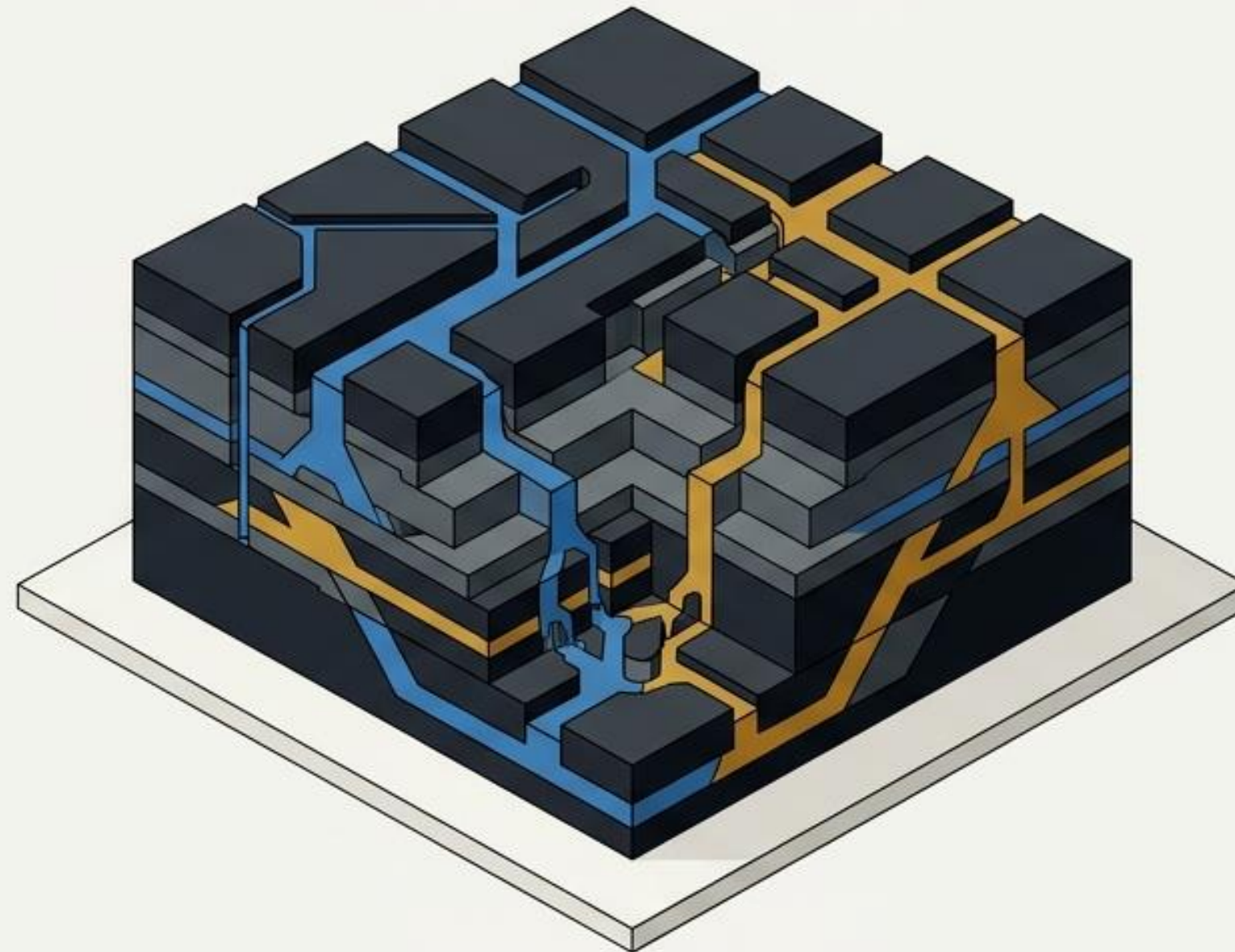
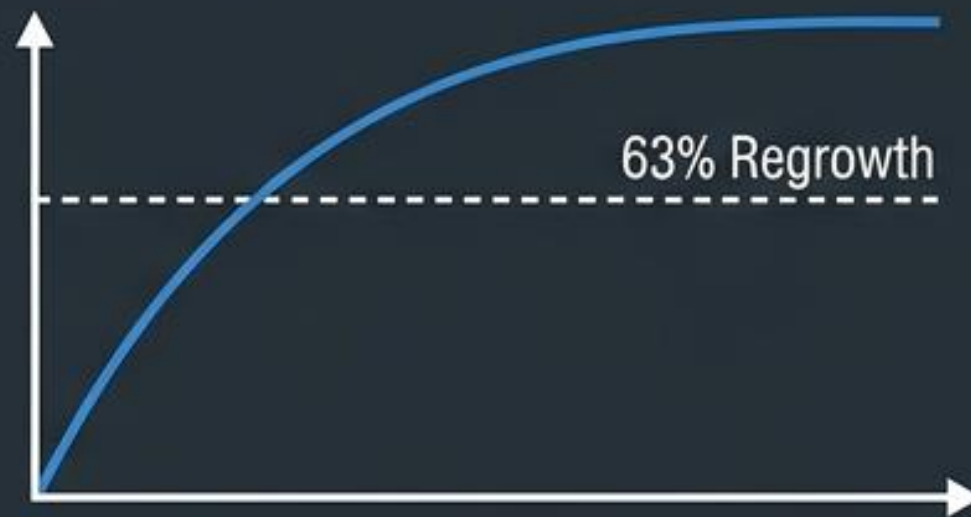
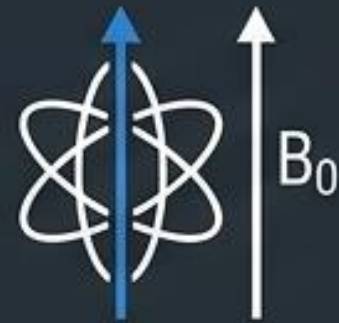


# Illuminating the Invisible



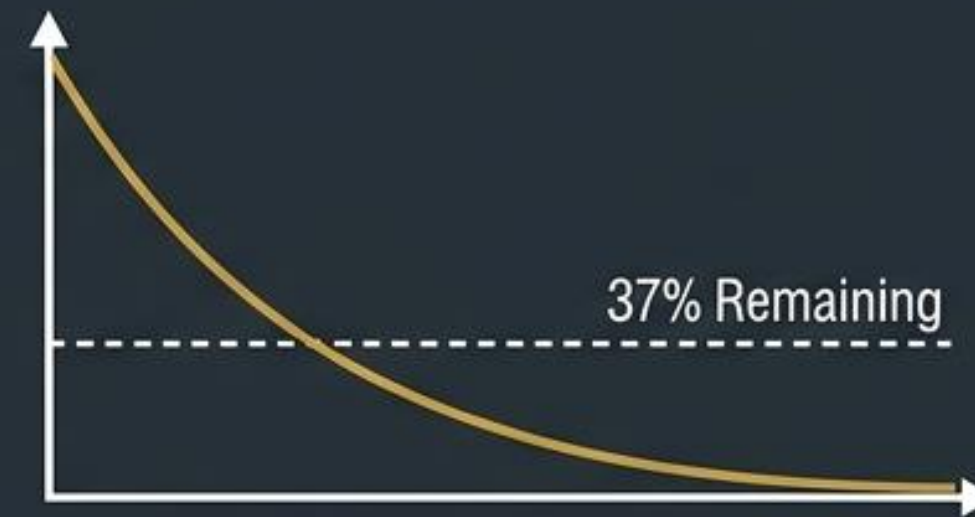
Unlocking bypassed hydrocarbons in mature fields using Remote Sensing Nuclear Magnetic Resonance (RSS-NMR)

# The Quantum Mechanics of Hydrogen Relaxation



## T1: Longitudinal Relaxation

The time required for hydrogen magnetization to regain 63% of its initial equilibrium. Energy is transferred to the molecular environment (the lattice).

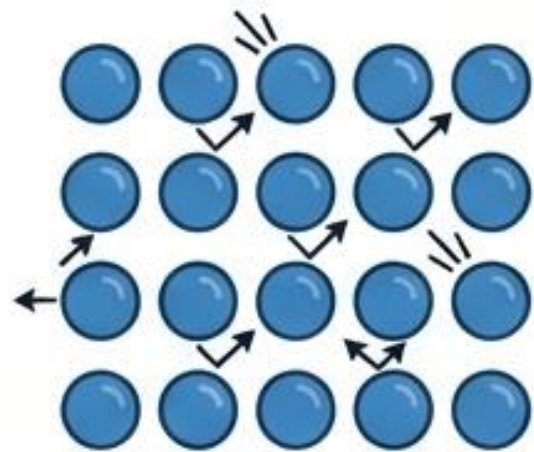


## T2: Transversal Relaxation

The time required for transversal magnetization to decay to 37% due to spin-spin interactions. T2 is always shorter than T1 and directly highlights fluid properties.

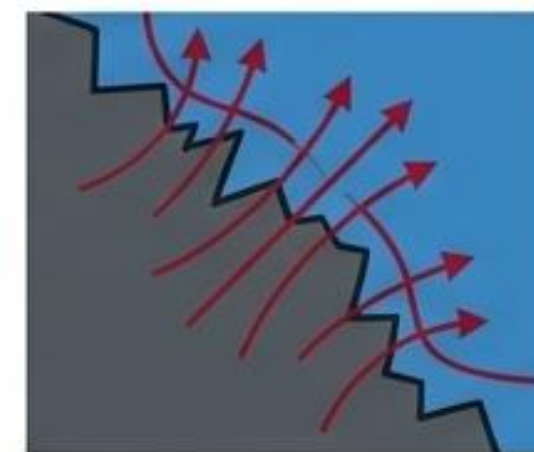
# The Reality of Reservoir Inhomogeneity

$$\frac{1}{T_2^*} = \frac{1}{T_2} + \frac{1}{T_{2(\text{inhomogeneous})}}$$



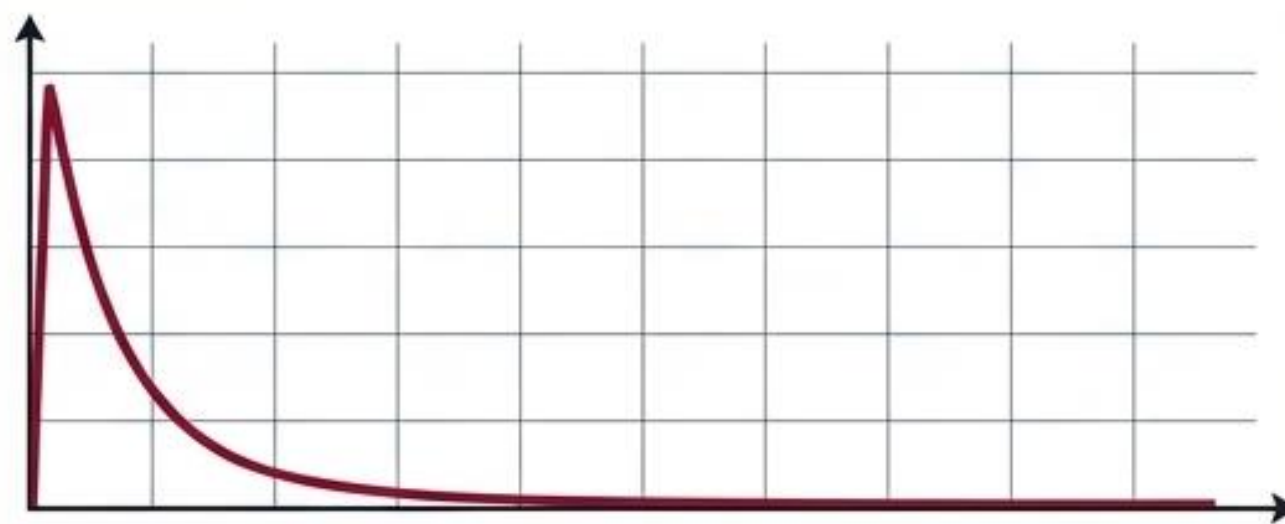
## True Relaxation

Driven by random molecular collisions and fluid properties.



## Magnetic Interference

Accelerated phase loss caused by spatial variations in porosity, permeability, and magnetic susceptibility at the rock-fluid interface.



## Effective Relaxation ( $T_2^*$ )

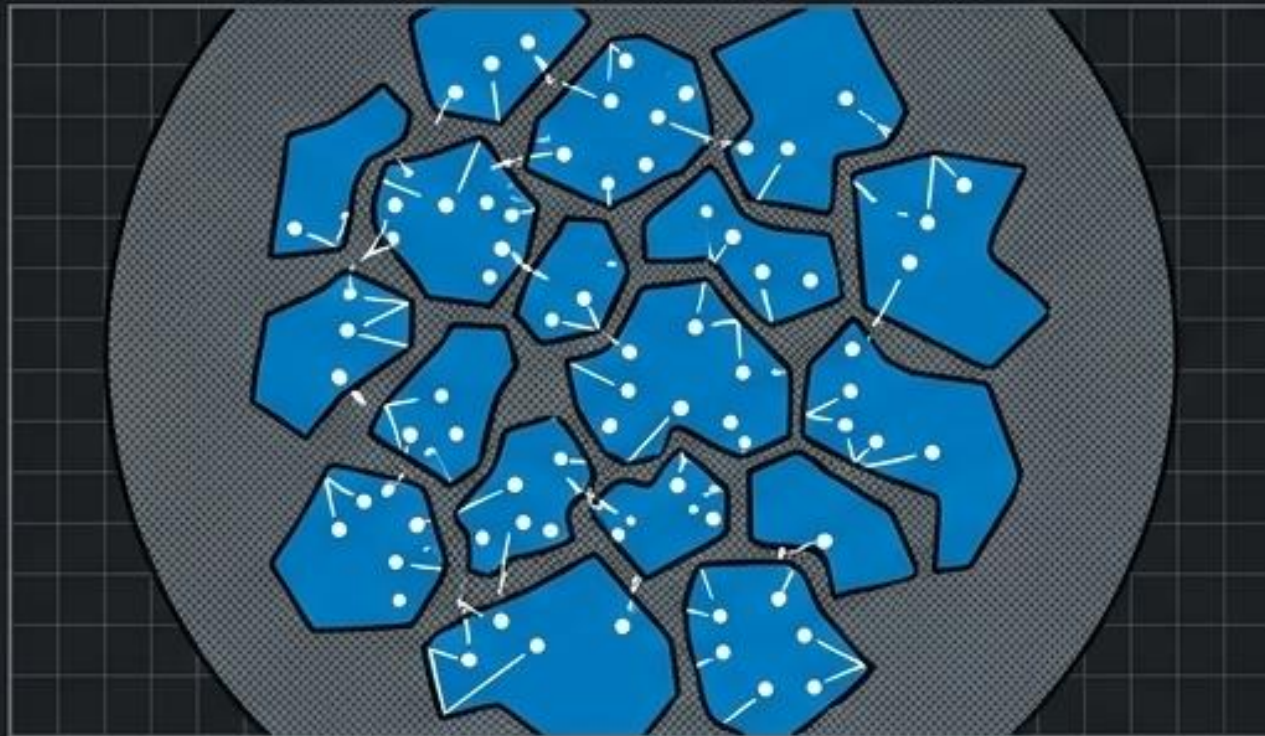
Static dephasing that masks the true fluid signal. This interference can be reversed and compensated using Spin Echo pulsing sequences.

# The Mechanism of Surface Relaxation

$$\frac{1}{T_2} \approx \rho_2 \cdot \left( \frac{S}{V} \right)$$

$\rho_2$  = Surface Relaxivity |  $S$  = Pore Surface Area |  $V$  = Pore Volume

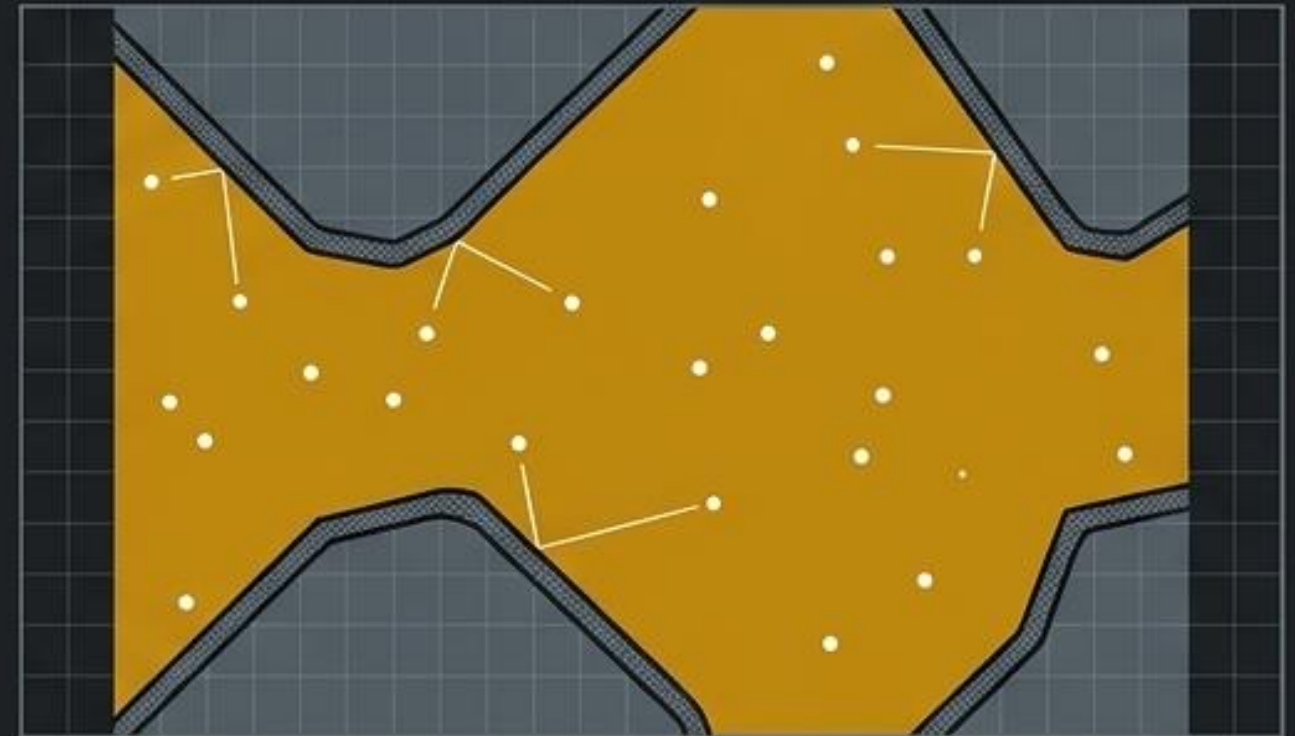
## High Surface-to-Volume Ratio



Short T2 Signal

Represents capillary-bound water permanently trapped in clays and micropores. Non-productive.

## Low Surface-to-Volume Ratio



Long T2 Signal

Represents free and mobile fluids (displaceable water, light oil, gas). The target 'sweet spots' for extraction.

# Diagnostic NMR Signatures of Reservoir Fluids

Fluid Type	T1 Time	T2 Time	T1/T2 Ratio	Viscosity & Mobility
<b>Free Water</b>	Long (~ 2-3 s)	Long (~ 2-3 s)	$\approx 1$	Low viscosity, highly mobile
<b>Bound Water (Clays)</b>	Very Short (< 10 ms)	Very Short (< 10 ms)	$\approx 1$	Immobile (matrix-bound)
<b>Light Oil</b>	Medium to Long	Medium to Long	$\approx 1$ to 2	Fluid, high commercial value
<b>Heavy Oil / Bitumen</b>	Short	Extremely Short	Very High (> 10)	Highly viscous, rapid relaxation
<b>Natural Gas</b>	Very Long (3-5 s)	Short (via diffusion)*	High	Extremely high diffusivity

\* Magnetic gradient diffusion severely reduces gas T2, providing a foolproof discrimination criterion against water.

# RSS-NMR: Remote Sensing Systems Integration

## Direct Fluid Resonance

Targets hydrogen nuclei directly. Measures physical fluid response rather than inferring presence through indirect rock resistivity.



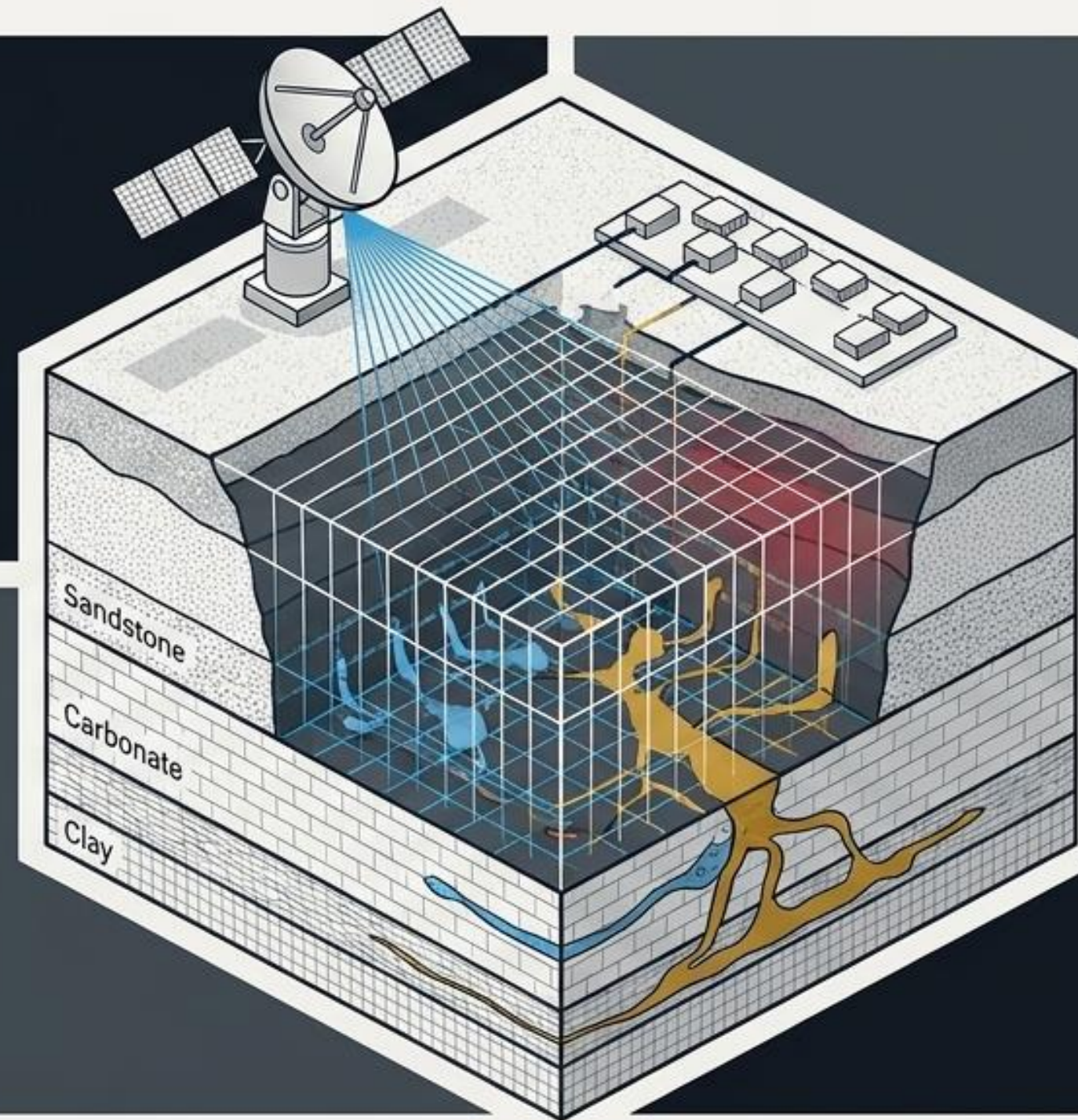
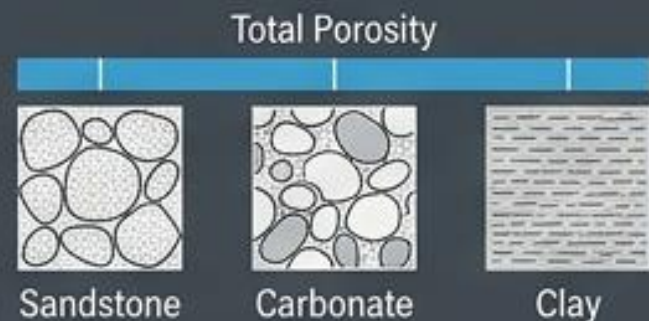
## Fluid Differentiation

Explicitly separates mobile hydrocarbons from capillary-bound water based on distinct relaxation decay times.



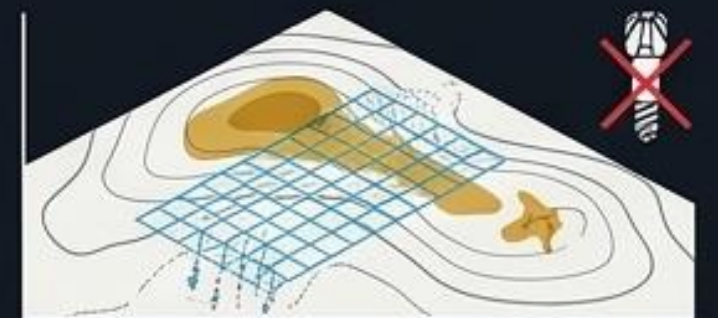
## Lithology Independence

Measures total and effective porosity entirely independent of the surrounding rock matrix (sandstone, carbonate, or clay).



## Satellite Remote Scanning

Projects resonant variations at scale, defining geometric contours and depths of bypassed anomalies before a single drill bit touches the ground.



# The Low Resistivity Pay (LRP) Trap

## Classical Electrical Logging / Archie's Law



### Measures Total Fluid Conductivity

Fails in complex lithologies by confusing conductive clay-bound water with fully saturated aquifers.

Consistently generates false negatives, leading to abandonment.

## NMR Logging



### Acts as a Magnetic Sieve

Isolates and discards the immobile bound-water signal, revealing the exact volume of hidden, exploitable mobile hydrocarbons.

# The Glaucconite Trap: Berkin Basin & Gulf of Mexico

## The Diagnostic Failure:

Classical electrical tools recorded collapsing resistivity below 1 to 2 Ohm.m.

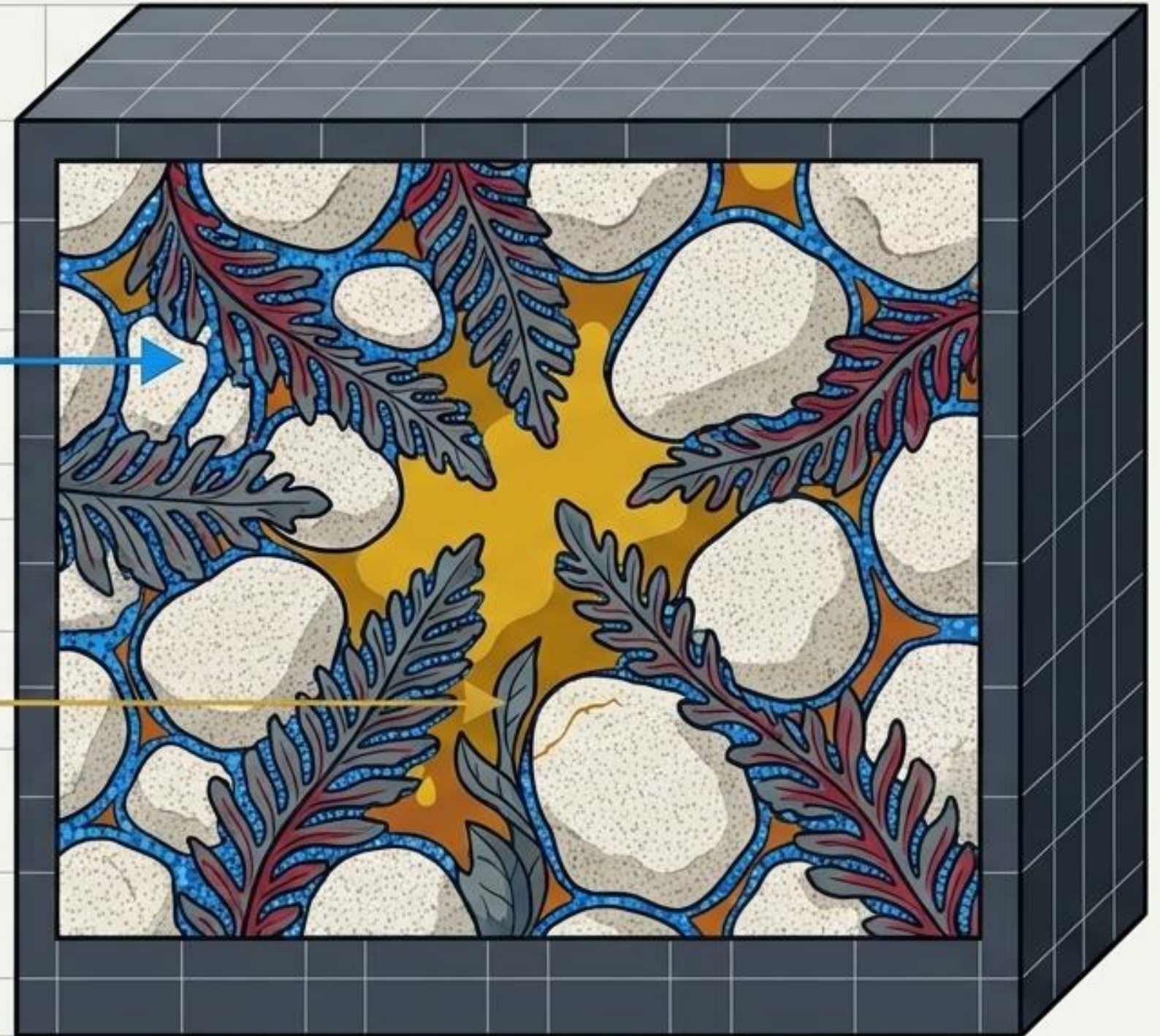
## The Archie Assumption:

Mathematical models concluded the rock was saturated with 60% to 70% salt water.

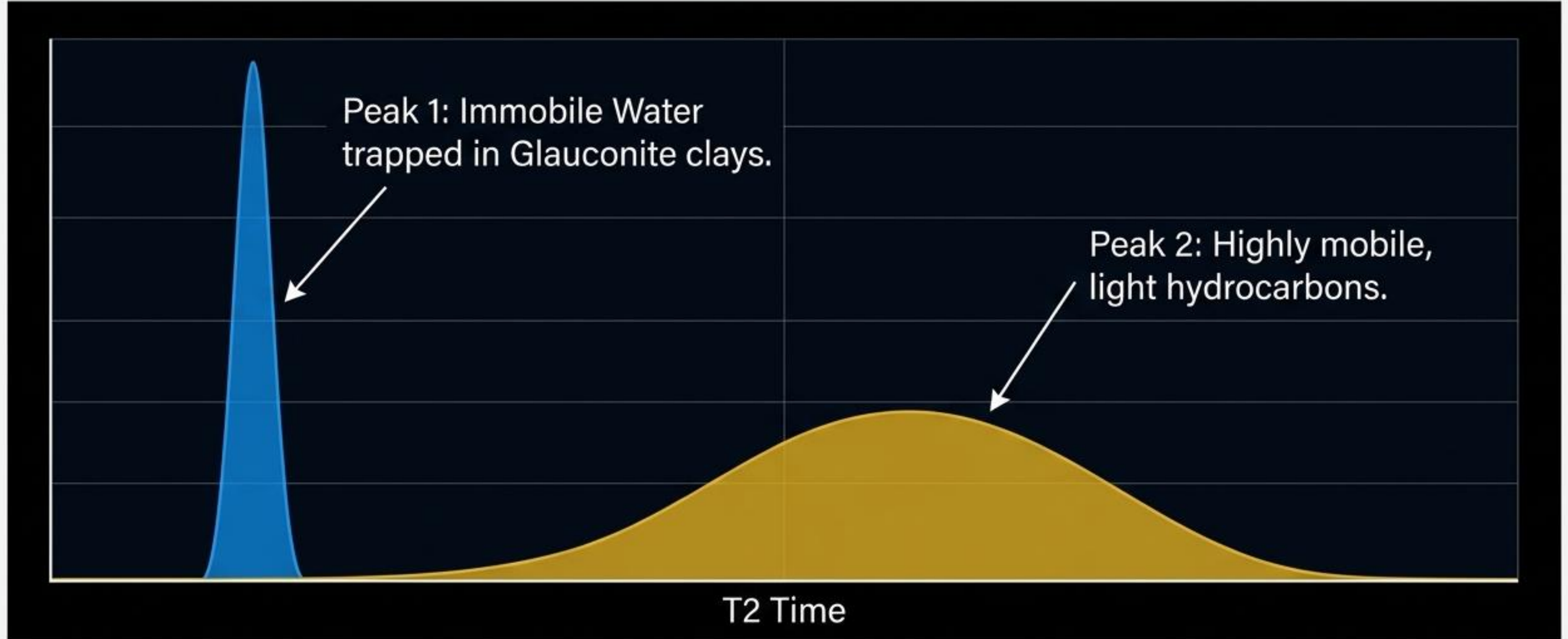
Zones were classified as sterile aquifers and abandoned.

Micropores trap massive networks of conductive bound water (creating false electrical signals).

Central macropores hold highly mobile, exploitable oil.



# Revealing Invisible Oil in Fine Sands



**The Commercial Outcome:** By proving the conductive water was strictly immobile, operators perforated the 'abandoned' zones. The wells produced 100% water-free hydrocarbons, recovering millions of bypassed barrels.

# The Bimodal Carbonate Trap: Shuaiba Formation

Carbonate formations account for nearly 80% of Middle Eastern oil production.

## The Diagnostic Failure:

Classical resistivity collapsed below 0.5 to 1 Ohm.m.

Archie's Law models calculated theoretical water saturation ( $S_w$ ) at 80% to 90%.

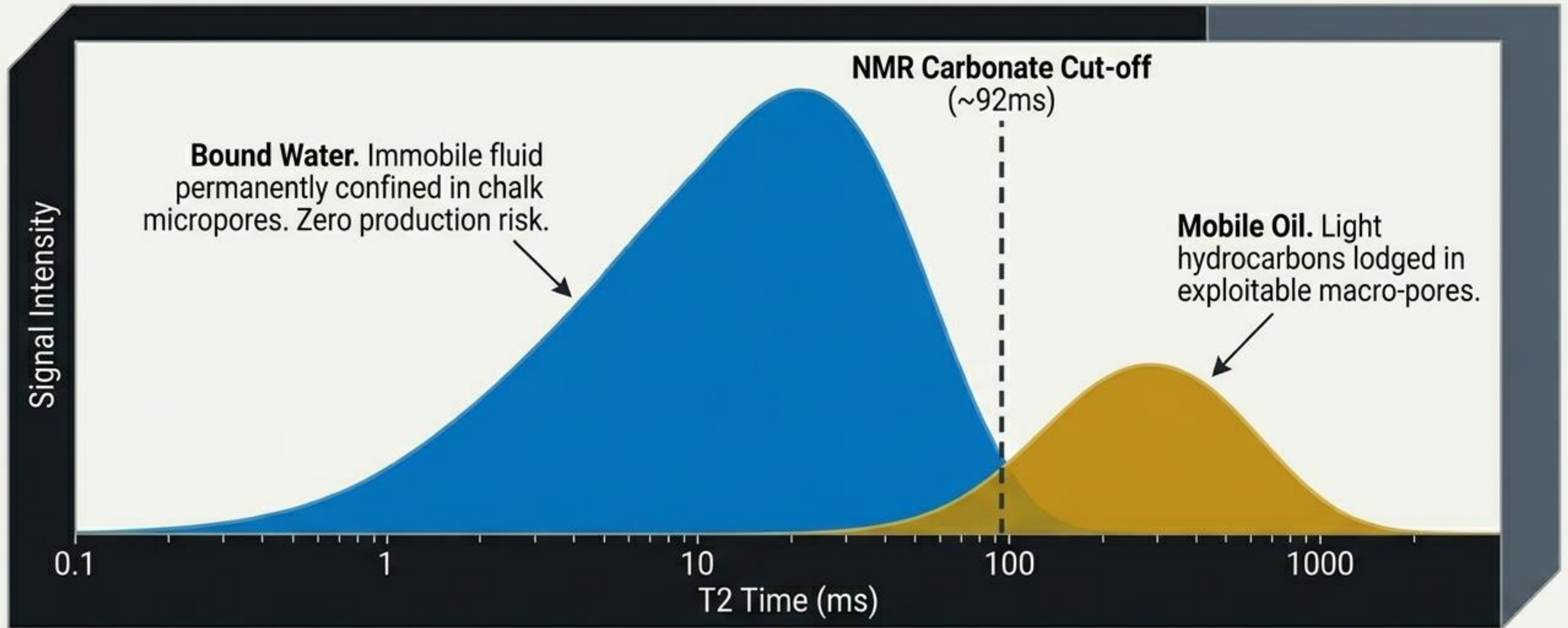
Categorized as non-commercial.



Macro-interstitial cavities hold trapped, mobile oil.

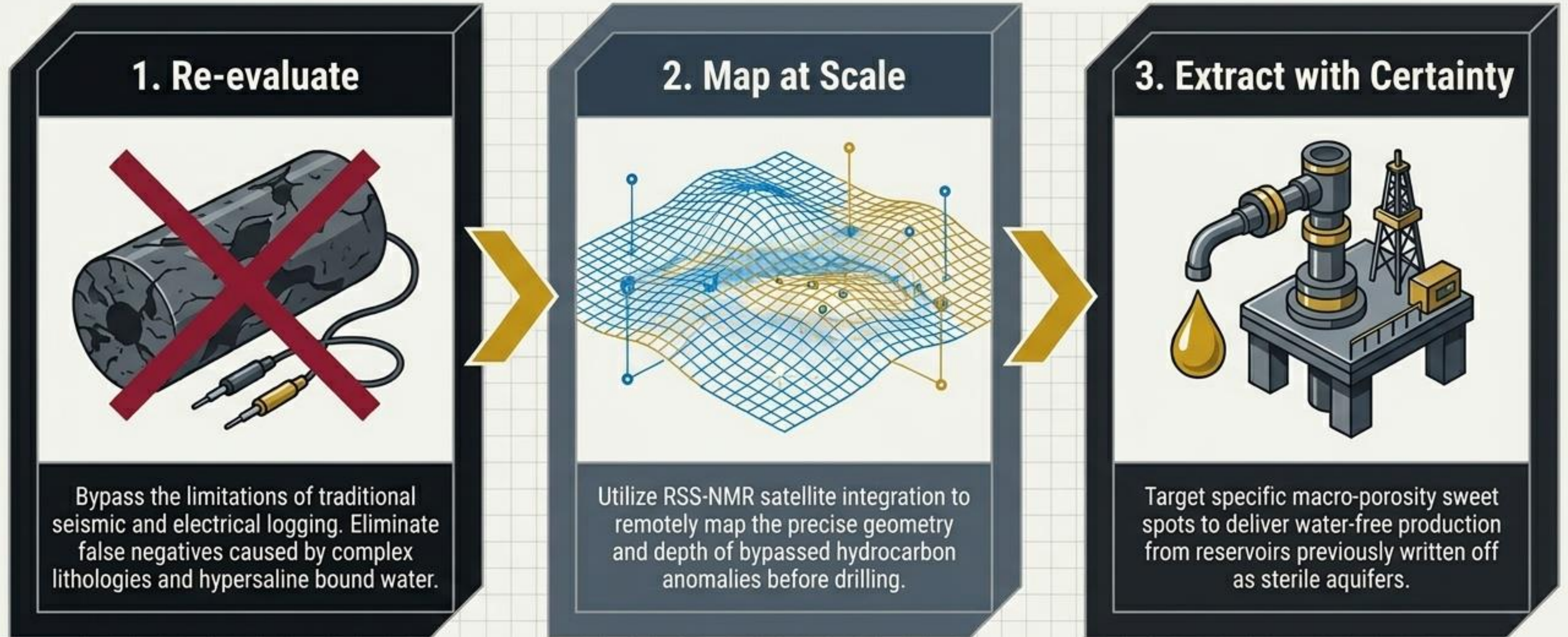
Micro-porous matrix traps massive volumes of hypersaline water, creating an electrical highway.

# The 92ms Cut-off: Redefining Shuaiba Reserves



**Outcome:** Proved free water saturation was negligible. Activated wells produced clean, high-flow oil with zero water trace, massively upgrading giant field reserves.

# Redefining the Lifespan of Mature Fields



**Transforming the invisible into the producible.**



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Срок действия с по

Applicant/Manufacturer: Poisk Group LLC, 299640, Russia, Sevastopol,  
st. Khristofora, 143

Заявитель/Производитель: ООО «ГРУППА ПОИСК», 299640, Россия, г. Севастополь,  
ул. Христофора, в. 143

Products: Methodology for calculating predicted ore reserves in deep-lying deposits, using  
the parameters of ore bodies obtained using remote geospace methods of geological exploration  
and field geophysical equipment of the Poisk complex (МЕТОДИКА для определения запасов  
продукции: Методика расчета прогнозируемых запасов руд в глубинных залежах, с  
использованием параметров рудных тел, полученных с помощью дистанционных  
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ООО «ГРУППА ПОИСК» № 105 от 07.10.2015 на соответствие «Надежность» системы  
добровольной сертификации «Сделано в России».

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A.V. Solodov  
А.В. Солодов

002647

СИСТЕМА ДОБРОВОЛЬНОЙ СЕРТИФИКАЦИИ «ПРИНП-ЭКСПЕРТ»  
Reg. № РОСС RU.31685.047903 от 14.11.2016 г.



## СЕРТИФИКАТ СООТВЕТСТВИЯ

№ РОСС RU.31685.100066

Срок действия с 18.09.2021 по 18.09.2028

№ 0057630

ОБЛАСТЬ СЕРТИФИКАЦИИ: РОСС RU.31685.1100119

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использованием параметров рудных тел, полученных с помощью дистанционных  
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России».

код ЦС  
01.11.11

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ИЗГОТОВИТЕЛЬ: Общество с ограниченной ответственностью «Группа Поиск», ОГРН: 11000000000, ИНН:  
7800040000, КПП: 7800000000, адрес: 299640, РОССИЯ, город Севастополь, ул. Христофора, д. 143, телефон:  
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НА ОСНОВАНИИ

Протокола испытаний № 0057630 от 18.09.2021 года, выданного Национальным лабораторией «Тестирование»  
(адрес: РОСС RU.31685.1100119)



ПОДПИСАНИЕ ИЛИ ПЕЧАТЪЮ  
Сфера применения: Т1



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Зеленчук

А.И. Фомин  
руководитель центра  
А.И. Никитин  
руководитель центра

Сертификат не признается при применении системы сертификации

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# VERSATILITY OF APPLICATION



## HYDROCARBONS

Oil  
Gas  
Condensed



## PRECIOUS METALS AND BASES

Gold  
Copper  
Lithium  
Nickel



## STRATEGIC

Uranium  
Diamonds  
Coal



## WATER RESOURCES

Drinking Water  
Underground  
Geothermal

The technology eliminates false positives by identifying the specific type of mineral.