Rock Dusts in Agriculture: Insights on Remineralization and Paramagnetism

By Steve Diver
Appropriate Technology Transfer for Rural Areas

Part I, Rock Dusts in Agriculture

Rock dusts, as the term is used in organic agriculture, refers to those granite meals and quarry dusts and rock flours that are derived from very finely ground rock minerals. Rock dusts are valued for the fineness of grind and a trace element content.

Some examples of rock dusts on the market include Azomite, McKenzie Rock Flour, Planters II, and Desert Dyna-Min. Flora-Stim is a clay-based rock dust material.

Rock dusts are part of a broad class of non-synthetic fertilizer materials used in organic farming. Generically, these materials are known as "rock powders" or "rock minerals." "Mineral fines" is another term used in association with finely-ground aggregate materials that are by-products of quarrying and related mining industries.

A companion ATTRA publication — *Sources of Organic Fertilizers and Amendments* — lists suppliers of rock minerals. In it, we have subdivided these into two categories: Rock Minerals–Phosphates (colloidal rock phosphate, hard rock phosphate, etc.) and Rock Minerals–Non-Phosphate (granite meal, gravel dusts, lime, greensand, etc.).

The uses of rock dusts in agriculture include:

- As an amendment to compost piles or compost windrows
- As an amendment to potting mixes for greenhouse crops and transplants
- As a topdressing to greenhouse potted plants
- Adding to fresh livestock bedding materials to reduce odors and absorb volatiles
- As an amendment to soils
- As an amendment to compost teas
- As an amendment to blended foliar fertilizers
- As a human dietary mineral supplement
- As an animal feed mineral supplement

A common notion among organic farmers is that rock dusts provide key mineral supplementation that enhances the "strength" and "vitality" of plants and thereby increases resistance to insect attack as well as improves the flavor and nutrition of crops. Concepts and terms like "strength" and "vitality" come from the practitioner experience rather than scientific literature, nevertheless they mean something to farmers who work closely with the soil. To support their claims that rock dusts enhance the sugar and mineral content of fruits and vegetables, the refractometer—also known as a brix meter—is commonly used to evaluate soluble solids measured on a scale known as Brix.

Remineralization

Soil remineralization is a common term used in association with rock dusts. In organic agriculture, remineralization has both a generic meaning and identification with a specific movement within organic

agriculture.

Remineralization No. 1: Remineralization can be used as a generic term for any addition of rock minerals to soils as a means to replenish mineral nutrients and provide agronomic benefits. It recognizes the fact that continuous harvesting of crops removes a certain amount of minerals from the soil, and that remineralization can provide essential mineral elements — or help balance mineral nutrients, especially trace elements and secondary nutrients like calcium and magnesium.

Remineralization No. 2: In 1982, John Hamaker and Don Weaver co-published *The Survival of Civilization*. Hamaker stressed the importance of "remineralizing" soils through the addition of ground glacial rock dusts to restore soils and forests, with a secondary goal to stabilize the global climate and prevent another ice age. This is a pretty big concept, but Hamaker was an engineer who published extensively on remineralization and a lot of people listened to what he had to say. Over time, however, most soil remineralization advocates have lightened up on the ice age scenario and settled into the agronomic benefits of rock dusts. In fact, a lot of Hamaker's focus on mineralization deals with the influence of soil microbial life interacting with the mineral elements to build a healthy, fertile soil to promote abundant vegetative growth (especially as it relates to afforestation), and also, to produce crops and livestock that are well nourished and minerally and nutritionally enriched.

The following points -- a summation from Hamaker materials, including an unpublished manuscript from 1969, *A Program of Natural Farming as the Key to Prevention of Degenerative Disease* -- summarizes Hamaker's remineralization theory in a nutshell (1):

- Optimum health requires the constant and abundant flow of ground rock of maximum variety to the soil. The only supply of adequately mixed rock is the glacial deposit that extends in a layer of hundred of feet thick from Michigan and Wisconsin to the North Pole. The key is readily available.

- Finely ground rock dusts possess immensely increased surface area compared to rock flakes, gravel, or parent material. The increased surface area enhances mineral availability, especially in combination with microbial action. A mixture of elements, including trace elements, is highly desirable.

> A block of rock one foot square can be buried in the earth and the area exposed to action of soil organic acids will be six square feet. Now take that block and slice it into slivers .001" in width. Now there is a total of (two sides) x 12,000 square feet = 24,000 square feet. Then slice each sliver of one square foot into cubes of .001" and there will be 2 x 24,000 = 72,000 square feet of area (1.75 acre). Rock ground to air entrainable particle size is smaller than .001". One ton of such rock would provide 1,000,000 square feet (22 acres) of chemically active nutrients (Source: Reference No. 1).

- Minerally enriched soils support healthy plant growth, and conversely, a buildup of organic matter. Increased levels of organic matter, in turn, provide food and habitat for a vigorous soil organism population that are essential in supplying crop plants with mineral elements from the soil matrix. Thus, minerals and organic matter go hand in hand to support a healthy soil agroecosystem.

> Breakdown of the rock dust and liberation of its nutrients is proportional to the quantity of soil organism activity and that in turn is proportional to the organic matter in the soil (Source: Reference No. 1).

- Soil microbial life plays an important role in the biochemical action on rock dusts. Organic acids and enzymes, microbial byproducts of organic matter decomposition, help to solubilize and transform mineral nutrients into bioavailable forms.

- A goal of natural farming methods is the production of high protein food crops that supply good amounts of

minerals and vitamins.

> Crop tonnage expressed largely as starch will not feed man. He just eats twice as much low protein food if that is what it takes to get enough protein. His hunger is not then satisfied because high starch foods seldom if ever have the full complement of proteins and vitamins. Without these proteins and vitamins as well as a full complement of minerals, he becomes sickly (Source: Reference No. 1).

- Studies show a relation between tooth decay and an inadequate mineral supply; studies find long-lived and healthy humans are located in geographical regions with glacial mountain waters and mineral-rich soils.

- Access to power and machinery to grind rock, especially mixed igneous rock in glacial deposits, that can therefore supply rock dust for use in remineralizing soils.

In retrospect, Hamaker's focus on soil restoration in association with promotion of healthy forest ecosystems and croplands parallels that of current legislative proposals to financially credit farmers for carbon sequestration; i.e., for soil organic matter building practices such as no-tillage and for vegetation establishment of trees and prairies. In this respect, Hamaker was a pioneer. Interestingly, the current paradigm is geared to global warming rather than Hamaker's global cooling, yet both discuss restoration of forests and grasslands as a solution to climate change.

Rock Dusts, Organic Matter, and Microbes

Rock dusts are said to stimulate soil microbial activity and to provide trace elements and secondary nutrients—including rare earth elements that are not recognized as plant essential elements by conventional agricultural scientists. In fact, it is the fineness of grind and mixture of trace elements that are said to enhance microbial activity; because: [1] finely ground rock powders have a huge surface area; and [2] trace elements function as chemical catalysts that microbes use to manufacture and release soil enzymes.

Here, I call your attention to a central concept of mineralization as it relates to organic agriculture and soil science. That is, solubilization and mineralization of mineral nutrients in soils and from parent material, as well as rock dusts, is facilitated by organic acids released by microbes during decomposition of organic materials— for example, animal manures, green manures, and composts. Biological processes in agriculture that feature solubilization and mineralization include: soil acidity; microbial decomposition of organic materials in soil; microbial activity in compost piles; active biosolubilization in preparation of organic hydroponic solutions.

One of the uses rock dusts, as an amendment to composts, is of particular interest with respect to enhancement of microbial activity and bioavailability of mineral elements contained in rock minerals. "Mineralized compost" is a term used in association with composts amended with rock dusts and rock phosphates, to take advantage of this microbial action (solubilization and mineralization).

Microbes play an integral role in the breakdown of raw organic materials placed in a compost windrow, as well as in the buildup phase, when raw organic materials are used as building blocks in the formation of complex humic substances. Composters who amend their windrows with rock dusts say the trace elements contained in the rock minerals function as biocatalysts in microbially-driven enzyme reactions critical to the breadkdown and buildup process. It may be helpful to think of composting as a complex bio-physico-chemical transformation factory where raw organic materials like straw and manure are turned into stable humus. It is in this millieu that rock dusts feed microbes with necessary trace elements and the byproducts of microbial activity, organic acids, help solubilize the slow-to-release mineral elements tied up in rock minerals. All of these reactions and activities occur simultaneously.

Though it should be noted that composts can be made without rock dusts and in fact rock dust supplementation of composts is more akin to the European tradition than the American tradition, the point here is that rock dusts are used by some composters as biocatalysts for microbial enzyme synthesis and to increase the biotic-mineral content of humus, which is the end result of composting.

The following helpful instructions on the use of rock dusts in composts were found in the Spring 1993 issue of *Remineralize the Earth*, in an article by George Leidig titled "Guidelines for Rock Dust Application in Compost by the Luebke Method" (2):

- Finely ground rock dust should be added at a rate of 10-20 lbs per cubic yard of raw material.
- The particle size should be less than 20 microns in diameter, or pass through a #300-mesh screen or finer. The fineness of the material is important, since you want to assure that the minerals are readily available to the microbes during the composting process
- Magnesium levels should be under 5%, since high magnesium levels rob nitrogen from the compost and soil
- Calcium levels between 5-10% are preferred—calcium is a macro-nutrient essential for microbial life and plant growth
- The rock dust analysis should display a well-balanced array of micro-nutrients, which, as in the soil, stimulates microbial action. This is even more important in composting, since the microbes are totally limited to the materials present in the pile for their nutrition
- Granite dust is not recommended for compost because of its quartz content. The larger size and slickness of the quartz particles resist breakdown and inhibit the attachment of organic particles necessary for proper humus crumb formation
- Rock dusts of volcanic origin are preferred, such as diabase or basalt, because of their high silica value. Silica is an often forgotten element necessary for proper cell structure in plants and animals. Recent studies have shown silica play a vital role in calcium and phosphorus assimilation
- Rock powders that test with high paramagnetic values are thought to favorably effect both the composting process and plant growth. Although this is a topic of much current research, there have not to date enough studies done to verify this scientifically

Rock Dust Resources

Enlivened Rock Powders by Harvey Lisle is a 208-page book published by Acres, USA. Lisle's book is the most recent and up-to-date treatise on this subject, and I recommend it as a starting point. Lisle reviews the history of soil remineralization and discusses the micronutrients supplied by rock dusts. He also identifies the paramagnetic forces associated with rock dusts and refers to these types of rock powders as "enlivened." Contact:

Acres USA Bookstore
P.O. Box 91299
Austin, Texas 78709
512-892-4400
512-892-4448 Fax
info@acresusa.com
http://www.acresusa.com

Bread From Stones, originally published by the German agronomist Julius Hensel in the 1880's, is a 102-page classic reprinted by Acres USA. Hensel showed that plants would grow better in soils formed by mimicking natural soil-forming processes that take millenia; for example, glaciers grinding over the earth's crust.

The Survival of Civilization by John Hamaker and Don Weaver is a 218-page book available for $12 through

Hamaker Weaver Publishers. Hamaker was an engineer who hypothesized that deposits from glaciers were instrumental in soil mineralization, and that rock dusts can help remineralize depleted soils. Available through Acres USDA or Hamaker Weaver Publiations, contact:

Hamaker Weaver Publications
P.O. Box 1961
Burlingame, CA 94010
415-347-9693

Stone Age Farming: Eco-Agriculture for the 21st Century by Alanna Moore is a 213-page book available for $25 through Acres USA. Ms. Alanna Moore is a master dowser who manages land in Australia, and her book reviews a number of the subtle energy theories surrounding soils and rock minerals, such as: paramagnetism, Schumann waves, and related naturally occurring energy fields. In addition, she addresses a number of techniques that collect and broadcast natural energies, such as radionics and stone towers and Lakovsky coils. This is one of the better all-round books to have on your bookshelf for a modern view of subtle energy in agriculture focusing on soils and rocks.

Remineralize the Earth in a non-profit organization that promotes the regeneration of soils and forests with finely ground gravel dust as an economically and ecologically sustainable alternative to chemical fertilizers and pesticides. In the 1980s and 90s, Remineralize the Earth published a quarterly journal, and back issues are an excellent way to read up on farmer practices and scientific research. Though it discontinued its print journal, RE, Inc maintains a website with articles from past journal issues, research reports, and an electronic forum on soil remineralization. RE, Inc. plans to develop an online magazine, a monthly digital newsletter, and a research database.

Joanne Campe, the editor, has compiled extensive resource packets containing research and practitioner-based information on the use of rock dusts in agriculture and forestry. Packets include:

- Soil Remineralization: Agriculture, 146 pages. $17.00
- Soil Remineralization: Forestry and Sewage Treatment, 82 pages. $12.00
- Complete Set for both Agriculture & Forestry/Sewage Sludge. $25.00

For further information, contact:

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Northampton, MA 01060-4021
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Contact: Joanna Campe
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http://Remineralize-the-Earth.org

The United States Department of Agriculture held a Soil Remineralization Workshop on May 23–24, 1994, in Beltsville, Maryland. At the time, USDA-Agriculture Research Service had just initiated field research into soil remineralization. Further information about USDA-ARS research is available from Dr. Ron Korcak with USDA. (3). The agenda and brief abstracts of the lectures are conveniently located on the web at: http://www.barc.usda.gov/psi/korcak/agenda.htm

In addition, a 4-tape set of the USDA-sponsored "Forum on Remineralization and Sustainable Agriculture" is available for $65 through Remineralize the Earth.

Selected papers of special interest:

'Soil Remineralization Around the World' - Ms. J. Campe
Editor, Remineralize the Earth, Northampton, MA
http://www.barc.usda.gov/psi/korcak/ab-3jc.htm

'Effects of Rock Dust on Soil Microbiology and Plant Nutrition'
Dr. David Miller, Biology Department, Oberlin College, Ohio
http://www.barc.usda.gov/psi/korcak/ab-12dm.htm

Also see mineral fines research at USDA:

Novel Utilization of Industrial By-Products: "Waste" Mineral Fines Utilization
http://www.barc.usda.gov/psi/korcak/rk-mf-ov.htm

Part II: Paramagnetic Rock Dusts

In recent years, paramagnetism has become recognized as important feature of certain rock dusts and mineral fines (e.g., magnetite, basalt, volcanic-derived material). Paramagnetism is a weak magnetic attraction to an applied field. In other words, paramagnetic materials exhibit a weak magnetic energy field in response to the Earth's electromagnetic field. In association with agriculture, this biomagnetic energy field has important implications for soil health and plant growth.

Dr. Phil Callahan, the entomologist and biophysicist who brought paramagnetism into the forefront of alternative agriculture, says that soils with poor paramagnetism produce weak crops that are predisposed to insect attack and less likely to produce healthy, nutritious crops. Conversely, soils with high paramagnetism can be expected to produce healthy crops.

Some of the paramagnetic rock dusts on the market include products marketed by Cairn Tech and Nothin' But Rock. CGS-Paramagnetism, as measured with the PCSM Meter (see below), is the standard unit of measurement the industry has adapted.

Whereas paramagnetism is a common term in chemistry and physics, recognition of its importance and application in agriculture is altogether new. The primary source of information on paramagnetism in agriculture is Dr. Callahan's books and articles, for example, *Modern Mysteries, Modern Visions: The Magnetic Life of Agriculture* (1984) and *Paramagnetism: Rediscovering Nature's Secret Force of Growth* (1995) — available through the Acres USA Bookstore.

Paramagnetism, as defined by *The Dictionary of Chemistry*: "In paramagnetism the atoms or molecules of the substance have net orbital or spin magnetic moments that are capable of being aligned in the direction of the applied field" (4). In other words, the dipoles align in the direction of the applied magnetic field and there is a weak positive attraction to the magnetic field.

Diamagnetism, as defined by *The Dictionary of Chemistry*: "Diamagnetism is the magnetization in the opposite direction to that of the applied magnetic field, e.g., the susceptibility is negative away from the magnetic field" (4). In other words, diamagnetic substance (e.g., organic matter, humus, microbes, plants) exhibit a weak negative magnetive force, they are repelled; conversely, the dipoles align in the opposite direction of the applied magnetic field.

Here we can see that certain mineral elements exhibit paramagnetism, while organic matter and plants exhibit

diamagnetism. Dr. Callahan alludes to the importance of a counterbalance between paramagnetism and diamagnetism, similar to the yin-yang of Chinese and Japanese geomancy. Further, we can also see an interesting correlation to positive and negative poles on a battery. When we pay attention to paramagnetism in soils and composts, we have the opportunity to enhance energy flow between positive (paramagnetic) and negative (diamagnetic) substances.

In practice, the current strategy among ecological farmers is to measure the paramagnetism of their soils and try to improve it through the addition of paramagnetic rock dusts.

To measure paramagnetism, Dr. Callahan took a $6,000 meter used in the British mining industry (Bartington Model MS2) and redesigned it for use in agriculture. The result is the Paramagnetic Count Soil Meter (PCSM), which sells for about $400 from Pike Lab Supplies in Strong, Maine. Contact:

Pike Agri-Lab Supplies
[Contact: Bob Pike]
RR 2, Box 710
Strong, Maine 04983
207-684- 5131
207-684-5133 Fax
info@pikeagri.com
http://www.pikeagri.com

The PCSM Meter provides a digital readout, using the standard unit of measurement of CGS, or Centimeter-Grams-Seconds, which is the weight of paramagnetic material that will move one centimeter to a magnet in one second. Substances that can be analyzed by this meter include rock dusts, humates, soils, minerals, fertilizers, and others agricultural amendments. The following table, Range of Paramagnetic Values, was provided by Dr. Callahan at the 1995 Acres, USA Conference in St. Louis, Missouri.

Range of Paramagnetic Values

CGS	Value
0-100	Poor
100-300	Good
300-800	Very Good
800-1,200	Excellent

Dr. Callahan also presented the following table, Range of Paramagnetic Values for Soils, at the 1995 Acres, USA Conference in St. Louis, Missouri:

Range of Paramagnetic Values for Soils

Soils	Paramagnetism
Poor	0-100
Good	100-300
Very Good	300-700
Superior	>700

In *Paramagnetism: Rediscovering Nature's Secret Force of Growth*, Callahan states that the key to a healthy, productive soil is Compost, Soil Organisms, and Paramagnetism, or C-O-P. Thus, the use of paramagnetic rock

dusts may be viewed as a complementary practice to traditional humus-building practices like composts, cover crops, green manures, and crop rotations.

Here it may be helpful to place paramagnetism in the larger context of alternative agriculture. Alternative farming systems include Organic Agriculture, Biodynamic Farming, Nature Farming, Permaculture, and Eco-Farming. Sustainable Agriculture may be viewed as an umbrella term that includes all of these alternative farming systems, as well as Low-Input. *Acres, USA* is the eco-farming magazine that publishes books and articles on Phil Callahan's work, paramagnetism, rock dusts, and related concepts and practices.

At the recent Acres, USA conference in Minneapolis, MN, on December 7–9, 2000, Dr. Callahan gave a keynote address on paramagnetism and related topics like insect attraction to infra-red frequencies, which occur as spots on plant leaves when crops are improperly fertilized (i.e., with synthetic nitrogen fertilizers). In reference to his latest research, Callahan said (paraphrased) "plant roots and leaf hairs are dielectric wave guides for carriers of biophoton light energy; therefore in the presence of paramagnetic materials, these organs become super charged."

Based on these latest insights from Callahan, my conclusion is that paramagnetism super charges the energetic plant system, thus enabling roots and leaves to function and metabolize at a higher rate of activity which results in enhanced photosynthetic carbohydrate production, thereby resulting in improved plant growth and yield, improved nutritional composition, and a natural ability to resist insect attack. Some of these outcomes, especially differences with insect attraction, are due as much to variations in resonance frequency as an improved status to plant health.

Part III: Paramagnetic Influence Separate from Any Biological-Chemical Affect

Rock dusts are known to enhance plant growth by altering biological and chemical aspects of the rhizosphere — that rich region of biological activity at the root-soil interface. A few researchers have designed experiments to look at the sole influence of paramagnetism on plant growth. That is, paramagnetic rock dusts were placed in close proximity to roots of seedling plants, rather than incorporating the rock powders into the potting medium itself.

In one experiment (5), Men of the Trees in Western Australia planted 80 Acacia scirpifolia tree seedlings in individual pots. A small plastic envelope containing 6 grams of granite rock dust was placed down the side of 40 pots to evaluate the effect of paramagnetism on survivability and plant growth. The other 40 pots served as a control. Acacia scirpifolia was chosen because it is difficult to propagate and because A. scirpifolia trees have responded well to rock dust applications in the field.

The results: 57.5% of the plants in treated pots survived, whereas only 15% of the un-treated plants survive. The researchers concluded that remote plant stimulation by rock dusts warrant further investigation.

In Florida, similar research was conducted by several students working with paramagnetic materials obtained from Dr. Callahan's lab. Plastic tubes and film canisters containing paramagnetic materials were buried in potting mixes to ascertain the effect of a subtle energy field on plant growth, separate from the rock dust material as a contributor of mineral nutrition. The results were significant. When paramagnetic materials were in close proximity to plants, increases were seen in root length, root branching, plant biomass, and plant height (6).

Part IV: Practical Application of Paramagnetic Rock Dusts

With respect to the cost of these materials, it is my understanding the bulk material itself is not too expensive—by the 50-lb bag or by the ton—but the shipping costs can be substantial depending on the distance from the source.

Since there is currently little information or substantiated data on the use of rock dust available from the scientific literature or the Extension Service to draw upon, my suggestion to farmers is to start with a trial quantity, for example a 50-lb bag, and experiment with paramagnetic rock dusts in greenhouse pot trials and on small plots of land raising vegetables or field crops.

How to Conduct Research on Your Farm or Ranch (5) is a publication from SAN, the Sustainable Agriculture Network sponsored by USDA, which you may find helpful. On-farm research is a common practice in sustainable agriculture. This SAN booklet provides the background information to help farmers design demonstration research plots and evaluate "new" practices and products in comparison to "traditional" methods.

References:

1) A summary of Hamaker's remineralization theory in a nutshell were compiled from from various Hamaker sources, especially:

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2) Leidig, George. 1993. Rock dust and microbial action in soil: The symbiotic relationship between composting and mineral additives. Remineralize the Earth. Spring. p. 12-14.

3) Dr. Ron Korcak
USDA-ARS Plant Sciences Institute
Henry A. Wallace Beltsville Agricultural Research Center
Bldg. 003, Rm. 228, 10300 Balt. Blvd.
Beltsville, MD 20705-2350
301-504-5650
rkorcak@asrr.arsusda.gov
http://www.barc.usda.gov/psi/korcak/korcak.htm

4) Callahan, Phillip S. 1995. Paramagnetism: Rediscovering Nature's Secret Force of Growth. Acres, U.S.A., Metairie, LA. 128 p.

5) Oldfield, Barrie. 1988. Another clue from Austria: Paramagnetic effects of granite rock dust are shown in seedling germination study. Remineralize the Earth. No. 12-13 (Spring). p. 22–24.

6) Dykstra, Thomas M. 2000. Paramagnetic effects on plant growth. Acres USA. September. p. 20-21.

7) SAN. 1999. How to Conduct Research on Your Farm or Ranch. Sustainable Agriculture Network. Washington, DC. 12 p.
http://www.sare.org/onfarm99/index.htm HTML Version
http://www.sare.org/onfarm99/onfarm99.pdf PDF Version

Suggested Reading:

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Remineralize the Earth collection:
An Overview and Reading List by Joanna Campe;
A Brief Perspective On Soil Remineralization and the Climate by John Hamaker, Don Weaver, Larry Ephron and Joanna Campe;
Rock Dust Application Brings Large Improvement to Vineyard in Solano County, California,
by Bob Cannard.
http://www.ibiblio.org/london/orgfarm/remineralization/remineralization.selected-writings

How to Improve Topsoil
By David Yarrow
http://danwinter.com/yarrow/soil.htm

Rock Dust Soil Amendment Shows Promise—Nursery Seedlings Demonstrate Early Vigor and Fast Growth
By Barrie Oldfield, Western Australia Men of the Trees
http://danwinter.com/yarrow/australa.htm

Soil Remineralisation
By Philip Charles Madeley
http://www.geocities.com/HotSprings/Sauna/1432/SoilRemineralisation1.htm

Further Information and World Wide links for Soil Remineralisation
http://www.geocities.com/HotSprings/Sauna/1432/SRInfo.htm

Rock Dust and the Mineral Cycle - Howard Tanner
http://www.organic.mcmail.com/bog/rockdust.htm

Paramagnetism - The Missing Link in High-Production Fertility
http://www.nutri-tech.com.au/articles/Paramagnetism.htm

List of Rock Powder Uses in Agriculture
By David H. Miller, Oberlin College
http://www.oberlin.edu/~dmiller/

David H. Miller < fmillerd@oberlin.edu>, Oberlin College
http://www.oberlin.edu/~biology/BIO.faculty.miller.html

Temporary Greenhouse Keeps Biology Classes Running Smoothly
http://www.oberlin.edu/newserv/ns-academics/19991011Temporary_Greenhouse.html

Effects of Rock Dust on Soil Microbiology and Plant Nutrition
USDA Soil Remineralization Workshop
Dr. David Miller, Biology Department, Oberlin College, Ohio
http://www.barc.usda.gov/psi/korcak/ab-12dm.htm

Agricultural Use of Rock Fines as a Sustainable Soil Amendment
Greenbook 2000 - Marketing Sustainable Agriculture
Minnesota Department of Agriculture
http://www.mda.state.mn.us/ESAP/greenbook2000/gb2000.html

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MacCormack, Harry. 1993. The science of remineralization. Organic Farmer. Fall. p. 43.

Meader, John. 1992. Lava fertility. Acres USA. April. p. 1, 8.

Miller, David. 2000. Scouting quarries for gravel dust. Acres USA. June. p. 29.

Two part remineralization brief from Organic Farmer, Fall 1993:
*A brief perspective on soil remineralization and the climate
*Right under your feet: A look at soil remineralization practices by Steve Gilman.

Rado, Yvonne. 1992. Rock dust supplies minerals that are as important to plant growth as NPK. In Good Tilth. January. p. 19-20.

Further Reading:

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Paramagnetism and Paramagnetics:

Copernic Search Results: Paramagnetic
http://ncatark.uark.edu/~steved/cs-parmagnetic.html

Copernic Search Results: Paramagnetic and Paramagnetism
http://ncatark.uark.edu/~steved/cs-pm-paramagnetism.html

ORMUS, Rare Earth Minerals, and Paramagnetism:

ORMUS and Paramagnetic Soils
By Barry Carter
http://www.subtleenergies.com/ormus/tw/paramag.htm

ORMUS, What is it?
http://www.subtleenergies.com/ormus/whatisit.htm

Paramagnetism in the Context of Eco-Farming:

An Eco-Farming Primer: Mineral Balancing, Humus Management, & Energy
http://ncatark.uark.edu/~steved/efp-acres.pdf

Mineralization, Solubilization, Amending Composts with Rock Dusts

Greensand & Other Rock Dusts
By Chris Shade, Australia
SANET Web Post, August 1997
http://www.ibiblio.org/london/sustainable-agriculture/remineralization/mineral-content-of-rock-dusts

Re: Buckwheat and biofumigation (and phosphorus solubilization)
Steve Diver (steved@ncatark.uark.edu)
Fri, 11 Sep 1998 09:58:59 +0000
SANET Web Archives
http://www.sare.org/htdocs/hypermail/html%2Dhome/28%2Dhtml/0001.html

Food nutrition and soil regeneration
Chris Alenson (oas@alphalink.com.au)
Tue, 16 Nov 1999 21:00:29 +0930
SANET Web Archives
http://www.sare.org/htdocs/hypermail/html%2Dhome/39%2Dhtml/0470.html

Clay-Humus: The Seat of Soil Fertility; A Treatise on the Vital Role of
Clay-Humus Crumb Structure and Organo-Mineral Complexes in Soils
1.Organo-Mineral Complexes and Clay-Humus Crumb
2. Adding Clay to Compost to Form the Clay-Humus Crumb
3.Rock Dusts to "Mineralize" the Clay-Humus Crumb
4.Paramagnetic Rock Dusts to "BioMagnetize" the Clay-Humus Crumb

By Steve Diver
http://ncatark.uark.edu/~steved/clay-humus.html

Further Reading:

Coleman, Eliot. No date. The Use of Ground Rock Powders in Agriculture, a Survey of the Literature on Granites, Feldspars, Micas, and Basalts. Small Farm Research Association, Harborside, ME. 22 p.

MacCormack, Harry. 1993. The science of remineralization. Organic Farmer. Fall. p. 43.

Meader, John R. 1992. Lava fertility. Acres, U.S.A. April. p. 1, 8.

Suppliers of Paramagnetic Rock Dusts:

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