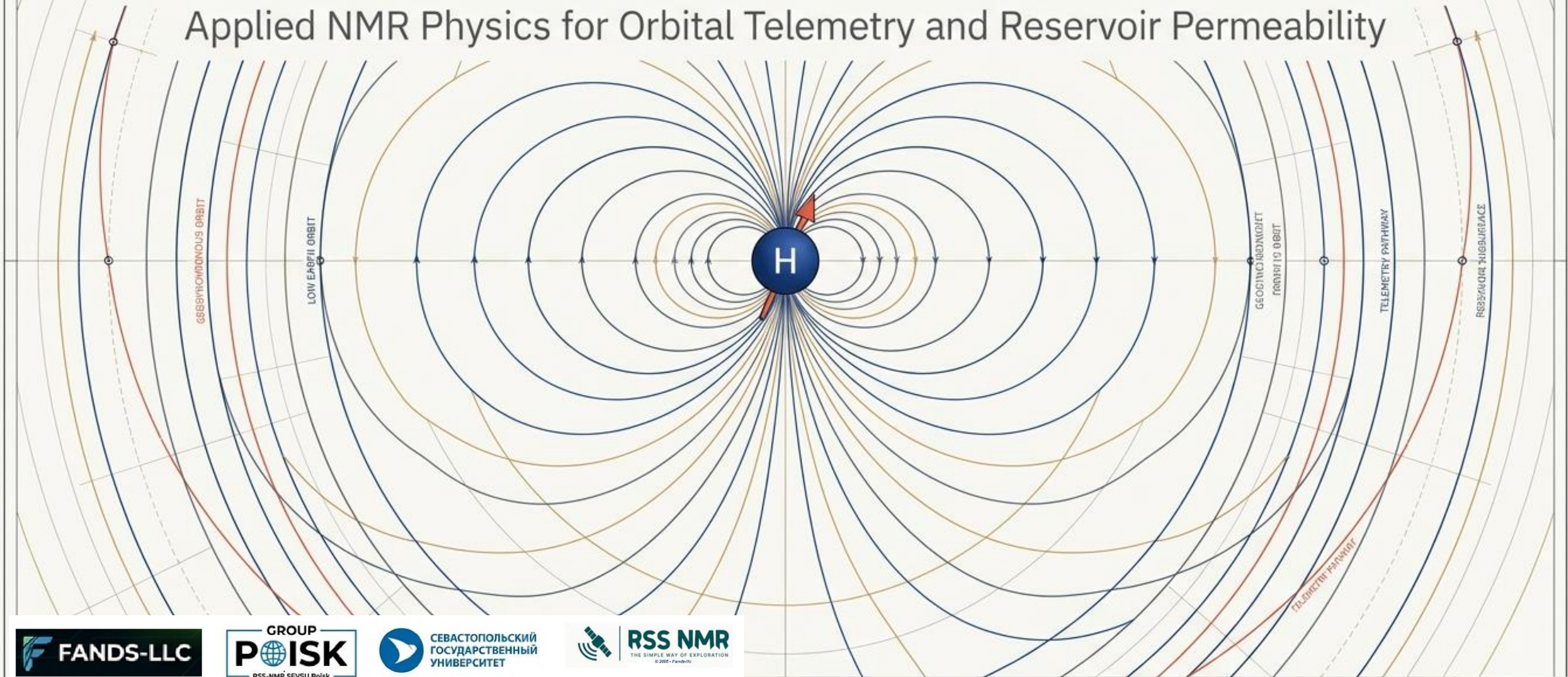


Resonance & Reservoirs: From Spin to Satellite

Applied NMR Physics for Orbital Telemetry and Reservoir Permeability



The Scales of Exploration

Atomic Scale (The Proton)

Hydrogen relaxation dynamics (T1/T2) under magnetic fields.

The diagram shows a proton (a small sphere) with a magnetic field B_0 passing through it. Concentric circles represent the magnetic field lines. The radius of these circles is labeled as 10^{-15} m. Below the diagram are two graphs: the first shows the T1 relaxation curve, and the second shows the T2 relaxation curve. Both graphs have a vertical axis labeled with a greater-than sign (>) and a horizontal axis labeled with T1 and T2 respectively.

Granular Scale (Rock Matrix)

Surface relaxivity, pore dynamics, and the pyrite anomaly in sandstones vs. carbonates.

The diagram shows a cross-section of a rock matrix with various grains. Labels include 'Sandstones carbonates', 'Pyrite crystals', and 'Pyrite'. A scale bar at the bottom indicates 'micrometers'. Below the diagram, there are two text blocks: 'Sandstones Surface s relaxivity, for relaxation behavior' and 'Carbonates Surface s relaxivity, for relaxation behavior'.

Reservoir Scale (Permeability)

Diagnostic models (Coates vs. SDR) to quantify fluid mobility.

The graph plots 'Permeability (mD)' on the top x-axis (0 to 30) and 'Permeability (mD)' on the bottom x-axis (0 to 120) against 'Depth' on the y-axis. Two curves are shown: a red curve for the 'Coates Model' and a blue curve for the 'SDR Model'. The Coates Model is labeled 'High = mobility' and the SDR Model is labeled 'High or Low fluid mobility'. To the right of the graph, there are three schematic diagrams of a reservoir showing 'Flow fluid saturation level' at different depths.

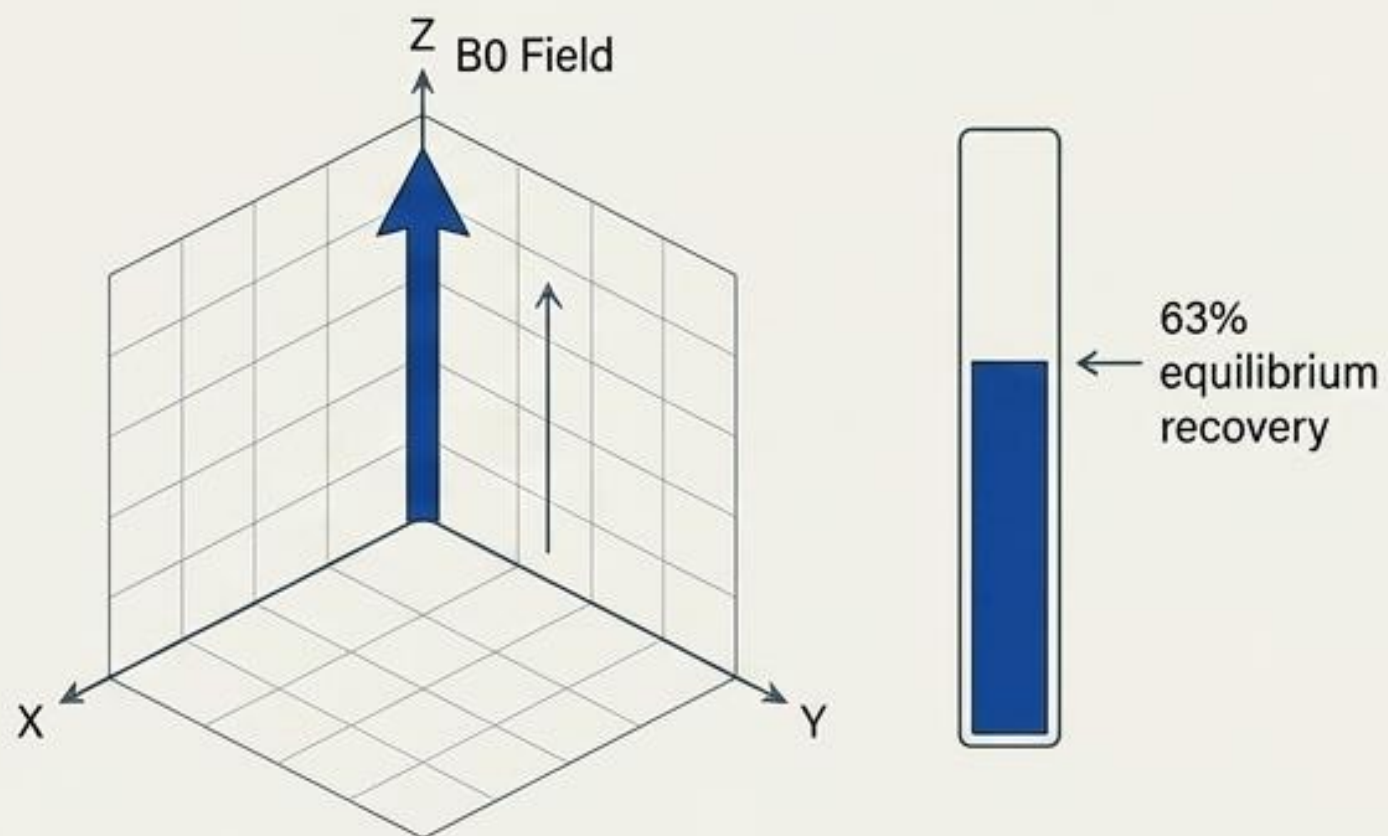
Planetary Scale (Orbital Survey)

RSS-NMR telemetry detecting fluid signatures from 7km above the surface.

The diagram shows a satellite in orbit with an 'Orbital path' indicated. A 'Telemetry cone of analyzing fluid signatures from' is shown as a cone extending from the satellite down to the Earth's surface. The distance from the satellite to the surface is labeled as '7km'. Below the surface, there are several layers representing different geological formations. A label indicates 'Data - 0.00na 28th - 7 km frequency band'.

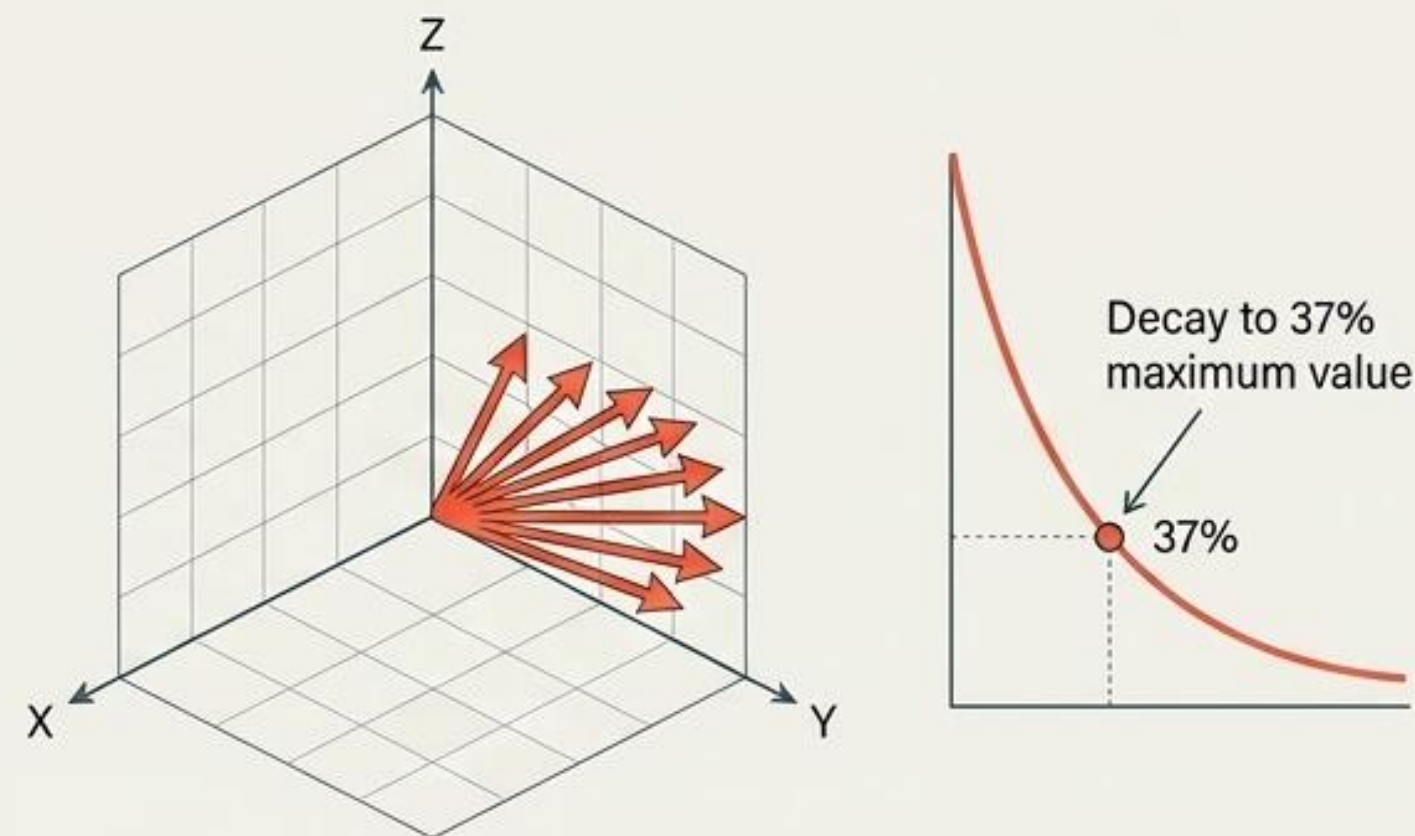
The Physics of Hydrogen Relaxation

T1 - Longitudinal Relaxation



Mechanism: Energy transfer to the molecular lattice
(Anatomical contrast, highly dependent on tissue/fluid type).

T2 - Transversal Relaxation

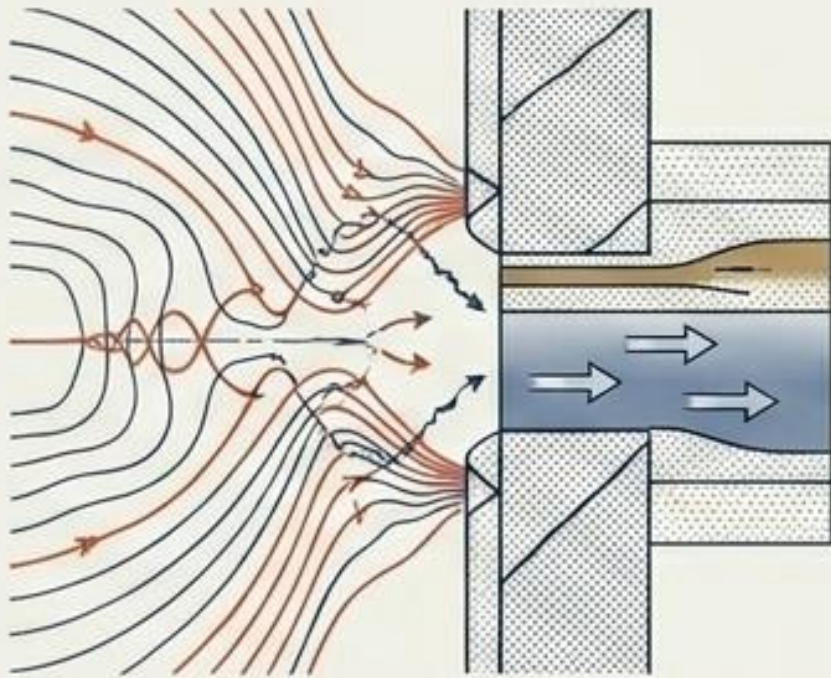


Mechanism: Spin-spin interactions and loss of phase coherence
(Fluid contrast).

Rule of Physics: T2 is always substantially shorter than T1.

The T2 vs. T2* Reality: Effective Relaxation

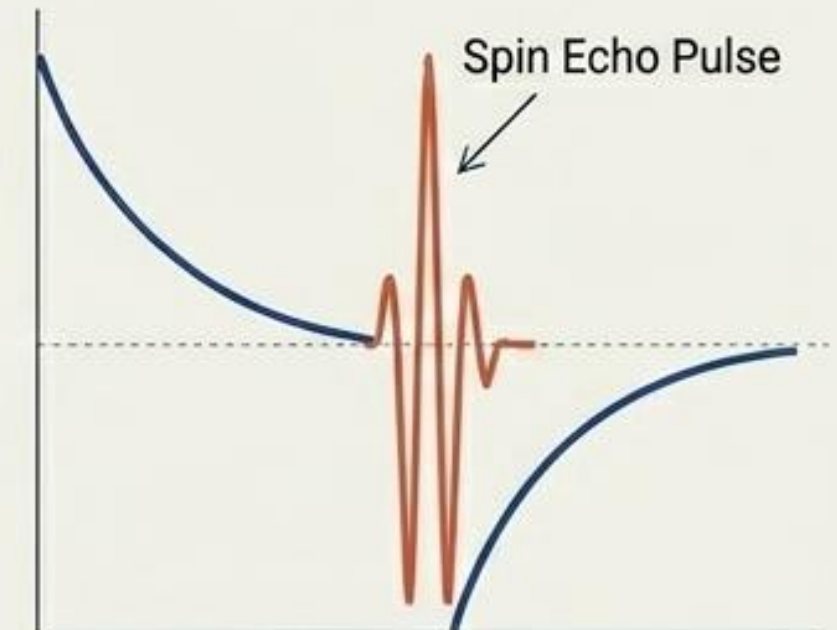
The Problem



Intrinsic field inhomogeneities (B0) and magnetic susceptibility variances accelerate proton dephasing beyond standard T2 limits.

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

The Solution

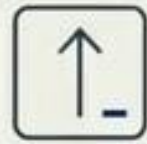


Because inhomogeneity is static, it is reversible. Applied recentering pulses (Spin Echo sequences) cancel this artifact to capture true T2.

Dynamic T2 Cut-Offs: The Matrix Comparison

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

Sandstone



Cut-off Threshold:
~33 ms (Short)



Surface Relaxivity (ρ_2):
High

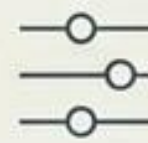


Mineralogy Context:
Contains clay minerals, iron oxides, and heavy metals with paramagnetic properties that accelerate proton relaxation on contact.

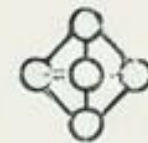
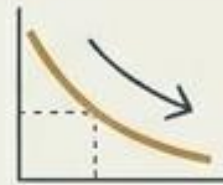
Carbonates



Cut-off Threshold:
~92 ms (Long)



Surface Relaxivity (ρ_2):
2x to 3x Lower

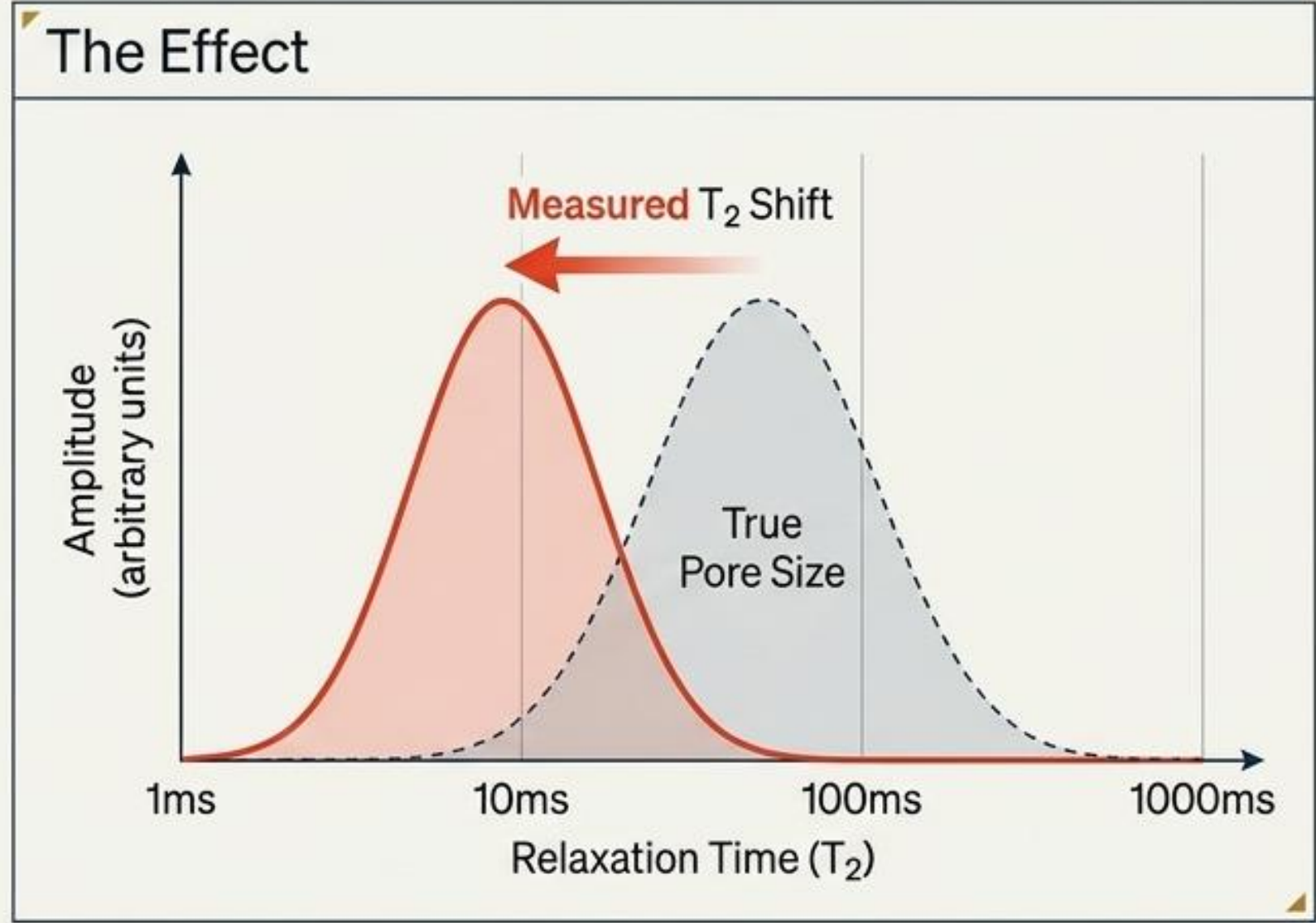
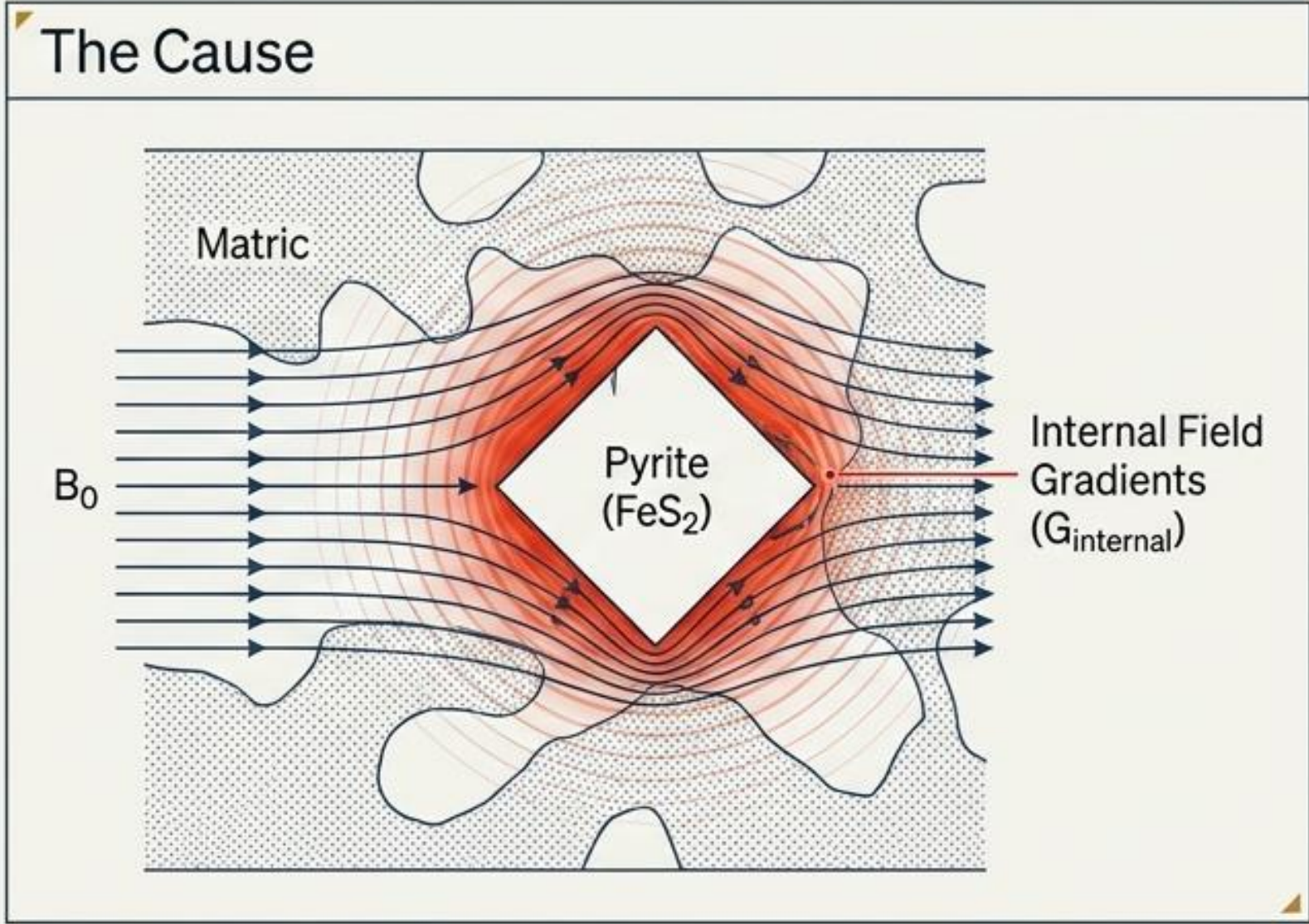


Mineralogy Context:
Pure matrices (calcite, dolomite) lacking paramagnetic centers, mechanically slowing transversal relaxation and shifting the cut-off boundary.

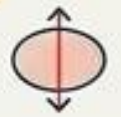
Diagnostic Note: The cut-off threshold hydrodynamically separates bound, non-productive water (microporosity) from free, mobile water (macroporosity).


The Pyrite Anomaly: Magnetic Susceptibility Distortion

$$\frac{1}{T_{2,\text{measured}}} = \frac{1}{T_{2,\text{surface}}} + \frac{1}{T_{2,\text{volume}}} + \frac{\gamma^2 \cdot G_{\text{internal}}^2 \cdot TE^2 \cdot D}{12}$$



 **Pore Shrinkage Illusion:** Misclassifies highly mobile, large pores as micropores.

 **BVI Inflation:** Drastically overestimates bound water volume (BVI) at the expense of mobile hydrocarbons.

 **Signal Erasure:** If dephasing outpaces the minimal Echo Time (TE), the signal is entirely masked.

Quantifying Permeability: Diagnostic Models

Coates Model (Free Fluid)

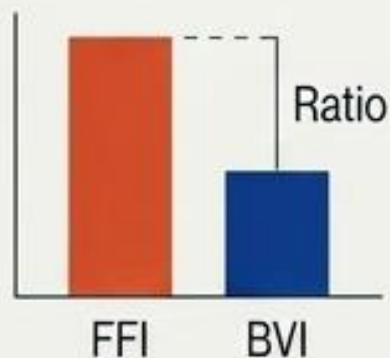
$$K_{\text{Coates}} = \left(\frac{\phi}{C}\right)^4 \cdot \left(\frac{\text{FFI}}{\text{BVI}}\right)^2$$

Mechanism:

Driven by the ratio of mobile fluids (FFI) to bound fluids (BVI).

Optimal Use:

Ideal for sandstones and simple, well-connected pore structures.



SDR Model (Schlumberger Doll Research)

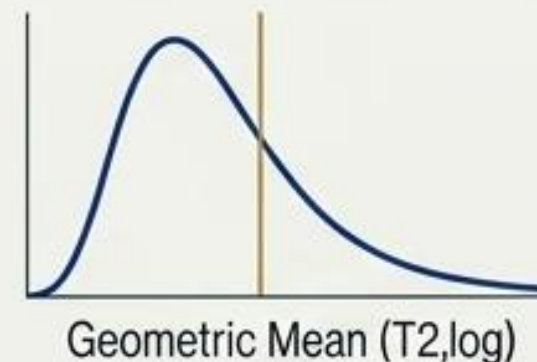
$$K_{\text{SDR}} = a \cdot \phi^4 \cdot (T_{2,\log})^2$$

Mechanism:

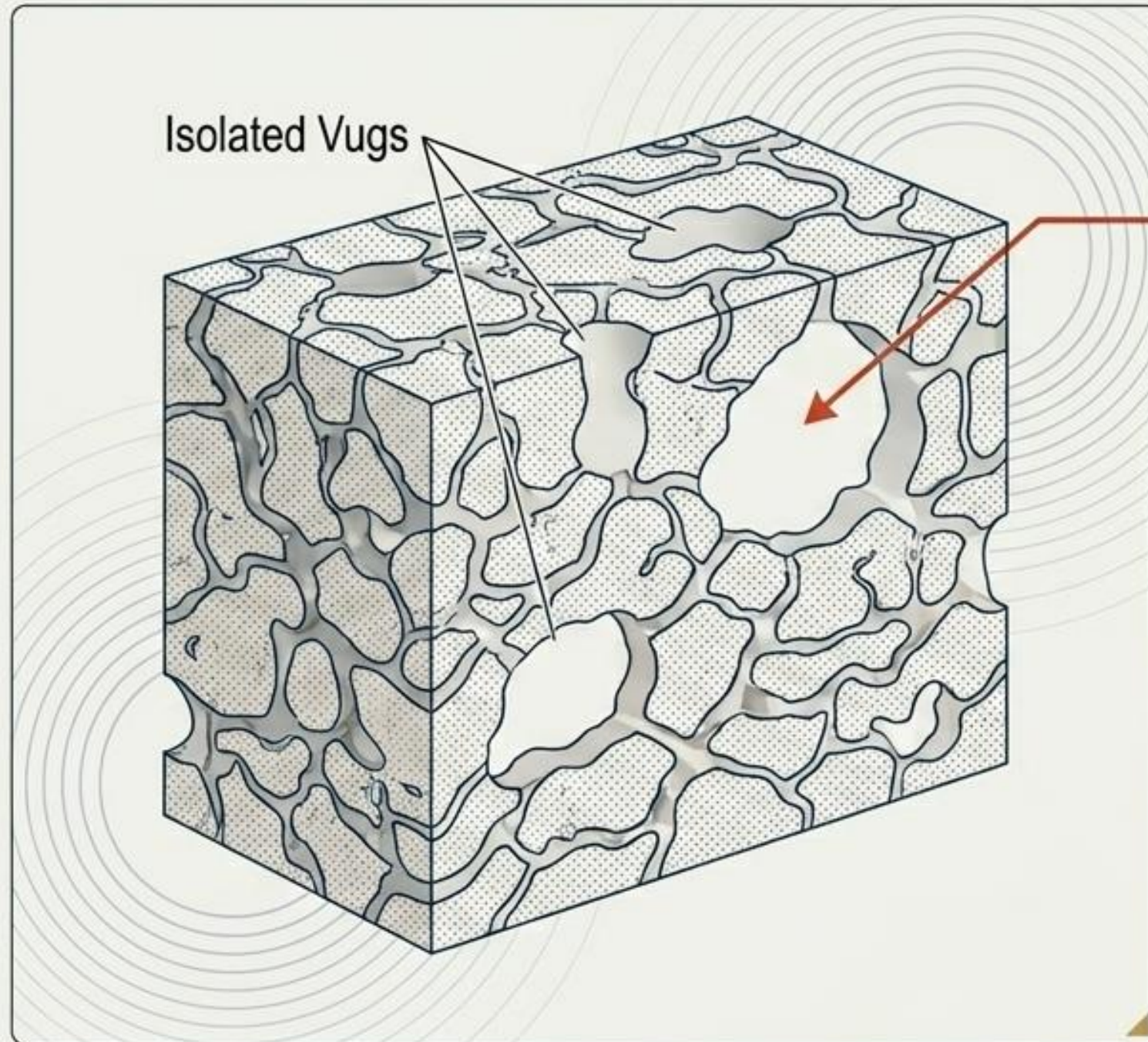
Driven by the geometric mean of the total T2 spectrum.

Optimal Use:

General continuous permeability across standard matrices.



The Carbonate Complexity: Breaking the SDR Model

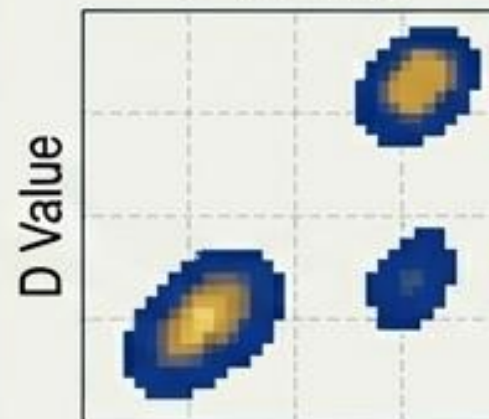


System Alert: SDR Model Failure

Because fluid in isolated vugs exhibits exceptionally long T2 times, the SDR geometric mean falsely calculates massive permeability despite zero actual fluid connectivity.

Advanced Parameterization

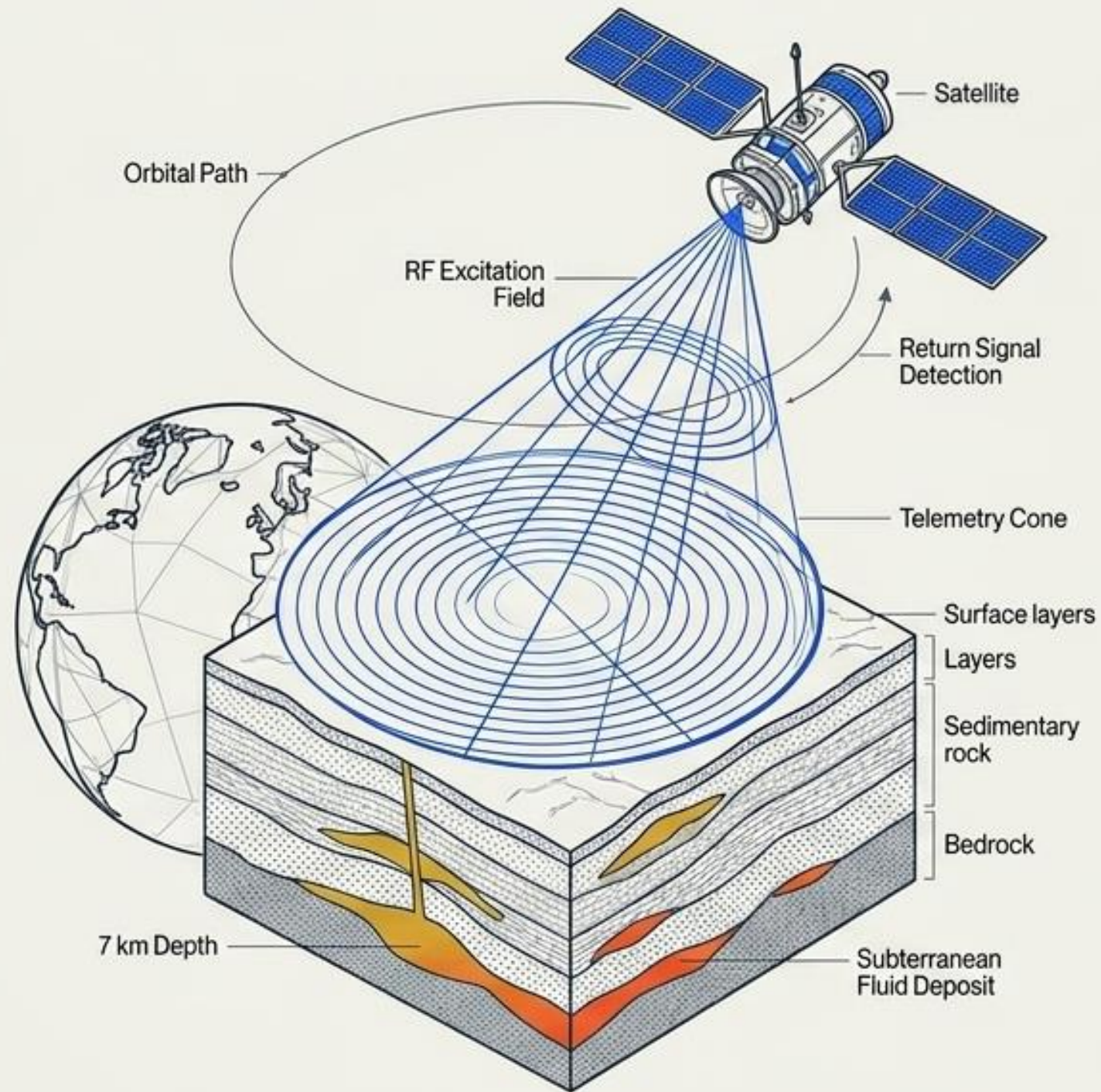
D-T2 Map



D-T2 Map

Resolution requires abandoning static models for Variable T2 cut-offs and multi-dimensional NMR mapping to physically isolate true hydro-connectivity.

The Macro-Shift: Passive Orbital Surveying (RSS-NMR)



Core Concept

Combining deep-penetration resonance with hydrogen relaxation physics enables remote deposit marking without surface contact.

Depth Targeting

$$\omega_0 = \gamma \cdot B_0$$

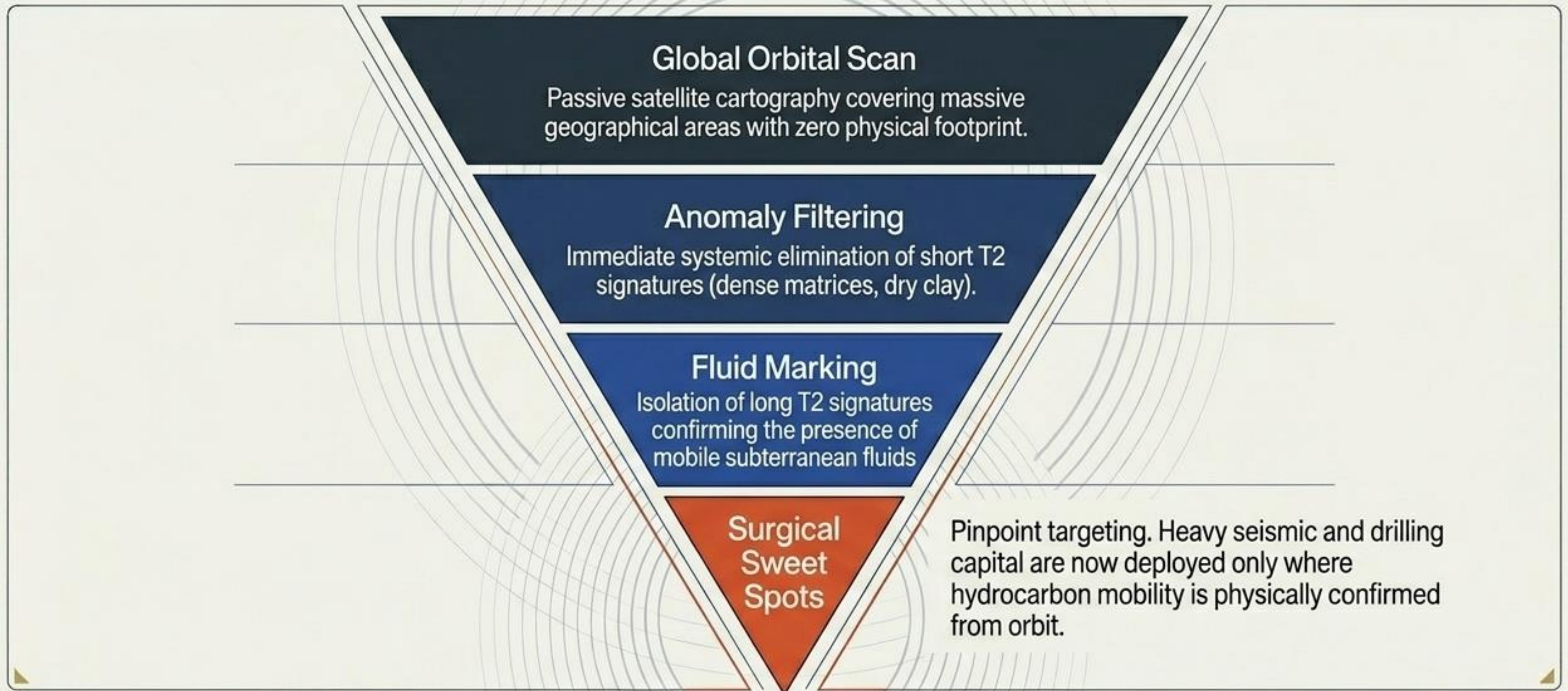
ω_0 : Larmor Frequency
 γ : Gyromagnetic Ratio
 B_0 : Static Magnetic Field

Depth calibration is achieved not by physical penetration, but by precise variation of the Larmor frequency. Tuning the frequency determines the exact depth slice of the targeted B_0 resonance.

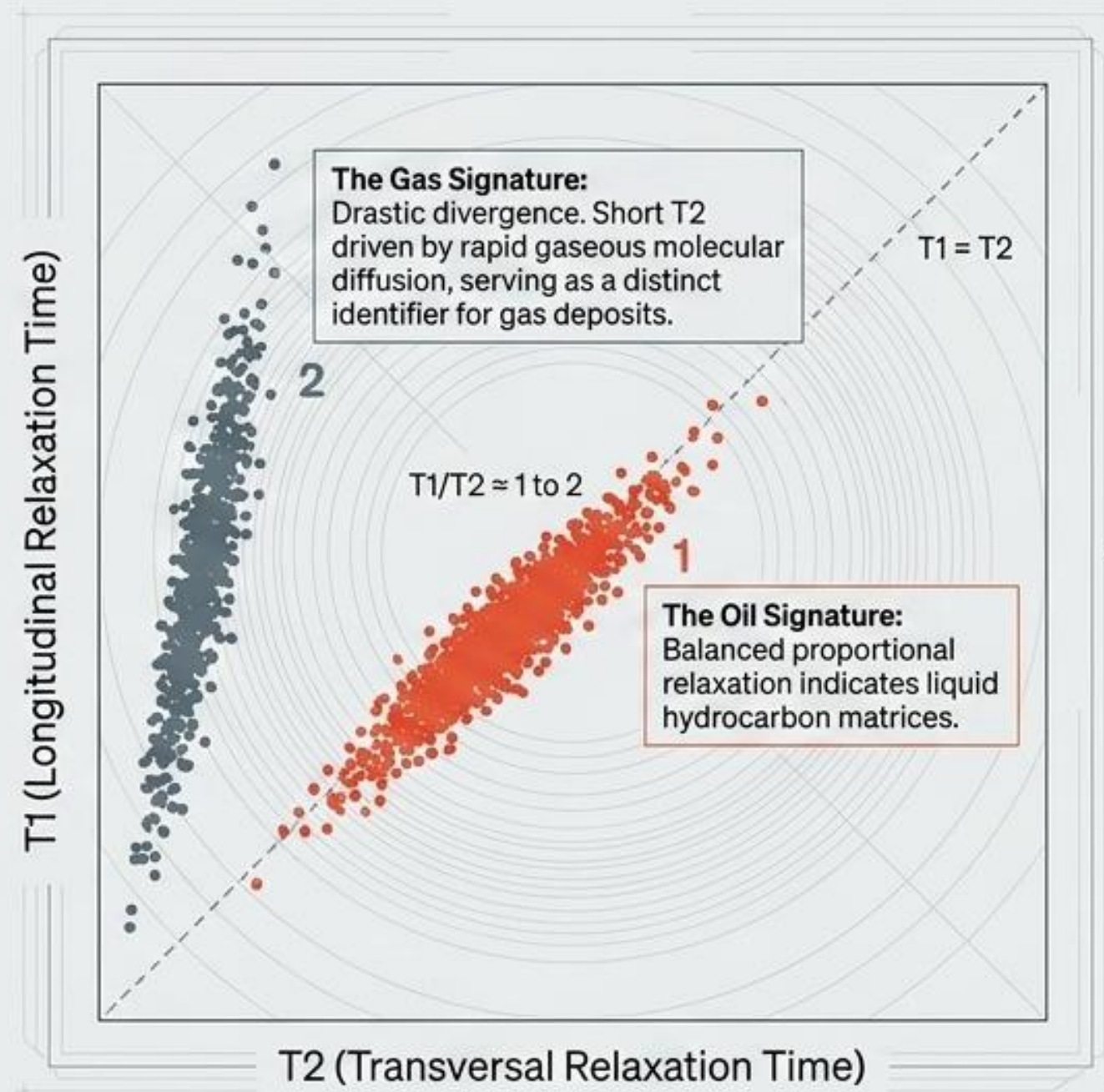
Detection

Once the pulse is cut, the spectral signature of the returning RF signal acts as a direct, physical descriptor of the subterranean fluid.

The Step Zero Methodology

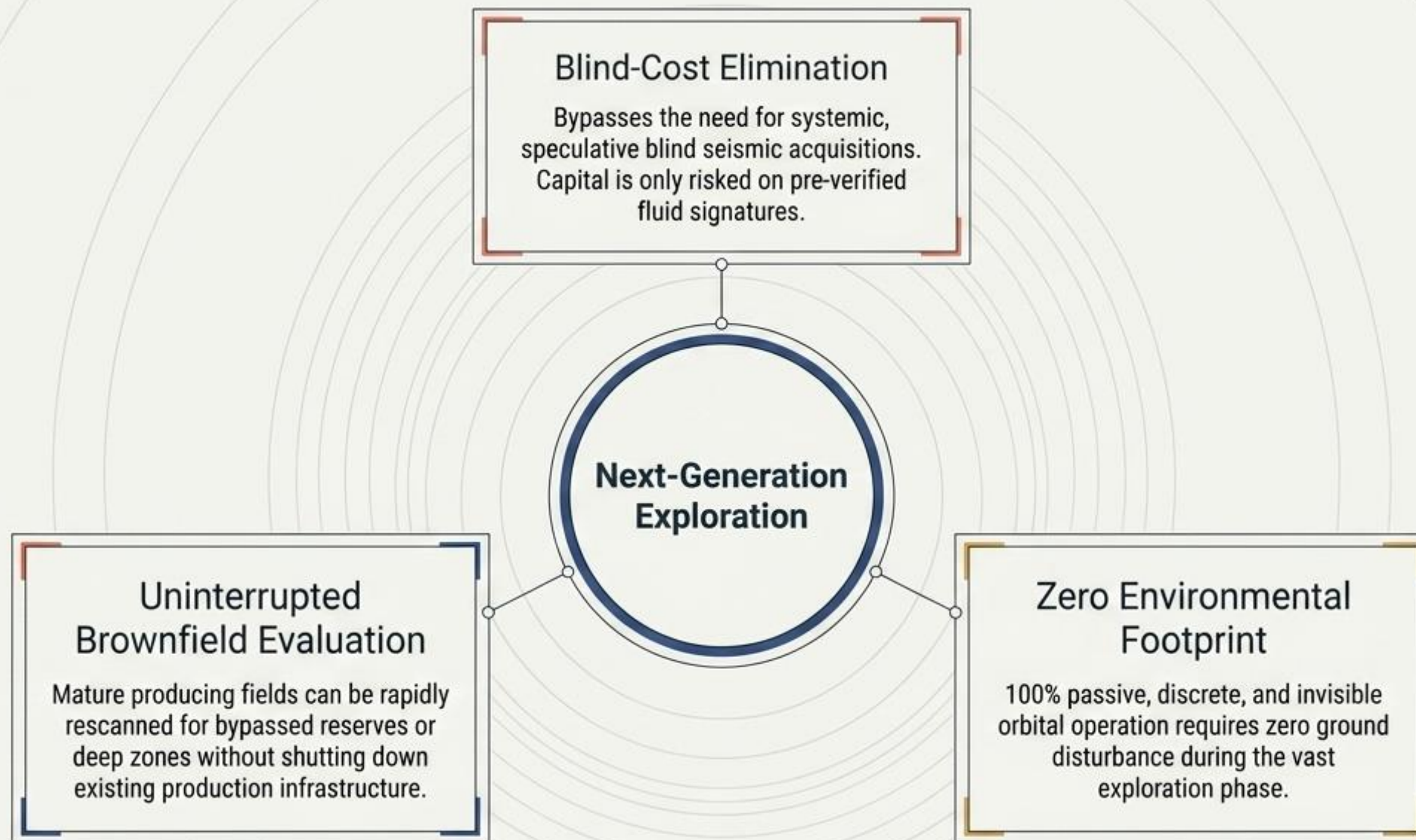


Fluid Characterization Signatures



Takeaway: The satellite does not just find fluids; it reads the intrinsic quantum ratios to classify the resource before deployment.

The Strategic Value Proposition





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Valid from 20.10.2025 to 05.10.2028

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, д. 143

Product: Methodology for calculating predicted ore reserves in deep-lying deposits, using the parameters of ore bodies obtained using remote geosound methods of geological exploration and field geophysical equipment of the Poisk complex (МЕТОДИКА) (METHODOLOGY)

Продукт: Методика подсчета прогнозируемых запасов руд в глубинных залежах, с использованием параметров рудных тел, полученных с помощью дистанционных геоакустических методов геологического изучения и полевой геофизической аппаратуры комплекса «Поиск» (604, ТН 002, ЕАЭС 9016809190)

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Дата СС
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ДОСТАВЛЯЕТСЯ НАД ПЕРИОДИЧЕСКИМ
Срок действия: 12



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Зеленчук

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VERSATILITY OF APPLICATION



HYDROCARBONS

Oil
Gas
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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.