Esso Australia Pty Ltd
Exploration Department

SCALLOP-1

QUANTITATIVE PETROPHYSICAL INTERPRETATION

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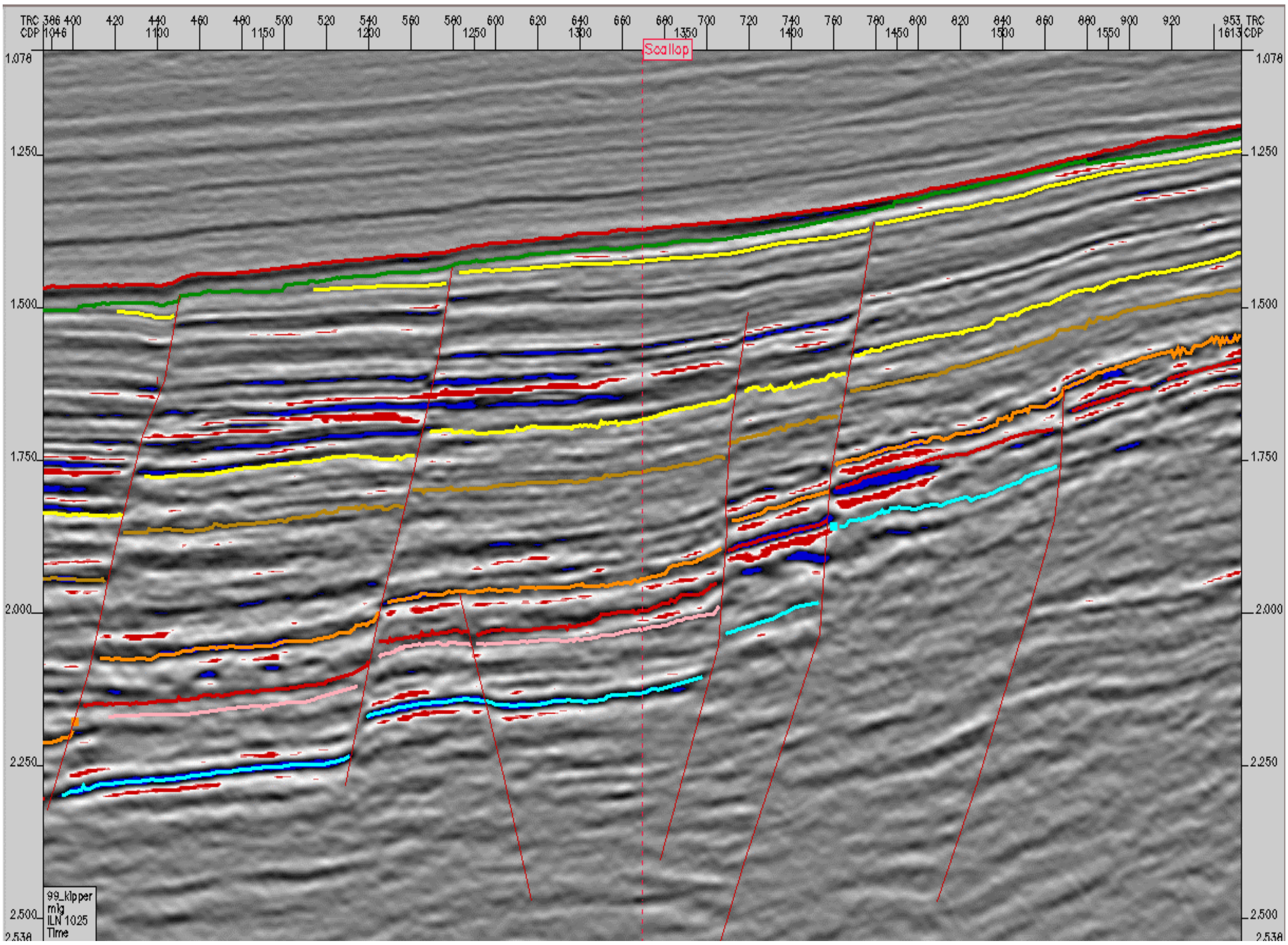

SUMMARY

The Scallop-1 wildcat exploration well, located in VIC/RL2, was drilled to test the hydrocarbon potential of the fluvial reservoirs of the Golden Beach Group mapped within a low side fault dependent closure in the Scallop fault block.

The well found water-bearing sands in the interval 1726 - 2611.6m MD. Below 2611.6m MD some 12 thin hydrocarbon sands interspersed with water-bearing sands have been identified. Of these, only 9 of the sands are of any significance from a reservoir quality and hydrocarbon saturation standpoint. Of the 9 "significant" hydrocarbon-bearing sands, two are oil bearing. These sands are found within an interval 2611.6 - 2883m MD, dominated by volcanic layers. All the gas sands are found between TD and 2883m, below the main series of volcanic layers.

The average effective porosities in the hydrocarbon bearing reservoirs range from 10% to 15%, with effective water saturation ranging from 39% to 75%.

The total net hydrocarbon pay is estimated to be 29.6m based on a porosity cut-off of 10% for oil and 8% for gas. Of the total net, 6.3m is estimated to be oil pay and 23.3m is estimated to be gas pay.
If only the "significant" hydrocarbon sands are taken into consideration the total net pay is reduced to 23.3m with all the reduction being in the net gas pay.

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1.0 Introduction

1.1 General

The Scallop-1 wildcat exploration well, located in VIC/RL2 (Fig. 1.1), was drilled to test the hydrocarbon potential of the fluvial reservoirs of the Golden Beach Group mapped within a low side fault dependent closure in the Scallop fault block. The well was spudded on the 2nd of February 2003, drilled to a total depth of 3174mRT (Driller) 3177.5mRT (Logger) and plugged and abandoned. The primary objective of this quantitative petrophysical interpretation was to evaluate the reservoirs for porosity, water saturation and net pay.

Note: All depths quoted in this report are logged mRT unless otherwise specified

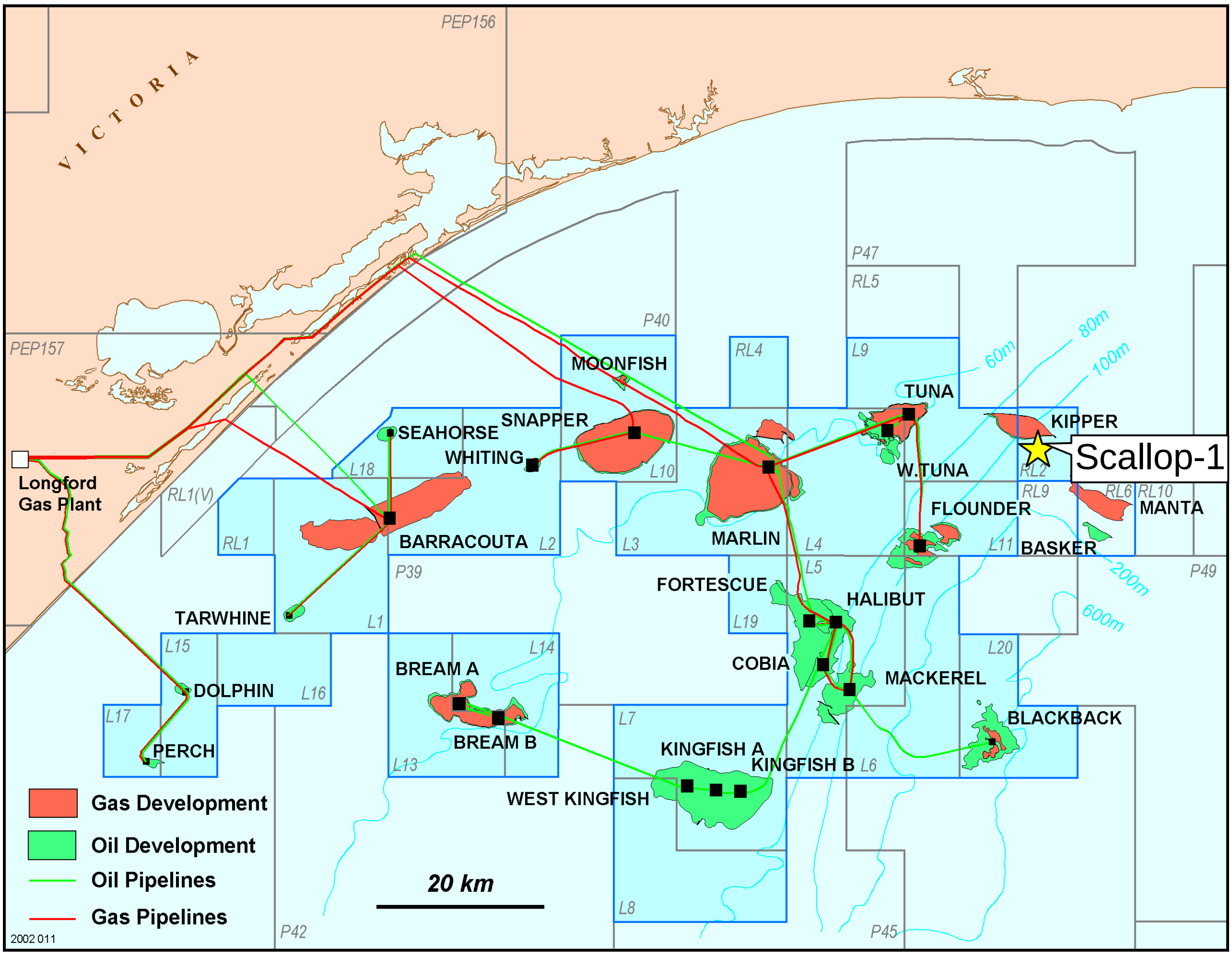


Fig 1.1 Scallop-1 Location Map

Data

2.1 Wireline Logs

The open hole logs run in the well are listed in Table 2.1.

Survey /Log	Company	Top (m MDRT)	Bottom (m MDRT
RAB8-MWD	Anadril-Schlumberger	2900	3174
PEX-HALS-HNGS-LEHQT	Schlumberger	900.2	3174.5
FMI-DSI-GR-LEHQT	Schlumberger	135.0	3177.5
MDT-GR-LEHQT	Schlumberger	1780.0	3162.0
DUAL CSAT-VSP	Schlumberger	173.6	3171.0
CST-GR4	Schlumberger	1717.0	3165.0

Table 2.1 Summary of Wireline Logs

2.2 Logging Suite 1

The PEX resistivity-density-neutron and gamma ray logs were acquired in high-resolution mode from 3174.5m to 1640m at 1800ft/hr. Above 1640m the same logs were acquired in standard resolution mode to 900.2m. The gamma ray logs from the HNGS measurement was corrected for potassium and barite in the mud. The DSI was logged in BCR mode from TD to at 3177.5m to the 13.375-inch casing shoe. The DSI was then logged in P & S mode together with GR through the casing until signal was lost at 270m. Logging was continued with the GR to 135m. The problems encountered during the logging job were:

- failure in the telemetry system enabling the tools to power up and establish communication between the MDT modules
- the FMI calipers were only partially open over the interval 3177 - 3102m. Required a second pass over this interval with the FMI.

2.3 Log Quality and Log Responses

The overall data quality of the resistivity, density-neutron logs and the MDT pressure data appear to be good and the calibration data appear to be acceptable

2.4. Data Processing

A combination of the high resolution and standard resolution logs were selected for the final petrophysical evaluation. The logs chosen for the interpretation are as follows:

Logs	Resolution
HRLD, RXO8, RHO8, HNPO	Hi-Res
PEFZ, HCGR, HFK	Standard Res

The neutron logs HNPO appeared to be a bit "noisy" and it was smoothed using a 5 point equal weighting filter.
It has been observed that in the Gippsland Basin the PEF values recorded by Schlumberger's nuclear density logs tend to be high and therefore the following adjustment to the PEFZ was made:

$$PEFZadjus = PEFZ - 0.53$$

No environmental corrections other than those made at the time of logging were made.
The RHO8 was chosen as the base log for depth matching purposes.. The HRLD, HRLS, RXO8 were then depth matched to RHO8.
The volumetric photoelectric factor U was computed using the following relationship:

$$U = PEFZ * ((RHO8 + 0.1883) / 1.0704)$$

A temperature log over the interpretation interval was created using the following data:

Depth	Temperature (deg.C)
1780	78.7
3170	118.5

These input temperature values were computed from the temperatures recorded by the MDT.
Flags indicating coal intervals (Flag_coal), volcanic intervals (Flag_volc) and hydrocarbon densities (Flag_rhoh, gas= 0.25gm/cc, oil=0.7gms/cc) were also created.

3.0 Quantitative Interpretation

3.1 Methodology

Schlumberger's Geoframe ELAN+ module was used to determine mineral volumes, Total Porosity, (PHIT), Effective Porosity (PHIE or PIGN), Total Water Saturation (SWT) and Effective Water Saturation (SUWI or SWE)..
Net reservoir and net pay were then calculated using a PHIE cut-off of 0.10 (10%) for oil and 0.08 (8%) for gas.

The ELAN+ model and input parameters are described in Appendix 1

3.2 Logs Used

The logs used in the ELAN+ model were HCGR, HRLD, RXO8, RHO8, HNPO, U and HFK.

3.3 Formation Salinities and Input Porosities

The formation water salinities were calculated using the RWA method for the water bearing intervals. An *m*=2, *a*=1 and a BHT=118.5^0 C (estimated from the MDT pressure testing run) were used in the calculations. The following table lists the salinities and input porosities for computing the zone parameters in ELAN+:

Depth Int	Sand Salinity(ppm)	Clay Salinity(ppm)	Tot. Por. Sand	Tot. Por. Clay
1700 - 2200	40000	10000	0.25	0.30
2200 - 2628.8	30000	10000	0.22	0.18
2628.8 - 2636	80000	10000	0.22	0.18
2636 - 3170	30000	6000	0.17	0.15

In the interval 2628.8 - 2636 the reservoir was determined to be oil bearing from the MDT, sidewall and cuttings data. To obtain meaningful water saturation values an apparent salinity of 80000 ppm NaCl equivalent was selected.

3.1 Results and Observations

It is clear from the interpretation that the sands in the interval 1726 - 2611.6m are all water bearing. Below 2611.6m, the petrophysical analysis and MDT data have identified some 12 thin hydrocarbon-bearing sands interspersed with water-bearing sands. Of these 12 hydrocarbon-bearing sands only 9 may be considered to be of any significance from a reservoir quality and hydrocarbon saturation standpoint. Of the 9 "significant" hydrocarbon sands, two sands are clearly oil bearing. The shallower of the two oil zones, 2628.6 - 2635.6m has very low resistivity and was only identified as an oil zone by mud log shows, the sidewall core shows and subsequent MDT sampling. The observed low resistivity in this sand could be due to the presence of conductive minerals other than clay. To obtain meaningful water saturations an apparent formation salinity of 80000ppm NaCl equivalent was used in this sand in the petrophysical evaluation. Below 2635m the shows in a sidewall core suggest the interval 2635.7 - 2638m is probably a residual oil zone. It is interesting to note that the two oil zones are found in an interval dominated by volcanic layers.

All of the gas zones are found in the interval TD - 2883, below the main series volcanic layers. Of the 10 gas zones identified, only 7 of them are of any significance from a reservoir quality and gas saturation standpoint. Of these the most significant gas reservoirs are found below the lowest volcanic layer at 3093m. The most significant of these gas sands is the gas sand that extends from 3138.5 – 3147.1m. Mud log shows, MDT pressure data and the petrophysical analysis clearly show this to be a gas sand; however, MDT “pump-out” and sampling only recovered some gas and mostly water. Similarly, MDT “pump-outs” at 3059m and 2983.2m, both these depths being within interpreted gas sands also recovered water.

Effective porosities and Effective water saturations of the hydrocarbon bearing sands range from 10% to 15% and 39% to 75% respectively

4.0 Net Reservoir and Net Pay

4.1 General

Net reservoir and net pay were determined using an effective porosity cut-off of 0.1(10%) for oil and 0.08(8%).

Taking into account the 12 hydrocarbon bearing zones the total net pay in is estimated to be **29.6m**. This consists of 6.3m of net oil pay and 23.3m net gas pay. If only the 9 'significant' hydrocarbon zones are considered, the total net pay is **25.3m** and this consists of 6.3m net oil and 19m net gas pay.

Table 4.1 is a summary of the results of the analysis

SCALLOP 1

Petrophysical Analysis Summary 1720 - 3165m

Net Thickness (for oil bearing intervals) is based on a PHIE Cut-off > :0.10 volume per volume
Net Thickness (for gas bearing intervals) is based on a PHIE Cut-off > :0.08 volume per volume

Depth Reference MDKB
Mean PHIE, Mean VSH, Mean SWE is of Net Thickness interval
Y= yes N= no

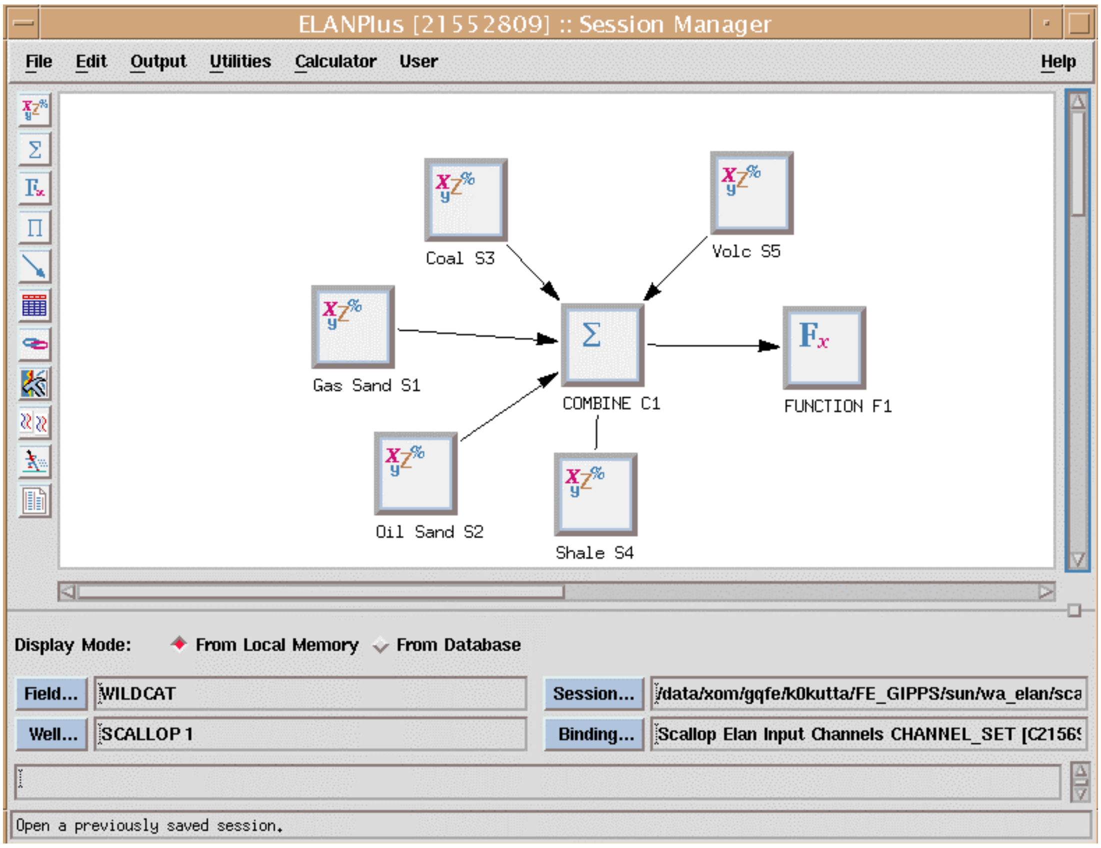
									All	Significant
Top Depth	**Bottom Depth**	**Gross Thickness**	**Net Thickness**	**Net/Gross Ratio**	**Mean VSH**	**Mean PHIE**	**Mean SWE**	**Comments**	**Net Pay (12 zones)**	**Net Pay (9 zones)**
1726.96	1767.89	40.9	12.4	0.303	0.477	0.128	1.000	Water bearing		
1770.95	2204.29	433.3	271.3	0.626	0.166	0.215	1.000	Water bearing		
2204.35	2435.51	231.2	89.0	0.385	0.214	0.181	1.000	Water bearing		
2435.57	2505.99	70.4	28.1	0.399	0.155	0.178	1.000	Water bearing		
2512.45	2517.05	4.6	3.6	0.783	0.262	0.159	1.000	Water bearing		
2523.96	2541.45	17.5	1.0	0.057	0.284	0.116	1.000	Water bearing		
2548.05	2557.95	9.9	8.7	0.879	0.205	0.175	1.000	Water bearing		
2559.55	2568.95	9.4	8.3	0.883	0.184	0.168	1.000	Water bearing		
2581.70	2585.50	3.8	2.4	0.632	0.280	0.158	1.000	Water bearing		
2590.70	2596.90	6.2	2.1	0.339	0.295	0.156	1.000	Water bearing		
2601.70	2604.16	2.5	0.3	0.122	0.390	0.110	1.000	Water bearing		
2607.70	2611.60	3.9	0.5	0.128	0.343	0.106	1.000	Water bearing		
2628.65	2635.66	7.0	3.7	0.528	0.271	0.136	0.534	Oil bearing	Y	Y
2635.80	2638.00	2.2	0.6	0.273	0.224	0.152	1.000	Water bearing		
2713.98	2715.87	1.9	0.8	0.423	0.143	0.138	1.000	Water bearing		
2739.08	2741.80	2.7	1.7	0.625	0.113	0.144	1.000	Water bearing		
2747.58	2754.79	7.2	2.1	0.291	0.114	0.122	1.000	Water bearing		
2758.66	2770.71	12.1	8.8	0.730	0.118	0.141	1.000	Water bearing		
2838.19	2841.37	3.2	2.6	0.818	0.129	0.158	0.393	Oil bearing	Y	Y
2888.28	2891.51	3.2	0.9	0.279	0.341	0.119	0.448	Gas bearing	Y	Y
2897.00	2901.47	4.5	2.2	0.492	0.243	0.129	0.531	Gas bearing	Y	Y
2912.08	2923.21	11.1	5.0	0.449	0.145	0.120	1.000	Water bearing		
2928.86	2931.06	2.2	1.4	0.636	0.228	0.132	1.000	Water bearing		
2939.84	2949.81	10.0	6.6	0.662	0.125	0.147	1.000	Water bearing		
2950.35	2956.49	6.1	3.5	0.564	0.127	0.110	1.000	Water bearing		
2959.19	2967.26	8.1	1.0	0.124	0.205	0.095	1.000	Water bearing		
2978.45	2984.45	6.0	1.2	0.200	0.269	0.099	0.478	Gas bearing	Y	Y
2986.19	2988.08	1.9	0.1	0.053	0.354	0.089	1.000	Water bearing		
3002.58	3003.71	1.1	0.5	0.443	0.190	0.085	0.750	Gas bearing	Y	
3004.56	3010.08	5.5	0.6	0.109	0.255	0.108	1.000	Water bearing		
3015.28	3016.48	1.2	0.4	0.333	0.314	0.091	1.000	Water bearing		
3028.76	3031.75	3.0	2.2	0.736	0.266	0.122	0.631	Gas bearing	Y	
3045.50	3046.66	1.2	0.6	0.517	0.206	0.119	1.000	Water bearing		
3054.47	3055.85	1.4	0.5	0.362	0.299	0.088	1.000	Water bearing		
3058.13	3063.47	5.3	1.6	0.300	0.265	0.097	0.674	Gas bearing	Y	
3099.12	3102.21	3.1	1.2	0.388	0.263	0.108	0.473	Gas bearing	Y	Y
3103.74	3109.80	6.1	4.7	0.776	0.197	0.131	0.504	Gas bearing	Y	Y
3115.88	3116.89	1.0	0.0	0.000						
3118.12	3124.91	6.8	2.7	0.398	0.180	0.130	0.305	Gas bearing	Y	Y
3127.29	3129.49	2.2	0.5	0.227	0.308	0.102	0.885	Water bearing		
3134.20	3135.02	0.8	0.0	0.000						
3138.49	3147.14	8.6	6.1	0.705	0.198	0.114	0.376	Gas bearing	Y	Y
3152.75	3157.45	4.7	2.0	0.426	0.191	0.110	1.000	Water bearing		
3161.15	3162.41	1.3	0.6	0.476	0.215	0.103	1.000	Water bearing		
			12 Zones	**9 Zones**						
Ney Oil Pay			6.3	6.3						
Net Gas Pay			23.3	19						
Total Net Pay			**29.6**	**25.3**						

Table 4.1 Petrophysical Summary 1726 - 3165m

APPENDIX 1

Scallop - 1

ELAN+ Analysis Model & Parameters



Scallop-1 Elan + Model

Elan Process Definition

```
Process            SOLVE1 "Gas Sand"
Equations          RHOB       NPHI       U          CXDC_DWA   CUDC_DWA   WWK
Volumes            QUAR       ORTH       ILLI       XWAT       UWAT       XGAS
UGAS

User Constraints
constraint(minXHyd, 0.2*UGAS + 0.2*UOIL - XGAS - XOIL < 0)
constraint(maxXHyd, -0.8*UGAS - 0.8*UOIL + XGAS + XOIL < 0)

Constraint Zones   Bottom                    Top
UNDEFINED          3163.0000(m )       1720.0000(m )

Constraints Applied
      UNDEFINED    - minXHyd
      UNDEFINED    - maxXHyd
      UNDEFINED    - IrreducibleXWater
      UNDEFINED    - IrreducibleUWater
      UNDEFINED    - WaterBaseMud_SXO_gt_SW
```

```
Process            SOLVE2 "Oil Sand"
Equations          RHOB      NPHI      U         CXDC_DWA  CUDC_DWA  WWK
Volumes            QUAR      ORTH      ILLI      XWAT      UWAT      XOIL
UOIL

User Constraints
constraint(minXHyd, 0.2*UGAS + 0.2*UOIL - XGAS - XOIL < 0)
constraint(maxXHyd, -0.8*UGAS - 0.8*UOIL + XGAS + XOIL < 0)

Constraint Zones   Bottom                   Top
UNDEFINED          3163.0000(m )      1720.0000(m )

Constraints Applied
      UNDEFINED    - minXHyd
      UNDEFINED    - maxXHyd
      UNDEFINED    - IrreducibleXWater
      UNDEFINED    - WaterBaseMud_SXO_gt_SW
      UNDEFINED    - IrreducibleUWater
```

```
Process            SOLVE3 "Coal"
Equations          RHOB
Volumes            COAL

Constraint Zones   Bottom                   Top
UNDEFINED          3163.0000(m )      1720.0000(m )
```

```
Process            SOLVE4 "Shale"
Equations          RHOB      NPHI      WWK
Volumes            QUAR      ILLI      XWAT      UWAT

Constraint Zones   Bottom                   Top
UNDEFINED          3163.0000(m )      1720.0000(m )
```

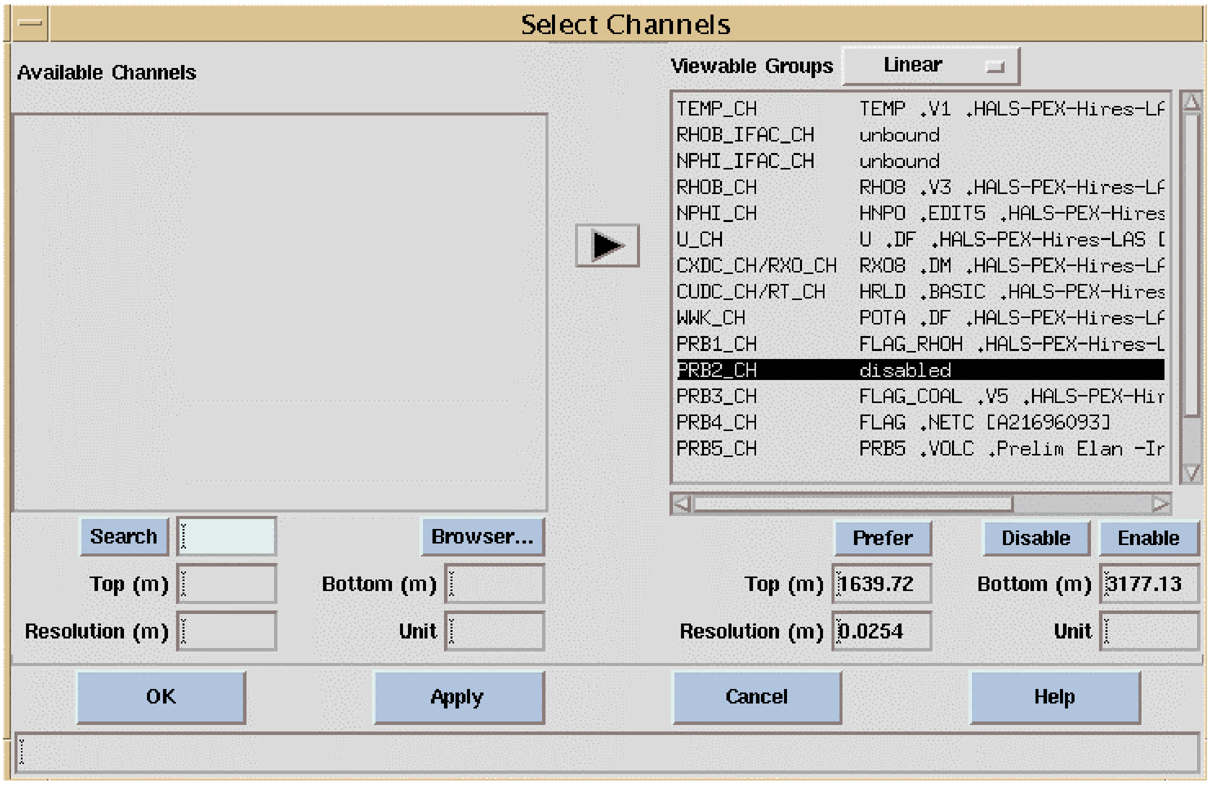
```
Process            SOLVE5 "Volc"
Equations          RHOB
Volumes            IGNE

Constraint Zones   Bottom                   Top
UNDEFINED          3163.0000(m )      1720.0000(m )
```

```
Process            COMBINE 1 "COMBINE"
Order              SOL.2 SOL.1 SOL.4 SOL.3 SOL.5
Combine Method
      "P & T1.1    " 10377.2969 (m ) Internal Average
```

Probability Functions

```
probability(SOL.5, PRB5_CH)
probability(SOL.3, PRB3_CH)
prob4 = linear(ILLI_VOL, 0.4, 0, 0.6, 1)
probability(SOL.4, prob4)
prob1 = if(PRB1_CH <= 0.3, 1, 0)
probability(SOL.1, prob1)
```

```
Process              FUNCTION 1 "FUNCTION"
Outputs              VCL        SWT        SUWI       PIGN       PHIT
User-defined Function swt_cmp = (UWAT_VOL + XBWA_VOL)/(UWAT_VOL + XBWA_VOL + UGAS_VOL +
UOIL_VOL)
output(SWT, swt_cmp)
```



Logs Used in Elan+ Interpretation

Parameter	Value	Parameter	Value
RHOB_QUAR	2.650(g/cm3)	RHOB_CALC	2.710(g/cm3)
RHOB_ORTH	2.570(g/cm3)	RHOB_ILLI	2.780(g/cm3)
RHOB_KAOL	2.620(g/cm3)	RHOB_COAL	1.200(g/cm3)
RHOB_IGNE	3.200(g/cm3)	RHOB_XOIL	0.700(g/cm3)
RHOB_UOIL	0.700(g/cm3)	RHOB_XBWA	1.000(g/cm3)
NPHI_CALC	0.000(m3/m3)	NPHI_ORTH	-0.010(m3/m3)
NPHI_ILLI	0.247(m3/m3)	NPHI_KAOL	0.450(m3/m3)
NPHI_COAL	0.450(m3/m3)	NPHI_IGNE	0.000(m3/m3)
NPHI_XWAT	1.000(m3/m3)	NPHI_UWAT	1.000(m3/m3)
NPHI_XOIL	1.000(m3/m3)	NPHI_UOIL	1.000(m3/m3)
NPHI_XBWA	1.000(m3/m3)	U_QUAR	5.000( )
U_CALC	14.100( )	U_ORTH	8.700( )
U_ILLI	9.000( )	U_KAOL	5.100( )
U_COAL	5.000( )	U_IGNE	14.000( )
U_UWAT	0.000( )	U_XOIL	0.136( )
U_UOIL	0.000( )	U_XGAS	0.012( )
U_UGAS	0.000( )	U_XBWA	0.398( )
CXDC_ILLI	-999.250(mS/m)	CXDC_XBWA	-999.250(mS/m)
CUDC_ILLI	-999.250(mS/m)	CUDC_KAOL	-999.250(mS/m)
CUDC_UBWA	-999.250(mS/m)	GR_QUAR	55.000(gAPI)
GR_CALC	11.000(gAPI)	GR_ILLI	210.000(gAPI)
GR_KAOL	104.000(gAPI)	GR_COAL	120.000(gAPI)
GR_IGNE	-999.250(gAPI)	GR_XWAT	0.000(gAPI)
GR_UWAT	0.000(gAPI)	GR_XOIL	0.000(gAPI)
GR_UOIL	0.000(gAPI)	GR_XGAS	0.000(gAPI)
GR_UGAS	0.000(gAPI)	GR_XBWA	0.000(gAPI)
WWK_QUAR	0.005(kgf/kgf)	WWK_ORTH	0.102(kgf/kgf)
WWK_ILLI	0.043(kgf/kgf)	WWK_COAL	0.000(kgf/kgf)
WWK_IGNE	0.000(kgf/kgf)	WWK_XWAT	0.000(kgf/kgf)
WWK_UWAT	0.000(kgf/kgf)	WWK_XOIL	0.000(kgf/kgf)
WWK_UOIL	0.000(kgf/kgf)	WWK_XGAS	0.000(kgf/kgf)
WWK_UGAS	0.000(kgf/kgf)	WWK_XBWA	0.000(kgf/kgf)
CT1_QUAR	0.000( )	CT1_CALC	0.000( )
CT1_ILLI	0.000( )	CT1_KAOL	0.000( )
CT1_COAL	0.000( )	CT1_XWAT	0.000( )
CT1_UWAT	0.000( )	CT1_XOIL	0.000( )
CT1_UOIL	0.000( )	CT1_XGAS	1.000( )
CT1_UGAS	-0.200( )	CT1_XBWA	0.000( )
CT2_QUAR	0.000( )	CT2_CALC	0.000( )
CT2_ILLI	0.000( )	CT2_KAOL	0.000( )
CT2_COAL	0.000( )	CT2_XWAT	0.000( )
CT2_UWAT	0.000( )	CT2_XOIL	1.000( )
CT2_UOIL	-0.200( )	CT2_XGAS	0.000( )
CT2_UGAS	0.000( )	CT2_XBWA	0.000( )
ARHOB_ILLI	2.780(g/cm3)	ARHOB_KAOL	2.620(g/cm3)
WCLP_ILLI	0.150(m3/m3)	WCLP_KAOL	0.096(m3/m3)
CECA_ILLI	0.248(meq/g)	CECA_KAOL	0.091(meq/g)
MST	69.800(degC)	RWT	-999.250(degC)
SALIN_ISOL	-999.250(ppk)	SALIN_PARA	-999.250(ppk)
SALIN_XWAT	90.634(ppk)	SALIN_XIWA	-999.250(ppk)
SALIN_UIWA	-999.250(ppk)	SALIN_XOIL	0.000(ppk)
SALIN_UOIL	0.000(ppk)	SALIN_XGAS	0.000(ppk)
SALIN_UGAS	0.000(ppk)	SALIN_XSFL	-999.250(ppk)
SALIN_USFL	-999.250(ppk)	CT1_ZP	0.000( )
CT2_ZP	0.000( )	RHOB_UNC_ZP	0.027(g/cm3)
NPHI_UNC_ZP	0.015(m3/m3)	U_UNC_ZP	0.225( )
GR_UNC_ZP	4.000(gAPI)	WWK_UNC_ZP	0.002(kgf/kgf)
CT1_UNC_ZP	0.015( )	CT2_UNC_ZP	0.015( )
VOLS_UNC_ZP	0.015(m3/m3)	RHOB_UNC_WM	0.800( )
NPHI_UNC_WM	0.800( )	U_UNC_WM	0.200( )
CXDC_UNC_WM	0.500( )	CUDC_UNC_WM	1.000( )
GR_UNC_WM	0.500( )	WWK_UNC_WM	0.500( )
CT1_UNC_WM	1.000( )	CT2_UNC_WM	1.000( )
VOLS_UNC_WM	1.000( )	RHOB_IFAC_ZP	1.000( )
NPHI_IFAC_ZP	1.000( )	A_ZP	1.000( )
N_ZP	2.000( )	C_DWA	1.000( )
M_DWA	1.800( )	BVIRR	0.015(m3/m3)