bp

MC 252 #1 (Macondo):

18⅛" x 22" hole-section review (18" CSG section)

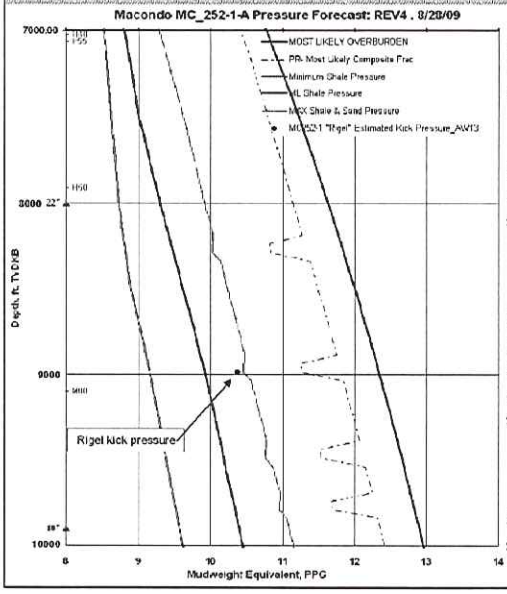
Drilling operations: 10/21/09 – 10/28/09

Key topics:

- PP/FG forecast
- Low leak-off test at 22" casing shoe
- Drilling 18⅛" x 22" hole with narrow drilling window
- Well control event (kick) at 8,970' (MD/TVD)
- Decision to drill ahead past kick interval to TD hole section in shale

[redacted]

PP/FG prospectus:



Question: what is the most probabilistic trend of pore-pressure increase with depth in the 18⅛ x 22" hole-section?

Strongly attune to seismic velocities as exhibited in the Isabella well? (most-likely scenario)

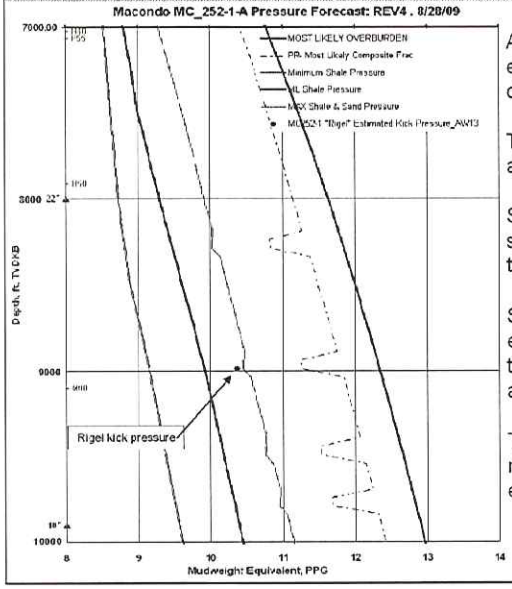
-or-

Similar to the maximum predicted pore-pressure as modeled from the Yumuri well, and corroborated by the kick pressure in the offset Rigel well? (maximum pore-pressure scenario)

-or-

Something intermediate to these two suggested end members

PP/FG prospectus:



A stuck pipe incident in the offset Rigel exploratory well (also in MC block #252) was determined to have been the result of a kick:

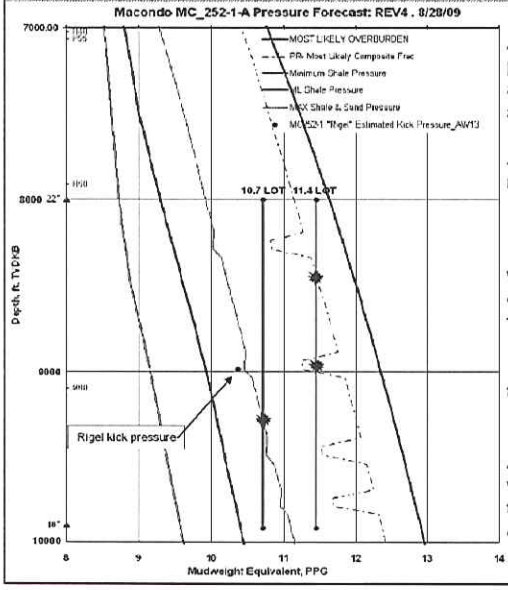
The kick event took place in the Rigel well in a sand at 9,038' (MD) / 9,018' (TVD).

Subsequent MDT pressure tests in this sand suggest sand pore-pressure at 9,018' (TVD) to be 10.26ppg MW equiv.

Structurally adjusted from Rigel, the estimated pore-pressure at ~8,970' TVD at the Macondo location was estimated to be approximately 10.20ppg.

This figure closely corresponds to the maximum sand/shale pore-pressure pre-drill estimate.

Desired leak-off test value:
(Downhole mudweight equivalent)



Assuming the well will follow the most-likely pressure forecast, the estimated pore-pressure at the targeted 9,900' hole-section TD will be approximately 10.4ppg.

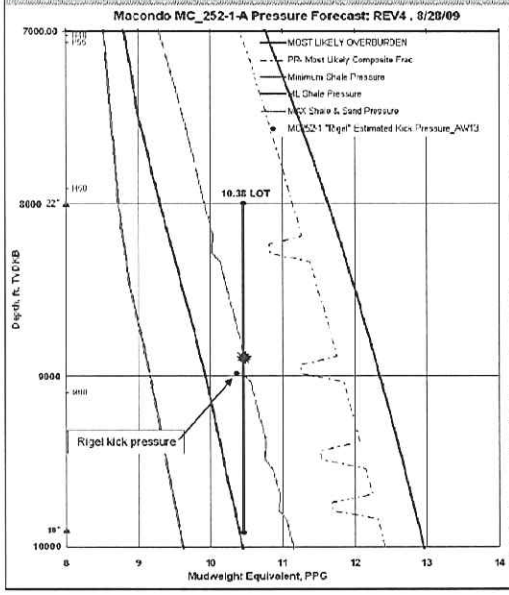
A 10.7 ppg LOT value would provide for 0.3ppg margin at 9,900'

Honoring the kick pressure point from the Rigel well, however, would suggest that the well could closely follow the maximum sand/shale pressure forecast.

Under this circumstance, the pore-pressure at the 18" casing point would be approximately 11.1ppg.

A 0.3ppg margin at projected TD (11.4ppg total) would exceed the composite fracture gradient at the 22" casing shoe, and the sand fracture envelope of any potential shallow sand intervals.

Leak-off test(s):



An undesirably low leak-off test severely hindered efforts towards achieving a 18" casing point depth near 9,900' (TVD). Weak formation/sand at 22" CSG shoe?

Performed 8 leak-off tests at 22" CSG shoe:
- 5 tests pumping down various combinations of choke/kill lines/drillpipe against annulars/pipe rams
- 1 after spotting an LCM pill on bottom
- 1 after reducing surface mudweight
- 1 after a cement/LCM slurry squeeze

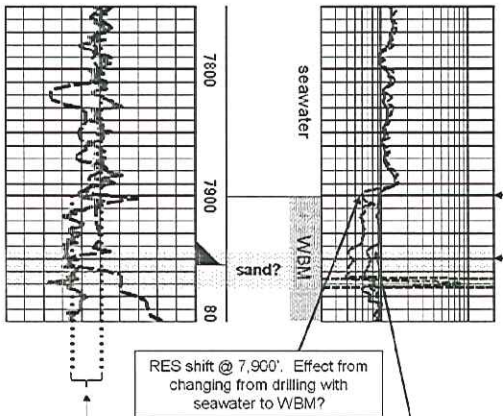
Results – (reported in downhole MW equivalent):
Minimum LOT: 10.33ppg
Maximum LOT: 10.47ppg
Mean LOT: 10.38ppg

Scenarios:
If well trended along the most likely pore-pressure gradient: Make it to projected 18" CSG section TD with little, if any, margin.

If well trended along the maximum sand/shale pressure gradient: Could become underbalanced around 9,000' (TVD). Potential wellbore influx or wellbore stability issues

Low leak-off test @ 22" shoe

It is thought that a sand is exposed near the 22" casing shoe.



Began drilling with 11.5ppg pump-and-dump WBM at ~7,900'

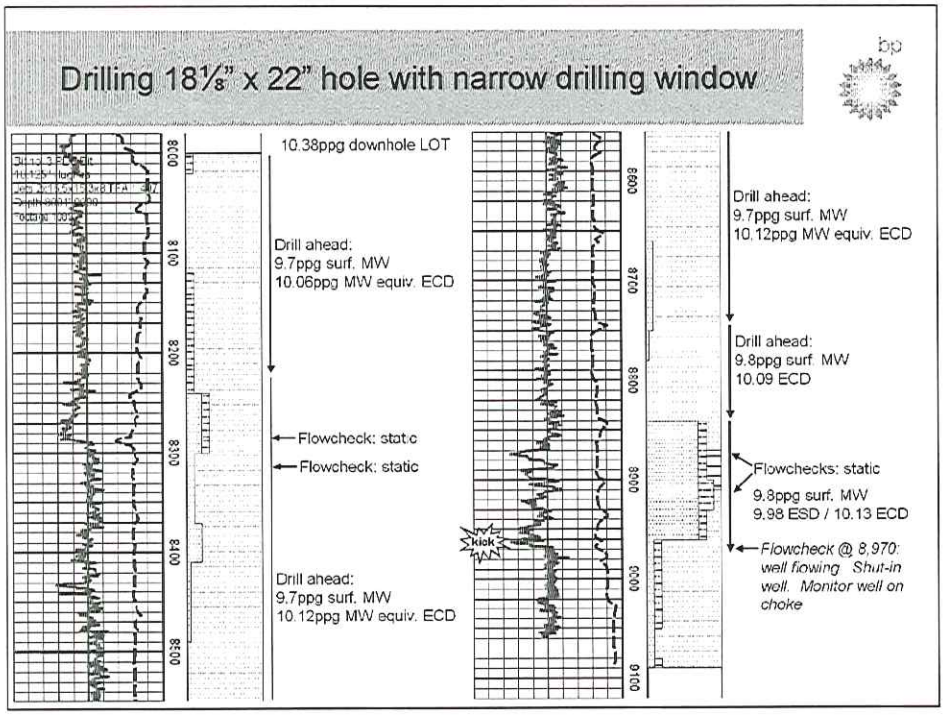
22" casing depth: 7,956'

RES shift @ 7,900'. Effect from changing from drilling with seawater to WBM?

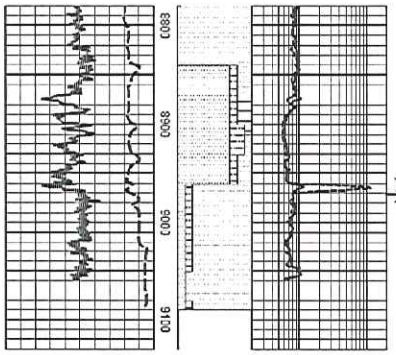
GR shift @ 7,900'. Effect from changing from drilling with seawater to WBM?

RES shift @ 7,940'. Lithology effect? Shale to sand transition?

Lesson learned:
While drilling the riserless section, transitioning from drilling with seawater to pump-and-dump water-based mud causes shifts in both GR and RES. This change in mud system, if executed too near to planned TD, can hamper detecting lithology changes near TD.



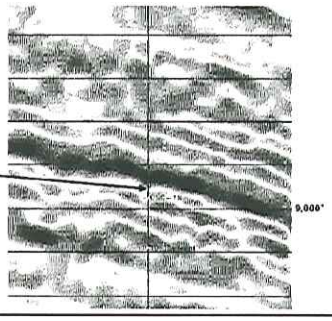
Well control event (kick) at 8,970' (MD/TVD)



kick

Parameters:

Surface mudweight:	9.8ppg
ESD:	9.98ppg MW equiv.
Hydrostatic: 4651psi	
ECD:	10.13 ppg MW equiv.
Dynamic:	472Cpsi
Shut-in DP pressure:	120psi
Casing pressure:	90psi
Kick pressure:	472Spsi
Kick pressure:	10.15 ppg MW equiv.
Underbalance (static):	78psi
Underbalance (dyn):	9psi
Kick volume: 11bbls	



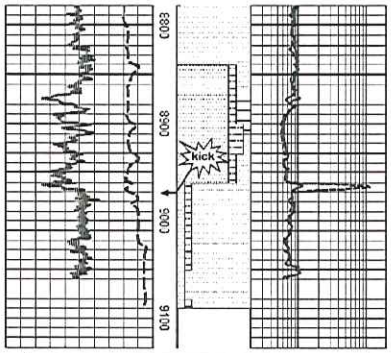
Well control operations:

- Shut-in and monitor well on the choke
  - 120psi drill pipe / 90psi casing pressure
  - Worked pipe every 15 minutes
- Increased surface MW to 9.9ppg and circulate 9.9ppg
- MW around on choke
  - Still detected drill pipe and casing pressure
- Displaced choke lines to 10.2ppg MW and open well
  - well static
- Displace riser to 10.1ppg MW: displace well to 10.0+ppg MW
  - well static

Decision to drill ahead:

- The team was faced with the decision on whether to drill ahead past the interval that caused the well control event.
  - *Stop and set casing at current depth:*
    - Risks: likely get a poor leak-off test at 18" shoe. Bring into play the 11 ¾" contingency liner, and perhaps an expandable liner. Potentially sacrifice hole-diameter in the reservoir interval
    - Reward: Avoid another, potentially uncontrollable, well control event. Stick BHA – sidetrack. Lose well.
  - *Drill ahead approximately 100' in order to set 18" casing shoe below problematic sand interval:*
    - Risks: drill into another overpressured sand package that would initiate a potentially uncontrollable well control event. Stick BHA. Lose well.
    - Reward: Drill ahead past problematic interval making it possible to isolate this interval behind 18" casing. Achieve adequate leak-off test pending hole-section TD is in a shale, and get "back on track" regarding planned casing point depths.
- Team decision: drill ahead approximately 100' to get 18" CSG shoe in a shale

Drill ahead past kick interval:



- Drilled ahead with 10.1ppg MW.
- Flowcheck at 9,064 – static
  - ESD: 10.26ppg equiv. MW
  - ECD: 10.34ppg equiv. MW
- *Minimum* leak-off observed was 10.33
  - Reduce MW to 10.0+ppg
  - ECD: 10.30ppg equiv. MW
- Drill ahead 9,064' to 9,090' (MD/TVD)
  - TD

- Decision was made to drill ahead approximately 100'.
  - 22" underreamer was approximately 100' behind the bit.
- Drilling 100'+ would ensure that the underreamer is sufficiently past the kick interval at 8,970'.
  - This would enable the 18" casing shoe to be set below the problematic interval at 8,970'
- The 18" casing section was drilled to a TD of 9,090' (MD/TVD) without further incident.
  - Increased MW to 10.1+ppg for trip out
  - Spot 16.0ppg pad mud in pilot hole.
  - POOH for casing
- 18" casing shoe was set at 8,983' (MD/TVD)

GR/RES and cuttings suggest that 18" casing shoe and hole-section TD are both in shale. Noted to be slightly marly at TD