THE POTENTIAL OF REMINERALIZATION WITH ROCK MINERAL FINES TO TRANSFORM AGRICULTURE, FORESTS, SUSTAINABLE BIOFUELS PRODUCTION, SEQUESTER CARBON, AND STABILIZE THE CLIMATE

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INTRODUCTION: SOIL FORMATION AND FERTILITY

Soil Remineralization (SR) creates fertile soils by returning the minerals to the soil, much the same way the Earth does: by weathering of minerals from rocks. Normally this is a slow chemical process, limited by the surface area of the rock exposed to water and CO2. During Ice Ages, glaciers crush rocks in their path, producing a fine rock "flour" that is carried by water and ice to form deposits at the end of the glacier called moraines. After Ice Ages end, winds blow the dust, called "loess" all over the globe. Loess soils, most abundant in China, Eastern Europe, and North America are the foundation of the highly productive agriculture of those regions.

Volcanoes erupt spewing forth minerals from deep within the Earth, and minerals are contained in alluvial deposits. As rocks weather, their minerals are released into new soils. These are extremely productive where fresh volcanic materials are weathered, but decrease in fertility with age as soluble minerals are leached from the soils, especially in warm areas with high rainfall. This is why young volcanic areas, such as Java, Costa Rica, and Hawaii are so fertile, and why older tropical areas such as Brazil, Africa, and Australia have such poor, mineral-deficient soils. Such infertile soils would benefit enormously by having volcanic rock powders added to them to increase their fertility.

Remineralization of denuded soils is one of the most effective techniques for dealing with global climate change. Denuded soils are often deficient in specific minerals that are limiting factors in biological systems. This means that through remineralizing these soils with often local and inexpensive mineral amendments we can set up a situation where these soils can greatly increase in biological vitality.

This principle of the limiting factor is well understood, and the tests and materials are well developed, and inexpensive. Forests can grow much more rapidly when limiting factor minerals are replaced, and eroded, and desertified lands can be brought back to life with simple proper remineralization protocols. Most importantly for humanity, and potentially the environment, agricultural lands can have yields, disease resistance, pest resistance, and nutritive levels increased dramatically through proper remineralization. Agricultural lands are already managed, amended, fertilized, and tended to, and a proper understanding of what base mineral deficiencies are present on each piece of

land, and remediation can have a profound effect on global atmospheric carbon levels as well as human nutrition and cultural stability.

Proper soil remineralization, with attention paid to amendments of deficient minerals and biological digestion of these minerals to make them available for plant life is key in increasing soil carbon, and numerous studies have shown the capacity to increase soil carbon levels .5% per year through biological growth and sequestration of carbon as humus in the soil.

The work of Alan Yeomans in “Priority One” (2005) documents the potential to bring atmospheric carbon to pre-industrial revolution levels in 5 years through targeted use of soil remineralization of the world’s agricultural lands. This remineralization along with proper management, would not only bring global CO2 levels down to safe levels, but would facilitate the revitalization of soil and biological life on the planet, and significantly increase human nutrition and health levels, strategically diminishing numerous seemingly intransient crises.

ROCK POWDERS AND SOIL FERTILITY

Igneous rocks contain a broad spectrum of up to 100 minerals and trace elements necessary for the well being of all life and the creation of fertile soils. Glacial moraine or mixtures of rock types applied to soils create a sustainable and superior alternative to the use of ultimately harmful chemical fertilizers, pesticides and herbicides. These minerals are slowly released and long lasting, as they must be weathered out of the crystals that contain them. The finer grained the material, the more rapidly they become available to soil and plant roots.

Rock powders act as fertilizers because their small grain size allows the mineral elements they contain to be readily released by the action of water, carbon dioxide, and organic acids released by plant roots and beneficial microorganisms. Finer materials have higher surface area and release their minerals more quickly. The greatest benefits are obtained on the most nutrient deficient soils. Rock dust amendments therefore are a strategy for improving soil fertility that mimic natural processes that are deficient in many places because elements essential to plant growth are deficient in the soil. Biochar can serve an important role to enhance the effect of rock powders because while biochar is not a fertilizer per se, it acts to retain soil water and nutrients, making them available to plant roots and symbiotic fungi that provide plants with much of their nutrition.

ROCK POWDERS IN AGRICULTURE

Industrial agriculture uses primarily chemical fertilizers that are rapidly released. This means that they can be oversupplied with regard to the plant's ability to take them up, so that the excess is lost. contaminating groundwaters and rivers. Therefore they last a short while, and must be continually added. Chemical fertilizers are expensive because

of the large amount of fossil fuel energy used in their manufacture, especially for nitrogen fertilizers. They consist largely of nitrogen, phosphorus, and potassium, but healthy plants need many other essential trace elements as well.

Organic agriculture uses composted organic material, containing nitrogen and phosphorus in organic form, to replace chemical fertilizers. These are released more slowly than inorganic chemical forms, and so are longer lasting. However if the organic material is deficient in other elements, those are not added. This is where rock powders can make an enormous difference.

Most agriculture is based on mining soil nutrients, and are constantly depleting soil fertility as essential elements are removed via crops and erosion, and not replaced. Rock powders provide a natural way to replenish soil fertility.

Soil Remineralization (SR) has been shown in scientific studies to increase yields as much as two to eight times for agriculture and forestry (wood volume), and to have immediate results and long term effects with a single application. Basalt dust application at a rate of 150 tons per hectare to forest soils resulted in four times greater tree wood volume than controls after 24 years, and the benefits only tapered off after 60 years (Sauter & Foerst, 1987). Experiments with tree seedlings in pots showed that tree growth rates increased with the amount of basalt powder added (Bruck, 1992). See Figure 1. In Western Australia eucalyptus seedlings amended with granite dust grew five times faster than controls, and potting out time before transplanting was reduced from 5 months to 6 weeks (Oldfield, 1992).

Similar results are found with crop plants. Application of glacial moraine dust to Michigan soils raised maize yields from 25 bushels/acre to 65 bushels/acre, and greatly increased its nutritional value. Protein increased by 28%, Calcium by 47%, Phosphorus by 57%, Magnesium by 60%, and Potassium by 90% (Hamaker, 1992). In highly weathered tropical soils that are very nutrient deficient the responses can be even greater. These poor soils predominate in Africa, South America, tropical Asia, and Australia.

Remineralize the Earth's Agroforestry Project in Costa Rica: Food, Fuel, and Income to Sustain Local Communities, designed by John Todd of Ocean Arks International, is a model project intercropping native commercial hardwoods, fruit trees, and Jatropha (a sustainable biofuel producing oil plant) on abandoned cattle pastures in the Guanacaste region using basalt rock dust from a local quarry (Todd, 2008). Over a thousand trees of more than 20 species were planted. Half of the trees received three kilograms of basalt rock powder. Jatropha

Remineralized Jatropha produces a higher yield of oil-bearing seeds

receiving rock dust produced larger and more bountiful seeds. The trees grew more vigorously. Duplicating this experience in Cameroon and other parts of Africa with sustainably intercropped Jatropha as a biofuel could replace firewood harvesting and expensive imported kerosene in rural areas. It could provide sustainable livelihoods in areas now severely damaged by drought, desertification, and hunger. Marginal soils planted with Jatropha sustainably could be restored to agricultural food production in a few years.

Millions of tons of appropriate rock dust for soil and forest regeneration are stockpiled by the gravel and stone industries worldwide as a non-toxic and inexpensive byproduct that can be used on a regional basis. While rock powder is a bulky item, and so the cost at remote locations largely reflects transportation costs, this is also true for chemical fertilizers or organic mulches. In contrast to chemical fertilizers, rock powders are a natural material, not a synthetic one, so production costs are much lower than for chemicals that must be extracted and refined into pure form, or synthesized, like ammonium or urea.

BENEFITS OF ROCK POWDERS

- Provides slow, natural release of elements and trace minerals.
- Increases the nutrient intake of plants.
- Increases yields and gives higher brix reading. Brix is the measure of dissolved solids in the sap of plants of their fruits that
- correlates with greater nutritive value.
- Rebalances soil pH.
- Increases the growth of microorganisms and earthworm activity.
- Builds humus complex.
- Prevents soil erosion.
- Increases the storage capacity of the soil.
- Increases resistance to insects, disease, frost, and drought.
- Produces more nutritious crops.
- Enhances flavor in crops.
- Decreases dependence on fertilizers, pesticides, and herbicides.

This microscopic photo shows a rock dusted insect disabled as the dust penetrates segments and organs.

ROCK DUST AND PEST CONTROL

Among organic methods of pest control, rock dust is one of the safest for people, soil, and plants. Any approach that focuses on killing insects carries a fundamental weakness: it encourages the proliferation of resistant pests. A farmer spraying insecticides on his fields is unintentionally breeding weak plants and strong insects. Any responsible approach to short-term pest control

must minimize this effect, and to the extent possible, it should be safe, practical, and cheap.

Rock dust emerges from these criteria as a promising option. Rock powder fits into the category of “inert dusts,” which were identified as effective insecticides by the end of the nineteenth century. Inert dusts operate primarily by absorbing or disrupting the waxy superficial layer that prevents insects from rapidly drying out. They also physically repel pests, disrupt their reproductive cycles, and abrade them. These small particles disable and discourage insects by causing various forms of mechanical discomfort.

Rock dust is capable of destroying and disabling insects to an extent that will limit their population and reduce crop damage. It does not obliterate insect life in a way that produces ecological imbalance and rapidly breeds resistant pests. This moderate efficacy facilitates the creation of a healthy agricultural ecosystem that will gradually require fewer palliative solutions to pest problems. It’s value as a fertilizer, along with its low cost and local availability, make rock dust preferable to diatomaceous earth.

BIOREMEDIATION AND TREATING RADIATION SICKNESS

Schindele’s Minerals (then called Superbiomin) was used in the wake of the Chernobyl disaster to treat radiation sickness. According to Peter Tompkins and Christopher Bird in their 1989 book *Secrets of the Soil*, the University of Vienna found that Schindele’s rock dust worked as a treatment for radiation sickness and this was confirmed by a Soviet institute for atomic physics in the Ukraine. As a result of these findings the Soviets sent a truck to pick up 2000 kg of this rock dust that was used to treat victims immediately after the accident.

The key is that the minerals provide reactive surface area for some kinds of radioactive ions, and so may remove some of them in soluble form from the body to be excreted. Schindele’s Minerals consists of 30% orthoclase (also referred to as potassium feldspar), 20-30% plagioclase feldspar, 20-30% quartz, 15-20% biotite, 5-10% disthene, garnet and sillimanite, as well as trace amounts of iron, zircon and rutile.

Given the recent disaster in northeast Japan, it is timely and urgent to get this information out on behalf of the disaster victims as well as others as the radiation circulates around the globe and throughout the biosphere, adding to our already present toxic overload. A modestly funded trial study could be created to monitor a group of subjects with high levels of radiation, giving about 1 tsp 3/day of an appropriate source of rock dust (or trial various sources) over a period of 10-14 days or more, compared with a control to see if it can be shown that radiation levels are lowered by rock dust supplementation. For decontamination it may potentially be a simple, natural and inexpensive means of alleviating the impact of radiation for soils and people. Because it was used to treat victims of the Chernobyl disaster, remineralization should be explored as means to decontaminate radioactive soils and treat radiation sickness in Japan.

A BRIEF HISTORY

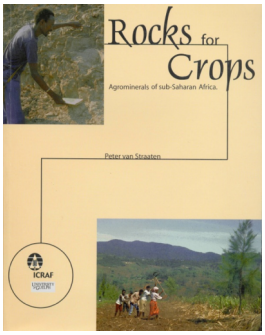
Remineralization has mainly been researched and explored by three distinct groups:

- First, German nutritional biochemist, Julius Hensel, pioneered SR in the 1880s with his book **Bread from Stones** and a modest agricultural movement came into being. Following his contribution, many scientists have done research on SR since the late 1930s in Germany and Central Europe for agriculture and forests, including one 60 year study of a forest.

  The technology was not available at the turn of the century to produce finely ground rock dust, so SR, as promoted by Hensel, could not be produced feasibly on a large scale. SR was revived about 40 years ago in Europe. Many rock dust products for agriculture, forestry and sewage sludge treatment have been created in Germany, Austria and Switzerland in the last several decades and have been successfully marketed. Companies such as Lava-Union (Germany), Sanvita (Austria) and Bernasconi (formerly known as Zimmerli, Switzerland), along with many others as well as the Natural Stone Industry (Die Naturstein Industrie) based in Bonn, Germany have also done a great deal of research.

  More recent researchers include Peter von Fragstein at the University of Kessel, Germany, who has researched remineralization as a slow-release fertilizer with many different rock types and to deter insects. In the short term, rock dust sprayed on plants deters insects and in the long term silica in rock dust strengthens plant tissue (which contain silica granules called phytoliths) and makes them less susceptible to drought, insects, and diseases (Fragstein, 1995). The Carl Duisberg Gesselschaft e.V., in partnership with the Technische Universität Berlin, the University of Abidjan, the Societe pour le Developpement Minier de Cote d'Ivoire and the German Federal Ministry of Cooperation organized regional workshops in the Ivory Coast in 1991 on Rock Fertilizers: A Chance for West Africa's Food Production.

- Second, is the more recently developed field of agrogeology. This research has been carried out mainly in Canada, Brazil, Tanzania, the Canary Islands, and West Africa--especially on laterite soils. Because of the intense tropical rainfall, NPK fertilizers are washed out in only a few weeks and cannot be stored by the soils, and are especially harmful to the groundwater. Rock fertilizers not only give nutrients over longer periods to cultivated plants, but also improve the ion-exchange-capacity of soils by forming new clay minerals during the weathering of the fertilizer. Researchers include William Fyfe, Ward Chesworth, Peter van Straaten, Suzi Theodoro Othon Leonardos and many others. The First International Conference on Rocks for Crops was held in Brasilia in 2004.



- Third, the grassroots movement concerned with the premise of John Hamaker in the book *The Survival of Civilization*, co-authored with Don Weaver, asserts that SR (soil remineralization) is not only the key to restoring soils and forests, but in the larger context, absolutely necessary and urgent to reduce levels of carbon dioxide in the atmosphere and stabilize the climate. Especially recommended are rock gravels and glacial moraine from glacial deposits which provide the most natural mixtures of rocks with the broadest possible spectrum of minerals and trace elements, as well as many hard silicate rock types. This movement began with Hamaker's writing in the early 1970s and expanded in the 1980s into a global grassroots community consisting of ecologically concerned individuals and organizations, farmers and gardeners, scientists and policy makers. The Seer Centre has ongoing demonstration plots in Scotland.

On May 24, 1994, the U.S. Department of Agriculture (USDA) (Beltsville, MD), the U.S. Bureau of Mines (USBM) (Washington, DC), the National Stone Association (NSA) (Washington, DC), and the National Aggregates Association (NAA) (Silver Spring, MD) and the nonprofit organization Remineralize the Earth co-sponsored a forum on "Soil Remineralization and Sustainable Agriculture" at the USDA Agricultural Research Station in Beltsville, MD.

The Forum brought together the by-product rock fines generating industry and the proponents of SR to explore environmentally sound uses of rock fines and to identify the state of the science supporting their use and the gaps in knowledge that need to be filled.

The USDA began a series of demonstration trials with rock fines (from Georgia, Maryland and New York) and other industrial by-products. Dr. Ronald Korcak, research leader of the fruit lab, directed the trials over a three-year period. They are researched the use of rock dust in compost under the direction of Dr. Larry Sikora. The U.S. Bureau of Mines designed a prototype for a GIS (Geographic Information Systems) database to target soils in most need of SR and their distance from regional sources of rock fines to calculate transport costs and marketability of specific rock fines. The National Aggregate Association created a Task Force on Remineralization exploring the possibilities for creating sustainable products for agriculture, forestry and other uses. Research projects were undertaken at universities and as part of research and development programs of some of the largest aggregate companies in the US, Europe and Australia and through organizations such as Men of the Trees in Australia.

Remineralize the Earth was invited by the State Department and the American Council of Renewable Energy (ACORE) to sponsor an Official Side Event at the Washington International Renewable Energy Conference. (WIREC2008).

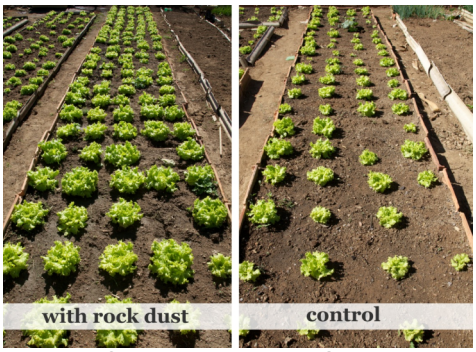
In September 2009 a conference on remineralization was held in Brasilia, the Primeiro Congresso Brasileiro de Rochagem, attended by 170 participants.

RECENT DEVELOPMENTS

The Real Food Campaign (BFA)

The Real Food Campaign, works directly with farmers in the field – discovering, uncovering and sharing information that can improve farm operations, and ultimately lead to greater crop quality and improve the health of those who eat it. The Real Food Campaign, a former project of Remineralize the Earth has recently evolved into the Bionutrient Food Association (BFA), a nonprofit research, education and advocacy organization with Dan Kittredge as Executive Director, whose objective is to improve quality in the U.S. food supply. BFA identifies interdisciplinary parameters that result in optimum soil vitality; educates growers on the principles necessary to achieve this result in the field; and advocates for and facilitates the mainstream availability and consumption of bionutrient food.

Panama Study (SER 2011)



A recent study compared tree growth rates over five years in highly infertile soils in Panama with those in basalt rock dust (Goreau et al., 2011). The trees in basalt dust grew nearly 10 times faster in terms of biomass. No chemical fertilizer or compost was added. It was concluded that even better results would have been achieved if biochar had been used. Several studies are now being set up in various countries, including Brazil, China, and the US to test various mixtures of rock dust, biochar, and compost. The results are planned to be presented in a technical book in 2013 entitled *Innovative Technologies for Soil Fertility Restoration, Carbon Sequestration, and Reversing Atmosphere CO2 Buildup* edited by Tom Goreau, Ron Larson (a founder of the US Biochar Initiative), and Joanna Campe (Remineralize the Earth).

Research in Brazil

The use of rocks to improve family agriculture in Brazil, is a research paper for a project in Bahia demonstrating remineralization to be an effective adjunct strategy for remote impoverished Quilombola communities to produce higher yields of quality crops while remaining independent from chemical fertilizers and government subsidies.
http://redalyc.uaemex.mx/pdf/327/32778408.pdf
http://remineralize.org/images/stories/research_materials/Stonemeal_Technology_Brazil.pdf

There has been considerable funding for remineralization research in Brazil for many years. CNPq, the National Council for Scientific and Technological Development has funded remineralization research since the mid-1990s, when EMBRAPA joined the research consortium. Funding has come from the Ministry of Mining and Energy and the Ministry of Science and Technology. Research centers have access to this funding, including the Center of Mineral Technology of Rio de Janeiro (CETEM), the universities, and EMBRAPA. Funding agencies are growing aware that remineralization helps to provide an incentive for poor family farmers to enter the market, to create food security,

and to transition toward sustainable agriculture, which is so important at this time when the world is looking for ways to preserve the environment and reverse climate change.For the most recent update from Dr. Suzi Huff Theodoro: http://www.youtube.com/watch?v=1xgMdxaSDc8

EMBRAPA, the Brazilian Enterprise for Agricultural Research is a state-owned company affiliated with the Brazilian Ministry of Agriculture. It is devoted to pure and applied research. EMBRAPA conducts research in many areas, including remineralization. The mission is to provide feasible solutions for the sustainable development of Brazilian agriculture. EMBRAPA is currently researching remineralization in the following regions: Southwest Goiás, South of Minas Gerais, North of Minas Gerais, the Central Region of Tocantins, Federal District, Brazil southern region. (Parana and Rio Grande do Sul). Field experiments are being conducted with rock dusts derived primarily from regional mining waste gravel and limestone. They are developing an experimental protocol for the validation of soil remineralization in commercial areas. They are exploring longer-term experiments, but for now, the minimum time for these experiments is five years, already in their third year (2009). They are studying annuals (soy, corn, sunflower), semi-perennial (cane sugar, bananas) and perennials (eucalyptus), among others crops. They are also interested in carrying out large-scale research for the study of carbon sequestration for remineralization.

Dr. Suzi Huff Theodoro of the University of Brasilia is coordinating a project funded by CNPq which aims to integrate Brazilian and African research and includes researchers from Cameroon, isSouth Africa and Angola. Particularly in Cameroon, geologically the areas are similar, have the same depleted subtropical soils and basalt rock dust to work with, and are looking to alleviate the poverty of small-scale farmers.

Latin America

Mexico Government Remineralization Program

Zacatecas is the state with the highest production of beans in Mexico, accounting for 35% of national production. In the span of only five years, yields of beans dropped from 1,200-1,400 kilos per hectare in 2002 to 300 kilos per hectare in 2007 — a clear example of soil depletion and over-cultivation leading to increasingly low crop production. In 2008, 8,000 hectares in different States of the Mexican Republic were remineralized. In 2009, Jorge Villaseñor Garibi, a Remineralize the Earth coordinator and his company Agro Insumos Nova Terra SA participated in a governmental program to support the farmers of Zacatecas, where, for the first time in all of Mexico, urea was replaced by rock dust. As a consequence in 2009 14,200 hectares were remineralized. The results were outstanding, with a bean yield three times higher than the previous year's. Production of corn, grape, peach, nopal and several varieties of chile also increased. These promising results convinced many farmers of the benefits of remineralizing their soils, and they continued using rock dust even after the governmental campaign ended. Jorge presented the governor of Zacatecas, Amalia García Medina, with a diploma on behalf of Remineralize the Earth in recognition of her

efforts to promote the use of rock dust, and five more diplomas were given to state officials that participated in the initiative, including the Secretary of Agricultural Development.

Now in 2011, a recent government campaign supported farmers in the township of Zapopan, Jalisco to use rock dust. The government is committed to making Zapopan a Green city, and in the summer of 2010 it provided farmers with diatomaceous rock dust to fertilize 1,250 hectares of crops, that included corn, nopal, agave, and fruit trees. Farmers are being trained to use rock dust in 28 towns throughout Zapopan as an integral part of the program to support the remineralization of depleted soils. Farms and crops, however, were not the sole beneficiaries: the governmental initiative included the fertilization of various green areas of Zapopan, such as public parks, gardens, and a forest area, about 1500 ha, estimated to contain 700 trees. As another part of this program, on the fourth of June—National Environmental Day—around 500 children from several elementary schools in Zapopan attended a workshop in which they were taught how to remineralize trees with rock dust. At the end of this program on June 5, 2012, members of Zapopan's government received formal recognition for this program.

Bernardo Castro Medina founded Eco-Agro, a company formed as a farmers collaborative, dedicated to the research and commercialization of organic alternatives to industrial fertilizers, and is providing farmers with organic fertilizers supplemented with hard silicate rock dust to ensure the sustainability of Sinaloa's producers. Based in Guamúchil, Sinaloa, Eco-Agro has been at the forefront of campaigns promoting the use of rock dust in and out of Mexico, highlighting both its fertilizing properties and its role in increasing the resistance of plants to disease and insect infestation. Eco-Agro organic fertilizer is made up of worm leachate containing 5-6% mycorrhizae, a natural way of providing nitrogen to nutrient-poor soils, and 5-6% silicate rock dust with 52% silica with more than 70 trace elements. Rock dust is an essential ingredient in this compost; it not only accelerates the composting process inducing the growth of microorganisms but also provides depleted soils with a wide range of minerals and trace elements for healthy and nutrient-rich plant growth. It has also been shown to be a valuable ingredient for feeding worms, which grow bigger when fed with rock dust. Eco-Agro runs several projects in Sinaloa, particularly corn and sorghum with excellent results. In its official website, Eco-Agro offers testimonials of farmers using rock dust as well as videos in Spanish that explain the production of rock dust and the rationale behind its use.

Colombia

The Western Andes Range has one of the richest mineral deposits of volcanic origin in the Andes Mountains. Agrempacados makes available a diabase rock dust for Colombian farmers, specifically small producers, to improve the production and nutritional properties of their crops. Corn, which has received the most study, has shown an increase in germination rate of 20-50% and an increase in production of 10% compared to areas without rock dust. Corn from fields treated with rock dust also exhibited improved resistance to humidity. There have also been good results for

tomatoes, bananas, avocados, vegetables, and flowers. In one striking example, coffee plantations that had stopped producing regained fertility in one year after they were treated with diabase rock dust. Eugenio Gras and Andrés Piñeiro, world-renowned experts on organic farming and members of COAS (Council for Sustainable Agriculture and Permaculture), present courses on remineralization in Central America, South America and Australia within the context of organic farming and permaculture. Agrempacados has sponsored several seminars and funded two diploma studies, which were completed in 2008 and 2010.

Cameroon

Experimenting with rock fertilizer technology on small-scale farms in Cameroon, contributing to food security and sustainable agriculture is a current project proposal, which will be implemented by the Research and Education Centre for Development (CREPD) and whose partners include the University of Yaoundé I, University of Dschang, University of Bamenda, Farmer communities and Remineralize the Earth. The project will focus on researching and using rock fertilizer as a means to alleviate poverty, reduce conventional fertilizer dependence, and ensure sustainable agricultural practices in tropical Africa. This project aims to promote agroforestry activities combining jatropha planting with native tree crops in the savannah highlands of Cameroon, producing a biofuel that will replace wood and kerosene within an intercropped agroforestry system and will provide employment to rural, poor, small-scale farmers in the project area as well as research for agricultural staple crops. The agroforestry project will eventually sustain local communities with food, fuel, and income. Remineralize the Earth is currently looking for funding for this project.

IMPROVING FOREST HEALTH WITH ROCK POWDERS (Lee Klinger)

As can be seen from the large annual wiggles in the graphs of rising concentration of atmospheric CO2, the world's forests contain and cycle an immense amount of carbon. The role of forests as either sources or sinks in the carbon cycle depends upon the degree to which plants and soils are managed, protected, or disturbed. Land management methods that improve the health of trees and fertility of soils are likely to create forests that both sequester carbon and provide a sustainable, renewable set of resources for any given region.

In recent years foresters have reported elevated levels of tree decline and dieback in many forested regions of the world. While climate change is often implicated in forest declines, as in the recent pine bark beetle outbreaks in the western US and Canada, a closer examination points to land management practices such as fire suppression as having major influences in the health and susceptibility of trees to diseases and pests. In California, for instance, a tree disease called Sudden Oak Death is devastating oak forests around the state. Oaks are a fire-adapted species that benefit from periodic fires that act to reduce the competition and remineralize the soils. Decades of strict fire protection measures in California's forests have created a situation where the oaks have

become stressed and susceptible to disease. Indeed, studies now show that in the oak forests that have burned within the past 50 years the incidence of Sudden Oak Death disease is “extremely rare”.

These findings have fueled the debate among those who wish to continue the prevention of fires to protect property and to avoid exceeding regional air quality standards and those that wish to expand the use of prescribed fires to improve the health of their land and trees. But this debate may well be unnecessary. Knowing that fire suppression leads to excess competition and soil acidification in fire-adapted oak and pine forests, foresters are devising a suite of tending practices that fall into the category of “fire mimicry”. Practices such as thinning stands, clearing brush, pruning trees, and amending soils with mineral fertilizers tend to mimic the effects of fire, but without all the smoke and flames.

There is a growing body of scientific evidence showing that tree health and productivity can be significantly enhanced by additions of calcium-rich mineral fertilizers to the soils. Trees and other woody plants need lots of calcium for building healthy wood and bark. Forests in decline are often found to have acidic soils that are depleted in calcium. Cornell scientists tracking the effects of a declining sugar maple forest treated with calcium-rich minerals (wollastonite) dropped from helicopters found improved crown density of mature trees, as well as enhanced seedling numbers, survivorship, and size in the treated sugar maple stands compared to untreated stands[iii]. Scientists in California have observed that amending the soils of declining oaks forests with a calcium-rich rock dust (AZOMITE® Soil Sweetener) in combination with other fire mimicry practices results in significant improvements in crown density and leaf longevity.

Mineral fertilizers are in common use in agriculture all around the world. They tend to be readily available and relatively inexpensive. Improving forest health and, therefore, carbon storage through additions of these mineral fertilizers is clearly feasible under certain conditions. Studies are now needed to determine the limits of feasibility of soil re-mineralization techniques in improving tree health and augmenting carbon sequestration in forested areas, especially in those forests that are showing decline.

ROCK POWDERS, BIOFUELS AND CARBON SEQUESTRATION

Efforts to mass produce biofuels have had profoundly negative side effects by converting native forests to plantation monocrop agriculture, and displacing farm land used for food production. Remineralization can contribute to renewable energy sources by restoring the fertility of degraded lands to allow sustainable production that does not compete with food supplies or damage native forests.

It can also contribute to sequester CO2 by increasing the biomass of living vegetation, and of roots and beneficial soil microorganisms, particularly if applied to reforestation

and agroforestry on degraded lands. In addition the chemical weathering of rock dusts serves as a CO2 sink in its own right.

CONCLUSION

Soil Remineralization will create abundance in an era of diminishing resources and shift us away from fossil fuels.

Remineralization is nature's way to regenerate soils, and is needed on a large scale because mismanagement is causing us to lose soils far faster than they can naturally regenerate. The techniques are simple, easily and intuitively learned, and can be rapidly scaled up at the community level. The materials are readily available and an inexpensive byproduct wherever there is building and road construction using stone aggregates or concrete. No extra energy is needed to grind them up since it is a waste product of gravel plants. Hard silicate rocks are the most abundant resource on earth. Millions of tons are readily available for the cost of transportation, and much more could easily be produced from existing rock crushing plants. Remineralization is an essential tool for sustainable development, economic empowerment, and social justice by creating a local nutrient dense food supply for all, and will improve health and generate livelihoods within local communities. It can play a critical role in overcoming hunger and poverty, ecological restoration, carbon sequestration and climate stabilization.

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ORGANIZATIONS AND LINKS

Remineralize the Earth
Remineralize the Earth raises public awareness of the role that soil remineralization with finely ground rock dust, sea minerals and other natural means plays in agriculture by increasing the growth, health, and nutrient value of all plant life, reversing global desertification through agroforestry and reforestation, producing sustainable biofuels, sequestering carbon, and stabilizing climate. RTE promotes partnerships with foundations and educational institutions, government agencies, international development agencies, the private sector, and NGOs.
www.remineralize.org

Bionutrient Food Association
The Real Food Campaign (Bionutrient Food Association) organizes networks and promotes healthier nutrient-dense foods for our food supply through remineralization.
www.realfoodcampaign.org

Rocks for Crops
Rocks for Crops works in Africa to improve agriculture through the utilization of natural geological materials.
www.uoguelph.ca/rocks

First International Rocks for Crops Conference 2004 abstracts and papers can be found at
www.uoguelph.ca/rocks

Primeiro Congresso Brasileiro de Rochagem 2009 presented research on advances in rock powder fertilization in agriculture.
www.congressorochagem.com.br

Renew the Earth

Renew the Earth encourages international exchange of ideas, information, and actions in the transition from a fossil fuel based economy to one increasingly reliant on sustainable energy and water.
www.renew-the-earth.org

Seer Centre
Seer Centre is committed to regeneration of soils with rock dust to remineralize the soil to benefit the grower and the environment, and operates a demonstration garden and farm.
www.seercentre.org.uk

Ocean Arks International
Ocean Arks International specializes in ecological water purification technologies, and disseminates ideas and practices of ecological sustainability and design worldwide. They explore linkages between ecology and economics to create new kinds of work and enterprises out of environmental protection and restoration initiatives.
http://www.oceanarks.org

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