Base Case Description

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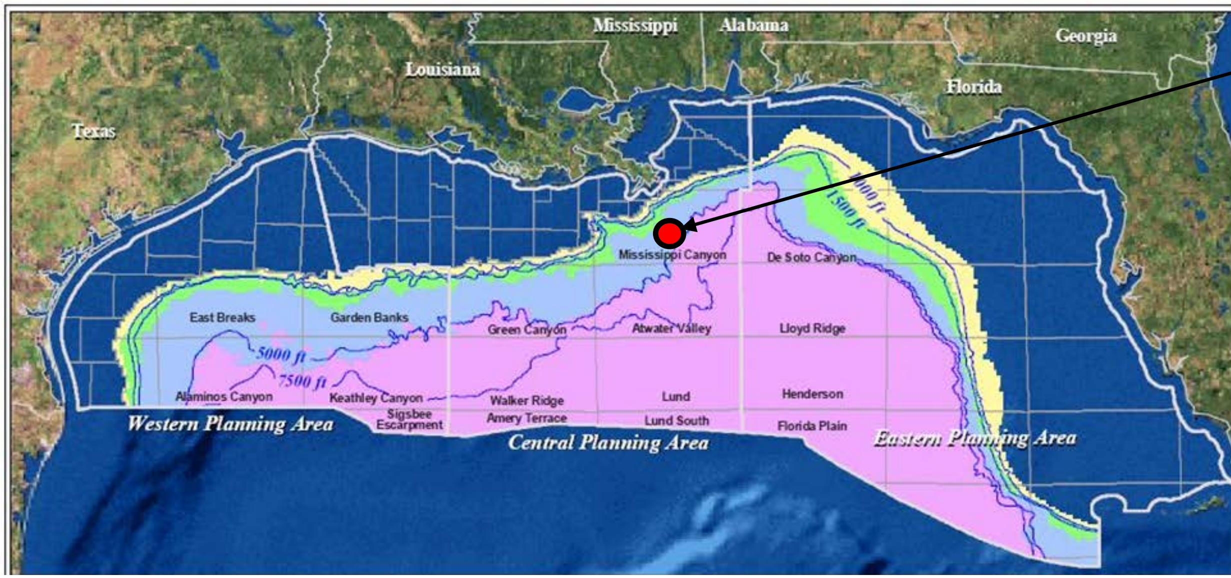
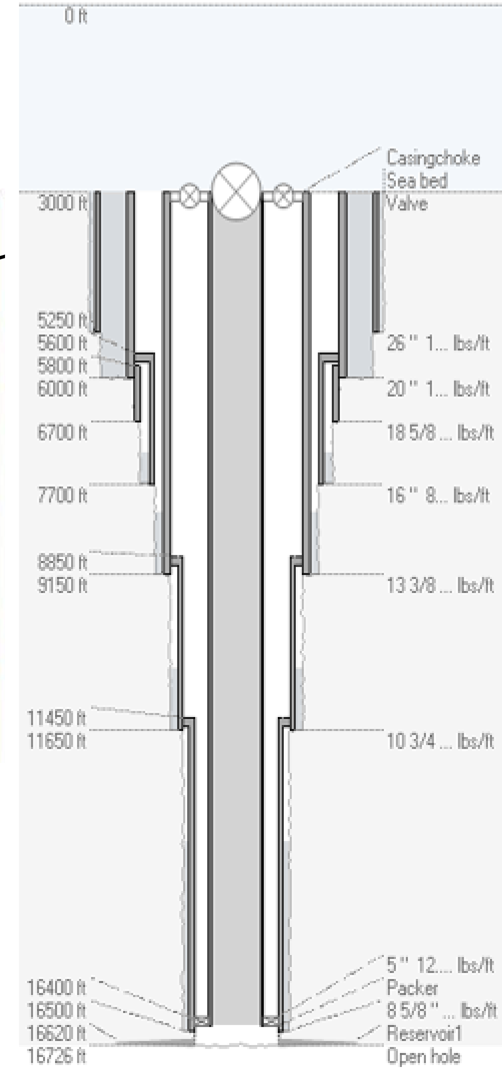
Base Case and Fluids

- **Base case**
  - **Representative Well and Reservoir Properties Selection**
- **Base Fluid Selection**
  - **Selection of fluids from data provided by BOEM**

Example – Location of GoM Well



(http://www.geographic.org/deepwater_gulf_of_mexico/definitions.html)



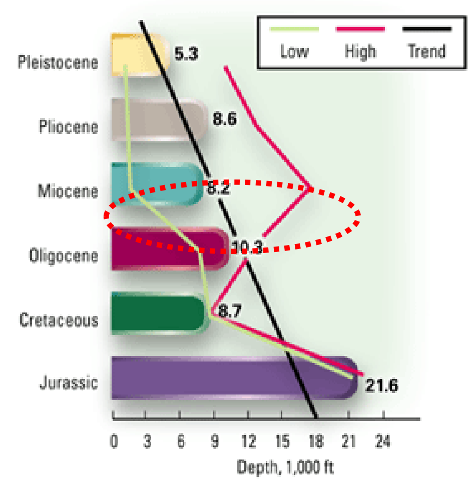
Hunter Fontenot, MS Project Report, LSU 2013.

Representative Reservoir Properties

Reservoir Property	N/O Sand (Yellow)	M1/M2 (Upper Green)
Area (acre)	4,917	3,715
Completion(s)	6 producers, 1 injector	3 producers, 1 injector
Permeability (mD)	125	171
Net/gross Sand	0.9	0.93
Thickness (ft)	99	106
Average Porosity	0.28	0.20
Water Saturation, Swi	0.22	0.26
Oil Initial FVF (rb/stb)	1.39	1.2
Datum Depth (ft)	16,726	16,237
Initial Pressure @datum (psia)	11,305	11,007
Bubble Point pressure (psia)	6,306	5,413

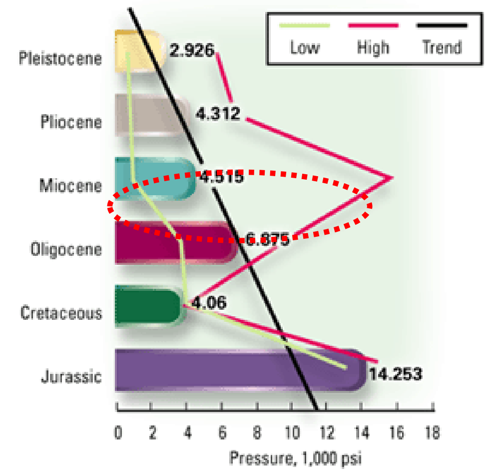
AVERAGE PRODUCTION DEPTH BY AGE

Fig. 1



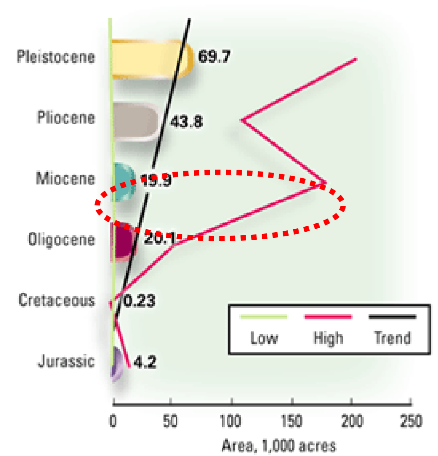
AVERAGE PRESSURE BY AGE

Fig. 2



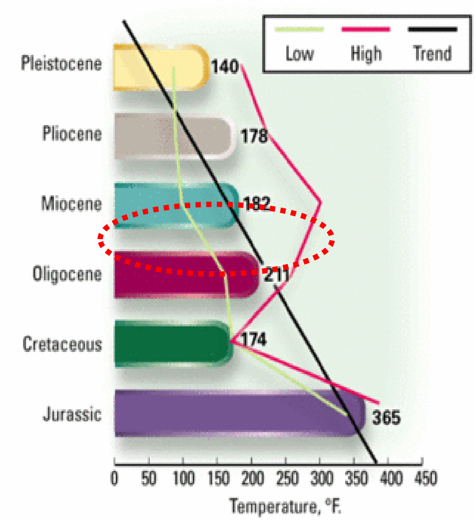
AVERAGE ACREAGE BY AGE

Fig. 3



AVERAGE FORMATION TEMPERATURE BY AGE

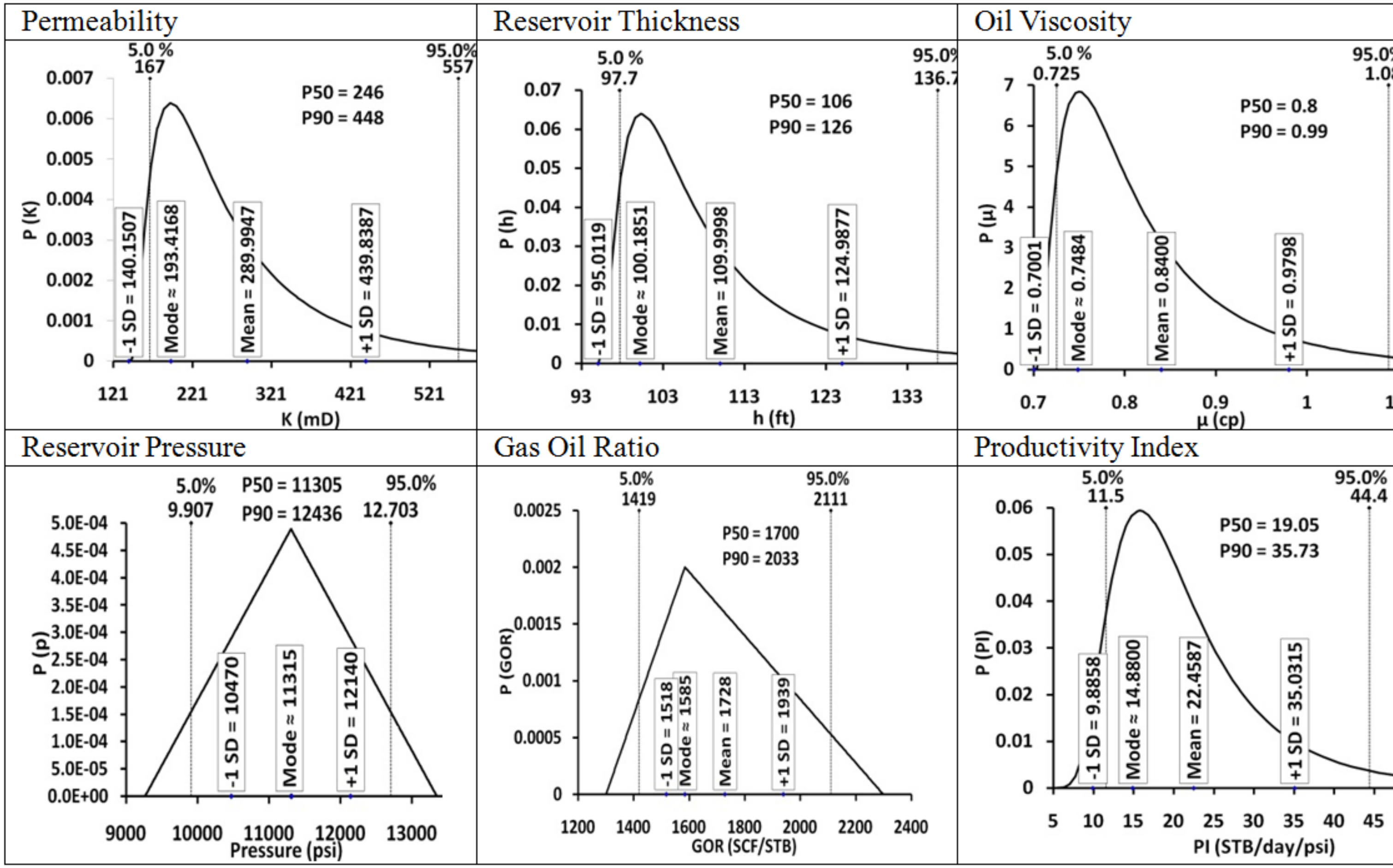
Fig. 4



RPSEA, "IOR for Deepwater Gulf of Mexico", Improved Recovery: Phase I, 07121-1701, December 15, 2010

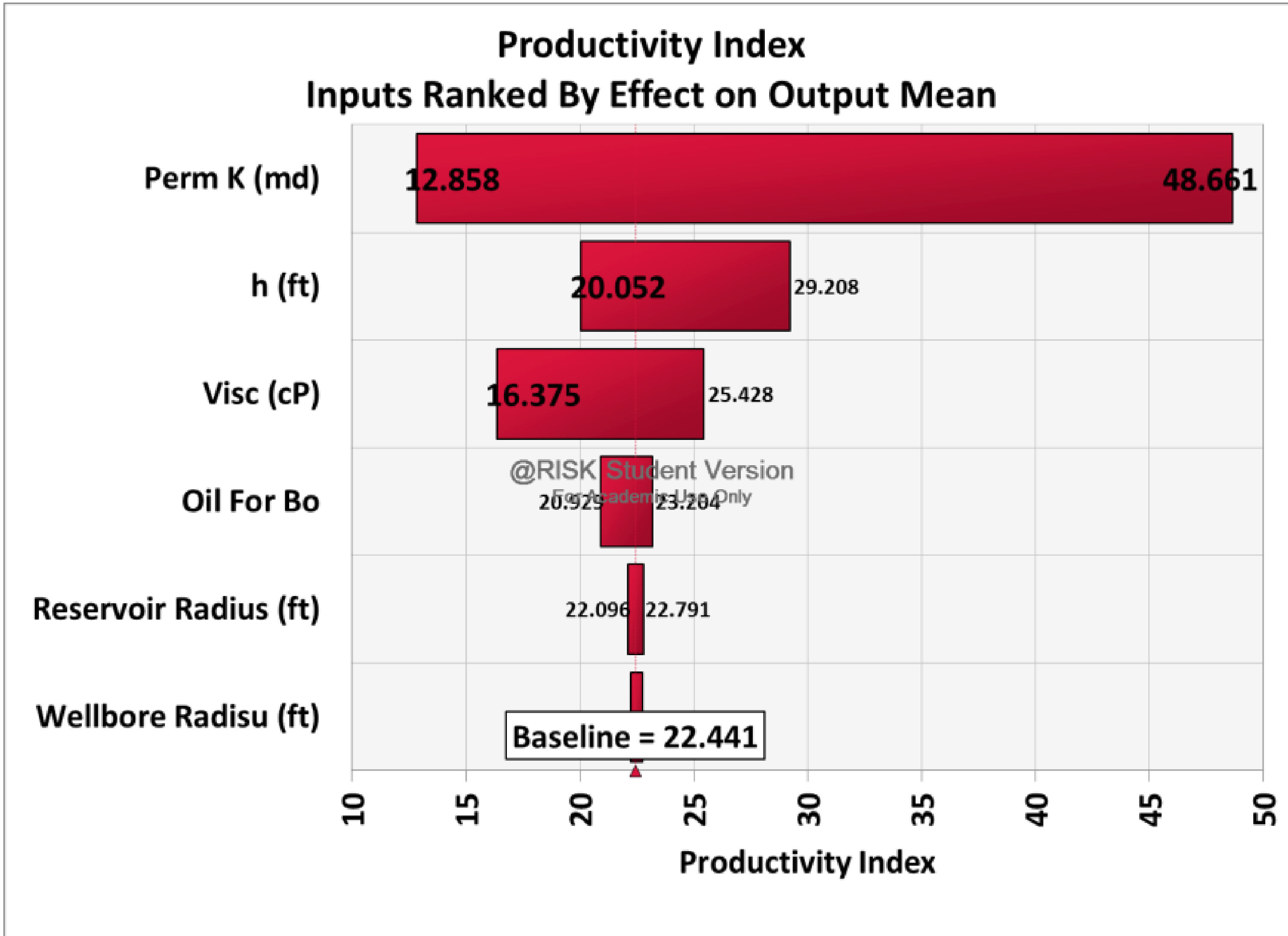
1* JANET HALL, "Gulf of Mexico reservoir properties are helpful parameters for explorers", Oil & Gas Journal, June 2005

Base Case – Reservoir Properties



RPSEA, "IOR for Deepwater Gulf of Mexico", Improved Recovery: Phase I, 07121-1701, December 15, 2010

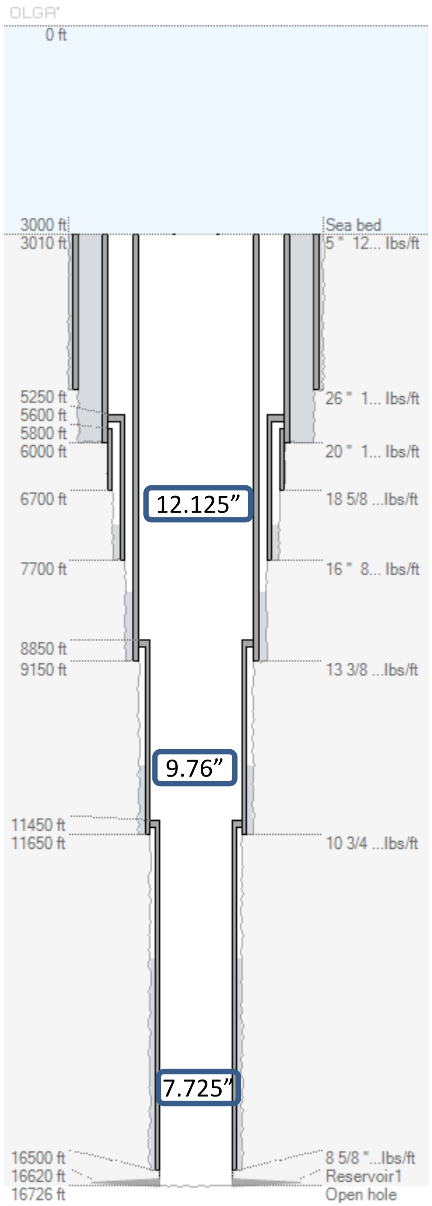
Example – Productivity Index Sensitivity Analysis



RPSEA, "IOR for Deepwater Gulf of Mexico", Improved Recovery: Phase I, 07121-1701, December 15, 2010

@ Risk Software : https://www.palisade.com/risk/

Selected Base Case for WCD Estimates



Variable	P50
P_R (psi)	11305
Temperature (F^0)	210
Thickness h (ft)	106
Permeability (mD)	246
GOR (SCF/STB)	1700
P_b (psi)	6306
API Gravity	28
Bo (rb/STB)	1.39
Reservoir Radius (ft)	8840
Wellbore Radius (ft)	0.7
Oil Viscosity (Cp)	0.8
PI (STB/day/psi)	19.05

Selection of Fluids for PVT Sensitivity Analysis for WCD Conditions

Selection of Fluids for PVT Sensitivity Analysis

- **Bubble point pressure variation in**
- **Select black oils that have similar reservoir pressure**
  - **Black Oil**
  - **Volatile Oil**
  - **Gas Condensate**

Fluid Selection Process

Property	Black Oil	Volatile Oil	Gas Condensate
API Gravity	15-45	42-55	45-60
Rs (SCF/STB)	200-900	900-3500	3500-30000
Bo (rb/STB)	1.1-1.5	1.5-3.0	3.0-20
C7-plus fraction	35-50	10-30	1-6

Other Factors Considered in Selection of Fluids

- **Production data from BOEM**
  - **to confirm whether well produced?**
  - **To distinguish between volatile oil and gas condensates when they are in the overlapping regions**

Selected Fluids

Base fluid	Reservoir measured depth (ft)	Reservoir pressure (psi)	Reservoir Temperature (°F)	GOR (scf/stb)	Bubble point Pressure (psi)	Oil gravity (API)	Oil viscosity (cp)
Basecase	16726	11305	210	1700	6306	28	0.8
BO1	19426	10391	166	1340	7693	25.3	1.49
BO2	19553	12523	251	1721	5192	36.1	0.173

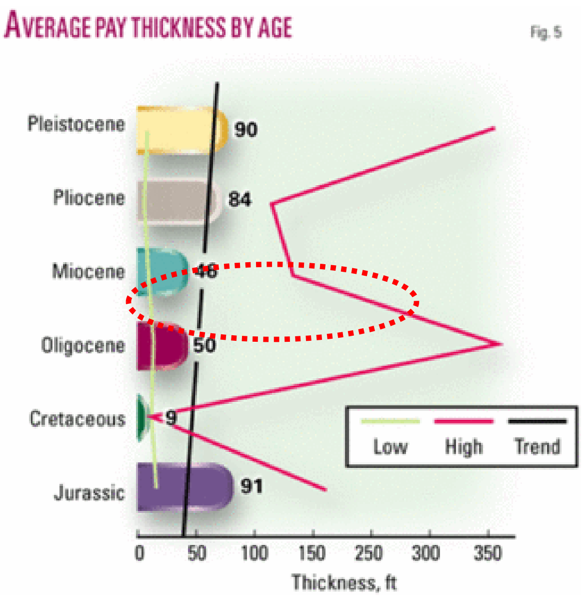
Base fluid	Reservoir measured depth (ft)	Reservoir pressure (psi)	Reservoir Temperature (°F)	GOR (scf/stb)	Oil gravity (API)
VO1	14631	11499	264	2123	34.6
VO2	14532	11055	263	1834	43.2
VO3	14374	11009	261	3451	42.1

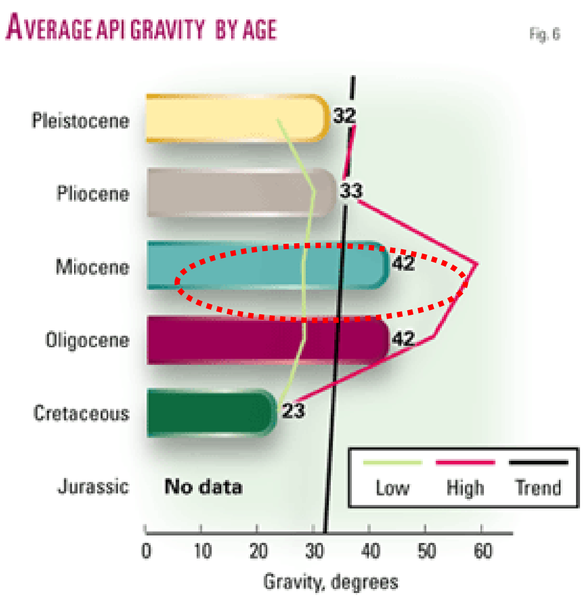
Base fluid	Reservoir measured depth (ft)	Reservoir pressure (psi)	Reservoir Temperature (°F)	GOR (scf/stb)	Saturation Pressure (psi)	Oil gravity (API)
GC1	14411	10100	178	10479	9288	40.1
GC2	14852	9306	199	5093	7350	39.6
GC3	16969	9160	150	10076	9100	40.8

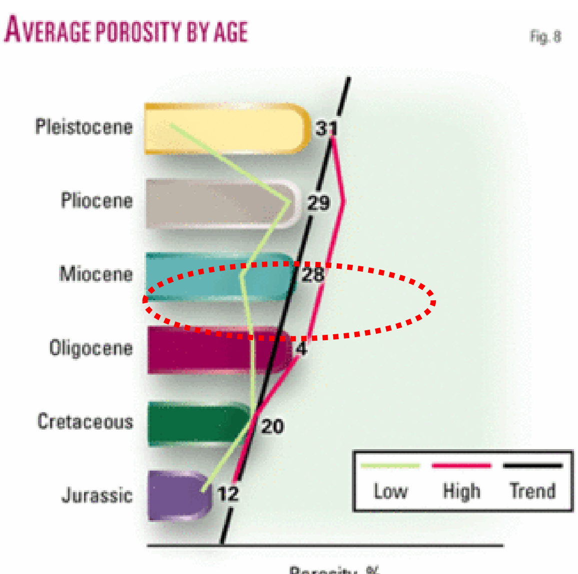
Questions/Feedback

Backup Slides

Some Trends in GoM

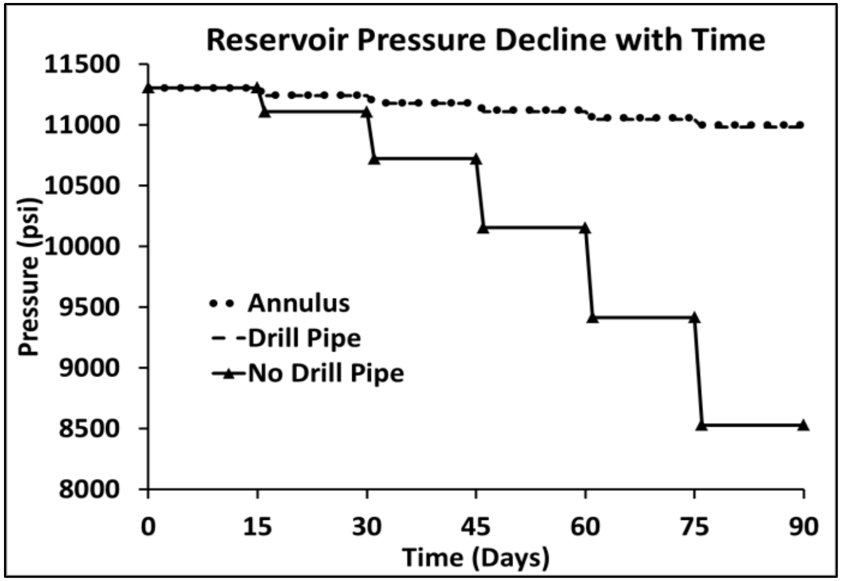






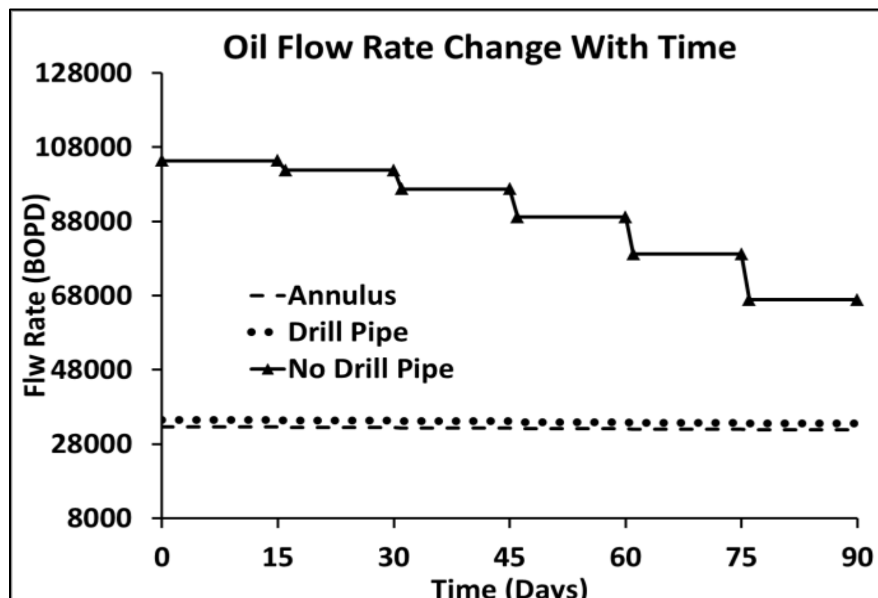
1* JANET HALL, "Gulf of Mexico reservoir properties are helpful parameters for explorers", Oil & Gas Journal, June 2005

Example – Reservoir Pressure Decline and Flow Rate



$$N_p = \frac{c_t N_i}{B_o}\left(\overline{P}_o - \overline{P}_t\right)$$

Where N_p : Oil produced, c_t: Total compressibility, N_i: Initial Oil in Place



Selected Gas Condensates

TABLE 9.1—PETROLEUM FLUIDS AND THEIR CHARACTERISTICS

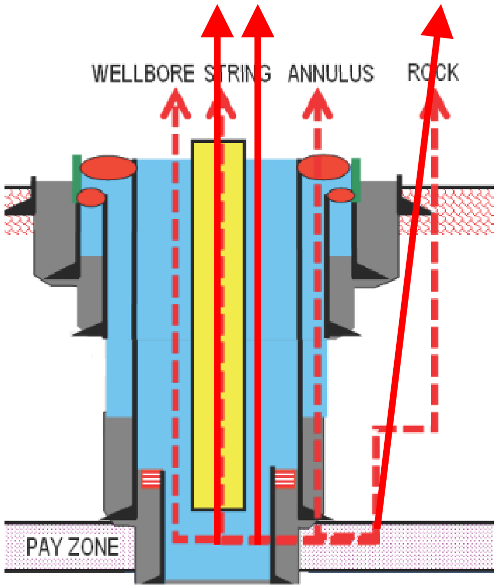
	Oils			Gases	
Characteristic	Heavy Oils and Tars	Black Oils	Volatile Oils	Gas Condensates	Wet and Dry Gases
Initial fluid molecular weight	210+	70 to 210	40 to 70	23 to 40	<23
Stock-tank-oil color	black	brown to light green	greenish to orange	orange to clear	clear
Stock-tank oil-gravity, °API	5 to 15	15 to 45	42 to 55	45 to 60	45+
C_7-plus fraction, mol%	>50	35 to 50	10 to 30	1 to 6	0 to 1
Initial dissolved GOR, scf/STB	0 to 200	200 to 900	900 to 3,500	3,500 to 30,000	30,000+
Initial FVF, B_{oi}, RB/STB	1.0 to 1.1	1.1 to 1.5	1.5 to 3.0	3.0 to 20.0	20.0+
Typical reservoir temperature, °F	90 to 200	100 to 200	150 to 300	150 to 300	150 to 300
Typical saturation pressure, psia	0 to 500	300 to 5,000	3,000 to 7,500	1,500 to 9,000	—
Volatile-oil/gas ratio, STB/MMscf*	0	0 to 10	10 to 200	50 to 300	0 to 50
Maximum vol% liquid during CCE**	100	100	100	0 to 45	0
OOIP, STB/acre-ft (bulk)	1,130 to 1,240	850 to 1,130	400 to 850	60 to 400	0 to 60
OGIP, Mscf/acre-ft (bulk)	0 to 200	200 to 700	300 to 1,000	500 to 2,000	1,000 to 2,200

*At bubblepoint pressure. **Constant composition expansion of reservoir fluid.

http://petrowiki.org/Oil_fluid_characteristics

Subsea Release Paths and rates

Flow Path	Prob.	Case ID	SCSSV or ASV	FSP	Oil Flow rate (bbl/day)	PPB
Tubing	0.63	SST1	Open	0.1	34546	0.063
		SST2	Restricted	0.9	21121	0.567
Annulus	0.25	SSA1	Open	0.1	32644	0.025
		SSA2	Restricted	0.9	20056	0.225
Outside Casing	0.12	SSR	NA	1	21121	0.12



Petersen (2011)

Duration range (days)		**<7 (Crew Intervention plus Others)**	**7-15 (Capping Stack Deployment)**	**15-30 (Capping Stack Deployment)**	**25-90 (Relief Well Drilling)**
Representative duration (days)		**7**	**15**	**30**	**90**
Probability	**Subsea (Base Case)**	**0**	**0**	**0**	**1**
	Subsea (Capping Stack)	**0**	**0.6**	**0.3**	**0.1**

Relief well duration = 90 days

Capping Stack option duration = 7*0 + 15*0.6 + 30* 0.3 + 90 * 0.1= 27 days