



DrillWell June 2009 Sydney

Casing Drilling® in PNG

Evolution of casing reaming into casing drilling in PNG, and it's application to help reduce costs on Moran volcanics wells

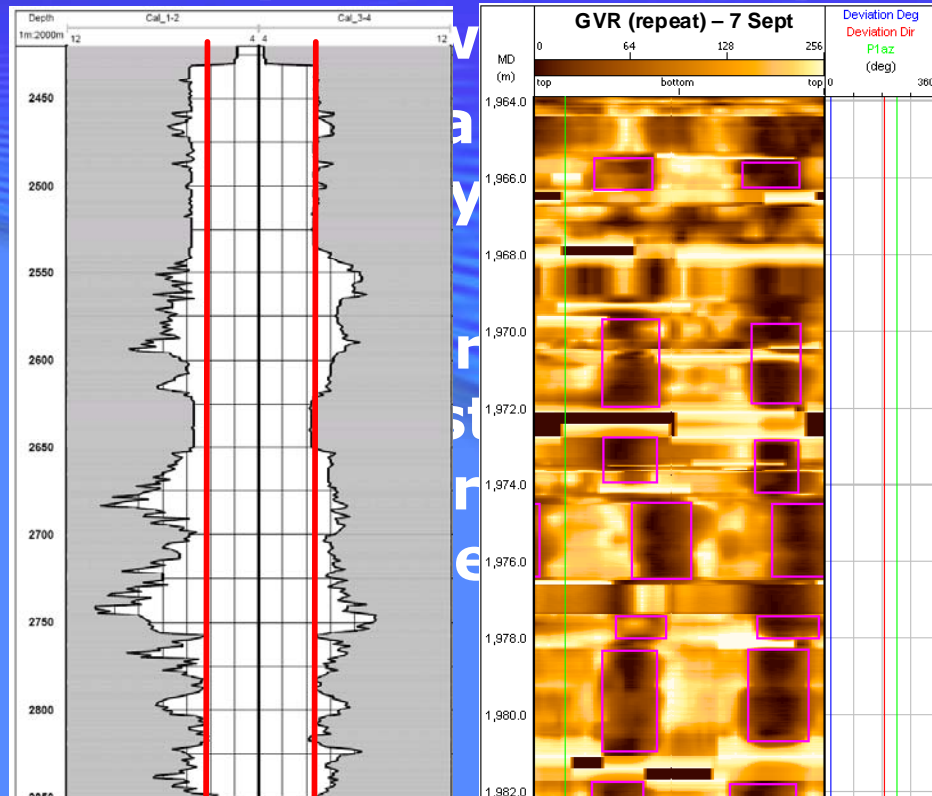
**Presented by Mike Dow
Oil Search**

**With thanks to Iain Wallace (ex OSL)
and Andy Harris of Tesco**

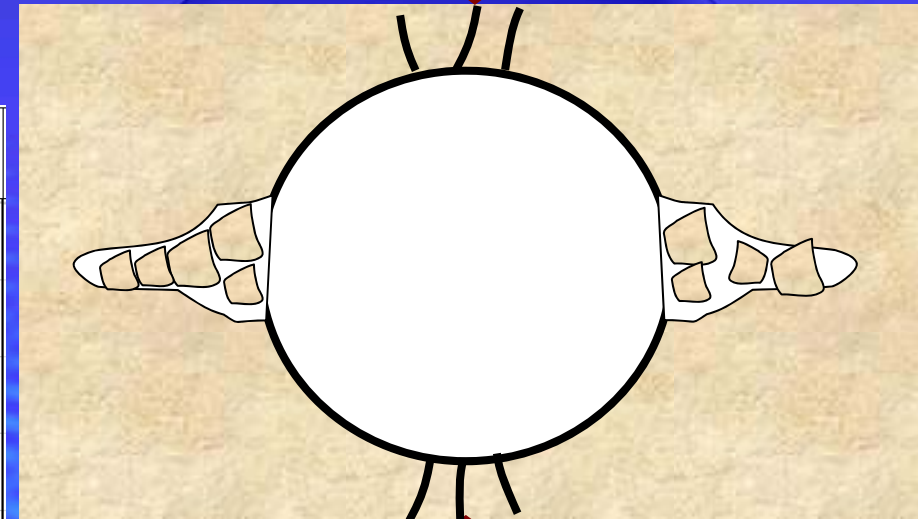


PNG Drilling Problem #1

➔ Having set 13³/₈" surface csg, have ~1200m of firm to mod hard clays/siltstones (Ieru frms), to directionally



Max horizontal stress

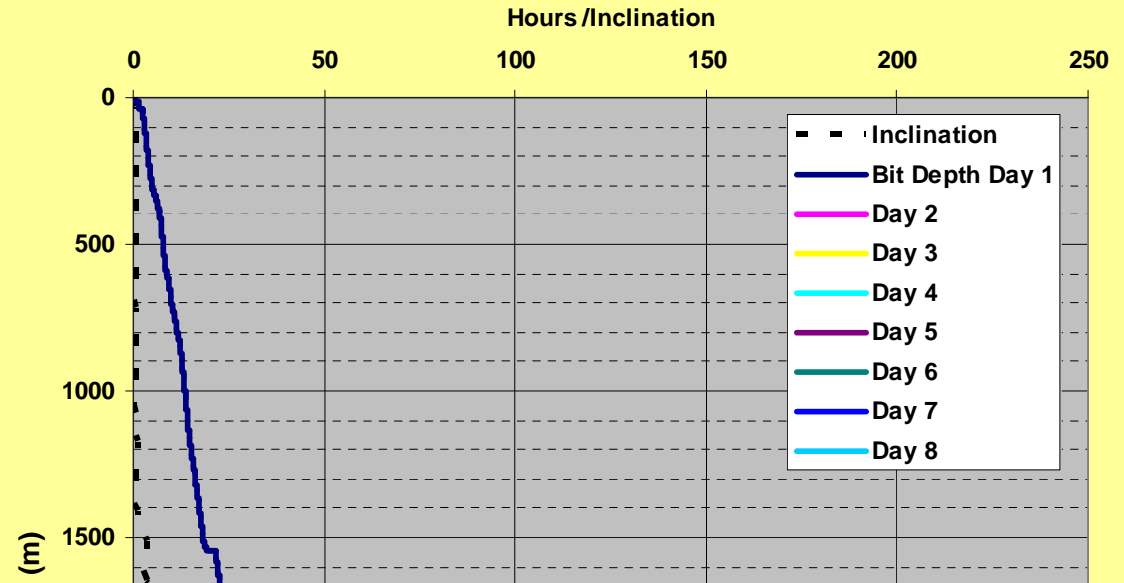




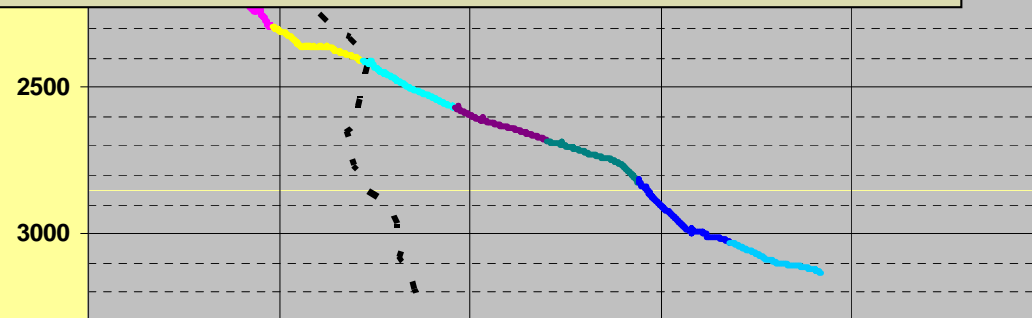
Consequences of break out

- Hole cleaning is difficult, 1-2" claystone/silt cvgs have to be removed
- Directional wt transfer with motors difficult
- Wireline-ing is hard
- Cvgs left in-situ in wellbore, reaming can release these en mass.
- Directional wells, extremely long trips, reaming intermed with drill days often.
- **Have to ream** 9⁵/₈" casing strings in.
- UDT 11-3 days trip out, 9 days csg running !

9 5/8" Casing Reaming UDT 11



If that is the problem – why trip out to run casing ?

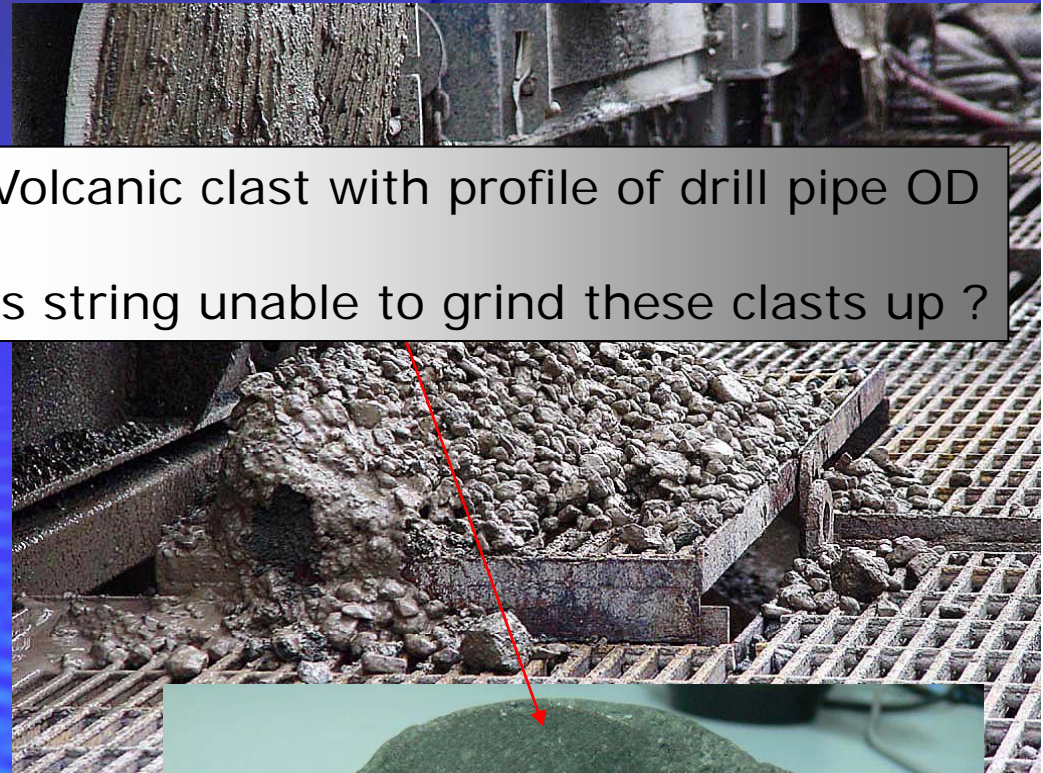




PNG Drilling Problem #2

- ➔ Volcanics – found in the NW of Moran field within the 12 ¼" Intermediate Ieru hole
- ➔ Hard volcanic clasts ½"-3", in very soft soluble clays
- ➔ Frm 50m-500m thick, repeats seen. Unpredictable
- ➔ Easy to drill, but ROPs slows, extremely difficult to trip and run casing through. Packs offs continually, stuck pipe and csg, sidetracks.
- ➔ Solutions: Bi-centre bits, under reamers, severing BHA & only pulling pipe thru the volcanics. Slick BHA w/ preemptive back reaming
- ➔ Time dependency, OSL Rule of Thumb – leave open for 7 days open max

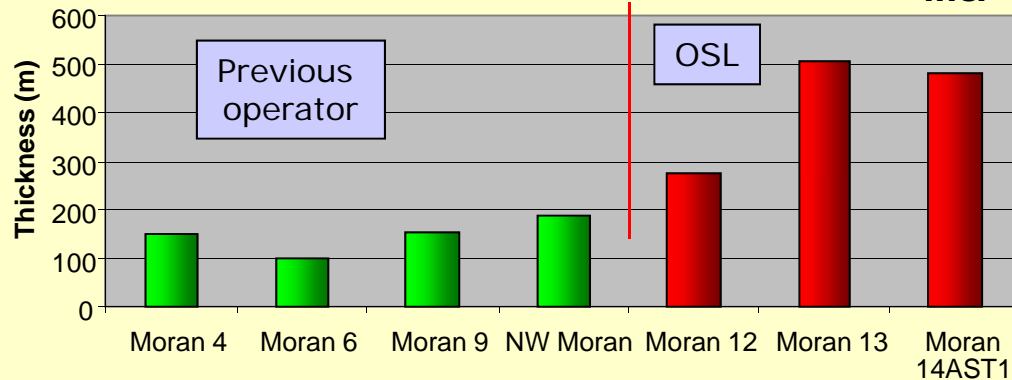
Volcanic clast with profile of drill pipe OD
Is string unable to grind these clasts up ?



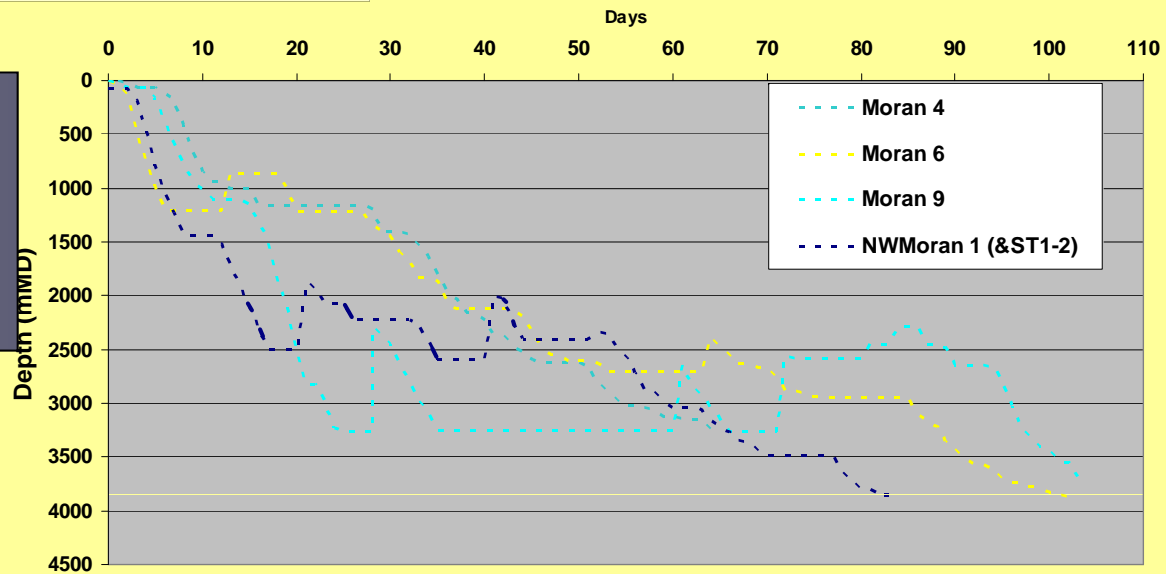


Volcanics – the Challenge

Max Volcanics Thickness **15 deg incl**



Moran Volcanic Wells
Days from Spud to TD



Volcanics Performance

Moran 4	0 sidetracks
Moran 6	3 sidetracks
Moran 9	2 sidetracks
NW Moran	2 sidetracks



Volcanics Reference Table

	Moran 14A	Moran 13	Moran 12A	NW Moran 1	NW Moran 1 ST1	NW Moran 1 ST2	Moran 6 ST2	Moran 9	Moran 9 ST1	Moran 9 ST2	Moran 9 ST3	Moran 9 ST4	Moran 4
Total Section Drilled	2690m	2415m	2224m	2500m	2592m	2400m	2952m	3262m	3255m	3262m	2590m	2590m	2617m
Volcanics Thickness	587m	510m	276m	128m	189m	62m	100m	149m	148m	58m	20m	153m	148m
Azimuth	330°	141°	246°	234°	25°	-	320°	50°	40°	55°	45°	355°	210°
Inclination of Well	17°	0.5°	3.9°	0.65°	18°	-	39°	8.5°	9°	14°	12°	2°	7°
BHA Used	12 1/4" Slick Assembly	12 1/4" Slick Assembly	9 5/8" Casing Drilling 8 1/2" slick assembly	12 1/4" slick motor directional BHA	12 1/4" motor directional BHA	12 1/4" motor directional BHA	12 1/4" directional BHA 8 1/2" directional BHA	12 1/4" directional BHA	12 1/4" directional BHA 14" Underreamer	10 5/8" rotary BHA 12 1/4" Underreamer	12 1/4" directional motor BHA	10 5/8" directional BHA 12 1/4" Underreamer	12 1/4" rotary BHA
Time to execute hole section	23.75 days	13 days	8.3 days 9.5 days	9 days	18 days	8 days	19 days	11 days	34 days	11 days	13 days	8 days	23 days
Time to Drill Volcanics	7.3 days	3.8 days	2.5 days 1.6 days	2 days	2 days	1 day	1 day	1 day	1.5 days	0.5 days	0.5 days	1 day	4 days
Time for Final Trip Out	2.8 days	1.75 days	0.35 days 2.5 days	1 day (Pipe Severed)	3 days (drill string severed)	1 day (sacrificial BHA)	1 day	2 days	1.5 day	1 day	1 day	1 day	3 days
Time from Top Volcanics Open to Casing Installed	12 days*	10 days	5 days 6.8 days	6 days	14 days	6 days	17 days	6 days	30 days	11 days	13 days	5 days	13 days
Mud System	Performadril	Performadril	Performadril	KCl / Glycol	KCl / Glycol	KCl / Glycol	Caustic Lime	KCl / Glycol / Lime	KCl / Glycol / Lime	KCl / Glycol / Lime	KCl / Glycol / Lime	KCl / Glycol / Lime	Caustic Lime

* Casing Stuck 25m into Volcanics. Moran 14A suspended



Casing Reaming to Casing Drilling

- **Commonality:**
 - Both problems have unstable, poor quality hole, with large cvgs/clasts produced.
 - Trouble occurs when tripping out and running casing
- The obvious solution to both of these problems is not to pull out of the hole
- Casing drilling has previously been used in areas of soft rock, GOM, Offshore Thailand etc
- Oil Search PNG drilling has been, and still is on a learning curve to apply this technology in this different PNG drilling environment.
- Will show how using our casing reaming experience
 - has evolved into casing drilling trials in PNG,
 - and it's recent succesful application has helped to help reduce costs and improve performance on Moran volcanics wells.



Weatherford Spear



- ➔ Drive system modified casing spear attached to top drive
- ➔ *Need correct casing couplings to take the torque !*



Tesco Casing Running Tool



CRT-NE-Animation-MPG-CODEC-25-sep-2003-R5-short.AVI



Volc Solution – Hole Cleaning

- ➔ Why do we pack off, are we cleaning the hole ?
- ➔ Can volcanic clasts be broken up and pass TJs ?

<i>Min Flow rate to clean</i>	<i>1" Clast 2.5 sg</i>	<i>3" Clast 2.5 sg</i>	<i>TJ Clearance</i>
5" DP 12¼" hole	495 gpm	1380 gpm	2.8" x2
Annular Velocity	29.5 m/min	82.3 m/min	
5 1/2" DP 12¼" hole	470 gpm	1330 gpm	2.5" x 2
6 5/8" DP 12¼" hole	420 gpm	1170 gpm	2" x 2
5" DP in 8½" Hole	190 gpm	560 gpm	0.9" x 2
<i>9 5/8" Csg 12¼" hole</i>	<i>220 gpm</i>	<i>637 gpm</i>	<i>Flush</i> <i>1.3" x 2</i> <i>Vam Top</i> <i>0.865" x 2</i>

Moran 12 volcanics drilled successfully in 8½" despite low 5" DP tool joint clearances similar to those for a 9 5/8" csg in 12¼" hole.

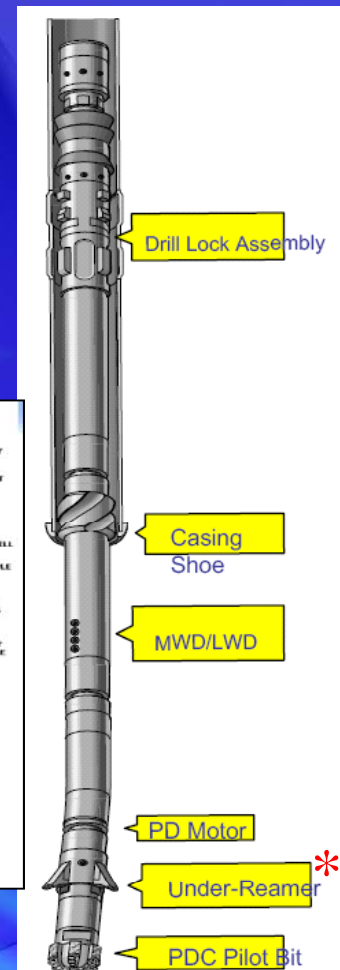
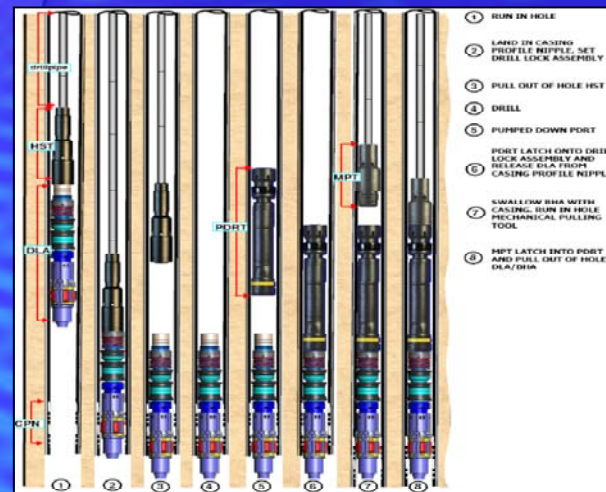
Trip out was still hard but was achieved. 7" Liner running went in well.



Volc Solution – Obtaining ROP. Casing Drilling with hang off retrievable BHA

- ↳ Lessons Learned from csg drilling/reaming:
 - ↳ Drilling by rotating a csg string gave slow inconsistent ROPs in the harder Ieru/Volcs, - w/ any type of shoe. (DS 3, EZcase)
 - ↳ Drilling with 9⁵/₈" csg in 12¹/₄" is the only way to get AVs to really clean hole of large cvgs
 - ↳ Despite having hard clasts, volc will pass by narrow clearances on Tool Joints (M12 8¹/₂" hole)

- ↳ Using a hang off drilling BHA/Bit w/ motor and under reamer could provide ROP
 - ↳ Faster 300 RPM, compare to 80
- ↳ 8¹/₂" hole and 9⁵/₈" csg in 12¹/₄" will give the required hole cleaning AVs
- ↳ Solution attempted on recent Moran 14AST1 (480m of volcanics)
- ↳ Tesco Casing Drilling® latch system and engineering used

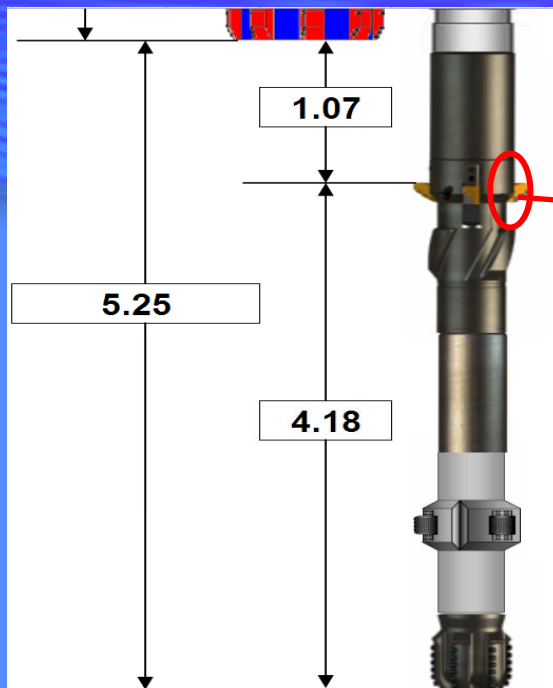


* worried about robustness for this application



Moran 14AST1 Results BHA #1

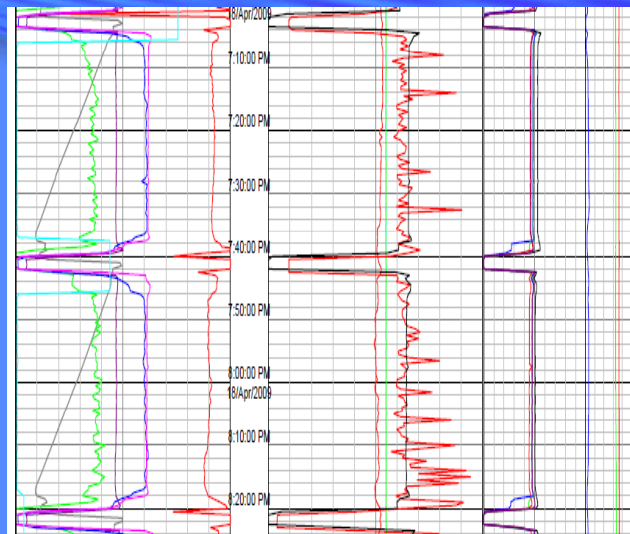
- ↳ Drilled 12¼" to Top Volcanics. POH for csg drilling.
- ↳ Ran 9⅝" csg w/ hang off BHA
- ↳ Flow test – 600 gpm pressure too low by 300 psi, but all seemed ok
- ↳ Drilled ahead. After drilled 4m, at 3.5 m/hr lost MWD, and ROP dropped. UR entering newly drilled 8½" pilot hole ?
- ↳ POOH with Csg to 13 3/8" shoe, retrieved the BHA on DP
- ↳ Washout in under reamer, bit slightly balled (soft frm)
- ↳ Chip hold down by Under Reamer jets ?





Moran 14AST1 Results BHA #2

- Changed under reamer, blanked off UR jets –RIH
- New BHA latched ok into casing. RIH w/ 9⁵/₈" casing
- 212m of volcanics drilled avg ROP 15.5 m/hr (inc cxns), max on bottom ROP = 28 m/hr
- No packoff or stuck pipe events, smooth torque & pressure
- Rotating off bottom torques higher than predicted, though PU/SO weights lower
- Lasted for about 1 day





Moran 14AST1 Results BHA #2 cont

- Csg drilled into known 14m thick fault zone
 - A lot of vein calcite appeared in returns
- Numerous Pack-Offs – 21.5 hrs to drill 1 jnt
- Drilled into repeat Ieru/volcanics at 7 m/hr
- Cont Csg Drlg ROP 1-2m/hr WOB up to 50klbs
 - Indications of hydraulic pump-off, pack off
 - Torque still steady/low motor diff pres
- Hole inclination building at 1°/ joint – Stop
 - Thought UR was damaged
- Had drilled ~ 90m slowly, ~170m volcs left
- Spaced out and washed the Csg hanger into the wellhead. Landed off w/ no problems
- Ran in hole on pipe and retrieved the BHA, recovered to surface
- Bit balled (soft), UR ok. Reamer shoe blocked?
- Cemented casing (7 days volcs open)



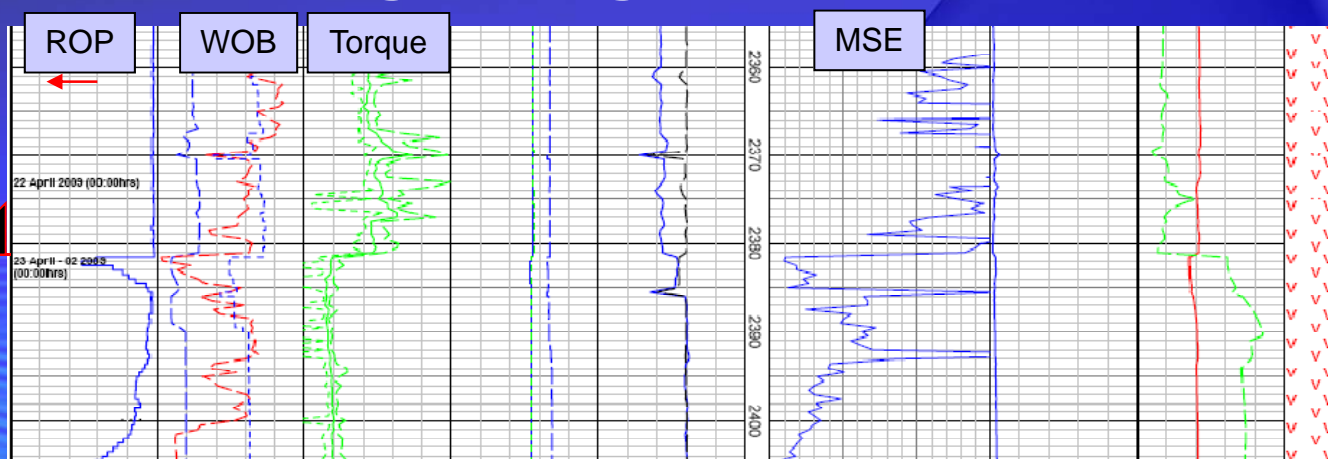
Fracture zone cvgs





Moran 14AST1 8½"

- ➔ 8½" drilling started ok with a motor BHA – but slowed down dramatically very quickly
- ➔ Was slow csg drilling ROP formation related ?



- ➔ But ROP then picked up. 8½" drilling of remaining volcs went well. (Used well stabilised slickbore motor BHA – no back reaming !)
- ➔ 5½" DP-7¼" Tool Joints in 8½" hole. No pack off problems.
- ➔ Drilled further 300m after volcanics or so. Hole open for 4 days prior to POH. Trip out easy ! No reaming.
- ➔ 7" liner running easy ! No reaming. (6 days total)
- ➔ So csg drilling volcs 75% success...but gives us great confidence !

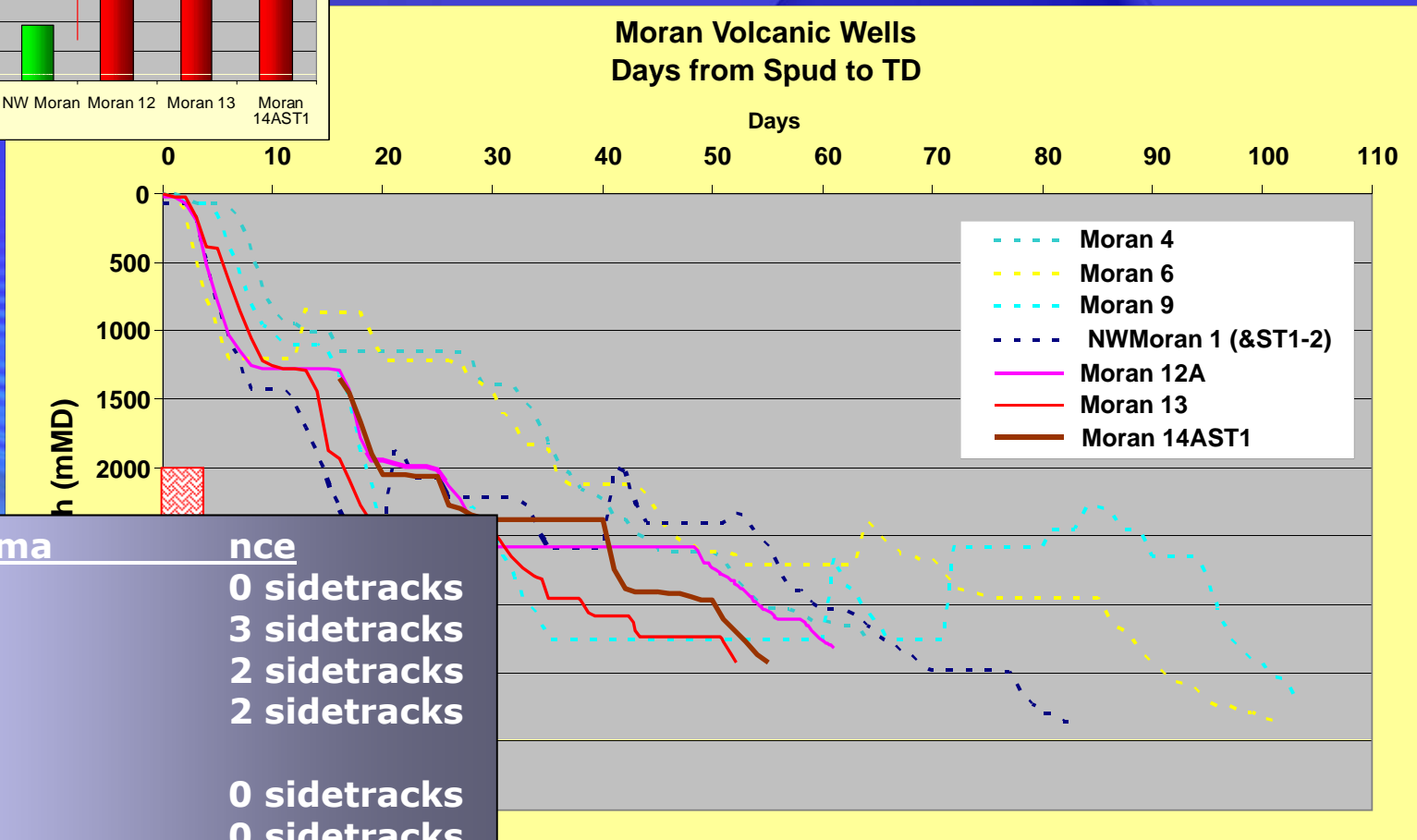
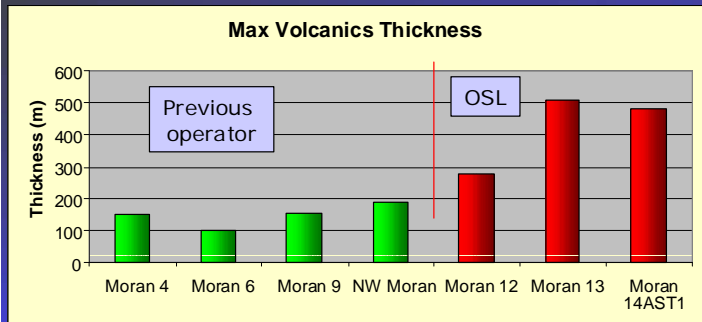


What was achieved

- 1. Proved that a motor hang off BHAs can provide the ROPs required to drill volcanics successfully**
- 2. The Tesco Under Reamer arms are robust enough for the job to drill volcanics**
- 3. PDC bits will not be damaged by volcanics if well stabilised**
- 4. Hard volcanic clasts can past by casing, or be broken up by casing.**
- 5. We can pull casing, and latch on to retrieve a BHA with out any trouble inside a shoe. Plus run back in.**
- 6. We can run in, latch and retrieve a BHA with out any trouble in open hole**
- 7. Volcanics vary in character, but not disturbing hole with drillstring vibrations (stiff csg, stabilised 8½" BHA, no back reaming), increased our chances of success.**



Volcanics Progress Now



Volcanics Performance	Side Tracks
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Moran 6	3 sidetracks
Moran 9	2 sidetracks
NW Moran	2 sidetracks
Moran 12	0 sidetracks
Moran 13	0 sidetracks
Moran 14/14AST1	1 sidetrack



The future....the progression continues

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