



Macondo data summary

November 9th 2010



CONFIDENTIAL

BP-HZN-2179MDL05368302

BPD399-003260

## Well logs



### Database

- All Logging While Drilling (LWD), Wireline, Mud logging, Pressure and Core data were loaded into Geology where formation evaluation was completed.

### LWD

- Halliburton was the LWD vendor. GR, Resistivity, Sonic and PWD tools were in the BHA while drilling plus Gentag formation pressure in the target section.
- In the section of the hole logged with wireline tools, LWD was depth shifted to TCOMBO Gamma Ray. In cased hole section, where wireline sonic in casing was run, LWD was shifted to it to match sonic response on LWD and wireline. From mudline to top of sonic in casing (-11,700' and) the depth shift was distributed.

### Wireline

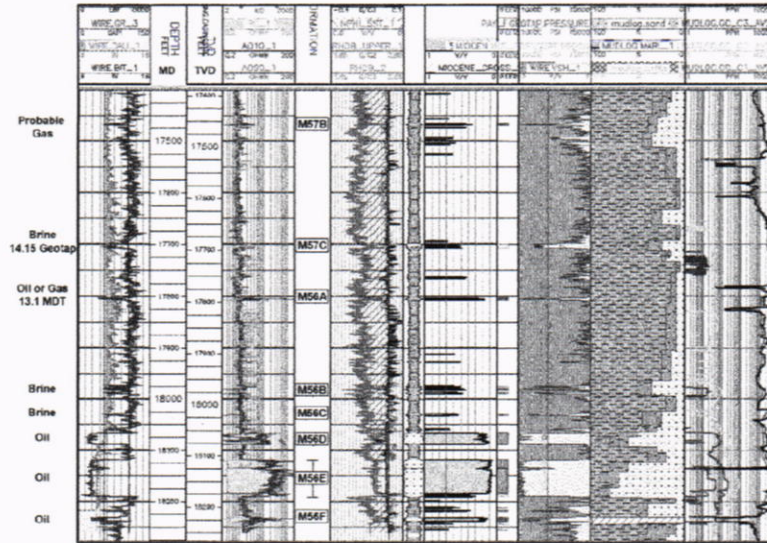
- The following Schlumberger open hole wireline logs were run in 6 descents in open hole section from 17,150'-18,270' MD. They include the following tools:
- R1D1: ZAT/ GPIT/ LDS/ CNL/ GR/ LEHQ/
- R1D2: CMR/ FVS/ HNC/ LEHQ/
- R1D3: Dual OBMI/ GPIT/ DSI/ GR/ LEHQ/
- R1D4: MET/ GR/ LEHQ/ (pressure and samples)
- R1D5: MSC/ GR/ LEHQ/ (rotary side wall cores) was not fully successful; repeated as
- R1D7 after R1D6
- R1D6: Quad VSI/ GR/ LEHQ/

## Core



- 44 rotary side wall core samples recovered from 3 MSCT runs.
- Sample preparation and analysis at Weatherford's Laboratories in Houston.
- Around 2/3rds of the samples were in a condition suitable for petrophysical analysis.
- 6 samples were dedicated for mechanical properties and pore compressibility studies.
- 19 samples were selected for Routine Core Analysis (RCA). The analyses from 17 samples from M56D and M56E have been completed.
- Special Core analysis (Electrical Properties and Capillary pressure measurements) were planned to be run on a sub-set of samples. The SCAL measurements are on hold as the samples have been subpoenaed.
- See Macondo Sample Tracking spreadsheet for details.

# Sand identification chart for MC0252\_1BP1



Sand identification chart for sands below the 9-7/8" liner that were penetrated by the MC0252\_1BP1 well.

# Net/Pay summary

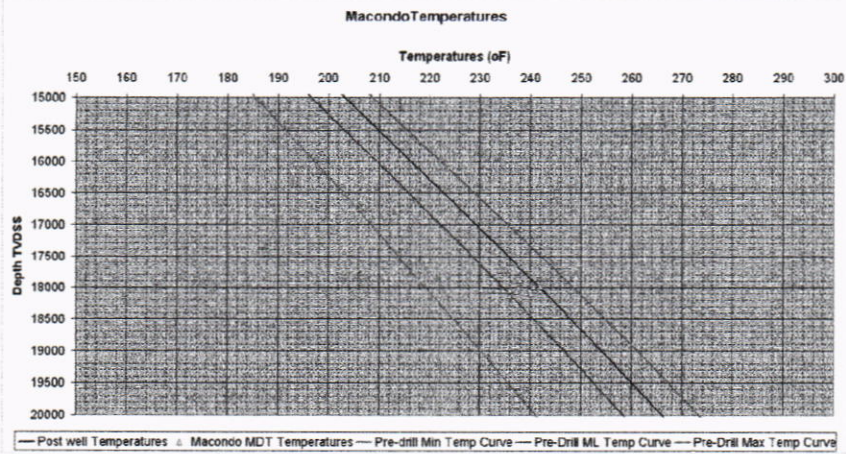


Top of Sand MD Depth	Bottom of Sand MD Depth	Top of Sand TV/DSS Depth	Bottom of Sand TV/DSS Depth	Fluid Content	Sand Name	Gross Sand	Net Sand	Pay Sand	Average Gross Porosity	Average Net Porosity	Average Pay Porosity	Average Net Sw	Average Pay Sw	Anticline Air Perm	Geometric Air Perm
Feet	Feet	Feet	Feet			Feet	Feet	Feet	%	%	%	%	%	MD	MD
17457.0	17458.0	17381.1	17383.1	Probable Gas	M57B	2	2	2	18.0	18.0	18.0	52	52	15	8
17700.0	17708.5	17614.1	17622.6	Uncertain	M57C	8.5	0	0	9.0						
17804.0	17806.5	17718.1	17720.6	Oil or Gas	M56A	2.5	2.5	2.5	22.5	22.5	22.5	24	24	1702	667
17975.5	17989.5	17889.6	17903.6	Brine	M56B	5	3	0	14.2	17.0		56		7	3
18030.0	18032.0	17944.1	17946.1	Brine	M56C	2	2	0	17.3	17.3		64		5	4
18067.0	18089.0	17981.1	18003.1	Oil	M56D	22	22	22	20.7	20.7	20.7	17	17	258	102
18120.0	18191.0	18034.1	18105.0	Oil	M56E	69.5	64.5	64.5	21.4	22.1	22.1	9.7	9.7	514	324
18217.5	18238.5	18131.5	18152.5	Oil	M56F	8.5	6.5	6.5	21.1	21.1	21.1	22	22	1441	130

Summary of the gross, net and pay sand. For M56D corrected Density porosity, Sw and Permeability are used for averaging.

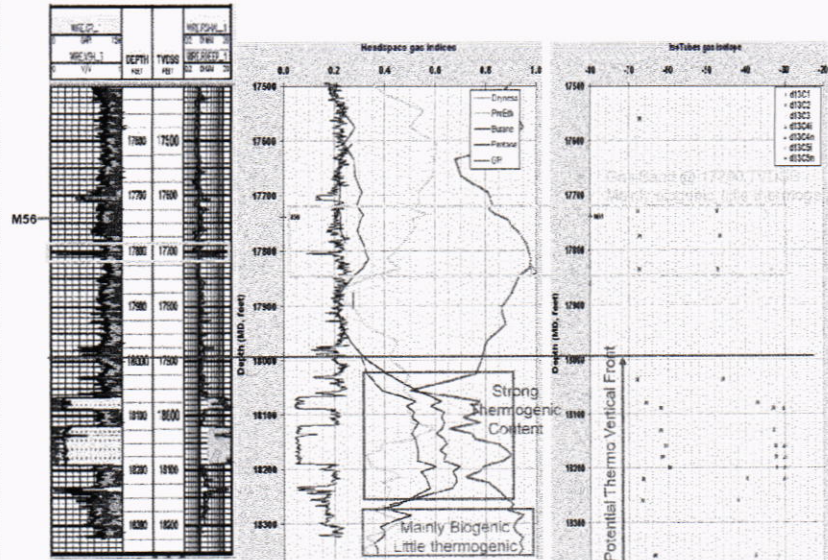


## Temperature data



The post well temperatures acquired from the MDT tool gave a range between 230 and 242 °F. The black curve is the post-well temperature curve. It takes into account the outer limit of the MDT temperatures as the closest reservoir temperature reading. The post-well temperature curve is slightly above the most-likely pre-drill curve (~7 °F) but is close to the pre-drill temperature prediction.

# Headspace gas and Isotopes



## Headspace gas and isotopes



- \* Using the headspace gas indices and isotope results from isotubes, the thermogenic vertical front appears at 18000' MD (17900' TVDSS). Indeed, the pro ethane, butane, and pentane indices increase drastically, while the dryness index severely decreases. Moreover, the methane isotopes appear less depleted and the butane isotopes become present.
- \* The base of the well (below 18250' MD / 18150' TVDSS) has more a biogenic signature. It is believed that the vertical thermogenic front does not pass exactly by the wellbore, giving the idea of a lateral charge. However, it is certainly a vertical thermogenic front.
- \* The section shallower than 18000' MD (-17900' TVDSS) has a strong biogenic signature with some rare amount of thermogenic hydrocarbon. However, it is mainly biogenic gas. The sand at 17800' MD (17700' TVDSS) is a good example: it is mainly biogenic methane, but has a small amount of ethane and propane coming from the thermogenic charge. This charge was lateral in nature.

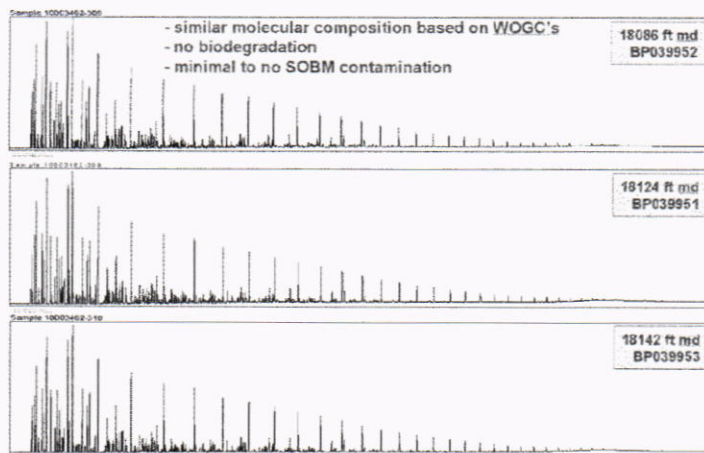


## Fluid samples



- \* Three fluid samples were taken at the level of the reservoir zone:
  - one sample in the M56D sand (upper sand lobe at 18086' MD / 17999' TVDSS).
  - 2 samples in the M56E sand (middle sand lobe at 18124' and 18142' MD / 18037' and 18055' TVDSS).
- \* Three dead oil samples were derived from those 3 fluid samples and were analysed for whole gas chromatography. The chromatograms are shown on the next slide.
- \* By comparing the three chromatograms, we can conclude that the 3 oil samples have a very similar molecular composition, that there is no biodegradation and a minimal contamination level from the drilling mud.
- \* By looking at the headspace and isotube concentrations as well as the isotope signatures, we can also conclude that the M56D, M56E, and M56F sands are oil and have similar composition. The M56F sand (18250' MD) is oil but has a higher content of biogenic gas than the M56D and M56E sands.

# Chromatograms



Chromatograms for the three dead oil samples derived from the 3 fluid samples

## PVT summary



- Three separate labs, Pencor, OilPhase, and Westport, conducted independent tests.
- Testing conducted at the labs (Note: not all labs did the same tests) are single-stage flash, viscosity and density measurements, constant composition expansion, differential liberation, multi-stage separator test, mini-assay, asphaltene onset pressure, and wax appearance test.
- Next slide is a summary of the measured results conducted by the labs at different sample depths. Full PVT reports are available.

## PVT summary



PVT Properties	Pencor (Core Lab)	OilPhase (Schlumberger)	Westport (Interak)	Sample Depth (MD, ft)
Reservoir Pressure (psia) at Reservoir Temperature	6,504	6,348	6,438	18,142
Saturation Pressure (psia) at Reservoir Temperature	6,600	N/A	N/A	18,124
Saturation Pressure (psia) at 100°F	6,438	6,336	6,107	18,142
Saturation Pressure (psia) at 100°F	6,540	N/A	N/A	18,124
GOR (scf/stb), Single-Stage Flash	2,810	2,848	2,831	18,142
GOR (scf/stb), Single-Stage Flash	3,046	3,096	N/A	18,086
GOR (scf/stb), Single-Stage Flash	2,890	2,994	N/A	18,124
API, Single-Stage Flash	36.2	34.6	36.8	18,142
API, Single-Stage Flash	34.3	34.7	N/A	18,086
API, Single-Stage Flash	34.7	34.9	N/A	18,124
Oil FVF (rb/stb) at Saturation Pressure, Single-Stage Flash	2,664	2,639	2,610	18,142
Oil FVF (rb/stb) at Saturation Pressure, Single-Stage Flash	2,618	N/A	N/A	18,124
GOR (scf/stb), Separator Test	2,664	2,442	2,747	18,142
GOR (scf/stb), Separator Test	2,466	N/A	N/A	18,124
API, Separator Test	38.2	37.4	37.4	18,142
API, Separator Test	38.3	N/A	N/A	18,124
Oil FVF (rb/stb) at Saturation Pressure, Separator Test	2,387	2,262	2,388	18,142
Oil FVF (rb/stb) at Saturation Pressure, Separator Test	2,339	N/A	N/A	18,124
Oil Density (g/cc) at Initial Reservoir Conditions	0.567	0.590	N/A	18,142
Oil Density (g/cc) at Initial Reservoir Conditions	0.583	N/A	N/A	18,124
Oil Viscosity (cp) at Initial Reservoir Conditions	0.168	N/A	0.260	18,142
Oil Viscosity (cp) at Initial Reservoir Conditions	0.203	N/A	N/A	18,124
Asphaltene Onset Pressure (AOP, psia) at Reservoir Temperature	N/A	9,500	N/A	18,086
Asphaltene Onset Pressure (AOP, psia) at Reservoir Temperature	N/A	6,816	N/A	18,124
Wax Appearance Temperature (°F) at 4,500 psia	N/A	80.0	N/A	18,142
Dead Oil Wax Appearance Temperature (°F)	89	N/A	N/A	18,142
Dead Oil Wax Appearance Temperature (°F)	N/A	92.5	N/A	18,124
Dead Oil Wax Content (wt%)	N/A	1.77	N/A	18,124





## Pore Pressure and Fracture Gradient



- The current interpretation of pore and fracture pressure at Macondo incorporates revisions to the pre-drill forecast based on: synthesis of LWD and wireline pressure indicators (pressure transforms based on resistivity, sonic, checkshot, and density); drilling parameters and data (D-Exponent, background, and connection gases); and direct drilling indicators (kicks, losses, and real-time/wireline direct pressure measurements). Pore pressure is interpreted to be higher than the pre-drill most likely curve from 9000' to 17750' TVDKB. This is due to slower than predicted interval velocities and revised pressure transform parameters more similar to those required to reconcile pressure measurements and indirect pressure estimates from logs at the high pressure, narrow margin offset well "Yumuri", MC382-1. Reservoir pressures at Macondo are much lower than predicted – pressure in the oil bearing reservoir sands represent the only interval which falls outside of the pre-drill minimum maximum pressure envelope. Pre-drill centroid modeling of channel sands draped over the large 4-way Macondo structure placed reservoir pressures 0.1-0.5 ppg higher than shale pressure. Actual reservoir pressures (similar reservoir pressure to Isabella) imply regional hydraulic connectivity, at least on a geologic time scale, to deeper water lower overburden/pore pressure environments to the south, or local connectivity up-dip beneath allochthonous salt bodies southwest and east of the prospect. Though wireline density is limited to the reservoir section, calibrated acoustic to density transforms of the Macondo sonic and checkshot imply that overburden is lower than predicted. Lower densities used in the calibrated postwell overburden are consistent with the higher than predicted pore pressure observed at the prospect. The narrow PPEF window above reservoir level and weak formations exposed at the 22" shoe, led to shallower than planned casing depths and the use of contingency liners.



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- R1D3: Dual OBMI-GPIT-DSI-GR-LEHQ
- R1D4: MDT-GR-LEHQ (pressure and samples)
- R1D5: MSCT-GR-LEHQ (rotary side wall cores) was not fully successful; repeated as
- R1D7 after R1D6
- R1D6: Quad VSI-GR-LEHQ



# Core



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18030.0	18032.0	17944.1	17946.1	Brine	M56C	2	2	0	0	0	0	17.3	17.3		64			5	4
18067.0	18089.0	17981.1	18003.1	Oil	M56D	22	22	22	22	22	22	20.7	20.7	20.7	17	17	17	258	102
18120.0	18191.0	18034.1	18105.0	Oil	M56E	69.5	64.5	64.5	64.5	64.5	64.5	21.4	22.1	22.1	9.7	9.7	9.7	514	324
18217.5	18238.5	18131.5	18152.5	Oil	M56F	6.5	6.5	6.5	6.5	6.5	6.5	21.1	21.1	21.1	22	22	22	1441	130

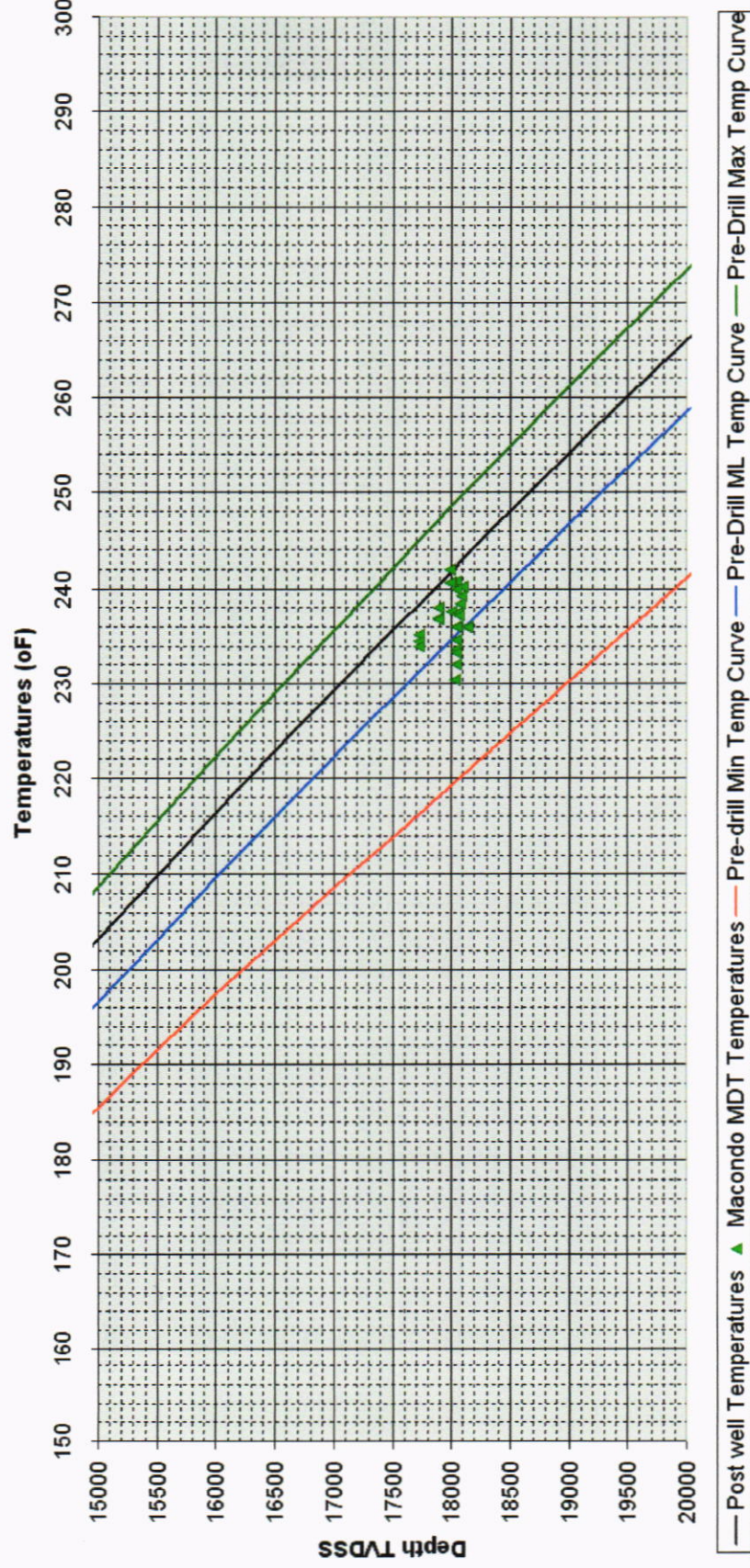
Summary of the gross, net and pay sand. For M56D corrected Density porosity, Sw and Permeability are used for averaging.



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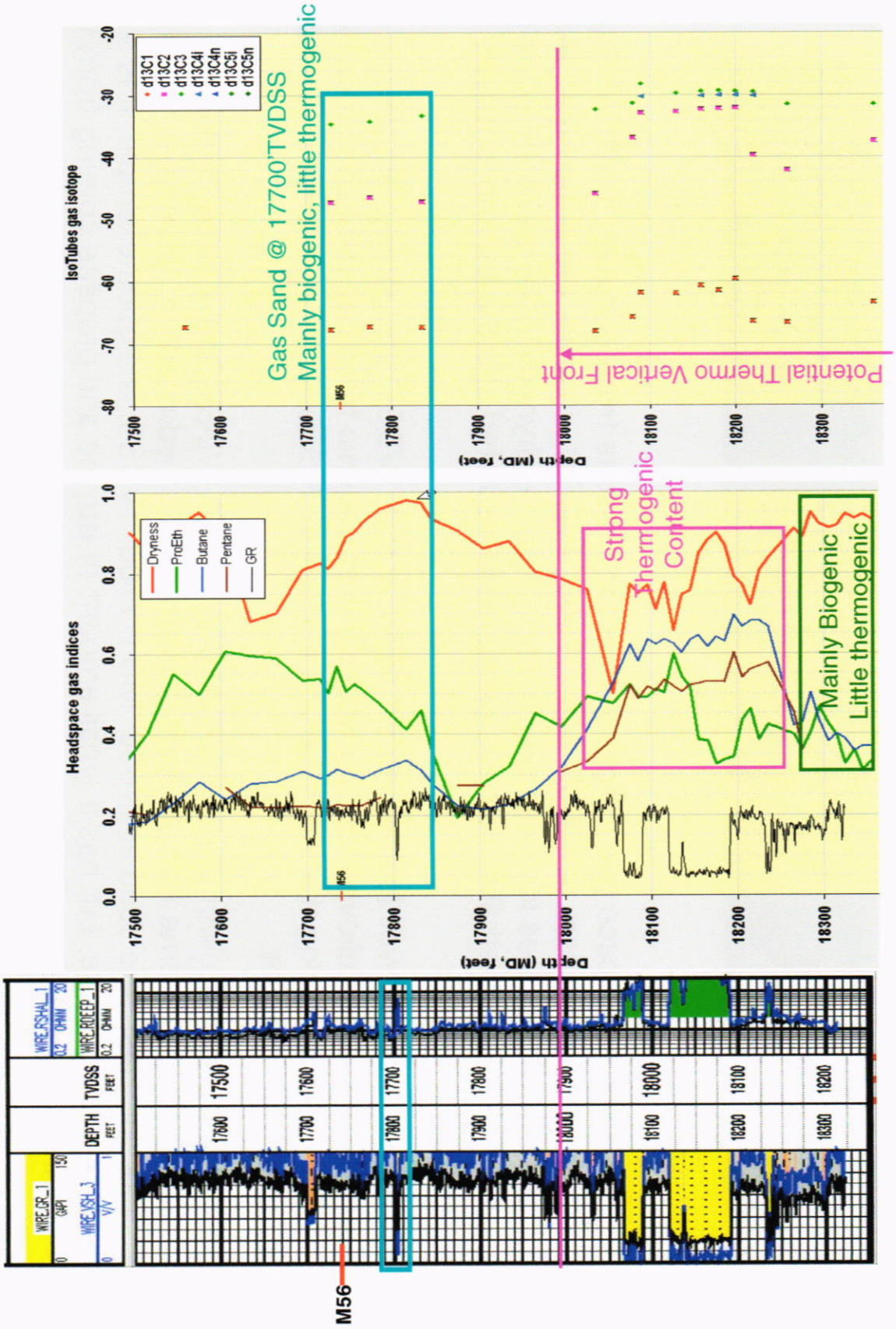
**Macondo Temperatures**



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# Fluid samples



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  - one sample in the M56D sand (upper sand lobe at 18086' MD / 17999' TVDSS),
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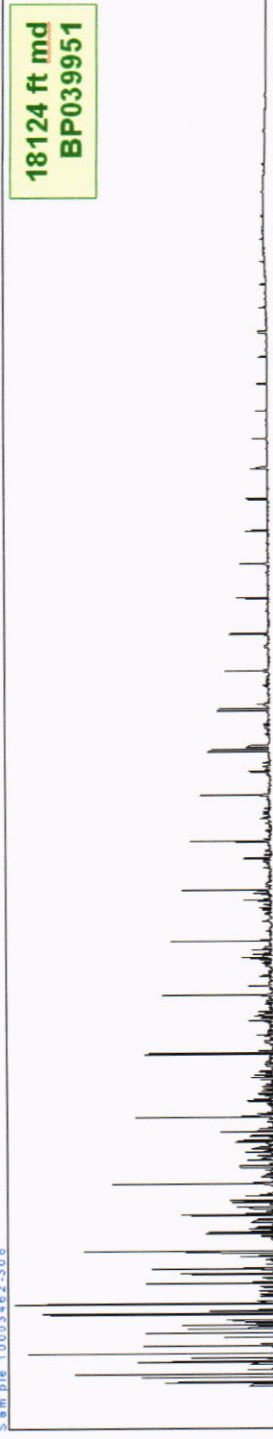
# Chromatograms



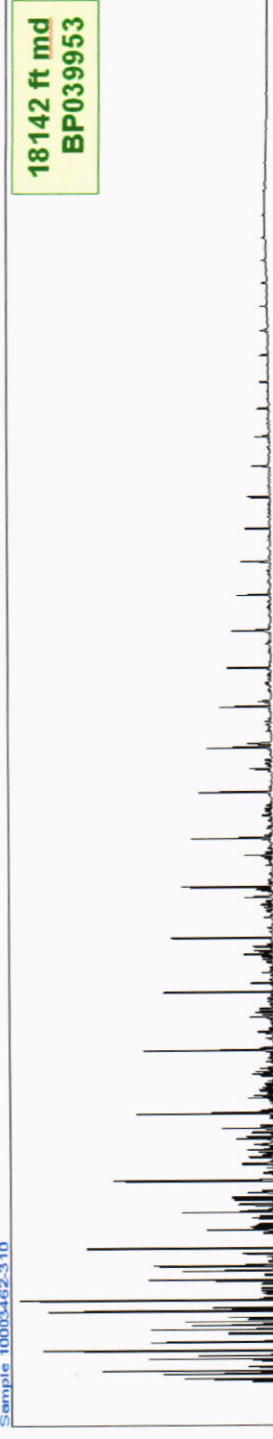
Sample 10003462-309



Sample 10003462-308



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Chromatograms for the three dead oil samples derived from the 3 fluid samples

## PVT summary



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Saturation Pressure (psia) at 100F	6,636	6,235	6,107	18,142
Saturation Pressure (psia) at 100F	6,640	N/A	N/A	18,124
GOR (scf/stb), Single-Stage Flash	2,810	2,945	2,831	18,142
GOR (scf/stb), Single-Stage Flash	3,056	3,096	N/A	18,086
GOR (scf/stb), Single-Stage Flash	2,890	2,994	N/A	18,124
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API, Single-Stage Flash	34.8	34.7	N/A	18,086
API, Single-Stage Flash	34.7	34.6	N/A	18,124
Oil FVF (rb/stb) at Saturation Pressure, Single-Stage Flash	2,564	2,539	2,510	18,142
Oil FVF (rb/stb) at Saturation Pressure, Single-Stage Flash	2,618	N/A	N/A	18,124
GOR (scf/stb), Separator Test	2,554	2,442	2,747	18,142
GOR (scf/stb), Separator Test	2,485	N/A	N/A	18,124
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Oil Density (g/cc) at Initial Reservoir Conditions	0.583	N/A	N/A	18,124
Oil Viscosity (cp) at Initial Reservoir Conditions	0.168	N/A	0.260	18,142
Oil Viscosity (cp) at Initial Reservoir Conditions	0.203	N/A	N/A	18,124
Asphaltene Onset Pressure (AOP, psia) at Reservoir Temperature	N/A	9,500	N/A	18,086
Asphaltene Onset Pressure (AOP, psia) at Reservoir Temperature	N/A	6,615	N/A	18,124
Wax Appearance Temperature (F) at 4,200 psia	N/A	80.0	N/A	18,142
Dead Oil Wax Appearance Temperature (F)	89	N/A	N/A	18,142
Dead Oil Wax Appearance Temperature (F)	N/A	92.5	N/A	18,124
Dead Oil Wax Content (wt%)	N/A	1.77	N/A	18,124

# Macondo MC\_252-1-A Pressure Forecast: REV4 , 9/7/10



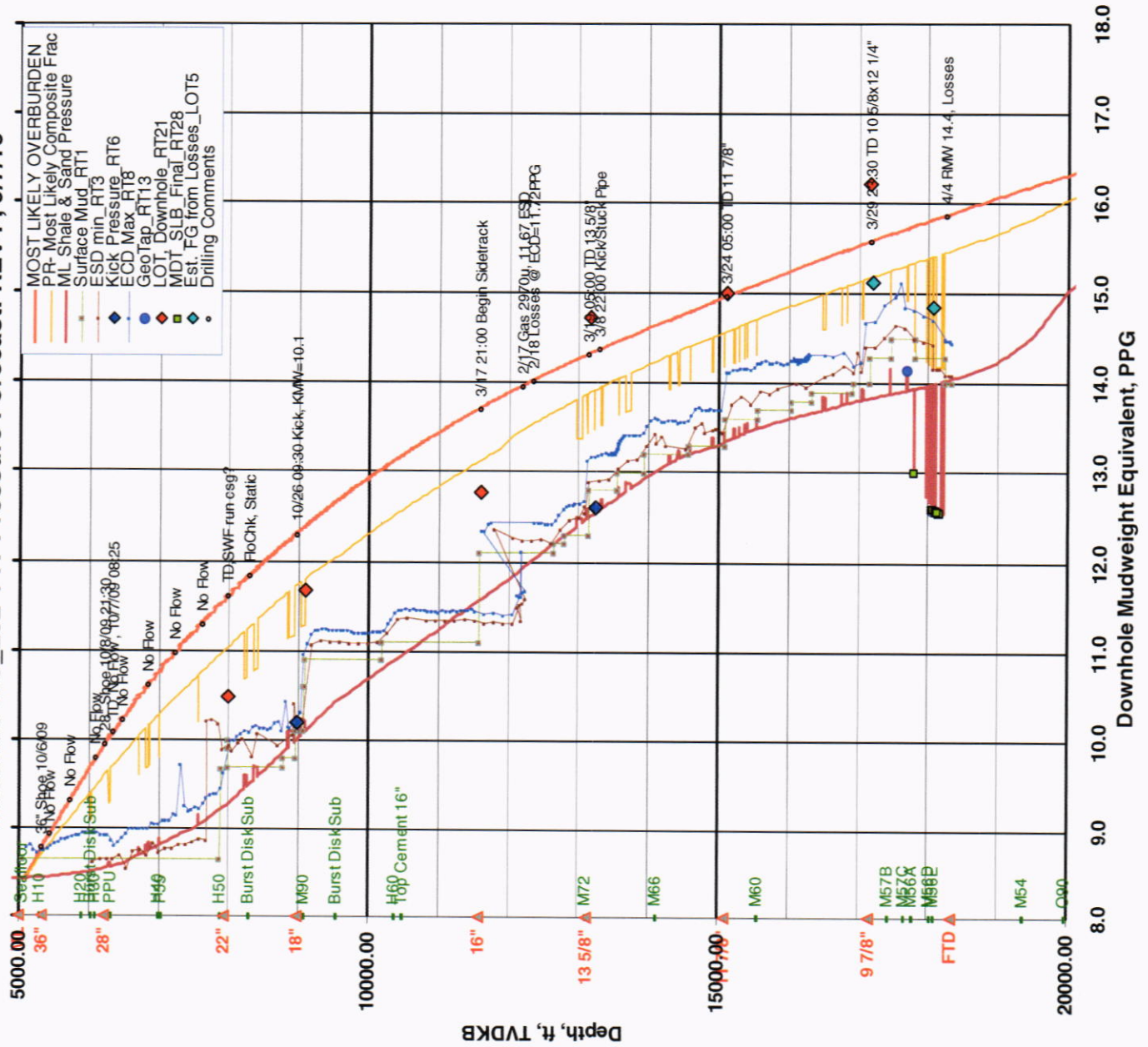
## Macondo Postwell PPFG Summary

### Pressure data collected while drilling:

- Surface Mudweight
- Equivalent Circulating Mud Density (ECD)
- Equivalent Static Mud Density (ESD)
- Pressure measurements while drilling (GeoTap)
- Wireline pressure measurements (MDT)
- Formation Integrity and Leakoff Test Data (FIT/LOT)
- Estimated formation pressure from kicks
- Estimated Rock strength from loss events

### Interpreted Pressure Curves:

- Sand/Shale composite pore pressure
- Sand/Shale composite fracture gradient
- Overburden





# Pore Pressure and Fracture Gradient



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