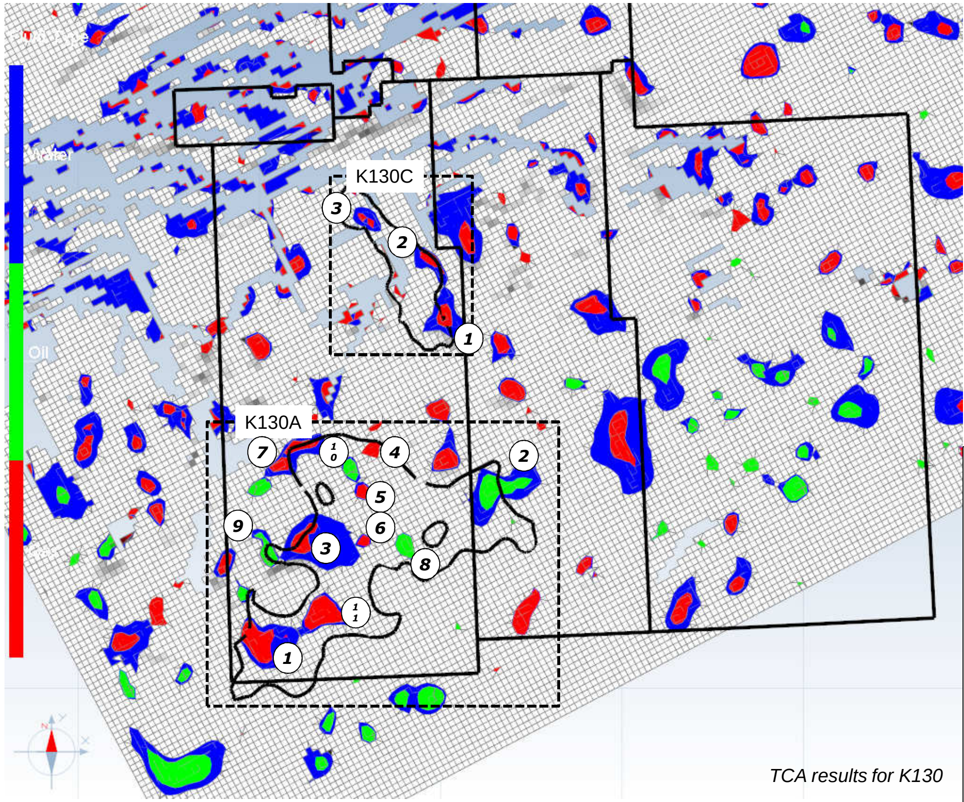
HC Composition

The hydrocarbon phase (red for vapor and green for liquid) corresponds to their physical state at reservoir conditions considering environmental conditions of pressure and temperature. The hydrocarbon composition bar at the base of each pie chart provides the components that will be obtained from the reservoir phase at standard conditions.

Hydrocarbons charged at leads K101A and K101D mainly correspond to oil, condensate and gas in vapor or liquid phase at bottom conditions. The gas fraction present in lead K101A is around 19% to 30% of trapped volume. The lead K101D, closer to the gas kitchen has around 35% of gas.

K101A Hydrocarbon Mass by fractions					
Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]		
1,79E+09	4,46E+09	3,08E+09	3,36E+09		
2,93E+08	5,96E+08	4,43E+08	5,60E+08		
1,12E+10	1,95E+10	9,28E+09	9,44E+09		
1,18E+10	1,98E+10	1,36E+10	1,88E+10	***Total Volume of Liquid HC [BBO]***	***Total Volume of Gas [TCF]***
2,51E+10	4,43E+10	2,64E+10	3,21E+10	**0,755**	**1,535**

K101D Hydrocarbon Mass by fractions					
Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]	***Total Volume of Liquid HC [BBO]***	***Total Volume of Gas [TCF]***
2,14E+08	1,69E+09	2,30E+09	2,38E+09	**0,035**	**0,114**

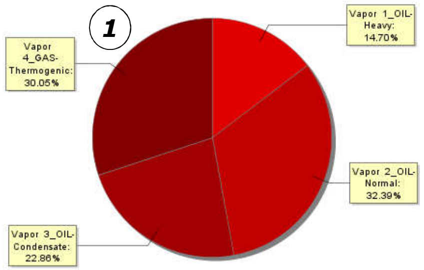


TCA results for K130

Voids in the map correspond to faults or salt.

K130A

HC Phase at bottom conditions

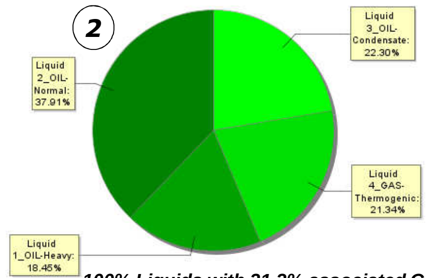


100% vapor with 69.9% of Liquids HC.

Heavy Oil – Oil – Condensate - Gas

HC Composition

HC Phase at bottom conditions

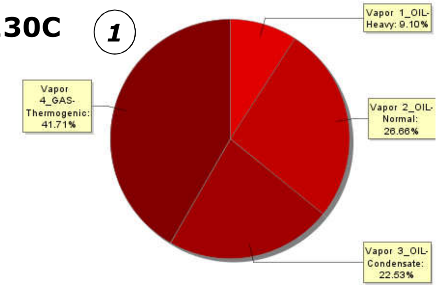


100% Liquids with 21.3% associated Gas.

Heavy Oil – Oil – Condensate - Gas

HC Composition

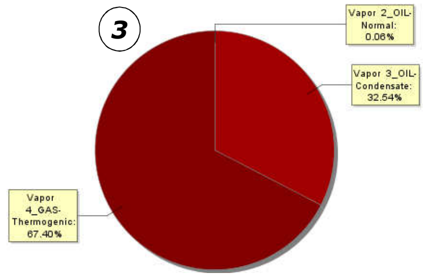
K130C



100% vapor with 58.3% of Liquids HC.

Heavy Oil – Oil – Condensate - Gas

HC Composition



100% vapor with 32.6% of Liquids HC.

Oil – Condensate - Gas

HC Composition

K130A Hydrocarbon Mass by fractions				
	Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]
K130A - 6	2,30E+08	5,12E+08	5,45E+08	8,43E+08
K130A - 2	5,99E+09	1,23E+10	7,24E+09	6,93E+09
K130A - 4	5,93E+08	1,45E+09	1,02E+09	1,14E+09
K130A - 1	4,54E+09	1,00E+10	7,07E+09	9,29E+09
K130A - 5	7,26E+08	1,50E+09	1,02E+09	1,22E+09
K130A - 7	1,07E+09	3,06E+09	2,68E+09	3,94E+09
K130A - 10	1,07E+09	2,32E+09	1,50E+09	1,64E+09
K130A - 9	1,41E+09	3,24E+09	1,80E+09	1,94E+09
K130A - 3	1,77E+09	4,12E+09	3,55E+09	5,06E+09
K130A - 11	4,65E+09	9,41E+09	6,68E+09	8,76E+09
K130A - 8	2,03E+09	3,72E+09	2,22E+09	2,56E+09
	2,41E+10	5,17E+10	3,53E+10	4,33E+10

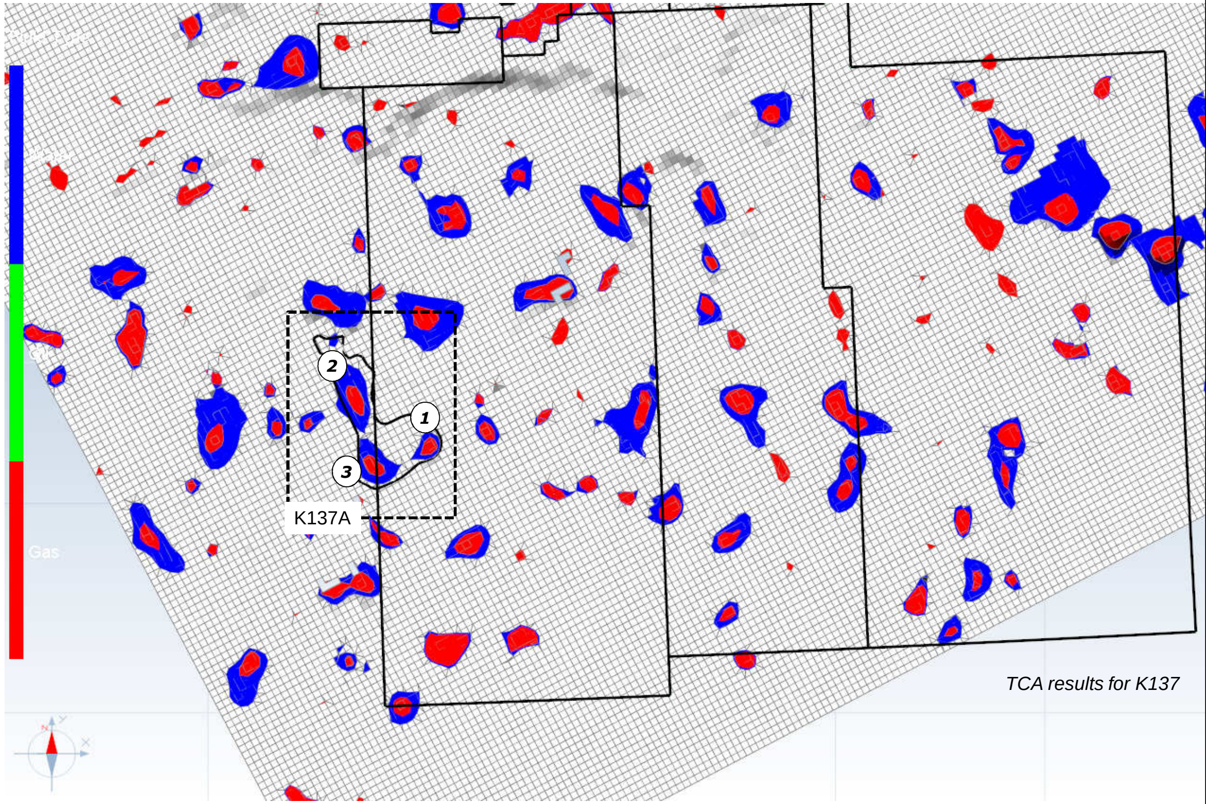
Total Volume of Liquid HC [BBO]	*Total Volume of Gas [TCF]*
0,884	2,069

The hydrocarbon phase (red for vapor and green for liquid) corresponds to their physical state at reservoir conditions considering environmental conditions of pressure and temperature. The hydrocarbon composition bar at the base of each pie chart provides the components that will be obtained from the reservoir phase at standard conditions.

Hydrocarbons charged at leads K130A and K130C mainly correspond to oil, condensate and gas in vapor or liquid phase at bottom conditions. The gas fraction present in lead K130A is around 21% to 30% of the trapped volume. The lead K130C, closer to the gas kitchen has a gas content of around 40% to 67%.

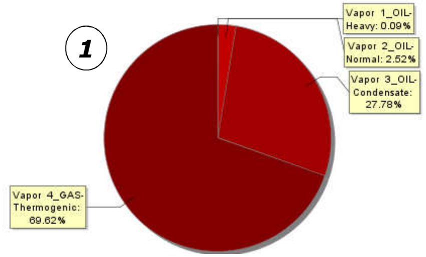
K130C Hydrocarbon Mass by fractions				
	Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]
K130C - 2	8,54E+07	1,64E+09	2,96E+09	5,34E+09
K130C - 1	9,49E+08	2,78E+09	2,35E+09	4,35E+09
K130C - 3	0	1,31E+06	7,07E+08	1,47E+09
	1,03E+09	4,42E+09	6,01E+09	1,12E+10

Total Volume of Liquid HC [BBO]	*Total Volume of Gas [TCF]*
0,095	0,533



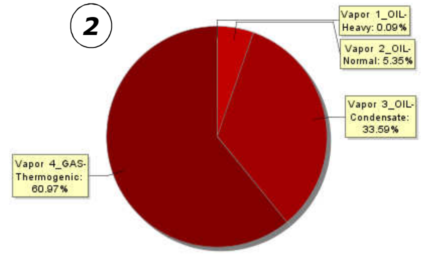
K137A

HC Phase at bottom conditions



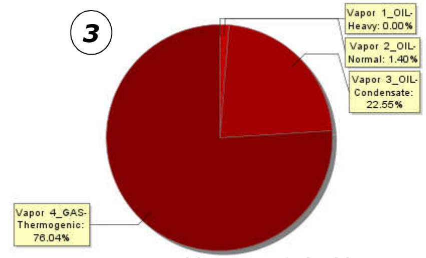
100% vapor with 30.4% of Liquid HC.

HC Composition

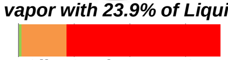


100% vapor with 39.03% of Liquid HC.

HC Composition



100% vapor with 23.9% of Liquid HC.



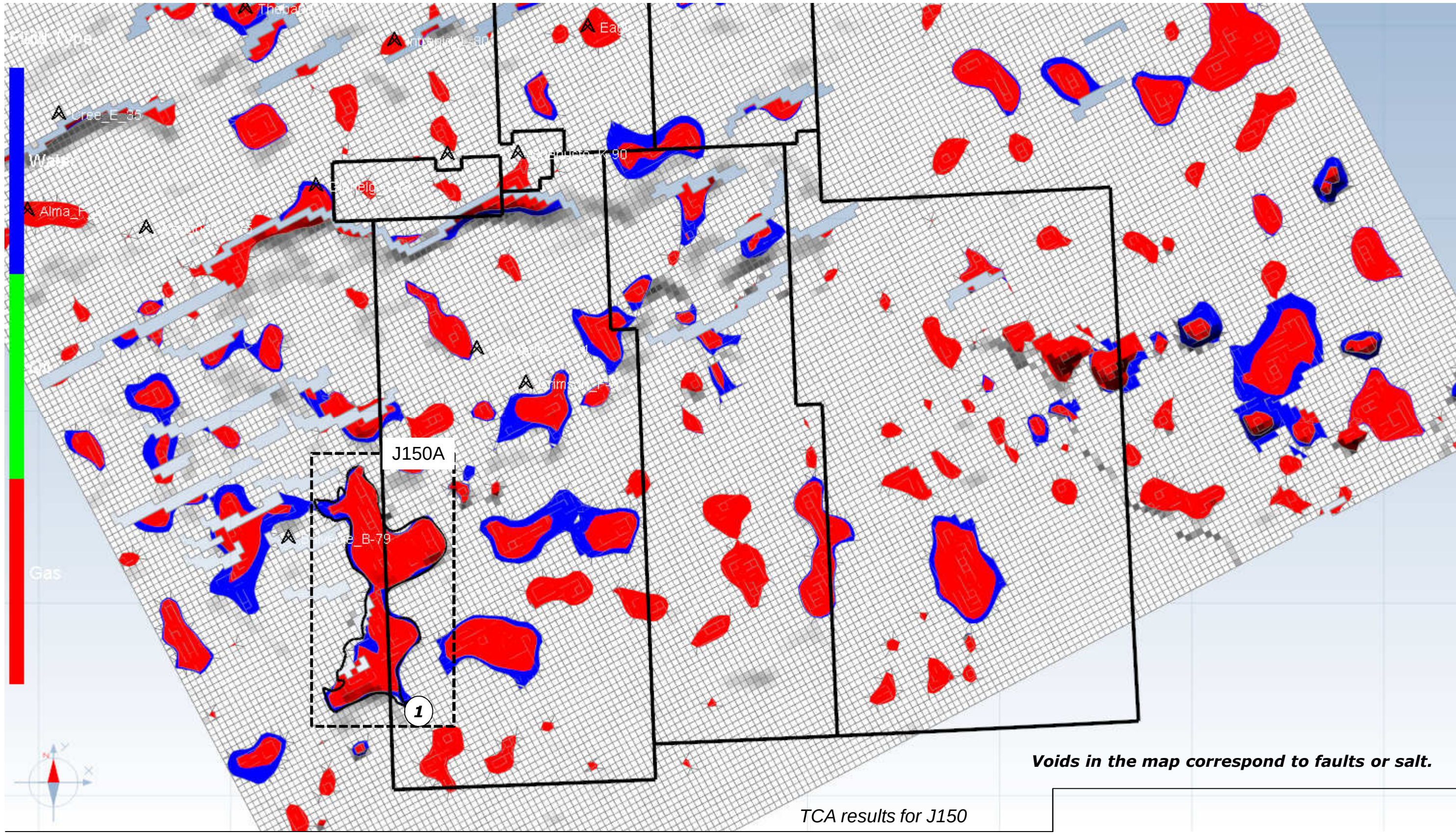
HC Composition

The hydrocarbon phase (red for vapor and green for liquid) corresponds to their physical state at reservoir conditions considering environmental conditions of pressure and temperature. The hydrocarbon composition bar at the base of each pie chart provides the components that will be obtained from the reservoir phase at standard conditions.

The lead K137A mainly corresponds to oil, condensate and gas in vapor phase at bottom conditions. The gas fraction represents around 60% to 76% of the trapped volume.

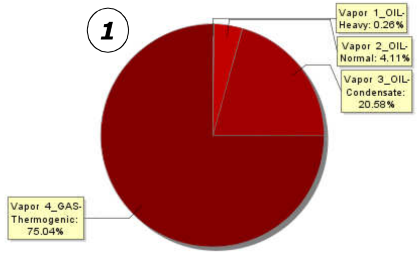
K137A Hydrocarbon Mass by fractions				
	Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]
K137A - 1	1,78E+06	4,92E+07	5,44E+08	1,36E+09
K137A - 2	1,78E+06	1,04E+08	6,53E+08	1,19E+09
K137A - 3	7,69E+04	2,55E+07	4,09E+08	1,38E+09
	3,64E+06	1,79E+08	1,61E+09	3,93E+09

Total Volume of Liquid HC [BBO]	*Total Volume of Gas [TCF]*
0,016	0,187



TCA results for J150

J150A



100% vapor with 65.9% of Liquid HC.

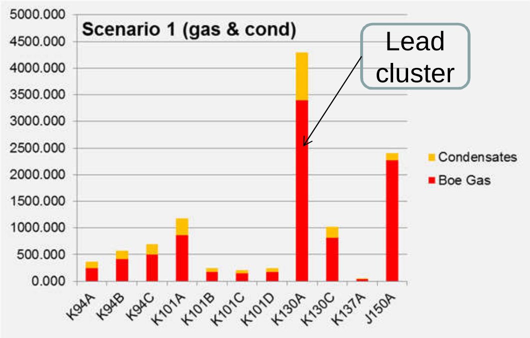
HC Composition

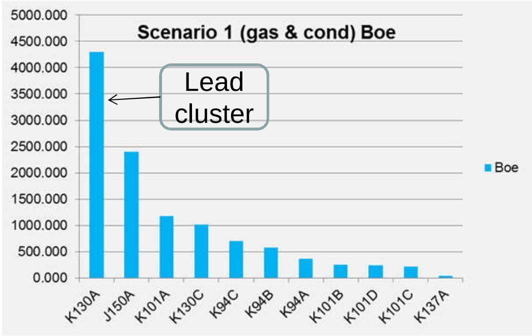
The hydrocarbon phase (red for vapor and green for liquid) corresponds to their physical state at reservoir conditions considering environmental conditions of pressure and temperature. The hydrocarbon composition bar at the base of each pie chart provides the components that will be obtained from the reservoir phase at standard conditions.

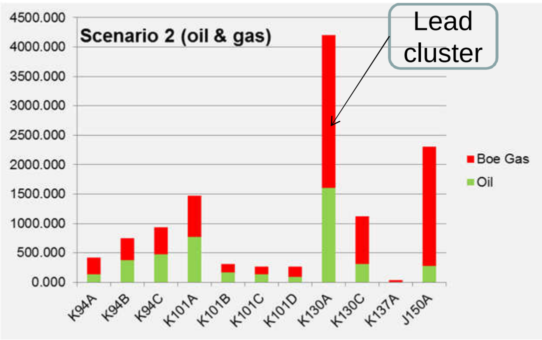
The lead K150A mainly corresponds to oil, condensate and gas in vapor phase at bottom conditions. The gas fraction represents 75% of the trapped volume.

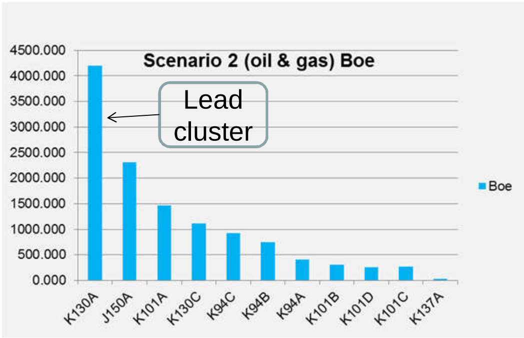
J150A Hydrocarbon Mass by fractions					
Total Heavy OIL Mass [kg]	Total OIL Mass [kg]	Total Condensate Mass [kg]	Total GAS Thermogenic Mass [kg]	***Total Volume of Liquid HC [BBO]***	***Total Volume of Gas [TCF]***
K150A - 1 4,23E+08	6,58E+09	3,30E+10	1,20E+11	**0,349**	**5,740**

Graphics showing volumes per lead (left) and lead ranking (right) for both scenarios (Gas and Condensate vs Oil and Gas)









Leads Ranking

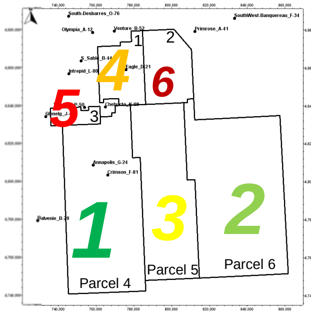
A summary of leads assessment from both the conventional geophysical and TemisFlow modelling approaches is presented here.

Results from the conventional geophysical approach are shown on the graphics on the left and volumes are summarized in Table 1. Results show a large range of values for both Oil and Gas, with similar results for Scenario 1 and 2. Gas values range from 0.2 Tcf (K137) to 15-19 Tcf (K130A) with most of the values around 2 to 4 Tcf. Oil values range from 2-4 MMbbl (K137) to 1600 MMbbl (K130A) with most of the values between 140 to 470 MMbbl. It should be noted that some large volumes are linked to lead clusters such as the K130A.

Results of the lead assessment from TemisFlow basin modelling is presented below and compared to the geophysical approach in Table 1. Total volumes for oil and for gas are presented for each parcel and for each play (Table 2). Results show a large range of values for both Oil and Gas, with the largest volumes in deep water. Gas values range from 5 Tcf (parcel 3) to 28 Tcf (Parcel 4). Oil values range from 392 MMbbl (Parcel 2) to 3762 MMbbl (Parcel 4) with again the largest volumes in deep water.

Parcels ranking shows that deep water parcels rank better than those on the shelf, with Parcel 4 as the most attractive area. When expressed into volume per surface unit, Parcel 1 in the shelf appears to be the most attractive, but Parcel 4 still ranks second (see also Chapter 7, PL. 7.3.25).

Key numbers: Total ~ 12 bnbbls liquids + 80 tcf gas (~26 mmboe)



Parcel ranking per volume

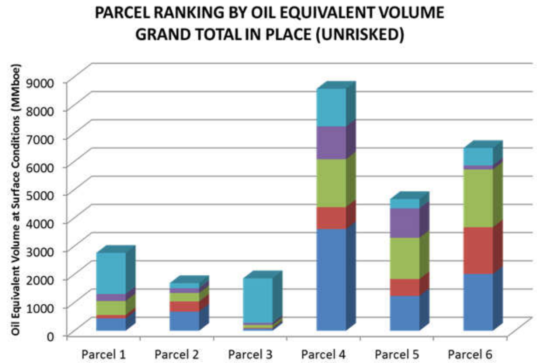


Table 1: Resources summary by stratigraphic position. Grand totals are shown in MMbbl in the last row

Play	Lead#	Gas & Condensates (S1)				Oil & Gas (S2)				TemisFlow			
		Gas	Boe Gas	Condensates	Boe	Gas	Boe Gas	Oil	Boe	Gas	Boe Gas	Liquid	Boe
		Tcf	MMbbl	MMbbl	MMbbl	Tcf	MMbbl	MMbbl	MMbbl	Tcf	MMbbl	MMbbl	MMbbl
K94	K94A	1.40	241.35	124.30	365.65	1.62	278.46	136.13	414.59	1.62	279.45	652	931.45
	K94B	2.40	413.75	157.50	571.25	2.16	372.77	370.24	743.02	0.25	43.44	108	151.44
	K94C	2.91	501.74	195.13	696.87	2.68	461.83	469.14	930.97	-	-	-	-
K101	K101A	5.00	861.97	319.80	1181.77	4.05	698.48	771.88	1470.36	1.54	264.63	755	1019.63
	K101B	1.03	178.21	68.59	246.80	0.86	148.59	163.33	311.93	-	-	-	-
	K101C	0.89	152.72	59.45	212.17	0.73	126.21	138.64	264.84	-	-	-	-
	K101D	1.00	172.39	66.70	239.09	1.03	177.45	84.69	262.14	0.11	19.65	35	54.65
130	K130A	19.70	3396.18	905.10	4301.28	15.04	2593.56	1606.20	4199.76	2,07	356,86	884	1240,857
	K130C	4.70	810.26	205.50	1015.76	4.66	803.97	313.03	1117.00	0.53	91.89	95	186.89
137	K137A	0.20	34.48	2.40	36.88	0.16	27.67	4.55	32.22	0.19	32.24	16	48.24
150	J150A	13.20	2275.61	124.30	2399.91	11.78	2031.47	276.04	2307.51	5.74	989.55	349	1338.55
	Total	52.43	9038.66	2228.77	11267.43	44.78	7720.46	4333.89	12054.35	12,05	2077.70	2894	4971.7

Table 2: TemisFlow Grand Total Volume and volume per Surface Area for all leads within each parcel

	Grand Total			Volume per Surface Area		
Parcels	Vol Gas (Tcf)	Vol Oil (MMbbl)	Total Volume (MMboe)	Vol Gas (bcf/km²)	Vol Oil (Mbbl/km²)	Total Volume (Mboe/km²)
Parcel 1	7	1512	2760	31	6418	11718
Parcel 2	8	392	1689	10	501	2158
Parcel 3	5	1072	1859	5	1144	1984
Parcel 4	28	3762	8576	8	1031	2350
Parcel 5	15	2063	4667	6	799	1807
Parcel 6	18	3319	6477	1	270	528
Total Parcels	81	12120	26028	4	592	1272