

Wollastonite

A versatile mineral which can support sustainable farming

07 June 2019



Business Risk Analysis – Visionary Execution



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Corporate Overview



- Vertical Exploration Inc. (the "Company" or "Vertical") is an advanced-stage, Canadian junior mining company which is listed on the Toronto Venture Exchange ("V.VERT"). The Company's flagship asset, the St. Onge wollastonite project, is located in the Lac Saint Jean region of Quebec, and Vertical's objective over the next 24 months is to fast track this world class deposit into an economically-viable project.
- The wollastonite deposit is high grade and open-pittable, with a NI 43-101 measured and indicated resource of 14 million tonnes ("Mt") at 36.61%, and an inferred resource of 18 Mt at 40.25%.
- Wollastonite is a naturally-occurring mineral, with a wide range of industrial applications, including ceramics, polymers such as plastics and rubber, paint fillers, metallurgy, paper and friction materials.
- According to the USGS summary on wollastonite, total global supply of refined product in 2018 amounted to 800,000 tonnes, with an estimated 530,000 tonnes produced in China alone, and only 10,000 tonnes produced in Canada.
- Large quantities of research also highlight the potential of wollastonite in the agricultural sector, and could be used as a soil amendment product, natural fungicide and slow-release fertilizer to support crop cultivation.



Strategy



- As a past producer of high-quality wollastonite product, the development of the St Onge deposit for industrial applications is central to the Company's strategy, and could be executed within a short 2-3 years. Vertical is looking for a strategic partner to assist with the construction of a mill to produce higher-revenue, filler-grade wollastonite.
- In addition to traditional uses, **Vertical is focused on new and fast-growing markets**, including soil amendments/fertilizers, cannabis, environmental remediation and construction.
- The potential use of wollastonite in the Agriculture sector, via a simple, low-cost quarry and crushing operation, provides Vertical with another opportunity to exploit the deposit:
 - Low technical risk; low capital expenditure, relatively little process, no chemical product and no tailings pond.
 - the generation of revenues would help Vertical to minimize additional capital-calls and shareholder dilution. Inhouse analysis supports the view that a crushed product could be delivered cost-competitively versus similar products offered in the market.
- Vertical has retained the services of AGRINOVA, a highly-regarded Center for Research and Innovation in Agriculture in Quebec, to conduct a three-phase research and development program on wollastonite and agricultural applications for the St Onge deposit, and the registration of products with the Bureau de Normalisation du Quebec ("BNQ" – the registration agency of Quebec).



AGRINOVA – Key Findings Phase 1



- In May 2019, Vertical announced encouraging results from Phase 1 of its R&D agreement with AGRINOVA on wollastonite from the St Onge deposit:
 - $\,\,$ Verticals' wollastonite could be BNQ-certified or registered under the Fertilizers Act in Quebec. $\,\,$
 - The safety profile of Vertical's wollastonite was successfully demonstrated by a germination and elongation test with barley.
 - Vertical's wollastonite has a neutralizing power and efficiency which compares it favorably with current lime products in the market, and that it has appreciable levels of major and minor elements (silicon, calcium, magnesium and manganese) that are essential for plant nutrition and growth.
 - Another benefit of Vertical's wollastonite that was identified by AGRINOVA is its high bio-availability of silicon that leads to both enhanced plant growth and resistance to abiotic and biotic stress in a range of agricultural crops, as studies have shown there is a significant need for this element that is not being filled by commercial fertilizers.
 - Results for the second market study component indicate that wollastonite has a significant potential to be used for maple production (maple syrup production), organic agriculture, sod production, large-scale crops (cereals, corn and soybeans) and boreal forestry (spruce budworm control and post-fire regeneration). Based on these uses, the potential agricultural demand for wollastonite in the initial target market of Quebec could be in the order of 274,000 tonnes for the province of Quebec as a whole, plus additional demand of approximately 59,000 tonnes from the Maritime Provinces of Canada, based on the increased potential for wollastonite to be used for regional blueberry and potato crops.



What is Wollastonite?



Wollastonite is a naturally-occurring, calcium metasilicate (CaSiO₃) mineral with a theoretical composition of 48.3% CaO and 51.7% SiO₂, and an acicular (needle-like) particle shape. It is usually white and can

withstand temperatures up to 1540°C.

Geology

Wollastonite is formed when impure limestone or dolostone undergo high temperature and pressure changes, sometimes in the presence of silicabearing fluids, as in skarns or contact metamorphic rocks.

Physical Properties

- High brightness
- Low moisture and oil absorption
- Low water solubility
- Basicity
- Low volatile content
- High melting point
- Acicular crystal structure
- Relatively high hardness (4.5 on Mohs' scale)



FIGURE 1: Wollastonite Cluster



Principle Uses



CONSTRUCTION: Wollastonite **improves flexural and impact strengths**. It has found application as a **substitute for asbestos in fire-resistant building products** and is an excellent lightweight reinforcing filler for cement boards.

PAINT & COATINGS: Fine acicular particles act as a flattening agent and allows paint to settle with uniform thickness, better corrosion and barrier properties, and improve thermal stability at high temperatures. High brightness and whiteness reduce pigment load and typically very low oil absorption, reduces the volume of binder required and contributes to reduced pigment costs.

PLASTICS: Wollastonite **improves the durability** of the composite due to its acicular structure. It also **enhances electrical insulating properties, adds fire resistance, and improves dimensional stability**, making it an ideal reinforcement in thermoplastics, engineering alloys, thermosets and elastomers. Wollastonite also improves knit/weld line strength and prevents splaying during injection moulding.

ADHESIVES & SEALINGS: Wollastonite is a highly effective functional filler in adhesive and sealant applications, including structural, high temperature, pressure sensitive, hot melt, heat activated and UV curable adhesives and sealants.



FIGURE 2: Crushed Powder Product

RUBBER: Wollastonite is used to improve physical properties in gaskets, belts, plugs, O-rings, seals and moulded parts.

CERAMICS: Wollastonite can be used in a variety of ceramic applications including ceramic glazes and bodies, enamels, frits, fluxes and in sanitaryware. This industrial mineral is a source of CaO to alkaline glaze formulations to improve the strength of the glaze.



St Onge Wollastonite Deposit

- Vertical is currently the only listed junior mining play with a world-class wollastonite deposit.
- The St Onge deposit is located 80km north of the city of Alma in the Lac St Jean region of Quebec.
- Quebec is an internationally-recognised, friendly and secure mining jurisdiction (Fraser Institute 4th place 2018) and supported production of refined wollastonite products in the 1990s.
- Excellent regional infrastructure:
 - Lac St Jean region mining expertise / manpower
 - Significant hydro-power dam system in region to supply electricity to the aluminium producers
 - Accessible by well-maintained gravel road
 - 50 km from rail line
 - 100 km from international sea port
- Operation-ready with a highly-qualified regional team in place.



FIGURE 3: Saint Onge Wollastonite Deposit



Mineral Resources	Wollastonite (%)	Tonnes
Measured	36.20	7,155,000
Indicated	37.04	6,926,000
Measured & Indicated	36.61	14,081,000
Inferred	40.25	17,896,000

TABLE 1: Pit constrained mineral resources at Wollastonite deposit (COG at 30% Wollastonite) from NI43-101 Resources Calculation Report April 2018.

Between 1992 and 1995, Orleans Resources carried out major exploration programs and important results were obtained:

- A mineralized envelope extending 2,300 metres in a north-east to south-west direction, outcropping at surface through an exploration depth limited to 100 metres over true widths ranging from 20 to 98 meters.
- According to Orleans, the concentrates produced from the deposit met the highest of industry standards in terms of aspect ratio, whiteness, loss on ignition, oil absorption and pH, key characteristics for acceptance of products on international markets.



FIGURE 4: Saint Onge Exploration & DDH Locations



SHARE STRUCTURE	TSX-V: VERT
Issued and outstanding Warrants Options Fully Diluted	61,409,423 22,485,907 2,450,000 86,345,330
52 week high 52 week low	C\$0.15 C\$0.025
CONTACT DETAILS	
789 West Pender Street,	

Suite 1240, Vancouver, BC CAN, V6C 1H2, Canada

Phone: +1-604-683-3995 Email: info@vertxinc.com

MANAGEMENT TEAM

Peter Swistak - President/CEO Director

Seung Oh – CFO Director

Ernest Brisbane - P.Eng, M.Eng Director

John Sutherland Director

ADVISERS

Bernard Lapointe – PhD Geo Martin Gallagher – BSc (Econ) Fin. VERTICAL EXPLORATION INC.



The Potential of Wollastonite in Agriculture



The Problem Worth Addressing

Framing the Context

- Population increases and the economic growth of developing countries are fuelling the consumption of food.
- As the enormous gains in Western agricultural production and productivity since 1970 (3,030kg/ha vs 1,600kg/ha) are mainly due to the heavy use of synthetic fertilizers (106 Mt vs 32Mt) and pesticides, the impulse is for more of the same.
- Yet, intensive farming has led to land degradation, salinization of irrigated areas, over-extraction of groundwater, the build-up of pest resistance and the erosion of biodiversity.
- With a share of 10–12% in carbon-dioxide equivalents (CO2eq.), agriculture also contributes substantially to global greenhouse gas (GHG) emissions.
- Soil health is intrinsically linked to the integrity of the food system, affecting everything from plant health to human wellbeing. <u>Soils have become one of the world's most vulnerable</u> <u>resources in the face of climate change, land degradation,</u> <u>biodiversity loss and increased demand for food production</u>.

In Search of a Sustainable Approach

- In a recent report, the Institute for Sustainable Development and International Relations ("IDDRI") examined how sustainable food and food security could be achieved in Europe while tackling the challenges associated with the protection of biodiversity and natural resources, the provision of a sustainable and healthy diet to Europeans and mitigation against climate change.
- Among its findings and recommendations were: (i) a precautionary principle to eliminate the use of pesticides; (ii) a return to agro-ecosystems that make maximum use of soil life and legume symbiotic nitrogen fixation capacities (which are inhibited by mineral nitrogen fertiliser inputs); (iii) yield assumptions based on organic agriculture references for Europe, being 10-50% lower than current average yields, depending on the crops in question; (iv) a reduction in greenhouse gas emissions from the agricultural sector by up to 40% by 2050.



Identifying a Potential Solution

Rationale – There is a growing realisation that the challenges of producing food and biomass while maintaining ecosystem services, cannot be met by modern intensive "non-organic" agricultural practices that rely heavily on synthetic fertilizer input and pesticide application. **Despite lower yields, organic farming delivers greater ecosystem services and social benefits** and needs to be considered for the development of sustainable farming systems.

Product – the development of a soil amendment/fertilizer product, incorporating naturally-occurring calcium silicate (CaSiO3). Through weathering, wollastonite breaks down into calcium and silicon, a combination of nutrients which promote plant growth, alleviate various environmental stresses and which can mitigate many of the negative effects of current crop production practices and climate change. Wollastonite is a mineral which is suited to the development of sustainable farming practices.

Recognition – Silicon ("Si") has been officially designated as a plant "beneficial substance" by the Association of American Plant Food Control Officials (AAPFCO) and plant-available Si may now be listed on fertilizer labels in the USA. Similar products have been certified for use in other G20 countries.





Enhanced Weathering of Silicate Rocks



FIGURE 5: Potential effects of applying crushed silicates on crop productivity, nutrient use efficiency, water quality and CO2 capture and sequestration, due to weathering.



FIGURE 6: Enhanced weathering and relationship with 21st Century threats to society of climate, food and soil security.



Desirable Characteristics of Calcium Silicate

- Calcium silicate (CaSiO3) products have emerged as the most commonly applied Si amendments for field application. Of these, wollastonite is a naturally-occurring calcium silicate. Highly-weathered soil is characterized by low calcium (Ca) and high aluminium (Al) content and, as a result, root growth will be impaired, and the water and nutrient uptake by the plant will be affected, hence restricting crop growth soil.
- Potassium silicate and sodium silicate, though highly expensive, are commonly used materials for high-value horticultural, greenhouse crop or hydropnonic applications. They are soluble Si products that can be added to nutrient solutions or used as foliar sprays.
- Steel mill slag by-products are also a rich source of calcium silicate. However, the solubility of Si and the contents of other elements vary widely. Steel mill slag needs to be checked for the presence of toxic heavy metals and contaminants.



FIGURE 8: Production of Pink tomatoes in Quebec



The Importance of Soil Balance

- One of the most important factors determining soil fertility is pH. The availability of plant nutrients and the soil's capacity to absorb and temporarily retain them are often mediated by the soil pH.
- Most plant material is slightly alkaline and repeated removal by grazing or harvest leaves residual hydrogen ions in the soil, causing the soil to become acidic.
- Plant growth and most soil processes are favoured by a soil pH range of 5.5 – 8, and when soil pH drops, aluminium becomes soluble, retarding root growth and restricting access to water and major plant nutrients (FIGURE 7).
- The problem of acidic soils is worldwide and is caused, among other things, by overuse of ammonium and elemental sulphur fertilizers, urea and growth of nitrogenfixing legumes.



FIGURE 7: Roots of barley grown in acidic subsurface soil are shortened by aluminium toxicity.

Studies have shown that calcium silicates can play a role in neutralizing soil acidification without harmful GHG emissions, and assist with improving nutrient uptake, root growth and crop yields.



CO2 sequestration and promoted plant growth

- Agricultural lime ("Ag lime") is commonly used in the management of croplands and grasslands to decrease soil acidity. Adding carbonates to soils in these forms, however, leads to CO2 emissions and is estimated to be responsible for around 2% of agricultural greenhouse gas emissions in the USA. Direct emissions from lime application were calculated according to IPCC (2006) using an emission factor (EF) for limestone of 0.396 kg CO2/kg.
- Studies conducted by the University of Guelph and the Ontario Ministry of Agriculture have demonstrated that
 wollastonite can be used as an effective substitute for Ag lime to neutralise soil acidity. Moreover, rather than
 leading to emissions of CO₂, wollastonite dissolved through enhanced weathering leads to the generation of
 silicate mineral-derived pedogenic carbonate, which sequesters CO₂ from the environment. Though the
 process happens in the soil, the origin of the CO₂ is the atmosphere; so, the direct removal of CO₂ responsible
 for climate change is achieved.
- In the same study, beans showed a 177% greater dry biomass weight, and corn showed a 59% greater plant height and a 90% greater dry biomass weight than the control.
- Wollastonite, therefore, can provide an effective substitution for Ag lime, not only achieving optimallytailored soil pH, but mitigating against global climate change without compromising on yield.



Function of Silicon in Plants

The practice of utilizing silicon in agriculture has expanded in recent years as awareness of its exceptional benefits has gained recognition:

- **Direct stimulation of plant growth and yield**. Silicon is primarily deposited on the walls of the epidermis and vascular tissues, conferring strength and rigidity on cell walls, and contributing to erect form and improved photosynthesis.
- **Resistance to Pathogens.** When silicon is deposited beneath the cuticle to form a cuticle-Si double layer, penetration by parasitical insects is physically impeded and the infection process is disrupted. The presence of silicon has been shown to protect against fungal pathogens (such as powdery mildew, gray leaf spot and rice blast) and some insects (such as stem borers, leaf spider mites, aphids and thrips).
- Silicon alleviates various environmental stresses, including lodging, drought, temperature extremes, freezing, UV irradiation. It increases drought tolerance in plants by maintaining plant water balance, photosynthetic efficiency, erectness of the leaves and structure of xylem vessels under high transpiration rates owing to higher temperature and moisture stress.
- It facilitates the improved uptake and utilisation of essential nutrients (e.g. N,P, K) while reducing the uptake of sodium and toxic heavy metals, (such as aluminium and manganese) and increases P availability, especially in highly weathered acidic tropical soils.



	IN SOIL	IN PLANT	
		PHYSIOLOGICAL	MECHANICAL
Increases resistance to pathogens and insects		Х	Х
Reduces Phosphorous deficiency	Х	Х	
Increases resistance to wind and rain			х
Alleviates drought		Х	х
Alleviates salt stress		Х	
Alleviates Fe toxicity	Х		
Improved intake of N, P, K & Ca		Х	
Reduces intake of nutirents when P&N are in excess		Х	
Alleviates Mn, Cd and As toxicity	Х	Х	
Alleviates Al and Zn toxicity	Х	Х	х

TABLE 1: Known Benefits of Silicon in the Soil and Plant (adopted from F. Guntzer et al 2012)

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Powdery Mildew

- Powdery mildew is a fungal disease of the foliage, stems and occasionally flowers and fruit, and is a major pathogen of cereal crops and many common edible and ornamental garden plants, including apples, pears, plums, blackcurrants, most berries, grapes, tomatoes, zucchini, beans, cucumbers, squash, pumpkin, wheat, Kentucky bluegrass, dogwood, roses and zinnia.
 While it usually doesn't kill plants, it can reduce marketable plant yield considerably: for example, in strawberries, between 20-70%.
- Greenhouse studies conducted at Rutgers University Vegetable Research Farm in East Brunswick, New Jersey from January 2013 to January 2014 found that wollastonite delayed the onset of powdery mildew disease by 20 fold more than all other amendments.
- Fungicides are often used to control powdery mildew, but this approach to disease management is unsustainable over the long term since diseases tend to develop resistance to chemical sprays.
- In the case of certified organic production, growers need alternatives to prohibited pesticides.
- Wollastonite is a multipurpose soil amendment that helps crops resist powdery mildew disease and has been certified for organic farms in the USA.





FIGURE 9: Powdery mildew disease suppression in pumpkin plants following Wollastonite application.



Examples of Pathogen Suppression by Silicon

Crop		Description		
Rice	Disease	Leaf and neck blast, Brown spot, Sheat blight, Leaf scald, Grain discoloration, Stem rot		
	Pest	Stem maggot, Green leaf hopper, Brown plant hopper, white backed plant hopper, Leaf spider, Stem borer, Grey garden slug, Mites		
Sugarcane	Disease	Sugar rust, Ring spot		
	Pest	Stalk borer, Stem borer		
Wheat	Disease	Powdery mildew		
	Pest	Green bug, Red flour beetle		
Banana	Disease	Panama wilt		
Grape	Disease	Powdery mildew		
	Pest	Fruit cracking		
Cucumber	Disease	Powdery mildew, Root disease		
Cowpea	Disease	Rust		
Barley	Disease	Powdery mildew, Aphids		
Реа	Disease	Leaf spot		
Strawberry	Disease	Powdery mildew		
Corn	Pest	Leaf aphid, Borer		
Sorghum	Pest	Green bug		



Effect of Silicon Fertilizer on Crop Yield

Crop Tested	Yield Increase Percentage Range	Average Yield Increase (%)	Benefit / Cost Ratio	Number of Trials
Rice	3.5–28.5	10.3	4.4	50
Maize	5.6-10.4	7.7	3.1	44
Cucumber	9.4–25.6	13.7	42.9	40
Tomatoe	8.7–15.9	12.0	35.7	35
Soybean	7.5–13.6	11.0	1.7	32

TABLE 2: The effect of field application of blast furnace slag-based silicate fertilizer on crop yield and benefit/cost ratio during 2005–2006 in north-eastern China (Y. Liang et al., unpublished). Silicon in Agriculture From Theory to Practice 2015. Liang P210.

It has been well documented that silicon (Si) is effective in enhancing the growth and yield of many crops of agricultural and horticultural importance. The major crops that are widely reported to respond positively to Si fertilization include some monocotyledonous crops such as rice, wheat, maize, barley, millet, sorghum and sugarcane (that actively absorb and accumulate high amount of Si in their organs), and some dicotyledonous crops such as cotton, soybean and some vegetable and fruit crops that are also able to accumulate Si through specific transporters.

The data from TABLE 2 clearly show that, with the exception of maize, although the average yield increase for all the crops tested was above 10 %, the ratio of benefit to cost differed greatly with crop species mainly due to the per unit area crop yield and the price of the products. **The application of Si fertilizer to greenhouse-grown cucumber and tomato led to extremely high economic benefits and thus was welcomed commercially.**



Target Market Examples

High Value, High Growth



Maple Syrup

- The Canadian maple syrup industry accounts for approximately 71% of the world's maple syrup and is the leading global producer of maple products. In 2017, maple syrup production reached 12.5 million gallons, valued at C\$494 million.
- The province of Quebec alone accounts for 90% of the country's maple syrup production. In 2016, about 42.5 million taps produced around 11.5 million gallons in Quebec, with another 5 million taps expected to start production in 2018.
- Assuming 80 taps per acre in mature planting, Maple syrup production in Quebec alone is covered by trees on around 240,000 hectares of land.
- When soils become too acidic as a result of acid rain, sugar maple trees become stressed and have a harder time growing or producing seeds and seedlings.



• Research was conducted at Hubbard Brook Experimental Forest (HBEF), a 3,160-hectare reserve near North Woodstock, N.H. The scientists added wollastonite in a test plot to replicate soil conditions that existed 25 years prior to the loss of sugar maples. Leaves of canopy sugar maples in the study area showed increased concentrations of calcium in just the second year after the wollastonite application, as soil acidity declined from pH 3.8 to pH 5.0. In the fourth and fifth years, leaf manganese concentrations declined (acid rain increases soil manganese, which can be toxic to maples at high concentrations) - was another positive result. By the sixth year of the experiment, the crowns of study-area sugar maples were noticeably healthier than those in nearby, untreated areas.



Cannabis Cultivation

- In Phase Three trials conducted at BC Bud Depot's ("BCBD") ACMPRlicenced Research and Development facilities in Vancouver, BC., BCBD measured and recorded significant improvements in root mass, powdery mildew control and pest elimination when applying an admixture rate of 10% to 15% wollastonite to the growth medium.
 <u>Most notably, powdery mildew, the most common fungal blight to</u> <u>affect Cannabis sativa, was virtually undetectable with wollastonite</u> <u>admixture above 10%</u>.
- An admixture above 10% wollastonite also correlated with sharp reductions in the presence of thrips and fungus gnats, insect pests with a sub-soil life phase in which the wollastonite crystals lacerate and impale their soft bodies, interrupting the life cycle without the use of pesticides. Root health indicates a plant's ability to resist disease and to support high yields of high-quality of finished marijuana.
- Wollastonite's unique properties also allow it to break down into calcium, magnesium and silicon in a highly bio-available form that balances soil PH throughout the growth cycle – this allows the cannabis plants to absorb silicic acid and promotes strong cell walls that better resist insect feeding and spore penetration, supporting increased growth and elevated product yields.





European Union: Growth of the Organic Sector



Combined, the market for organic food in the USA, Canada & EU-28 was worth EUR77.3BN in 2017. Almost 1.4M hectares was devoted to organic fruit trees and berries, vineyards and olive groves in EU-28



Agriculture in Africa – linking productivity and social development

- Agriculture is the backbone of the African economy accounting for approximately 20% of the region's GDP, 60% of its labour force, 20% of its total exports and the main source of income for the region's rural population.
- However, with acid soils covering more than a third of the region, agricultural productivity is low and declines rapidly under cultivation. This contributes to acute under-nourishment in the region and food insecurity.
- Improving the productivity and the economic returns of agriculture has immediate effects on poverty and hunger in the region. Research shows that for each 10% increase in small-scale agricultural productivity in sub-Saharan Africa, almost 7 million people are moved above the dollar-a-day poverty line.
- The average fertilizer use in Africa was still only 11kg/ha in 2014. Such low levels of fertilizer uptake, combined with shorter fallow periods and insignificant organic fertilizer inputs, represent a serious threat to agricultural sustainability.
- Amending soils with ground Ca/Mg-rich silicate rocks has a long history of being practiced on a small scale, especially in highly weathered tropical soils, such as in Brazil, Malaysia and Mauritius.
- Sustainable soil management is a prerequisite for achieving the UN Sustainable Development Goals in the African context, particularly, Goals 2, 3, 12 and 15.



Appendix

Wollastonite in Environmental Remediation



Acid Mine Drainage

- Acid mine drainage ("AMD") is an unavoidable by-product of the mining industry and is caused by the weathering of sulphide minerals, especially iron sulphides.
- AMD accounts for most of the surface and ground water contamination associated with mines, and is usually characterized by high concentration of dissolved heavy metals, sulphate and acidity, with pH as low as 2. When untreated mine water discharges into other natural water bodies, this acidity and high concentration of toxic metals is very harmful to vegetation and aquatic ecosystems, as it is not biodegradable.
- The cost of mitigation of environmental damage from AMD is great. The US
 Forest Service estimates that between 20-50,000 mines are currently generating
 acid on lands managed by that agency, affecting some 8,000 to 16,000kms of
 streams. In Canada, AMD has been identified as the largest environmental
 liability facing the mining industry, and is estimated at C\$2-5 billion.
- In experiments conducted in Spain on reddish water emanating from the pyriterich wastes around the abandoned mines in the Iberian Pyrite Belt, crushed wollastonite was applied in a ratio of 1:25 solid/liquid. The release of calcium into the solution resulted in a pH increase from 2.1 to 3.5, and promoted the removal of a variable fraction of trace elements dissolved in the AMD solution, especially arsenic, chromium, copper and zinc. Higher applications of wollastonite would reduce acidity further and improve metal retention, suggesting that wollastonite can be a useful first stage product used in the attenuation of acidity and metal contamination.





Waste Water Effluence

- Scientists at the Banaras Hindu University (BHU), India, have found that wollastonite is an efficient and economically viable material for the removal of toxic hexavalent chromium (Cr⁶⁺) from industrial wastewater effluents. Hexavalent chromium is a by-product of industries such as steel manufacturing, leather tanning and paint manufacturing.
- Toxicological studies by environment protection agencies worldwide have identified Cr⁶⁺ as a highly toxic substance – a human carcinogen. Exposure can also contribute to allergic skin reactions and intestinal ulcerations. Current technologies used for its removal from wastewater are expensive and often beyond the capacity of developing nations.
- The research concluded that Wollastonite, with its large surface area and a porous structure, could be a cost-effective solution to the problem. It contains mainly silica and calcium oxide, both of which are good adsorbents, where Cr6+ particles from the wastewater adhere to the surface of the wollastonite.

