

# Well Integrity/Shut-In Discussion

July 20, 2010  
11:00am CDT

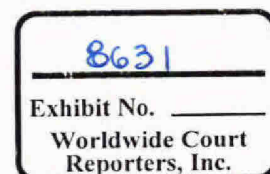


7/20/2010

10.0 Daily Meetings\10.1 WIT Mtgs\19 JUL 1100

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ERP001-003232



TREX 008631.0001

## **Topics for Discussion July 20, 11:00am CDT**

- 1. Revised Plan for Monitoring Near and Far Field– Marcia McNutt**
- 2. Update to July 18 Reservoir Discussion – Consensus Comments - Timeline– Tina Behr-Andres**
- 3. Horner Plot Resolution– Paul Hsieh, Bob Merrill**

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# **1. Revised Plan for Monitoring Near and Far Field– Marcia McNutt**

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## Bounding Leak Rate From Seismic Monitoring

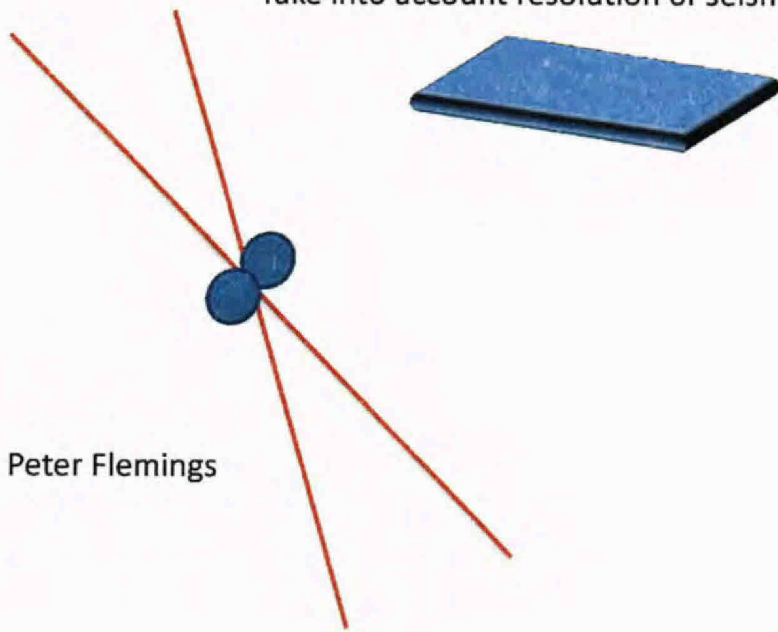
- Start with the Murphy's Law Scenario:
  - Leaks will be perfectly oriented with the obtuse angles in the seismic data acquisition
- Assume Darcy's Law for flow of hydrocarbons from leaking well:
  - Flow =  $\frac{\text{permeability} \times \text{Pressure Gradient}}{\text{dynamic viscosity}}$
- How long until flow intersects existing lines?

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Take into account resolution of seismic data



Cathy Enomoto and Peter Flemings

Numbers to come!

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**2. Update to July 18 Reservoir and Flow Discussion –  
Consensus Comments - Timeline– Tina Behr-Andres**

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## Four Reservoir & Flow Questions

- 1) Is the Macondo reservoir aquifer supported and, if so, on what time scales?  
Current pressure time data can be adequately represented by a variety of parameter choices (aquifer supported or not, system compressibility, flow rate during production...), and it is hard to distinguish between them.
- 2) Can we use pressure-vs-time data recorded during shut in to differentiate between cases in which: i) there is high depletion and no or very little leakage, or ii) there is low depletion and high leakage.  
We cannot use pressure vs time data based on reservoir modeling to differentiate between these cases. But other distinctive characteristics are being assessed to try and distinguish between them.
- 3) If the well is not strongly supported and has been depleted by 2000 psi, then why was a large drop in BOP pressure prior to shut in *not* observed?  
There is no consensus yet on the pressure response to be expected below the BOP, depending on influence of multiphase flow, varying restrictions in BOP, riser, and whether the response is pressure or flow driven.
- 4) What conclusions about well integrity can be reached based on integrating all scientific evidence?

# Well Integrity

## Data/Evidence to Consider

- **Temperature** vs. Time data at well head
  - Temperature has cooled and is stable at ~40°F indicating static conditions at the well head
- **Pressure** vs. Time data at BOP and Kill Line
  - BOP Pressure is not necessarily reliable but trends without discontinuities may be useful
  - BP is providing detailed chronology of well head and riser conditions post incident to help interpret BOP pressure history
  - Kill Line Pressure are similar to past results from conventional shut in tests (e.g., Thunder Horse data); no remarkable features
- **Acoustic, Sonar and Seismic** data
  - Current results indicate no anomalies (Use these data to bound a maximum case for leakage?)
- **Oil Flow** at well head (pre shut-in)
  - Reservoir analyses and analyses of potential leaks are being conducted using previously published estimates of flow rate based on measured collection
- **Fluid Properties**
  - Gas volume fraction estimated at 65% at 2250psi; multiphase flow to be considered in these analyses

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## Pending Follow Up Actions

- Analyzing BOP pressure during June 4-15 when there were no changes in the well head configuration to determine indication of reservoir depletion-Paul Hsieh, next priority
- Working with BP on Horner plot data to resolve different interpretations-Paul Hsieh, completed
- Investigating effect of temperature change on shut-in pressure – Ron Dykhuizen, in progress
- Calculating range in possible annular flow – Wayne Miller, in progress.

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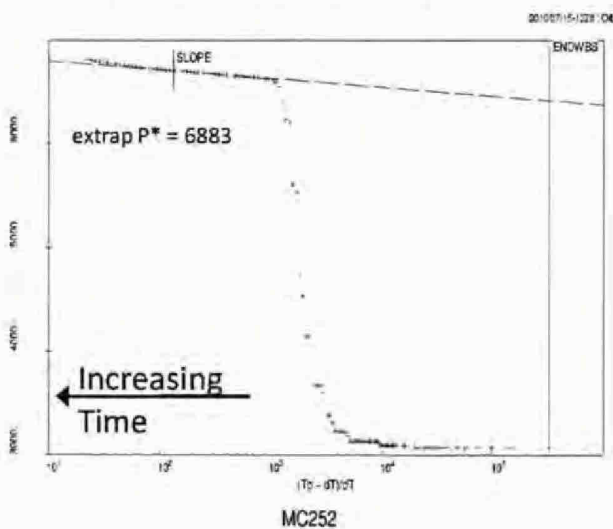
### **3. Horner Plot Resolution– Bob Merrill, Paul Hsieh**

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# Horner Plot – Resolution – Bob Merrill



- MC252 Shut-In pressure data to 19-July (14:30)

- Horner Plots were proposed as means of linearizing the data
  - Easier identification of changes of the slope of  $\Delta P$
  - Horner plot analysis (of  $P^*$ ) does not require rate data
    - $P^*$  is not average  $P_{res}$ , except for unbounded reservoir
  - Upward curvature of Horner plot (post-straight line region) indicates reservoir boundaries
  - At  $t = \infty$  slope will flatten
- Horner plots (and all pressure transient analyses) are not quantitative unless rate information is known
  - Impacts estimates of skin, permeability and radius of investigation.

## Interpretation of Horner Plot – Paul Hsieh

- Discussions were carried out on interpretation of Horner plot, using a common set of assumed reservoir properties, reservoir total volume, and flow rate.
- If the reservoir area has an aspect ratio of 1, then the Horner plot should flatten after about 100 hrs (about 4 days).
- If the reservoir area has an aspect ratio of 1:8.24 (channel of 3,400 ft wide and 28,000 ft long), then the Horner plot show:
  - Increase of slope after the straight line segment
  - Flattening occurs at about 1,000 hr (42 days) after shut in.

# NOAA SHIP PISCES

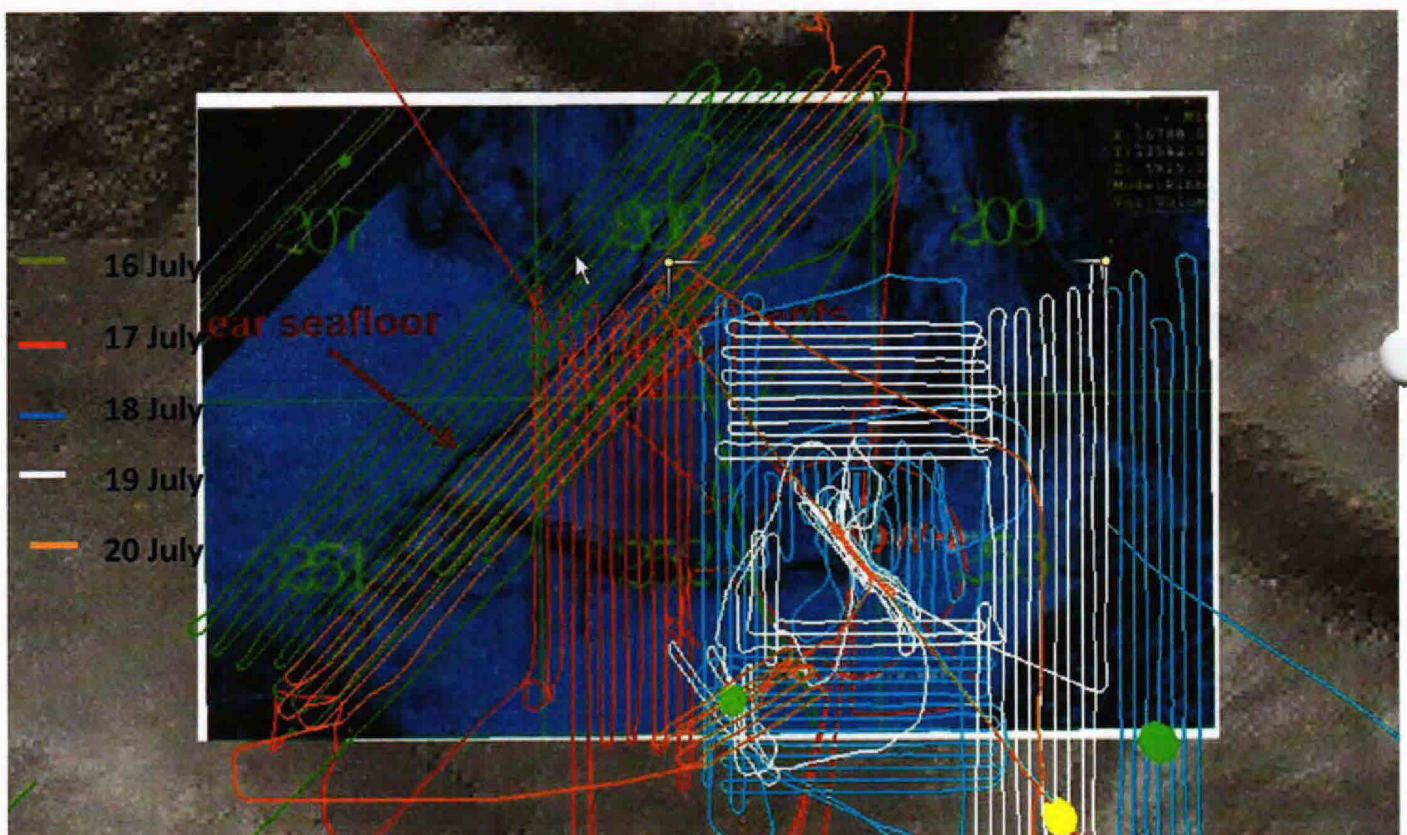
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20 July 2010 11:00 Central Time Presentation

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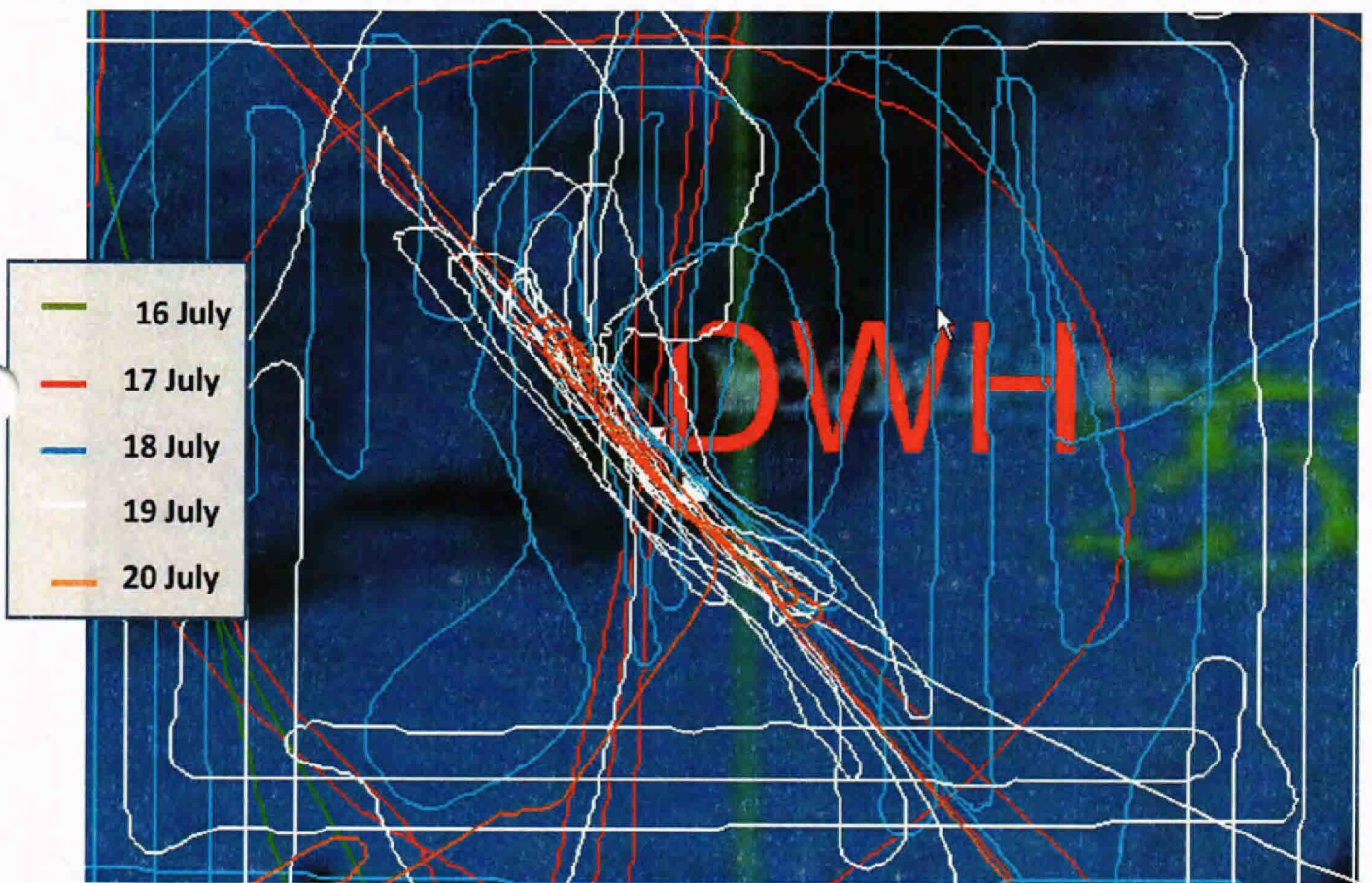
## PISCES SONAR COVERAGE AS OF 1000 EDT 20 July 2010



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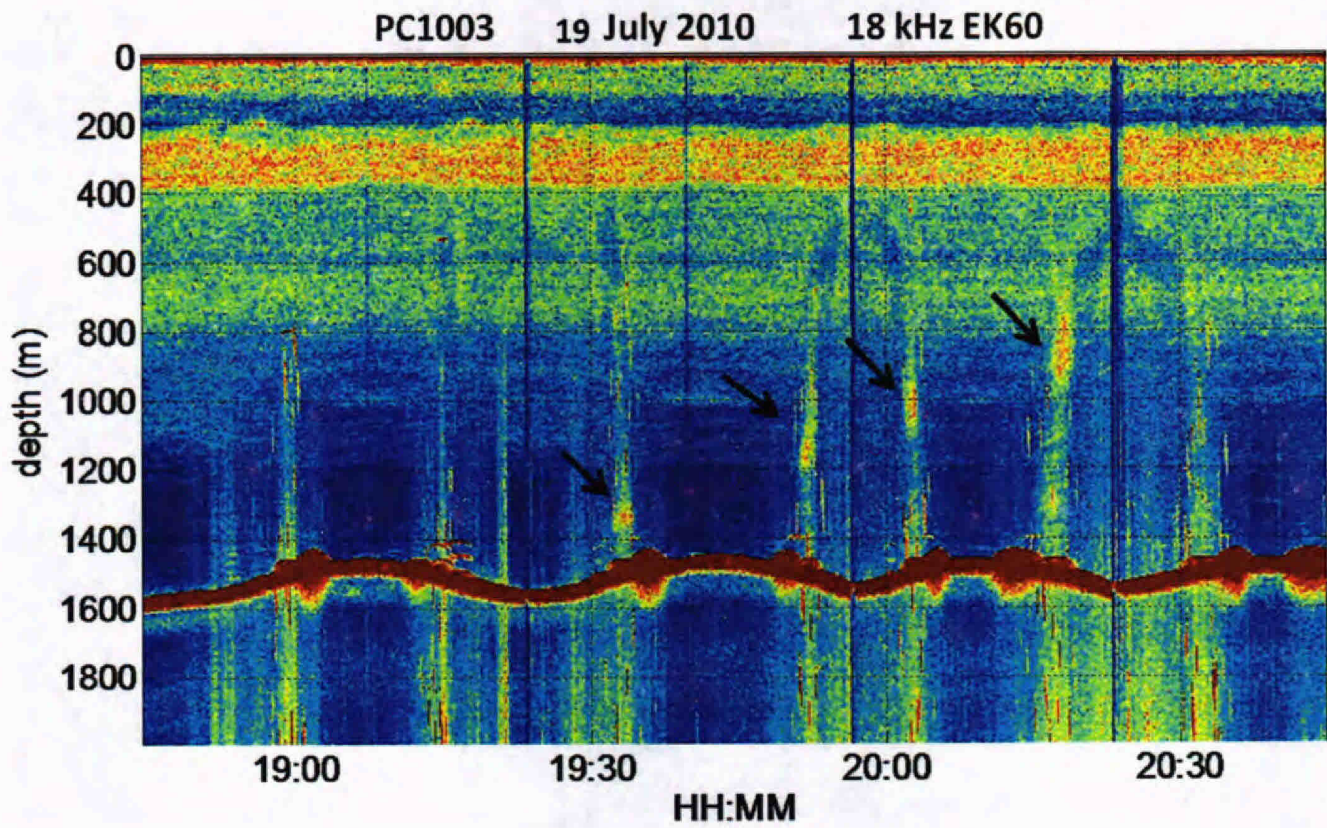


## PISCES SONAR COVERAGE AS OF 1000 EDT 20 July 2010



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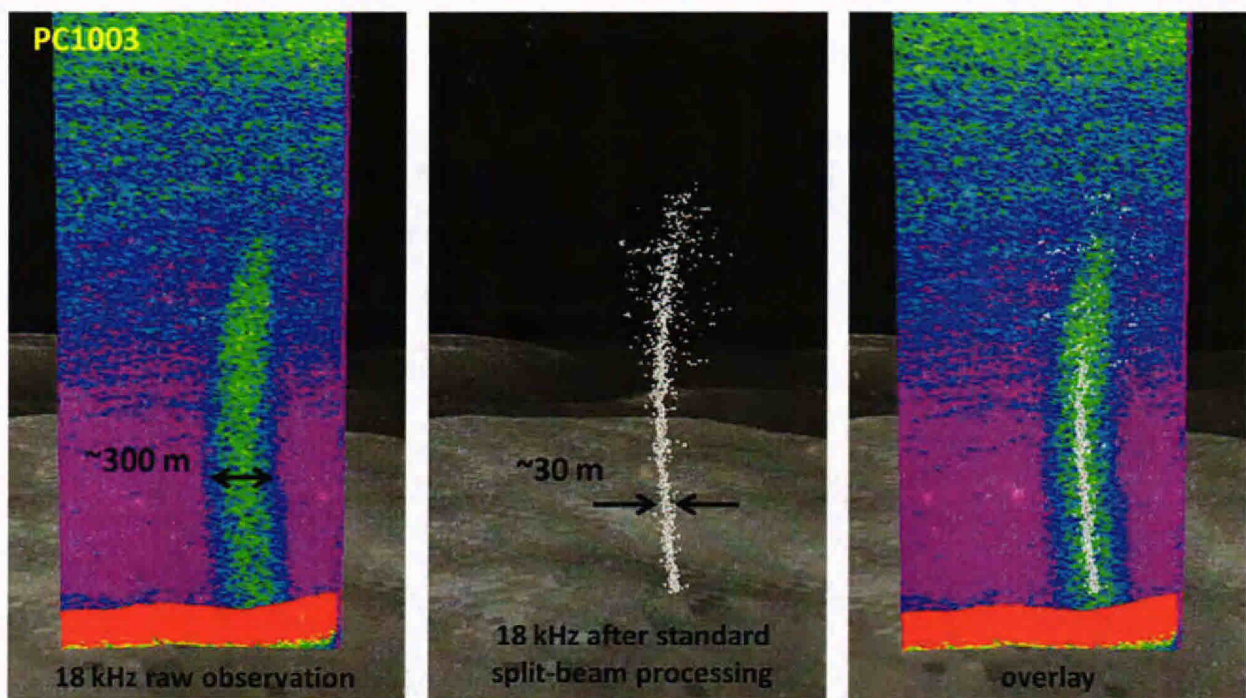
# Transects of Well-head



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**Improved positional resolution with split-beam processing – but... needs high S/N and small target relative to beamwidth**



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## **PISCES PLAN FOR TODAY**

- **Continue to monitor near well-head**
- **Fill gaps in 1.5 km radius**



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