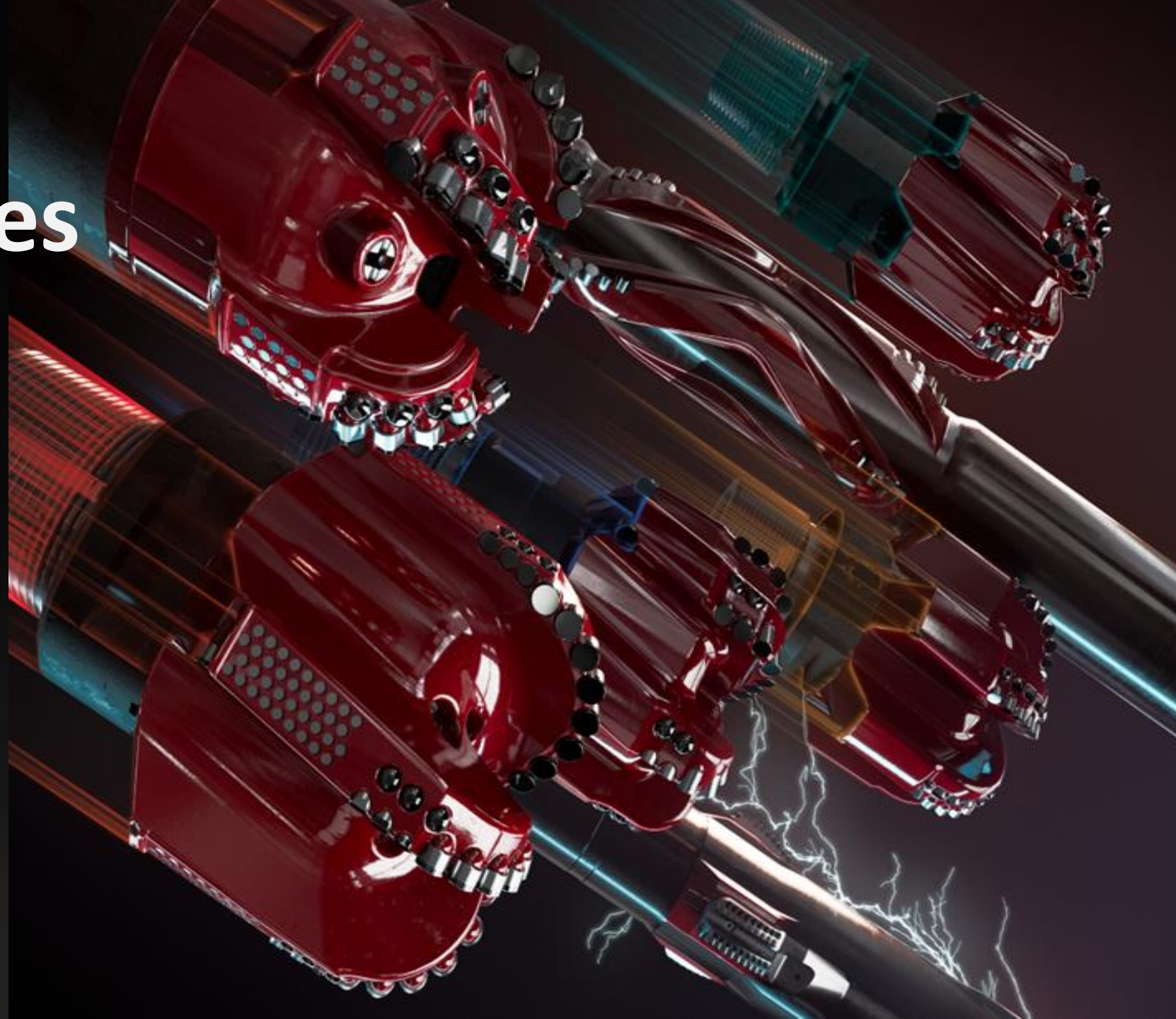
Coring Services Overview

Deepesh Tripathi
APAC Business Development Manager



NOV Coring Services Portfolio

Providing a Full Range of Coring Services

Conventional Coring
- High Torque DuraTEQ™ Core Barrel
- Hole Sections: 5 ½ ” – 12 ¼”
- SuperGlide™ Vented/Aluminum Lined
- Velocity™ System

Enhanced Oil Saturation (Sponge Coring System)
- Oil absorbent Polypropylene felt liner

Oriented Coring
- Multi-shot or ESS (Electronic Single Shot) Survey

Horizontal Coring
- High Torque DuraTEQ™ combination with Downhole Mud Motor

Anti Jamming System
- Jam mitigation system - JamTEQ™ System

Unconsolidated formation coring
- Full Closure Coring System – DuraClose™

Corion Express® Wireline Coring
- 4” Drift – 3” Core through Standard XT54 Pipe
- Deep Core – 3” to 3.5” Core
- SlimHole Express – 3.5” Core in 6” Hole
- Option to run drilling application insert to drill whilst coring
- Logging Conveyance System

Surface handling and Processing



© 2021 NOV Inc. All rights reserved.

Conventional Coring

© 2021 NOV Inc. All rights reserved.

Conventional Core Barrels

DuraTeQ™ High Torque Conventional Core Barrels by NOV

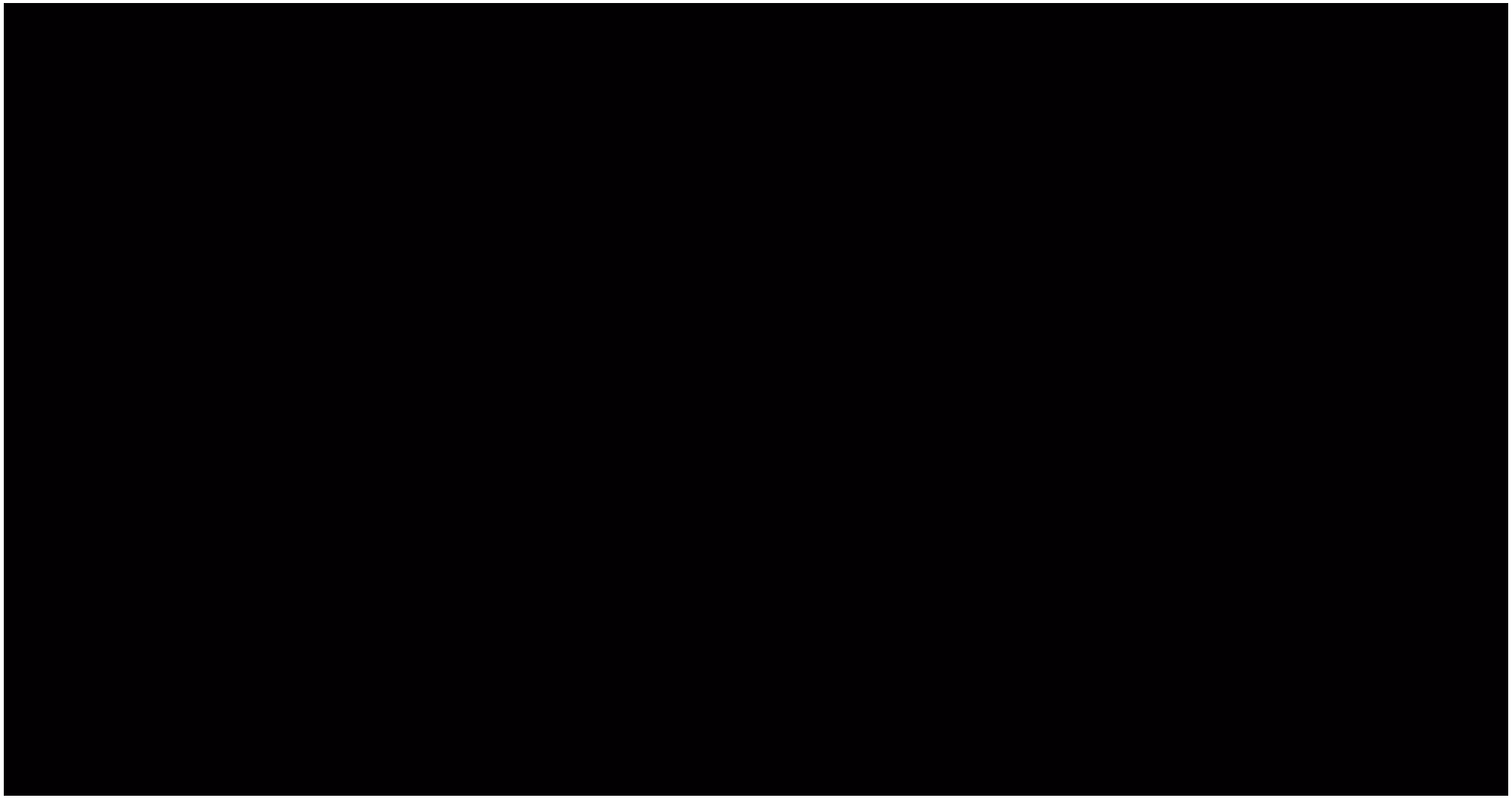
Barrel Size	4 ¾” x 2-5/8”	7” x 4”	9 ½” x 5 ¼”	5 ¼” x 3 ½” Velocity™
Hole Diameters	5 ½” – 6 ¾”	7-7/8” – 9-7/8”	12 ¼”	6” – 7-7/8”
Core Diameter	2-5/8”	4”	5 ¼”	3 ½”
Outer Tube	OD: 4.75” ID: 3.75”	OD: 7.00” ID: 5.50”	OD: 9.50” ID: 7.75”	OD: 5.25” ID: 4.375”
Inner Tube	OD: 3.375” ID: 2.875”	OD: 4.75” ID: 4.25”	OD: 6.25” ID: 5.50”	OD: 4.00” ID: 3.65”
Connection	NC38	NC50	6-5/8” REG	NC38
Length	30ft increments (9m)	30ft increments (9m)	30ft increments (9m)	30ft increments (9m)
Make Up Torque	10,000 ft-lbs	31,500 ft-lbs	62,000 ft-lbs	8,736 ft-lbs
Yield Torque	15,500 ft-lbs	48,500 ft-lbs	103,255 ft-lbs	13,440 ft-lbs
Tensile Yield	470,000 lbs	1,037,000 lbs	1,051,000 lbs	285,000 lbs



Corion Express® Wireline Retrievable Coring System

© 2021 NOV Inc. All rights reserved.

Corion Express



© 2021 NOV Inc. All rights reserved.

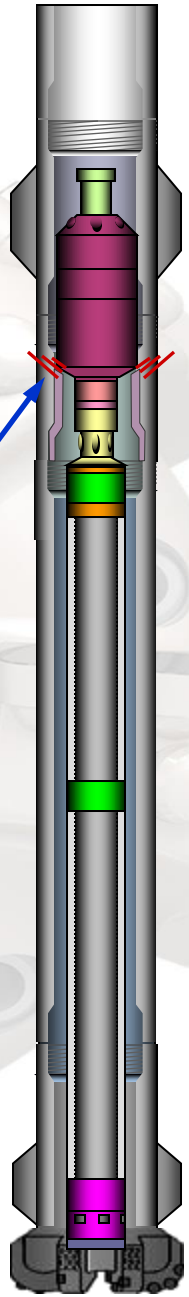
How it Works – Coring Assembly

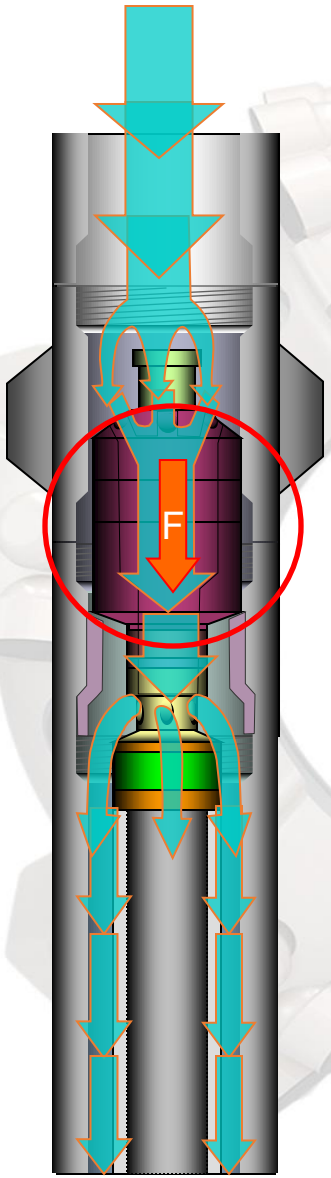
Hydraulically Seated Inner Barrel

Inner barrel is dropped from surface…

…sails through the drill string and…

… lands on the seating sub (metal to metal)



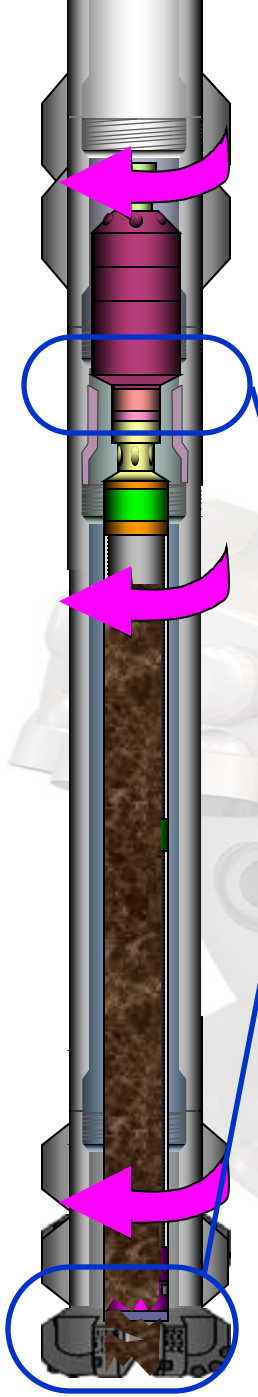


Fluid circulates from surface and reaches the pressure head…

…Fluid pressure holds the seated barrel in place, by creating a thrust load on the pressure head…

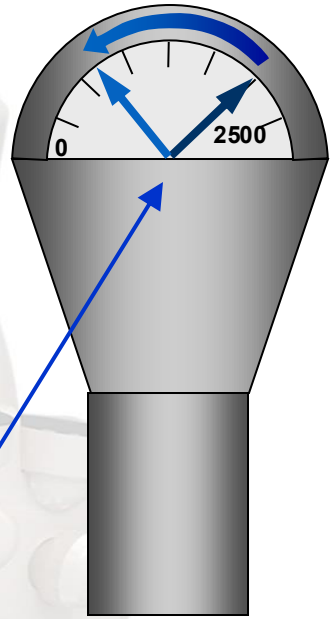
…Fluid is then diverted from the pressure head into the outer barrel feeding the bit

Coring Assembly: Anti-Milling Feature

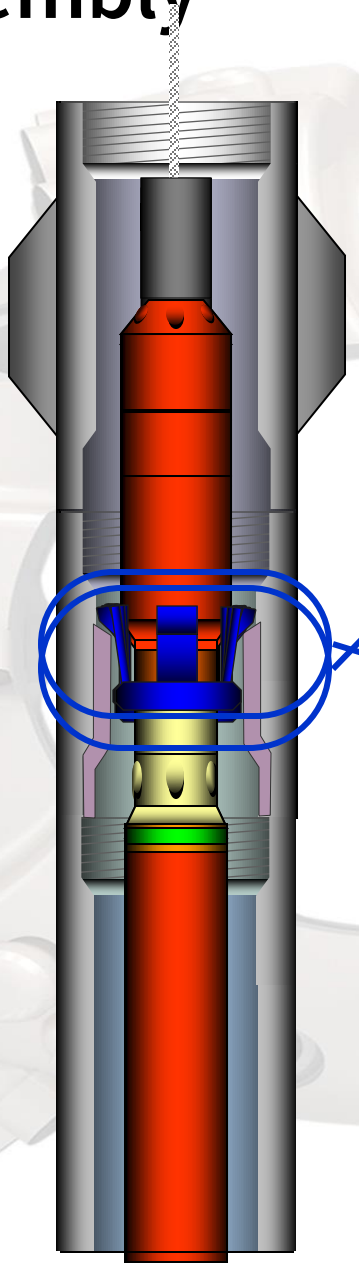


While coring, if a jam occurs, there is a weight transfer from the core bit to the inner barrel…

…causing the inner barrel to unseat which is seen at surface by a pressure decrease



Drilling Assembly



When the drill rod assembly is inserted…

…the pins on the overshot are sheared…

…the collets lock in place and…

…overshot is wirelined to surface…

Application for Express Coring

- Unconsolidated Formation







- Highly Fractured Formation







Full Closure Core Catcher System

DuraClose™

© 2021 NOV Inc. All rights reserved.

DuraClose™ Dual Core Catcher System with Full Closure

- **Complete Capture** – Full-closure catcher system completely retains the core, even in problematic formations
- **Backup Catcher** – Secondary spring catcher secures core in place in the event that coring terminates in a hard stringer
- **Slick Entry** – Unobstructed entry prevents jamming in the catcher area
- **Efficient Shearing** – High-energy activation of clam shells cleanly shears core
- **At-Will Activation** – Hydraulic drop ball system does not rely on inner barrel weight, allowing targeted activation



Full Closure Core Cather System – DuraClose™



© 2021 NOV Inc. All rights reserved.

JamTEQ™ Coring System
Core Jam Mitigation System

© 2021 NOV Inc. All rights reserved.

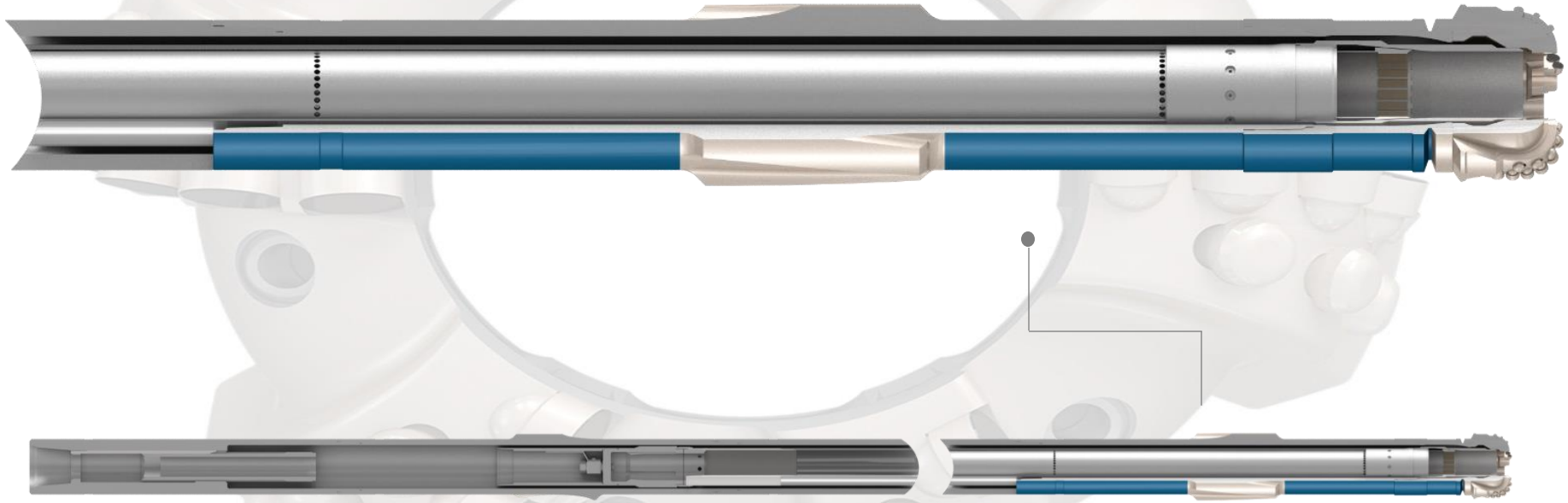
JamTeQ™ – Jam Mitigation System



© 2021 NOV Inc. All rights reserved.

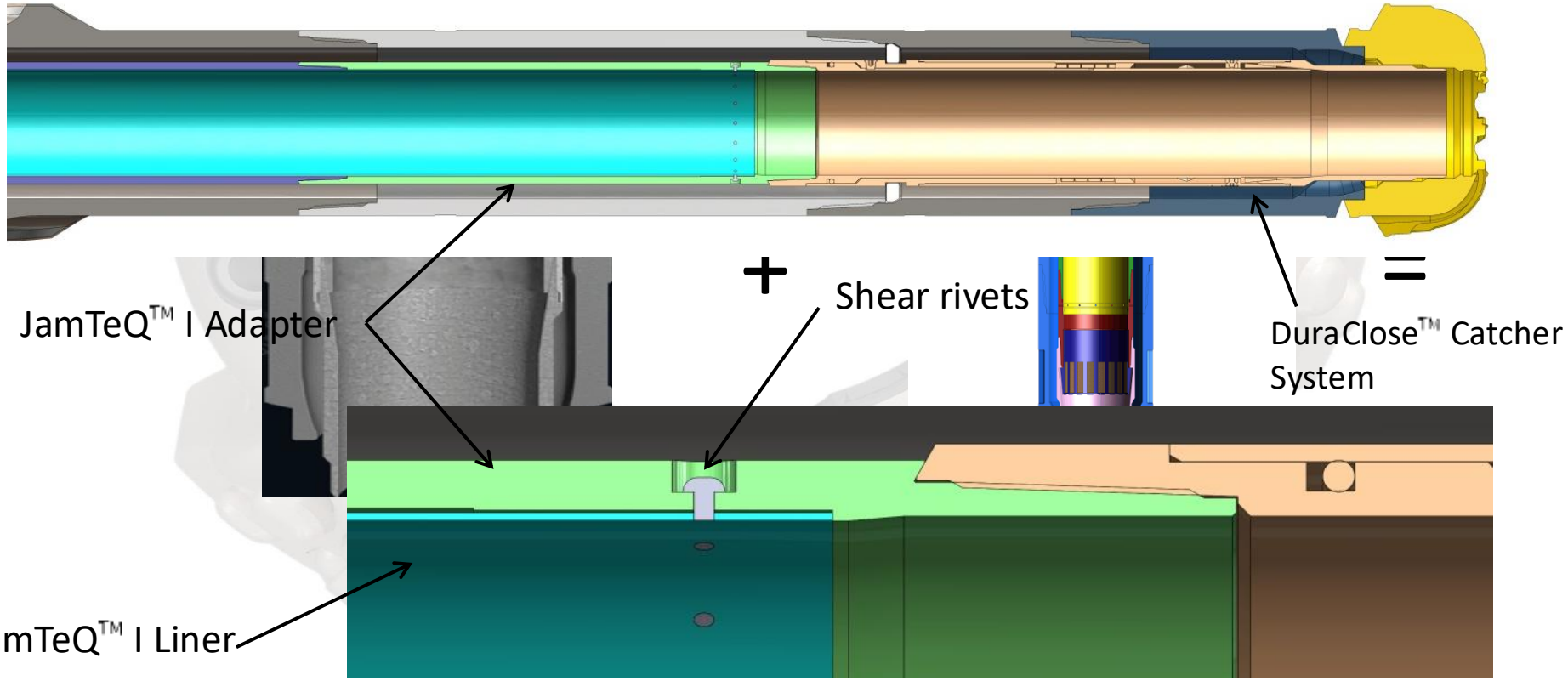
JamTeQ™ – Jam Mitigation System

- Formation Specific
  - Adjustable settings to match the rock strength of the formation



COMBO - DuraClose™ /JamTeQ™ Combination

- This system consist of a typical DuraClose™ built with an addition of a JamTeQ™ I adapter and liner.
- The system require an additional 30ft of Inner Tube to accommodate for liner displacement.



96% Recovery in Highly Fractured Geothermal Formation with JamTeQ

Outstanding *DuraTeQ*™ Conventional (equipped with JamTeQ Jam Mitigation System) Coring Performance in Geothermal Formation

Challenge:
To obtain ~10m of high quality 4" core samples from the 8-1/2" hole in the fractured volcanic fm for a geothermal well. The following are the challenges:-

- Highly fractured volcanic formation – prone to jamming
- High downhole temperature of 175˚C circulating
- High rock strength
- Well inclination of 38˚

Solution:
The 7" x 4" *DuraTeQ* system was recommended. Slick Aluminum Inner Tube, JamTeQ Jam Mitigation System & CDPF913S Core Head were used. There are two planned sections to be cored, each about 9m.

Results:

- 96% average recovery for a total of 9.8m run. A vast improvement over previous runs which averaged only 40% recovery. Client was very satisfied.
- The JamTeQ system successfully activated 4 times on the first run and 3 times on the second run.

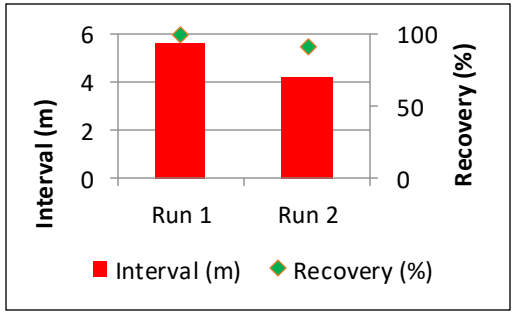
Client	Confidential
Well Name	Geothermal Well
Field/Block	South Sumatra
Country	Indonesia
Date	October 2017
Lithology	Highly Fractured Andesit Lava, Breksi Tuff Fm



Laid out used JamTeQ liner shows that it has activated 4 times.

Run	Depth In (ftMD)	Interval (m)	Rec (%)	ROP (m/hr)	Bit Dull
1	2090.0	5.6	100.0	1.0	1-1-WT-A-X-1-NO-TD
2	2540.0	4.2	91.0	0.7	3-2-BT-A-X-1-CT-TD





90% Recovery in Highly Fractured Geothermal Formation with DuraClose

Outstanding *DuraTeQ*TM Conventional (equipped with DuraClose as Full Closure System, Steel inner Tube and Liner Aluminum) Coring Performance in Geothermal Formation

Client	Pertamina Geothermal Energy (PGE)
Well Name	HLS-P2
Field/Block	Hulu Lais Bengkulu, South Sumatra
Country	Indonesia
Date	April 2017
Lithology	Highly Fractured Andesit Lava, Breaks Tuff Fm

Challenge:

To obtain ~10m of high quality 4" core samples from the 12-1/4" hole in the fractured volcanic fm for a geothermal well. The following are the challenges:-

- Highly fractured volcanic formation – prone to Total Loss / Core Jamming and Washed Out Core.
- High downhole temperature of 132˚C circulating
- High rock strength
- Well inclination of 45˚

Solution:

The 7" x 4" *DuraTeQ* system was recommended. Steel Inner Tube and Aluminum Liner used along with DuraClose System & CDPF913S Core Head were used. There are two planned sections to be cored, each about 9m.

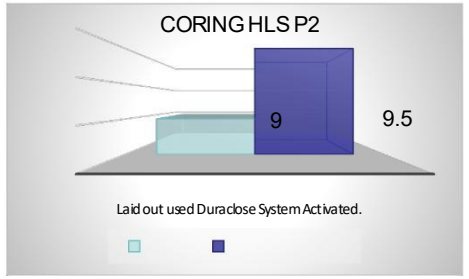
Results:

- 90% average recovery for a total of 9m run. Client was very satisfied.
- The Duraclose as Full Closure System with Steel Inner Tube and Liner successfully activated

Run	Depth In (ftMD)	Interval (m)	Rec (%)	ROP (m/hr)	Bit Dull
1	2380.0	9	90.0	1.0	1-1-WT-A-X-1-NO-TD







Core Recovery %



JamTEQ™ run in Oman with the longest barrel

ReedHycalog™
Coring Services

DuraTeQ™ + JamTeQ™ - NOV's Global Record with excellent performance – 305ft cut in 1 single run

Challenge:
To obtain 300ft of high-quality core in 1 single run through the Sahmah formation consisting of Sandstone and shale with excellent core recovery rate and ROP.

Solution:
The *DuraTeQ™* 7" x 4" Conventional High Torque Core Barrel capability, dressed with aluminum inner barrels, JamTeQ™ - Jam mitigation system and low invasion 8.5" x 4" CDPC713S PDC core head fitted with the latest ION™ 3D premium cutters were proposed for this application.

Results:
- 305ft of core cut in one run.
- 101% recovery rate with outstanding average ROP of 20ft/hr.
- Achieved excellent barrel efficiency of 100%.
- Core head came out with a good dull grade.

EOG 8.5" 330FT DT + JT | Thara'a-1 WELL | Oman



Customer	EOG
Well	Thara'a-1
Country	Oman
Date	Sep-21
Drive Type	Top Drive System
Lithology	Sandstone + Shale

DuraTeQ™

7" x 4" *DuraTeQ™* Core Barrel + JamTeQ™ successfully cuts 305ft recovering 101% core with an Average ROP of 20ft/hr in Sahmah formation, Q3, 2021.



8.5" x 4" CDPC713S
A222410

nov.com/reedhycalog

ReedHycalog | NOV Wellbore Technologies

SliqTEQ™ and Easy Access Liner systems

© 2021 NOV Inc. All rights reserved.

Easy Access Liner



New design gives VERY high speed opening liner for easy access



Easy Snip tabs



New design, eliminated heat / sparks for cutting tabs – NO FIRE SOURCE

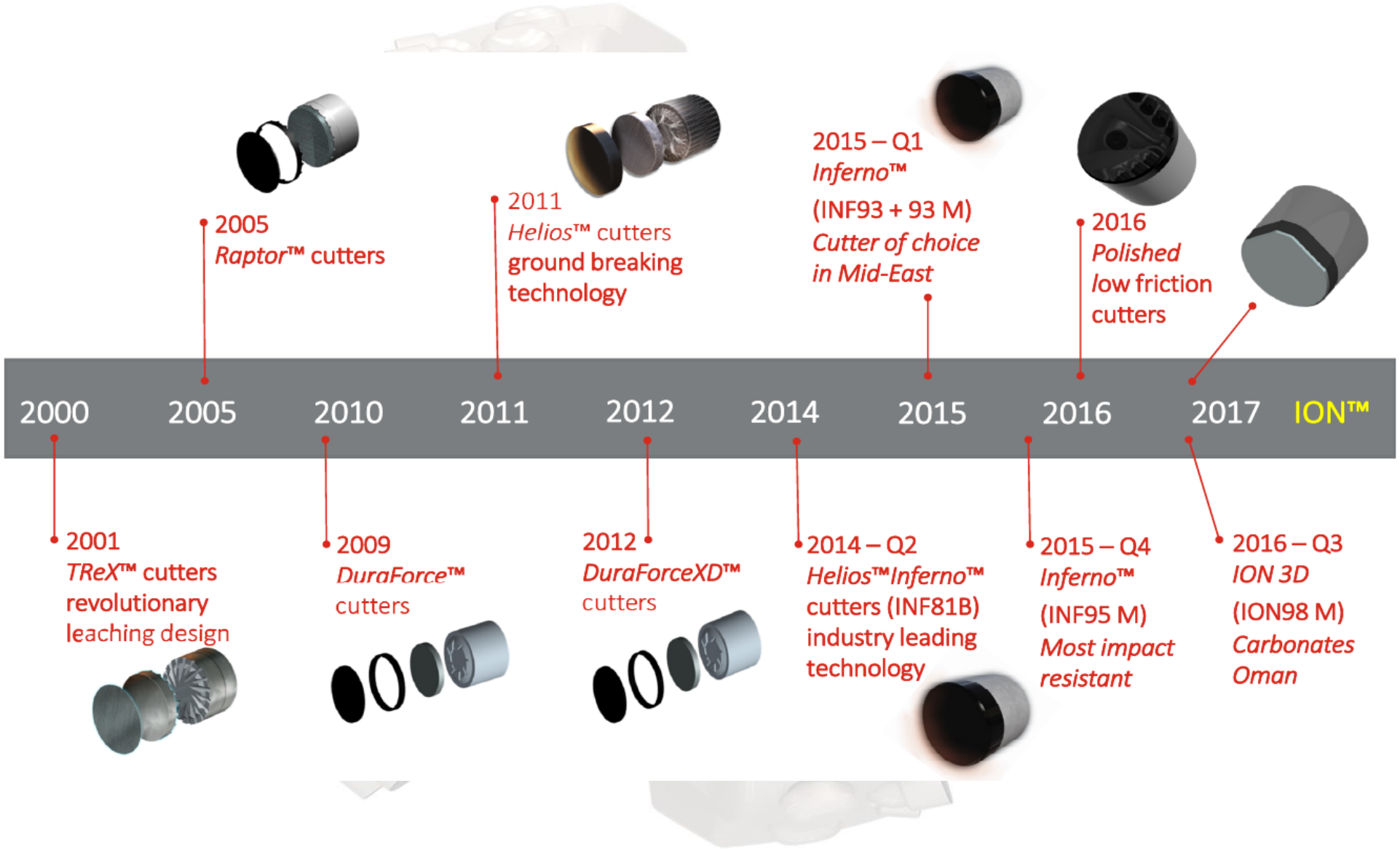


© 2021 NOV Inc. All rights reserved.

Chainsaw Core Head
Special Designed Core bit

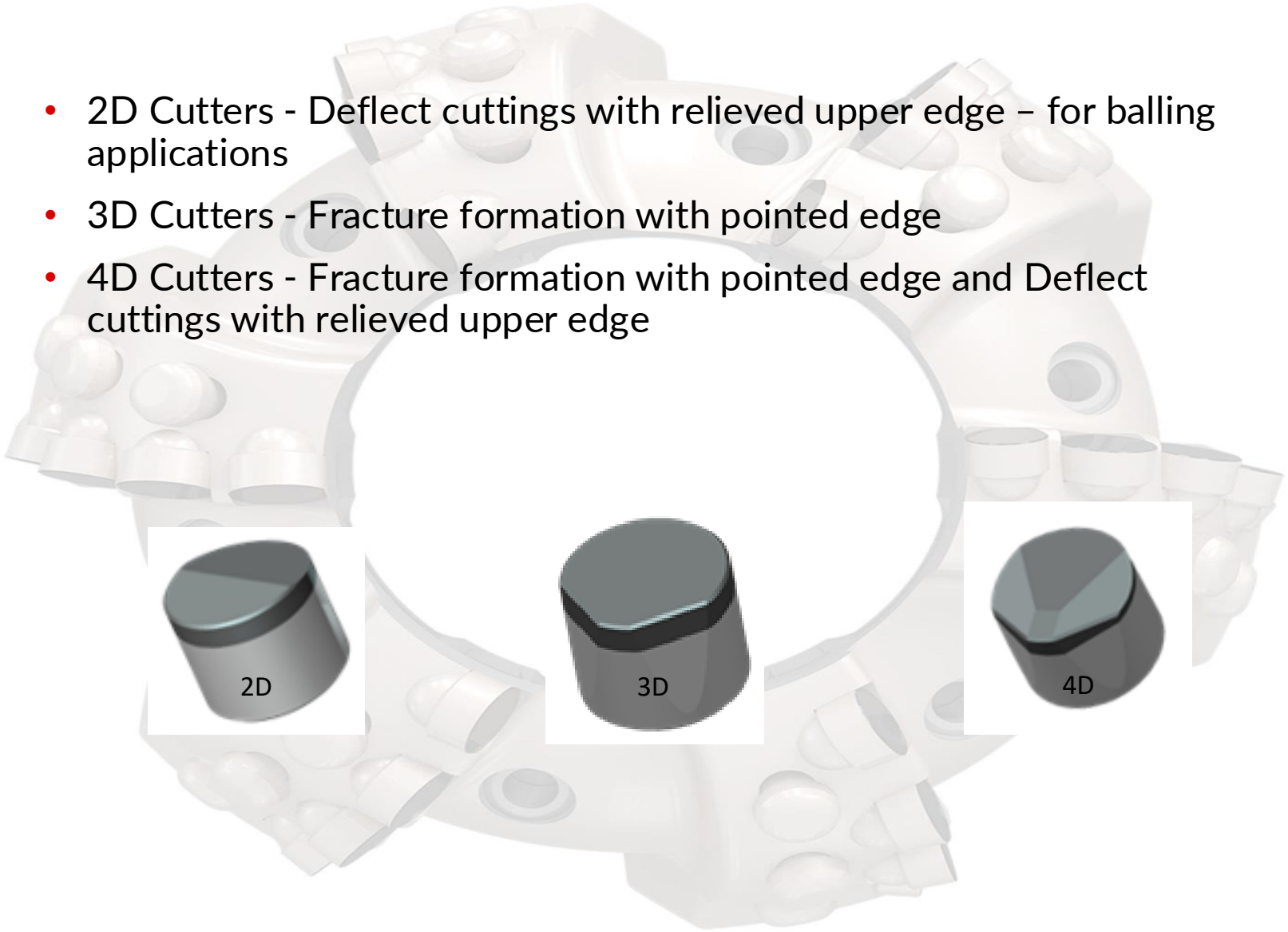
© 2021 NOV Inc. All rights reserved.

Cutter Family History



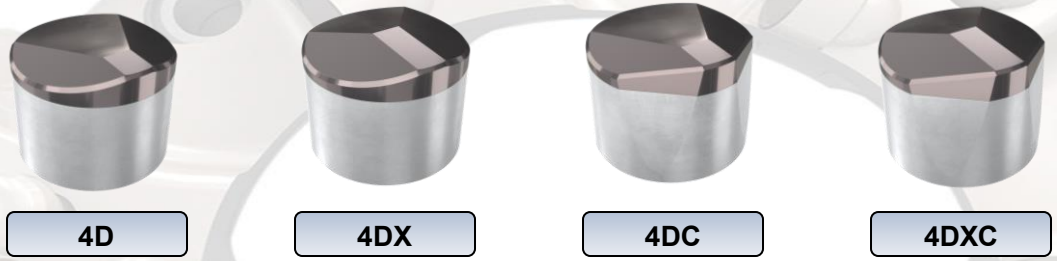
Core Heads - Shaped Cutters

- 2D Cutters - Deflect cuttings with relieved upper edge – for balling applications
- 3D Cutters - Fracture formation with pointed edge
- 4D Cutters - Fracture formation with pointed edge and Deflect cuttings with relieved upper edge



ION 4D Shaped Cutter Family

NOV-ReedHycalog's fastest most efficient patented cutter geometry



ION 4D & 4DX reduce torque while increasing rate of penetration.

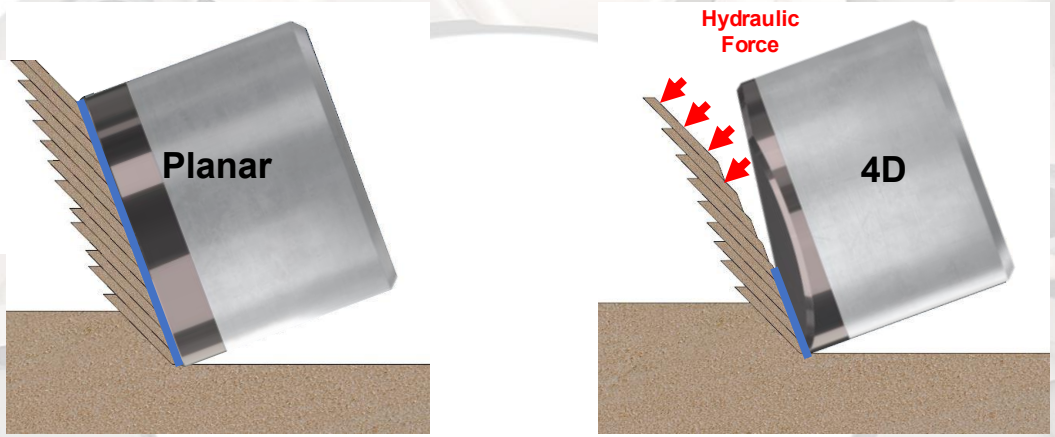
- 4D nonplanar cutting face creates a plough effect increasing point loading in the shearing direction while reducing drag, and creating smaller cuttings

ION 4DC & 4DXC shapes couples 4D technology with proven 3D (chisel) technology

- ION 3D chisel cutting-edge profile produces point loading in the axial (WOB) direction improving fracture propagation and further lowering mechanical specific energy through torque reduction while achieving much higher ROP

ION 4D Geometry Theory

Cuttings Ribbon Generation – Smaller Cuttings and Evacuation



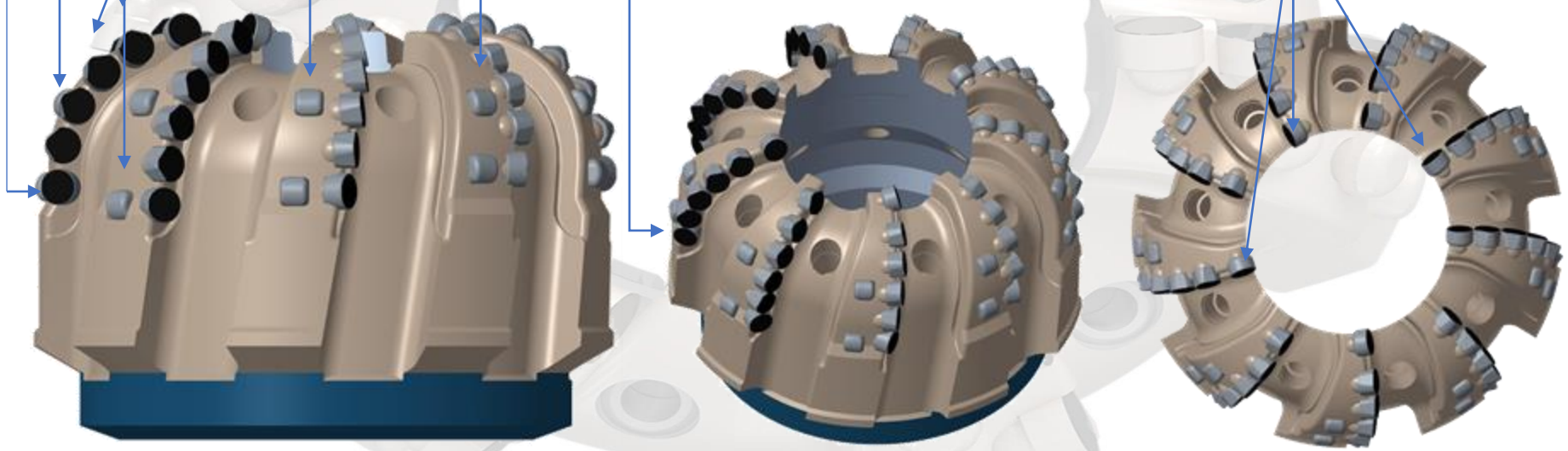
Angled rear flank allows creates a fluid channel behind the cutting

- Decreasing adhesion to the cutter face decreasing frictional losses
- Increasing hydraulic force onto the cutting breaking them into smaller pieces

Chainsaw Core Head

8.5” x 4” CDPFX913S

- Face Cutter - 3D – Less WOB on same ROP, Better stability
- Gauge Cutters – Cylindrical
- ID Cutters – Cylindrical – for smoother core cutting
- TORCS™ - increase lateral stability
- Overhanging cutters – Better Cleaning and cooling
- Polished cutters - – Better Cleaning and cooling



Other Core Head Designs



CDPC516S Core head –ION™ 4D Cutters



CDPC616 Core head –ION™ 4DX Cutters

ION™ 4D Performance

7” x 4” *DuraTeQ*™ Core Barrel successfully recovered 99.47% with excellent ROP in OBM application through swelling shale formation, Q1, 2020.

Challenge:

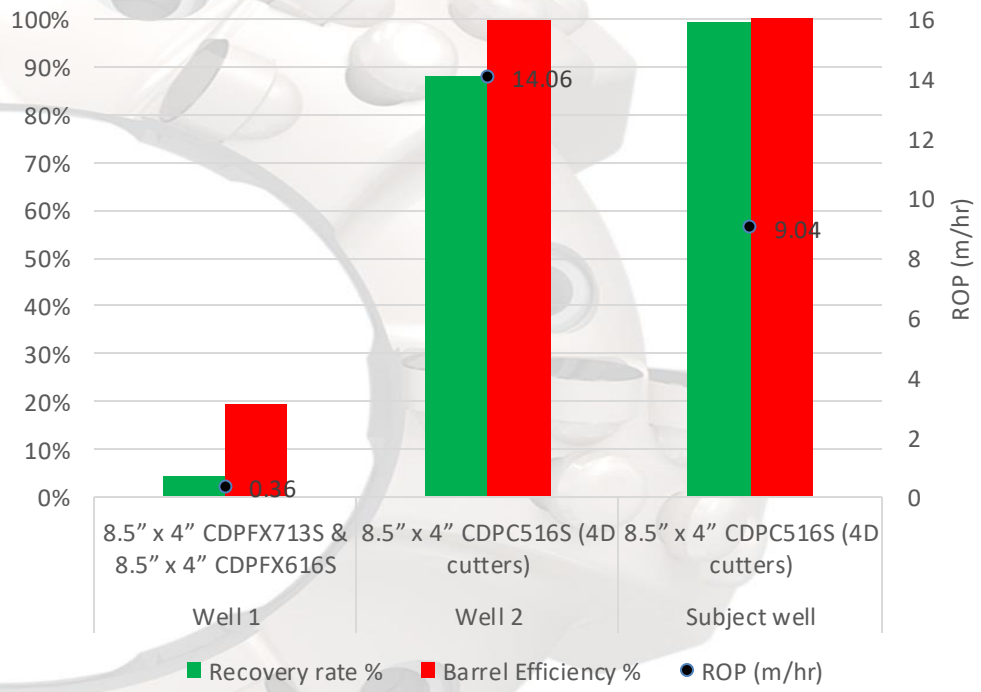
- To core 72m of 4” core in 8.5” hole section, in challenging formation mainly composed of interbedded swelled Shale and unconsolidated loose Sandstone.

Solution:

- The 7” DuraTeQ™ High Torque Conventional Coring System was chosen due to it being the latest and most robust coring system available for 4” core size.
- Fiberglass / Aluminum inner tubes.
- 8 ½” x 4” CDPC516S Core Head fitted with 4D cutters, larger open face volume (OFV) and bigger Junk slot area (JSA) to overcome bit balling issue when using OBM mud type.

Results:

- 74.1m of core cut in 4 runs.
- 73.71m of core recovered.
- 99.47% recovery rate.
- 9.04m/hr average ROP.
- Excellent dull grade of 1-1-WT-A-X-I-BU-TD.



Well Name	Well 1	Well 2	Subject well
Core head	8.5” x 4” CDPFX713S & 8.5” x 4” CDPFX616S	8.5” x 4” CDPC516S (4D cutters)	8.5” x 4” CDPC516S (4D cutters)
BHA Length (m)	36	36	72
Core Cut (m)	7	36	74.1
Core Rec (m)	0.3	31.76	73.71
Time (hrs)	19.51	2.56	8.2
ROP (m/hr)	0.36	14.06	9.04
Recovery rate %	4.29%	88.22%	99.47%
Barrel Efficiency %	19.44%	100.00%	102.92%
Formation	Shale, Sandstone	Shale, Sandstone	Shale, Sandstone
Mud Type	WBM	WBM	OBM

Wellsite Handling and Processing

© 2021 NOV Inc. All rights reserved.

Wellsite Handling and Processing

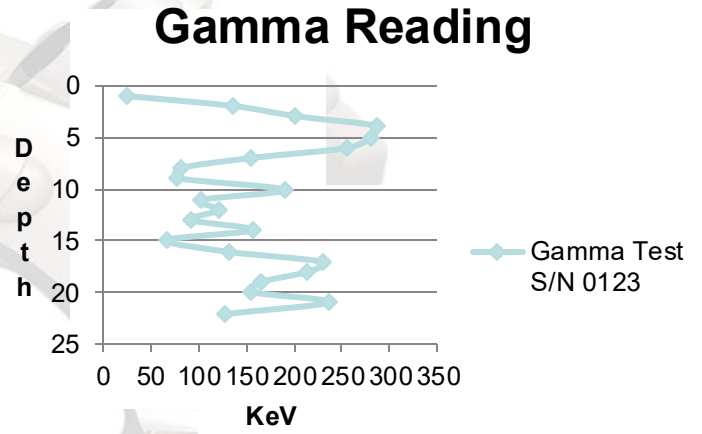
Stabilization	Advantages	Disadvantages	Picture
Gypsum	1. Easily obtainable materials; found in nearly all geographic locations 2. Non Toxic 3. Fills entire void space thanks to the liquid nature of the initial mix 4. Causes minimal grain disturbance, 5. Does not induce fractures 6. Uses 'Free Flow' technique, no additional machinery. • Pump delivery systems may be unreliable due to their complexity and also require toxic solvents to keep the lines free	1. No Dangerous Goods shipping required 2. More time consuming process than some other options 3. Might affect fluid saturations • Dean and Stark analysis requested?	
Foam Injection	1. Annular fill on either intact 30ft inner barrels or pre-cut meter sections 2. Core material is well supported within the inner tube 3. Expansion of the foam into the void space overcomes any blockage restricting ingress to other stabilization mediums caused by fractures or slumping. 4. Causes minimal grain disturbance. 5. Does not induce fractures 6. Mobile drilling mud is displaced by the foam as it expands		
Resin	1. Good Annular fill on pre-cut meter sections due to initial fluid state of the resin 2. Unconsolidated Core material is 'fixed' within the inner tube • Aluminum + core slabbing to access material 3. Ultra Violet fluorescence options 4. Causes minimal grain disturbance, 5. Does not induce fractures 6. Uses 'Free Flow' technique, no additional machinery. • Pump delivery systems may be unreliable due to their complexity and also require toxic solvents to keep the lines free	1. Dangerous Goods shipping required for the 2 components 2. More time consuming process than some other options 3. Some heat generation during reaction/setting phase. 4. Any 'wellsite' analysis required, e.g. chip samples, photographs, must be completed prior to resignation.	
Dry Ice	1. Stabilization of truly unconsolidated sands 2. Compatible with NOV's foam stabilization system if required 3. Use of spreader beams and laydown cradles minimizes core flexure. 4. Cause minimal grain disturbance 5. Rapid temperature drop minimize fluid expansion 6. System components designed to maintain the core temperature during transport to the laboratory 7. Shipping parameters monitored		

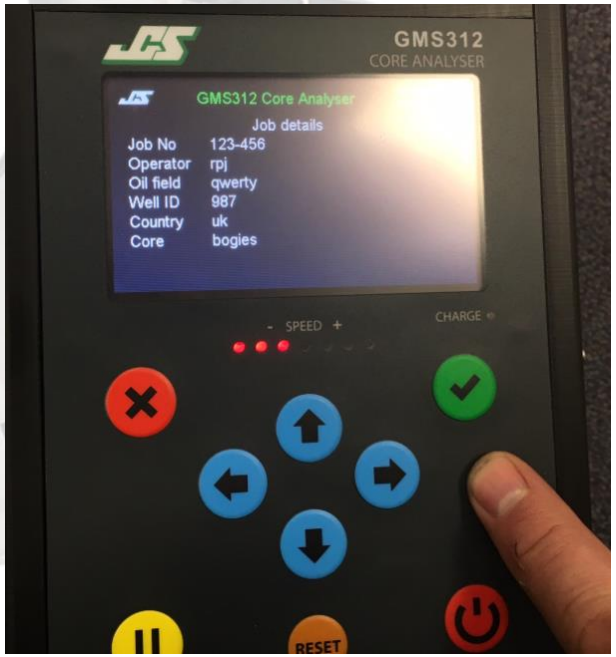
Wellsite Handling and Processing

Gamma Ray – Rolling Core Gamma

- Rolling Gamma Logger
  - Spot Type
  - Spectral / Total output







Additional Wellsite Handling and Processing

HDPE Pallets

- Available for different sizes of inner barrel
- Well supported core sections
- Use in any environmental conditions
- Ease of movement with forklift once filled
- Standard size for shipping
- Comes with lid and lockable security strap
- Fold down sides assist in manual handling
- Compatible with shock monitoring devices
- Crates are clearly labelled with relevant well and core information
- Various shock monitoring devices can be employed with the crates to further advise of the delicate nature of the cargo, and the need to handle with care





Thank you!

© 2021 NOV Inc. All rights reserved.