From: Kurtz, Jessica A
Sent: Tue Jul 06 18:43:08 2010
To: McAughan, Kelly; Schott, David W
Cc: Merrill, Robert C
Subject: RE: Compressibility
Importance: Normal
Attachments: IsabelaCompTable.txt; Isabela Rock Mechanics Report Compressibility_Sept_07_HH-36872.ZIP

Also, included is the Isabela SWC data (excel sheet below, M56 and M55 UPVC) and CMT table used in the original sanction-case VIP model (M55 only) - we have since updated this table to the ones I sent previously based on the SC whole core.

<<...>> (base case is CMT 1)

<<...>>

Galapagos does have higher porosity as shown on your graph - actually, I think if you removed the TH data (which all ranges of porosity have low compr) you would just have Na Kika data and your trend curve would shift up.

From: McAughan, Kelly

Sent: Tuesday, July 06, 2010 1:11 PM

To: Kurtz, Jessica A; Schott, David W

Subject: Compressibility

I was wondering if you could tell me what the measured compressibility of Santa Cruz rock (or any core in Galapagos) was versus what you are using. So if you went from 10 E-6 to 20 E-6 then I will increase Macondo's by a factor of 2.

I'm attaching 2 slides on how we did our pre-drill estimate (porosity & depth came in spot on). This is so you can see our porosity is lower and we are buried deeper so on the trend we have lower compressibility. I also attached the rock mechanic report. Would love to hear your thoughts or opinions on this! Please feel free to call me.

MANY Thanks,

Kelly

<< File: Macondo PVC.ZIP >> << File: BP Macondo Rock Mech Report HH-46949.ZIP >>

8770

Exhibit No. _____

Worldwide Court Reporters, Inc.

```
C -------------------------------------------------------
C Rock Compressibility and Perm as function of Pressure
C -------------------------------------------------------



C Average compressibilities for samples 1-31R and 1-37R   BASE CASE
CMT 1
        P       PVMULT  TAMULT ! Calculated from
file:/gomdp/dat06/nakika/Isabela/Isabela_NBouffin.xls
      3702  0.894111          0.8                   !   1.4E-06
         4702      0.905132  0.823529  !   1.7E-06
         5702      0.916563  0.847059  !   1.65E-06
         6702      0.927813  0.870588  !   1.5E-06
         7702      0.939108  0.894118  !   1.5E-06
         8702      0.951348  0.917647  !   1.4E-06
         9702      0.962496  0.941176  !   1.2E-06
         10202     0.969233    0.952941          !   1.3E-06
         10702     0.97653   0.964706  !   1.2E-06
         11202     0.983881  0.976471  !   1.2E-06
         11702     0.991908  0.988235  !   1.3E-06
         12202     1         1                   !   1.2E-06

C LOW 6*10^-6 psi-1
CMT 2
        P       PVMULT  TAMULT ! Calculated from
file:/gomdp/dat06/nakika/Isabela/Isabela_NBouffin.xls
      3702  0.950279          0.8                   !
         4702      0.955997  0.823529  !
         5702      0.961751  0.847059  !
         6702      0.967539  0.870588  !
         7702      0.973361  0.894118  !
         8702      0.979219  0.917647  !
         9702      0.985112  0.941176  !
         10202     0.988072    0.952941          !
         10702     0.99104   0.964706  !
         11202     0.994018  0.976471  !
         11702     0.997004  0.988235  !
         12202     1         1                   !


C HIGH 18.1*10^-6 psi-1
CMT 3
        P       PVMULT  TAMULT ! Calculated from
file:/gomdp/dat06/nakika/Isabela/Isabela_NBouffin.xls
      3702  0.857401          0.8                   !
         4702      0.873061  0.823529  !
         5702      0.889007  0.847059  !
         6702      0.905245  0.870588  !
         7702      0.921779  0.894118  !
         8702      0.938615  0.917647  !
         9702      0.955759  0.941176  !
         10202     0.964447    0.952941          !
         10702     0.973215  0.964706  !
         11202     0.982063  0.976471  !
         11702     0.9990991 0.988235  !
         12202     1         1                   !
```

Document Produced Natively

OMNI Laboratories

ROCK MECHANICS TESTING & ANALYSES
ISABELA PROSPECT
MISSISSIPPI CANYON BLK. 562 NO. 1 BP01
BP EXPLORATION & PRODUCTION

ROCK MECHANICS FINAL REPORT

OMNI HH-36872

Performed by:

OMNI LABORATORIES
8845 Fallbrook Drive
Houston, TX 77064

Ohmyoung Kwon, Ph.D.

Report Issued:

September, 2007

Procedures for Uniaxial Strain Pore Volume Compressibility Test

The general procedures for the pore volume compressibility test under uniaxial strain condition using stepwise pore pressure depletion method are summarized in the following:

(1) Physical dimensions of the specimen are recorded and the specimen is saturated with 2% KCl brine.
(2) A small amount of confining pressure (200 psi) is applied to the sample and several pore volumes of pore fluid are flowed through the sample to ensure as complete saturation as possible.
(3) Increase pore pressure to initial testing value while maintaing confining pressure 200 psi above the pore pressure.
(4) Further increase the confining pressure to the initial testing condition while holding the pore pressure constant.
(5) Increase the axial stress to the initial overburden stress state while holding the confining pressure and pore pressure constant.
(6) Upon achieving initial testing stress condition, all pressures are maintained constant for minimum four hours to attain sample stabiliaztion.
(7) The pore pressure is depleted by 500 psi in two minutes or 1000 psi in four minutes and followed by a specified period of stabilization. The pressure steps and stabilization period for eash sample are listed in Presssure Step Table along with the initial stress conditions.
(8) During the pore pressure depletion and stabilization period, the confining pressure is continually adjusted to maintain zero radial strain. The overburden stress is maintained constant throughout the test.
(9) The test is stopped after pore pressure is depleted to specified value.

For data analysis, it is assumed that the grain compressibility is negligible and hence the change in the pore volume (ΔV_p) is equal to the change of bulk volume (ΔV_b). The pore volume compressibility (C_p) can be calculated by $C_p = \Delta V_b / (\phi V_b \Delta P^*)$ where ϕ is the initial porosity, V_b is the initial bulk volume and ΔP^* is the change in pressure. The strains at the end of each stabilization period were used to calculate the volume change. The driving force (pore pressure in this study) was used for the P*. The porosities determined for routine core analysis at 1850 psi (sample no. 1-2R and no. 1-12R) and 2100 psi (sample no. 1-31R and no. 1-37R) were used as the initial porosity. The bulk volume of the sample determined at the onset of the pore pressure depletion were used as the initial bulk volume for the determinations of pore volume compressibilities.

Pore Volume Compressibility Test - Pore Pressure Depletion (Stepwise Depletion)

Pressure steps and waiting period

Samples No. 1-2R and No. 1-12R

Initial Reservoir Conditions:

13969	psi overburden
12750	psi confining pressure
11838	psi pore pressure

Pore Pressure (psi)	Duration (hours)
11838	4
11338	1
10838	1
10338	1
9838	1
9338	1
8338	1
7338	0.5
6338	0.5
5338	0.5
4338	0.5
3338	0.5
2338	0.5
1338	0.5

Samples No. 1-31R and No. 1-37R

Initial Reservoir Conditions:

14618	psi overburden
13240	psi confining pressure
12203	psi pore pressure

Pore Pressure (psi)	Duration (hours)
12203	4
11703	1
11203	1
10703	1
10203	1
9703	1
8703	1
7703	0.5
6703	0.5
5703	0.5
4703	0.5
3703	0.5
2703	0.5

OMNI Laboratories

OMNI HH-36872

SUMMARY OF PORE VOLUME COMPRESSIBILITY TESTS

(under uniaxial strain condition with stepwise pore pressure depletion)

BP Exploration and Production
Isabela Prospect

Mississippi Canyon Blk. 562 No. 1 BP01

		with 1 hr stabilization period		with 30 min stabilization period		
Sample No.	Depth (ft)	Bulk Compressibility 1 (10^{-6} psi^{-1})	UPVC 1 (10^{-6} psi^{-1})	Bulk Compressibility 2 (10^{-6} psi^{-1})	UPVC 2 (10^{-6} psi^{-1})	
1-2R	18168.00	8.41	24.88	6.35	18.79	M56
1-12R	18209.90	2.66	8.78	1.96	6.48	
1-31R	18926.20	5.02	18.12	3.29	11.89	M55
1-37R	18947.00	3.03	11.99	3.25	12.86	M55

Pore Volume Compressibility Test - Pore Pressure Depletion (Stepwise Depletion)

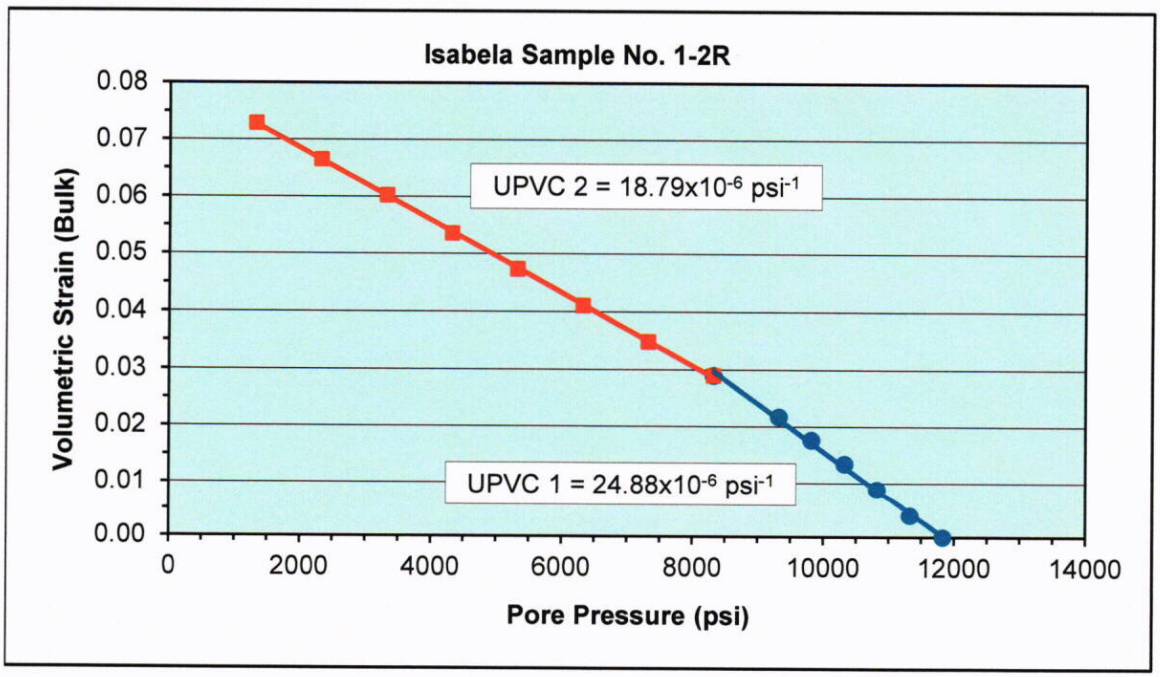
Company	**BP**	**Sample No.**	**1-2R**
Project	**Isabela**	**Depth (ft)**	**18168.00**
OMNI Job No.	**OMNI HH-36872**	**Saturation**	**2% KCl**
Date	**Sep., 2007**	**Porosity (%)**	**33.8** at 1850 psi NCS

	1	2	
C bulk* =	8.41	6.35	$x10^{-6}$ psi^{-1}
UPVC** =	24.88	18.79	$x10^{-6}$ psi^{-1}

* Bulk compressibility
1. One hour stabilization

** Uniaxial pore volume compressibility
2. Thirty minutes stabilization

Pore Pressure (psi)	Confining Pressure (psi)	Axial Stress (psi)	Volumetric Strain	Differential Stress (psi)	Mean Stress (psi)	Velocity (ft/sec)	
						Comp	Shear
11826	12748	13967	0.00000	1219	1328	8377	4067
11325	12511	13968	0.00393	1457	1672	8433	4077
10823	12276	13966	0.00884	1690	2016	8472	4082
10325	12071	13965	0.01344	1894	2377	8504	4089
9820	11857	13941	0.01767	2084	2732	8551	4096
9324	11666	13977	0.02166	2311	3112	8598	4105
8323	11330	13972	0.02897	2642	3888	8684	4116
7323	11041	13945	0.03484	2904	4686	8763	4133
6323	10800	13956	0.04108	3156	5529	8853	4165
5323	10570	13972	0.04734	3402	6381	8941	4205
4322	10347	13948	0.05360	3601	7225	9038	4260
3323	10090	13981	0.06021	3891	8064	9122	4510
2324	9830	13945	0.06647	4115	8878	9223	4525
1323	9552	13984	0.07290	4432	9706	9297	4550



Pore Volume Compressibility Test - Pore Pressure Depletion (Stepwise Depletion)

Company	**BP**	**Sample No.**	**1-12R**
Project	**Isabela**	**Depth (ft)**	**18209.90**
OMNI Job No.	**OMNI HH-36872**	**Saturation**	**2% KCl**
Date	**Sep., 2007**	**Porosity (%)**	**30.3** at 1850 psi NCS

	1	2	
C bulk* =	2.66	1.96	$x10^{-6}$ psi^{-1}
UPVC** =	8.78	6.48	$x10^{-6}$ psi^{-1}

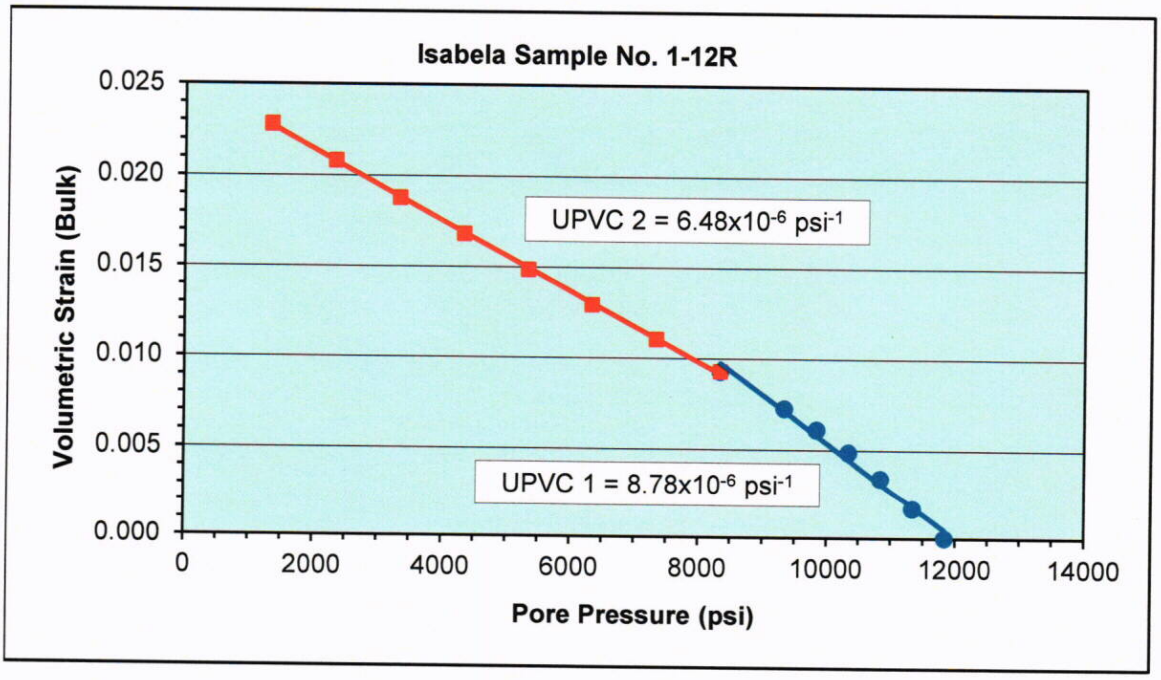
* Bulk compressibility

** Uniaxial pore volume compressibility

1. One hour stabilization

2. Thirty minutes stabilization

Pore Pressure (psi)	Confining Pressure (psi)	Axial Stress (psi)	Volumetric Strain	Differential Stress (psi)	Mean Stress (psi)	Velocity (ft/sec)	
						Comp	Shear
11836	12749	13954	0.00000	1205	1315	10441	6048
11336	12319	13956	0.00168	1637	1529	10544	5998
10840	11934	13949	0.00342	2015	1766	10674	6001
10338	11530	13971	0.00486	2441	2006	10772	6004
9838	11102	13963	0.00610	2861	2218	10840	6027
9337	10700	13995	0.00725	3295	2461	10883	6061
8339	9922	13955	0.00929	4033	2927	10936	6094
7338	9171	13973	0.01104	4802	3434	10951	6139
6337	8528	13983	0.01293	5455	4009	10946	6164
5338	7921	13980	0.01487	6059	4603	10926	6154
4339	7382	13992	0.01684	6610	5246	10906	6145
3340	7013	13949	0.01880	6936	5985	10884	6151
2339	6620	13964	0.02082	7344	6729	10874	6151
1339	6284	13937	0.02279	7653	7496	10864	6151



Pore Volume Compressibility Test - Pore Pressure Depletion (Stepwise Depletion)

Company	**BP**	**Sample No.**	**1-31R**
Project	**Isabela**	**Depth (ft)**	**18926.20**
OMNI Job No.	**OMNI HH-36872**	**Saturation**	**2% KCl**
Date	**Sep., 2007**	**Porosity (%)**	**27.7** at 2100 psi NCS

	1	2	
C bulk* =	5.02	3.29	$x10^{-6}$ psi^{-1}
UPVC** =	18.12	11.89	$x10^{-6}$ psi^{-1}

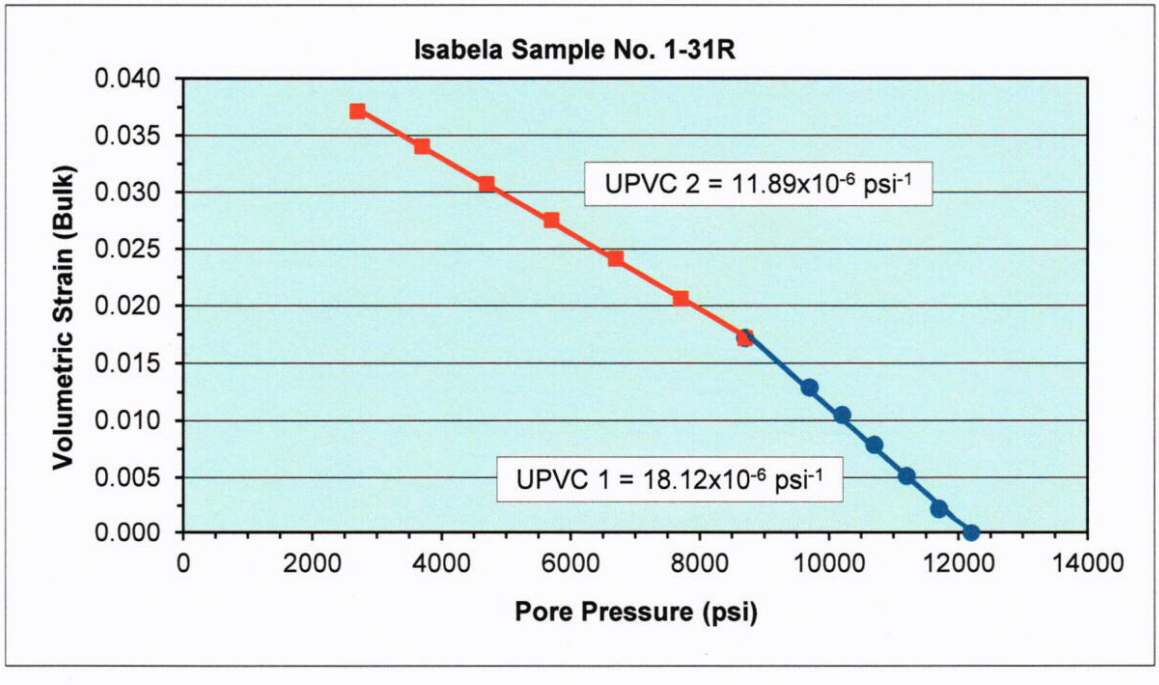
* Bulk compressibility

** Uniaxial pore volume compressibility

1. One hour stabilization

2. Thirty minutes stabilization

Pore Pressure (psi)	Confining Pressure (psi)	Axial Stress (psi)	Volumetric Strain	Differential Stress (psi)	Mean Stress (psi)	Velocity (ft/sec)	
						Comp	Shear
12203	13243	14588	0.00000	1345	1488	9137	4442
11701	12908	14606	0.00228	1698	1773	9182	4447
11201	12600	14612	0.00516	2012	2070	9225	4437
10703	12309	14632	0.00790	2323	2380	9259	4430
10203	12035	14646	0.01050	2611	2702	9290	4429
9703	11770	14612	0.01290	2842	3014	9330	4431
8705	11289	14620	0.01720	3331	3694	9385	4442
7704	10842	14625	0.02062	3783	4399	9426	4450
6703	10394	14660	0.02415	4266	5113	9456	4456
5704	10058	14632	0.02748	4574	5879	9480	4451
4703	9701	14631	0.03071	4930	6641	9503	4441
3700	9452	14654	0.03404	5202	7486	9531	4434
2703	9207	14636	0.03710	5429	8314	9558	4444



Pore Volume Compressibility Test - Pore Pressure Depletion (Stepwise Depletion)

Company	**BP**	**Sample No.**	**1-37R**	
Project	**Isabela**	**Depth (ft)**	**18947.00**	
OMNI Job No.	**OMNI HH-36872**	**Saturation**	**2% KCl**	
Date	**Sep., 2007**	**Porosity (%)**	**25.3**	**at 2100 psi NCS**

	1	2	
C bulk* =	3.03	3.25	$x10^{-6}$ psi^{-1}
UPVC** =	11.99	12.86	$x10^{-6}$ psi^{-1}

* Bulk compressibility
** Uniaxial pore volume compressibility
1. One hour stabilization
2. Thirty minutes stabilization

Pore Pressure (psi)	Confining Pressure (psi)	Axial Stress (psi)	Volumetric Strain	Differential Stress (psi)	Mean Stress (psi)	Velocity (ft/sec)	
						Comp	Shear
12201	13239	14636	0.00000	1397	1504	8777	4878
11703	12817	14639	0.00138	1822	1721	8837	4901
11205	12391	14628	0.00290	2237	1932	8877	4931
10704	11978	14637	0.00446	2659	2160	8900	4970
10203	11631	14626	0.00588	2995	2426	8914	5026
9704	11206	14620	0.00748	3414	2640	8918	5067
8703	10532	14627	0.01059	4095	3194	8900	5096
7704	9932	14611	0.01336	4679	3788	8882	5088
6704	9412	14625	0.01669	5213	4446	8837	5058
5703	8928	14625	0.01975	5697	5124	8803	5017
4704	8577	14618	0.02298	6041	5887	8784	4971
3703	8283	14614	0.02631	6331	6690	8773	4917
2703	8119	14631	0.02972	6512	7587	8757	4898