

Commitment Admissibility Under Subsurface Ignorance

A Decision-Governance Framework for Irreversible Exploration

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1. The Structural Contradiction

Subsurface and frontier exploration frequently operate under a fundamental paradox.

The system cannot be fully understood from a distance. Yet the act of verification, whether drilling, landing, injecting, excavating, or disturbing, may require infrastructure and capital that begin to create irreversible commitment.

The challenge is not only managing risk. It is governing the threshold where a project transitions from inquiry into inheritance.

2. The Purpose of This Framework

This framework generalizes the lunar commitment argument for high-stakes environments where consequences are severe, evidence is indirect, and reversal is costly.

These are settings where core assumptions rely on remote sensing, geophysical inference, sparse sampling, or early operational evidence. Once the physical system is disturbed, the path may not be cleanly unwound.

3. Governing the Blind Spot

Standard development logic often assumes that uncertainty decays as a project advances. In subsurface environments, uncertainty can persist until the point of irreversible action.

Sustainable Exploration works at this blind spot.

The question is not only:

1. **Is this project feasible?**

The governing question is:

2. **Is this commitment admissible given what remains unresolved and what the next action would make difficult to reverse?**

4. Core Objectives

1. **Identify the threshold:** Pinpoint where a decision begins to become difficult to reverse.
2. **Separate exploration from dependency:** Ensure that the act of gathering evidence does not prematurely

lock the project into a specific infrastructure, site, or architectural path.

3. **Enforce admissibility:** Prevent capital, infrastructure, or operational escalation until the remaining uncertainty has lost decision-changing power.

5. Application Domains

1. **Geothermal, Mining & Subsurface Energy:** Drilling, stimulation, or reservoir commitment before reservoir behavior, stress state, permeability, induced seismicity, or production response is bounded.
2. **Carbon Storage & Injection Systems:** Injection or storage commitment before long-term containment behavior, pressure evolution, plume migration, monitoring sufficiency, or liability exposure is resolved.
3. **Critical Minerals & Resource Development:** Exploration, drilling, access, processing, or offtake commitments before resource continuity, grade, metallurgy, water, power, permitting, or infrastructure constraints are sufficiently bounded.
4. **Energy Infrastructure & Grid:** Queue entry, site control, point-of-interconnection fixation, gen-tie routing, or capital escalation before grid congestion, upgrade exposure, deliverability, or site constraints are understood.
5. **Offshore & Marine Infrastructure:** Cable routes, seabed corridors, landfalls, foundations, port interfaces, or offshore infrastructure before environmental, geotechnical, permitting, maintenance, or access uncertainty is bounded.
6. **Orbital Systems & Proximity Operations:** Servicing, rendezvous, inspection, relocation, debris interaction, orbital data infrastructure, or proximity operations before consent, attribution, collision, autonomy, insurance, escalation, or revocation conditions are bounded.
7. **Lunar Surface Systems:** Landing-zone hardening, mobility corridors, fixed power, communications, excavation, ISRU dependency, or surface infrastructure before volatile distribution, regolith mechanics, thermal behavior, access geometry, or precedent effects are bounded.