Halliburton coring technology is the subject of the following U.S. patents:

4,930,587  5,169,183  5,209,310
5,351,765  5,460,230  5,501,285
6,116,348  6,145,604  6,158,534
6,164,389  6,341,656  6,394,196
6,644,424  7,021,404  7,117,958
7,320,373

Trademarks of Halliburton:
CAL™
CD™
CleanCore™
CQL™
CoriBead™
CT™
FCS™
Fibertube™
Glider™
HSB™
Latch-Les™
Low Invasion™
MITP™
PosiClose™
Sponge Coring™
TB™
TBT™
TD™

Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale.
Coring Services
Providing Excellence in Core Recovery and Core Data Analysis
The Leader in Total Core Management

Halliburton is the leader in managing in-depth coring projects that add value to your reservoir. Halliburton has over 50 years experience obtaining the most meaningful data in challenging, complex fields. Total Core Management starts with in-depth planning to understand all the needs of the drilling engineer, geologist, petrophysicist, and reservoir engineer. The process is complete with on-site data collection and analysis and post-coring reports with lessons learned and recommendations for continual improvements.

Halliburton is most qualified for managing your major coring projects and has been the leader in advancing the science of coring and some related analysis with its innovative technologies. Examples include Corienting which allow reliable 3-D reservoir modeling, Low Invasion Coring which provides native state samples without chemical alteration, and on-site analysis enabling real time decisions. Halliburton has provided its services in virtually all the oil producing regions of the world in the most demanding of applications.
Exploration and Development Drilling
Coring is used to evaluate production potential of wildcat and offset wells. Coring determines subsurface structural and stratigraphic conditions, new drilling locations, definition of field limits, and identification of fluid contacts and variations across a field.

Well Evaluation
Data from core samples help estimate initial production pressure drive down, depletion sequences and probable recovery, as well as net pay, and oil or gas in place.

Competition Processes
Coring is important for determining drill stem test intervals, optimum order of completions where several horizons are present, and completion depths and intervals for equipment placement, perforating, and other well testing.

Secondary and Tertiary
Secondary and tertiary recovery programs depend on effective reservoir modeling which requires detailed information from producing formations. Only down hole formation samples can provide this material information.
The Leader in Challenging Applications

This application-and-solution table provides a look at critical issues facing drilling engineers and geologists. Halliburton has the answers with its innovative technologies. For planning your most difficult coring applications, contact a Halliburton representative, the company with the most experience in coring for advanced analysis in challenging environments.

<table>
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<th>APPLICATIONS</th>
<th>FRACTURED RESERVOIRS TENDANCY TO JAM</th>
<th>SOFT FRIABLE OR UNCONSOLIDATED</th>
<th>EXPENSIVE RIG TIME</th>
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The Importance of Coring

Coring provides the only valid representation of the formation. It’s the only means of direct measurement. All other methods such as well logs require interpretation. While conventional well logs play an important part in reservoir identification, only coring can ensure reliable correlation of those logs to the actual subsurface conditions. And for the most advanced analysis, only core samples can yield critical data such as porosities, permeabilities, and saturations.
Standard Core Barrel

For a Full Range of Advanced Systems

The standard core barrel system is the industry benchmark for reliability and efficiency. Its Heavy Duty Threads (patented) make it the most rugged system for applications such as long barrel coring which reduces trips. The Adjustable Safety Joint allows quick and accurate spacing adjustments without breaking connections, saving valuable rig time. The standard core barrel system covers the full range of coring applications with the foremost family of technologies.

Core Barrel Upper Section

The Adjustable Safety Joint connects the inner and outer barrels, with a number of special benefits. It saves rig time since the spacing between the lower shoe and core bit can be adjusted more quickly and accurately without breaking any core barrel connections. It enables the running of a greater range of core barrel lengths and allows easy adjustment of long core barrels. The safety joint also allows extraction of the inner barrel if the outer barrel becomes stuck in the hole. It allows easy and convenient separation for servicing.

Turning a handle at the top of the safety joint box connection lowers the inner tube until the correct spacing is obtained.

An optional safety joint with a longer thread area is available for high-angle and long-barrel coring.

The swivel assembly allows the inner tube to remain stationary while cutting the core.

A ball check valve in the upper inner tube prevents mud from flowing around the core during coring. The drilling fluid flows down the annulus around the inner tube to the cutting structure of the corehead.

The Heavy Duty Threadform
**Core Barrel Lower Section**

**The outer assembly** is the drilling joint of the barrel. It transmits weight and torque to the corehead.

**Stabilizers** at 15 or 30 foot intervals between outer barrel sections provide centering within the wellbore.

**The disposable inner tube** receives the core and is made from either fiberglass or aluminum. It also protects the core during handling and transport and saves rig time.

**The shoe assembly** breaks the core free from the formation and retains the core within the inner tube.

**High performance coreheads** reduce rig time and the number of trips. They minimize mud invasion of the core and avoid core jamming.

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**Heavy Duty Core Catcher**

The Heavy Duty Core Catcher is designed for coring medium hard, hard fractured, or inter-bedded formations. BOTTOM LEFT. The spring catcher opens as the core enters. BOTTOM RIGHT. When the core barrel is lifted off bottom, the spring catcher closes to break off the formation and retain it within the inner tube.
Core Barrel Specialty Systems

The Hydro-Seat Barrel (HSB™)

The Hydro-Seat Barrel (HSB™) system, an optional feature, provides a clear and instantaneous indication on the rig floor if core jamming occurs. LEFT. This floating, flexible barrel is hydraulically seated which means much less stress on the core at entry. RIGHT. Jamming lifts the inner barrel, restricts mud flow, and increases the pressure reading at the surface.

The Heavy Duty Threadform (patented)

The Heavy Duty Threadform reduces thread damage and costly delays. It adds reliability in horizontal applications and allows longer core barrels for saving trips and valuable rig time. The heavy duty buttress threads are double shouldered and flush internally and externally. They greatly increase tensile strength, flex capacity, torsional strength, and fatigue life compared with conventional threads. Its fatigue life is ten times greater than conventional types.
**Full Closure System (FCS™)**

The Full Closure System (FCS™) is ideal for soft, unconsolidated formations. Hydraulic collapsing sleeve minimizes mechanical parts and increases reliability.

**Glider™ System**

The Glider™ system provides a layer of lubricating non-reactive fluid between the core and inner tube to prevent jamming and protect the core from the drilling mud.

**PosiClose™ System**

The PosiClose™ system also maximizes core recovery in soft formations. Unrestricted entry eliminates jamming from premature catcher-core contact.
Low Invasion Coreheads

Halliburton coreheads reduce rig time, the number of trips, and total cost. They also help avoid core jamming, core erosion, and reduce mud invasion. Halliburton bits are the benchmark for both anti-whirl designs and cutters resistant to wear and impact.

PDC (Polycrystalline Diamond Compact) Coreheads

Generally for Softer Formations

The Elite Series (ES™) cutters provide resistance to wear and impact far beyond any previous industry limits.

On-site analysis is instantly fed to Halliburton’s decision room.

Halliburton’s satellite system enables instant communications.
**TSP (Thermally Stable Polycrystalline) Coreheads**

*Generally for Medium to Hard Formations*

TSP cutters provide fast penetration rates and long bit life in medium to medium-hard and abrasive formations.

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**Full Diamond Impregnation Coreheads**

*Generally for the Hardest, Most Abrasive Formations*

Fully impregnated coreheads drill the most abrasive, high compressive strength formations at high speeds.

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**Real Time Reservoir Description**

On-site analysis allows operators to make decisions in real time. From gamma logging and plug taking, operators can decide whether to continue coring or to log, test, perforate or stimulate production. On-site Corienting procedures provide operators a 3D reservoir model to refine plans for drilling and producing a complex reservoir. Wireline gets core samples to the surface quickly without tripping the BHA for near real time solutions. Communication with Halliburton’s decision center helps operators digest coring data which is the only direct and valid source of formation-reservoir information.
Wireline Coring

Saves Rig Time

Wireline coring provides significant rig time savings by recovering cores without tripping the whole drill string. It’s ideal for long sections and continuous coring. The system also provides an instant indication of jamming at the surface. In coalbed methane applications, wireline gets the core to the surface quickly to minimize gas escapement for best measurement. Wireline is effective in all formations and operations including soft formations.

Drill Plug System

The drill plug system converts the corehead into a drill bit, which allows drilling to another formation after retrieving the core, without tripping, saving valuable rig time.

Full Closure System

The Full Closure System (FCS™) is ideal for soft, sandy, and unconsolidated formations.

Hydro-Seat Barrel

Hydro-Seat Barrel (HSB™) system indicates jamming at the surface, a standard feature in the wireline system.

Glider™ System

The Glider™ system provides a layer of lubricating fluid between the core and inner tube to prevent jamming and protect the core.
Drill Plug System

- Inner barrel is dropped from the surface.
- System is coring.
- Core sample is retrieved at the surface.
- System drills deeper with the drill plug.
Soft, Unconsolidated Formations

A Broad Range of Highly Effective Systems

Halliburton provides a number of effective systems for soft, unconsolidated formations, all of which provide total closure for complete capture. All these systems are available for standard core barrel applications. The full closure system and flapper are available in wireline applications.

PosiClose™ System

The PosiClose™ system allows unrestricted entry which eliminates jamming from premature catcher-core contact. The “clam shells” cut the core cleanly to totally retain the core. The spring core catcher catches the core in the standard method if the “clam shells” do not catch it properly.

Flapper System

The Flapper system is a specially-designed upper half shoe developed for highly fluid cores. The system is similar to a PosiClose catcher and requires no mechanical or hydraulic activation.
The Full Closure System (FCS™) is hydraulically activated which minimizes mechanical parts and increases reliability. LEFT. The FCS system is receiving the core. RIGHT. Hydraulic pressure collapses the sleeve to totally enclose the core. Combined with a spring core catcher, the system is suitable for all types of formations.
**Enhancing Reservoir Value**

Uninvaded, native state core samples enable the most advanced analysis for planning enhanced oil recovery, identifying oil and transition zones for tertiary recovery, or measuring oil and water saturations and permeability. Halliburton provides a wide variety of systems and many years of experience in high value service.

**Sponge Coring**

Sponge Coring provides the most realistic petrophysical data, essential for planning enhanced oil recovery and identifying oil zones and mobile oil zones. Sponge coring allows measurement of in-situ conditions, oil and water saturation, permeability, relative permeability, capillary pressure, and gas saturation.

- **Fins** support sponge and core during coring and transport to laboratory.
- **Aluminum liner** is perforated with 1/16 inch holes to allow presaturation fluid to be displaced and gas to escape during trip out.
- **The sponge liner** recovers oil escaping from the core when tripping out of the hole, which enables analysts to reconstitute better native state conditions.
Corienting™ Service

Corienting™ service provides data that indicates the core’s orientation in the reservoir prior to removal. It enables reliable 3-D modeling of the reservoir, drainage patterns, directional permeability, and field boundaries.

Low Invasion™ Core System

The Low Invasion™ Core system delivers a native state core sample untouched by drilling fluid which can alter the core chemistry. Low invasion coreheads (above) protect the core from drilling mud. Plug taking, trimming, and mud tracing provide an inner core of in-situ condition.

Glider™ System

The Glider™ system protects the core from drilling fluids with a layer of lubrication. Lubra-Beads can support the core from broken, fractured formations.

Wireline

Wireline enables cores to be retrieved quickly without tripping the entire string, minimizing gas escapement for the best measurements in coalbed methane projects.
Effective Surface Handling

Contributes to Meaningful Core Data

High quality surface procedures are critical in providing meaningful core data by preventing mechanical damage and chemical alternation. Special pull-out and lay-down procedures prevent bending and fracturing. Plug taking, trimming, and sealed transport are part of Low Invasion procedures to provide native state core samples for advanced analysis. Plug taking and gamma logs help operators make on-site drilling and production decisions by correlating cored sections with anticipated lithology and offset well logs.

**Plug Taker** cuts core samples to aid on-site operating decisions or to ship samples to the laboratory for further analysis. Operators also take plugs on-site to prevent further mud invasion, and after trimming, provide the laboratory an inner plug untouched by drilling fluids, which prevents alteration.

**Portable Core Gamma Logger** provides on-site analysis with gamma ray logs. It allows real time decisions on further coring, testing, or completions. The Core Gamma Logger correlates cored sections with anticipated lithology from offset wells by delineating shale from non-shale sections.
Hydraulic Shear Clamp

The Hydraulic Shear Clamp prevents core damage while breaking connections. It cuts the tube and insulates the core from the relative rotation of the two inner tubes, and keeps the core in the tube during lay-down.

Lay-Down Cradle

Lay-Down Cradle protects against bending and impact damage. The cradle is equipped with rollers.

Gypsum Preservation Service

Gypsum Preservation Service stabilizes the core with a gypsum mixture inside the inner tubes. It’s also the best solution in terms of health, safety, and environmental.

Shipping Baskets

Special shipping baskets can be spring-loaded to protect cores during transport. They can ship both full length and cut cores.