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Petrophysical Analysis ELAN Field Study of the Bass Basin

Globex Far East, Schlumberger

OR-0445

564002

CONTENTS

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Transmittal Memo

Dallas Center Ref.No. 55228

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Re: Bass Basin - Tasmania

Enclosed is a brief report of the petrophysical work done on nine (9) wells in the Bass Basin of Southern Australia. The report summaries the data availability, data handling, and interpretation model and procedures used to determine petrophysical answers. The report is backed up by prints, plots, and digital data delivered under a separate package. This digital data includes the raw wireline data, edited wireline data, environmental corrections and transforms, and volumetrics of the interpreted wells.

John T. Watson
Sr. Log Analyst

Field Study of the Bass Basin

Introduction:

The Bass Basin lies submerged, generally less than 100 meters, in the offshore waters of Australia. The basin is bounded on the north by the Australian mainland of Victoria and to the south by the island of Tasmania. To the east the small island of Flinders bounds the extent in that direction as King Island does to the west. Since 1965, over 30 wells have been drilled in this offshore environment looking for accumulations of oil and gas. While there have been several discoveries of both oil and gas, no significant production of hydrocarbon liquids has begun. There are many zones of hydrocarbons that exist as low to medium grade coals, and it can be expected that gas would exist in these coal beds as the coals matured.

A study of nine wells was initiated for the purpose of studying porosity and lithology of the Bass Basin. The study consisted of analyzing well log data from selected wells. Due to limitations of the data set only seven wells could be analyzed in detail. These wells generally had modern logging data sets though some of the data sets came from different logging companies and different logging tools due to the passage of time.

The project study was performed on GeoFrame petrophysical software. The data set consisted of a LIS tape of composited data for the nine wells. The data set had been prepared by Wiltshire Geological Services of Australia. The well data had been selectively purged of much of the ancillary wireline data channels such count rates, cable speed, etc. that would be found on service company data tapes. Also, the LIS files did not contain any parameter information that would allow complete environmental corrections to be made to the data. Finally, the data set was found to have been corrected for true vertical depth using sea level as the reference datum. Thus, all prints of well logs and interpretation plots will be presented using this datum reference. They will not be on depth with the original plots made by the service companies, and may or may not agree with published cross-sections of the basin.

Data Preparation:

The work flow of the project consisted of loading the LIS data and making initial plots to determine what data was present and what was the vertical extent of the data in each well. A summary of this collection is found in Appendix A. Examination of the data showed that the data had not been extensively edited. Thus is was necessary to depth match all of the curves to a base log. The base log was chosen to be the deep resistivity curve which in this data base is generally the deep induction channel, "ILD". The last portion of the edit phase was to patch some of the data in areas where the readings were noticeably inaccurate. Primarily, this occurred just below the casing shoe where the logging tools could not make good pad contact due to severe hole washouts. Also, in the volcanics and in the coal beds, the logging tools were prevented from reading properly due to bad hole conditions.

Only a limited set of environmental corrections and porosity transforms were made. Insufficient resistivity data was available to compute true resistivity, "RT" using the tornado chart approach. The deep resistivity, usually the deep induction, was chosen for "RT". Matrix and borehole corrections were applied to the neutron logs. The three porosity tools (sonic, neutron, and density) each had porosity calculated assuming sand, lime, and dolomite matrices. The sonic porosities were calculated using the Hunt-Raymer equation. Total porosity was calculated from the neutron and density logs, which further allowed the computation of several transforms including "U" matrix apparent ("UMA"), apparent grain density ("RHGX"), and resistivity water apparent ("RWA"). Finally, the "SP" was baseline shifted. A display of several of these computed transforms along with the corrected data was made and titled "Press Display". This display along with cross-plots is used as the primary interpretation graphics for model choosing/switching and parameter selection.

Elan Model:

The interpretation is done in GeoFrame's Elan software. This program solves for mineral and fluid volumes using a system of equations both linear and non-linear. The program allows for multiple mineral models to exist that can be solved separately and then merged together based on statistical methods. Five models were chosen for these wells each of which addressed different mineralogical combinations. In a statistical model such as Elan, no single tool or measurement is used to calculate a particular volume. The volumes are calculated based on a best fit method with certain measurements weighted more heavily than others. For the tools used, the majority of the tool response equations are linear. The resistivity tool is the exception to this. The non-linear dual water equation was chosen based on its proven use in sand-shale environments. Finally, a permeability calculation was made. This permeability should be considered a "index" and not a absolute value since no calibration data was available. This permeability index should nicely correlate with any measured perms from cores or flow test.

The permeability computation is based on a perm factor applied to each volumetric percentage where the summation of these factors plus volume of moveable fluid yields an empirically derived permeability. The procedure was developed at the Schlumberger Doll Research Center and is based on the premise that permeability is related to mineralogical composition. The basic idea is that pore system properties that control permeability in clastic sediments are strongly interrelated with the mineralogy. Such textural parameters as grain size, sorting, grain location, cement, and surface area particularly in clay minerals correlate with permeability as well as porosity. This procedure attempts to draw a mathematical relationship between the minerals present and their relationship to permeability. These empirical relationships assume a fixed correlation between mineral volumes and grain size, sorting, etc. for a given zone, well, or field. The volume and type of clay minerals found in the Elan analysis have the most control over the permeability relationship in that they have a large negative factor applied. Carbonate minerals when present as cementing material also have a negative impact on permeability.

It was easily seen that the wells showed correlateable trends that were consistent with previous geological studies. Identified formations tended to show consistent log data readings from well to well allowing for general assumptions to be made in model selection and parameter picking. Computed formation water resistivity, clay content, and to a lesser extent porosity showed good correlation from well to well. Volcanics are found in the deeper section of many of the wells. The volcanics have the least consistent log response and the least consistent mineral composition. They are characterized by heavy density, high neutron response, and variable sonic and gamma ray response. A modeled assumption was that the volcanics contained some water even though the fluid might not be moveable (chemically bonded or zero permeability). Resistivity supports this assumption. Reports have stated that carbon was present throughout the volcanics in varying quantities. Thus the model was chosen to consist of volcanics, coal or burnt carbon, and trapped water. Tool responses chosen for the volcanics was selected in zones with the highest resistivity with the assumption that the least amount of water would be present.

A separate coal model was chosen for the more consistent shallower coals. This model consisted of coal and ash. The response of the tools to coal was chosen to be that of a standard bituminous coal. The response to ash was generally chosen to be that of the surrounding shales. This model makes the assumption that the maturity of the coal is constant which it is not. Thus the accuracy of the computed coal volume will be affected by the maturity of the coal. Coals of significantly lower grades will have a computed coal content larger than probably present. The coal model is a stand alone model which cannot be mixed with other models, thus the presence of coal is not allowed to exist with other models such as the sand-shale or primary model.

The third model is a carbonate model. This model addresses zones usually quite thin that contain a tight carbonate, either limestone or dolomite. The model is another of the stand alone models. This model was chosen to represent tight, thin carbonate beds that have little or no porosity. Log responses of some of the tools particularly the resistivity logs have resolutions greater than the thickness of these beds. A normal interpretation would tend to show that the formation was tight but did have some intermediate porosity. This model addresses that thin bed problem.

The fourth model is the principal model for reservoir rock. This model uses all the available measurements and attempts to solve for the presence of two clays, quartz, limestone (primarily as a cementing material), and porosity filled with water and oil. The porosity is further broken down into a flushed and unflushed zone. The flushed zone is considered to contain drilling fluid filtrate and residual hydrocarbon as opposed to formation water and all hydrocarbons in the unflushed zone. One reason for this approach is that some of the logging tools read deeply while other do not. The true resistivity measurement sees only the unflushed zone while the "PEF" channel and the sonic see only the flushed region. Tools like the density and neutron see a combination of the two zones. This distinction is important when accumulations of gas are present in the wells. Published material on the basin make reference to many of the sands being cemented with carbonate material. The references indicate that dolomite is often the cementing material but limestone is often present. Log responses tend to indicate a greater proportion of limestone being present in the sands than dolomite. Since the model would have too many unknowns to solve for both minerals, limestone was chosen. When dolomite is actually present, the model will show carbonate material being present, but since the type of mineral is wrong, then the volume of carbonate will be in error but should not be significant.

The reservoir rock model is not a stand alone model. It can be merged with the shale model (fifth model). The shale model allows for the presence of the two clays plus silt. In this model silt (quartz based) replaces quartz as one of volumes. No effective porosity is present in this model. The assumption is made that as shale content increases, the quartz sandstone is gradually replaced by a finer grained quartz material. This silt has much the same properties as that of the quartz sandstone although it would be less permeable.

Model Switching:

Because there are five models defined in this Elan analysis, switching between different models can become somewhat complicated. The Elan program calculates the results of all five models for each level. The results from each model are then weighted by logic provided by the analyst to yield a final volumetric description which may contain percentages from one or more models. The reservoir rock model described above is the default output model and is chosen when no other model is found to be mathematically acceptable. The shale model can co-exist with the reservoir rock model. The program has been setup for this project to begin allowing the probability of this model to be greater than zero when the total clay content from the reservoir model is 35%. By the time the total clay content is 50%, the probability of the shale model is 1.0 and the probability of the reservoir model is 0. Thus the two models can and do co-exist in shaly sands.

The carbonate model which is a stand alone model is triggered by log data. This model is switched to a probability of 1.0 when both sonic log data goes below an analyst picked threshold and density log data goes above a similarly picked threshold. When both logs pass the logic test, the carbonate model is chosen with all other models turned off. The threshold values for the sonic and density were chosen arbitrarily and are zoned in some of the wells, however, zones chosen by this model can be readily identified from a visual look at the logs.

The coal model is similar to the carbonate model in that it is triggered by log data. In coals, the density, sonic, and neutron all yield very high apparent porosity readings. Threshold values were chosen for these three logging tools such that there were minimal conflict with tool readings in shales where there could be some confusion between coal-ash mixtures and areas of high shale content. The greatest chance for error in triggering this model is in areas of rugose hole and washouts where the logging tools spike towards a high apparent porosity reading that can confuse the program into selecting the coal model. Many of these washouts were manually edited to make these zones of bad log readings more representative of the formation they were trying to evaluate, usually shale.

The volcanics model is turned on and off by analyst interaction. The presence of volcanics was determined from sample descriptions and mud logs.

Model Exceptions:

As mentioned previously, the wells showed good data correlation. However, two of the wells due to their age did not have Litho-density tools run. In their place, the standard compensated formation density were run which yielded a good density log ("RHOB"), but did not yield a photo-electric effect channel ("PEF"). The Dondu #1 and the Cormorant #1 well did not have LDT logs but had FDC logs instead. Also, the Cormorant #1 did not have a compensated neutron log of any type run across its intervals. Since the "PEF" channel is particularly useful for lithology determination, the models on these two wells had to be degraded. The primary effect is that it becomes very difficult to accurately solve for the two different clays and calcite cementing material being present in the reservoir rock model. The calcite material was disallowed from the reservoir rock model. Calcite is probably present in these two wells as a cementing material for the quartz sandstone. However, Elan displays do not show its presence thus the indication that the wells are different. Also, the Dondu well did not attempt to solve but for one clay type (Clay #1). Clay #2 is described as being a denser clay probably containing more iron than Clay #1. Its presence was not observed in the Dondu well as easily seen in others, thus it was left out of the model. This allowed the model to be more robust in its solution especially since the tool set was reduced.

The gamma ray logs on many of these wells do not respond nicely to the sand-shale lithologies. The gamma ray logs are generally lazy with poor dynamic range between maximum and minimum values in clean sands compared to pure shales. Many of the zones also show poor correlation between gamma ray response and shale content. "SP" logs were available on all the wells and generally provided better dynamic range than the gamma ray for delineating shale content. However, the "SP" log is much lazier than the other curves for bed resolution and often misses small lithological changes. The primary thought was to use both pieces of data in the Elan model to help with volumetric shale determination. Both tools are allowed in most of the wells. The weights applied to each tool was arbitrary and was decided on how well each tool correlated to the shale content. These parameters were often zoned in a given well.

Parameter Selection:

Parameter selection for the Elan models consisted of using theoretical parameters and parameters determined from log response in given zones. Nuclear properties for sand, lime, coal, and dolomite generally come from theoretical responses. All parameters for the different clays come from log responses. Fluid resistivities, "Rw" free and "Rw" bound come from log responses. All gamma ray parameters came from log responses. Parameter selection from log responses were made in a manner that attempted to use field wide parameters whenever possible. Small changes due borehole environments and logging tool differences can be expected though not sizable.

Neutron, density, sonic, and gamma ray response can be seen in Appendix B for both of the clays and clean sandstone response in a selected well. Plot #1 is crossplot of density versus neutron with gamma ray in the Z-axis. This is a discriminated plot to show the areas where the response is close to or trending to pure values. Clean sands and the shale designated as Clay #1 cluster nicely while Clay #2 is less tightly clustered.

Plot #2 is a non-discriminated plot of density versus neutron porosity (lime matrix) of the whole well. The clean sands plot to the north-west and are shaded in red due to their low gamma ray readings. Coals and washouts are plotting to the far north-east with a varied gamma ray response. The shales in the well show a somewhat unexpected trend to the south. This would indicate that the shales are much denser than the sands but due not have a significantly higher neutron response as might be expected.

Plot #3 is a plot of rho-matrix apparent versus U-matrix apparent. Rho-matrix and U-matrix apparent are both transformed data used for lithology determination. Rho-matrix apparent is the density value of the matrix when the porosity is water filled. It is calculated by taking a value of total porosity, in this case neutron-density cross plot porosity, and selecting the density response for the water present. The total density response for the assumed water present is removed from the log response of the density tool and the volume normalized for the volume of matrix present yielding a density value representative of the rock. This apparent value is correct only if the porosity is water filled. It is most in error when the porosity is gas filled. The U-matrix apparent is a transform of "U" which is the absorption cross-section derived from the "PEF" curve, photo-electric effect. It is determined in the same manner as the rho-matrix apparent and holds the same assumptions. The two are used together to give a excellent visual interpretation of the type of rocks present in the formation. It is important to note on this plot that the clean sands plot on a 2.65-2.66 gm/cc line, however, they do form a line and not a cluster. The U-matrix apparent readings start around 7 for these clean sands and trends upward to as high as 19. These high "UMA" readings do not correlate in the shale sections or in any sections where permeability is low or non-existent. This would indicate that even though the mud weight was light; there was a high barite content in the mud and it has had a major effect on the "PEF" measurement.

Plots #4-5-6 are continuation of the non-discriminated plots of density porosity (sand matrix) versus neutron porosity (sand matrix), neutron versus sonic, and density versus sonic. These plots confirm the general trends seen on the original plots.

Plots #7-8-9 are discriminated plots to show the response in the coals. The plots show good clustering for the sonic, density, and neutron porosity measurements, but show a very poor correlation for "PEF". Again, it is surmised that the poor correlation of the photo-electric effect in the coal beds is due to the barite content of the mud be present in the cleating system of the coals.

Plot #10 is a discriminated plot of resistivity water apparent versus gamma ray with the Z-axis color coded to show three water bearing sands. While not shown on this crossplot, sands below 2000 meters generally showed Rw values greater than .1 ohm-meter and trending down to .06 ohm-meter for sands in the 1600-1900 meter range. In this example of the King #1 well the sand present at 1462 meters exhibits a Rw value of 0.04 ohm-meters. Again, while not shown, the shallowest sands start to freshen up in their salinity values.

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APPENDIX A.

STRT.M	226.7712	:START DEPTH
STOP.M	2358.9998	:STOP DEPTH
STEP.M	0.1524	:STEP LENGTH
COMP.	Company	:Esso Australia Inc.
WELL.	Well	:Bass 1
FLD .	Field	:Eastern Bass Basin
COUN.	County	:Bass Straits
NATI.	Nation	:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	228.45	2350.47	6.6374	6.9549
GR	226.77	2343.45	9.0369	81.6078
ILD	237.59	2347.57	0.2712	7.8705
MSFL	234.70	2350.31	0.4036	1.4024
SN	237.13	2350.92	0.4563	14.5418
SP	236.37	2358.85	0.7089	60.6422

564012

STRT.M		242.7732	:START DEPTH
STOP.M		1803.8064	:STOP DEPTH
STEP.M		0.1524	:STEP LENGTH
COMP.	Company		:Esso Australia Inc.
WELL.	Well		:BASS 2
FLD .	Field		:Eastern Bass Basin
COUN.	County		:Bass Straits
NATI.	Nation		:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	247.80	1687.98	9.7412	9.7412
DT	257.86	631.55	103.7275	113.1900
GR	242.77	1737.97	11.3787	63.7928
ILD	251.31	1801.67	0.1688	4.6956
MSFL	250.24	1687.68	-1.9443	1.0153
SN	251.46	1687.07	0.3997	2.9936
SP	249.63	1803.65	36.0531	77.0000

STRT.M		83.9724	:START DEPTH
STOP.M		3005.0232	:STOP DEPTH
STEP.M		0.1524	:STEP LENGTH
COMP.	Company		:Esso Australia
WELL.	Well		:CORMORANT 1
FLD .	Field		:Eastern Bass Basin
COUN.	County		:Offshore
NATI.	Nation		:Bass Straits

Channel Name	Start	Stop	Minimum	Maximum
CALI	237.13	3000.45	6.4313	11.1342
DRHO	900.07	3001.06	-0.0390	0.0872
DT	359.21	2994.96	47.4916	82.3768
GR	83.97	3004.87	12.9173	85.0406
ILD	249.02	3002.89	0.3300	6.0165
MSFL	1280.31	2011.68	0.9400	9.5892
RHOB	894.59	3003.19	1.3451	2.5104
SN	248.56	3001.37	0.3746	8.3265
SP	249.48	2997.71	18.8443	190.4596

564014

STRT.M	82.6008	:START DEPTH
STOP.M	2938.4246	:STOP DEPTH
STEP.M	0.1524	:STEP LENGTH
COMP. Company		:Esso Australia
WELL. Well		:DONDU 1
FLD . Field		:Eastern Bass Basin
COUN. County		:Offshore
NATI. Nation		:Bass Straits

Channel Name	Start	Stop	Minimum	Maximum
CALI	851.31	2928.82	11.2284	12.1990
DRHO	856.49	2933.85	-0.0642	0.1443
DT	856.03	2930.65	52.5601	74.3224
GR	82.60	2930.80	10.1744	65.1497
ILD	856.64	2933.55	0.1841	26.8921
NPHI	857.25	2933.40	0.0394	0.1504
RHOB	856.03	2934.16	1.4345	2.4522
SFLU	856.64	2932.18	0.3364	8.2407
SP	855.12	2938.27	-4.3450	72.4178

564015

STRT.M	81.2292	:START DEPTH
STOP.M	2225.0398	:STOP DEPTH
STEP.M	0.1524	:STEP LENGTH
COMP.	Company	:SAGASCO Resources Ltd.
WELL.	Well	:King #1
FLD .	Field	:Eastern Bass Basin
COUN.	County	:Bass Straits
NATI.	Nation	:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	395.02	2209.65	7.9868	8.3115
CAL2	1231.39	2209.80	7.1290	8.4369
DEVI	1209.29	2214.68	0.0069	1.5648
DRHO	1239.01	2208.58	-0.0806	0.0459
DT	395.02	2209.65	38.1000	81.1205
GR	81.23	2202.48	5.2415	105.4398
GR2	1231.39	2202.64	0.9990	103.8787
GRCO	81.23	2202.48	5.2697	104.3616
LLD	398.07	1241.15	0.7806	1.6709
LLS	398.07	1241.15	0.6288	1.5026
MINV	1239.01	2214.52	0.4265	5.8587
MNOR	1239.01	2214.52	0.5768	5.0078
MSFL	398.07	2214.52	0.2919	13.2154
HDSR	1239.32	2214.52	0.4088	8.7401
HMSR	1239.32	2214.52	0.4478	8.4783
NPHI	1239.01	2208.58	0.0806	0.3595
HAZI	1209.29	2214.68	0.0134	27.4838
PEF	1239.01	2208.58	0.2384	3.3539
RHOB	1239.01	2208.58	1.2067	2.5478
ROP	133.96	2224.89	-0.0162	8.1281
URAN	1231.39	2208.58	0.0175	5.4804
SP	398.07	2214.52	-10.6061	71.1238
POTA	1231.39	2208.58	0.0100	2.5347
THOR	1231.39	2208.58	0.0100	18.8231

564016

STRT.M		199.6440	:START DEPTH
STOP.M		2887.8276	:STOP DEPTH
STEP.M		0.1524	:STEP LENGTH
COMP.	Company		:Hematite Petroleum Pty. Ldt.
WELL.	Well		:NANGKERO 1
FLD .	Field		:Eastern Bass Basin
COUN.	County		:Bass Straits
NATI.	Nation		:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	975.51	2879.45	11.4923	12.1700
DRHO	983.44	2887.68	-0.0728	-0.0040
DT	217.17	2884.47	45.2663	79.4260
GR	971.70	2882.34	9.3028	34.6386
ILD	200.56	2887.22	0.2913	5.6852
NPHI	971.85	2881.58	0.0765	0.2216
RHOB	971.40	2880.66	1.3193	2.0606
SFLU	199.64	2886.30	0.4662	4.3540
SP	200.25	2887.22	8.5271	83.3993

564017

STRT.M	78.6384		:START DEPTH
STOP.M	3901.5925		:STOP DEPTH
STEP.M	0.1524		:STEP LENGTH
COMP.	Company		:Amoco Australia Petroleum Company
WELL.	Well		:Tilana #1
FLD .	Field		:Eastern Bass Basin
COUN.	County		:Bass Straits
NATI.	Nation		:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	413.00	3901.44	11.5703	20.5200
DRHO	1652.47	3898.39	-0.0762	0.0850
DT	399.90	3892.30	31.2500	74.0202
GR	78.64	3899.31	6.0273	30.5469
ILD	413.16	3898.39	0.0635	36.6562
MSFL	1652.32	3886.50	0.1162	17.8073
NPHI	1652.32	3899.31	0.0103	0.1807
PEF	1652.32	3898.09	0.6123	4.0898
RHOB	1652.47	3898.39	1.1914	2.2800
SFLA	413.16	3900.53	0.2036	69.4375
SFLU	413.16	3900.53	0.1240	71.7500
SP	413.00	3900.53	-8.6172	188.3203

564018

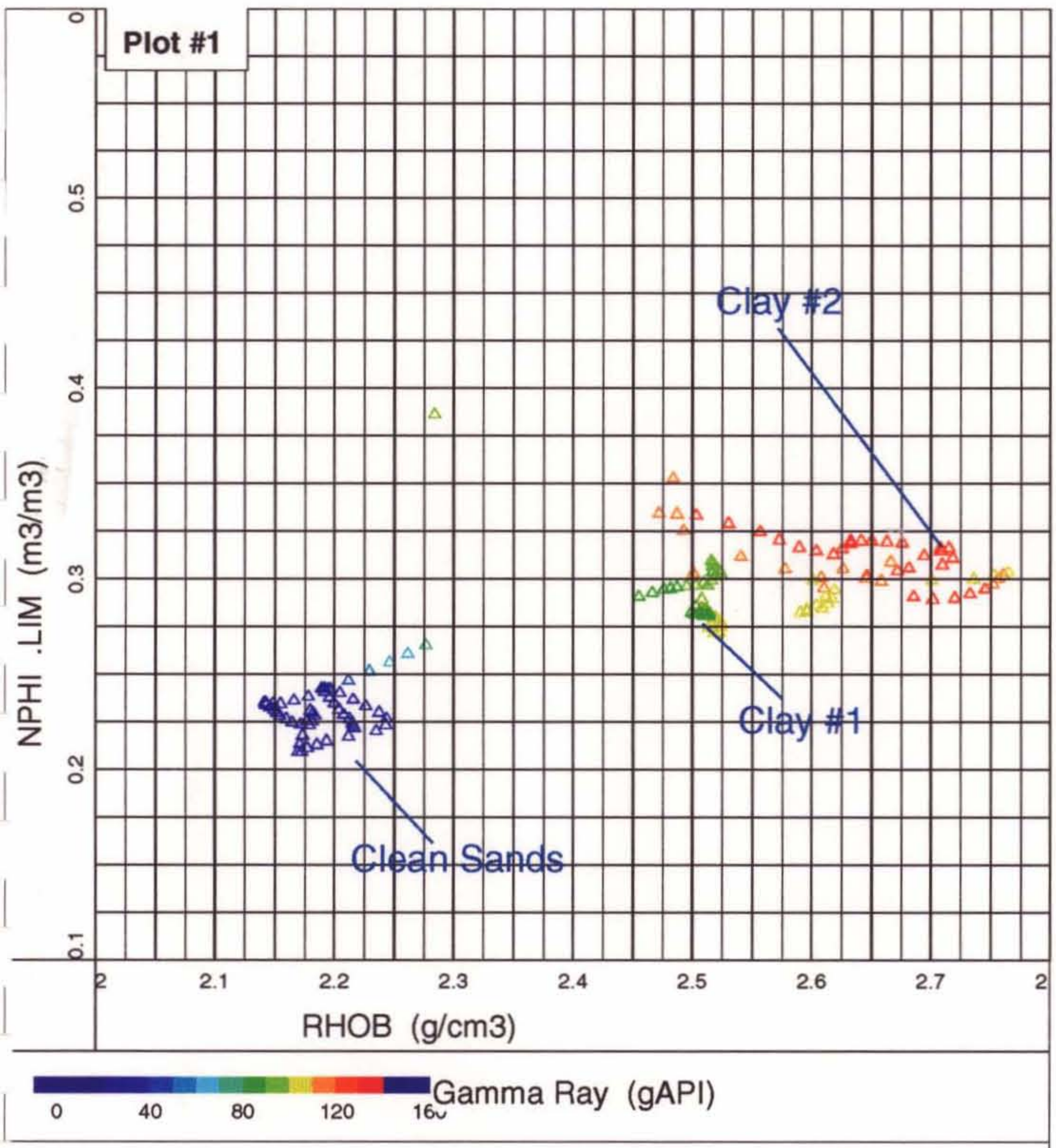
STRT.M	43.1292	:START DEPTH
STOP.M	3350.8188	:STOP DEPTH
STEP.M	0.1524	:STEP LENGTH
COMP. Company		:Amoco Australia Petroleum company Ltd.
WELL. Well		:Yolla #1
FLD . Field		:Eastern Bass Basin
COUN. County		:Bass Straits
NATI. Nation		:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	399.90	3350.67	4.8945	9.7734
DRHO	1755.65	3350.67	-0.1787	0.0684
DT	390.14	3341.52	35.4679	98.8762
GR	43.13	3341.22	0.0000	37.8125
ILD	399.90	3350.36	0.0708	2.7441
MSFL	399.90	3333.90	0.1226	5.0924
NPHI	1754.73	3343.66	0.0972	0.3818
PEF	1755.50	3350.67	0.6787	6.0625
RHOB	1754.73	3350.67	1.2109	2.0879
SFLA	399.90	3350.36	0.1777	2.6094
SFLU	399.90	3350.36	0.1343	2.6230
SP	399.90	3350.06	58.1250	161.9375
MINV	399.90	1744.37	1.2585	2.2839
MNOR	399.90	1744.37	0.0015	1.3000

564019

STRT.M		91.4400	:START DEPTH
STOP.M		2443.7341	:STOP DEPTH
STEP.M		0.1524	:STEP LENGTH
COMP.	Company		:Esso Standard Oil (Australia) Ltd.
WELL.	Well		:Yurong #1
FLD .	Field		:Eastern Bass Basin
COUN.	County		:Bass Straits
NATI.	Nation		:Australia

Channel Name	Start	Stop	Minimum	Maximum
CALI	1340.82	2432.76	9.3103	9.3107
DRHO	1340.82	2440.84	-0.0186	0.1559
DT	1021.08	2438.70	54.6618	86.7066
GR	91.44	2433.83	9.8454	28.0894
ILD	898.40	2439.31	0.2014	7.0304
NPHI	1340.51	2439.62	0.0844	0.1484
RHOB	1340.82	2440.99	1.4406	2.1031
SFLU	897.94	2437.18	0.3183	7.6341
SP	897.94	2443.58	45.4477	78.7593



X – Formation Density

Y – Neutron Porosity – Limesto

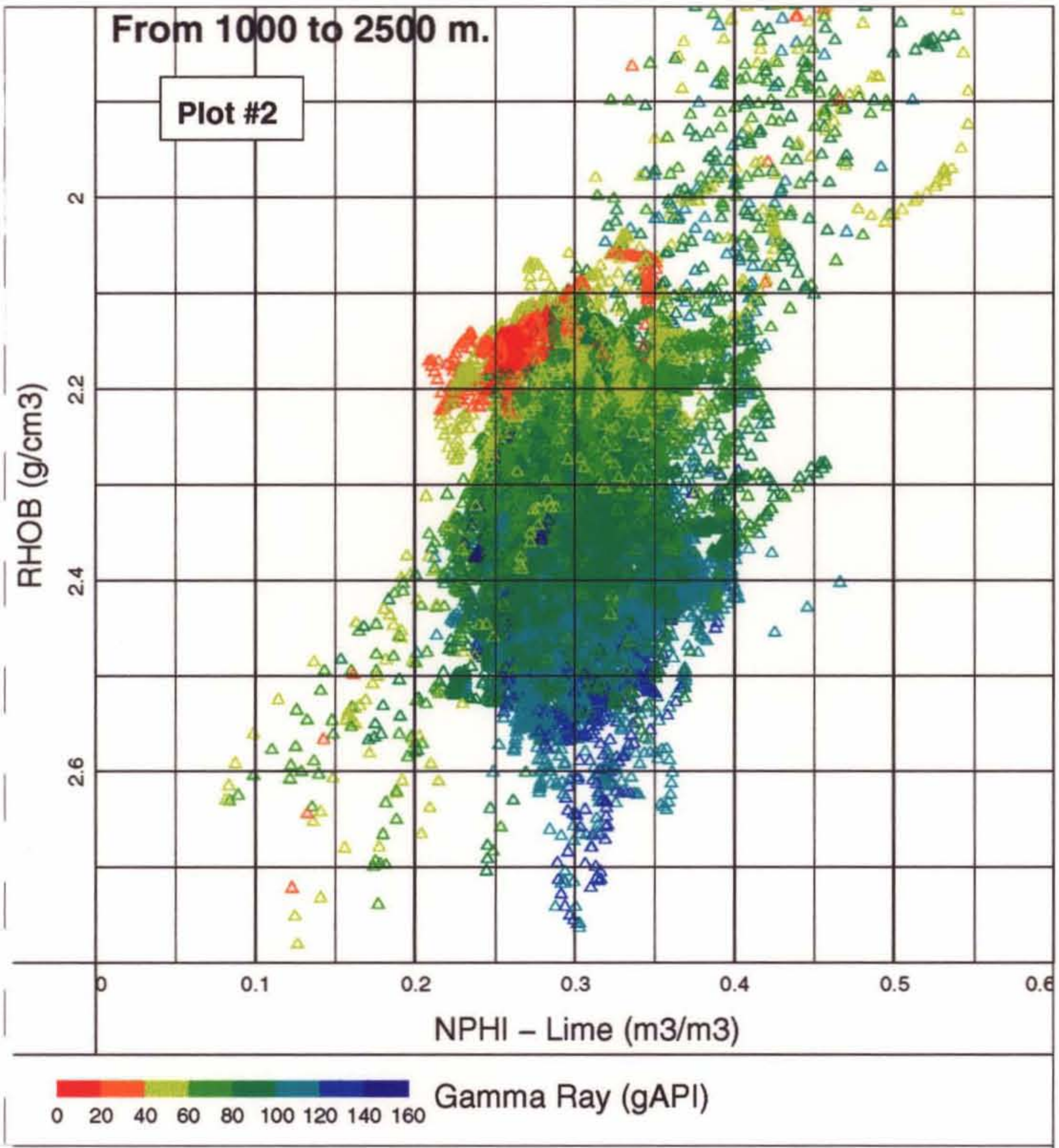
Z – Gamma Ray

		# Points Total:	14667
Start Depth:	2100 m	# Points Plotted:	166
Stop Depth:	1000.05 m	# Points Absent:	0
Sampling Rate:	0.075 m	# Points Cut:	14510
X Max Value:	2.76596 g/cm3	# > X Scale Max:	0
X Min Value:	1.22449 g/cm3	# < X Scale Min:	840
Y Max Value:	0.780149 m3/m3	# > Y Scale Max:	324
Y Min Value:	0.0806859 m3/m3	# < Y Scale Min:	6
Z Max Value:	210.522 gAPI	# > Z Scale Max:	23
Z Min Value:	5.31042 gAPI	# < Z Scale Min:	0

Appendix B

5 cm

564021



X – Neutron Porosity – Limeston

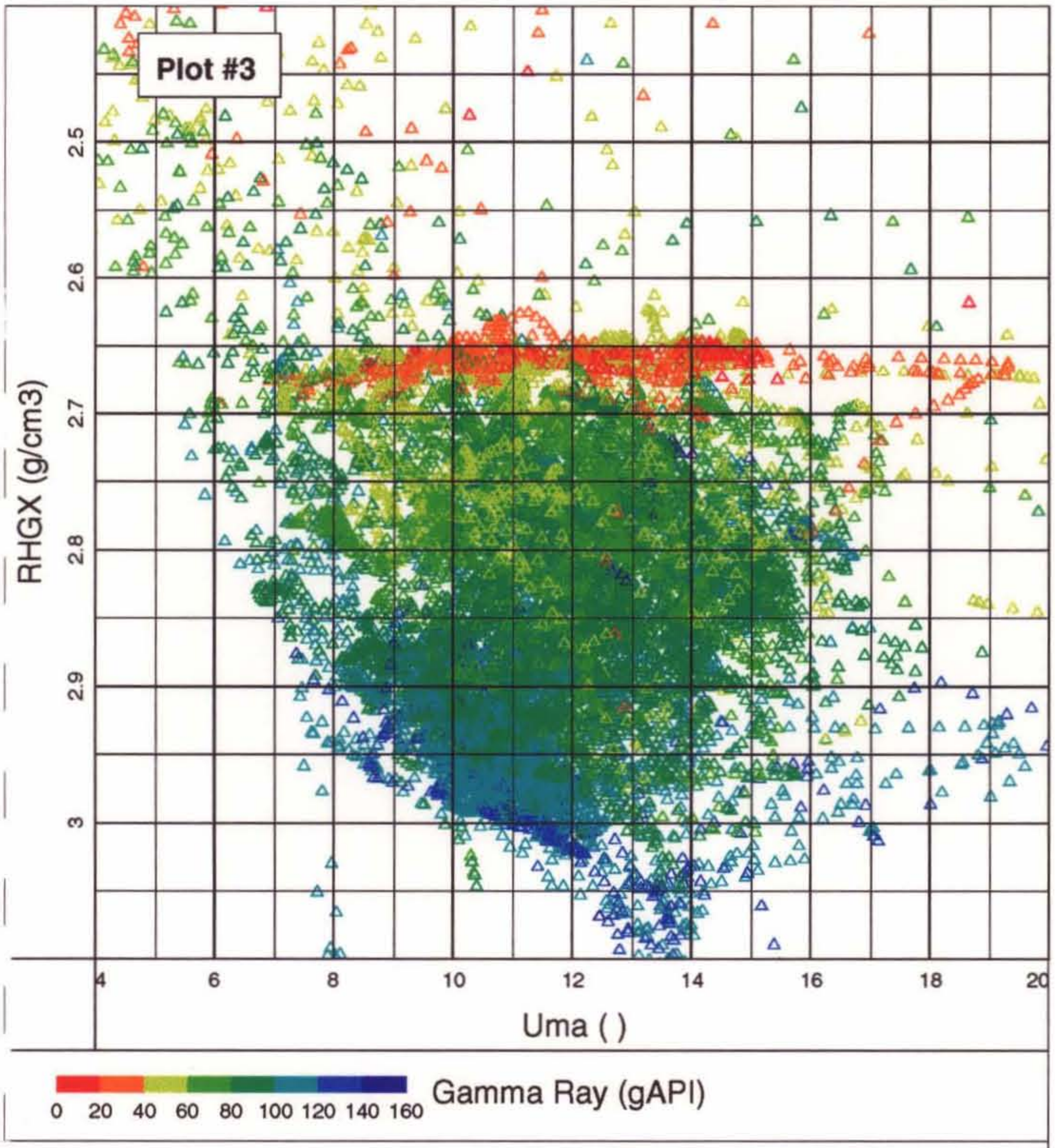
Y – Formation Density

Z – Gamma Ray

		# Points Total:	20000
Start Depth:	2500 m	**# Points Plotted:**	12064
Stop Depth:	1000.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	306
X Max Value:	0.779692 m3/m3	**# > X Scale Max:**	340
X Min Value:	0.0815676 m3/m3	**# < X Scale Min:**	0
Y Max Value:	2.7803 g/cm3	**# > Y Scale Max:**	0
Y Min Value:	1.22451 g/cm3	**# < Y Scale Min:**	767
Z Max Value:	214.601 gAPI	**# > Z Scale Max:**	15
Z Min Value:	5.30381 gAPI	**# < Z Scale Min:**	0

5 cm

564022



X – U Matrix Apparent

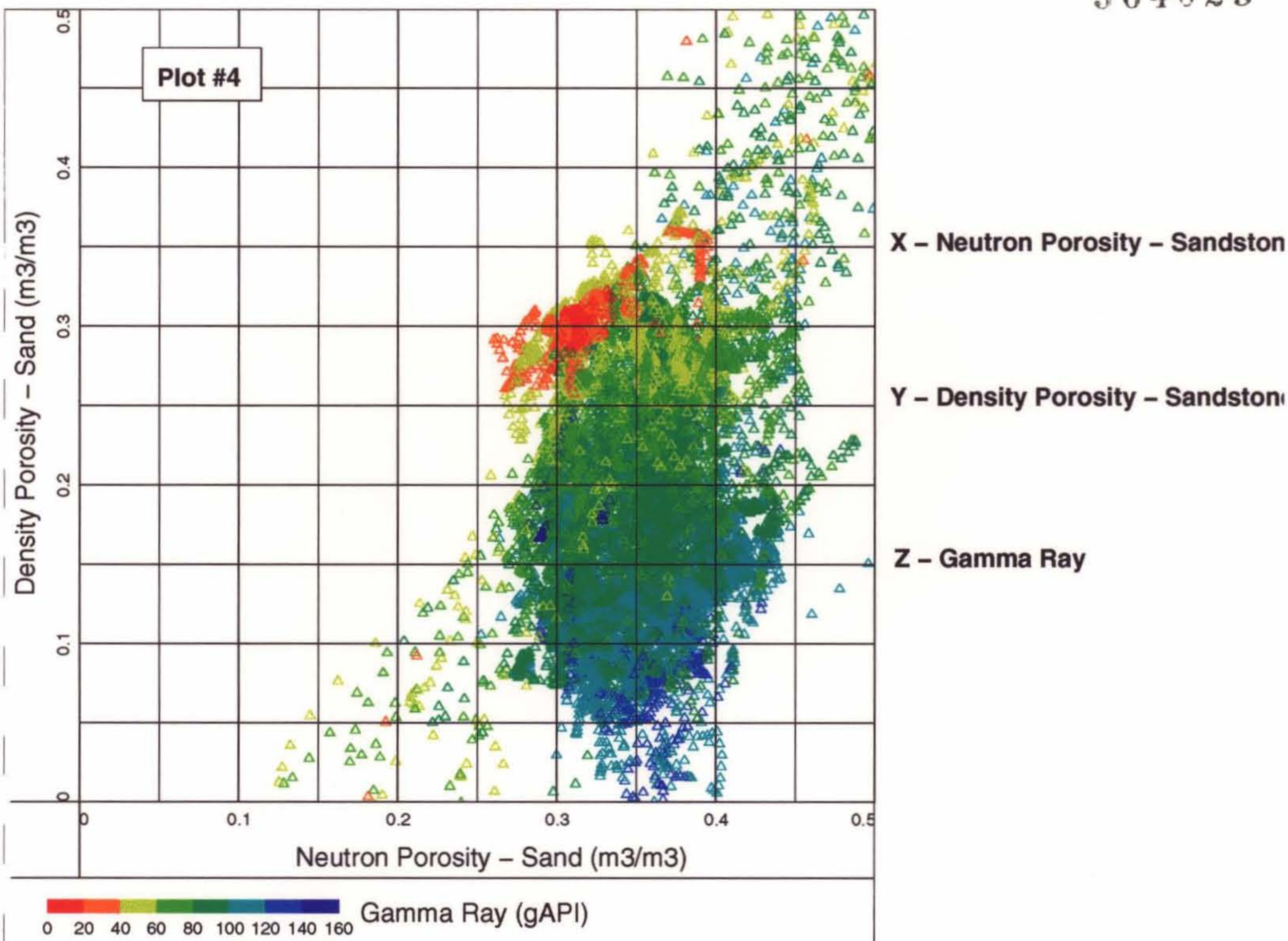
Y – Density (Rho) Matrix Appare

Z – Gamma Ray

		# Points Total:	20000
Start Depth:	2500 m	**# Points Plotted:**	12184
Stop Depth:	1000.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	306
X Max Value:	44.5158	**# > X Scale Max:**	205
X Min Value:	–0.00599934	**# < X Scale Min:**	204
Y Max Value:	3.13341 g/cm3	**# > Y Scale Max:**	18
Y Min Value:	1.9075 g/cm3	**# < Y Scale Min:**	505
Z Max Value:	214.601 gAPI	**# > Z Scale Max:**	15
Z Min Value:	5.30381 gAPI	**# < Z Scale Min:**	0

5 cm

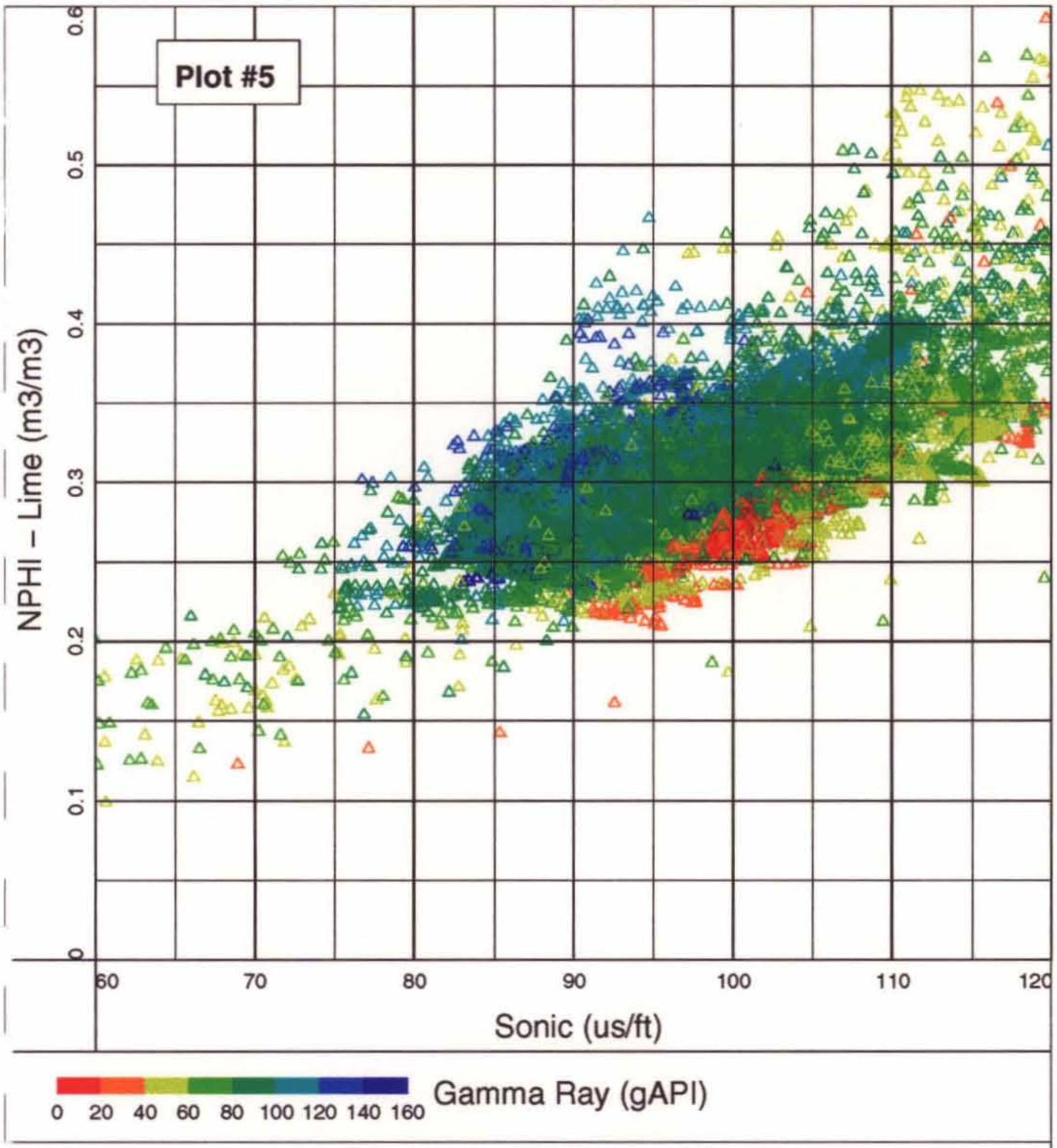
564023



		# Points Total:	20000
Start Depth:	2500 m	**# Points Plotted:**	11942
Stop Depth:	1000.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	306
X Max Value:	0.78616 m3/m3	**# > X Scale Max:**	712
X Min Value:	0.125385 m3/m3	**# < X Scale Min:**	0
Y Max Value:	0.868719 m3/m3	**# > Y Scale Max:**	786
Y Min Value:	−0.0793422 m3/m3	**# < Y Scale Min:**	66
Z Max Value:	214.601 gAPI	**# > Z Scale Max:**	15
Z Min Value:	5.30381 gAPI	**# < Z Scale Min:**	0

5 cm

564024



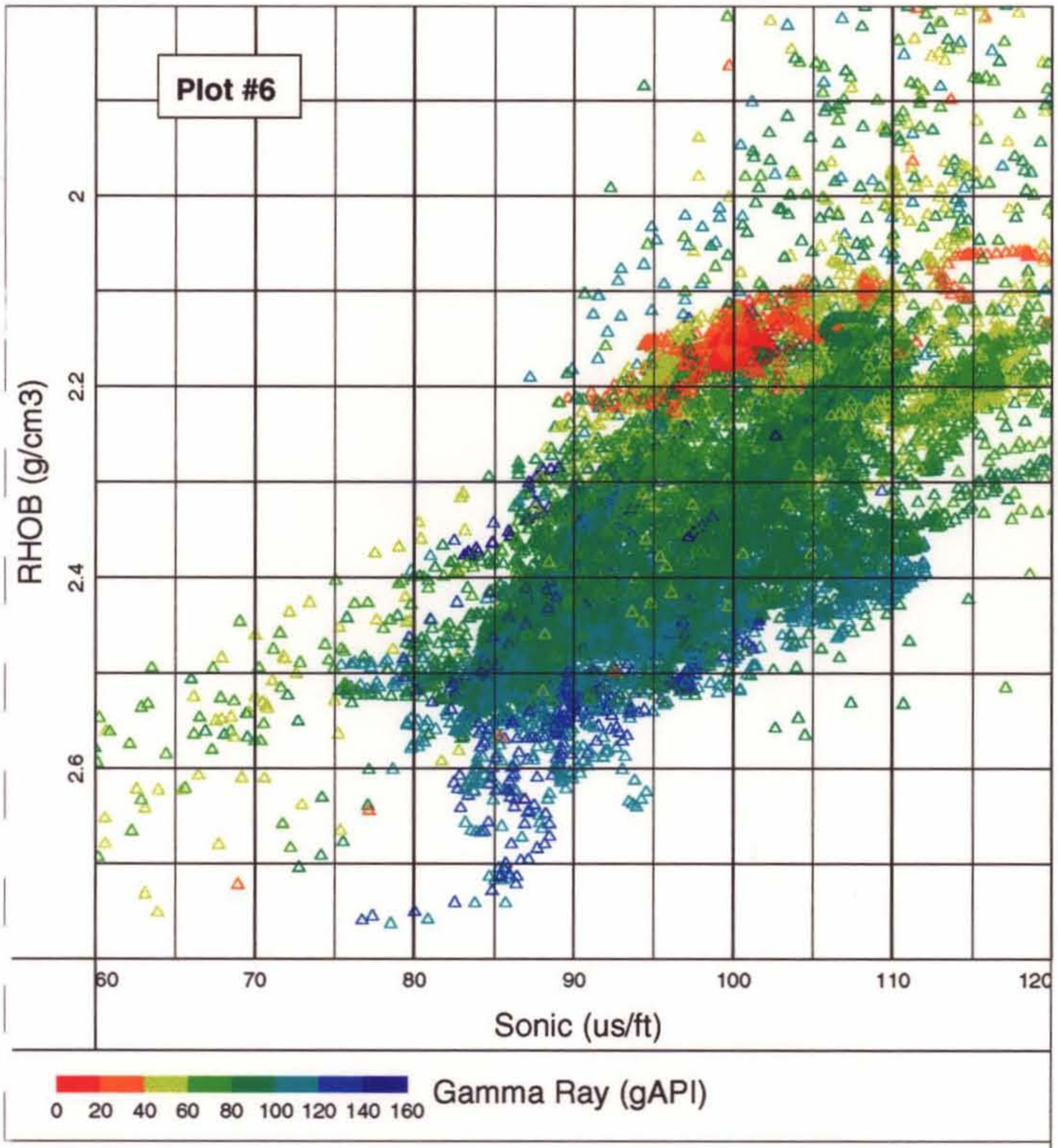
X – Sonic Transit Time

Y – Neutron Porosity – Limeston

Z – Gamma Ray

		# Points Total:	20000
Start Depth:	2500 m	**# Points Plotted:**	12005
Stop Depth:	1000.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	306
X Max Value:	159.41 us/ft	**# > X Scale Max:**	3043
X Min Value:	47.8219 us/ft	**# < X Scale Min:**	19
Y Max Value:	0.779692 m3/m3	**# > Y Scale Max:**	340
Y Min Value:	0.0815676 m3/m3	**# < Y Scale Min:**	0
Z Max Value:	214.601 gAPI	**# > Z Scale Max:**	15
Z Min Value:	5.30381 gAPI	**# < Z Scale Min:**	0

5 cm



X – Sonic Travel Time

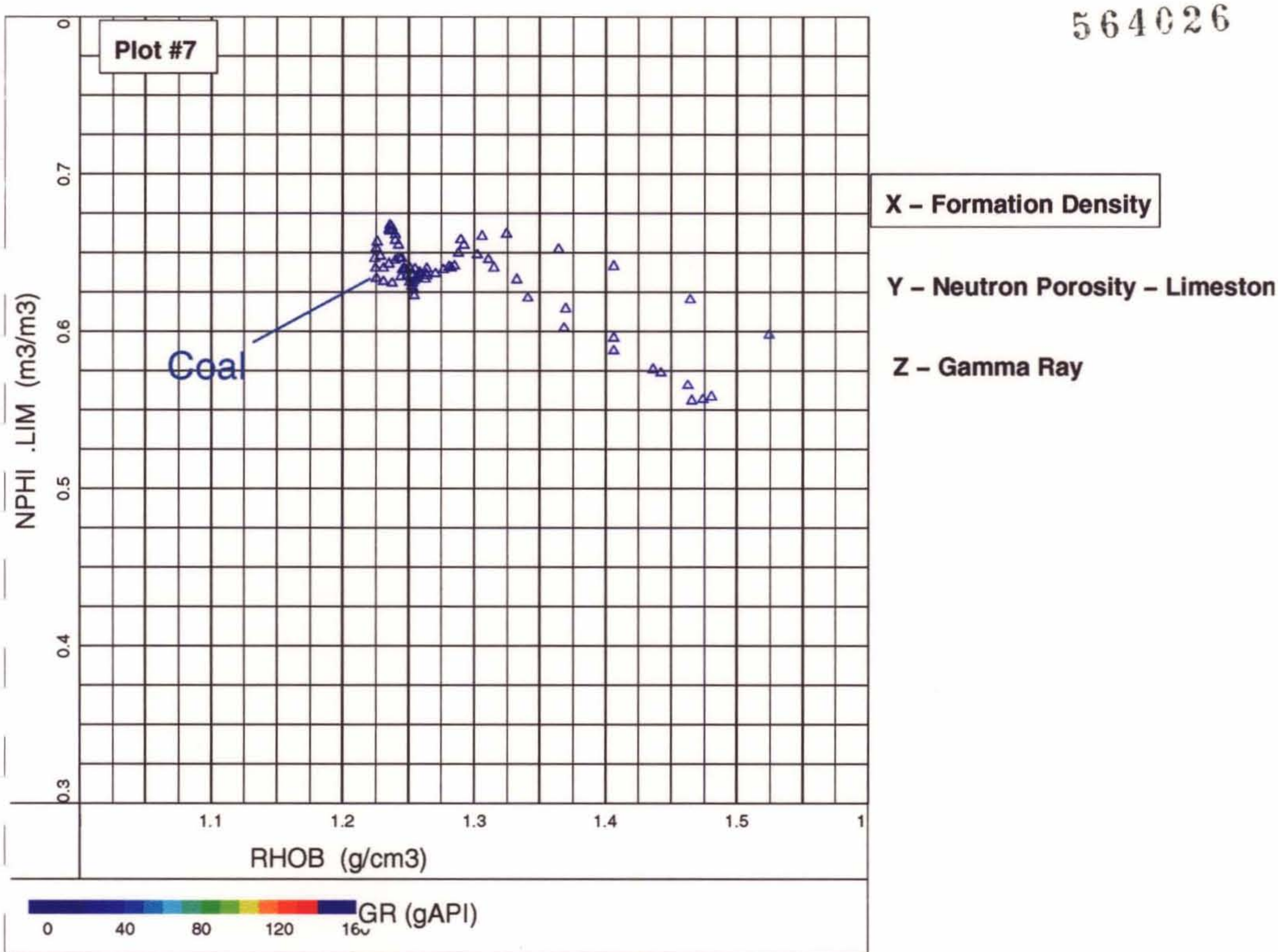
Y – Formation Density

Z – Gamma Ray

		# Points Total:	20000
Start Depth:	2500 m	**# Points Plotted:**	11902
Stop Depth:	1000.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	306
X Max Value:	159.41 us/ft	**# > X Scale Max:**	3043
X Min Value:	47.8219 us/ft	**# < X Scale Min:**	19
Y Max Value:	2.7803 g/cm3	**# > Y Scale Max:**	0
Y Min Value:	1.22451 g/cm3	**# < Y Scale Min:**	767
Z Max Value:	214.601 gAPI	**# > Z Scale Max:**	15
Z Min Value:	5.30381 gAPI	**# < Z Scale Min:**	0

5 cm

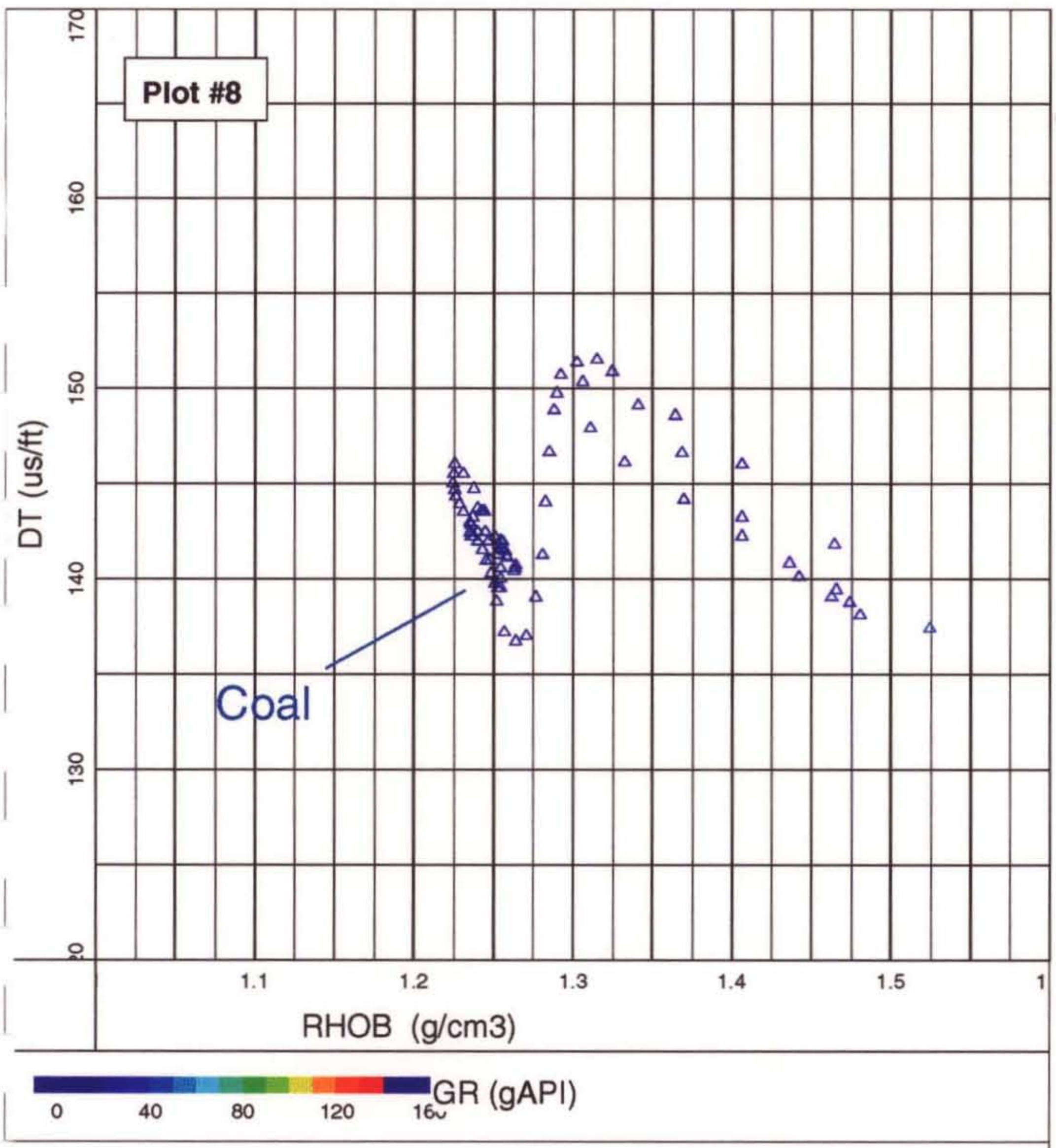
564026



		# Points Total:	2000
Start Depth:	2100 m	**# Points Plotted:**	71
Stop Depth:	1950.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	1909
X Max Value:	2.76458 g/cm3	**# > X Scale Max:**	1818
X Min Value:	1.22449 g/cm3	**# < X Scale Min:**	0
Y Max Value:	0.667612 m3/m3	**# > Y Scale Max:**	0
Y Min Value:	0.0806859 m3/m3	**# < Y Scale Min:**	1082
Z Max Value:	141.111 gAPI	**# > Z Scale Max:**	9
Z Min Value:	5.31042 gAPI	**# < Z Scale Min:**	0

5 cm

564027



X – Formation Density

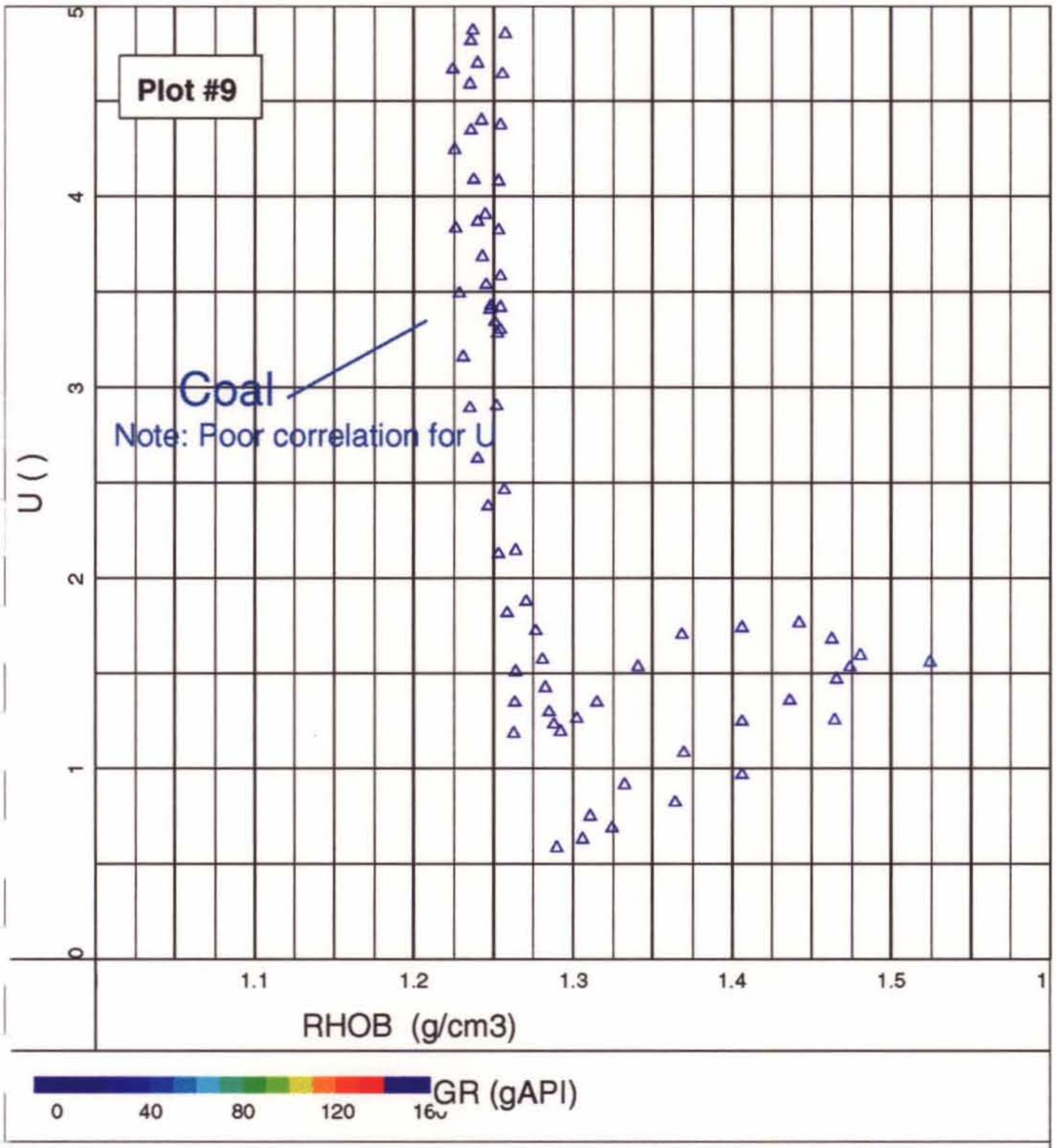
Y – Sonic Transit Time

Z – Gamma Ray

		# Points Total:	2000
Start Depth:	2100 m	# Points Plotted:	76
Stop Depth:	1950.07 m	# Points Absent:	0
Sampling Rate:	0.075 m	# Points Cut:	1909
X Max Value:	2.76458 g/cm3	# > X Scale Max:	1818
X Min Value:	1.22449 g/cm3	# < X Scale Min:	0
Y Max Value:	152.316 us/ft	# > Y Scale Max:	0
Y Min Value:	47.2264 us/ft	# < Y Scale Min:	1776
Z Max Value:	141.111 gAPI	# > Z Scale Max:	0
Z Min Value:	5.31042 gAPI	# < Z Scale Min:	0

5 cm

564028



X – Formation Density

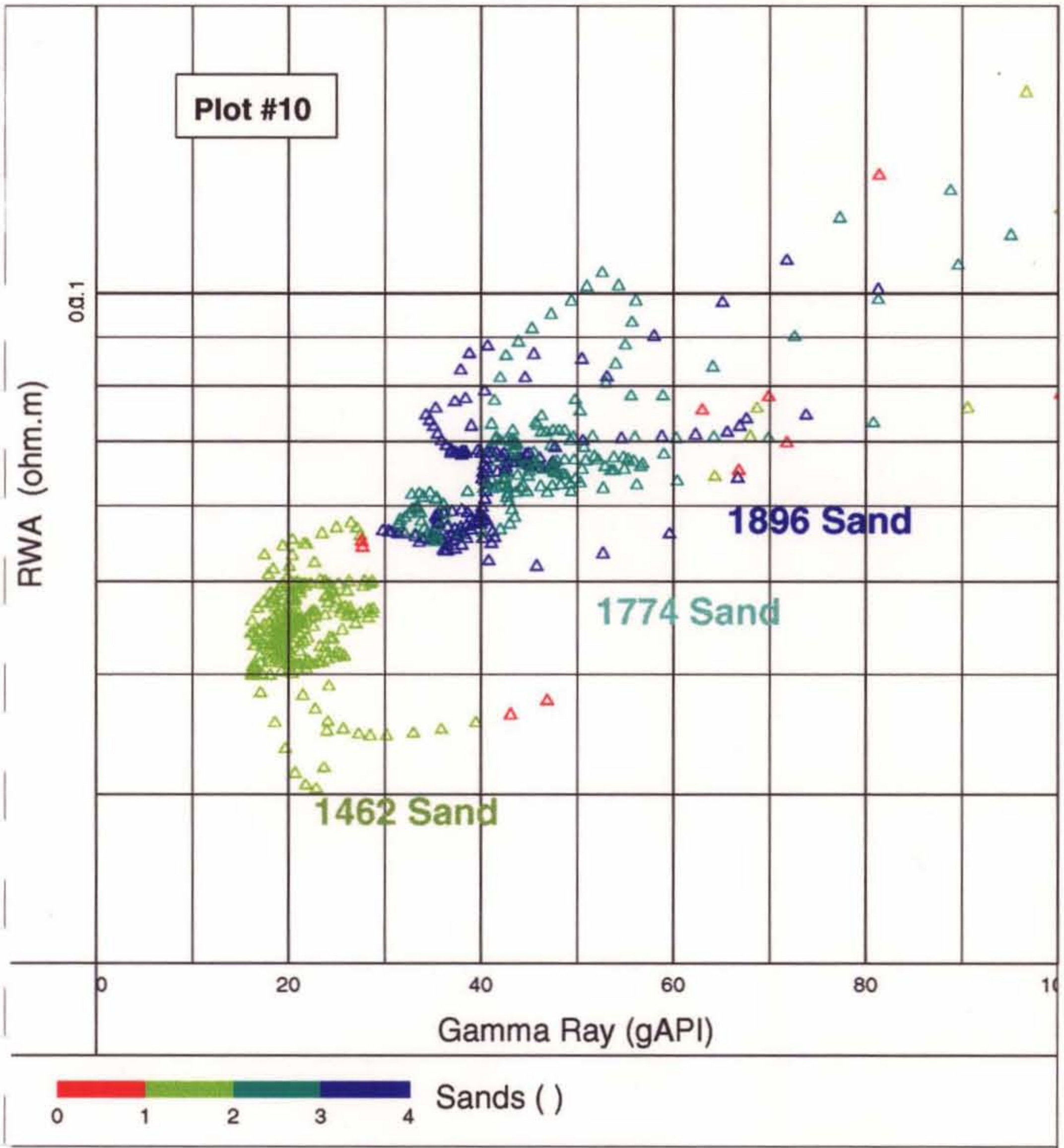
Y – Volumetric Photo Electric Fa

Z – Gamma Ray

		# Points Total:	2000
Start Depth:	2100 m	**# Points Plotted:**	0
Stop Depth:	1950.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	1909
X Max Value:	2.76458 g/cm3	**# > X Scale Max:**	1818
X Min Value:	1.22449 g/cm3	**# < X Scale Min:**	0
Y Max Value:	14.8921	**# > Y Scale Max:**	2000
Y Min Value:	0.541368	**# < Y Scale Min:**	0
Z Max Value:	141.111 gAPI	**# > Z Scale Max:**	0
Z Min Value:	5.31042 gAPI	**# < Z Scale Min:**	0

5 cm

564029



X – Gamma Ray

Y – Resistivity of Water Apparen

Z – Specific Sand Units

		# Points Total:	20000
Start Depth:	2500 m	**# Points Plotted:**	573
Stop Depth:	1000.07 m	**# Points Absent:**	0
Sampling Rate:	0.075 m	**# Points Cut:**	15783
X Max Value:	214.601 gAPI	**# > X Scale Max:**	4064
X Min Value:	5.30381 gAPI	**# < X Scale Min:**	0
Y Max Value:	11629.6 ohm.m	**# > Y Scale Max:**	7437
Y Min Value:	0.0265993 ohm.m	**# < Y Scale Min:**	0
Z Max Value:	3	**# > Z Scale Max:**	0
Z Min Value:	0	**# < Z Scale Min:**	0

5 cm

564030

OR-0445 Vol II

ENCLOSURE 1

Schlumberger

GEOFRAME PROCESSED INTERPRETATION

5 cm

Petrophysical Analysis
Elan

*A Mark of Schlumberger

COMPANY:	Esso Australia		
WELL:	CORMORANT 1		
FIELD:	Eastern Bass Basin		
County	Offshore		
	Bass Straits		
COUNTRY:	Australia		
Date Logged:	27-July-1970	Date Processed:	12-Sept-1997
Well Location:			
Elevations:	KB: 30.5m	DF: 30.2m	GL: -73m
API Number:	NA	Job Number:	55228

Using the following logs: IES - GR - Sonic - Density

FOLD HERE The well name, location and borehole reference data were furnished by the customer.

All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretations made by any of our officers, agents or employees. These interpretations are also sublect to Clause 4 of our General Terms and Conditions as set out in our current Price Schedule.

Field Recording:	Location: SEA	Software Version: Panels	Engineer: NA
Office Recording:	ICS Center: Dallas ICS	Baseline: GF 2.5.2	Log Analyst: JTW

Mud and Borehole Measurements:

Rm @ Measured Temperature: 0ohm.m	@ 6.39488e-14degC	BHT: 0degC	Bitsize: 12.25in
Rmf @ Measured Temperature: 0ohm.m	@ 6.39488e-14degC	Fluid in Hole:	Lignosulfonate
Rmc @ Measured Temperature: 0ohm.m	@ 6.39488e-14degC	Mud Density: 1.28g/cm3	

Remarks:

PHIT is from limestone sonic - using Hunt

1600
1650
1700
1750
1800
1850
1900
1950
2000
2050
2100
2150
2200
2250
2300
2350
2400

2400
2450
2500
2550
2600
2650
2700
2750
2800
2850
2900
2950
Water Saturation
1 (v/v) 0
SW
Intrinsic Perm
10000 (mD) 0.1
Water
Gas
Oil
SP
-80 (mV) 20
Gamma Ray
0 (gAPI) 150
5 cm
Volume Analysis
0 (v/v) 1
Illite
Glauconite
X Zone Bound Water
Ash
Silt
Coal
Quartz
Calcite
Dolomite
X Zone Oil
X Zone Water
Moved Hydrocarbon
Fluid Analysis
0.5 (v/v) 1
X Zone Oil
X Zone Water
Moved Hydrocarbon

OR-0445 VOL II

564031

ENCLOSURE 8

Schlumberger

GEOFRAME PROCESSED INTERPRETATION

5 cm

Petrophysical Analysis Elan

*A Mark of Schlumberger

Using the following logs: ISF - Sonic - LDT - CNT - SGT

COMPANY:	Amoco Australlia Petroleum company Ltd.
WELL:	YOLLA #1
FIELD:	Eastern Bass Basin
	Bass Straits
Country	Australlia
COUNTRY:	Australlia
Date Logged:	21-August-1985 Date Processed: 25-Sept-1997
Well Location:	Lat: 39 50' 18.890"S
	Long: 145 48' 20.550"E
Elevations:	KB: 11m DF: 10.7m GL: -79.5m
API Number:	NA Job Number: 55228

FOLD HERE The well name, location and borehole reference data were furnished by the customer.

All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretations made by any of our officers, agents or employees. These interpretations are also sublect to Clause 4 of our General Terms and Conditions as set out in our current Price Schedule.

Field Recording:	Location: SEA	Software Version: NA	Engineer: NA
Office Recording:	ICS Center: Dallas ICS	Baseline: GF 2.5.2	Log Analyst: JTW

Mud and Borehole Measurements:

Rm @ Measured Temperature: 0ohm.m @ 6.39488e-14degC	BHT: 0degC	Bitsize: 12.25in
Rmf @ Measured Temperature: 0ohm.m @ 6.39488e-14degC	Fluid in Hole:	Lignosulphonate/Seawater
Rmc @ Measured Temperature: 0ohm.m @ 6.39488e-14degC	Mud Density: 1.17g/cm3	

Remarks:

2500
2550
2600
2650
2700
2750
2800
2850
2900
2950
3000
3050
3100
3150
3200
3250

3200
3250
3300
Water Saturation
1
0
(v/v)
SW
Volume Analysis
0
1
(v/v)
Clay #1
Clay #2
X Zone Bound Water
Ash
Silt
Coal
Quartz
Volcanic Rock
Calcite_F1
Dolomite_F1
Isolated Fluid
X Zone Oil
X Zone Water
Moved Hydrocarbon
Intrinsic Perm
10000
0.1
(mD)
Water
Gas
Oil
SP
-80
20
(mV)
Gamma Ray
0
150
(gAPI)
5 cm
Fluid Analysis
0.5
1
(v/v)
X Zone Oil
X Zone Water
Moved Hydrocarbon

564032

OR-0445 VOL II

ENCLOSURE 3

Schlumberger

GEOFRAME PROCESSED INTERPRETATION

5 cm

Petrophysical Analysis
Elan

*A Mark of Schlumberger

Using the following logs: ISF - Sonic - LDT - CNT - SGT

COMPANY:	Amoco Australila Petroleum Company
WELL:	TILANA #1
FIELD:	Eastern Bass Basin
	Bass Straits
Country	Australila
COUNTRY:	Australila
Date Logged:	21-November-1985 Date Processed: 25-Sept-1997
Well Location:	Lat: 39 53' 36.730" S
	Long: 145 58' 41.970" E
Elevations:	KB: 22m DF: 21.7m GL: -82m
API Number:	NA Job Number: 55228

FOLD HERE The well name, location and borehole reference data were furnished by the customer.

All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretations made by any of our officers, agents or employees. These interpretations are also sublect to Clause 4 of our General Terms and Conditions as set out in our current Price Schedule.

Field Recording:	Location: SEA	Software Version: NA	Engineer: NA
Office Recording:	ICS Center: Dallas ICS	Baseline: GF 2.5.2	Log Analyst: JTW

Mud and Borehole Measurements:

Rm @ Measured Temperature: 0ohm.m	@ 6.39488e-14degC	0degC	Bitsize: 12.25in
Rmf @ Measured Temperature: 0ohm.m	@ 6.39488e-14degC Fluid in Hole:		Lignosulfonate/Sea Water
Rmc @ Measured Temperature: 0ohm.m	@ 6.39488e-14degC Density: 1.18g/cm3		

Remarks:


2350
2400
2450
2500
2550
2600
2650
2700
2750
2800
2850
2900
2950
3000
3050
3100
3150


3200
3250
3300
3350
3400
3450
3500
3550
3600
3650
3700
3750
3800
3850
Water Saturation
1
0
(v/v)
SW
Volume Analysis
0
1
(v/v)
Shale #1
Shale #2
X Zone Bound Water
Ash
Silt
Coal
Quartz
Volcanic Rock
Calcite
Dolomite
Isolated Fluid
X Zone Oil
X Zone Water
Moved Hydrocarbon
Intrinsic Perm
10000
0.1
(mD)
Water
Gas
Oil
SP
-80
20
(mV)
Gamma Ray
0
150
(gAPI)
5 cm
Fluid Analysis
0.5
1
(v/v)
X Zone Oil
X Zone Water
Moved Hydrocarbon