The Potential of Remineralization as a Global Movement

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Summary
Soil remineralization can play a critical role in sustainable agriculture, ecological restoration, carbon sequestration and climate stabilization while addressing major social issues. History, current developments and potential future directions explored briefly here will address these ecological and social challenges on a global scale.

Keywords
soil remineralization, sustainable agriculture, nutrient density, ecological restoration, carbon sequestration

History

Soil remineralization has been researched and explored by three distinct groups:

First, German nutritional biochemist, Julius Hensel, pioneered soil remineralization in the 1880s with his book Bread from Stones , and with it a modest agricultural movement came into being. Industrial rock grinding made remineralization more feasible on a larger scale, and much research has been done, particularly in Germany, Austria, and Switzerland, through universities, commercial companies, and the Natural Stone Industry based in Bonn, Germany. Peter von Fragstein and others have researched remineralization as a slow-release fertilizer with many different rock types. 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, the field of agrogeology has been explored and carried out mainly in Canada, Brazil, Tanzania, the Canary Islands, and West Africa, especially on laterite soils. Due to the intense tropical rainfall in these regions, NPK fertilizers are washed out in only a few weeks and cannot be stored by the soils, making them especially toxic to groundwater. In contrast, rock fertilizers not only supply nutrients to cultivated plants over longer periods, 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, Othon Leonardos, Suzi Theodoro, and many other notables. Othon Leonardos originally initiated research in Brazil on his own and later began working together with agrogeologists. The First International Conference on Rocks for Crops, was held in Brasilia in 2004. In September 2009 a conference on remineralization was held in Brasilia, the Primeiro Congresso Brasileiro de Rochagem, attended by 170 participants, hosted by researchers from the University of Brasilia. The Second Congress will be held in May 2013.

Third, the grassroots movement concerned with the premise of John Hamaker in the book The Survival of Civilization asserts that 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. This movement has expanded into a global grassroots community consisting of ecologically-concerned individuals and organizations, farmers and gardeners, scientists and policy makers, including Remineralize the Earth (RTE), based in Northampton, Massachusetts USA and incorporated as a 501(c)(3) nonprofit organization since 1995, and the Seer Centre, a permaculture-focused center with ongoing demonstration plots in Scotland. RTE's mission is to educate and facilitate a worldwide movement dedicated to the application of land (rock dust), sea-based minerals, and other natural means to promote sustainable farming and forestry, and ensure a healthier soil, food, and environment. Through research, education, advocacy, partnerships, and implementation, RTE is contributing to healthy soils and forests around the world, increasing the nutritional quality and yield of food production, and stabilizing the climate.

Reversing Desertification and Climate Change

Forests can grow much more rapidly when limiting factor minerals are replaced, bringing eroded and desertified lands back to life. Most importantly for humanity, and potentially the environment, soil remineralization can dramatically increase crop yields, disease resistance, pest resistance, and nutritive levels of agricultural lands. There is a potential to bring atmospheric carbon to pre-industrial revolution levels in five years through targeted use of the world's agricultural lands. This would not only bring global CO2 levels down to safe levels, but facilitate the revitalization of soil and biological life on the planet and significantly increase human nutrition and health levels, strategically diminishing numerous, seemingly unending, crises (Alan Yeomans, 2005).

Forests

The following is a small sample of selected research:

Long-term experiments in central Europe have shown that the wood volume was 4 times higher in a forest area where pine seedlings were remineralized than in an untreated area after 24 years. One application lasted for 60 years before the benefits tapered off (Sauter & Foerst, 1987). This was traced back to the increasing content of easily accessible potassium, calcium, and phosphorus.

The Men of the Trees organization based in Western Australia did trials with many species of trees in Australia, resulting in 5 times the growth of tree seedlings for one variety of eucalyptus, E. gomphocela, over the untreated controls. The nursery potting out time was shortened from 5 months to 6 weeks, with the use of a local granite dust (Oldfield, 1991).

Studies are now needed to determine the feasibility of soil remineralization techniques in improving tree health and augmenting carbon sequestration in forested areas, especially those forests that are showing decline (Klinger, 2005).

In Panama a recent study compared tree growth rates over 5 years in highly infertile soils to those grown in basalt rock dust. No chemical fertilizer or compost was added. The results were an 8-fold increase in biomass, 2.17 increase in the height of the trees, and 4 times the survivability from the trees on basalt. The trees on the local soil did not survive. 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. Researcher of the study, Dr. Tom Goreau, recommends performing a large-scale research project to further optimize use of various rock powders, plants, soil types, climate regimes, and management practices (Goreau et al., 2011).

Agroforestry Project in Costa Rica: Food, Fuel, and Income to Sustain Local Communities

As a project of Remineralize the Earth, John Todd of Ocean Arks International intercropped native commercial hardwoods, fruit trees, and Jatropha (a sustainable, biofuel-producing oil plant) on abandoned cattle pastures in the Guanacaste region of Costa Rica, using local basalt dust as a fertilizer. Over 1,000 trees of more than 20 species were planted. Jatropha receiving rock dust produced larger and more bountiful seeds, and all the trees grew more vigorously. Marginal soils planted with Jatropha sustainably could be restored to agricultural food production in a few years. Jatropha as a biofuel could replace firewood harvesting and expensive imported kerosene in rural areas in Africa. It could provide sustainable livelihoods in areas now severely damaged by drought, desertification, and hunger (Todd, 2008).

Agriculture

Nutrient Density

In a seminal study by John Hamaker in The Survival of Civilization, Hamaker applied glacial moraine dust to Michigan soils and raised corn yields from 25 bushels/acre to 65 bushels/acre, greatly increasing its nutritional value. Protein increased by 28%, calcium by 47%, phosphorus by 57%, magnesium by 60%, and potassium by 90% (Hamaker, 1982).

Today in large-scale organic agriculture, the largest carrot grower in the world, California-based Grimmway Farms, and the largest blueberry grower, Purewal Blueberries in British Columbia, have remineralized thousands of acres with a source of rock dust from the southwest of the United States. Nutrient-dense foods have higher levels of vitamins, carbohydrates, minerals, enzymes, antioxidants, and trace minerals essential to human health.

RTE's Real Food Campaign (2008-2012), now the Bionutrient Food Association (BFA), has trained over 700 growers on how to produce high quality crops based on biological soil management that includes remineralization, and focuses on nutrient density. BFA is now researching the development of a supermarket model scanner that can provide accurate readings of nutritional quality to consumers and growers (Kittredge, 2013).

Alternative to pesticides

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). A farmer spraying insecticides on his fields is unintentionally breeding weak plants and strong insects. Any responsible approach to short-term pest control must be safe, practical, and inexpensive. Rock powders physically repel pests, disrupt their reproductive cycles, and abrade them. These small particles disable and discourage insects by causing various forms of mechanical discomfort. It does not obliterate insect life in a way that produces ecological imbalances and rapidly breeds resistant pests. This facilitates the creation of a healthy agricultural ecosystem that will gradually require fewer palliative solutions to pest problems. Insect populations are brought into balance and crop damage is reduced. Silica eventually strengthens plant tissue and the vigorous growth deters insects, nature's recyclers of weaker plants. Rock dust is the ideal soil amendment for promoting improved immunity to pests and disease.

Brazil

Brazil has a top-down approach that is dedicated to creating accessibility to small family farms. Their emphasis is on sustainable development, economic empowerment, and social justice, with the end goal of creating a local, nutrient-dense food supply and a commitment to improving heath and generating livelihoods within communities. Brazil is dedicated to creating energy independence. With deficient soils but large resources of rock types available, Brazil has the opportunity to regenerate soils for agriculture, agroforestry, and the production of sustainable biofuels.

A research project in Bahia has shown soil remineralization to be an effective adjunct strategy for remote, impoverished communities to produce higher yields of quality crops while remaining independent from chemical fertilizers and government subsidies. A team of Brazilian scientists led by Suzi Huff Theodoro, PhD, and first initiated by Othon Leonardos, PhD, work in Sustainable Development at the University of Brasilia and have been specializing in remineralization research and project implementation for the past 15 years.

In their projects, rock powders were mixed with organic matter, manure, and other affordable, natural, and locally materials and applied to soils where primary food crops for the region were planted. In the first two years of testing, yields increased by 10-30%. Soil pH shifted from highly acidic to mildly acidic to mildly alkaline, and the nutrient availability in the soil was greatly improved. Farmers noted that the most significant aspect of the project for them was the improved capacity of remineralized soil to hold water, as shortages and droughts are common during the dry season (Theodoro and Leonardos, 2006). This model has carried over to Africa by Dr. Theodoro who is coordinating a project funded by CNPq that aims to integrate Brazilian and African research.

Several research institutions (such as Embrapa, UnB, UFV, and CPRM) have confirmed that soil remineralization is an alternative and/or complement to standard fertilizers in research and demonstration trials that have since taken place. Since it is in agreement with agroecological

principles, soil remineralization has become a viable alternative for regenerating degraded soils. Agroecology is an interdisciplinary science founded in Brazil that applies ecological concepts and principles to the design, development, and management of sustainable agricultural systems, and includes mineral cycles, energy transformation, biological processes, and socioeconomic relationships.

Mexico

Zacatecas is the state with the highest production of beans in Mexico, accounting for 35% of national production. In a 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. Jorge Villase ñor Garibi and Agro Insumos Nova Terra SA participated in a governmental program to support the farmers of Zacatecas and other regions in which urea was replaced by rock dust. Consequently, 22,200 hectares were remineralized in 2008-2009. 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 pepper also increased.

In 2011, a government campaign supported farmers in the township of Zapopan, Jalisco, and in the summer of 2010 it provided farmers with rock dust to fertilize 1,250 hectares of crops including 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. The governmental initiative included public parks, gardens, and a forest area of about 1500 ha and estimated to contain 700 trees. Around 500 children from several elementary schools in Zapopan attended a workshop in which they were taught how to remineralize trees with rock dust (Ruiz Castro, 2010).

Bernardo Castro Medina founded Eco-Agro in 1997, 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 Guam úchil, Sinaloa, Eco-Agro has been at the forefront of campaigns promoting the use of rock dust.

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. Additional good results have been recognized 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 (Ruiz Castro, 2011).

Cameroon

Experimenting with rock fertilizer technology on small-scale farms in Cameroon, contributing to food security and sustainable agriculture is a current project proposal by RTE and the Research and Education Centre for Development (CREPD), and will include participation of the Peace Corps/Cameroon. The goal is to reduce the food insecurity of rural, small-scale farmers in the Cameroon Volcanic Line (CVL). The anticipated result will be to: increase small-scale farmers ' income through improved agricultural output and increased crop productivity and nutrient density; make locally-available rock fertilizers an alternative to expensive conventional fertilizers and pesticides; increase knowledge of small-scale rural farmers in sustainable agriculture, agroforestry, remineralization, and business techniques; and enhance nutrition in the crops produced using these sustainable techniques to reduce food insecurity in rural areas.

Increase is a scientific technical book on remineralization and biochar being published by CRC Press (In Press 2013). Papers from Brazil, Cameroon, and all continents except for Antarctica are included, and this book will assist in funding and policymaking.

From Current to Future Directions

Brazil is paving the way for soil remineralization on a national scale through its longer-term development of research and policymaking, its plans to create a regulatory agency, and in potentially creating distribution hubs that will make rock dust available to farmers throughout the country.

In Mexico, government partnerships and subsidies on the local, state, and national levels have covered large tracts of farmland, as well as remineralizing public spaces and forests.

Remineralize the Earth has developed an agroforestry model in Costa Rica that can potentially sustain local communities with food, fuel, and income, particularly appropriate to international development on the local community stakeholder level in semitropical and tropical environments, leading to availability of rock dust for small farmers and farmer cooperatives and contributing to self-sufficiency, the flourishing of farmers markets, and the overcoming of poverty and malnutrition, similar to Brazilian models and initiatives.

RTE is partnering with New Harmony Farm, a Community Supported Agriculture (CSA) organic farm in West Newbury, MA, to find the most efficacious ratios of compost, rock dust, and biochar, and to take the results one step further by analyzing not only plant and soil nutrients and biological activity, but also the effects on soil carbon storage and greenhouse gas emissions. The project is being supervised by Dr. Tom Goreau, with testing on soil carbon storage done by Dr. Jim Tang of the Woods Hole Institute. This research is evolving into a larger project, potentially with the New England Small Farms Institute and the University of Massachusetts and Remineralize the Earth is looking to expand the project through more partners.

Reforestation with rock dust has the potential to create healthy drought and fire resistant forests so that trees can store carbon rather than give off CO2, especially in places such as Australia, Greece, Southern California, and New Mexico where prevention of forest fires is of paramount importance. The rock dust can be applied as part of community projects by volunteers, hydraulically from trucks, or sprayed by plane or helicopter.

There are numerous other applications of remineralization, from bioremediation of chemicals and radiation in soils and for people (rock dust taken internally and affected by Fukushima); dairy and livestock operations, and many possibilities that have the potential of creating a more humane and sustainable relationship between people, flora and fauna, and the biosphere. From carbon credit programs, such as the Carbon Farming Initiative (CFI) in Australia, to remineralization of forests, carbon can be sequestered on a massive scale to stabilize the climate.

Conclusion

The techniques of soil remineralization are simple, easily and intuitively learned, and can be rapidly scaled to the community level. The materials are readily available as an inexpensive byproduct that can be found wherever there is building and road construction using stone aggregates or concrete, and can also be sourced from the ocean; rocks and sea minerals are the most abundant resources on Earth. Often, no extra energy is needed to grind rocks up since they are a waste byproduct of gravel plants. Soil Remineralization will create abundance in an era of diminishing resources and shift us away from fossil fuels. Remineralization is nature's way of regenerating soils, and is needed on a large scale, as mismanagement is causing us to lose soils far faster than they can naturally regenerate, and this innovative method will contribute to the increased storage of carbon in our soils and forests.

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