Basalt Dossier

Basalt Flour as the Green, Regenerative & Longevity-Aligned Backbone of the Flour Yield Token (FYT)

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Foreword

The global climate and nutrition crises demand solutions that deliver more than single-issue fixes. **Basalt flour**—an abundant volcanic rock ground to a fine dust—has emerged from the scientific literature and early field trials as a rare *dual-impact* material: it can *durably remove atmospheric CO_2* while *restoring depleted soils* with essential minerals and bioactive silicon.

This dossier distils the geological fundamentals, peer-reviewed field evidence, environmental co-benefits and ESG considerations that make basalt a compelling **green asset**. It is intended for investors, policymakers, agronomists, and sustainability professionals who wish to understand *why* basalt lies at the heart of the **Flour Yield Token (FYT)** collateral strategy.

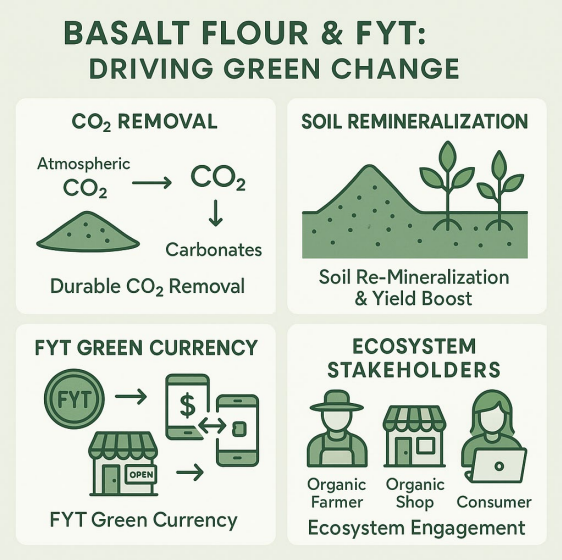
Scope clarification: This document **does not explain FYT's token mechanics, economics, or regulatory pathway**. Those topics are comprehensively addressed in the **Flour Yield white paper** available at https://www.flour-yield.com. Readers seeking details on FYT issuance, governance, or the broader project roadmap should refer directly to that primary source.

What follows is therefore a focused exploration of basalt itself—its origin, chemistry, carbon-removal potential, soil-health impacts, supply-chain realities, and suitability as a verifiable, mission-critical asset in a regenerative economy.

Contents

1 | Executive Snapshot

Basalt rock flour delivers a *dual planetary dividend*: durable **carbon dioxide removal (CDR)** through enhanced rock weathering *and* broad-spectrum **soil remineralisation** that restores essential macro-, micro- and silicon nutrients to degraded agricultural lands.



In a world facing accelerating climate risk and nutrient decline in food crops, anchoring FYT in verified basalt deployment creates a green token with **intrinsic geochemical value, measurable climate benefit, and human-health adjacency**. FYT is designed to monetize—and transparently report—both carbon and nutrient impacts, positioning it as a next-generation, high-integrity regenerative asset.

Abbreviations & Technical Terms

Abbreviation	Meaning
FYT	*Flour Yield Token* – blockchain token collateralised by basalt's carbon and soil-health impacts
CDR	*Carbon Dioxide Removal* – durable sequestration of atmospheric CO_2
ERW	*Enhanced Rock Weathering* – application of silicate rock dust (e.g., basalt) to accelerate natural CO_2 drawdown
SiO_2	*Silicon Dioxide (silica)* – predominant oxide in basalt; source of plant-available silicon
N-P-K	*Nitrogen, Phosphorus, Potassium* – primary macronutrients in conventional fertilisers
MRV	*Measurement, Reporting & Verification* – processes that substantiate climate & soil impact claims
CEC	*Cation Exchange Capacity* – soil's capacity to hold and exchange nutrient cations
CRCF	*Carbon Removal Certification Framework* – upcoming EU standard for certifying CDR methodologies

MiCA	*Markets in Crypto-Assets Regulation* – EU legal framework for crypto-asset issuance & operation
EU FPR	*EU Fertilising Products Regulation* (2019/1009) – sets safety & quality specs for fertiliser products
ESG	*Environmental, Social & Governance* – non-financial performance metrics used by investors
LCA	*Life-Cycle Assessment* – cradle-to-grave accounting of environmental impacts
EIA	*Environmental Impact Assessment* – study evaluating ecological & social effects of industrial projects
ICP-OES	*Inductively Coupled Plasma Optical Emission Spectroscopy* – laboratory method for elemental analysis
DAO	*Decentralised Autonomous Organisation* – blockchain-based, token-weighted governance structure
NFT	*Non-Fungible Token* – unique blockchain token used for provenance & nutrient-density data
KPI	*Key Performance Indicator* – metric used to track project or pilot success
MOU	*Memorandum of Understanding* – formal but non-binding agreement between parties
PEP	*Politically Exposed Person* – individual in a public role requiring enhanced due-diligence
tCO_2	*Metric tonne of carbon dioxide* (1,000 kg)
pH	Numerical scale (0–14) indicating acidity or alkalinity

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2 | Basalt at a Glance: Geology, Abundance, and Silica Content

Definition: Basalt is a mafic volcanic rock, dark in colour, rich in magnesium and iron, and **typically contains ~45–52 wt% silica (SiO_2)**—the range used in standard petrological classifications. It is one of the most abundant rock types on Earth (ocean crust is largely basaltic) and is widely quarried, making supply scalable. (volcanoes.usgs.gov, nps.gov, geologyscience.com)

Why silica matters: During weathering, small fractions of basalt's silica matrix dissolve to form *monosilicic acid* (H_4SiO_4)—the bioavailable form of silicon that plants can take up. Silicon deposition

in plant tissues improves structural strength, pest and disease resistance, and tolerance to abiotic stresses in a wide range of crops. (See Section 7.) (pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov)

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3 | The Planetary Problem Set FYT Targets

3.1 Climate Overshoot

Anthropogenic CO_2 concentrations require *durable* removals in addition to emissions cuts. Enhanced rock weathering (ERW)—the application of finely ground silicate rock (e.g., basalt) to land—accelerates natural geochemical CO_2 drawdown, converting CO_2 into dissolved bicarbonate that ultimately stores carbon in oceans on >10k-year timescales. Recent modelling shows US agriculture alone could remove on the order of **hundreds of millions of tonnes CO_2 annually by mid-century** if ERW is scaled. (nature.com, sheffield.ac.uk, pnas.org)

3.2 Global Soil Mineral Collapse & Hidden Hunger

Decades of yield-maximisation under synthetic N-P-K regimes, erosion, acidification, and the "dilution effect" have driven **measured declines in mineral density (Fe, Ca, Mg, Zn, K) in fruits and vegetables over the last 50–70 years** in the US, UK and elsewhere. This contributes to global "hidden hunger"—micronutrient deficiencies that impair immunity, metabolism, cognition and healthy ageing across billions of people. (pmc.ncbi.nlm.nih.gov, theguardian.com, mdpi.com)

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4 | Basalt & Durable CO_2 Removal (Enhanced Rock Weathering)

4.1 Mechanism (Simplified)

1. CO_2 dissolves in rain/soil water → carbonic acid.
2. Carbonic acid reacts with Ca/Mg silicates in basalt → releases base cations + bicarbonate.
3. Bicarbonate leaches to rivers → ocean → precipitates / remains dissolved for millennia (durable storage).
4. Released cations also buffer soil acidity and mobilise nutrients. (nature.com, pnas.org, inplanet.earth)

4.2 Empirical & Modelled CDR Ranges

- **Large-scale US modelling:** 160–300 Mt CO_2 yr^{-1} potential removal by 2050 (state-resolved cost curves; scenario dependent). (nature.com, sheffield.ac.uk)

- **Corn Belt field programme:** Multi-year replicated trials report measurable inorganic carbon capture plus agronomic gains (maize/soy). (pnas.org, nature.com)
- **Commercial precedent:** InPlanet & Isometric issued the *first independently verified ERW CDR credits* (235.53 t CO_2) delivered to Adyen in Jan 2025—proof of market acceptance, MRV readiness, and buyer demand. (inplanet.earth, isometric.com)

4.3 Economics & Market Signals

ERW sits in the ~$80–180/t$CO_2$ techno-economic band in early analyses and is attracting advance market commitments from major tech, finance, and climate procurement coalitions (Frontier, Microsoft deals; early buyers Adyen, Stripe). (ft.com, wired.com, inplanet.earth)

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5 | Basalt for Soil Remineralisation & Agronomic Resilience

Basalt flour functions as a **multi-nutrient, slow-release soil amendment** supplying Ca, Mg, K, P, Si, and trace elements while raising pH and improving soil structure.

5.1 Field & Controlled Trials

Study	Application	Key Soil Response	Crop/Context
New England organic farms (VT & MA)	6.7 t ha^{-1} basalt rock dust	+62–252% plant-available Ca, Mg, K in top 30 cm; improved aggregation to depth	Mixed organic systems. (mdpi.com)
Brazil greenhouse (soybean & maize)	0–99 Mg ha^{-1} basalt rock powder vs lime	↑ pH, ↑ Ca, ↑ P & K; greater biomass vs lime alone	Tropical soils; import substitution relevance. (pmc.ncbi.nlm.nih.gov)
Silicate Rock Powders review (Amazon)	Various SRPs incl. basalt	Weathering releases macro & micronutrients; long-tail nutrient supply in low-input systems	Review synthesis. (mdpi.com)

5.2 Co-Benefits Beyond Nutrients

Basalt amendments can reduce soil acidity, increase cation exchange, support microbiome diversity, and in some settings decrease bioavailability of toxic metals via pH and competition effects—improving both yield stability and food safety. (mdpi.com, mdpi.com, pmc.ncbi.nlm.nih.gov)

5A | Pest Resistance & Reduced Pesticide Load

Early agronomists—most famously **Dr Julius Hensel** in his 1893 work *Brot aus Steinen* ("Bread from Stones")—noted that crops supplied with a full spectrum of mineral nutrients show striking resilience against insects and diseases. Modern studies confirm that basalt-driven remineralisation can **cut synthetic pesticide demand by 20 – 60 % or even render treatments unnecessary**:

- **Silica armour** – Soluble silicon from basalt is deposited in leaf and stem tissues, creating a physical barrier that deters chewing and sucking pests.
- **Balanced mineral nutrition** – Adequate Ca, Mg and K improve cell-wall lignification and osmotic balance, making plants less attractive to fungal pathogens.
- **Induced systemic resistance (ISR)** – Mineral-rich soils trigger phenolic and flavonoid pathways, priming innate plant immunity for faster response.

Reduced pesticide use lowers production costs, protects beneficial insects, and eliminates chemical residues—key advantages for organic producers and a further boost to FYT's ESG credentials.

For foundational insights see Julius Hensel (1893). Contemporary peer-reviewed sources are listed in the reference section of this dossier.

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6 | From Soil Minerals to Human Nutrition & Longevity

Declining soil mineral capital translates into diminished mineral density in crops; repeated meta-analyses and composition table reviews show downward trends in Ca, Mg, Fe, Zn and other micronutrients in produce across decades. (pmc.ncbi.nlm.nih.gov, theguardian.com, mdpi.com)

Health stakes: Mineral deficits contribute to hypertension, impaired glucose metabolism, anaemia, immune dysfunction, bone demineralisation and accelerated biological ageing. Silicon, while not classically "essential," is increasingly associated with connective-tissue and bone health in observational and interventional studies. (pubmed.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov)

Longevity thesis: By rebuilding soil mineral diversity (including bioavailable silicon), basalt-grown foods can help close micronutrient gaps that drive chronic disease burden—aligning FYT with functional nutrition, preventive health, and the TarCasso longevity narrative. (mdpi.com, pubmed.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov)

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7 | Silicon Spotlight: The Under-Appreciated Agronutrient in Basalt

Silicon (Si) delivered from basalt weathering enters soil solution as monosilicic acid, the plant-available form. Although not officially classed as an "essential" element for all crops, Si is now recognised as **beneficial for many high-value species—including tomatoes, cereals, and legumes—improving structural integrity, disease resistance, stress tolerance, and sometimes yield and fruit quality.** (pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov)

7.1 Evidence in Tomato Systems

- Foliar or root-zone Si has raised tomato **yield, firmness, and soluble solids** in multiple trials. (pmc.ncbi.nlm.nih.gov)
- Si supplementation **reduced early blight severity (Alternaria solani)** and modulated defence gene expression in tomatoes. (pmc.ncbi.nlm.nih.gov)
- Broader Si stress-tolerance literature supports improved resistance to biotic and abiotic stress across crop classes—mechanisms include reinforced cell walls, induced phenolics, and primed signalling pathways. (pmc.ncbi.nlm.nih.gov)

7.2 Human-Health Adjacency: Silicon & Bone/Connective Tissue

Umbrella review work suggests positive associations between dietary silicon intake and markers of **bone mineral density and connective-tissue integrity**, though dose-response and bioavailability forms remain active research areas. This offers an additional *longevity link* for FYT's consumer-facing story. (pubmed.ncbi.nlm.nih.gov)

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8 | FYT Value Architecture: Tokenising Basalt's Multi-Layer Impacts

FYT is structured to recognise and monetise stacked benefit layers that basalt uniquely provides.

Layer	Data Trigger	Token Logic	Stakeholder Benefit
Carbon Floor Credits	Verified ERW CDR (MRV registry issued tonnes)	Each verified tCO_2 creates/locks FYT backing claim; fractionalised into tradable units	Buyers access durable CDR; FYT gains intrinsic asset floor.

Soil Mineral Credits	Independent lab soil tests (baseline vs post-spread) showing net gain in Ca/Mg/K/Si & pH buffering	Smart contract mints bonus FYT to farmer pool proportional to gain within agronomic bands	Farmers compensated for regenerative practice adoption.
Silicon Performance Boosters	Plant tissue Si % or stress-resilience metrics (pilot crops: tomato, cereals)	Optional premium FYT tiers for Si-verified produce	Premium crop marketing; data differentiation.
Nutrient Density Provenance	Crop nutrient analytics (Fe/Zn/Mg/K ratios) + QR traceability	NFT metadata appended to consumer products (grain, EVOO blends)	Consumers pay premium for measurable nutrition & climate co-benefit.

Sources underpinning stacked-benefit design: ERW commercial credits; soil/plant mineral uplift trials; Si agronomy & human bone health literature; nutrition decline datasets. (inplanet.earth, mdpi.com, pmc.ncbi.nlm.nih.gov, pubmed.ncbi.nlm.nih.gov)

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9 | MRV Stack Design (Carbon + Minerals + Silicon)

Goal: Generate auditable, low-friction data streams that can be cryptographically linked to FYT issuance.

9.1 Carbon Module

• Rock application records (tonnage, particle size, field geo-polygons).
• Reactive transport models + weather/soil data to predict dissolution.
• Empirical sampling: leachate alkalinity, soil cation depletion, isotopic tracers (mass-balance validation work emerging from ERW research consortia). (pnas.org, pnas.org, nature.com)

9.2 Mineral Uplift Module

Baseline & interval soil cores; Mehlich-3 or ammonium acetate extractables; pH; CEC; bulk density; stratified by depth. Demonstrated in New England basalt trials & Brazilian greenhouse studies. (mdpi.com, pmc.ncbi.nlm.nih.gov)

9.3 Silicon Availability Module

0.01 M $CaCl_2$ or acetic acid extractions for plant-available Si; tissue assays (ICP-OES) for Si accumulation; linked to crop performance datasets (e.g., tomato quality and blight resistance). (pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov)

9.4 Data-to-Token Oracles

Certified labs push signed results → FYT registry; smart contracts release or escrow FYT units based

on thresholds; supports audit and secondary market trust. Commercial ERW registries (Isometric) provide precedent for cryptographically linked MRV. (isometric.com, inplanet.earth)

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10 | Regulatory Alignment Pathways

(Preliminary strategy; jurisdictional scoping required.)

1. **EU Carbon Removal Certification Framework (CRCF)** – ERW is under active technical discussion; FYT carbon layer should be structured to meet durability, additionality, and MRV provisions as methodologies emerge. Policy momentum is reinforced by peer-reviewed ERW scaling analyses. (nature.com, ft.com)
2. **MiCA Considerations** – FYT positioned as a *utility / environmental performance token* redeemable for basalt application services, data credits, or consumer goods; avoid e-money characteristics by not promising redemption for fiat; evaluate whether carbon-linked claims risk asset-referenced classification in EU. (Evidence: rapidly forming ERW credit markets; no fungible fiat peg.) (inplanet.earth, isometric.com)
3. **EU Fertilising Products Regulation (2019/1009)** – Basalt flour marketed as a soil improver / liming material / mineral fertiliser analogue; nutrient and contaminant specifications (heavy metals) must be documented—supported by soil-response literature. (mdpi.com, pmc.ncbi.nlm.nih.gov)

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11 | Supply Chain & ESG Safeguards

Feedstock Quality Screens

- Particle size (<100 µm median for fast reactivity; adjust by climate/soil).
- Neutralising value & reactive Ca/Mg fraction.
- Trace/heavy metals (Cr, Ni, Co) below agronomic thresholds.
- Total SiO_2 confirmation (basalt class) for Si co-benefits. (geologyscience.com, nps.gov, mdpi.com)

Sourcing Principles

Leverage existing quarry fines to minimise new mining; lifecycle framing consistent with ERW market leaders emphasising low additional environmental footprint. (inplanet.earth, wired.com)

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12 | Adoption & Economics for Farmers

Cost Offsets: FYT grants + carbon revenue + reduced liming/fertiliser inputs improve payback vs standalone application. Early commercial ERW buyers (Adyen; tech coalitions) show willingness to

pre-purchase tonnes—capital that can subsidise farmer participation. (inplanet.earth, isometric.com, ft.com)

Yield & Soil Benefits: Documented nutrient increases and pH buffering translate into resilience and, in some trials, yield lifts (soybean/maize biomass; disease-resistant tomatoes; improved organic system soil metrics). (pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov, mdpi.com)

12A | FYT as Green Currency & Ecosystem Payments

Purpose: Translate FYT's carbon-and-mineral collateral into a *circulating green medium of exchange* that rewards regenerative action and underpins commerce across the soil-to-table value chain.

Two-Phase Currency Roll-out (High-Level)

Phase	Regulatory Status	Backing & Peg	Core Users	Key Transactions
Phase 1 – Utility Token (2025-2026)	MiCA "other crypto-asset" (no redemption promise)	Soft reference to kg basalt applied per FYT; value driven by network demand	Farmers, agronomy labs, bloggers, organic shops	• Rewards for verified basalt spreading & soil tests • Payment for MRV/lab services • Loyalty/affiliate payouts
Phase 2 – Asset-Referenced Token (ART) (from 2027)	MiCA ART licence (reserve & audit)	Basket: ① verified ERW tCO_2 ② nutrient credits ③ ≤30 % fiat/USDC	Organic wholesalers, retailers, consumer checkout, payroll	• B2B produce invoices • Retail purchases with auto-convert to EUR • Green payroll allocations

Stakeholder Value Snapshot

Stakeholder	FYT Benefit	Contribution to Ecosystem
Organic Farmers	FYT offsets rock-dust costs; bonus for nutrient gains	Verified soil-health + CDR data that back FYT collateral
Organic / Zero-Waste Shops	Wholesale discounts & consumer-facing green currency USP	On-ramp for real-world FYT payments

Food Bloggers / Influencers	Affiliate bounties in FYT; exclusive product stories	Demand-side storytelling, boosting token velocity
Consumers	Loyalty cash-back in FYT; transparency via QR-linked NFTs	Retail demand; validation of nutrient-dense premium

Roadmap (Condensed)

2025-H2: Launch Phase 1 pilot (10 farms, 5 shops, 20 bloggers); FYT rewards + POS plug-in (auto-convert to EUR at checkout).
2026-H1: Expand to 50 shops across DACH; integrate Visa/Mastercard on-ramp; initiate ART licence prep.
2026-H2 / 2027: ART launch with audited reserve; begin B2B invoicing and partial payroll trials; list on green-asset exchange.

Risk quick-take: token price volatility (mitigated by auto-convert), MiCA ART compliance path, consumer UX frictions.

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13 | Risk Register & Mitigations

Risk	Mitigation	Evidence Basis
Over-application / pH overshoot	Rate calculators tied to baseline pH & buffering capacity; staged applications	Field & greenhouse studies document pH shifts; regulatory fertiliser frameworks. (mdpi.com, pmc.ncbi.nlm.nih.gov)
Heavy metal accumulation	Certified quarry assays; blending; exclusion thresholds	Basalt composition datasets & fertiliser regs. (geologyscience.com, mdpi.com)
MRV uncertainty in CDR	Hybrid model + empirical sampling + registry verification (Isometric precedent)	First verified ERW credits; MRV guidelines emerging in scientific lit. (isometric.com, inplanet.earth, nature.com)
Farmer adoption friction	FYT incentive stack; agronomic extension & demonstration plots	Commercial pilots (InPlanet; ERW start-ups); nutrient decline awareness driving demand. (inplanet.earth, wired.com, pmc.ncbi.nlm.nih.gov)

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14 | R&D & Pilot Questions to Strengthen FYT Thesis

Carbon: What is field-measured dissolution/CO_2 capture per tonne basalt across soil pH, rainfall, and temperature bands representative of FYT target regions? (Leverage isotopic mass-balance methods.) (pnas.org, nature.com)

Silicon Mobility: How quickly does plant-available Si rise post-application, and what application rates maximise tomato quality vs cost? (pmc.ncbi.nlm.nih.gov, pmc.ncbi.nlm.nih.gov)

Nutrient Density Tracking: Can cost-effective lab panels quantify Fe/Zn/Mg/K shifts in food products at scale for consumer-facing FYT provenance labels? (Build on mineral decline datasets.) (pmc.ncbi.nlm.nih.gov, theguardian.com)

Tropical vs Temperate Performance: Compare nutrient release kinetics and CDR delivery in tropical (high weathering) vs temperate (slower) regions—critical for portfolio carbon forecasting. (mdpi.com, inplanet.earth)

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15 | Conclusion: Why Basalt-Backed FYT Can Be Game-Changing

Basalt delivers verified **carbon durability**, measurable **soil mineral restoration**, and biologically meaningful **silicon-driven crop resilience**—all from an abundant, low-cost geological resource compatible with existing farm machinery. These stacked benefits directly address two defining 21st-century risks: climate destabilisation and the silent erosion of nutritional quality in the global food supply. By tokenising field-verified impacts and tying them to consumer-visible provenance and longevity branding, **FYT can bridge climate finance, regenerative agriculture, and health-centred food markets in a single, data-rich green asset.** (nature.com, inplanet.earth, pmc.ncbi.nlm.nih.gov)

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16 | Selected References (Alphabetical by Lead Source)

- Beerling, D. J. et al. *Transforming US agriculture for carbon removal with enhanced weathering.* Nature, 2025. (nature.com)
- InPlanet & Isometric. *World's first enhanced rock weathering carbon removal credits issued.* Press release, Jan 6, 2025. (inplanet.earth, isometric.com)

- MDPI Agriculture. *Basalt Rock Dust Amendment on Soil Health Properties…* New England organic farms study, 2025. (mdpi.com)
- MDPI Minerals. *Potential Soil Remineralizers from Silicate Rock Powders…* 2023. (mdpi.com)
- PMC. *Silicon application improves tomato yield and nutritional quality.* 2025. (pmc.ncbi.nlm.nih.gov)
- PMC. *Silicon supplementation improves early blight resistance in tomato.* 2021. (pmc.ncbi.nlm.nih.gov)
- PMC. *Role of silicon in plant stress tolerance: opportunities to achieve a sustainable cropping system.* 2019. (pmc.ncbi.nlm.nih.gov)
- PubMed. *Silicon Supplementation for Bone Health: Umbrella Review.* 2024. (pubmed.ncbi.nlm.nih.gov)
- USDA/USGS Glossary of Basalt; NPS Igneous Classification; GeologyScience Basalt Composition (silica 45-52 wt%). (volcanoes.usgs.gov, nps.gov, geologyscience.com)
- "An Alarming Decline in the Nutritional Quality of Foods." *Foods* (MDPI) review. 2024. (pmc.ncbi.nlm.nih.gov)
- *The Guardian.* Vegetables losing nutrients; global biofortification response. 2024. (theguardian.com)
- *Brot aus Steinen.* Dr. Julius Hensel & John Schacher (Amazon.de)