GEOM

GREENLAND ENERGY OIL & MINERALS

THE INTELLIGENCE LAYER FOR OIL AND MINERALS

A verifiable record, a first-party oracle, and the settlement rails
for the tokenisation of physical resource assets.

Abstract

Real-world asset tokenisation has reached treasuries, private credit and real estate. It has not reached the ground. Across the 45 tokenised resource instruments GEOM tracks, tokenised crude oil stands at zero and tokenised rare earths stand at zero. The barrier is not demand and it is not technology; it is that no verifiable, first-party record of the physical resource base exists on-chain, and the legal rails to issue against such a record have not been built.

This paper describes GEOM: a cryptographically verifiable record of the world's oil fields, mines, rare-earth deposits, pipelines and power plants, published by a foundation-governed association of exploration companies holding Greenland licences granted before the 2018 licensing halt and incapable of being reissued. Section 5 specifies the attestation oracle in full (canonicalisation, SHA-256 digesting, Ed25519 signing and Solana mainnet anchoring) and states precisely what it establishes and what it does not. Section 6 specifies the tokenisation engine, the component this project is ultimately built to deliver: a chain-agnostic issuance layer built on permissioned token standards, with every regulated function performed by a licensed GEOM subsidiary, ring-fenced from the Foundation. Section 8 sets out a five-stage roadmap in which each stage is gated behind a legal opinion, a professional engagement, a licence, or a change in law, terminating in a closed-loop system that originates the data, proves it, issues instruments against it, then trades, custodies and settles them inside one group, with $GEOM operating as a payment token under Greenlandic and Danish financial authorisation.

The magnitude of the opportunity is set by the size of what is currently absent. Oil, gas and hard-rock minerals are the largest physical asset class on earth with effectively no on-chain representation. When the tokenisation engine of Section 6 is operating under licence, the addressable base is not a niche within digital assets but the reserve base itself: the Jameson Land Basin alone carries an independent assessment of 13.03 billion barrels of gross unrisked prospective resources, and the Association's stated ambition is to bring that basin's reserves on-chain through GEOM. This is infrastructure built for the category of on-chain commodities before that category exists.

$GEOM is the Association's token. Its design principles and regulatory position are set out in Sections 7 and 11, and both are specific to the present stage: the token today carries no financial claim of any kind. That position is the design, not a limitation of it. The tokenised instruments the engine is built to carry are a different asset class, designed to carry economic rights to produced volumes. Section 7.4 states precisely what changes, what does not, and for which asset.

Authored by the GEOM Foundation

Version 4.0 · August 2026

geom.org · $GEOM · Solana

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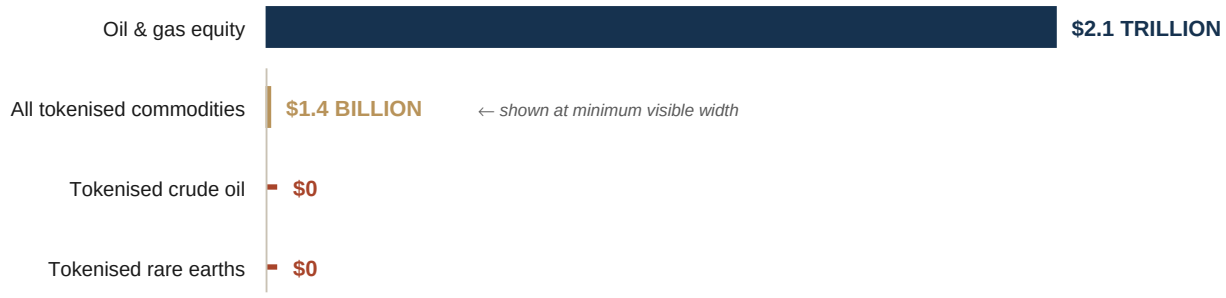
1 Introduction

1.1 The gap

Three numbers contain the entire thesis of this document.



Drawn to linear scale. The tokenised commodity market is approximately one fifteen-hundredth of the equity above it; at this scale it is a hairline, and crude and rare earths do not register at all.

Figure 1: The gap, to scale.

The equity of the global oil and gas industry trades at approximately $2.1 trillion. The entire tokenised commodity market is approximately $1.4 billion, and nearly all of that is gold. Tokenised commodities are therefore roughly one fifteen-hundredth of the equity sitting above them. The quantity of crude oil represented on-chain is zero. The quantity of rare earth elements represented on-chain is zero.

This is not a gap in enthusiasm. Tokenisation has moved decisively into United States Treasuries, into private credit, into money market funds and into real estate, and institutional issuers now operate at scale in each of those categories. It has not moved into the ground. Oil, gas and hard-rock minerals remain the largest physical asset class with effectively no on-chain representation, and they are the class with the highest legal barriers to entry: title is held under state-granted licences, reserve figures are technical estimates rather than balances, and the instruments that would represent them are regulated financial products in most jurisdictions in which they might be sold.

Those barriers are the opportunity. The infrastructure that will eventually serve this category does not exist, and the entity that holds the data, the record and the rails when the barriers move will define the market that forms behind them. GEOM is being built now so that it is finished when the law is.

The scale of what sits behind that gap is worth stating without understatement. The Association's own founding position (a single basin, independently assessed at 13.03 billion barrels of gross unrisked prospective resources, held under licences that cannot be reissued) is by itself larger than the entire tokenised commodity market by any measure of underlying value. **The Association's stated ambition is to bring the basin's reserves on-chain through GEOM.** If the engine described in Section 6 operates under licence and that ambition is realised, the category being created is not an increment to tokenised commodities; it is the establishment of on-chain commodities as an asset class, on infrastructure GEOM authored.

1.2 What GEOM is

GEOM maps the oil fields, mines, rare-earth deposits, pipelines and power plants that matter; records which of them have been tokenised; and cryptographically signs every dataset it publishes so that the record can be verified by any

third party without trusting GEOM. Three components are live at the date of this document and can be inspected without an account, a key, or a permission:

- **The map.** 110 curated assets (43 oil and gas fields and 67 mines, rare-earth deposits and nuclear facilities), together with 34,936 power plants and 12 trunk pipeline routes, presented on a three-dimensional globe.
- **The tracker.** A registry of 45 tokenised resource instruments, maintained instrument by instrument. Tokenised crude and tokenised rare earths both stand at zero, and the registry exists in part to document that fact in public until it changes.
- **The oracle.** Every dataset GEOM publishes is canonicalised, hashed with SHA-256 and signed with an Ed25519 keypair; the manifest of digests for each publication window is anchored on Solana mainnet in a memo transaction signed by the same key. Section 5 specifies this in full.

Behind those components sits a foundation being established in Ras Al Khaimah and an association of exploration companies holding Greenland licences that cannot be reissued. Two of those companies are listed on public markets and file with their regulators; one is pending a listing. Every claim this document makes about them can be checked against the public record.

What GEOM becomes

That is the system today. It is deliberately the smallest part of what is being built, and describing only the shipped software would understate the design by an order of magnitude.

The stages set out in Section 8 add, in sequence: professional verification of operator data; the issuance engine that turns a verified reserve into a transferable on-chain instrument; licensed subsidiaries holding the authorisations to custody, match and broker those instruments; and finally a settlement layer in which $GEOM operates as a payment token within the Greenlandic resource economy. **At the end of that sequence GEOM is not a data provider with a token attached. It is a closed-loop system that originates the data, proves it, issues instruments against it, trades them, custodies them and settles them, every stage inside the GEOM group, on infrastructure GEOM built and under licences GEOM holds.**

The scale that unlocks is set by the underlying rather than by the software. A single Association basin carries an independent assessment of 13.03 billion barrels; the Association's stated ambition is to bring that reserve base on-chain through GEOM; and operators in adjacent minerals and natural-resource categories have already approached the Association wanting to tokenise their own assets on the same rails (Section 3.7). The category being built is not a niche within digital assets. It is on-chain commodities as an asset class, and GEOM intends to be the system it runs on.

1.3 Why an association, and why these companies

A data layer for physical resources fails if its data is second-hand. The distinguishing property of GEOM's record is that operator data enters it *first-party*: signed at source by the company that generated it, timestamped, and anchored on a public chain. This is the same architectural insight that separated Pyth Network from earlier oracle designs in financial market data: rather than scraping public APIs and aggregating them, Pyth persuaded the firms actually making the markets to publish their own prices directly. GEOM applies that principle to the physical resource base, and arrived at it independently for the same reason: an aggregator can be wrong without anyone being accountable, whereas a signed first-party submission has a named author and a cryptographic signature attached to it forever.

The Association's founding members are three exploration companies operating two independent projects in Greenland. They are not endorsers or advisers. They are the source of the data, and their licences (granted before Greenland's 2018 halt on hydrocarbon licensing and incapable of being replicated under current policy) are the reason

the Association's position is defensible rather than merely early.

1.4 Structure of this document

Section 2 sets out the geological and political context in Greenland, including the Jameson Land Basin assessment and the licensing position. Section 3 describes the Association and each founding company. Section 4 gives the system architecture. Section 5 specifies the oracle in complete technical detail and is the longest section in this paper. Section 6 specifies the tokenisation engine, which is the component everything else is ultimately built to support. Section 7 describes $GEOM. Section 8 sets out the five-stage roadmap with the gate conditions attached to each stage. Sections 9 through 12 cover governance, security, the regulatory position and the risks. Appendices give references, nomenclature and the attestation record schema.

2 Greenland: Geological and Strategic Context

2.1 Two billion years of geology

Greenland covers more than 2.16 million square kilometres, making it the world's largest island and, in geological terms, an unusually complete stratigraphic archive. Its exposed rocks span most of Earth's history, from Archaean gneisses among the oldest known crustal material to Mesozoic and Cenozoic sedimentary basins along both margins. That range matters commercially for a simple reason: the diversity of commodities that can occur in a terrane is a function of the diversity of geological processes it has recorded, and Greenland has recorded almost all of them [1].

The commodity suite historically documented in Greenland includes cryolite (the Ivittuut deposit was for a century the world's only commercial source), uranium, gold, zinc, nickel, copper, platinum group elements and rare earth elements, alongside the hydrocarbon systems of the east and west coast basins [1].

2.2 The hydrocarbon record

Greenland has been among the more actively explored frontier petroleum provinces of the past five decades, with well-documented research on resource potential and a succession of drilling campaigns across both margins [1]. The most significant historical work on the east coast was conducted between 1970 and 1990 by the Atlantic Richfield Company (ARCO), which invested in excess of US$275 million in present-day terms in detailed exploration and evaluation of the Jameson Land Basin, identifying multiple large hydrocarbon targets in the process.

That programme is the reason the basin is not a speculative prospect. The seismic, stratigraphic and geochemical groundwork was completed at industrial scale by a major operator, and the work product exists. What has never happened is a modern well.

2.3 Critical minerals and rare earths

Greenland holds the eighth largest rare earth element reserves in the world, estimated at approximately 1.5 million tonnes [1]. Rare earths are inputs to permanent magnets, and therefore to electric drivetrains, wind turbines, precision-guided munitions and effectively every category of electrified machinery whose demand curve is rising. The strategic significance of that position is amplified by concentration risk elsewhere in the supply chain: the principal alternative source of scale in rare earth processing and export is China [2].

Nickel sulphide, copper, cobalt and platinum group elements are the second critical-minerals axis, and the Disko-Nuussuaq district on the west coast is the Association's exposure to it.

2.4 The closed door: the 2018 licensing halt

In 2018 Greenland ceased issuing new hydrocarbon exploration licences, and in 2021 the government cancelled all future licensing rounds. The consequence is structural and is central to the Association's position: **the hydrocarbon licences that exist in Greenland today were granted before those decisions and cannot be replicated under current policy.** A competitor cannot obtain an equivalent position by applying for one, because there is no longer an application to make.

This is a materially different basis for a resource position than a forecast of commodity prices. It does not depend on oil trading at a particular level or on any assumption about the pace of the energy transition. It depends on an administrative fact that has already occurred. The Association's founding hydrocarbon position rests on that fact.

2.5 Strategic attention

Greenland's mineral and geopolitical significance has been elevated substantially by renewed United States interest in the territory. Analysis published by the Center for Strategic and International Studies frames that interest less as a conventional territorial question and more as a resource-security one, situating Greenland's rare earth position within a wider contest over critical mineral supply chains and Arctic security [2]. Whatever view one takes of the politics, the practical effect is a sustained increase in institutional attention to Greenlandic resource assets, and a corresponding increase in the value of an authoritative, verifiable record of what those assets are.

2.6 The Jameson Land Basin

13.03 BILLION	**2.1M**	**OCTOBER 2026**
BARRELS · GROSS UNRISKED PROSPECTIVE RESOURCES JAMESON LAND BASIN · SPROULE ERCE	ACRES ACROSS THREE EXCLUSIVE LICENCES	TARGETED SPUD · THE FIRST MODERN WELLS IN THE BASIN'S HISTORY

An independent assessment by Sproule ERCE estimates the Jameson Land Basin at approximately 13.03 billion barrels of gross unrisked prospective resources, positioning it among the most substantial undeveloped oil accumulations identified globally and, on current estimates, within the top fifteen largest undeveloped accumulations worldwide [3]. The basin exhibits a clear genetic link to the North Sea petroleum system and a scale comparable to major producing regions.

Greenland Energy is targeted to begin drilling in October 2026. Two exploration wells, designated OPW-1 and OPW-6, are planned to approximately 3,500 metres, with Halliburton contracted for the programme. These will be the first wells drilled in the basin's history using modern methods.

The date matters to this document for a reason beyond the geology. ARCO's work established the basin's prospectivity four decades ago and no modern well has tested it since; October 2026 is when a forty-year-old thesis is drilled. It is also the first occasion on which live hydrocarbon data from an active Greenlandic programme enters the GEOM record as signed, timestamped, first-party attestation, the record's first real test against events rather than against seed data.

A note on resource terminology is warranted, because the distinction is frequently collapsed in commentary and should not be. *Gross unrisked prospective resources* is an estimate of the total volume potentially present across a play before any adjustment for the geological probability of discovery and before any deduction for working interest. It is not a reserve, it is not a resource attributable to any single party, and it does not imply that any particular volume will be produced.

2.7 Disko-Nuussuaq

The Disko-Nuussuaq project in West Greenland is a district-scale magmatic nickel sulphide system, with associated copper, cobalt and platinum group elements. The district sits within the same class of magmatic systems as the world's largest nickel camps, and its principal characteristic is that it is substantially under-explored relative to its indicated scale.

The reason for that under-exploration is technical rather than geological. The depths and conditions required to test the system were not economically accessible with previous generations of drilling technology; they are now. The current campaign, funded and directed by USFM Corporation, began in July 2026 and constitutes the Association's first first-party minerals data flow.

Figure 2: The two Association projects. Schematic; not to scale.

2.8 Jurisdiction and resource authority

Greenland's constitutional position is directly relevant to Sections 6 and 8 of this paper and is frequently misunderstood. Greenland is an autonomous constituent country within the Kingdom of Denmark. Under the 2009 Self-Government Act, effective 1 January 2010, authority over mineral resources was transferred to the Government of Greenland, which administers licensing through its own Mineral Resources Authority. Resource policy (including the 2018 hydrocarbon licensing halt) is therefore made in Nuuk, not Copenhagen.

Financial regulation follows a different line. Greenland withdrew from the European Communities in 1985 and holds Overseas Country and Territory status, meaning that the European Union's financial services regime, including the Markets in Crypto-Assets Regulation, does not apply directly. The currency is the Danish krone, and the applicable financial supervisory framework derives from Danish law as extended to Greenland. Any payment or settlement function contemplated in Stage 5 of the roadmap must be authorised within that framework rather than under an EU passport, and Section 8.7 treats this as a gate condition rather than an assumption.

3 The Association and the Founding Companies

3.1 Legal architecture

The Association is operated by a foundation being established under the RAK ICC Foundations Regulations 2019 in Ras Al Khaimah, United Arab Emirates. A foundation is used rather than a company for one structural reason: it has no shareholders. The Foundation's constitutional documents prohibit the distribution of income or property to its Founder, Council members or Guardian, or to any person connected to them. Nobody owns the entity that publishes the record and holds the treasury.

This is not decorative. The entire compliance position described in Section 11 depends on there being no identifiable party whose profit is the purpose of the structure. Section 9 sets out governance in detail.

3.2 Greenland Energy, Inc. · Nasdaq: GLND

Who they are

A Nasdaq-listed exploration company built around a single asset: the Jameson Land Basin. Executive Chairman Larry Swets Jr. rang the Nasdaq opening bell at listing. The board has since added directors including Sidus Space chief executive Carol Craig. The company is led by industry veterans and supported by a roster of senior technical consultants.

What they hold in Greenland

Three exclusive exploration and exploitation licences covering approximately 2.1 million acres of East Greenland, funding 100% of the costs of the exploration wells. The wells are designed to delineate the sedimentary structure and energy potential of the basin. The licences pre-date the 2018 licensing halt and are grandfathered. The independent assessment of the basin runs to 13.03 billion barrels of gross unrisked prospective resources.

Why GEOM

The Jameson Land Basin is the single largest asset on GEOM's map, and GLND data enters the record first-party: signed at source, timestamped, anchored on Solana. When tokenisation reaches oil, the operator whose data is already on-chain and already independently verifiable starts in front of the operator whose data is in a PDF.

What happens next

Two wells, OPW-1 and OPW-6, drilled to approximately 3,500 metres, Halliburton contracted for the programme, first drilling targeted for October 2026.

3.3 USFM Corporation · Nasdaq: VEEE

Who they are

A United States critical-minerals company focused on advancing high-quality mineral exploration, with an acute focus on Disko-Nuussuaq. USFM's operating emphasis is the advancement of drill-ready targets and discovery-driven outcomes rather than long-horizon concept work. The company has completed its combination with Twin Vee PowerCats Co. and trades on Nasdaq as VEEE pending completion of the ticker change.

What they hold in Greenland

USFM funds and directs the Disko-Nuussuaq drilling campaign, advancing drill-ready targets across the district. The company's operating focus is discovery-driven progress rather than long-horizon concept work, supporting efficient campaign delivery in a demanding Arctic operating environment.

Why GEOM

USFM's thesis is American access to critical minerals. A public, signed, on-chain record of what is in the ground (and of who submitted the data and when) serves that thesis directly, and does so in a form that a counterparty or an agency can verify without relying on the company's own presentation of it.

What happens next

Completion of the listing, and continued funding of the drill programme at Disko-Nuussuaq.

3.4 The Chairman

Larry Swets Jr. chairs the Association. He is also Executive Chairman of Greenland Energy, Inc. (Nasdaq: GLND), the operator of Jameson Land.

Swets has spent two decades putting companies onto public markets. He founded the advisory firm Itasca Financial in 2005, served as Chief Executive of Kingsway Financial Services on the New York Stock Exchange from 2010 to 2018, and led FG Financial Group on Nasdaq from 2020 to 2024. He has taken companies public through special purpose acquisition vehicles twice: 1347 Capital, which became Limbach Holdings, and FG New America, which became OppFi. He holds the Chartered Financial Analyst designation.

His position in the underlying operator is a matter of public record rather than assertion. Securities and Exchange Commission filings show open-market purchases of Greenland Energy stock through 2026, building a position of 500,000 shares. **The chairman of the Association is a buyer of the underlying operator with his own money.**

On why crypto and why now: Swets has listed companies on every venue the market has offered him. Tokenisation is the next venue. An association holding real licences, running real drills and filing real disclosures needs someone who has done listings for twenty years to prepare it for a new kind of listing, and that is the role he has taken.

3.5 Membership

Membership of the Association is open to oil and minerals exploration companies with a genuine interest in the Greenland region and, in due course, other frontier resource jurisdictions. Membership is subject to Council approval to preserve the integrity and quality of the GEOM record.

Membership does not confer any ownership interest in the GEOM Foundation. Participation is solely for collaboration, data contribution, and access to Association services under the applicable membership agreement.

3.6 Why operators join

The commercial logic for a listed exploration company is not sentimental. Four things follow from having operator data on a signed, timestamped, publicly verifiable record:

- **Provenance under scrutiny.** An operator that has been signing its own data continuously can demonstrate what it said and when it said it, in a form that does not depend on its own archive.
- **Counterparty diligence.** Farm-in partners, offtakers and lenders repeat the same verification work on every transaction. A canonical signed record reduces that work for every counterparty simultaneously.

- **Position when tokenisation arrives.** When resource tokenisation becomes legally viable, the instruments that issue first will be those whose underlying data already has an auditable on-chain history. That history cannot be created retroactively.
- **Category authorship.** Three operators founding the registry that documents the category is a materially different position from being listed on someone else's registry later.

3.7 The inbound pipeline

The three founding companies are the beginning of the membership rather than the whole of it. Operators and asset holders in adjacent minerals and natural-resource categories have approached the Association about joining as partners, and admissions are expected to begin shortly and to continue on a rolling basis as each candidate completes Council approval.

What is notable about the inbound interest is its stated motivation. These are not parties seeking marketing association with a token. **They have approached the Association because they want their own assets tokenised, on the rails described in Section 6.** That is the demand signal the entire roadmap is built against, and it is arriving before the engine exists.

Each admission widens the record in the way that compounds: a new member brings a new first-party data flow, a new commodity or jurisdiction on the map, and a further instrument-issuance candidate for the engine. The Association is structured to carry that expansion: Section 2.7 and Section 4 describe a system deliberately not tied to a single company, commodity or country.

4 System Architecture

4.1 Layered design

GEOM is organised as four separable layers. Layers 2 and 3 constitute the core of the system as it exists today and are specified in Sections 5 and 6 respectively.

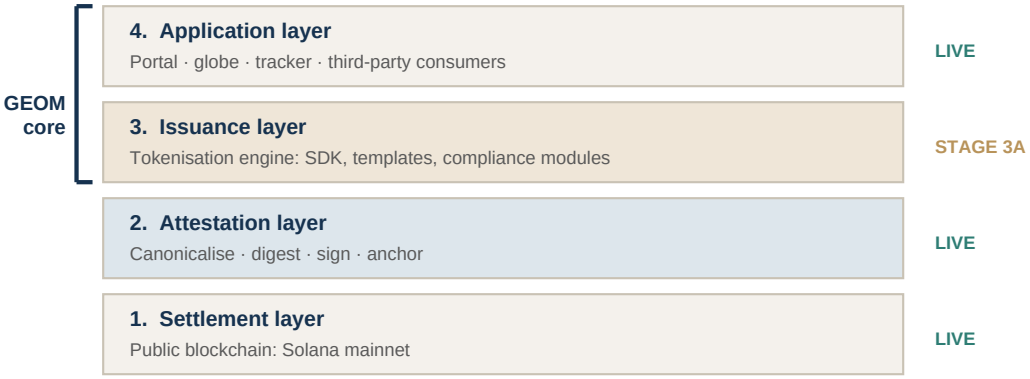


Figure 3: Layered design. Layers 2 and 3 constitute the core of the system.

4.2 Components

Four components make up the system as deployed.

The map

A three-dimensional globe presenting 110 curated assets (43 oil and gas fields, and 67 mines, rare-earth deposits and nuclear facilities), together with 34,936 power plants and 12 trunk pipeline routes. The curated layer is editorial: assets are included because they are material to the resource economy, not because a dataset happened to contain them.

The tracker

A registry of 45 tokenised resource instruments, tracking issuer, jurisdiction, underlying commodity, instrument structure and status. Its function is longitudinal: to record the emergence of a category from before the category existed. Tokenised crude and tokenised rare earths both stand at zero at the date of this document.

The oracle

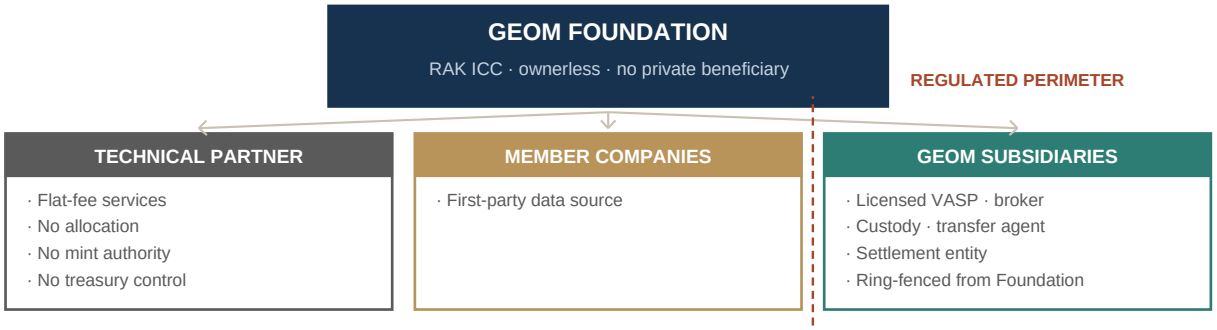
The attestation pipeline. Specified in full in Section 5.

The portal

Planned holder access to the Association's exploration content: operational updates, drilling data as disclosed, technical commentary and recurring sessions with the geologists and project teams of member companies.

All datasets are public. No account, key or permission is required to read the record or to verify it.

4.3 Entity stack



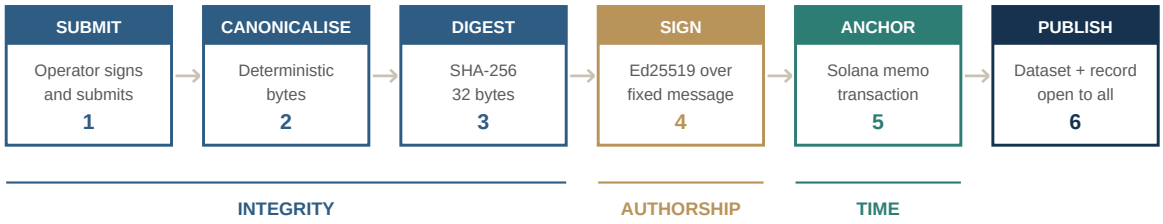
Regulated functions sit in licensed GEOM subsidiaries, each separately incorporated and ring-fenced from the Foundation.

Figure 4: Entity stack. Nobody owns the Foundation; the licensed group sits beside it, not above it.

4.4 Data flow

The path a datum takes from an operator to a verifiable public record has six steps:

- **1. Submission.** A member operator submits a dataset (reserve estimates, production figures, survey results, asset coordinates) through an authenticated channel.
- **2. Canonicalisation.** The payload is reduced to a deterministic byte representation (Section 5.3).
- **3. Digesting.** The canonical bytes are hashed with SHA-256 (Section 5.4).
- **4. Signing.** The digest is signed with an Ed25519 keypair over a fixed message format (Section 5.5).
- **5. Anchoring.** The manifest of all digests in the publication window is committed to Solana mainnet in a memo transaction signed by the same key (Section 5.6).
- **6. Publication.** Dataset, digest, signature and anchor reference are published together. Any third party can now verify the record without GEOM's cooperation (Section 5.8).



Steps 2–3 establish that the data has not changed. Step 4 establishes who published it. Step 5 establishes when.

No step establishes that the data is accurate, see §5.10.

Figure 5: The attestation pipeline.

4.5 Why Solana

The attestation layer is chain-agnostic in design (nothing in Sections 5.3 through 5.5 depends on a particular ledger) but the anchor has to land somewhere, and Solana was selected on four grounds.

- **Cost at frequency.** Attestation is a high-frequency, low-value-per-transaction workload. A record that anchors on every publication window is only viable where per-transaction cost is negligible. On settlement layers with volatile or material fees, publication frequency becomes an economic decision rather than a technical one, which is the wrong constraint for a record.
- **Finality.** Sub-second confirmation and rapid economic finality mean the anchor is queryable almost immediately after publication, rather than after a probabilistic confirmation window.
- **The memo program.** Solana provides a native, minimal instruction for committing arbitrary bytes to a transaction, requiring no bespoke program deployment, no upgrade authority and no contract risk on the critical path of the record. The smallest possible trusted computing base for an anchor is no contract at all.
- **Token-2022 for the issuance layer.** Solana's Token Extensions program provides the compliance primitives the tokenisation engine requires (transfer hooks, permanent delegate, default account state, metadata pointers) natively at the token standard level rather than through bespoke contract logic (Section 6.3).

5 The Oracle

This section specifies the attestation oracle in full. It is the longest section of this paper because it is the component on which everything else rests: the tokenisation engine of Section 6 has no reason to exist unless the data underneath it can be verified by someone who does not trust the party publishing it.

5.1 Design rationale: first-party sourcing

Oracle systems in production today divide broadly into two families. *Third-party aggregators* collect data from public sources (exchange APIs, government publications, commercial feeds) and reconcile them into a single output. *First-party publishers* require the entity that originates the data to publish it directly, under its own key.

The distinction is not a matter of engineering taste. In an aggregator model, the failure mode is diffuse: if the output is wrong, responsibility is distributed across a scraping pipeline, a set of upstream sources and a reconciliation algorithm, and no named party is accountable for the specific number. In a first-party model, every record carries the signature of an identified originator, permanently. Pyth Network established the commercial force of this distinction in financial market data by persuading market makers and exchanges to publish their own prices rather than having a network scrape them.

GEOM applies the same principle to the physical resource base. The Association exists precisely so that the entities generating the data (the licence holders and operators) are the entities signing it. This is why Section 3 spends as much space on who the founding companies are as on what GEOM builds: in a first-party system, the identity and accountability of the publishers *is* the product.

5.2 Datasets

GEOM currently publishes seven datasets under attestation.

Dataset	Records	Character
Proven crude reserves by country	23	Curated seed data from public sources
Major oil and gas fields	43	Curated seed data; asset-level
Mines, deposits and nuclear facilities	67	Curated seed data; asset-level
Global power plants	34,936	Republished from WRI Global Power Plant Database v1.3.0 (CC-BY 4.0)
Trunk pipeline routes	12	Curated seed data; route geometry
Tokenised-instrument registry	45	Maintained registry; the tracker
Market-structure series	series	Derived time series on tokenised commodity market composition

Table 1: Attested datasets at the date of this document.

Two properties of this set are worth stating explicitly. First, it is deliberately broader than Greenland: a record that only described the Association's own assets would be a marketing artefact rather than infrastructure. Second, the curated layers are *seed data*, compiled from public sources including OPEC, the United States Energy Information Administration, operator disclosures, published mining rankings and the World Nuclear Association. Their figures are approximate. Section 5.10 states what follows from that.

5.3 Canonicalisation

A digital signature commits to bytes, not to meaning. If the same logical dataset can be serialised into two different byte sequences (by reordering keys, by varying whitespace, by differing float formatting) then a signature over one serialisation fails to verify against the other, and the attestation is worthless in practice even though it is cryptographically sound.

GEOM therefore canonicalises every payload before hashing. The canonical form is produced by recursively sorting object keys into a deterministic order and removing insignificant whitespace, yielding exactly one byte representation for any given logical dataset. The approach follows the principle established by JSON Canonicalization Scheme (RFC 8785): serialisation must be a function of content alone.

The practical consequence for a verifier is that they do not need GEOM's serialiser. They need the published dataset and the canonicalisation rule, and they can reproduce the exact bytes GEOM signed.

5.4 Digesting

The canonical bytes are hashed with SHA-256, producing a 256-bit digest. SHA-256 is used rather than a more recent construction for interoperability reasons: it is available in every language runtime, every hardware security module and every browser without a dependency, which matters for a system whose verification story depends on third parties actually performing the check.

The digest is the commitment. Any modification to the dataset (a changed digit in a reserve figure, an added record, a reordered field that survives canonicalisation as a semantic change) produces a completely different digest, and the mismatch is detectable by anyone holding the original attestation.

5.5 Signing

The digest is signed with an Ed25519 keypair over a fixed message format. Ed25519 is used for three reasons: it is deterministic, so signing the same message twice yields identical bytes and there is no nonce-reuse failure mode; it is fast enough that verification is trivial in a browser; and it is the native signature scheme of Solana, which means the same key material serves both the attestation and the anchoring step without a second key hierarchy.

The message format is fixed and versioned. Signing over a structured, prefixed message rather than over a bare digest prevents cross-protocol signature reuse, a signature produced for an attestation cannot be replayed as a signature over an unrelated payload that happens to hash to the same value in a different context. Appendix C gives the record schema.

5.6 Anchoring

Signing establishes authorship and integrity. It does not, by itself, establish *time*: a signature carries whatever timestamp its signer chose to include, and a signer can backdate. Anchoring solves this.

In each publication window, the manifest of all dataset digests is committed to Solana mainnet in a memo transaction signed by the same Ed25519 key. The block in which that transaction confirms carries a consensus timestamp that GEOM does not control and cannot retroactively alter. The result is that the existence of a given manifest at or before a given time becomes a fact about the public ledger rather than a claim by GEOM.

The memo program is used deliberately in preference to a purpose-built on-chain program. A custom program would introduce an upgrade authority, a deployment, and a class of contract risk directly onto the critical path of the record. The memo instruction is a native primitive with no upgrade surface and no state, which makes the trusted computing

base of the anchor as close to nothing as the architecture permits.

Anchoring runs on Solana mainnet today. Every publication window since launch is carried in a mainnet memo transaction that anyone can look up.

5.7 The manifest and Merkle commitment

A manifest is the per-window record: a versioned object listing every dataset published in that window with its digest, its record count and its publication timestamp. The manifest is itself canonicalised, digested and signed, and it is the manifest digest that is anchored on-chain. This means a single on-chain transaction commits to the complete state of the record for that window, rather than requiring one transaction per dataset.

The current design anchors a flat manifest. The architecture supports, and Stage 2 anticipates, replacing the flat structure with a Merkle tree over dataset digests. The advantage is inclusion proofs: with a Merkle root anchored on-chain, a verifier can be shown that one specific record (a single reserve figure, a single well result) was part of a published, anchored dataset, without being given the whole dataset and without trusting the party providing the proof. That property matters for the tokenisation engine of Section 6, where a compliance module may need to check a single attested value on-chain rather than ingest an entire published corpus.

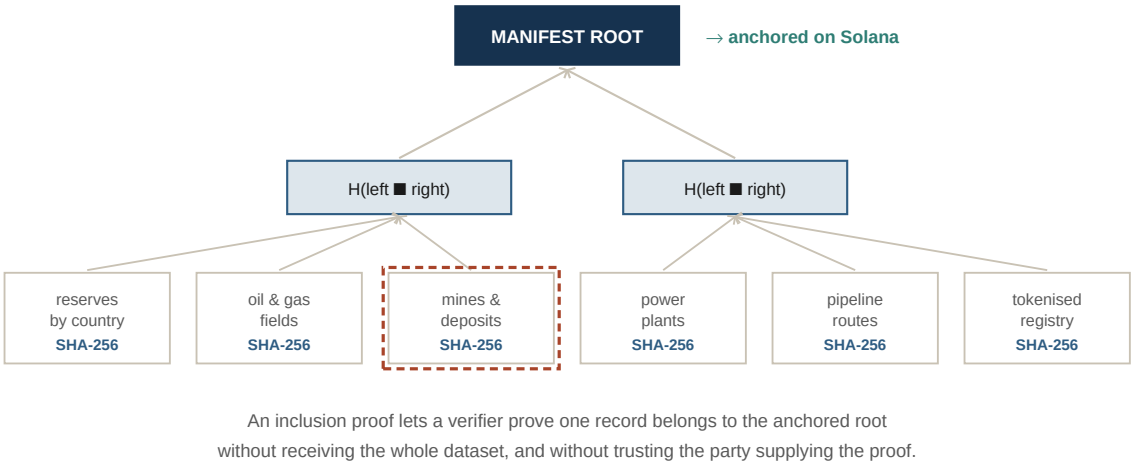


Figure 6: Manifest as a Merkle commitment (Stage 2). v1 anchors a flat digest list.

5.8 Verification

The verification procedure is deliberately trivial. It requires approximately five lines of code against any Ed25519 library, and a self-contained verifier runs in the browser. Any third party can perform it without GEOM's cooperation, without an API key, and without GEOM being online.

```
# Verify a GEOM attestation
1.  Fetch the published dataset D and its attestation record A.
2.  Canonicalise D  ->  bytes C          (sort keys recursively, strip whitespace)
3.  digest = SHA-256(C)
4.  assert digest == A.digest            # integrity: D is byte-for-byte what was published
5.  msg = format(A.prefix, A.version, A.dataset_id, A.digest, A.timestamp)
6.  assert Ed25519.verify(A.pubkey, msg, A.signature)   # authorship: GEOM published it
```

```
7.  tx = solana.getTransaction(A.anchor_tx)
8.  assert A.manifest_digest in tx.memo  # existence: committed at or before tx.blockTime
9.  assert tx.signer == A.pubkey         # same key anchored it
```

Steps 4, 6 and 8 correspond exactly to the three claims of Section 5.9. A verifier who completes all three has established the full extent of what GEOM asserts, and nothing beyond it.

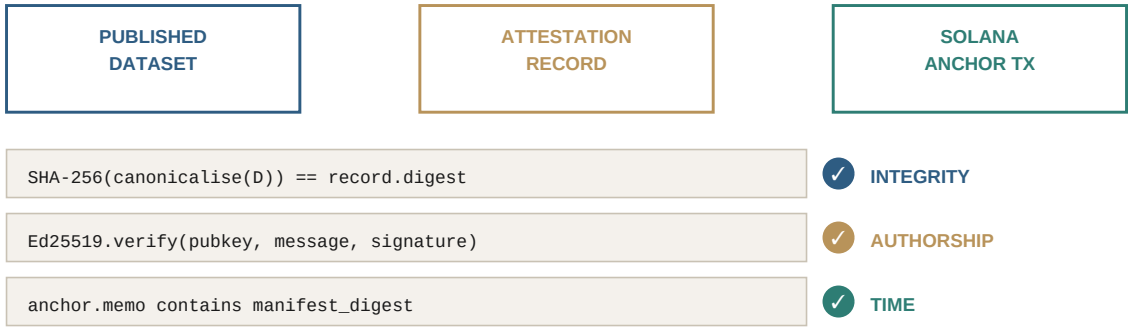


Figure 7: The three verification checks.

5.9 What it confirms

Three things, and only those three:

- **Integrity.** That a dataset is byte-for-byte what GEOM published.
- **Time.** That GEOM published it at or before a specific, independently observable moment recorded on a public ledger.
- **Authorship.** That GEOM, and specifically the holder of the published key, is the publisher.

5.10 What it does not confirm

The Oracle does not verify, audit or confirm that the underlying data is accurate.

This distinction is the single most important sentence in this document and is not a disclaimer appended for caution. It is a statement of what the system does. Attestation is a provenance and integrity function: it establishes who said what, and when, and that it has not been altered since. It establishes nothing whatever about whether what was said is true.

The curated datasets are seed data compiled from public sources, including OPEC, the EIA, operator disclosures, published mining rankings and the World Nuclear Association. Their figures are approximate and require verification before formal publication. The power plant dataset is republished from the WRI Global Power Plant Database v1.3.0 under CC-BY 4.0.

GEOM does not describe oracle output as *verified* data. *Signed* and *attested* describe what the tool provides. *Verified* would overstate it, and the overstatement would be material: a party relying on a GEOM attestation as though it were an independent confirmation of a reserve figure would be relying on something GEOM has never claimed to provide. Section 8.2 describes the separate, professionally-gated work required before any substantive verification claim can be made.

No token, security or other asset is created, issued or sold through this tool.

5.11 Key management and rotation

The security of the entire record reduces to the security of the signing key. Three properties govern its handling. The signing key is held in hardware-backed storage with access restricted to the publication pipeline. The public key is published and is the reference against which every historical attestation is checked. Rotation, when it occurs, is performed by publishing a rotation record signed by the outgoing key that names the incoming key, so that the chain of authority is itself attested and a verifier can follow it forward from any historical point without an out-of-band trust decision.

Compromise of the signing key would allow an attacker to produce attestations that verify. It would not allow an attacker to alter previously anchored manifests, because those are committed to the ledger; the damage of a key compromise is bounded forward in time, not backward.

5.12 The legacy prefix

The signing and anchoring message formats retain a `GAEA` prefix from the project's former working name. Existing signatures and on-chain anchors depend on those exact bytes: changing the prefix would change the signed message, and every signature produced before the change would cease to verify against the published procedure.

The prefix is therefore retained deliberately. Cosmetic consistency with the current brand is worth less than the continuous validity of every attestation the system has produced since launch, and a record that invalidates its own history to tidy a string is not a record.

5.13 Threat model

Threat	Mitigation	Residual
Retroactive alteration of a published dataset	Digest mismatch is detectable by any holder of the attestation; manifest is anchored on a ledger GEOM does not control.	None material.
Backdating a publication	Anchor timestamp is set by Solana consensus, not by GEOM.	Forward-dating is possible but is not a useful attack.
Impersonation of GEOM as publisher	Ed25519 signature over a versioned, prefixed message; public key is published.	Depends on key custody (5.11).
Signing key compromise	Hardware-backed custody; attested rotation procedure; historical anchors remain immutable.	Forward-looking exposure until rotation is published.
Cross-protocol signature replay	Fixed prefixed message format; signatures are not bare digests.	None material.
Submission of false data by a member operator	Attribution is permanent and public: the operator's own signature is attached to the claim.	**Not mitigated by the oracle.** Accuracy is out of scope (5.10).
Chain reorganisation affecting an anchor	Anchors confirmed to economic finality; window re-anchored if not.	Bounded by Solana finality characteristics.

Table 2: Attestation layer threat model. The final row is the one that matters most: the oracle is not a truth mechanism, and no cryptography in this section makes a false submission true.

5.14 Comparison with existing oracle designs

	Chainlink	Pyth Network	GEOM
Data source	Third-party node operators	First-party publishers (market makers, exchanges)	First-party publishers (licensed operators)
Domain	Financial and general-purpose	Financial market data	Physical resource assets
Delivery	Push	Pull	Publish-and-anchor
Update cadence	Continuous / threshold	Sub-second	Per publication window
Asserts accuracy	Aggregated consensus of reporters	Aggregated first-party prices with confidence interval	**No.** Provenance and integrity only
On-chain footprint	Aggregator contracts	Price feed accounts	Memo anchor; no program

Table 3: Comparison of oracle architectures. GEOM's deliberate restraint in the accuracy row is what keeps its liability profile narrow at Stage 1, and is precisely what Stage 2 is gated against changing.

The comparison also clarifies why the physical resource domain is architecturally different from the financial one. A price has a continuously observable market reference and can be aggregated toward consensus in milliseconds. A reserve estimate has no market reference, changes on the timescale of drilling campaigns, and is produced by a professional judgement process that no aggregation of reporters can reproduce. That is why GEOM's Stage 1 asserts provenance only, and why Stage 2's move toward substantive verification requires qualified professionals rather than more nodes.

5.15 The path to the verified layer

Stage 2 of the roadmap extends the oracle from confirming submission integrity to confirming the substance of a technical claim. That transition is not an incremental feature. It moves GEOM from attesting *that an operator said X* to attesting *that X is accurate*, which is the function performed in the hydrocarbon industry by qualified reserve engineers and in mining by Qualified Persons under codes such as NI 43-101 and JORC.

Those functions are professionally regulated for a reason that the history of the extraction industries makes plain: falsified assay and reserve data relied upon by investors has produced some of the largest frauds in the sector's history. Any system that positions itself as confirming the truth of such data inherits that liability surface. Section 8.2 therefore gates Stage 2 behind qualified professional engagement, professional liability insurance, and a dedicated legal opinion on the shift; and until all three are in place, the language of Section 5.10 governs without exception.

6 The Tokenisation Engine

This is the component the project is ultimately built to deliver. Sections 1 through 5 describe a record; this section describes what the record is *for*. The engine is not live, is gated behind the conditions in Sections 8.3 through 8.5, and nothing in this section should be read as describing a deployed system.

6.1 Why oil and minerals are unsolved

Tokenisation has succeeded where the underlying asset is already a financial instrument. A Treasury bill is a claim with a defined issuer, a known face value, a settlement convention and an existing regulatory wrapper; representing it on-chain is a change of delivery mechanism, not a change of legal nature. The same is broadly true of money market fund units, private credit participations and, with more friction, real estate special purpose vehicles.

Physical resource assets resist this for four structural reasons.

- **Title is licensed, not owned.** A hydrocarbon or mineral position is typically a state-granted licence or a working interest carved out of one, held subject to conditions, work commitments and transfer approvals. The state is a party to the asset in a way it is not a party to a bond.
- **Quantity is an estimate, not a balance.** A reserve figure is a probabilistic technical judgement that changes as wells are drilled. There is no equivalent of a custodian confirming a balance, and any token whose supply purports to track a reserve is tracking an opinion.
- **The natural instruments are securities.** A tokenised working interest, royalty or revenue participation is an investment contract in most jurisdictions in which it would be sold. This is not changed by tokenising it; regulators have stated plainly that tokenisation is a delivery method, not a new asset class, and that a token representing a security remains a security.
- **Verification of the underlying is expensive and professional.** Confirming that a stated resource exists requires qualified engineers and geologists, not consensus among anonymous nodes.

The first two are why a data layer must exist before an issuance layer. The third is why GEOM's engine is designed so that GEOM never becomes the issuer. The fourth is why Stage 2 precedes Stage 3.

6.2 Architectural principle: separation by entity, integration by group

The engine's central design commitment is that regulated functions and unregulated functions are never performed by the same legal entity. It does not follow, and GEOM does not intend, that regulated functions are performed by strangers.

The regulated seats (custody, matching, brokering, investor onboarding, register maintenance, settlement) are to be filled by **GEOM subsidiaries holding their own authorisations**, each separately incorporated, separately capitalised and ring-fenced from the Foundation. This is the structure operated by the established participants in regulated tokenisation, which hold broker-dealer, transfer-agent and trading-venue authorisations in-house rather than renting them, and it is chosen for the same two reasons they chose it: control of the full instrument lifecycle, and capture of the economics at every stage of it rather than at one.

The consequence is a closed loop. The operator signs its data; GEOM attests it; an instrument is issued against the attested record; a GEOM-licensed venue matches it; a GEOM-licensed custodian holds it; a GEOM-licensed settlement entity settles it. Each of those functions sits behind an authorisation, and each authorisation sits in a distinct entity, but the loop closes inside the group.

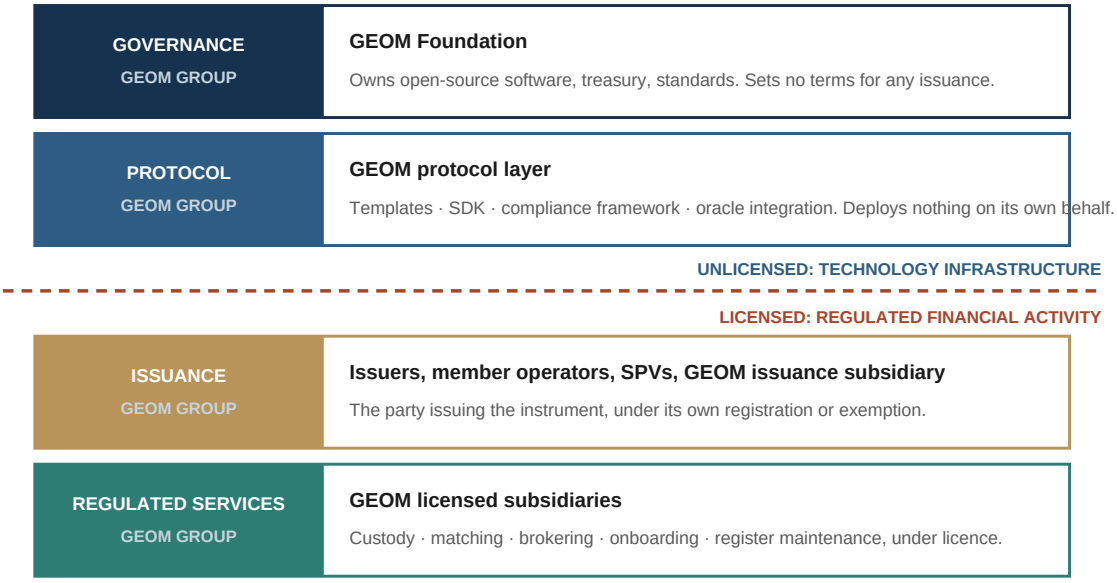


Figure 8: The GEOM group. The dashed line is the licensing boundary, crossed only by an authorised subsidiary.

The boundary is therefore a licensing boundary, not an ownership boundary. An unlicensed entity may not custody assets, match buyers with sellers, broker sales, advise on investments or maintain an authoritative ownership register, and until the corresponding authorisation is granted, no GEOM entity does any of those things. Section 6.9 states those exclusions and the stage at which each falls away; Section 8.4 makes the grant of each licence a gate condition rather than a design assumption.

6.3 Token standards

The engine is chain-agnostic by design and targets the two standards where permissioned real-world asset issuance has actually converged.

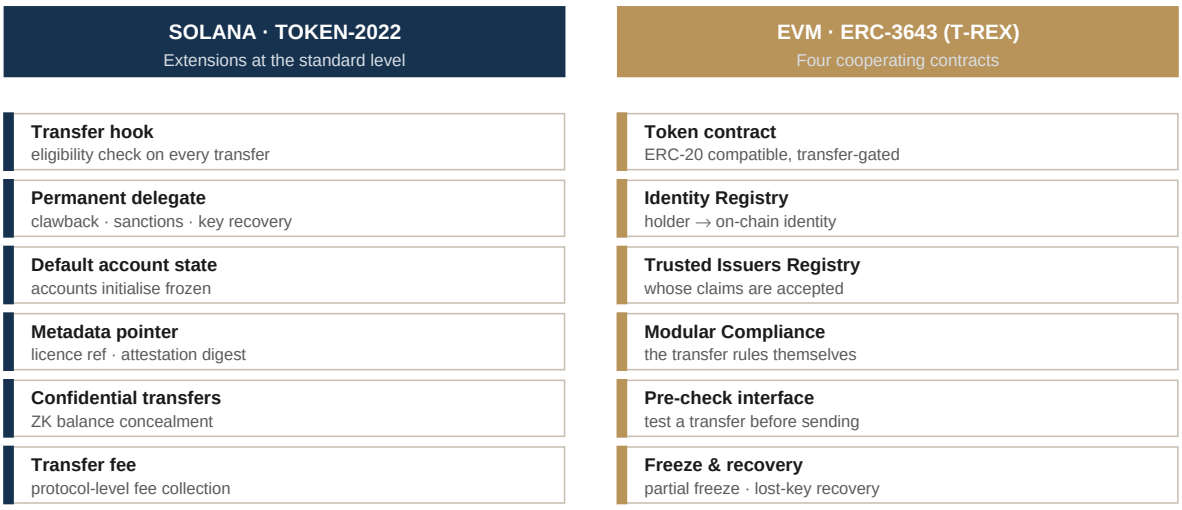
Solana: Token-2022 (Token Extensions)

Token-2022 is a superset of the original SPL Token program, adding optional extensions enabled at mint creation. It is the standard on which regulated stablecoin issuers have built on Solana, and it provides the compliance primitives an issuer of a permissioned resource instrument requires natively, rather than through bespoke program logic:

Extension	Function in a resource instrument
Transfer hook	Routes every transfer through a custom program for eligibility checks: allowlists, jurisdiction restrictions, holding-period locks, maximum-holder counts.
Permanent delegate	Designated authority able to move or burn tokens from any account. Required for court-ordered transfers, sanctions compliance and lost-key recovery.
Default account state	New token accounts initialise frozen, so that no holder can receive the instrument before eligibility is established.
Metadata / metadata pointer	On-chain instrument metadata (asset identifier, licence reference, attestation digest) without an external dependency.

Extension	Function in a resource instrument
Confidential transfers	Zero-knowledge concealment of balances and amounts where an issuer requires holder privacy while preserving auditability.
Transfer fee	Protocol-level fee collection where an instrument's terms require it.

Table 4: Token-2022 extensions relevant to permissioned resource instruments. Most extensions must be enabled at mint creation and cannot be added later, which makes instrument design an upfront exercise.



Architecturally convergent: an identity layer, a rules layer, and enforcement at the point of transfer.
That convergence is what makes a single SDK across both standards feasible.
Figure 9: Target permissioned token standards.

EVM: ERC-3643 (T-REX)

On EVM chains the engine targets ERC-3643, the permissioned token standard originally developed as T-REX and now governed by the ERC-3643 Association. ERC-3643 is ERC-20 compatible but makes every transfer conditional on an on-chain compliance check, and separates that check into four cooperating components: the token contract, an Identity Registry mapping holders to on-chain identities, a Trusted Issuers Registry naming the parties whose identity claims are accepted, and a modular Compliance contract holding the transfer rules themselves. The standard also mandates capabilities a regulated issuer cannot operate without: a pre-check interface to test whether a transfer would pass before submitting it, partial or total freezing of holder balances, and a recovery mechanism for lost keys.

The two standards are architecturally convergent (an identity layer, a rules layer, and enforcement at the point of transfer) which is what makes a single SDK across both feasible.

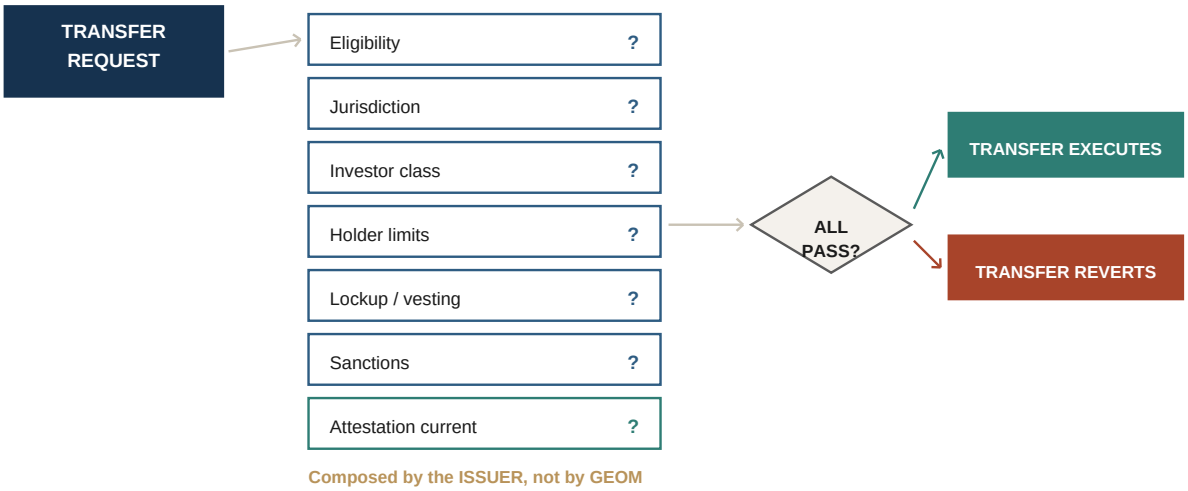
6.4 The compliance module system

An issuer's obligations differ by jurisdiction, by instrument and by investor class, and they change. Hard-coding them into a token contract produces an instrument that must be redeployed and migrated every time a rule moves. The engine therefore treats compliance as a set of composable modules evaluated at transfer time, each answering a single question with a boolean.

Module class	Question evaluated at transfer	Typical source of the rule
Eligibility	Does the recipient hold a valid, unexpired claim from a trusted issuer?	Issuer's offering terms; KYC provider
Jurisdiction	Is the recipient's jurisdiction permitted for this instrument?	Securities regime of the offering
Investor class	Is the recipient accredited / professional / qualified as required?	Exemption relied upon by the issuer
Holder limits	Would this transfer breach a maximum holder count or concentration cap?	Registration thresholds; fund rules
Lockup and vesting	Has the applicable holding period elapsed?	Distribution compliance periods
Sanctions	Is either party subject to a sanctions designation?	OFAC, UN, UK, EU lists
Attestation	Is the referenced asset attestation current and unrevoked?	GEOM oracle (Section 5)

Table 5: Compliance module classes. Modules are composed per instrument by the issuer, not imposed by GEOM.

Two design rules govern the module system. Modules are *additive and independently auditable*: each is small enough to be reasoned about and audited in isolation, and the composition of modules for a given instrument is a public, inspectable configuration. And modules are *selected by the issuer*: GEOM publishes the framework and reference implementations, but does not choose which rules apply to a third party's offering, because choosing them would be advising on the offering.



Every module answers one boolean question, is independently auditable, and is evaluated at transfer time.

Figure 10: Compliance module evaluation. Modules are composable and jurisdiction-specific.

6.5 Identity and eligibility

Permissioned transfer requires a mapping from a wallet address to a set of verified claims about the holder. The engine does not maintain that mapping itself and does not perform know-your-customer checks. It integrates with on-chain identity infrastructure (ONCHAINID on the EVM side, credential-issuing programs on Solana) in which the claims are

issued by regulated verification providers and merely *read* at transfer time.

The privacy property that follows is worth stating: what lands on-chain is a claim reference (that a trusted issuer has attested that this holder satisfies a condition) not the underlying personal data. The identity provider holds the documents; the chain holds a cryptographic assertion about them. No personally identifiable information is written to the ledger by the engine.

6.6 Instrument design patterns

The engine is intended to support four instrument archetypes. Each is described here as an engineering pattern. Each, if issued, would in most jurisdictions be a security, and would be issued under a registration or exemption held by the issuing party, a member operator, a special purpose vehicle, or in due course a GEOM issuance subsidiary holding the necessary authorisation. No instrument is issued by an unlicensed entity.

Pattern	Represents	Principal design problem
Working interest participation	A fractional undivided interest in a licence's production and costs	Licence transfer approvals; joint operating agreement consent; state as counterparty
Royalty / NPI stream	A right to a share of revenue or net profits, without cost exposure	Payment waterfall enforcement; oracle dependency for production volumes
Development funding note	A debt or convertible instrument funding a defined work programme	Milestone verification; use-of-proceeds attestation
Offtake / delivery right	A right to future physical delivery at a defined price or discount	Retail commodity transaction rules; delivery windows; deliverability to the holder class

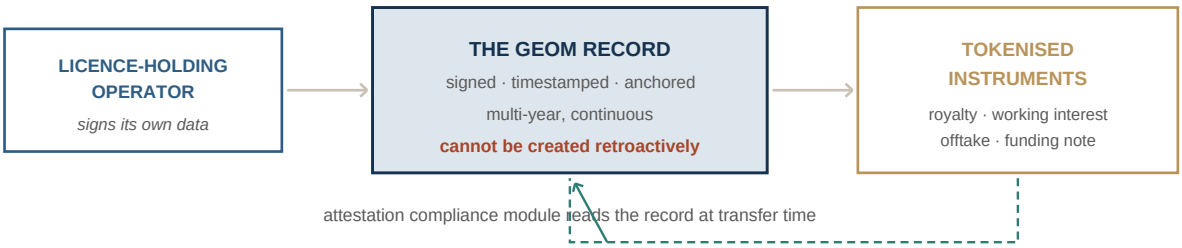
Table 6: Instrument archetypes. The fourth carries a distinct regulatory profile from the first three: a right to future delivery of a physical commodity to non-institutional holders can engage commodity regulation independently of securities law.

6.7 Oracle integration: the structural moat

This is the point at which Sections 5 and 6 join, and it is the reason the record is built first.

Every instrument in Table 6 depends on a fact about the physical world that the chain cannot observe: whether the reserve exists, what was produced last quarter, whether the licence remains in good standing, whether the work programme was completed. A tokenised royalty that pays against production volumes needs those volumes to arrive on-chain from a source the holders can check. A working interest participation needs the licence status it depends on to be verifiable.

Today, that data arrives (if at all) as a PDF on a corporate website, asserted by the same party that benefits from it, with no cryptographic link between the number an investor reads and the number the operator generated. The GEOM record replaces that with an attested, timestamped, independently checkable input: the attestation compliance module of Table 5 can require that an instrument reference a current, unrevoked attestation, and the Merkle inclusion proofs described in Section 5.7 allow a single figure to be proven on-chain without publishing the entire dataset.



Contract templates are replicable. A first-party record produced by the licence holders themselves is not.

This is why Stage 1 ships years before Stage 3 is legally possible.

Figure 11: Oracle integration, the structural moat.

The strategic consequence is the one stated in Section 1.1. Any competent engineering team can build issuance contracts; contract templates are not a defensible position. What is difficult to replicate is a multi-year, continuously anchored, first-party record produced by the licence-holding operators themselves, because that record cannot be created retroactively, and because it requires the operators to have chosen to participate before there was an obvious reason to. That is what the Association is, and it is why Stage 1 exists years before Stage 3 is legally possible.

6.8 SDK components

The Stage 3A deliverable is a software development kit, distributed open-source or as a hosted service, comprising:

- **Contract templates.** Audited reference implementations for each archetype in Table 6, on Token-2022 and ERC-3643, parameterised rather than bespoke.
- **Issuance workflows.** Deployment tooling that takes an issuer from configuration to a deployed, verified contract: mint configuration, extension selection, compliance module composition, metadata binding to an attestation reference.
- **Compliance module library.** Reference implementations of each module class in Table 5, individually audited, composable by the issuer.
- **Identity connectors.** Adapters to on-chain identity infrastructure and to third-party KYC providers, so that eligibility claims are read from a regulated source rather than originated by the engine.
- **Oracle client.** Libraries for consuming, verifying and referencing GEOM attestations from within a compliance module or an off-chain application, including inclusion-proof verification.
- **Pre-flight simulation.** An interface allowing an issuer or holder to test whether a proposed transfer would satisfy every configured module before submitting it on-chain, a capability ERC-3643 mandates and which materially reduces failed-transfer cost and confusion in permissioned markets.

6.9 What GEOM does not do before it is licensed to do it

The following are hard commitments for the unlicensed protocol layer, and they bind until the corresponding authorisation is actually held by a GEOM subsidiary. They are sequencing commitments, not permanent renunciations: the object of Stages 3B and 3C is precisely to obtain the licences that permit these functions to be performed lawfully. Until each licence is in hand, the protocol layer does not:

- custody customer assets;

- match buyers and sellers, or operate any venue on which instruments trade;
- broker, place or solicit the sale of any instrument;
- advise any party on the structure, terms or merits of an offering;
- issue any regulated financial product on behalf of a client;
- maintain the authoritative ownership register for a third party's instrument.

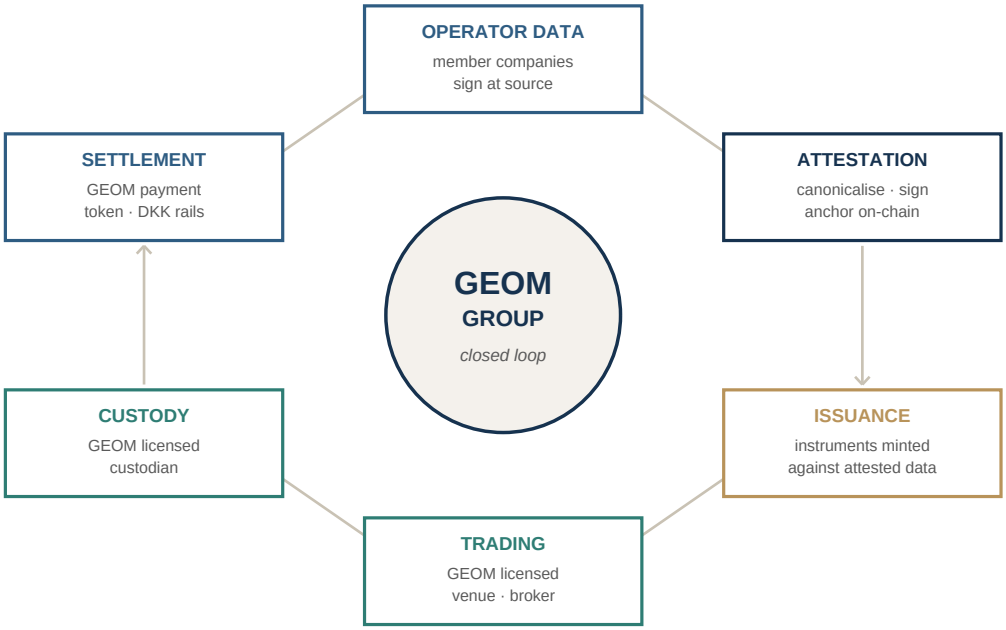
The economic corollary matters as much as the functional one, and it is also stage-dependent. For as long as the protocol layer is unlicensed, its compensation is structured as flat licensing or subscription fees rather than as a percentage of amounts raised or of instrument value: transaction-based compensation is among the clearest indicators regulators use to identify brokering activity, and a fee that scales with deal size makes the infrastructure characterisation considerably harder to sustain. Once a GEOM subsidiary holds the relevant authorisation, that constraint falls away for the licensed entity (a licensed broker may lawfully be paid like one) and the group's revenue model broadens accordingly. Section 7.5 addresses what that does, and does not, mean for $GEOM.

6.10 The licensing path

The engine's regulatory position is staged deliberately, and Section 8 attaches gate conditions to each step. Stage 3A operates as unlicensed technology infrastructure within a free-zone regime that accommodates non-regulated Web3 infrastructure activity, on the strength of a legal opinion confirming that the SDK as scoped is not itself a regulated activity. Stage 3B is the licensing stage: GEOM subsidiaries apply for and obtain the authorisations required to perform custody, matching, brokering and register maintenance, on a working assumption of a three-to-four month application and approval cycle per jurisdiction. Stage 3C is the closed loop operating, every seat filled by a licensed GEOM entity, with the instrument lifecycle running end to end inside the group.

Two structural requirements govern the whole sequence. Each licensed function sits in its own incorporated, capitalised, separately governed subsidiary, so that an enforcement or solvency event in one does not reach the others. And every licensed subsidiary is ring-fenced from the Foundation, so that regulated-activity liability cannot reach the ownerless entity that publishes the record, the record must survive any commercial failure in the group.

Nothing in the sequence assumes a regulatory outcome. Each transition is gated on an authorisation actually being granted, and the sequence is designed so that failure to obtain one halts progress at that stage rather than propagating risk into the layers already operating. This is a materially more capital-intensive and compliance-intensive path than renting third-party licences, and it is chosen deliberately: the closed loop is the product.



Every stage of the lifecycle (from the operator's signature to final settlement) runs inside the GEOM group, **on infrastructure GEOM built and under licences GEOM holds.**

Figure 12: The closed loop.

7 $GEOM

7.1 Design principles

$GEOM is the Association's token, issued on Solana. Three principles govern its design, and each was chosen for a compliance reason rather than a marketing one.

- **No financial claim.** The token confers no claim of any kind on the Foundation, the Association, or any member company. There is no mechanism by which holding it entitles anyone to a distribution.
- **No price-support mechanism.** There is no burn, no buyback, and no reward mechanism of any kind funded by Foundation or member revenue. A mechanism that deploys an identifiable entity's revenue to support a token's price is, in substance, a profit-distribution mechanism regardless of its label, and the absence of one is deliberate.
- **No insider allocation.** The distribution is fair-launch, with no allocation to the Foundation's Founder, Council, members or technical partner.

7.2 Distribution

$GEOM was fair-launched on Solana. No allocation was made to the Foundation's Founder, Council members, the Association's member companies, or the contracted technical partner. A development wallet retains 5–10% of supply, locked, for protocol operations and the community-benefit programme.

The absence of member allocation is structurally load-bearing beyond its optics. Because no member company holds tokens, a member's public statement that it belongs to the Association is a factual statement about an affiliation rather than promotion by a financially interested party; which is a materially different position under the disclosure rules governing paid endorsement.

7.3 Utilities

Utility	What it provides	Status
Attestation access	Priority and extended access to the attestation pipeline and inclusion-proof tooling described in Sections 5.7 and 5.8.	Live
Basin intelligence portal	Planned holder access to exploration content across the Association's active projects: operational updates, drilling data as disclosed, technical commentary.	Planned
Monthly sessions	Recurring access to geologists and project teams from member companies.	Live
Advisory governance	Non-binding voting on community programming, partner selection and comparable matters. No claim on Foundation or member assets.	Live
Burn-to-redeem	Site-visit entries and event access, redeemed at a fixed, disclosed rate.	Live
Community-benefit fund	A defined share of creator fees directed to a Greenlandic scientific research recipient. A public-benefit programme, not a price-support mechanism.	Live

Table 7: $GEOM utilities. The attestation access utility is the cornerstone: it is the one tied to the infrastructure the rest of this paper describes.

7.4 What $GEOM is today, and what changes

A precise statement is required here, because the answer is stage-dependent, and because two different assets are routinely collapsed into one another in discussion of this project. They are not the same thing and their economics are not the same.

Today

$GEOM confers no financial claim of any kind on the Foundation, the Association, or
any member company. It grants no rights over any licence, any barrel or any ounce. It is not backed by, redeemable for, or priced against any physical asset. No expectation of profit is offered or implied. Nothing described in the roadmap at Section 8 beyond Stage 1 is live; GEOM does not tokenise assets today, and nothing is issued, custodied, matched, brokered or settled through any system GEOM operates.

What the tokenisation engine changes, and for which asset

The instruments issued through the engine of Section 6 are a different asset class from $GEOM, and they are designed from the outset to carry economic rights to produced volumes. That is their entire purpose. A tokenised royalty stream pays against production. A tokenised working interest carries a proportionate share of production and of cost. A tokenised offtake right is a claim to physical delivery. These are instruments tied to oil and mineral yields in the most direct sense, and building the rails on which they can be issued lawfully is the object of this entire project.

The Association's stated ambition, articulated by its chairman, is to bring the basin's reserves on-chain through GEOM. If that is achieved, the reserve base described in Section 2.6 becomes issuable, transferable and verifiable on public infrastructure for the first time, and the category of on-chain commodities acquires an actual underlying.

Three properties of those instruments must be stated without ambiguity. They are securities in most jurisdictions in which they would be sold. They will be issued under a registration or exemption held by the issuing party (a member operator, a special purpose vehicle, or a GEOM issuance subsidiary) and traded, custodied and settled through licensed GEOM entities, once the authorisations described in Section 8 are in hand. And **they are not $GEOM: holding $GEOM does not confer, and will not confer, an interest in any instrument issued through the engine.**

What may change for $GEOM itself

Stage 4 contemplates a mechanism connecting Association revenue to $GEOM. It is real, it is designed, and it is gated, on a change in United States law that has not occurred, on a restructuring of governance toward diffuse and non-discretionary control, and on contemporaneous securities counsel confirmation that the specific mechanism does not itself create a security. Until every one of those conditions is satisfied, the position stated under *Today* above governs without qualification, and no such mechanism is scheduled.

7.5 Future value creation

The honest statement of the long-term thesis is this: **value, if it accrues, is expected to accrue to the network rather than to a mechanism.**

Pyth Network is the closest available precedent and is instructive precisely because it was criticised for the same thing. For most of its history PYTH had governance and little direct value capture (no fee burn, no revenue share, no mandatory payment in the token) and analysts asked the obvious question: why should the token appreciate if the oracle succeeds? Yet the market valued the network at scale anyway, on adoption, on the difficulty of replicating a first-party publisher set, and on the optionality that governance could one day connect the two. Only later did the DAO move toward a revenue-linked model.

GEOM's position is the same in structure and deliberately more conservative in execution. The asset being built is a first-party record of the physical resource base produced by licence-holding operators, and the difficulty of reproducing it is the point. What GEOM does *not* do is pre-commit to the mechanism Pyth eventually adopted, because a revenue-funded buyback executed at the discretion of a small identifiable body is the fact pattern regulators have litigated most directly. Section 8.6 gates any such mechanism behind a change in law, a restructuring of governance toward diffuse and non-discretionary control, and contemporaneous securities counsel sign-off on the specific design.

Until every one of those conditions is satisfied, $GEOM carries no revenue-share, buyback or price-support mechanism, and none is scheduled. Section 8.6 is included for transparency about long-term thinking; it is not a plan, and it may never proceed.

8 Roadmap

GEOM is built in stages, and each stage is larger in scope and in regulatory consequence than the one before it. Each is gated behind a requirement that must be satisfied before it goes live: a legal opinion, a professional engagement, a licence, or in two cases a change in law. **The gates are what allow the structure to keep standing as it grows.** Target timings are aims for reaching those requirements, not commitments to launch by a fixed date, and no stage beyond Stage 1 is live.

Where a stage requires a licence or an authorisation rather than an opinion, the working assumption is a three-to-four month application and approval cycle per jurisdiction, running in parallel with the engineering work for that stage rather than after it. That assumption is the principal schedule risk in the roadmap: regulatory timetables are not within the Foundation's control, and a stage does not open because its engineering is finished.

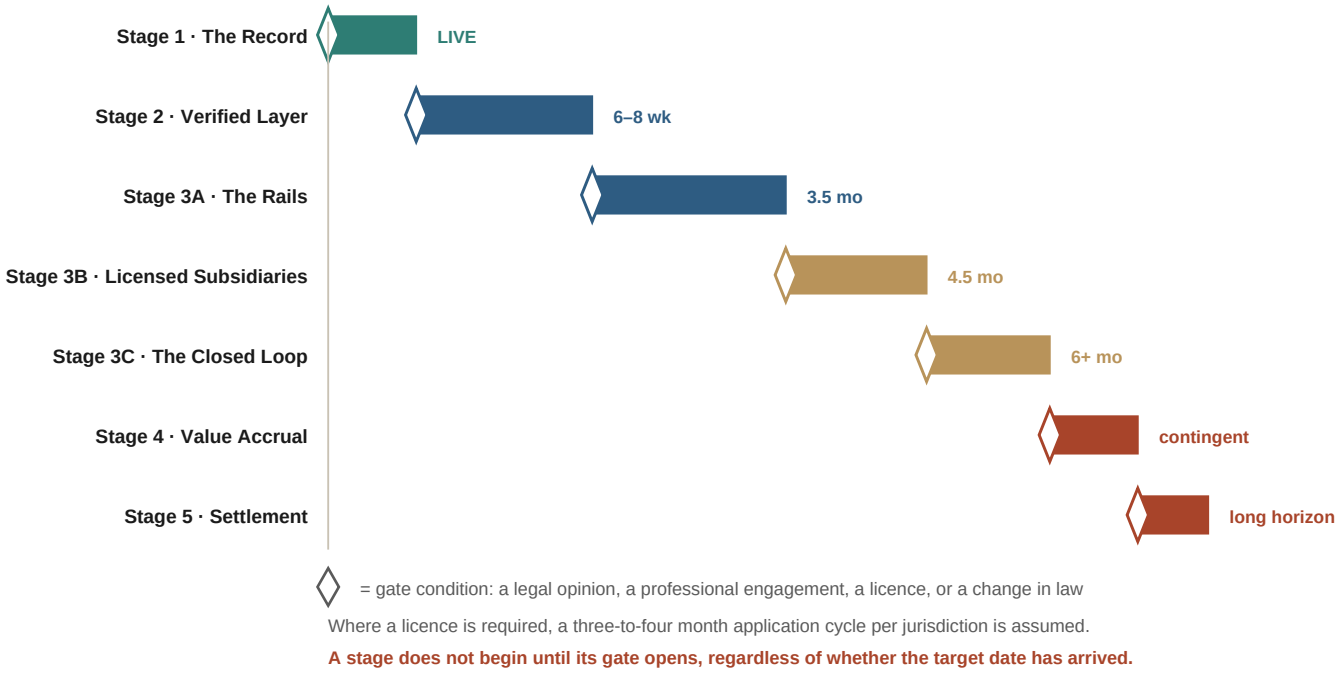


Figure 13: Staged roadmap. Horizontal position is indicative sequence, not committed schedule.

8.1 · STAGE 1 · LIVE NOW

The Record

Shipped

The provenance oracle. Every dataset GEOM publishes is canonicalised, hashed with SHA-256, signed with Ed25519 and anchored on Solana mainnet in a memo transaction. Publication and integrity, provable by anyone, permanently.

Technical scope. Seven datasets under attestation (Table 1); flat manifest per publication window; browser-executable verifier requiring no GEOM cooperation; hardware-backed key custody with an attested rotation path. The record of the physical resource world already runs; this document is describing shipped software.

> **UNLOCKED BY** Nothing. It is live.

8.2 · STAGE 2 · TARGET 6–8 WEEKS

The Verified Layer

Extends attestation from provenance to substance

Operator-submitted reserves, production and survey data, cross-checked against professional verification and attested on-chain. Reserve figures stop living in PDFs and start living as signed, independently checkable records.

Technical scope. Migration of the manifest from a flat digest list to a Merkle tree, enabling inclusion proofs for individual records (Section 5.7); a submission pipeline with per-operator signing keys, so that each member signs its own data rather than GEOM signing on its behalf; a revocation and restatement protocol, since technical estimates legitimately change as wells are drilled and a record that cannot express a restatement will be falsified by ordinary industry practice; and an AI-assisted cross-check layer that reconciles submitted figures against satellite observation, historical production curves and public filings. That layer is a *complement to* professional verification, not a substitute for it, the sign-off remains a qualified human judgement.

This is the first time exploration data from listed operators will exist as an on-chain, independently checkable record.

> **UNLOCKED BY** Qualified reserve and resource professionals engaged. Professional liability insurance in place. A dedicated legal opinion on the shift from provenance to verification.

8.3 · STAGE 3A · TARGET 3.5 MONTHS

The Rails

Tokenisation SDK, pure infrastructure

The tokenisation SDK: contract templates, issuance workflows and compliance modules that let developers deploy their own token contracts for resource assets. Specified in Section 6.8.

Technical scope. Audited reference contracts on Token-2022 and ERC-3643 for the archetypes of Table 6; the composable compliance module library of Table 5; identity connectors reading claims from regulated verification providers; the oracle client with inclusion-proof verification; and pre-flight transfer simulation. Distributed open-source or as a hosted service, compensated by flat licensing fees rather than transaction-based compensation (Section 6.9).

GEOM does not custody assets, match buyers and sellers, operate an exchange, broker sales or advise on investments. The tooling that puts oil and minerals on-chain exists, and GEOM built it.

> **UNLOCKED BY** Legal confirmation that the SDK as scoped constitutes technology infrastructure rather than a regulated activity under the applicable free-zone regime, and a binding product commitment excluding custody, matching and brokering.

8.4 · STAGE 3B · TARGET 4.5 MONTHS

Licensed Subsidiaries

GEOM obtains the authorisations itself

The licensing stage. GEOM incorporates and capitalises the subsidiaries that will hold the authorisations required to perform regulated functions (custody, matching and brokering, investor onboarding, and register maintenance) and files for those authorisations in each target jurisdiction.

Scope. Entity formation and capitalisation per regulated function; licence applications on a working assumption of a three-to-four month cycle per jurisdiction, run in parallel rather than in series; the governance, audit, reporting, safeguarding and client-asset segregation infrastructure each authorisation requires; and the ring-fencing that separates every licensed subsidiary from the Foundation, so that regulated-activity liability cannot reach the ownerless entity that

publishes the record.

This is a business and legal milestone as much as a technical one, and it is the stage most exposed to timetables outside the Foundation's control. A regulator's queue is not shortened by the engineering being finished.

> **UNLOCKED BY** Subsidiaries incorporated and capitalised. Licence applications filed and granted in each target jurisdiction. Legal opinions on the group structure and on the effectiveness of the ring-fencing between each licensed subsidiary and the Foundation.

8.5 · STAGE 3C · BEYOND 6 MONTHS

The Closed Loop

The full lifecycle operating inside the group

The licensed subsidiaries go live and the loop closes. An operator signs its data at source; GEOM attests it; an instrument is issued against the attested record; a GEOM-licensed venue matches it; a GEOM-licensed custodian holds it; a GEOM-licensed entity maintains the register and settles the trade. Every stage of the instrument lifecycle runs on infrastructure GEOM built, under licences GEOM holds.

Scope. Production operation of each licensed subsidiary; end-to-end lifecycle integration from attestation through settlement; inter-entity controls and conflict-of-interest management appropriate to a vertically integrated group; supervisory reporting in each jurisdiction; and independent audit of the separation between licensed entities and the Foundation.

This is the state the whole architecture is built toward, and it is what distinguishes GEOM from a tooling vendor. A vendor sells software into someone else's market. A closed loop *is* the market, and captures the economics of every stage of it rather than one.

> **UNLOCKED BY** All Stage 3B authorisations granted and in force. Operational readiness and supervisory sign-off per jurisdiction. Independent audit of inter-entity controls and of the ring-fencing between the licensed group and the Foundation.

8.6 · STAGE 4 · BEYOND 6 MONTHS · CONTINGENT ON US LAW

Value Accrual

Not a plan. Included for transparency.

A mechanism connecting Association revenue to $GEOM. Payouts, in plain language.

It requires a change in United States law that has not occurred, a move toward diffuse and non-discretionary governance, and contemporaneous confirmation from securities counsel that the specific mechanism does not create a security. Section 7.5 explains why each of those conditions is present rather than decorative: the analytical risk in a revenue-funded token mechanism turns substantially on control dynamics, and a mechanism operated at the discretion of a small identifiable body is the least defensible version of it.

When the law turns, the mechanism is already designed, the data layer is already running, and the operators are already inside.

$GEOM carries no revenue-share, buyback or price-support mechanism today, and none is scheduled. This stage is included for transparency about long-term thinking rather than as a plan, and it may never proceed.

> **UNLOCKED BY** Enactment of United States legislation reclassifying actively traded tokens. Governance restructuring toward diffuse, non-discretionary control. Securities counsel sign-off on the specific mechanism at the time.

8.7 · STAGE 5 · LONG HORIZON · CONTINGENT

Settlement in Greenland

The end state the record is built toward

The furthest stage in this roadmap closes the loop between the record and the territory it describes: licensing in Greenland, and the establishment of **$GEOM as a payment token**, a settlement instrument used for actual value transfer within the Greenlandic resource economy, in cooperation with the Government of Greenland and Greenlandic banks.

The phrase is used deliberately and in its technical sense. A payment token is an instrument used to acquire goods or services or to transfer value, as distinct from a utility token granting access or an investment instrument conferring a claim on returns. That characterisation carries its own regulatory consequences, which are the subject of the gate conditions at the end of this stage: payment tokens are regulated as payment instruments, not merely as digital assets, and no jurisdiction permits one to operate on the strength of a whitepaper.

Why this is coherent rather than aspirational

Greenland's resource economy has a structural settlement problem that is not obvious from outside it. Operators are international; the currency is the Danish krone; correspondent banking to a population of approximately 57,000 across 2.16 million square kilometres is thin; and the resource sector's payment flows (licence fees, contractor settlement, royalty distribution, community-benefit disbursement) are large, cross-border and infrequent. A settlement layer purpose-built for that flow, operated with the authorisation of the relevant authorities and integrated with the domestic banking system rather than routed around it, is a genuine infrastructure proposition rather than a token use-case invented after the fact.

The regulatory reality, stated precisely

Section 2.8 sets out the constitutional position, and it governs this stage. Mineral resource authority sits with the Government of Greenland under the 2009 Self-Government Act. Financial supervision does not: Greenland uses the Danish krone and its financial services framework derives from Danish law as extended to Greenland. Greenland is

outside the European Union with Overseas Country and Territory status, so an EU passport under the Markets in Crypto-Assets Regulation does not confer the right to operate here, and MiCA authorisation elsewhere is not a substitute for domestic authorisation.

The practical consequence is that this stage requires two distinct approvals from two distinct authorities: resource-sector cooperation from Greenland, and payment or electronic money institution authorisation under the Danish supervisory framework. Neither substitutes for the other, and neither is in hand.

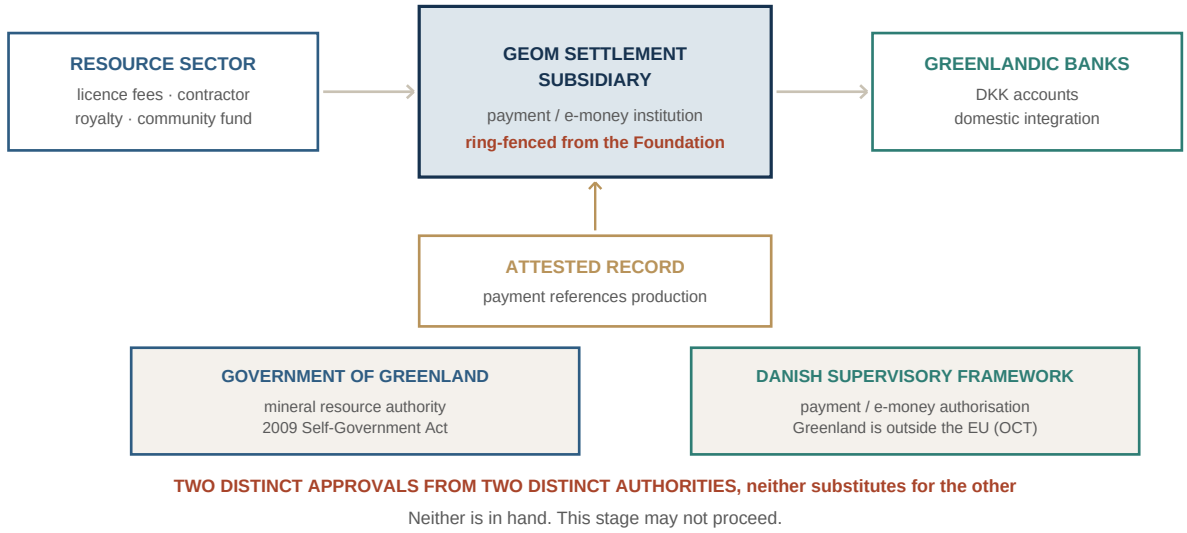


Figure 14: Stage 5 settlement architecture and its regulatory preconditions.

What would be built

Component	Function
GEOM settlement subsidiary	A locally authorised payment or e-money institution within the GEOM group, operating the settlement function. Ring-fenced from the Foundation.
DKK settlement rail	On- and off-ramp between $GEOM-denominated settlement and Danish krone accounts at Greenlandic banking partners.
Resource-sector payment flows	Licence fees, contractor and supplier settlement, royalty distribution, community-benefit disbursement.
Attested payment reference	Settlement instructions referencing the attested record of Section 5, so that a payment against production is linked to a verifiable production record.
Domestic banking integration	Integration with the Greenlandic banking system rather than disintermediation of it.

Table 8: Stage 5 components. Every regulated function sits with an authorised entity; the Foundation operates none of them.

The necessary licences will be obtained before any element of this stage operates. That sequencing is not a preference; it is the condition on which the stage exists at all.

UNLOCKED BY Payment institution or electronic money institution authorisation under the applicable Danish supervisory framework as extended to Greenland. A cooperation framework with the Government of Greenland. Banking partnership agreements with Greenlandic institutions. Legal opinions in each relevant jurisdiction on the payment characterisation of the instrument. None of these conditions is met today, and this stage may not proceed.

8.8 Summary table

Stage	Target	Delivers	Gate
1: The Record	Live	Provenance oracle; seven attested datasets; Solana anchoring	None, live
2: Verified Layer	6–8 weeks	Merkle manifests; per-operator keys; AI-assisted cross-check under professional sign-off	Qualified professionals; E&O; insurance; legal opinion
3A: The Rails	3.5 months	Tokenisation SDK; templates; compliance modules; oracle client	Infrastructure opinion; exclusion commitment
3B: Licensed Subsidiaries	4.5 months	GEOM entities incorporated, capitalised and authorised for custody, matching, brokering, registers	Licences granted per jurisdiction (3–4 month cycle each); ring-fencing opinions
3C: The Closed Loop	6+ months	Full instrument lifecycle operating inside the GEOM group, attestation through settlement	Authorisations in force; supervisory sign-off; inter-entity control audit
4: Value Accrual	6+ months, contingent	Mechanism connecting Association revenue to $GEOM	Change in US law; governance restructuring; counsel sign-off
5: Settlement	Long horizon, contingent	Greenland settlement and payment layer; DKK rails; banking integration	Danish-framework payment authorisation; Greenland cooperation; banking partners

Table 9: Roadmap summary. The gate column is the operative one.

The staging is informed by Pyth Network's trajectory, which demonstrates both the credibility of first-party data sourcing and the regulatory complexity of revenue-linked token mechanisms.

9 Governance

9.1 The Foundation

The Foundation is established under the RAK ICC Foundations Regulations 2019, with the Courts of the Dubai International Financial Centre elected as its governing forum. Its objects are built around ecosystem development, research, community and education relating to Nordic and Arctic exploration. Its constitutional documents expressly prohibit any distribution of income or property to its Founder, Council members or Guardian, or to any person connected to them.

The Foundation is supported by a contracted technical partner engaged under a flat-fee services arrangement to build and operate infrastructure. That partner holds no token allocation, no mint authority, no treasury control and no ownership interest in the Foundation.

9.2 Council and Guardian

The Council consists of a Chairman and an independent Council member, and is the body that manages the Foundation in accordance with the Charter. A Guardian is appointed in an oversight capacity, mandatory under the RAK ICC regime for a foundation with a specified non-charitable object, and is held independently of the Council. Neither Council members nor the Guardian may receive any distribution of Foundation income or property.

9.3 Member Advisory Committee

Each member company may designate one representative to a Member Advisory Committee, which provides a structured channel for collective member input on community programming, event scheduling and the selection of community-benefit recipients. The Committee is advisory only. It has no power to bind the Foundation, direct or overrule the Council, amend the Charter, alter the Foundation's constitutional restrictions, or create any obligation on the treasury.

The limitation is deliberate and structural: giving members collective governance authority over the Foundation would recreate the ownership relationship the entire architecture exists to avoid.

9.4 Token governance

$GEOM holders participate in non-binding advisory voting on community programming and comparable matters. This is participation in community decisions, not governance of the Foundation, and confers no claim on Foundation or member assets. Section 8.6 notes that any future move toward diffuse, non-discretionary governance is a gate condition on Stage 4 rather than a present feature.

10 Security

10.1 Cryptographic methods

The system uses SHA-256 for digesting and Ed25519 for digital signatures, as specified in Sections 5.4 and 5.5. Both are selected for ubiquity of implementation as much as for their security properties: a verification story that depends on third parties actually performing the check is served better by primitives present in every runtime than by more exotic constructions.

The architecture is extensible to additional algorithms. Because the signed message format is versioned (Appendix C), a future migration (including to post-quantum signature schemes as they standardise) can be expressed as a new message version without invalidating historical attestations, which remain verifiable under the version they were produced with.

10.2 Data integrity

Integrity rests on three properties. Published datasets are append-only in practice: a restatement is published as a new attested record referencing the prior one, rather than as an edit, so the historical record of what was said and when remains intact. Every dataset carries a digest that changes completely on any modification. And every publication window is committed to a ledger GEOM does not control, so the existence of a record at a given time is not GEOM's claim to make or to withdraw.

10.3 Attack vectors

Table 2 in Section 5.13 sets out the attestation-layer threat model in full. The row that warrants repetition here is the last one: **submission of false data by a member operator is not mitigated by any cryptography in this system.** What attestation provides against that threat is attribution, the operator's own signature is permanently attached to the claim, and the claim cannot later be quietly revised. Accountability is not the same as prevention, and Section 5.10 governs.

For the issuance layer, the principal attack surface is different in kind. Permissioned token standards concentrate significant authority in compliance roles, the permanent delegate extension permits an authority to move or burn tokens from any account, and a transfer hook program executes on every transfer. These are necessary capabilities for regulated instruments and are also the capabilities most abused in fraudulent deployments. The engine's response is threefold: these authorities belong to the *issuer* of each instrument, they are disclosed in that instrument's public configuration, and they are auditable before purchase. Where the issuer or the intermediary is a GEOM subsidiary, those authorities are additionally exercised under licence and subject to supervisory reporting; which is a stronger control than an unlicensed operator holding the same keys, not a weaker one.

10.4 Operational security

Signing keys are held in hardware-backed storage with access restricted to the publication pipeline. Key rotation is performed through an attested rotation record signed by the outgoing key, so that the chain of authority is itself part of the verifiable record (Section 5.11). All communications with the submission pipeline are transport-encrypted and authenticated. Reference contracts and compliance modules are independently audited before release, and audit reports are published alongside them.

11 Regulatory Position

11.1 Design for non-security status

$GEOM is designed as a precursor token carrying no financial rights, consistent with staff guidance distinguishing utility tokens from disguised securities offerings. The design choices that support that position are structural rather than presentational: the ownerless structure of the issuing Foundation (Section 9.1); the fair-launch distribution with no insider allocation (Section 7.2); the absence of any revenue-share, buyback or price-support mechanism (Section 7.1); the confinement of utilities to access, collectible and non-binding governance rights (Section 7.3); and marketing discipline that avoids quantified resource-value claims and price-related messaging (Section 11.3).

11.2 Jurisdictional perimeter

Four perimeters are relevant and are managed separately.

- **United States.** Securities law applies extraterritorially wherever US persons are offered or sold securities, or where US means of interstate commerce are used. Entity domicile does not determine this. The design in Section 11.1, rather than any offshore structure, is what the position rests on.
- **United Arab Emirates.** The Foundation is a RAK ICC entity electing DIFC Courts. Token issuance and the marketing of virtual assets are separately regulated regimes with their own perimeters, and marketing that targets the UAE engages those rules irrespective of where the marketing entity is domiciled.
- **European Union and EEA.** Marketing into the EEA engages the Markets in Crypto-Assets Regulation notwithstanding that Greenland itself sits outside the EU (Section 2.8).
- **Greenland and Denmark.** Relevant from Stage 5 only, and addressed in Section 8.7.

11.3 Marketing discipline

Public materials do not quantify resource value in connection with the token, do not project price or return, and do not present any member company's operational results as a reason to acquire $GEOM. Resource figures appear in this document in their proper context, as descriptions of the assets member companies hold, on the basis independently assessed, and with the technical meaning of the terms stated in Section 2.6. They are not presented as a valuation input for a token that has no claim on them.

Member companies making public statements of Association membership do so under agreed language discipline: factual statements of affiliation, not recommendations, price commentary or any suggestion that the token tracks their operational performance. Where a member is a listed company, such statements are made through general corporate or community channels rather than through the channel designated for shareholder- and market-facing announcements.

11.4 Limits of this position

This structure has not been reviewed or approved by the SEC, the CFTC, VARA, the Danish FSA, or any other regulator, and no regulator has expressed a view on $GEOM. The analysis in this section reflects the Foundation's own design intent and its advisers' input. It is not a legal conclusion, it does not bind any regulator or court, and prospective participants should not treat it as a guarantee of any particular regulatory outcome.

12 Conclusion

The tokenisation of physical resource assets has not happened because the two things it requires do not exist: a verifiable record of what is actually in the ground, produced by the parties who know, and a legal path from that record to an issued instrument. GEOM is building both, in that order, because the order is not optional.

Stage 1 is live. Seven datasets are canonicalised, digested, signed and anchored on Solana mainnet, and any person reading this document can verify every one of them in five lines of code without GEOM's cooperation. The map is live, the tracker is counting, and the oracle signs everything GEOM publishes. Behind it sits an association of listed and pre-listing operators holding Greenland licences that were granted before the door closed in 2018 and cannot be reissued, drilling two projects, with the first modern wells in the Jameson Land Basin's history targeted for October 2026.

What follows is staged deliberately and gated honestly. The verified layer requires qualified professionals and insurance before it can claim more than provenance. The rails require a legal opinion that they are infrastructure. The market requires licensed parties in every regulated seat. Value accrual requires a change in law that has not occurred. Settlement in Greenland requires authorisation from authorities that have not granted it. Each of those is stated as a condition rather than an assumption, because a structure that grows past its own gates does not survive contact with the regulators it will eventually meet.

What is being built toward is not a niche. Oil, gas and hard-rock minerals are the largest physical asset class on earth with effectively no on-chain representation, and the Association holds a position in that class (assessed at 13.03 billion barrels in a single basin, under licences that cannot be reissued) that it intends to bring on-chain through GEOM. If the engine operates under licence and that ambition is realised, GEOM will not have participated in the market for on-chain commodities. It will have built the infrastructure that market runs on.

The record is already running. The rest is what it is for.

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Appendix B Nomenclature

Term	Definition
Anchor	A transaction committing a manifest digest to a public ledger, establishing existence at or before the ledger's timestamp.
Attestation	A signed assertion of provenance and integrity over a dataset. Not an assertion of accuracy.
Canonicalisation	Reduction of a payload to exactly one deterministic byte representation, so that a signature over it is reproducible.
DKK	Danish krone. The currency of Greenland.
Ed25519	Edwards-curve digital signature algorithm; deterministic, fast to verify, native to Solana.
ERC-3643	Permissioned token standard for regulated assets on EVM chains, originally T-REX.
Earn-in	An arrangement under which a party acquires an interest in a licence by funding defined work.
Gross unrisked prospective resources	Estimated total volume potentially present before adjustment for geological chance of success and before deduction for working interest. Not a reserve.
Inclusion proof	A Merkle proof that a specific record was part of a committed dataset, without disclosing the whole dataset.
JORC / NI 43-101	Professional reporting codes governing public disclosure of mineral resources and reserves.
Manifest	The per-window record listing every published dataset with its digest, record count and timestamp.
Memo transaction	A Solana transaction carrying arbitrary bytes via the native memo instruction, requiring no deployed program.
OCT	Overseas Country and Territory. Greenland's status relative to the European Union since 1985.
Permanent delegate	A Token-2022 extension designating an authority able to transfer or burn tokens from any account.
PGE	Platinum group elements.
Provenance	Who published a datum, and when. Distinct from accuracy.
RAK ICC	Ras Al Khaimah International Corporate Centre. Registry under whose Foundations Regulations 2019 the Foundation is established.
REE	Rare earth elements.
SHA-256	256-bit cryptographic hash function from the SHA-2 family.
Token-2022	Solana's extended token program, supporting compliance extensions at the standard level.
Transfer hook	A Token-2022 extension routing every transfer through a program that may permit or reject it.
VASP	Virtual Asset Service Provider. A licensed category covering custody, exchange and transfer services.
Working interest	A fractional interest in a licence carrying a proportionate share of both production and costs.

Appendix C Attestation Record Schema

The attestation record is the object published alongside each dataset. It contains everything a verifier requires to execute the procedure of Section 5.8 and nothing that must be trusted.

```
GEOM Attestation Record  --  version 1

AttestationRecord ::= {
    prefix           STRING,     -- fixed domain-separation prefix (see 5.12)
    version          INTEGER,    -- message format version; v1 described here
    dataset_id       STRING,     -- stable identifier of the dataset
    record_count     INTEGER,    -- number of records in the dataset
    canonical_alg    STRING,     -- canonicalisation rule identifier
    digest_alg       STRING,     -- 'SHA-256'
    digest           OCTET[32],  -- SHA-256 over canonical bytes
    timestamp        UTCTIME,    -- ISO-8601 UTC, publisher-asserted
    pubkey           OCTET[32],  -- Ed25519 public key of the publisher
    signature        OCTET[64],  -- Ed25519 over the formatted message
    manifest_digest  OCTET[32],  -- digest of the window manifest
    anchor_tx        STRING      -- Solana transaction signature of the anchor
}

Manifest ::= {
    version          INTEGER,
    window           STRING,     -- publication window identifier
    published_at     UTCTIME,
    entries          SEQUENCE OF {
        dataset_id   STRING,
        digest       OCTET[32],
        record_count INTEGER
    },
    root             OCTET[32]   -- Merkle root over entries (Stage 2; flat digest in v1)
}

SignedMessage := prefix || version || dataset_id || digest || timestamp

Verification:
    SHA-256(canonicalise(dataset))           == record.digest
    Ed25519.verify(pubkey, SignedMessage, signature) == true
    solana.getTransaction(anchor_tx).memo   contains record.manifest_digest
    solana.getTransaction(anchor_tx).signer  == record.pubkey
```

The three assertions at the foot of the listing correspond exactly to integrity, authorship and time, the three claims of Section 5.9, and the complete extent of what GEOM asserts.
