CANADIAN WOLLASTONITE
CROP & SOIL BENEFIT RESEARCH SUMMARY

Table of Contents

About Wollastonite

Wollastonite is a valuable and uncommon calcium-silicate mineral ($CaSiO_3$) created when impure limestone is subjected to high temperature and pressure. Wollastonite is only available for industrial and agricultural applications in a few places worldwide with three mines currently in operation in North America. Wollastonite is a white mineral with a granular texture and reacts quickly in soil releasing the following nutrients:

- Calcium %26.5 CaO
- Silicon %55.2 SiO_2
- Magnesium %6.62 MgO
- Iron %2.23 Fe_2O_3
- Potassium %1.55 K_2O
- Sulphur %1.66 SO_2

Wollastonite is an excellent source of calcium and silicon. Silicon is a lesser-known nutrient that is developing a big reputation as a cost-effective way to boost plant growth while reducing damage from pests, diseases, and environmental extremes. Spreading wollastonite is the safest and easiest way to supply silicon to agricultural fields. Wollastonite can be applied at a rate of 1.2x the rate of lime for a similar effect on soil pH.

Below is a collection of summarized studies and articles on the benefits of wollastonite and silicon fertilizer use in agriculture. The table of contents is clickable on most devices.

Liming with Wollastonite & Calcium Silicate					
Topic	**Title**	**Summary**	**Key Points**	**Year**	**Links**
Lime replacement & disease resistance Pumpkin	Applying Wollastonite to Soil to Adjust pH and Suppress Powdery Mildew on Pumpkin	Wollastonite was compared with lime 1:1 and produced a similar pH adjustment in a greenhouse pot experiment using pumpkins. Wollastonite significantly reduced the incidence of powdery mildew in pumpkins.	-Confirmed wollastonite has similar liming ability (CCE 93%) -Lime and wollastonite applied at the same rate -Replacing lime with wollastonite provided sufficient disease protection, excess application did not improve disease tolerance -3 to 6 tonnes/acre resulted in highest tissue Si concentrations and lowest levels of disease resistance -Wollastonite is suggested as an effective lime replacement for cucurbit producers	2019	Applying Wollastonite to Soil to Adjust pH and Suppress Powdery Mildew on Pumpkin
Lime replacement Soybean, Corn	Surface application of limestone and calcium magnesium silicate in a tropical no-tillage system	Detailed experiment comparing calcium-magnesium silicate with lime. Silicate treatment equalled or surpassed lime release effects and supplied silicon throughout the soil profile.	-Silicate treatment met or exceeded lime performance: OM accumulation, pH increase, reducing soluble Al, Ca release, base saturation, and more. -Silicate liming effects were found deeper in the soil profile compared with lime -Increasing soil silicon levels were shown to increase P concentrations in the crops compared with the lime application	2016	Blog Surface application of limestone and calcium magnesium silicate in a tropical no-tillage system
Lime replacement Rye, Pumpkin	Building soil fertility using soil amendments	Master thesis summarizing a comparison of wollastonite and Ca-Mg silicates with lime for soil and plant impacts.	-Silicates increased soil pH as well as liming materials at the same application rates -Wollastonite was more effective than slag at increasing soil Si levels -Silicates extended onset of powdery mildew 20x -Silicate increased Si availability 10x over control	2014	Building soil fertility using soil amendments
Lime replacement & disease resistance	Efficiency of Calcium Silicate and Carbonate in Soybean Disease Control	Study compares calcium silicate and calcium carbonate for disease resistance.	-Calcium silicate reduced incidence of Frog's Eye Leaf Spot and Downy mildew -Disease resistance was inversely proportional to leaf Si concentration -Leaf Si concentration was highest at 8 mt/ha of calcium silicate -Yield was not evaluated	2006	Efficiency of Calcium Silicate and Carbonate in Soybean Disease Control
Benefits of Silicon Overview					
Silicon overview -	The Soil Profile: Silicon and Soil Fertility	Detailed newsletter article providing a strong general	-Provides historical background of how silicon has become recognized as an important nutrient for plant	2012	Silicon and soil fertility

General		overview of benefits of silicon in agriculture. Written by Joseph Heckman a leader in silicon research.	growth -Concepts explained in simple language -Positive impacts on crops described for corn, oats, pumpkin, cabbage, grasses, dogwood. Recommendations: * Consider applying silicon fertilizers with ammonium sulphate as N source to improve silicon uptake * Adjust pH with calcium silicate instead of lime to increase silicon supply in the soil * Strong residual silicon effects are seen in crops for 3-4 years after a single application * Test sources of silicate for heavy metals * Foliar applications are generally less effective than soil-based applications * Silicon is generally available in the soil across a wide soil pH range		
Silicon overview - Technical	Silicon: A Beneficial Substance	Overview of silicon functions in plants, fertilizer rates, plant and soil analysis for Si. Article from industry magazine written by Joseph Heckman.	-Plant species can accumulate up to 10% Si in tissues -Si reinforces cell walls, stimulates plant growth, reduces pest and disease pressure -Sandy soils can benefit from Si applications	2013	Silicon: A Beneficial Substance
Yield increase	Optimization of source and rate of soil applied silicon for improving the growth of wheat	Calcium silicate was the most effective silicon source and lead to significant increases in shoot and root length, fresh, and dry weights, shoot to root ratio, and total plant biomass when compared with the control.	-Calcium silicate increased shoot length by 33% over the control -Calcium silicate was the most effective silicate treatment when compared with silicic acid and sodium silicate -Silicate treatments showed the greatest benefits at the medium rate with no difference at the high rate	2013	Optimization of source and rate of soil applied silicon for improving the growth of wheat
Yield increase, NUE	Effect of calcium silicate on yield and nitrogen use efficiency (nue) of wetland rice	Calcium silicate addition increased grain and straw yield in wetland rice increasing the nitrogen use efficiency.	-Rice grain increased 600 kg/ha with 2 mt/ha calcium silicate addition -Rice straw yield increased 800 kg/ha with 2 mt/ha calcium silicate addition -Increased leaf erectness suggested as a contributing factor to reduce shading and increase yields	2013	Effect of calcium silicate on yield and nitrogen use efficiency (nue) of wetland rice

Insect Resistance

Topic	Title	Summary	Key Points	Year	Links
Insect resistance	Silicon: Potential to Promote Direct and	Review paper, discussing potential for silicon fertilization	-Since Si fertilization has been shown to attract natural arthropod pest predators, and regulate plant secondary	2016	Blog

	Indirect Effects on Plant Defense Against Arthropod Pests in Agriculture	to affect multiple trophic levels. Proposes herbivore induced plant volatiles (HIPV) could be enhanced with silicon fertilization.	metabolites, what effects may be occurring at a third trophic level? -Silicon has increased physical and chemical plant defenses, this review makes the case that more work is required for HIPV and pest predator silicon interactions.		Silicon: Potential to Promote Direct and Indirect Effects on Plant Defense Against Arthropod Pests in Agriculture
Insect resistance	Silicon enhances natural enemy attraction and biological control through induced plant defences	Silicon fertilized plants attracted more pest predators only in the presence of pests.	-Pest predators ate 7x more eggs from Si treated plants -Authors suggest, increased production of plant secondary metabolites by Si treated plants could result in increased predation by attracting predators. -Silicon treatment doubled leaf Si concentrations in cucumber	2010	Blog Silicon enhances natural enemy attraction and biological control through induced plant defences
Insect resistance	Calcium Silicate and organic mineral fertilizer applications reduce Phytophagy on Eggplants	Foliar calcium silicate treatments reduced insect damage to leaves from thrips, a common eggplant pest.	-Calcium silicate reduced population and damage from thrips on eggplant -3-6 foliar applications needed -Mode of action assumed to be strengthening of leaf tissues preventing thrips from eating the leaves	2008	Calcium Silicate and organic mineral fertilizer applications reduce Phytophagy on Eggplants

Disease Resistance

Topic	Title	Summary	Key Points	Year	Links
Disease resistance	Towards establishing broad-spectrum disease resistance: Silicon leads the way	Review paper proposing silicon plant interactions to account for broad-spectrum disease resistance from silcon fertilization.	-Describes role silicon plays in preventing infection and enhancing immune responses to pathogens -Provides overview of silicon forms and availability in soil and uptake in plants -Silicon has been shown to be highly influential in plant hormone regulation -Identifies need for further research, there are many genetic responses to silicon that need further investigation.	2013	Towards establishing broad-spectrum disease resistance: silicon leads the way
Disease resistance	Silicon Suppresses Fusarium Crown and Root Rot of Tomato	Silicon reduced fusarium presence in the leaves and roots of tomato plants in a side-by-side comparison Si+ and Si-.	-Si accumulated in roots and shoots of tomato -Si recommended as management strategy for fusarium crown and root rot -Si fertilization considered more effective than available bio-pesticides -Data suggest Si fertilization was at a low level which may have limited the effect, young plants showed high levels of accumulation which decreased during the experiment	2011	Silicon Suppresses Fusarium Crown and Root Rot of Tomato
Disease resistance -	Calcium Silicate Suppresses Powdery	Field study showing enhanced disease resistance and yields from	-10-44% reduction in mildew lesions compared with lime plots	2010	Calcium Silicate Suppresses Powdery

Wheat	Mildew and Increases Yield of Field Grown Wheat	calcium silicate (slag) compared with lime.	-Increased wheat yield by 10% over lime treated plot -Identified calcium silicate as a suitable source of lime due to added disease protection and yield gain		Mildew and Increases Yield of Field Grown Wheat
Disease resistance - Ryegrass	Silicon and the Development of Gray Leaf Spot of Perennial Ryegrass Turf	Turf grass leaf silicon content increased as disease severity decreased with increasing wollastonite application.	-Wollastonite applied at 0.5 to 10 mt/ ha -Results were similar in potting mix and field soil with same application rate -Results add Ryegrass to a wide range of grass species that respond to silicon treatments	2010	Silicon and the Development of Gray Leaf Spot of Perennial Ryegrass Turf
Disease resistance - Wheat	Calcium Silicate Suppressed Powdery Mildew and Increases Yield of Field Grown Wheat	Compared with industry standard fungicides, significant reductions in powdery mildew and leaf blotch were observed in the flag leaves of wheat.	-Powdery mildew reduced %44 -Yields increased 10% -Authors conclude calcium silicate is effective for raising soil pH and may offer added disease suppression benefits	2010	Calcium Silicate Suppressed Powdery Mildew and Increases Yield of Field Grown Wheat
Disease resistance - Tomato	Calcium silicate and organic mineral fertilizer increase the resistance of tomato plants to Frankliniella schultzei	Repeat foliar applications of silicon fertilizers, one of them calcium silicate increased tolerance to the common pest thrips on tomatoes.	-Thrip nymph mortality increased with the number of applications, up to 12 suggesting they were unable to feed -Calcium silicate treatments were compared to a control using industry standard rates of fungicides	2008	Calcium silicate and organic mineral fertilizer increase the resistance of tomato plants to Frankliniella schultzei
Disease resistance	Pumpkin Production Practices that Reduce Cost	Newsletter article with summary of calcium-silicate benefits for pumpkin and wheat.	-Demonstrated as cost effective alternative to lime -Reduction of powdery mildew in pumpkins -Wheat grown the following year in the experimental plot had higher yield and reduced disease pressure	2006	Pumpkin Production Practices that Reduce Cost
Disease resistance	Silicon and plant disease resistance against pathogenic fungi	Silicon plays an important role in pathogen defense. Silicon likely interacts in multiple ways to increase plant pest resistance to parthenogenic fungi.	-Silicon shown to accumulate in leaves at site of parthenogenic infection -Silicon is present all plant tissues and plays a role in local and systemic resistance to pathogens -Silicon is seen as an important player in communicating and controlling plant immune system responses to pathogens		Silicon and plant disease resistance against pathogenic fungi
Disease resistance	Role of Silicon in Suppressing Rice Diseases	Comprehensive analysis of use cases for silicon fertilizer showing a net financial benefit in all cases.	-Microscope analysis showed Si fertilized plants showed fungal strands in infected cells surrounded and trapped with amorphous material -Silicon likely amplifying chemical immune responses to infection -Phosphorus applications can be reduced with calcium silicate use -Base case shows a net profit increase of $270/ha with use of calcium silicate in rice production	2005	Role of Silicon in Suppressing Rice Diseases
Disease resistance - flowers	Research Update: Does Silicon Have a Role in Ornamental Crop	Summary of silicon benefits for ornamental crop production. Nutrient regulation, disease, and	-Reduced powdery mildew in zinnia, phlox, and sunflower -Increased wilting tolerance and recovery in poinsettia	2010	Research Update: Does Silicon Have a Role in Ornamental Crop

	Production?	post-harvest benefits noted.	-Zinnia avoided copper toxicity with Si fertilization -Organic sources of silicon were not effective		Production?
Disease resistance	Accumulation of Silicon by Bermudagrass to Enhance Disease Suppression of Leaf Spot and Melting Out	Bermudagrass accumulated silicon with increasing calcium silicate addition and showed reduced leaf spot severity.	-First experiment demonstrating Si accumulation in bermudagrass. -Leaf tissue concentration peaked at 0.8% Si -80% increase over non-amended soil -39% reduction in leaf spot severity -Calcium silicate recommended for golf course management	2003	Accumulation of Silicon by Bermudagrass to Enhance Disease Suppression of Leaf Spot and Melting Out

Drought & Temperature Resilience

Topic	Title	Summary	Key Points	Year	Links
Salinity & drought tolerance	The Role of Silicon in Higher Plants under Salinity and Drought Stress	Technical review article summarizing Si effects: stronger cell walls, more efficient water use, increased oxidative stress tolerance.	-Silicon forms glass barrier in cell wall and improves solute control in and out of the cell -Improved salt tolerance begins in the root with improved Na and Cl exclusion -Silicon improved water use efficiency under drought conditions -Silicon reduced oxidative stress and increased antioxidant activity	2016	The Role of Silicon in Higher Plants under Salinity and Drought Stress
Stress tolerance	Functions of silicon in plant drought stress responses	Silicon improves drought tolerance from a combination of structural cell changes as well as enhancing biochemical processes throughout the plant.	-Silicon strengthens leaf cell walls reducing water loss -Silicon improves regulation of leaf stomata and increases antioxidant production -Includes excellent table of previous work on page 7 organized by drought stress resistance mechanism	2021	Functions of silicon in plant drought stress responses
Drought tolerance	Effects of Silicon on Growth, Yield and Fruit Quality of Cantaloupe under Drought Stress	Cantaloupe quality and yield improved with silicic acid 75%, and 100% of field capacity and under drought conditions.	-Improved quality measured by increased flesh thickness and total soluble solids -Maximum yields and quality achieved at 200 kg/ha and 400 kg/ha silicic acid	2020	First page: Effects of Silicon on Growth, Yield and Fruit Quality of Cantaloupe under Drought Stress
Climate change & pest tolerance	Benefits from Below: Silicon Supplementation Maintains Legume Productivity under Predicted Climate Change Scenarios	Silicon was shown to have positive impacts in multiple simulated climate scenarios while increasing tolerance to herbivore pests at the same time.	-Some climate scenarios led to increases in pest pressure on the controls, silicon amended plants showed increased resistance and less pest pressure -Silicon increased root nodulation in scenarios where root nodulation of the control declined -Silicon fertilization can help sustain current soybean yields in a warming climate that may otherwise decrease yields	2018	Benefits from Below: Silicon Supplementation Maintains Legume Productivity under Predicted Climate Change Scenarios

Benefits of Silicate Fertilization – Soil Toxicity					
Topic	**Title**	**Summary**	**Key Points**	**Year**	**Links**
Mineral excess & deficiency	Improvement of the physiological response of barley plants to both Zinc deficiency and toxicity by the application of calcium silicate	Calcium silicate reduced the effects of zinc toxicity and deficiency at the same dose in barley plants.	-Calcium silicate increased zinc accumulation when deficient and limited accumulation when barley was grown at toxic levels -Calcium silicate reduced oxidative stress and enhanced beneficial cellular level chemical responses	2022	Blog Improvement of the physiological response of barley plants to both Zinc deficiency and toxicity by the application of calcium silicate
Reduce soluble aluminum in soil	Soluble Silica with High Affinity for Aluminum under Physiological and Natural Conditions	High aluminum levels in agricultural soils reduce uptake of essential nutrients. Silicon is shown to be very reactive and readily immobilize soluble aluminum in this lab-based study.	-Oligomeric silicon (larger molecules) has >1,000,000 affinity for Al compared with monomeric silicon -Al helps to stabilize Si complexes preventing dissolution -"Traces of oligomeric silica in biological systems would profoundly affect the availability of aluminum and would readily account for many of the existing results."	1997	Soluble Silica with High Affinity for Aluminum under Physiological and Natural Conditions
Reducing soluble aluminum in soil	Neoformed aluminosilicate and phytogenic silica are competitive sinks in the silicon soil–plant cycle	Study demonstrating the ability of soluble silicon and aluminum to form aluminosilicates in the soil, removing the aluminum from the soil solution. Aluminosilicates are the building blocks for clay and can increase soil CEC.	-With sufficient soluble silicon, aluminosilicates can form at rates of 0.85g/kg soil/day -Describes basic silicon cycle and sources of bioavailable silicon in the soil -Experiment evaluated movement of silicon between biological and mineral forms	2022	Blog Neoformed aluminosilicate and phytogenic silica are competitive sinks in the silicon soil–plant cycle
Carbon Capture in Soils by Enhanced Rock Weathering (ERW)					
Topic	**Title**	**Summary**	**Key Points**	**Year**	**Links**
Soil ERW	Carbon capture in real-time	Blog summary of new CW R&D Project.	-Trent & Yale involvement -Experiment started in June 2023 -10 acres applied, 2.5-acre control currently in soybeans -Unique analysis of CO_2 gas exchange with and without wollastonite treatment	2023	Blog Trent University Research Profile: Carbon capture in real-time
Soil ERW	Rock 'flour' from Greenland can capture significant CO2, study shows	Glacial rock flour on the shores of Greenland can capture carbon when spread on agricultural soils. These rock flour deposits occur in large enough quantities to be used	-ERW solutions are gaining momentum -Demonstrates 0.73 mt CO_2 capture with 50 mt ha^{-1} application of glacial rock dust over three years -Glacial rock dust requires significant transportation but no processing	2023	Blog Article: Rock 'flour' from Greenland can capture

		on agricultural lands around the world.	-Compared to wollastonite, carbon capture rate is much lower per mt of material and not as fast acting		significant CO2, study shows Full study: Quantification of CO2 uptake by enhanced weathering of silicate minerals applied to acidic soils
Soil ERW	The carbon economy is going to be a game changer for agriculture	Article highlighting recent University of Guelph news report about research on ERW with wollastonite.	-Wollastonite identified as an optimal mineral for ERW -Describes how ERW can benefit agricultural production while permanently storing carbon	2023	Blog Carbon-smart soils used to combat climate change
Soil ERW	Lime with wollastonite- An easier decision than you might think	Describes benefits of using wollastonite as a source of calcium for agricultural soils.	-1 mt of wollastonite can remove up to 300 kg of CO_2 from the atmosphere through enhanced rock weathering within the first year of application -Lifetime CO_2 capture is expected to achieve 600 kg per mt of wollastonite applied to soil. -Replacing lime with wollastonite will further mitigate up to 44 wt % in CO_2 otherwise released from lime -Wollastonite offers a balanced Ca:Mg ratio reducing need for dolomite applications -Wollastonite availability is faster than limestone	2023	Blog
Green energy	A win for green energy: Wollastonite increases natural gas production and reduces CO2 emissions in sewage sludge	Summary and graphic of a recent study that found CO2 levels decreased while methane production increased when calcium silicate was added to the sludge in the bioreactor.	-Calcium reacted with CO_2 forming Calcium carbonate -Calcium silicate increased methane yield by over 30% -Feasible applicate rate at 16 g/L of sludge	2023	Blog Carbon dioxide sequestration and methane production promotion by wollastonite in sludge anaerobic digestion
Soil ERW	Wollastonite is the safest and most cost-effective carbon capture mineral for agricultural soils	Summary of study comparing different silicate minerals with a focus on nickel release.	-Wollastonite was the cleanest most effective mineral studied -Wollastonite is possible to use for repeated annual applications -Olivine releases large amounts of nickel potentially contaminating soils creating a significant hurdle for use on agricultural lands	2023	Blog Assessment of the enhanced weathering potential of different silicate minerals to improve soil quality and sequester CO_2
Soil ERW	Video Launch: How CW Grow boosts plant growth and captures carbon	Blog featuring a short, animated video introducing CW Grow with a basic explanation of ERW.	-Simple animation and explanation of ERW -Wollastonite can permanently store CO_2 in the soil -Wollastonite is a source of calcium, magnesium, silicon and micro-nutrients -Wollastonite benefits plant growth by increasing stress	2023	Blog

			tolerance and resistance to pests and diseases by supplying silicon		
Soil ERW	Mineral–Soil–Plant–Nutrient Synergisms of Enhanced Weathering for Agriculture: Short-Term Investigations Using Fast-Weathering Wollastonite Skarn	Links are drawn between three preceding studies to demonstrate the multiple benefits of ERW in agriculture.	-Plant growth increases shown in every study -Silicon content of root sand shoots increased -Inorganic carbon capture shown using multiple verification methods. -Wollastonite highlighted as ideal silicate for ERW in agriculture	2022	Blog Mineral–Soil–Plant–Nutrient Synergisms of Enhanced Weathering for Agriculture: Short-Term Investigations Using Fast-Weathering Wollastonite Skarn
Soil ERW	Canadian Wollastonite & Accelerated Weathering in the Mainstream (Farm) Media	Blog featuring a well circulated article that introduces using wollastonite and ERW for agricultural soils including interviews and summary with Guelph researchers Emily Chiang and Rafael Santos.	-Wollastonite selected as fastest weathering mineral for carbon sequestration -Describes benefits of using crushed rocks for agricultural productivity and carbon sequestration -Summary of well-known wollastonite effects on plants because of increased silicon levels (increased disease resistance and climate stress tolerance)	2022	Blog Farming with rock dust could boost crops, buffer climate
Soil ERW	DIY Carbon capture with CW Grow and the Urey Reaction	Blog and graphic describing the Urey Reaction, the natural rock weathering processes that has captured and stored 99% of CO_2 in the atmosphere over time.	-Urey reaction is the name of the reaction that describes 'enhanced weathering', summarized as follows: -Water vapour and carbon dioxide combine in the atmosphere to form carbonic acid -Carbonic acid falls to the earth and reacts with calcium and magnesium silicate minerals in the soil and on exposed rock surfaces to form carbonates -Calcium carbonate washes down into the soil and then into oceans to form limestone resulting in permanent storage for carbon dioxide that started in the atmosphere	2021	Blog
Soil ERW	Research so fresh it's alive -Wollastonite, microbes & carbon sequestration	A blog and graphic that highlights a study showing importance of soil microbes in ERW based carbon capture.	-Microbes are a key part of ERW in soils -Plants and microbes work together -The exudates released by plant roots use carbon dioxide captured from the atmosphere through photosynthesis -Plants can produce significant amounts of carbonic acid in the soil as root exudates that further enhances ERW	2021	Blog Is the climate change mitigation effect of enhanced silicate weathering governed by biological processes?
Soil ERW	The research has been piling up for a long time, now it is time for action	A blog that summarizes a study from 1999 that identified wollastonite as an ideal rock to sequester carbon dioxide from the atmosphere using enhanced weathering.	-One of the first studies to suggest using rocks and accelerated weathering to capture carbon from the atmosphere -Research determined that wollastonite was the best option tested	2021	Blog Absorption and fixation of carbon dioxide by rock weathering (1999)

Soil ERW	Adding rock dust to farmer's fields captures carbon and boosts yields	Blog featuring Yale news article describing large-scale field trials of enhanced rock weathering.	-Profiles large-scale field trials happening in the US, Australia, and Canada -Describes positive impacts when using ERW on a wide variety of different crops for improved yield & carbon capture -ERW estimated to currently remove 1 billion tons of CO_2 per year from the atmosphere	2021	Blog How Adding Rock Dust to Soil Could Help Get Carbon into the Ground
Soil ERW	Bonus climate solution: Add wollastonite to green roof and urban agriculture soils	Describes potential of capturing 1% of global carbon dioxide emissions using roof top and urban soils amended with wollastonite.	-Presents theory for sufficient urban green spaces to be 'greened' while providing benefits to the urban environment (food, cooling) and sequestering CO_2 -Describes ERW process in urban context -Identifies wollastonite as an ideal candidate for use in urban agricultural soils -Features research by University of Guelph: Fatima Haque, Rafael Santos, and Emily Chiang	2021	Blog Urban Farming with Enhanced Rock Weathering As a Prospective Climate Stabilization Wedge
Soil ERW	The science of capturing carbon	Profile of Ontario field trial research being conducted by the University of Guelph.	-Study shows formation of calcium carbonate in soil by direct measurement -Features Ontario research confirming carbon capture and positive impacts with a wide diversity of crops: lettuce, potatoes, green beans, corn and soybean	2021	Blog CO2 sequestration by wollastonite-amended agricultural soils – An Ontario field study
Soil ERW	How does CW Grow capture carbon?	Infographic showing carbon capture by wollastonite.	-Simple visual depiction of ERW	2021	Blog
Soil ERW	Potential for large-scale CO_2 removal via enhanced rock weathering with croplands	Study summarizes potential of ERW across global croplands.	-Uses mathematical models to show ERW potential from a net CO_2 sequestered while factoring in costs -Depicts sequestration potential by country with calculations of relative costs	2020	Potential for large-scale CO2 removal via enhanced rock weathering with croplands
Soil ERW	Optimizing Inorganic Carbon Sequestration and Crop Yield with Wollastonite Soil Amendment in a Microplot Study	Study examined alfalfa and soybean growth and carbon capture in soils with wollastonite.	-Used a wide range of doses to determine ideal dose range -Confirmed carbonate formation on soil particles -Demonstrated plant growth benefits while capturing carbon dioxide	2020	Optimizing Inorganic Carbon Sequestration and Crop Yield With Wollastonite Soil Amendment in a Microplot Study
Soil ERW	Characterization of Physically Fractionated Wollastonite-Amended Agricultural Soils	Early study of chemical reactions that occur when wollastonite is mixed with soil. Detailed engineer style report.	-Showed formation across various sizes of particles in the soil -Study determined scientific methods to use in future work	2019	Characterization of Physically Fractionated Wollastonite-Amended Agricultural Soils
Soil ERW	Stacking Benefits: Crop performance + Carbon Sequestration	Features Ontario study demonstrating carbon capture and	-When grown with wollastonite: Corn -177% more biomass, Beans -9x the amount of carbon capture in soil than soil grown without beans	2019	Blog

		crop growth benefit from wollastonite use.	-Demonstrated clear crop benefits while sequestering significant amounts of CO_2 with wollastonite addition		Co-Benefits of Wollastonite Weathering in Agriculture: CO2 Sequestration and Promoted Plant Growth
Soil ERW	Alkaline Mineral Soil Amendment: A Climate Change 'Stabilization Wedge'?	Detailed description of wollastonite weathering reactions in the soil. Includes impacts of organic and inorganic carbon, shows mechanism for inorganic carbon sequestration.	-Early study published by University of Guelph team, provides technical background on reactions and the potential of wollastonite to sequester carbon -Study shows chemical reactions occurring as wollastonite reacts in the soil to capture and store carbon based organic acids as carbonate minerals -Study demonstrates potential of ERW as a solution to reducing carbon dioxide levels in the atmosphere	2019	Alkaline Mineral Soil Amendment: A Climate Change 'Stabilization Wedge'?
Soil ERW	New Research: Enhancing CO_2 sequestration with Wollastonite	Technical report describing the reaction carbonates are created from free calcium released by wollastonite.	-Evaluates enzymes and metal organic frameworks for their potential to enhance weathering -Explains weathering mechanism for wollastonite -Metal organic frameworks are identified for their potential to enhance mineral weathering rates with wollastonite	2018	Blog The Carbonation of Wollastonite: A Model Reaction to Test Natural and Biomimetic Catalysts for Enhanced CO2 Sequestration
Soil ERW	New research project: Innovative carbon-sequestering fertilizers	University of Guelph partnership announcement.	-General description of partnership with University of Guelph Research Team -Brief description of ERW and potential for wollastonite in agricultural soils	2018	Blog
Soil ERW	The contribution of agricultural lime to carbon dioxide emissions in the United States: dissolution, transport, and net emissions	Research report describes estimated CO_2 net emissions release in USA from the use of agricultural limestone.	- Describes prediction that carbon dioxide emissions from the application of aglime account for 22% of the total aglime applied resulting in between 4.4 and 6.6 Tg of CO_2 released in 2001 -Explains the flow of carbonates from the soil into oceans	2005	The contribution of agricultural lime to carbon dioxide emissions in the United States: dissolution, transport, and net emissions
Soil ERW	Fight Global Warming By Boosting Calcium Silicates In Soil -Theory	News article describing the role of plant exudates in ERW with calcium silicates and an overview of a local research project to the UK.	-Summary of exploratory study for ERW in soils with calcium silicate -Simple explanation of carbon sinks and ERW potential	2008	Fight Global Warming By Boosting Calcium Silicates In Soil -Theory

Organic Carbon Capture					
Topic	**Title**	**Summary**	**Key Points**	**Year**	**Links**
Forests	Increased carbon capture by a silicate-treated forested watershed affected by acid deposition	Published study on Hubbard Brook research with wollastonite showing a net carbon capture of 3x weight applied over 15 years. Study shows persistence of calcium from wollastonite in ecosystem as well as the flow of carbon dioxide out of the ecosystem in river waters.	-Demonstrates wollastonite provided net 3x CO_2 capture in a large forest per mt of wollastonite applied -Identifies wollastonite as an ideal mineral over limestone which releases CO_2 when weathered -Wollastonite chosen for similar or faster reactivity over other silicates -Potential for large scale wollastonite applications on forests investigated with large amounts of measurable CO_2 export through river waters	2021	Increased carbon capture by a silicate-treated forested watershed affected by acid deposition
Organic soil carbon	Calcium-mediated stabilisation of soil organic carbon	Research paper describes how calcium can stabilize organic matter to increase the storage potential for organic forms of carbon in the soil.	-Demonstrates potential for calcium to stabilize soil organic matter -Describes how calcium can increase soil organic matter resistance to oxidation helping to stabilize the carbon in an organic form in the soil for longer term storage	2017	Calcium-mediated stabilisation of soil organic carbon