For almost 30 years, Weatherford Laboratories has set the standard for retrieving, preserving and transporting core. In that time, the company has introduced numerous innovations to the industry including:

- Pioneered methods and equipment for field measurements, sampling, preservation and stabilization of core samples
- Customized equipment and procedures which exceed safety requirements and adapt to the needs of individual projects
- Introduced the practice of stabilizing rotary sidewall cores in the receiver tube on location
- Dedicated processing units able to acquire and preserve plug samples and/or full diameter sections on location in a controlled environment
- Collaborative planning with our clients to ensure that each project is executed to maximize the accuracy of all subsequent laboratory testing
- Comprehensive, multi-level training programs that ensure personnel are completely versed in wellsite processes and procedures
- Unsurpassed attention to safety from proper equipment to practices to conform with the most stringent HSSE requirements
- Experience in such varied locales as the North Slope of Alaska, the GoM, rural China, and the shores of Tripoli

innovation always
Expertise in every play type, on or offshore, around the world.

Why Take Core?
Of all the methods for evaluating the types of oil and gas formations that lie deep underground, core analysis is the best method to measure reservoir properties. That's why we call this the Ground Truth. Many other, more common measurements are inferred. Core analysis can provide:

- Lithologic information including rock type, depositional environment, mineralogy and geochemistry
- Fracture orientation and sedimentological description
- Confirmation of fluid saturations within a reservoir
- Capillary pressure and wettability data
- Data to refine and calibrate downhole calculations including resistivity, image and porosity logs, among others

Traditional Types of Core

Conventional Core
A continuous cylinder of rock, potentially ranging in diameter from less than 2” to more than 5”, is extracted from a well in lengths that can exceed 300’ of continuous formation. Conventional core is critical when analysis is required at either the micro or macro scale. The wealth of information available from a conventional core makes it the most accurate fundamental tool available for understanding oil and gas reservoirs.

Rotary Sidewall Core
Rotary sidewall coring allows numerous, site-specific core samples to be collected via a wireline tool. This method involves using a mechanical tool to drill core samples from the wellbore (generally 0.9” - 1.5” in diameter and up to 1.75” - 3.0” in length). Generally, up to 50 samples can be acquired per descent. While the sample has less than the ideal volume of rock necessary for the entire suite of laboratory testing, many basic analytical evaluations are still available.

Percussion Sidewall Core
During percussion sidewall coring, an explosive charge is used to fire a hollow “bullet” into the wellbore to capture the desired formation. The core is then retrieved via wireline. Generally, percussion sidewalls are the least expensive core samples to acquire. While the technique can result in significantly damaged samples, some valuable analysis can be quickly performed on these samples to yield invaluable data for the client.

Specialized Types of Coring Systems

Pressure Core
Core samples are captured via a system that is designed to maintain the core’s in situ gasses and liquids. When the cores get to surface, Weatherford Labs works with the operator and coring vendor to measure the gasses as they emit from the core on surface. Weatherford Labs can make precise measurements on both conventional and rotary sidewall pressure cores.

Sponge Core
Conventional coring system which has an absorbent material lining the inner tube of coring assembly. The “sponge” absorbs the fluids as they flow from the core, helping ensure that no fluids are lost as the core is tripped to surface. Weatherford Labs works with the operator and the coring vendor to sample and preserve the core and sponge to ensure that subsequent analysis is as pristine as the core.

Other Systems
Weatherford Labs has experience with all other relevant coring systems, including Liquid Trapper™, JamBuster™, Splitable liner systems, and all other wireline or drillstring tripped systems.

Critical Elements for Taking Core Successfully
As the costs and demands of drilling a well have increased exponentially over the years, Weatherford Laboratories has consistently met the challenge. Whether the well is a tight gas sand, a CO2 sequestration job, a shale oil play, or a prospect exceeding 30,000 feet in the deepwater, Weatherford Labs strives to ensure that all steps in the process yield pristine data. From the cradle to the grave, we:

1. PRESERVE the core to prevent fluid loss
2. STABILIZE the core to ensure structural integrity
3. DOCUMENT the core from the moment of retrieval, recording its depth and photographing its condition and lithology
4. SAMPLE the core to help ensure accurate and expedited data
5. TRACK the core via an unbroken chain of custody from wellsite to laboratory

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Core Stabilization and Preservation

Weatherford Laboratories offers a multitude of methods for stabilizing and preserving core. The method chosen will depend on the condition of the core and the analytical goals of the well operator.

Core Stabilization and Preservation
Proper stabilization and preservation is the most critical component of a coring project. If done improperly, all the money that was spent to acquire the core could be wasted and all subsequent analysis is potentially jeopardized.

Weatherford Labs has been working with operators for three decades to ensure that the onsite stabilization and preservation of the core is tailored to exceed the client’s needs to ensure the most accurate analysis possible.

Shimming
Plastic strips are placed in the annulus of the inner tube assembly which locks the core against the inner tube. The core is secured against the inner tube, which reduces vibration of core and potential structural damage during transport. It is a chemical-free stabilization technique and allows for easy removal of core from the inner tube once core arrives in lab. This ensures that all sampling and testing techniques are available to the core.

Foam Injection
A two-part foam chemical is injected into the annulus of the inner tube bonding the core to the inner tube. The core is well protected from transport shocks and vibrations. This technique allows core to be removed from inner tube, allowing a more comprehensive suite of analysis than epoxy (i.e. Whole Core Analysis).

Epoxy Stabilization
A two-part epoxy is poured into the annulus of the inner tube, which permanently bonds the core to the inner tube. The core is exceptionally well protected from vibrations and shocks while being transported from wellsite. This is the most robust method available to protect core. Sealing of core while in inner tube acts to better preserve the fluid saturations of core.

Dry Ice Stabilization
Sometimes core samples are too unconsolidated and/or have inadequate annular space to accommodate a chemical or mechanical stabilization technique. In instances like this, dry ice can be used to freeze the core, using the in situ fluids to maintain the structural integrity of the core.

Wax Preservation
Full diameter core sections are wrapped in plastic wrap, aluminum foil, a thermal paper barrier, and then an additional layer of plastic wrap. After packaging, the core is dipped in hot wax. The core is sealed in lengths up to three feet or one meter in length. Entire core runs can be wax-preserved if transport times are anticipated to be lengthy. Weatherford Labs’ use of a thermal barrier prevents the heat from the wax from reaching the core itself, ensuring accurate fluid analysis.

Chilling/Heating
Weatherford Labs completes jobs in North Dakota in winter and West Texas in summer – so we understand how widely temperatures can vary at job sites. We rely on our experience with thermodynamics to protect cores from temperature-related issues such as microfracturing. Our electronic boxes, for example, can maintain a specific chilled or heated temperature to promote proper fluid preservation for cores obtained under any ambient temperature.

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Today our services encompass coal characterization (density, proximate, ultimate, sulfur, ash, moisture), adsorption isotherm analysis, in situ permeability testing, formation evaluation, CBM reservoir engineering, and critical desorption pressure determinations. The result is a comprehensive picture of sorption reservoirs, enabling accurate evaluation of coal bed and shale gas prospects.

Desorption

Weatherford Laboratories has been awarded three patents for vapor desorption technology. These patents relate to the use of an electronically controlled humidity chamber to measure extended range air/brine capillary pressure on core samples. This analysis system can be used with both conventional and unconventional resource plays to provide superior pore structure information.

Pressure Core

Our engineers believe mass flow measurements yield stronger results than volumetric techniques, and they developed our patented Pressure Core Management System™ to enhance the outcomes and accuracy of pressure core analyses. Our unique approach can prove invaluable in helping operators fine-tune their fracturing schedule for unconventional plays.

Subsampling and Testing on Location

Weatherford Labs has pioneered processes and techniques to quickly and efficiently allow sampling of cores on location, allowing expedited and accurate testing, both on location and in the lab. Plugs can be acquired on location to help ensure that diffusion of drilling fluids doesn’t compromise fluid measurements. In addition, these plugs taken on location can be “fast-tracked” when back in the lab to give clients the answers they need in the time that they want. Onsite analysis is available for the core including quantification of mineralogic composition via XRD, chemostratigraphy by XRF, and total organic content (TOC) with Weatherford Labs’ Source Rock Analyzer (SRA).

Gas Content

As shale plays have become more and more common throughout the world, expertise in measuring gas content has become a critical component of exploration and drilling. Weatherford Laboratories leads the industry in comprehensive sorption reservoir characterization. In fact, our facility in Denver, Colorado (USA) is the largest sorption laboratory in the world. Among our accomplishments:

- Pioneering work to determine gas content from desorption experiments
- Over $25M in R&D work
- 800+ well studies in 30+ basins with 100+ clients
- Over 100 technical papers and hundreds of industry presentations
- Authors of the Gas Research Institute books on CBM gas content analysis

Mud Tracing and Gas Content
Safe transport of cores from the field to the laboratory is critical to maintaining the integrity of the core and its analytical value. Weatherford Laboratories has developed a number of options that offer insulation, temperature control and shock monitoring for your precious cargo. Furthermore, your core can be tracked every mile of the way via cellular monitoring so you always know its precise location as well as its exact moment of arrival. Comprehensive chain of custody documentation adds another layer of security to core shipments.

Chain of Custody
Weatherford Labs personnel maintain custody of cores from the wellsite to the laboratory. It is best practice to have a Weatherford Labs employee ride with the core at all times, ensuring good communication between the wellsite and lab regarding delivery date and time, and to safeguard the core in transit. If this is against the operator’s policy or deemed unsafe, we will arrange for offshore samples to be met at the dock by an authorized representative, and will schedule transportation for equipment and personnel from the dock to Weatherford Labs.

RockVault
Best practices dictate that core should be kept within a defined temperature range (35 - 50 degrees F) to maximize retention of in situ fluids and to minimize structural damage from microfracturing. Weatherford Labs offers an upgraded shipping container, which can maintain a constant temperature. Capacity is twice that of a standard insulated core box, holding 180 feet of 4-inch core. Thus, you get two times the capacity with significant technological enhancements.

Temperature/Shock Monitors
Both standard and upgraded boxes can monitor temperature and shock during transport. In our standard container, shock and temperature sensors, which have been programmed by a computer, are placed in the box with the core. In our upgraded boxes, monitors are integrated digitally into the container and record readings at regular intervals. Both systems can generate a comprehensive temperature/shock report covering the life of the trip.

Near Real Time Tracking of Core Back to the Lab
In upgraded containers, an integrated computer broadcasts GPS coordinates and records the internal condition of the cargo for the duration of the journey. Reports include temperature, pressure, humidity and shock readings, and provide door-to-door monitoring of your core.

Rotary Receiver Tube and Transport Box
When rotary core samples reach the surface, Weatherford Labs has the ability to transport the coring vendor’s tube in its entirety back to the lab in one piece. This capability greatly minimizes opportunity for error. There is no risk of getting samples or depths confused on location, or incurring misidentification. If desired, the tube can be opened up and samples can be labeled before shipping. The rotary tube travels in one of two specially-sized insulated boxes.

Proprietary shipping containers protect valuable core.
Weatherford Laboratories is dedicated to training its wellsite services teams to exacting standards, thereby ensuring they are ready to meet the challenges of any well. Operations specialists must successfully complete rigorous competency-based training to join our team. The training program begins with classroom instruction and ends with hands-on tests at a wellsite processing practice area. This competency-based training includes courses for basic and advanced Field Specialists, as well as for Mud Tracing and Sampling.

Consistent, validated training means that every Field Specialist is certified to perform at the same high standard around the globe. Additionally, every training class begins with a Safety Orientation, designed to mitigate hazards at the wellsite through implementation of proven, established safety procedures.

**RockTrac**
The Weatherford Labs’ RockTrac, a sample management system, was designed to track various types of samples from the wellsite to their final destination; documenting and transmitting location details every step of the way. The use of RFID (Radio Frequency Identification) and GPS technologies, integrated with specially designed software, offer a near real-time view of sample location. The purpose of this service is to mitigate sample loss and increase audit efficiency.

**RocKlaw**
The RocKlaw, a lifting apparatus, is designed to reduce personal injury threats to personnel due to the elimination of manual lifting, bending, and twisting motions necessary when working with heavy core at wellsite. Safety features include:
- Designed for safety of the operator and the core
- Pneumatic — intrinsically safe
- Adjustable controls for lifting/lowering speed
- Brakes on all pivot points
- Reserve air tank in case air pressure is lost (enough to complete 1½ cycles)
- Park mode in case a drill or alarm goes off on the rig so the core can be secured for the duration
When your exploration or completion program calls for procuring core, you can count on the specialists at Weatherford Laboratories to retrieve, stabilize and transport it expertly. Our processes and procedures have been perfected over a period of nearly 30 years. Offshore, we stabilized record core runs in 1999 and again in 2007; we stabilized the record depth core in 2006; and we have stabilized, sampled, preserved and transported over 24,000 feet of core from deepwater prospects alone since 2000. Onshore, Weatherford Labs has been at the forefront of every play type – from traditional, conventional oil plays in sandstones and carbonates to unconventional plays like shale gas plays in the Marcellus, to Athabasca oil sands in Canada, to coalbed methane formations in Australia.

Throughout our history, Weatherford Laboratories has continuously expanded its capabilities, perfected its processes and enhanced its analyses to serve clients better. Superior customer service is one of our core principles. In fact, we measure our success by the longevity of client relationships, many of which extend over decades. At Weatherford Laboratories, we are committed to Higher Standards. We expect more from ourselves so you can expect more from us.
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