



VERMONT PHOSPHORUS INNOVATION CHALLENGE
[PHASE 3: PATH TO COMMERCIALIZATION](#)

**Deploying Regional Minerals and BioCarbon for Nutrient
Management in Mitigating Excess Phosphorus and Nitrogen
Pollution from Agriculture and Forestry in Vermont Watersheds**

OVERALL TECHNOLOGICAL DESCRIPTION: EXECUTIVE SUMMARY

Thomas Vanacore, CEO Rock Dust Local LLC

Introduction and Project Overview.

This project is envisioned as a viable commercial response to the environmental mitigation problem of excess nutrient loads reaching Vermont waterways from agricultural and forest land. Project focus is on the manufacture and deployment of local mineral and forestry resources with the proven potential to capture and manage solution reactive phosphorus (SRP) on land. Through a coordinated effort deploying regional mining and aggregates companies, agricultural mineral production sales and distribution operators, forestry and forestry resources, this proposal engages pre-qualified businesses with a scientific team of experts to validate the materials and methods for Best Management Practice (BMP).

Opportunities for Rapid Deployment in a Commercial Setting.

The opportunities outlined below are based on the rational development of market-based materials and methods to solve a regional environmental problem, but with the potential exportation of materials, methods and knowhow to points beyond Vermont to address similar problems elsewhere. The business is focused around the development of geologic resources and biomass derived carbon for the commercial production of mineral based soil amendments, and as nutrient management tools for mitigation of Solution Reactive Phosphorus (SRP) and Denitrification, with proven potential in engineered settings such as manure management systems, surface water run-off catchments and leachate sorbent applications. SRP is a target pollutant in water quality initiatives in many watersheds, including the Champlain Valley where the material naturally occurs and where human activities including modern agricultural practices have been identified as primary contributors. At present the State of Vermont has identified a \$50MM / annum expenditure for the next 20 years associated with mitigating SRP within the waters of the State, primarily in drainages entering Lake Champlain.

A Two Phased Approach: Rapid Deployment. Commercial Viability with Flexible Adaptability.

Commercialization of this project follows the stated objectives outlined in the Vermont Phosphorus Innovation Challenge Project Overview with a focus on point and non-point nutrient management. These are concurrent activities. The first phase deploys the manufacture, application and continued scientific study and documentation of mineral and mineralized bio-carbon soil amendments in the field for in-situ management of SRP, including broadcast field applications, animal bedding admixtures and in-situ filtration media for the purpose of controlling solution reactive phosphorus (SRP) as well as nitrogen loss in a nutrient management setting. The second phase commercializes an effluent treatment application in a manure management system deploying engineered programs, systems, and flexible "modules" capable of mineralizing SRP in final stage processing for pre-existing or new manure management systems installed on-farm to consolidate and digest bio-solids.

Background:

Rock Dust Local has identified and tested at least two economic supplies of a natural geologic material in Vermont with strong SRP capture characteristics occurring in several species of shale. These economic supplies are currently being mined for hard rock construction aggregates in two locations within the Champlain Valley in Vermont, in the towns of Shoreham and Swanton. These unique geologic materials were generally identified in 1961 within Charles W. Welby's Bedrock Geology of The Central Champlain Valley of Vermont as contained within the deep geologic horizons of the Ordovician era deposits of shale known as the Iberville and Stoneypoint formations. (See illustration excerpt from the book at the end of this proposal). Extensive and ongoing testing of these materials have been performed by Rock Dust Local and affiliated laboratories, chemists and soil scientists as well as third party investigators over several years. Commercially known as "St. George Black" (SGB) in the Shoreham deposit and currently referred to as Swanton Black (SWB) in the Swanton deposit, these materials have been qualified as United States Department of

Agriculture National Organic Program (USDA/NOP) compliant soil amendments and are being proposed here for controlling solution reactive phosphorus (SRP) at concentrations typically found in agricultural field settings. Further testing has been initiated over the past 12 months on both the Shoreham and Swanton materials to validate the potential of the material to absorb and manage SRP for nutrient management settings in conformance to the objectives of the Federal Natural Resources Conservation Service (NRCS) Code 590 regulatory framework. These investigations have been primarily aimed at determining the mode of action (MOA) within the natural mineral complex in order to replicate and augment this action for commercial applications. Bench top experiments have shown that the local shales when properly handled have the potential to capture approximately 50 lbs. of SRP per ton of natural rock when in pulverized form, with up to 3X this capacity with the addition of selected mineral admixtures.

The natural stone is currently fully permitted for extraction and processing in the State of Vermont and is compliant for use in commercial conventional or certified organic agricultural production under the Federal USDA/NOP rule 205.203(d)(2). As a result, this material represents a ready and existing technology for land applied mitigation of SRP at the most cost effective price to the government agencies or private end user, and on a per pound basis represents perhaps the most cost effective tool for mitigating SRP on land of any existing technology known for this purpose. We believe these materials and methods will be validated for inclusion for Best Management Practice (BMP) for the purpose of satisfying the objectives of the Vermont State Required Agricultural Practices (RAP) mandate as well as for consideration for inclusion in the Federal NRCS code 590 Nutrient Management protocols. At a loose bulk price FOB per ton, suitable gradations for land application in pulverized form are being offered at a price range of \$50./ ton for the St. George Black labeled product and \$200./ short ton (2000 lbs.) in standard FIBC bulk sack. With a calculated SRP capture field potential of (43.5 lbs.) per ton, under the bench top results of (50 lbs.), the FOB price potential of SRP capture is .17 cents per lb. for unlabeled product in loose bulk (SWB), \$1.15/ lb. in labeled product in loose bulk (SGB), or \$4.60/ lb. in labeled product (SGB Rock Dust, Phos-Cap™) in FIBC bulk sacks.

The Immediate Objective of Manufacturing Commercial Products for SRP Management

Existing mineral controls for SRP exist in the marketplace for engineered management of stormwater and wastewater treatment applications but remain prohibitively expensive for large scale deployment in Vermont or elsewhere. These materials are largely unproven as a nutrient management tool in agricultural settings. See Imbrium Systems, www.imbriumsystems.com.

Our own work within the VPIC and elsewhere for the purpose of developing local mineral resources for on-land use as manufactured products with SRP capture potential are favorable. We have tested over 25 natural mineral materials and fortuitously found the regional Vermont shale as the most favorable for economic use of any tested thus far. Based on the scientific underpinnings and product development to date there are significant benefits of utilizing the natural mineral resource alone, or to enhance for dramatically increased SRP potential with the admixture of selected minerals or biocarbon in the form of biochar, for land applications in nutrient management settings through formulating.

Manufacturing powdered product “as is”, formulating with mineral admixtures or bio-carbon, or manufacturing of pelleted product can be accomplished at a fully operational and existing processing facility at the Shelburne Limestone Corp (SLC) works in Swanton for distribution over the road or via rail or at the Wilcox Quarry in Shoreham for distribution over the road. The “Phase 2” engineering has been validated on the bench and in the field extending the Mode of Action (MOA) to phosphorus recovery and management systems using knowledge gained through bench top investigation of materials for mineralizing and filtering SRP and N for in-situ management, capture and removal methods in point and non-point source as modular add-ons to existing manure management technologies, or for entirely new system design and deployment in hard or softscapes.

Distribution networks and supply relationships are already in place to rapidly deploy the materials into field applications for on-farm or forestry

use through the established farm supply and crop services businesses located throughout the State of Vermont. Additionally, Shelburne Limestone Corporation maintains a fleet of rail cars suitable for moving finished pelleted products anywhere served by rail, originating at their own loading facility in Swanton VT or delivering admixtures into VT for value added manufacturing from points beyond. Rock Dust Local, LLC and Shelburne Limestone Corp. have agreed to commit their own financial and in-kind material resources for the purpose of matching funds forthcoming from the State of Vermont through the Phosphorus Innovation Challenge Phase 3 path to commercialization.

Commercial Applications; Broadcasted, Formulated, Livestock Bedding Admixtures, Feed Additives, Manure Management, Surface Water Catchments, Ground Water Filtration

Our in-house investigations and third party studies have demonstrated the proposed materials perform well for field applications aimed at nutrient management in broadcast applications, formulated products, as livestock bedding admixtures, livestock feed additives, for manure management systems, as surface water catchments, for subsurface end of drain tile filtration and for potential applications in ground water filtration. The SGB has outperformed any material tested to date for filtration applications targeting SRP in agricultural runoff. Extending the MOA of the Iberville Black Shale to engineered applications for manure and biomass waste to energy systems with a nutrient management objective has yielded improvements to the art with Patent Pending status. UVM Dept. of Plant and Soil Sciences has conducted a series of comparative tests with other mineral media and found the SGB outperformed or performed favorably in comparison to other tested minerals, including those conventionally associated with SRP capture including natural gypsum, carbonates and wastewater treatment residuals. Greenhouse growth response and soil-mineral interaction with a focus on phosphorus has been performed by UVM Plant and Soil Science students under the guidance of Prof. Ross whose reports are documented in this submission. Our own chemists have done extensive testing to determine the mode of action (MOA) and have designed weathering tests to determine the longevity of the material in engineered and land applications at simulated scale.

Deliverability: Commercially Viable and Available Immediately.

Rock Dust Local introduced the first line of commercial products in 2017 utilizing the St. George Black undivided and in blend with bio-carbon and biologics for field use with a phosphorus management benefit under the St. George Black “Phos-Cap” label. See Rockdustlocal.com/carbon-smart and Rockdustlocal.com/catalogs. See attached product sheets. The material can be deployed in barns, lagoon settings or field applications to manage phosphorus and nitrogen, targeting pollutants in clean water initiatives in any watershed where natural soil amendments are permitted. These materials are United States Department of Agriculture National Organic Program (USDA/NOP) compliant and provide valuable mineral nutrients for biologic growing practices for both commercial conventional or certified organic operators, including a suite of mineral nutrients in useful capacities; Calcium, Magnesium, Iron, Silica, Nitrogen, Phosphorus, Potassium, Sulfur, Sodium, Vanadium, Zinc, Cobalt, Chromium, Copper, Molybdenum and Boron. The SRP management component is being marketed as a “value added” feature, which has allowed access to existing agro-mineral markets.

Our commercialization plan is to manufacture simple pulverized gradations of natural stone from the SLC Swanton and Wilcox Shoreham works with and without biocarbon for control of non-point phosphorus loads on land, and then build additional capacity to granulate fine powders for ease of material handling efficiencies and marketability at large, an activity proposed here within the Phosphorus Innovation Challenge and in a partnership between Rock Dust Local, LLC and Shelburne Limestone Corporation, both Vermont companies. A business relationship is well established between Rock Dust Local LLC and Wilcox Construction of Shoreham VT for manufacturing and distributing the St. George Black (SGB) in pulverized powder and powdered mineralized bio-carbon blends as well as between Rock Dust Local and Shelburne Limestone Corp. All resources and capacities will be included in the VT Phosphorus Innovation Challenge Phase 3 as proposed. Significantly, a Letter of Intent to collaborate on the commercialization of an innovative phosphorus management and recovery system has been executed between Rock Dust Local and Vanguard Renewables for the purpose of deploying the innovations in permitted biomass to energy Anaerobic Digester in VT.

Scientific validation and commercial development is being provided by a team of qualified individuals and businesses including David Demarey of Demarey Solutions, Tadeusz S. Wysocki Jr. of the South Meadow Farm and Research Center in Wales MA, Stephen J. Herbert, Prof. of Agronomy and member Agricultural Innovation Working Group, Shelburne Limestone Corporation of Essex VT, Rock Dust Local LLC of Bridport VT, Wilcox Construction of Shoreham VT, and Vanguard Renewables of Wellesley MA

Utilizing Existing Aggregates Technologies to Produce Commercial Mineral Fertilizers and Products for Environmental Mitigation

Rock Dust Local is recognized nationally as a pioneer in the use of local mineral and bio-carbon resources for use as mineral fertilizers, soil amendments and additives. Rock Dust Local identified several useful materials within the State of Vermont for this purpose and has been marketing them since 2010. Wilcox Construction of Shoreham (SGB) quarry has been in operation since 1992 using conventional dry crushing and screening methods to produce pulverized graded materials for construction and road building. Rock Dust Local evaluated this local resource in 2012 and has been deploying the fine screenings as suitable for use as agricultural minerals in field applications, utilizing undersize material (1/8"-0). Within SRP capture end uses larger gradations can be deployed for ditch works, bio-swales, catchments etc. Mill fines, undersized natural screening gradations and dusts from both the Swanton and Shoreham Quarries are suitable for use "as is" on land. Manufactured granules or pellets, using conventional binders, either as an "undivided" mineral or in formulation with other minerals or nutrients in a nutrient management setting can be produced at SLC's existing processing facility located at its Swanton quarry. We do not see any impediments to processing the SWB or the SGB for clean aggregate, chip, pulverized fines and dusts using conventional crushing screening and conveyance equipment, if properly managed. There exists an economic potential use for every production gradation from 3/4" down to highly micronized fraction for nutrient management on land and filtration in manure management systems from both the SLC Swanton and the SGB Shoreham deposits.

Geographic Locations of the Natural Mineral Deposits in Economic Supply are Favorable for Rapid Commercialization and Deployment

The Swanton Black (SWB) appears to be the northern geologic equivalent to the St. George Black (SGB) in Shoreham, with some differences noted in geologic horizon and over all geochemical makeup based on the analysis performed and on site evaluations of both quarries cross referenced with the historical overview of the bedrock geology of the Champlain Valley as provided by Welby. The geographic location in Swanton provides an obvious potential for utilizing the Swanton Black for mitigating SRP within the northern watersheds of the Champlain Valley entering Lake Champlain through St. Albans Bay or isolated bodies of water such as Lake Carmi in Franklin County. Proximity to processing, scale house, rail loading facilities and over the road transport directly from the Swanton works recommends Shelburne Limestone Corporation as a focal point of an economic development initiative aimed at rapidly commercializing the material for use on land. The St. George Black (SGB) is situated in the central watersheds of the Champlain Valley including the Otter Creek, is a fully permitted and operational mining and aggregates facility. Both quarry locations recommend themselves to full scale economic initiatives aimed at developing these natural resources for improving water quality by mitigating Phosphorus run-off throughout the Champlain Valley and beyond.



Shelburne Limestone Corp., Swanton Works

Bio-carbon as a Best Management Practice Material (BMP) for Nutrient Management.

The use of Bio-carbon in the form of biomass derived charcoal, a.k.a. Biochar, has been validated by numerous scientific studies over the course of decades. Vermont forestry, having ready and sustainable stocks of woody biomass feedstocks, provides a potential economic opportunity not only as a commercial outlet for low grade timber but as a natural resource to be deployed for the mitigation of phosphorus and nitrogen pollution entering the waterways. This proposal envisions the deployment of biochar in combination with minerals derived from regional sourcing as a first step in the development of local bio-carbon production capacities with the added potential advantages of bio-fuels production in the form of syngas, liquid fuels, and co-generation of heat and electricity for a sustainable carbon negative outcome. Rock Dust Local has begun stockpiling horticultural grade charcoal screenings (a.k.a. biochar) in the Wilcox quarry for the production of mineralized carbon targeting a nutrient management end use.

Historical Background in the Use of Biocarbon: A Regional and Global Perspective.

In 2008 The Pioneer Valley Biochar Initiative (PVBI) was formed to utilize biochar (a.k.a. horticultural charcoal) as a carbon negative soil amendment once used by the ancient Amazonian Native Peoples. This fertile soil that Soembroek, Lehmann, Steiner, et. al. studied extensively was known as “Terra Preta” (Black earth), and “Terra Mulata” (Brown earth), which were discovered as archeological sites of deep, carbon rich fertile soils located within degraded rain-forest native soil types. Mineral additions within the black earth deposits were found to include pottery shards, which through scientific analysis suggested these mineral and ceramic additions were originally large porous pottery jars originally used for collecting household wastes (charcoal, bones, compost, manure, etc). The original “Terra Preta” and “Terra Mulata” were found to be extremely stable, mineral rich, high carbon garden growing media which survived for centuries. In 2009, members of the Pioneer Valley Biochar Initiative, one of the oldest Biochar associations in the United States, and its founding member Ted Wysocki, who is part of the team of scientists engaged in this project,

conducted tests to determine Biochars' ability to capture nitrogen and manage other nutrients such as phosphorus. Findings suggested that bio-carbon can absorb nitrogen rapidly, including the volatiles, and then release it slowly in plant available form. This same capacity to exchange ions and anions in growing media combined with its ability to absorb, filter and retain water proved to be a big benefit in upgrading poor sandy or degraded soil.

Beginning in the 1980's Dr. Makoto Ogawa in Japan showed that charcoal and the resident AM fungi were crucial to creating fertile soil. Eventually Dr. Ogawa was able to process the waste heat from a local coal fired electric generation station to make horticultural charcoal. This charcoal was then applied to 200,000 hectares of degraded and eroded farmland in New Zealand with positive benefits documented for overall agricultural productivity. Additionally, an added economic benefit flowed back to the power generator in the form of applied carbon sequestration credits as GHG CO₂ offsets against the coal fired emissions resulting from the carbon capture potential for biochar deployed on land as defined in the Kyoto Climate protocol. (For every ton of fixed carbon contained in horticultural grade charcoal land applied at least 3.5 tons of CO₂ is captured on land. This metric is exponentially increased as soil carbon content and photosynthesis of growing plants increases within the impacted ecosystem.) Biochar was later utilized to mitigate radioactive contamination of land and water in and around the Fukushima nuclear disaster. Use of bio-carbon for water filtration, for mitigating nutrient loss, for animal feed additives, for human consumption as a pharmaceutical, for cosmetics and cleaning products, for industrial sorbents, for primary and secondary building materials, for nanotech applications in military and industrial end use are well documented and represent a potential boon for the Vermont economy as bio-carbon production and use is developed within the State.

A working perspective shaping SRP mitigation and BMP-

“If the chemical analysis of the Earth's crust show between 1,300 ppm and 1,800+ ppm Total Phosphorus (P₂O₅), and most mineral loads in fertile soils are essentially weathered rock dusts, then the soil has plenty of P₂O₅, and if the plant uses only the soluble fraction (aka SRP's), then... we need to decide how to achieve an economically sustainable balance.”

- *Tadeusz Wysocki Jr., South Meadows Farm and Research Center to Thos. Vanacore CEO of Rock Dust Local LLC.*

CONCLUSION: Based on extensive laboratory, greenhouse testing and field test results evaluating the Swanton Black (SWB) and St. George Black (SGB) FOR NUTRIENT MANAGEMENT IN FIELD APPLICATIONS as well as extensive laboratory results from the ENGINEERED APPLICATIONS we conclude that these natural materials and applied technologies utilizing the Mode of Action (MOA) can manage phosphorus effectively in-situ and without causing phosphorus deficiencies in growing plants. Documented in-house discussion regarding the Mode of Action (MOA), Excerpt:

“Calcium, Magnesium and Aluminum will take down Phosphate at high concentrations of Phosphate and at elevated pH. The range of testing has been useful for surface applications of the SGB and SWB as they will initially react with high concentrations of free phosphate. We can claim that adding the SGB or SWB as a surface application will trap soluble (Leachable) Phosphate and hold it in the soil, later releasing it to the plant’s roots through root zone processes. The Iron reactions are much more durable. For low level field treatments at (20) ppm SRP the numbers remain at (1) acre/ ton for a (50) pound SRP capture using the straight SGB or three (3) acres /ton of SGB “high test” spiked with mineral admixtures. Predicated on 25% runoff from the fields, this level of treatment (1 ton/acre) in the natural form would manage/ capture **ALL** of one year’s Phosphate leachate in a plant available form through mineralization. Adding bio-carbon in the form of horticultural grade charcoal (a.k.a. biochar) adds carbon building capacity, water filtration and nutrient management through cation and anion exchange capacity, adding nitrogen control by absorbing N₂O and ammonia off-gassing, through conversion and regulation of nutrient loads from solution to mineral and back to solution in the root zone, houses beneficial microbes and forms nucleation sites for the formation of stable humus, the foundation of carbon rich soil health.” ~*Ted Wysocki*

For the Engineering applications the results are unequivocal: It is clear from our research and testing that this technology can far exceed the results with Phosphate capture that have been attainable working with strong Phosphate solutions to date. This process is capable of operating across a wide Phosphate concentration range encompassing everything from Fish Hatcheries and greenhouse operations all the way up to the very concentrated and difficult to handle dairy and food waste. We believe the process once perfected, will qualify as Best Available Technology (BAT) under EPA rules and its applicability across such a wide Phosphate concentration range should result in its widespread use.

~*David Demarey*

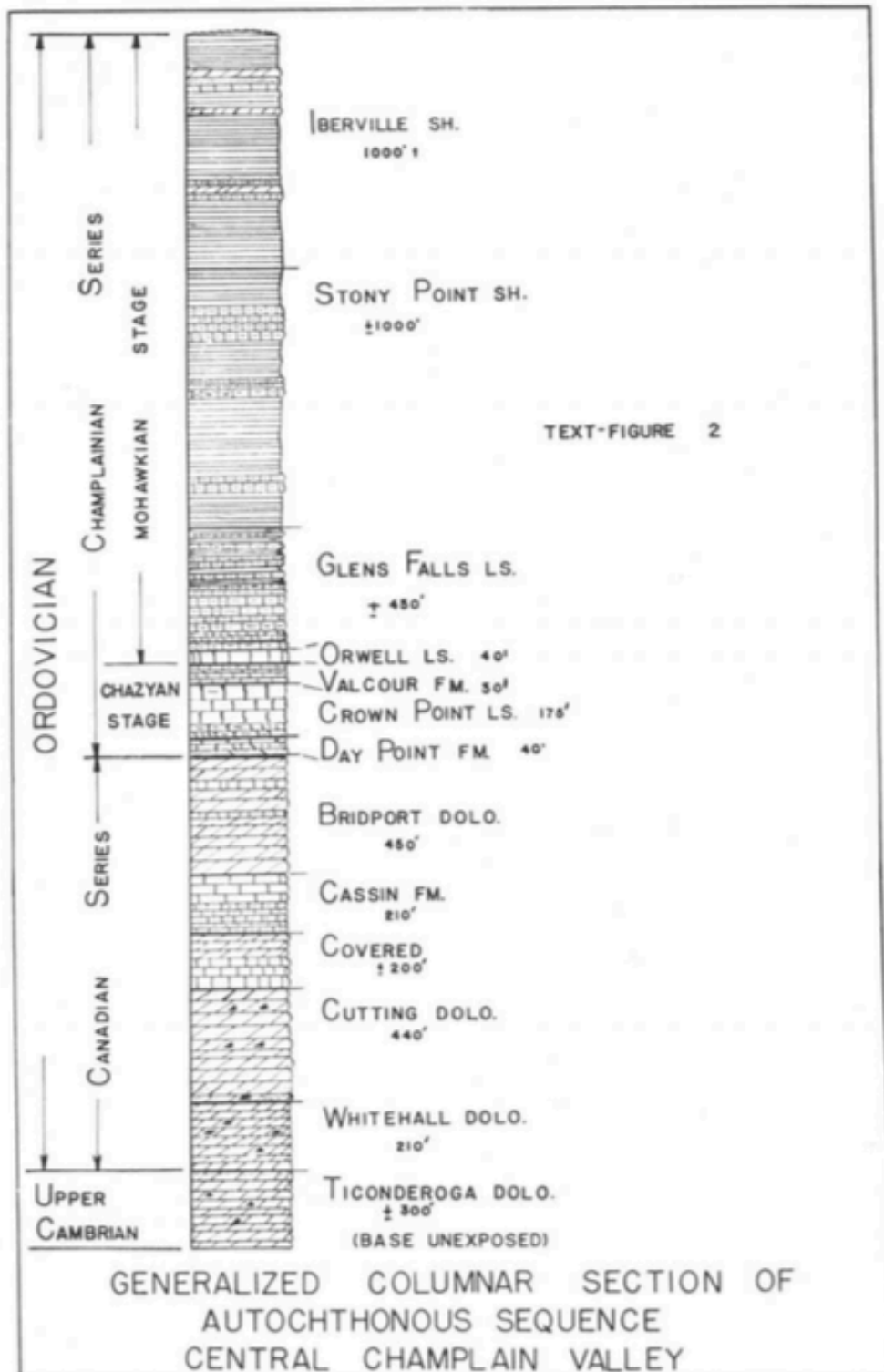
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Photo Phos-Cap™ Stock Production, Wilcox Quarry

Photo by Thos. Vanacore



Text-fig. 2. Generalized columnar section of autochthonous sequence.



SAINT GEORGE BLACK ROCK DUST

A sedimentary clay mineralogy of high nutritive content including Nitrogen, Phosphorus, Potassium, Silicon, Calcium, Magnesium, Iron, Sulphur, and significant traces including Vanadium, Zinc, Cobalt, Chromium, Copper, Molybdenum and Boron. Includes nearly 5% Total Carbon, 1% Organic Carbon and .1% Total Nitrogen

A "grits-to-dust" gradation (1/8"-0) suitable for remineralization and phosphorus management in direct to ground applications; soils, tillage, potting mixes and composting. This rock dust is dampened to reduce dusting hazard and improve handling.

Suggested application rates when broadcast directly to ground: 1-25 lbs./100 sq. ft. (400 lbs.-5 Tons/acre). Benefits are correlated to application rates. St. George Black is an alkaline material which will tend to buffer acidic soils as the material weathers. For Phosphorus management use as directed in the field or use as an admixture to animal bedding at 10% by volume. For maximum benefit in nutrient management applications use the RICHmix "Phos-Cap" formulations.

Typical Geochemical Analysis: SiO₂ 44.76%, Fe₂O₃ 4.63%, CaO 15.61%, MgO 2.47%, Na₂O .96%, P₂O₅ 0.15%, Sulphur 1.16%, V 112 ppm, Zn 63 ppm, Co 19ppm, Cr 52 ppm, Cu 32 ppm, Mo 2ppm, B 72 ppm

Natural Earth Product. USDA/NOP Compliant for certified organic production.

HAZARD WARNINGS / CAUTION

AVOID BREATHING OR INGESTING ROCK DUSTS AND SOIL AMENDMENTS

Breathing dust may cause nose, throat or lung irritation or choking. Gross ingestion may cause intestinal distress. Avoid inhalation of dust. Use adequate ventilation when working in confined areas or wear suitable respiratory protection equipment.

Warranty Disclaimer

This product conforms to the product description and is reasonably suited for the purposes as stated. In no event shall the manufacturer or the seller be held liable for any incidental, consequential, or special damages resulting from the use or handling of this product. The exclusive remedy of the buyer or user for all claims shall be the return of the purchase price of the product, at the sole discretion of the seller.

Manufactured by Rock Dust Local, LLC Bridport Vermont. www.rockdustlocal.com Tel: 802-758-2220
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PHOS-CAP™

REMINERALIZED BIOCARBON

LIVESTOCK BEDDING AND GROUND APPLICATIONS TARGETING PHOSPHORUS MANAGEMENT

Use as an admixture to livestock bedding at 5-10% by volume in stalls, free stalls, and cages, direct to ground in paddocks, feed lots or other areas of confinement where excess phosphorus or nitrogen are of concern. Can be used as a soil amendment or as an admixture to compost and manure management systems.

COURSE/ LARGE LIVESTOCK

Safe and Effective. All Natural. Conforms to USDA National Organic Program Standards

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SHELBURNE LIMESTONE CORPORATION

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Shelburne Limestone Corporation

Incorporated under the laws of the State of Vermont on September 9th, 1964

The corporation is owned by third generation Vermonter Trampas Demers of Shelburne, Vermont.

Shelburne Limestone's 54 Vermont employees operate three quarry operations throughout the state. The primary business objective is producing high calcium animal feed and fertilizer supplements in Shelburne and Swanton, Vermont operations. The corporation also operates the Middlebury marble quarry for Omya.

Shelburne Limestone has a long history dating back to late 60's producing land-applied material for the agricultural industry. The corporation has been involved with Vermont, New York and Quebec farms for generations. Along with the farm products produced, SLC produces spec products for the asphalt and concrete industries, pelletized lime for the turf market and general aggregates for the building industries.

The main offices are located at the company's maintenance facility in Colchester, which also houses one of three trucks to train loading facilities within the company. Colchester is also home to the fabrication department, which builds and maintains the rock crushing plants and manages the company's roll stock.

Shelburne Limestone has a long history of being a leader and innovator in the mineral processing industry. SLC enjoys a great reputation both in the communities the quarries reside in along with government departments both State and Federal.

Thank you for considering SLC.

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Shelburne Limestone Corp. Swanton. Dennis Demers, Trampas Demers, Ted Wysocki





