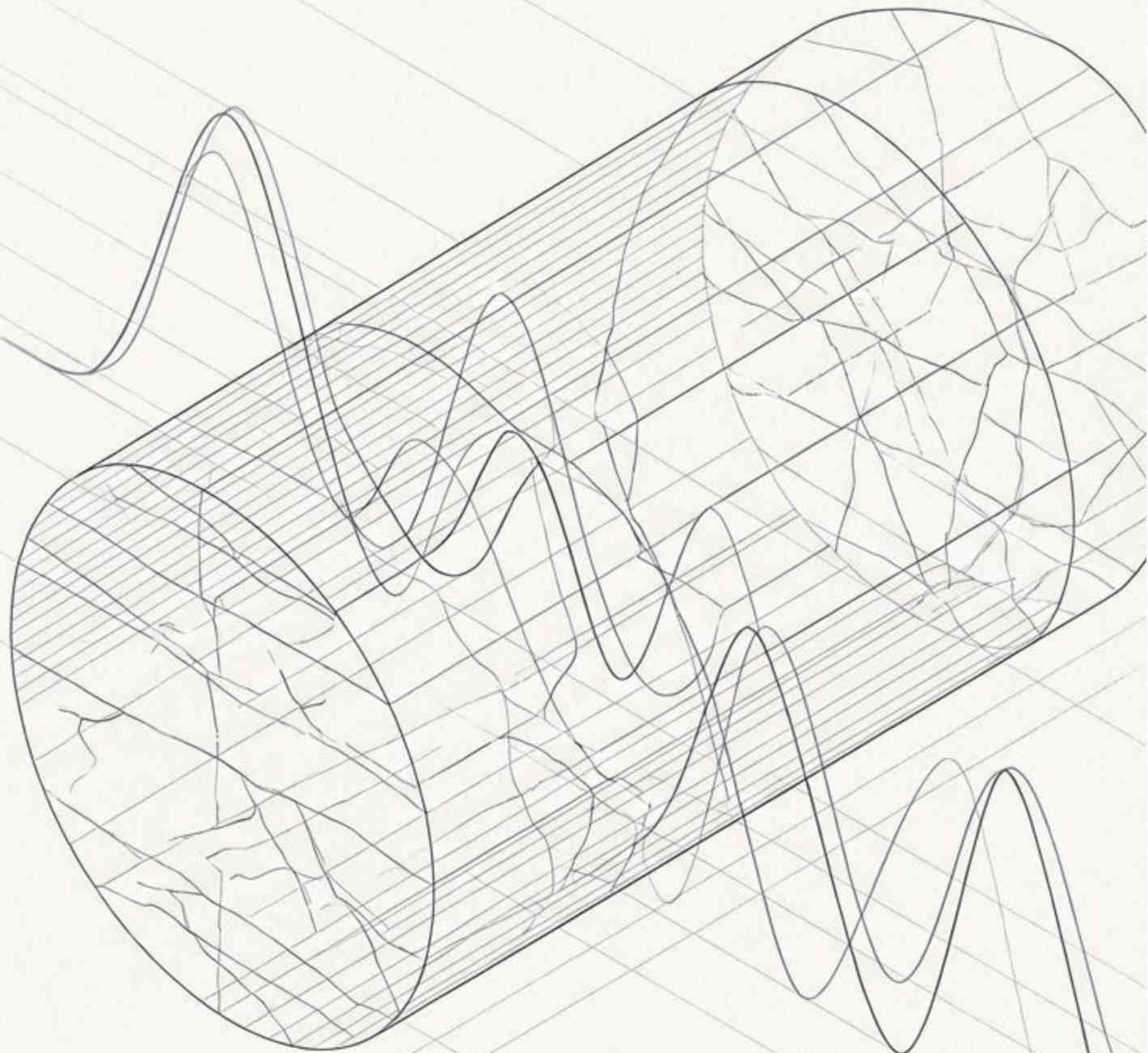


# Nondestructive Subsurface Diagnostic Diagnostics

Evaluating NMR Technology  
in Shale Oil and Gas Reservoirs

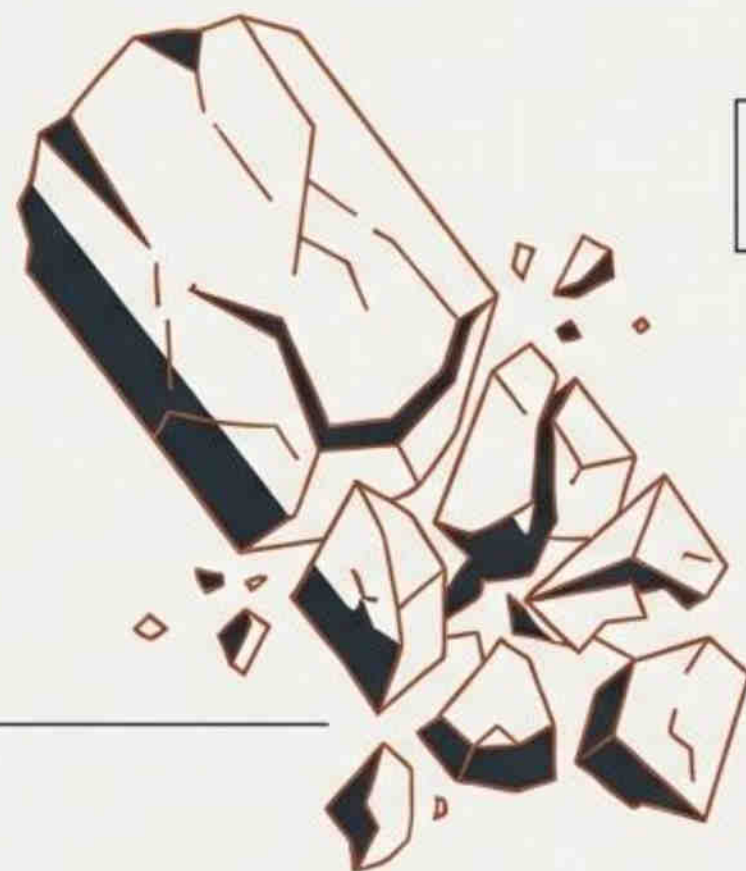
**Context:** A visual Research Brief based on the 2022 publication by SUN Zhongliang, LI Zhiming, SHEN Baojian, ZHU Qingmin, and LI Chuxiong.

**Institutions:** Wuxi Research Institute of Petroleum Geology, SINOPEC | State Key Laboratory of Shale Oil and Gas Enrichment Mechanisms.

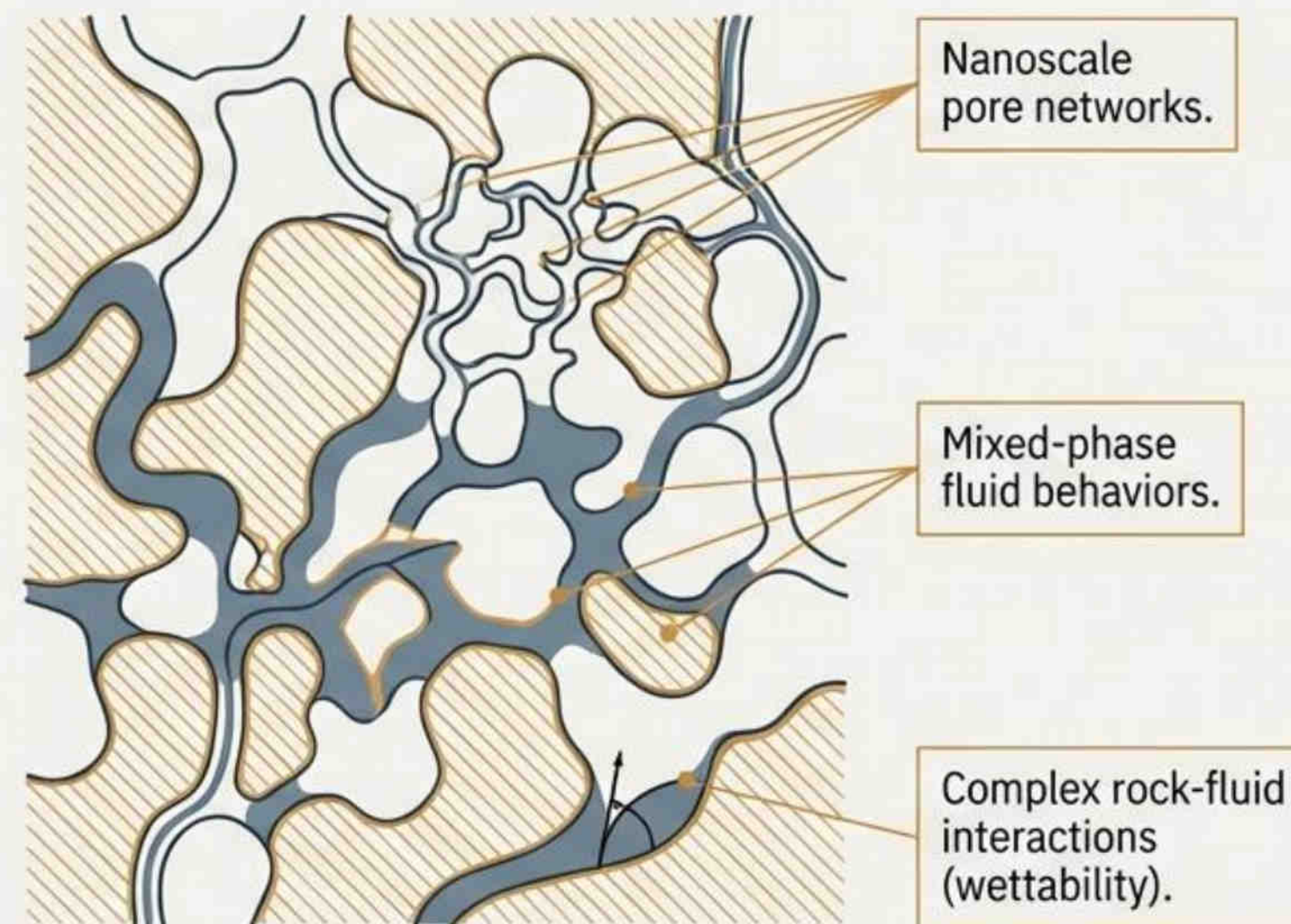


# The Unconventional Shale Bottleneck

The development of unconventional oil and gas business demands a higher resolution of reservoir understanding. Traditional evaluation methods struggle with the complex, micro-scale realities of shale formations.

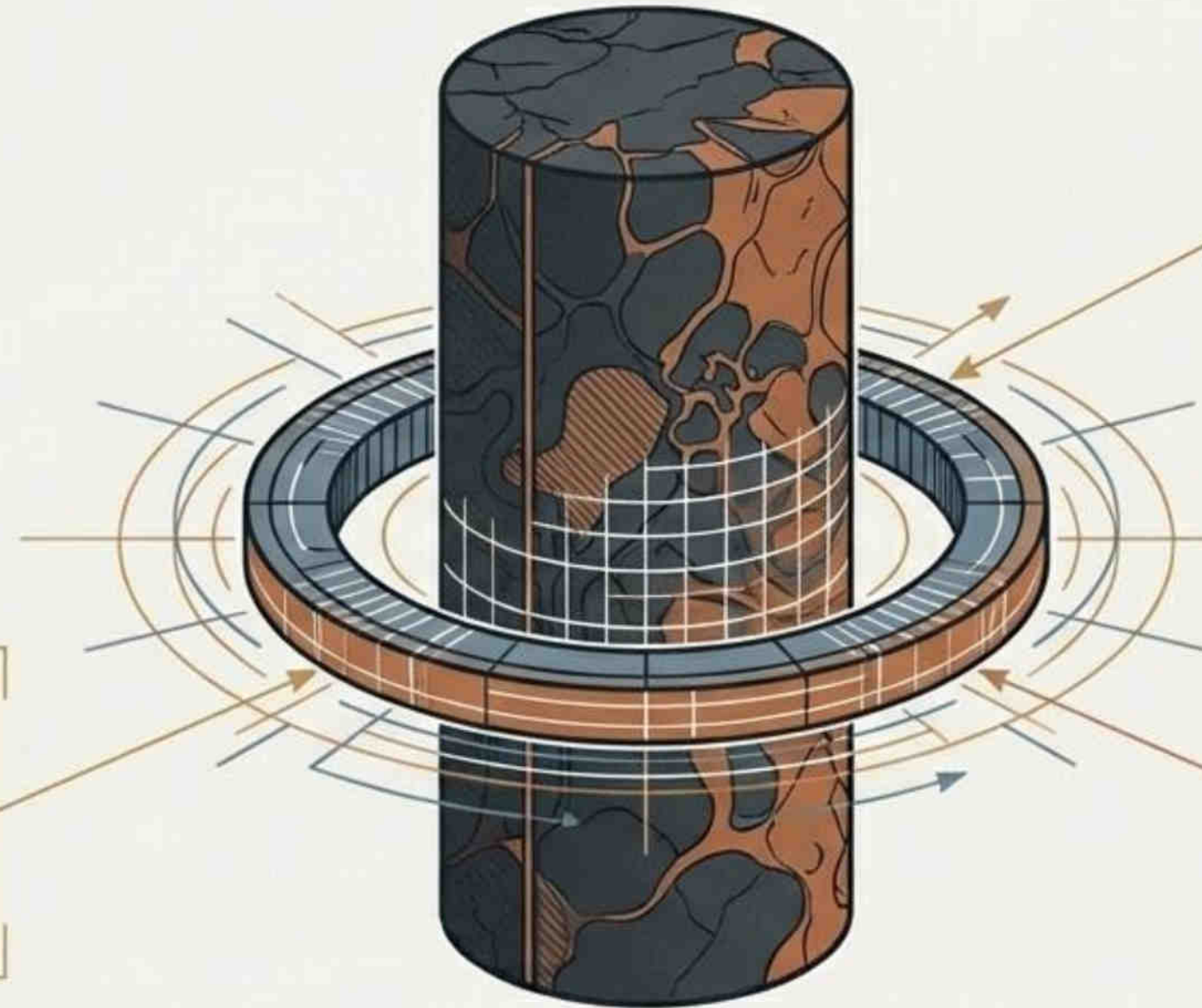


Traditional:  
Destructive & Limited



To unlock unconventional reservoirs, the industry requires an evaluation method that operates at the molecular level without altering the physical sample.

# The Nondestructive Lens: NMR Technology



## Nondestructive

Leaves the physical rock core intact for secondary testing and continuous baseline analysis.

## Sensitive

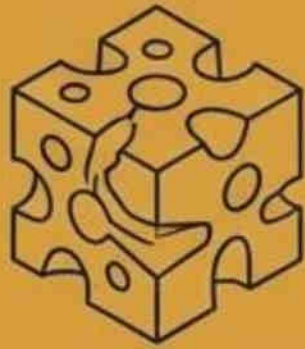
Captures sub-micron pore structures and complex fluid mobility with high fidelity.

## Fast

Accelerates the evaluation cycle compared to sequential laboratory core destruction.

Since the rise of the unconventional gas business, NMR technology has become one of the most important diagnostic methods for shale oil and gas reservoir evaluation, serving as a non-invasive 'MRI' for subterranean rock formations.

# The NMR Diagnostic Toolkit



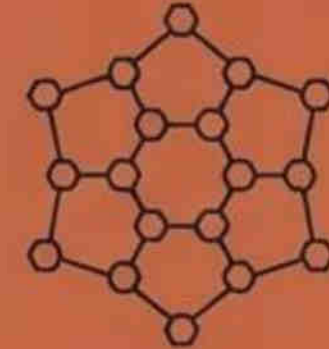
## Structural Architecture

- Characterizing shale porosity
- Determining organic vs. inorganic pores
- Analyzing pore connectivity
- Mapping fracture distribution



## Fluid Dynamics

- Describing water migration
- Methane adsorption and desorption
- Carbon dioxide displacement
- Tracking overall fluid mobility



## Material Composition

- Evaluating pore wettability
- Classifying fluid types
- Analyzing high-viscosity asphalt and kerogen
- Calculating oil-shale interface area

# Mapping Structural Architecture

NMR provides an integrated characterization of pore and fracture distribution, mapping the physical storage capacity of the reservoir.

## Total Porosity

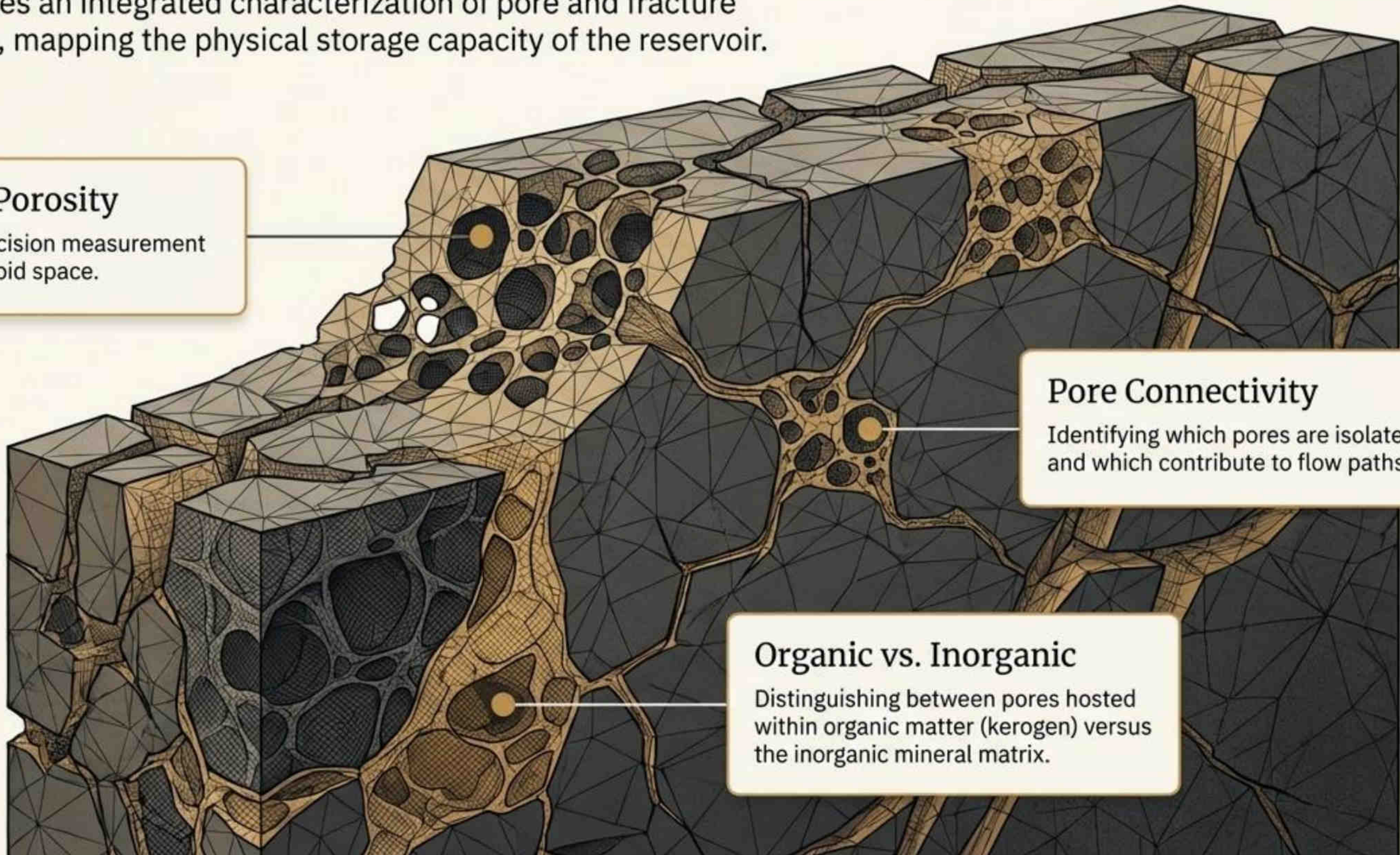
High-precision measurement of total void space.

## Pore Connectivity

Identifying which pores are isolated and which contribute to flow paths.

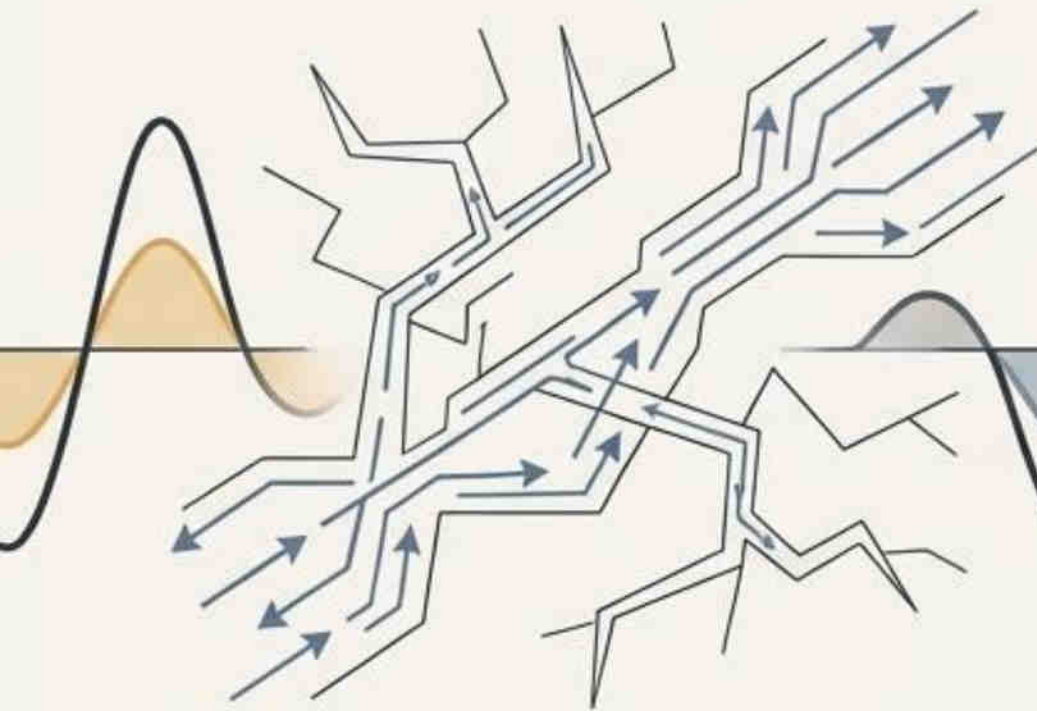
## Organic vs. Inorganic

Distinguishing between pores hosted within organic matter (kerogen) versus the inorganic mineral matrix.

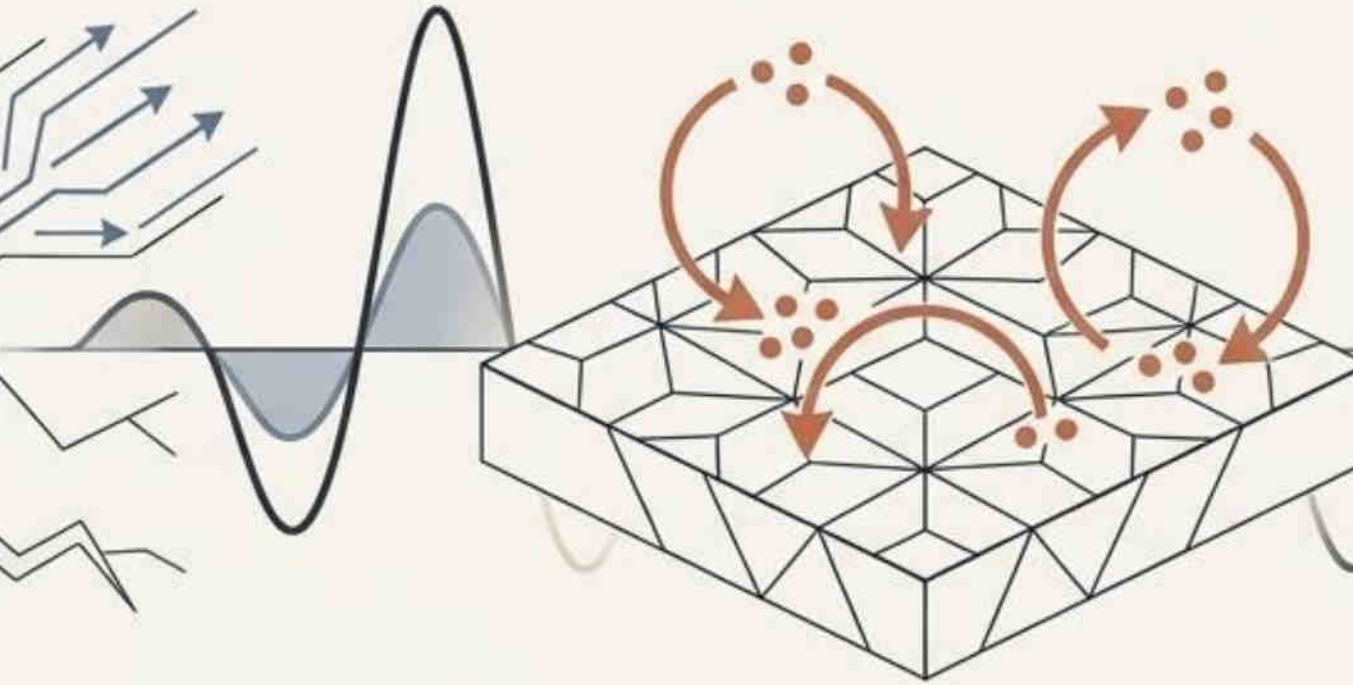


# Tracking Fluid Dynamics and Behavior

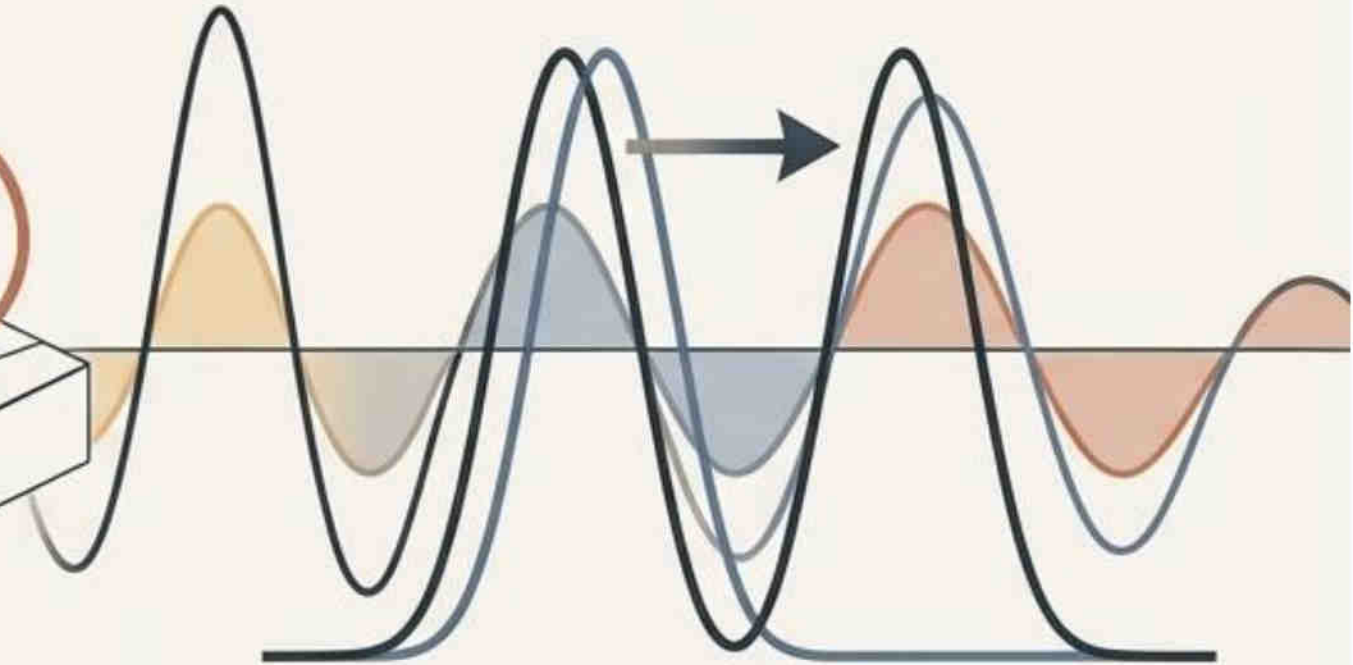
## 1. Mobility & Migration



## 2. Adsorption/Desorption



## 3. Displacement Mechanics



## 1. Mobility & Migration

Tracking fluid mobility and the specific pathways of water migration through the micro-fractures.





## 2. Adsorption/Desorption

Monitoring methane gas bonding to and releasing from the rock surface.

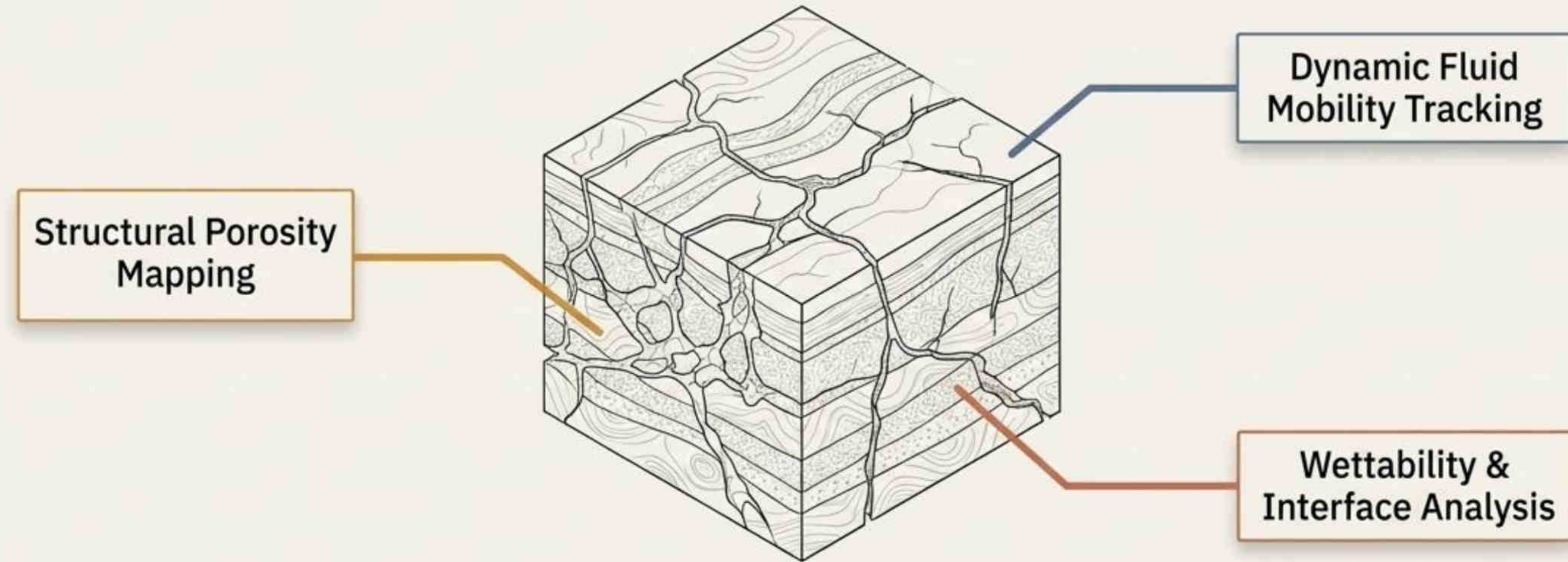
## 3. Displacement Mechanics

Carbon dioxide (CO2) displacing native fluids, tracked in real-time by shifting NMR signal peaks.

# Fluid & Interface Classification Matrix

	Mobile Water 	Methane Gas 	CO2 	Kerogen & Asphalt 
Migration Tracking	Highly effective	-	Tracks Displacement	-
Adsorption / Desorption	-	Primary Metric	-	-
Fluid Classification	Differentiates mobile	Differentiates mobile	-	Bound organic matter
	Accurately maps the complex boundary layer between the oil phase and the solid shale matrix.			

# The Full-Scale Integrated Characterization



**NMR is not just a tool for calculating porosity. It is the ONLY holistic method that unifies structural mapping, dynamic fluid tracking, and chemical composition data into a single, nondestructive evaluation model.**

*By synthesizing pore connectivity with wettability and fluid classification, geoscientists can predict total reservoir yield with unprecedented accuracy.*

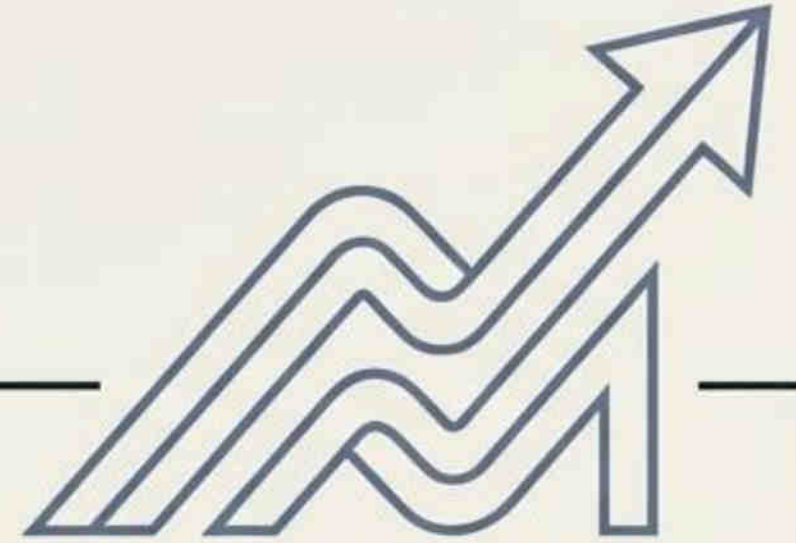
# The Future Horizon of NMR Evaluation

## Current Limitations

- Interpreting complex multi-phase fluid signals in ultra-low permeability shale requires advanced, often proprietary, inversion algorithms.
- Distinguishing signals between highly viscous asphalt and solid kerogen remains a frontier challenge.

## Development Trends

- Transitioning from lab-based core analysis to advanced, continuous downhole logging tools.
- Enhanced multi-dimensional NMR (T1-T2 mapping) for sharper fluid classification.
- Integration with other diagnostic modalities for a hybrid geophysics approach.



# Research Impact & Engagement

## Citation Velocity

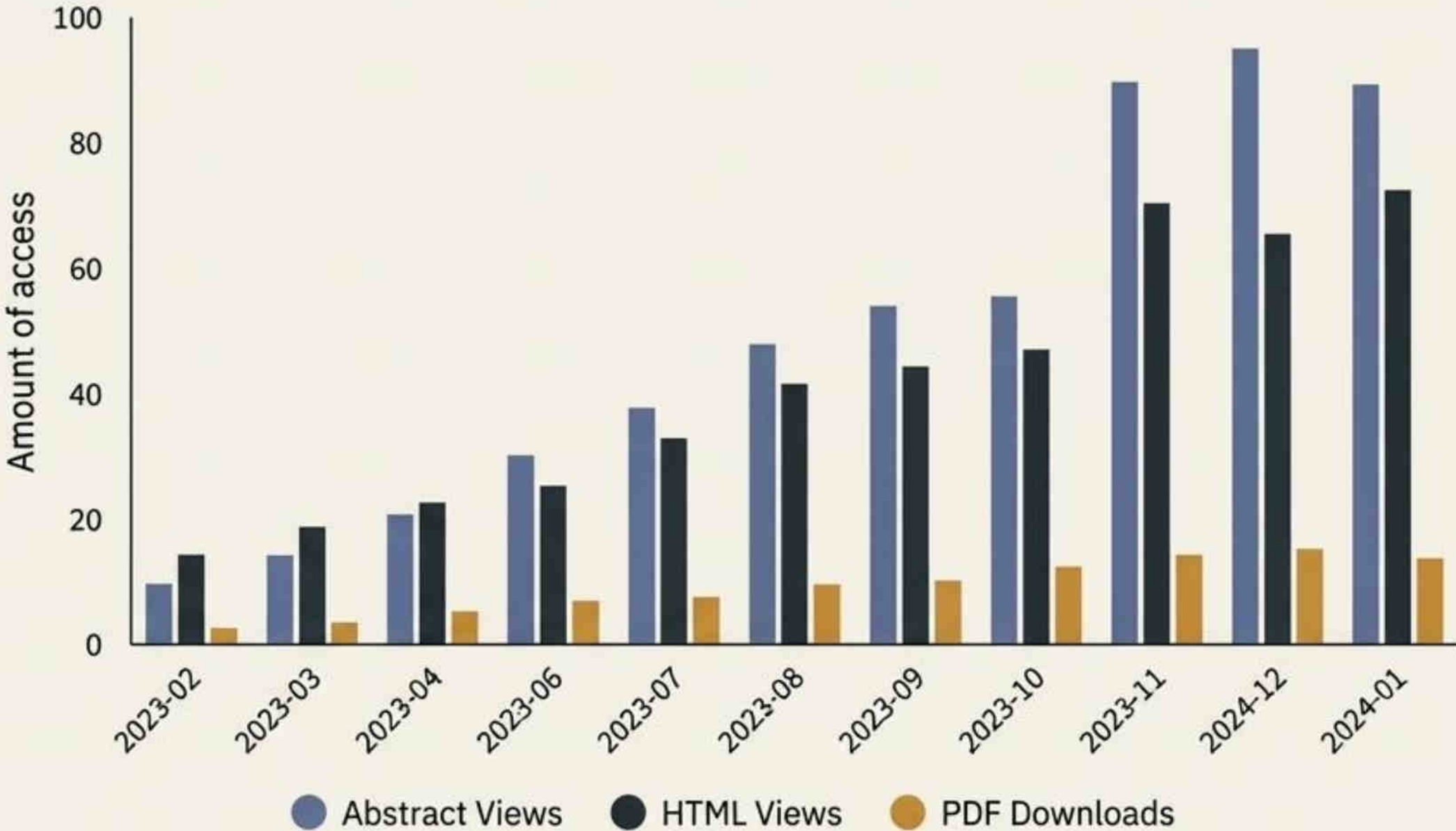
**13 Total Citations**

(7 Periodical, 6 Other), demonstrating rapid integration into subsequent geoscientific research.

## Engagement Takeaway

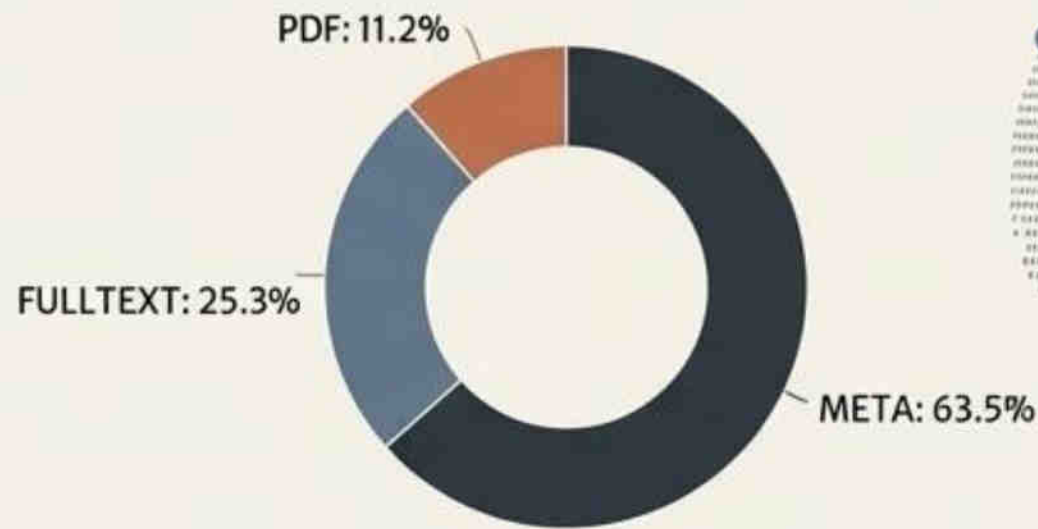
The data shows a massive spike in sustained academic interest throughout late 2023 and early 2024, indicating the methodology's growing relevance to field operations.

### Abstract Views, HTML Views, PDF Downloads Statistics



# Global Reach & Application

## Access Class Distribution



## Geographic Footprint

- **Primary Hubs:** Beijing (9.1%), Jining (7.5%), Chengdu, Xi'an, and Karamay—tracking closely with major Asian unconventional shale development zones.
- **International Nodes:** Connections to researchers in Seattle, Tulsa, and Kyoto, proving the cross-border necessity of advanced NMR diagnostics.

**The global distribution of this research underscores a universal industry pivot: the future of shale evaluation relies on high-resolution, nondestructive diagnostic technologies.**

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