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The Significance of Fine Grinding: A Response to Harvey Lisle

Over the last year, silica and the biodynamic horn silica preparation have been discussed in these pages from a number of diverse points of view (see BIODYNAMICS #238, p. 2ff, p. 7ff, #239, p. 18ff & #241, p. 19ff). Continuing this theme, the following article offers a comprehensive perspective on the significance of fine grinding in the production of the horn silica preparation.

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1. Introduction

In a recent article in *BIODYNAMICS,*[1] Harvey Lisle writes that when the horn-silica preparation ("501") is made with finely ground silica or quartz, this destroys the quartz' crystalline structure and thereby destroys "the very properties we are after." Specifically, if a quartz crystal is ground so finely that it can pass through a 200-mesh screen, he claims that the quartz is then transformed into an amorphous, "clay-like powder," which will bring about "clay/earth results" rather than the "silica/sun results which we are after when we use 501." In support of this argument he cites three experiments that he conducted using kinesiology (muscle testing) and dowsing. Lisle's overall conclusion is not only that coarse grinding is superior to fine grinding, but that a good horn silica preparation can be made even without any grinding—either by using the circa millimeter-sized quartz crystals embedded in the clay mineral rectorite, or by using any fine-grained beach or river sand.

This recent article is very similar to a much briefer article of Lisle's that appeared already in 1985 in a small, now-discontinued biodynamic newsletter.[2] In that article he expressed his basic conviction quite clearly and succinctly: "The crux of the crystal is its form. If we destroy the form we have nothing." He then went on to say, "I am sure that [200-mesh powder] is much finer than Steiner had in mind when he stipulated that the silica be 'ground to a fine mealy powder'." Lisle also reported at that time that he had performed copper chloride crystallization tests and alfalfa growth tests on 200-mesh and 100-mesh silica powder, and that with the coarser 100-mesh silica the results were "good," but that with the 200-mesh silica the results "did not appear good." Regrettably, he did not provide any further details about these experiments.

I know Harvey Lisle as a true gentleman, and I think that the questions he raises about this preparation are fully legitimate, but I cannot concur with his conclusions and recommendations against fine grinding. He may be correct that if we destroy a crystal's form and reduce it to amorphousness "we have nothing," but it does not follow from this that we should refrain from creating such amorphousness in the process of making the horn silica preparation. As Faust said to Mephistopheles in Goethe's famous drama, "In your Nothing I hope to find the All,"[3] so will I try to demonstrate in this article that bringing about *amorphousness* or *chaos* is one of the keys to achieving the particular effects that Steiner expected from the horn silica. Inasmuch as currently produced horn silica preparations do not always lead to these effects, however, I certainly support Lisle's efforts to re-examine this question. In any case, I thank him for stimulating me to pull together my own thoughts regarding the significance of fine grinding within the whole concept of this preparation.

2. The Effects of Grinding Crystalline Materials

The most obvious effect of grinding or crushing a crystalline material is that the pieces become smaller and smaller. At the same time, certain structural changes may occur, but in order to appreciate these latter changes, it is necessary to have a clear idea of the scale of the small particles produced by such grinding. Table 1 gives a survey of the terminology and size equivalents for some selected particles over a range of eight orders of magnitude (from 2000 microns [2 millimeters] to 0.00001 microns [0.1 angstroms]). From this table one can see, for instance, that those particles that can just pass through a 200-mesh sieve are about 75 microns in diameter, which is roughly the size of the particles of very fine sand or pastry flour. One can also see that these particles are considerably larger (by more than an order of magnitude) than what are called clay-sized particles, which are 2 microns or smaller.[4]

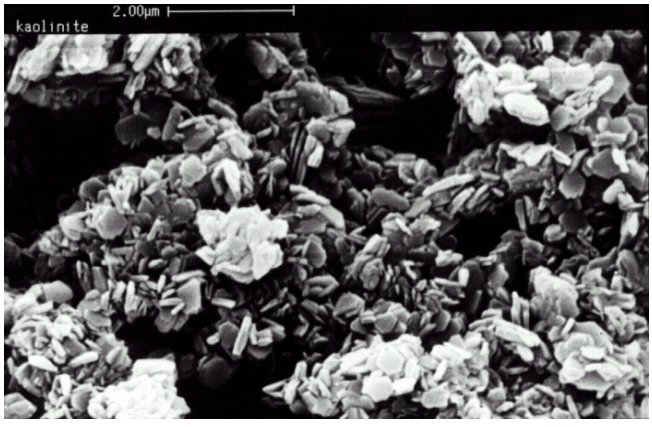
On the basis of *size*, therefore, it is certainly not possible to say that 200-mesh silica or quartz powder is "clay-like," as Lisle does in his article. He makes the argument, however, that 200-mesh silica powder "has lost its crystalline structure and is amorphous," and that

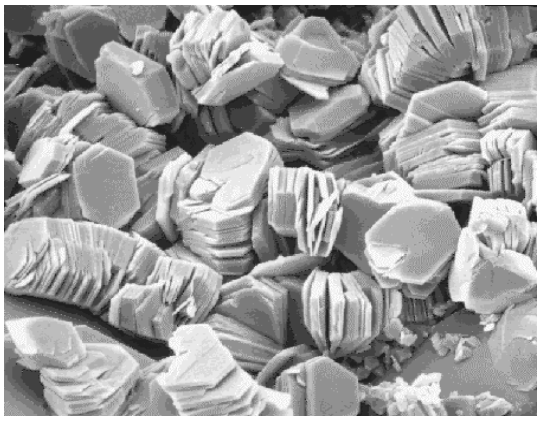
TABLE 1 Selected Particle Size Equivalents

US Standard Mesh Size	Maximum Particle Diameter (microns [= micrometers])	USDA Soil Particle Size Classification	Approximate Common Size Equivalents (*and Resolution Limits*)
10	2000 (= 2 millimeters)	very coarse sand	millet seeds
18	1000 (= 1 millimeter)	coarse sand	poppy seeds
35	500	medium sand	business card thickness
60	250	fine sand	*human vision limit;*
100	150		fine spray droplets
----	100	very fine sand	bread flour particles;
170	90		office paper thickness
200	75		pastry flour particles;
230	63		potato starch granules
----	50	silt	lycopodium powder;
325	45		fog droplets
----	10		human red blood cells
----	2	clay	E. coli bacteria
----	0.1		*light microscope limit*
----	0.01 (= 10 nanometers)		polio virus
----	0.001 (= 1 nanometer)		DNA helix diameter
----	0.0001 (= 1 angstrom)		small molecules; *electron microscope limit*
----	0.00001 (= 0.1 angstroms)		atoms; *x-ray diffraction limit*

amorphous silica is clay-like because "clays are amorphous." This is a very peculiar argument, if only because since at least the 1940s it has been widely accepted that most natural clay minerals are in fact crystalline, although the individual clay crystals are always microscopic (see Figs. 1a & 1b). Lisle does not mention this at all and yet quotes from a book by C. Edmund Marshall in which the view that clays are crystalline is clearly endorsed.[5] Indeed, this view is implicit in the very passage that he quotes from this book. When Marshall wrote that "the constitution and properties of the amorphous products [of grinding] are quite distinct from those of the original minerals," he was not talking about grinding *silica* but rather about grinding *clay*. This is apparent from his next sentence, which Lisle does *not* quote: "Thus, few conclusions regarding the [original] constitution of the clays can legitimately be drawn from [x-ray diffraction] experiments on the ground products."[6] Lisle thus misuses Marshall's remarks about grinding clay crystals (of less than 2 microns) to support his own ideas about grinding silica crystals down to 75 microns (200 mesh).

The fact that 75-micron silica particles are at least an order of magnitude larger than either clay crystals or their ground products turns out to be quite significant. In a recent technical review of the effects of





Figs. 1a & 1b. Scanning electron micrographs of kaolinite clay crystals (scale bar in Fig. 1a = 2 microns)

grinding quartz, Deane K. Smith explains that researchers have consistently found a correlation between the particle size of the ground products and their degree of crystallinity (as measured by the x-ray diffraction response).

> The general interpretation is that quartz particles develop an x-ray amorphous layer on the surface, and as the particles become smaller, the volume of the amorphous fraction becomes a larger fraction of the total particle volume. Only the crystalline volume contributes to the diffracted peaks, so the [diffracted] intensity response versus weight of sample becomes proportionally smaller [as the particles become smaller]. . . . The [amorphous surface] layer is estimated to be 0.03 microns thick, and for particles 2 microns or less in diameter, the diffracted intensity is appreciably diminished.[7]

In other words, ground quartz particles remain mostly crystalline until they are reduced to about 2 microns in diameter, and only below this "threshold" does the amorphous surface layer begin to become dominant. this means that, if the amorphous surface layer remains 0.03 microns thick, then all regularly shaped particles half this size (0.06 microns) should be fully amorphous (because the surface layers from either side of the particle will have met in the middle), while the irregularly shaped particles should be fully amorphous at slightly larger sizes. Conversely, however, Lisle's 75-micron particles will still be almost 100% crystalline.

Lastly, besides affecting the size and structure of the particles, grinding also increases their *surface-to-volume ratio*. When a crystal is broken into ever smaller pieces, its total volume remains the same, but its total surface area greatly increases. For example, if we assume for simplicity's sake that the crystal is a 1-millimeter cube with a surface area of 6 square millimeters (1 mm x 1 mm x 6 sides), then if it is subdivided into eight ½-millimeter cubes (see Fig. 2), each of these cubes will have one *eighth* of the original volume, but each will still have a surface area of 1½ square millimeters (½ mm x ½ mm x 6 sides), i.e., one *quarter* of the original 6 square millimeters. In short, by subdividing the original cube, the volume of the smaller cubes diminishes faster than does their surface area. Hence their surface-to-volume ratio increases; it doubles from 6 (6:1) to 12 (1½:1/8). If we plot this trend on a graph, we can see that when the subdivided particles get smaller than about 1 micron, their surface-to-volume ratio starts to skyrocket (Fig. 3).

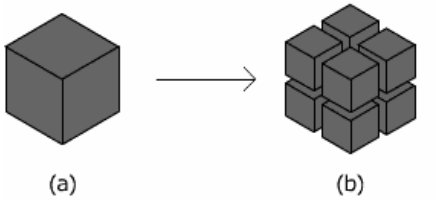


Fig. 2 Subdividing a Cube

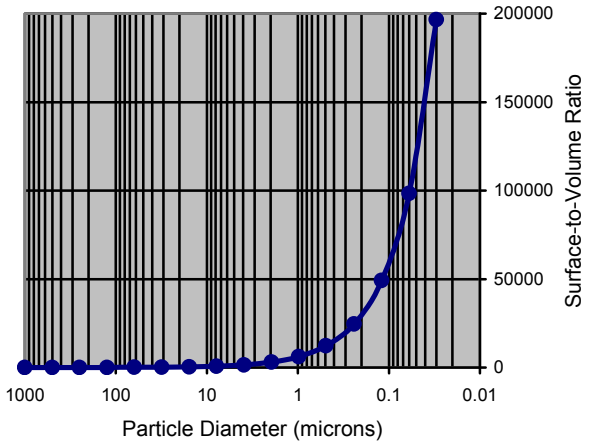


Fig. 3 Relation of Particle Size and Surface-to-Volume Ratio

The surface-to-volume ratio of a particle expresses its relationship to its environment. Through its volume, which is proportional to its mass, it is related to the force of gravity. Through its surface it is related to the forces of its surroundings. A pebble sinks in a lake because it is denser than the surrounding water, but the *rate* at which it sinks is determined not only by the viscosity of the water but by its own surface-to-volume or surface-to-mass ratio. Smaller pebbles or particles sink more slowly than larger ones because they have proportionally larger surface areas; there is proportionally more "drag" between their surface and the surrounding water. With very small particles the drag becomes great enough and the mass small enough that the particles stay in suspension for years if not centuries. For quartz particles in water, this happens when they are reduced to about 0.1 microns.[8] Such particles, however, lose their identity as separate particles and instead become one with the surrounding medium; together the particles and the water form what is known as a *colloid* or *colloidal suspension.* In this fashion the quartz particles overcome their solidity and become like fluids. Unlike solids, however, fluids are not subject solely to the physical forces of the earth, according to Steiner, but are also influenced by the etheric forces that emanate from the planets.[9] For quartz in relation to water, therefore, 0.1 microns represents another threshold. Whereas the 2-micron

threshold concerns the inner structure of the particles, the 0.1-micron threshold concerns the particles' relation to their environment.

3. Steiner's Instructions for Grinding Crystalline Materials

Having examined the effects of grinding crystalline materials, we will now review the practical instructions that Steiner gave for doing such grinding. In the fourth lecture of the Agriculture Course, Steiner's instructions for making the horn silica preparation were very concise:

> Once again one takes cow horns, but this time, instead of filling them with manure, fill them with quartz or silica—or also feldspar (orthoclase)—that has been ground to the fineness of flour. Make this into a paste that has the consistency of a very thin dough and fill the cow horn with this.[10]

Here we may note that in addition to the somewhat vague word "flour," Steiner also refers here to a "paste" and "dough." What are these really? They are not merely mixtures of solids and liquids, but are mixtures in which the solids *remain* suspended; they are, in short, *colloidal* suspensions. If the silica (or orthoclase) were in this condition, it would, presumably, be more receptive to the etheric forces of the planets during the time the horn was subsequently buried in the earth. There is also a hint that Steiner expected the silica still to be in colloidal condition when it was later stirred in water and sprayed out. In response to a general question about stirring and spraying, Steiner emphasized the necessity of stirring vigorously (for an hour) in order to achieve an "intimate permeation" between the water and "*any kind of thickened substance*" (emphasis added). This description could certainly apply to a thin colloidal paste of silica as well as to the thick colloidal mass of the horn manure preparation ("500").[11]

Making the silica into a colloid already implies that the silica must be very finely ground, but Steiner also made this explicit the next day in response to the question: "How does one grind quartz and silica? In a small mill, or with a mortar and pestle?" Steiner replied:

> In this case it's best to do it first in a mortar—you will need an iron pestle for this—and in the mortar grind it to a very thin flour. With quartz you will first need to grind it as far as possible with the mortar and pestle, and then also grind it further on a glass plate, for it has to be a very fine flour, and with quartz this is very difficult to achieve.[12]

Thus, in Steiner's instructions for making the horn silica preparation, there is no suggestion that the silica should not be ground beyond a certain point. Similarly, there seems to be no other evidence from Steiner's life and work that he ever recognized such a limit (Lisle certainly does not cite any). Quite to the contrary, what other evidence is available only reinforces the idea that Steiner believed that the more finely the silica were ground, the better it would be for the preparation. Consider, for instance, the instructions Steiner gave many years prior to the Agriculture Course for grinding paint pigments.

Steiner was concerned not only about the quality of our earthly food but also about the quality of the colors we surround ourselves with in our buildings. Up until about the middle of the nineteenth century, all the pigments used by artists and house painters were derived from natural minerals, plants or even animals. By the beginning of the twentieth century, however, these pigments had been almost entirely supplanted by synthetic pigments derived from coal tar or petroleum, which were cheaper to produce and more convenient to use, but whose colors could also be experienced as being much "colder" and "harder." In 1911 Steiner began encouraging and helping certain painters and chemists to develop a more living palette of colors, namely, a palette of colors derived solely from plants, which would be luminous, translucent and also lightfast. In 1912 a research and production laboratory was started for this purpose. The basic manufacturing procedure was to extract a pigment from a suitable plant, precipitate this liquid extract with a mineral substance and then dry and grind the precipitated crystalline aggregates into a fine powder. The final paint was made by mulling the pigment powder with a binder consisting of an emulsion of various oils, resins and waxes. ("Mulling" is a combination of grinding and mixing performed with a circular motion using a pestle or "muller" on a slab. This circular motion causes shearing and smearing as well as crushing and thus allows each particle of the powder to become surrounded by and suspended in the liquid binder.)[13]

What is of particular interest here are Steiner's specific instructions regarding the grinding and mulling. It is reported that Steiner reluctantly allowed the initial coarse grinding to be done mechanically, but insisted that the final mulling be done by hand. Furthermore, in some cases he stipulated that the mulling had to be done in bright sunshine and for up to 100 hours![14] This stipulation was understood to be part of a long

tradition; one of the painters commented, "Already the old masters placed great emphasis on grinding the pigments as long as possible, because in this way the luminosity of the colors can be considerably enhanced."[15] A further explanation for the extensive grinding was offered by one of the chemists working on the development of the pigments.

> It was necessary to obtain the colors from the plant, yet in the process of extracting them, to lose as little as possible of the plant's etheric forces, and to restore, by means of the preparatory steps (the grinding, etc.), the quantum of etheric forces that was lost in the extraction.[16]

It is not known exactly what particle fineness was achieved after the many hours of mulling, but it is commonly accepted that the particle size for oil-paint pigments should be less than 10 microns, and some watercolor pigments are even ground to 0.01 microns.[17] Interestingly enough, pigments tend to become most *opaque* (reflective) when their particle size is around 0.3 microns, but if the particles are further reduced in size they become increasingly *translucent* and ultimately (below 0.01 microns) become *transparent* to visible light.[18] Since Steiner as well as the old masters wanted their pigments to have a translucent quality, it is likely that they were in fact trying to reduce the pigment particle size considerably below 0.3 microns.

Achieving submicron fineness with quartz is more difficult than with most pigments because of its greater hardness and toughness.[19] Steiner acknowledged that grinding quartz finely enough for the horn silica preparation "would be very difficult to achieve," but as the above history shows, he did not shrink from requiring many hours of hand grinding and he reckoned with very small particle sizes.[20] At the same time, however, it appears from the foregoing that he had in mind a slightly different—and probably more effective—grinding procedure than the one usually followed in biodynamic circles. Steiner's instruction to do the final grinding of the quartz on a glass plate is usually understood to mean a "dry" grinding, while his other instruction to make the quartz flour into a "paste" is usually taken to mean adding water to the finished flour in order to facilitate the process of filling the horn.[21] In reality, however, both of these instructions may well refer to the same process, namely, wet grinding or mulling. On the one hand, in order to make a true colloidal paste, the flour and the water cannot just be stirred together, they must be *mulled* in order to break up the aggregates and properly disperse the particles. On the other hand, mulling is also a form of grinding, and wet grinding is in fact easier than dry grinding because the liquid acts as a lubricant. Wet grinding is also safer because it controls the dust, which in the case of quartz is especially hazardous to inhale. (Further details about grinding techniques will be discussed in Section 6.)

4. The Significance of Chaos

In the area of medicine, Steiner again emphasized the necessity of transforming quartz and other silicates by means of "splitting, dividing and grinding,"[22] and he also gave some important hints as to the significance of these procedures. For example, in a medical lecture given shortly before the Agriculture Course, he drew a parallel between the "chaos" that can come from pulverizing quartz and the "chaos" that he said naturally arises during seed formation in plants.

> Take a quartz crystal. It is an earthly thing. Well, why is it an earthly thing? The quartz crystal is something that pedantically holds on to its form. The quartz has its form through its inner force; and if you take a hammer and break it up, the single pieces still retain the tendency to be six-sided prisms, capped by six-sided pyramids. This tendency exists. . . . The quartz does not allow itself to be taken so far that the cosmos can do something with its forces. Therefore the quartz does not live. [But] if the quartz were to be pulverized to such an extent that the pieces no longer had the tendency for each piece to follow its own forces, then something living and cosmic would grow out of the quartz. That is what happens in seed formation. There matter is driven so far into chaos that the etheric forces of the cosmos can intervene. One must regard the world as a continuous process of coming into chaos and then coming out of chaos. The quartz crystal also once emerged from the cosmos, but it has become stationary . . . it no longer exposes itself to the cosmic forces. However, as soon as it enters the living realm, it must always pass again through chaos.[23]

What Steiner means by quartz emerging from the cosmos becomes clear when one recalls that in his basic works he described the evolution of the earth as consisting of great periods of alternating condensation and spiritualization. During the periods of spiritualization, the whole material manifestation of the earth is raised to a condition of pure warmth or chaos, while during the periods of condensation the material earth

essentially precipitates out of the warmth and becomes ever more differentiated.[24] In addition, Steiner said specifically that the earth's quartz and other silicious minerals were formerly in a more fluid and waxy condition and were in a certain way actually united with the ancestors of today's plant kingdom. At that time there was a single mineral-plant kingdom that shared a common life. When in the course of evolution this kingdom split in two, the physical-material forces became concentrated in the present mineral kingdom, while the etheric life forces became concentrated in what we now know as the plant kingdom. Thus, although the mineral kingdom today is largely crystallized and lifeless, it was alive and chaotic in the distant past and will again be so in the distant future.[25]

Moreover, what the whole mineral kingdom has experienced in the past, or will experience in the future, also takes place in miniature whenever crystalline minerals are ingested by living beings—be they plant, animal or human. In these beings the minerals are at least to some degree "chaoticized" so that the spirit of each being can then work from within the minerals to congeal or precipitate them appropriately for that being's physical organism.[26] In a similar way, forces of the past or of the future are brought into the present when a mineral is properly made into a remedy.[27]

Pulverizing quartz, therefore, is a way of bringing it back into a condition where it can again be enlivened by the etheric forces from the cosmos, as well as by the spiritual forces that work within these etheric forces. Although Steiner did not make this point so explicitly in the Agriculture Course, he did declare in the second lecture, after again describing the chaos of the seed:

> If ever we want the forces of the cosmos to take effect within earthly substance, then it is necessary that we drive this substance as strongly as possible into chaos. Everywhere where we want to bring the cosmos into effect, we must drive the earthly as strongly as possible into chaos.[28]

When the cosmos takes effect, however, it cannot leave the earthly substance unchanged. The etheric and spiritual forces of the cosmos act to overcome the earthly chaos and to create a new whole, within which they are then anchored. Hence the final substance of a successfully made medical or agricultural preparation will not be the same as the original substance. In another medical lecture, Steiner illustrates this principle with silica:

> Although silica is not often used in modern medicine, it is used. But in doing so, one thinks only of what the chemist has in mind, namely, this compound of silicon and oxygen, SiO_2. This is all that one has in mind. In truth, however, when one dispenses silica, one is dispensing an outer material substance that does not hold together the spirit but rather only allows it to pass through itself. One must know this. If one offers silica to a human being as a [true] remedy, one must shape the preparation in such a way that the spirit becomes seated in it in the proper way.[29]

In the course of making a silica preparation, the relation of the spirit to the silica must change, and in doing so the physical silica changes as well. The original silica is transparent to the spirit because it is crystalline; the spirit passes through it "like an express train through a local station."[30] The final silica preparation, on the other hand, should have the spiritual forces "seated" within it, and for this very reason it cannot be crystalline. The overcoming of the intermediate stage of chaos, therefore, cannot consist merely of a process of recrystallization. The original substance must change in some more fundamental way.

In the agricultural lecture following the one in which he introduced the horn silica preparation, Steiner offered a tantalizing clue as to the nature of this change. He mentioned in passing that in a living organism there is a process whereby "silicon . . . is transmuted into an extremely important substance, one which is currently not counted at all among the chemical elements."[31] Although he made this remark in connection with one of the compost preparations (dandelion), it is likely that this transmutation takes place in many living organisms and it is quite conceivable that Steiner also expected such a process to take place in the buried horn silica, for he regarded the soil as a living organ within the organism of the farm.[32] Biological transmutations involving silicon have been described by Kervran, but no such process has been documented in either the dandelion or the horn silica preparation.[33] At least in the case of the horn silica, however, it seems evident that unless we properly transform the silica's form—i.e., pulverize the silica crystals to chaos—there is little likelihood of our ever discovering that the spirit has subsequently transformed the silica's substance.

5. Steiner's High Expectations

Whatever the exact nature of the transformation undergone by the silica in the horn may be, Steiner certainly expected a lot from the resulting substance. In fact, he apparently expected it to be more powerful than the horn

manure preparation, for when he introduced these preparations in the fourth lecture of the Agriculture Course, he first instructed the farmers to use one hornful of horn manure for about a third of an acre, but with the horn silica he stated:

> In this case . . . you will need much smaller quantities; you can take a portion the size of a pea, or perhaps only as big as a pinhead, and disperse it by stirring it into a bucket of water. This too needs to be stirred for an hour.

He then described how to use the horn silica and how he expected it to act upon the plants:

> If you use this to spray the plants themselves—it will prove its value especially with vegetables and the like ... you will see how its effect complements and supports the influence coming from the other side, from the soil, as a result of the cow-horn manure. And if you were to extend this also to entire fields, which would not be a bad thing at all—it shouldn't be too difficult to construct machines that will apply to a whole field the very light spraying that is needed—you would then see how the cow-horn manure pushes from below and how the other stuff [the horn silica] pulls from above, neither too strongly nor too gently. Particularly with grain crops it could be wonderfully effective.

What effect did he expect this "pulling from above" would have? Here one needs to recall that Steiner mentioned already in the first lecture of the Agriculture Course that silica is found not only in quartz and other rocks but is also present "in extremely fine dilution in the atmosphere." In that lecture he further indicated that silica is related to the ability of plants to grow in girth and become trees, as well as to their ability to serve as nourishment for animals and human beings. Then in the second lecture he affirmed that part of the "ABC of judging plant growth" is to know how to adjust the composition of the soil so that the ethers, which enter the soil via the silicious rocks, are either held back in the roots and leaves, or are "sucked up into the flowers, giving them color, or into the fruits [especially tree fruits], permeating them with fine flavor." The force that "sucks up" these ethers into the flowers and fruits is evidently the "pulling" force that Steiner expected from the horn silica spray. He evidently expected this spray to complement the effect of the silica in the soil and to reinforce the effect of the silica already in the atmosphere and thus play a central role in ensuring the kind of nourishment that is needed by human beings today.[34]

Steiner, in short, had some very high expectations for a light spraying of a pea-sized or pinhead-sized portion of the horn silica preparation. Such expectations would not be reasonable, however, unless he had also expected the silica in the horn to have undergone a very fundamental transformation. The elemental transmutation mentioned in the previous section may seem radical, but it is consistent with Steiner's level of expectation for the final preparation.

Steiner also had high expectations for his audience; he offered a conceptual framework for understanding the preparations and expected his audience to try to grasp the processes rationally.

> Nowadays we do everything by trial and error and do not penetrate rationally into the process. But this is now the fundamental condition that must re-emerge if we hope at all to continue working on the earth.[35]

Within the framework that he offered, the transmutation of silica appears plausible, but it is plausible only if the silica is initially ground to the point of chaos (amorphousness). If it is claimed that the horn silica preparation is best made with coarsely ground silica, or even with unground silica, then we have no conceptual framework—at least not from Steiner or from Lisle—for understanding how spending a few months in a buried horn could transform this coarse material into something capable of what Steiner expected of it. Any transformation that did take place could only be regarded as miraculous. Steiner, however, was not interested in miracles, he was interested in encouraging *insight*, because this is the basis for human *freedom*. He would not have introduced the practical preparations without the conceptual framework needed for comprehending them. This does not mean that he always spelled things out—quite the contrary—but it does mean that he expected his audience to look for and to find connections between what he offered as the preparations and the conceptual framework of anthroposophy.

Nevertheless, it is always desirable to confirm or correct our rational considerations by means of empirical data. The empirical investigations that Lisle undertook, therefore, are to be welcomed insofar as they are sound. The experiments mentioned in his 1985 article seem promising and it is only disappointing that he has never published any details about them. On the other hand, his recent experiments are much more curious and have some serious design flaws. Inasmuch as Lisle associates properly made horn silica with the sun, he

seems to share Steiner's expectation regarding the effect of this preparation on plants. If so, then in order to demonstrate the superiority of using one rather than another type of horn silica in biodynamic agriculture, one would expect that his experimental design would (a) involve plants, and (b) involve applying the horn silica to the plants in much the way that Steiner originally described. But, sadly, only *one* of Lisle's three recent experiments involved a plant, and *none* of them involved using horn silica samples that were actually stirred in water and sprayed out. In the experiment involving the plant (a pear tree), each sample of horn silica to be tested was merely placed on a branch (probably still in its zip-lock shipping bag). (Lisle also does not make clear how the parameter he chose to measure here—the strength of the tree's "aura" as revealed through his dowsing—relates to any physical parameter or to anything mentioned by Steiner.) In the other two experiments—one to test the effect of horn silica on a person's muscle strength, the other to test the effect on a person's "iron dowsing ability"—the (bagged?) horn silica was simply held in the hand or placed in a shirt pocket. Lisle makes no attempt in his article to explain the relevance of these latter experiments to biodynamic agriculture. Furthermore, it should be noted that the samples tested by Lisle did not include any in which the median particle size was below the 2-micron threshold identified in Section 2, let alone below the 0.1-micron threshold. (The "stock 501" from JPI that Lisle used consists of a blend of three commercially available silica powders with median particle sizes of 75, 45 and 10 microns, which has not undergone any further grinding.)

6. Practical Aspects of Making the Horn Silica Preparation

It may now be accepted that the real question about making the horn silica preparation is not *whether* to grind it finely but *how best* to do so. This is a real question and in the following I can offer only a few suggestions and perspectives.

As far as the starting material is concerned, it is beyond the scope of this article to discuss the relative merits of using quartz or orthoclase or any of the numerous varieties of these minerals. Some people choose to use gem quality crystals to make horn silica, but this seems wasteful and is not something that Steiner ever stipulated. (Nor did he place any emphasis on the transparency of the crystal; in fact, he specifically mentioned that even though smoky quartz is not transparent to light, it is still perfectly transparent to the spirit.[36]) On the other hand, there are other people who choose to start with natural quartz sand. This does not seem problematic in itself, but one cannot assume that all "sand" is quartz—any mineral can be weathered until it becomes "sand."

As regards the condition or form of the starting materials, there is an important point to be made. Because reducing silica crystals to amorphousness has been emphasized here, it might seem easiest simply to start out with silica that is already in an amorphous condition (e.g., some form of opal or diatomaceous earth, or even some man-made silica product). These forms of silica are much softer than crystalline silica and would be much easier to grind, but the reason Steiner did not suggest this himself seems to be because what he was specifically interested in capturing in the preparation was the *process* of overcoming the crystallinity through *grinding*. In connection with the medical remedies that he developed, Steiner explained:

> What is especially important with these remedies is that we wish to heal not through substances but through processes. We produce remedies in the hope—and of course these things have been verified—that the processes we carry out through having understood the connection between nature and man will in a way be preserved in the preparation and then released in the human organism as a healing process. That is what is essentially new in these things of ours. We wish to heal through processes, through how the remedies are prepared.[37]

In the case of the horn silica preparation, the important processes seem to be (1) the overcoming of the initial crystallinity through grinding, and (2) the overcoming of the subsequent chaos (as discussed in Section 4). Since the latter process occurs while the silica is in the horn and is largely outside our control, we will focus on the process of overcoming the crystallinity through grinding.[38]

Although Steiner mentioned using an iron mortar and pestle for the initial crushing of the silica or quartz crystals, an ordinary bowl-shaped mortar easily allows chips and dust to escape. More efficient crushing can be done in a mortar made from a short, upright iron pipe welded to a base plate with a solid iron rod as a pestle or ram. A flexible cloth sleeve around the rod and the pipe will help contain the silica dust, but some of it will inevitably escape, at the latest when the pipe is emptied. Therefore, whenever working with *dry* silica, *it is highly advisable to wear a tight-fitting, half-mask respirator*

(not a disposable dust mask) with a clean filter.[39] Fine crystalline silica dust, especially freshly fractured dust, poses a serious, non-reversible respiratory hazard (pneumoconiosis or silicosis) because the particles cannot be dissolved by the body and therefore cause chronic lung inflammations. Consider also using a strong fan with a filter (at least a wet cloth) to collect the airborne dust so that it does not endanger other people or animals in the vicinity. Alternatively, consider putting water in the mortar along with the crystals. The water will not interfere with the crushing or with the subsequent sieving and grinding, and if deemed necessary any rust can be removed with a magnet.

After most of the material in the mortar is reduced to a coarse sand, a fine sieve is useful for separating out the fine sand fraction, which is now ready to be ground on a glass plate; the remainder can be returned to the mortar for further crushing. In Section 3 it was suggested that wet grinding or mulling on a glass plate is easier and safer than dry grinding and that this wet method may in fact have been what Steiner intended for the horn silica preparation. With this wet method, however, one cannot use a second glass plate as a mulling instrument (as is commonly done in dry grinding) because the thin layer of liquid tends to create a seal that immobilizes the two plates. To prevent this, the mulling instrument should have a convex grinding surface (for instance, a thick glass bottle held sideways). As the paste spreads out on the plate it will quickly dry out, so a spatula and a spray bottle with water are needed to move it around and keep it moist.

A natural concomitant or extension of this wet grinding technique is to use water to suspend the smallest particles and separate them from the larger, heavier ones. For this the mulled paste is scraped into a wide-mouthed glass jar with some added water, the lid tightened and the jar then vigorously shaken. If the water depth is about 12½ centimeters (1/8 of a meter), all of the particles larger than about 1 micron will settle out in about one day (see note 8) and the liquid will probably appear clear. However, if a thin beam of light is shone sideways through the jar, any fine particles still in suspension will reflect the light and thus become visible (the so-called "Tyndall effect"). If such are visible, the suspension is drawn off with a pipette and transferred to a dish or pan to evaporate the water and concentrate the fine silica particles. In the meantime the larger particles that have settled out in the jar are returned to the mulling plate and the mulling and water-separating steps are repeated until a sufficient quantity of colloidal silica paste is accumulated.[40]

Since the steps just outlined are certainly tedious and time-consuming, especially when one is trying to make enough silica paste to fill a horn, the question naturally arises: what if one doesn't need a whole hornful? Depending on the size of the horn and the size of the portion, a hornful of horn silica could be enough for hundreds, if not thousands, of acres. Is there any way to make a smaller batch of horn silica? It was possibly in response to this sort of question that Steiner later suggested an alternative procedure for making this preparation. As reported by Ehrenfried Pfeiffer:

> For the horn silica preparation Dr. Steiner said it would also suffice to fill the horn with a bean-sized piece of quartz that had been mixed and kneaded together with soil from the field to be sprayed. It would still contain enough silica radiation if a little bit of this were dissolved and stirred.[41]

The indication that the soil should come from the field to be sprayed is somewhat puzzling (did he mean 'farm' instead of 'field'?), but it is interesting that the word "kneaded" is used here. This reminds us not only of Steiner's original indication about making the silica flour into a "dough" but also implies that the kneaded soil is somewhat moist and that the bean-sized "piece" of quartz actually means a bean-sized *amount* of *pulverized* quartz that can be mixed into the soil. Whereas Steiner originally mentioned using a "pea-sized" portion of the final preparation, the suggestion here is to use a "little bit" of the final quartz-plus-soil mixture. Making this "diluted" preparation requires a very small amount of pulverized quartz and thus again confirms the tremendous potency that Steiner expected the quartz to possess after it had been buried in the horn.

The other obvious question that arises is: what about using machines to do the grinding? Steiner did not comment in the Agriculture Course on this question, but from his comments reported in Section 3 we know that he was not in favor of this as far as pigment grinding was concerned, at least not for the final stages. Most probably he would have regarded mechanical grinding in much the same way that he regarded mechanical stirring, about which he said in the Agriculture Course:

> There is no question that stirring by hand does have a quite different significance than mechanical stirring, though of course someone with a mechanistic worldview would not admit this. Just consider what a huge difference there

> really is: when you stir by hand, all the fine movements of your hand go into the stirring, and quite possibly all kinds of other things too, including the feelings you have as you stir. Of course people nowadays don't think that makes any difference, but in the field of medicine, for instance, the difference is quite noticeable. Believe me, it is really not a matter of indifference whether a certain remedy is prepared by hand or by machine.[42]

It becomes easier to believe Steiner if we recall his remarks quoted earlier about how the remedies are meant to capture *processes*. The quality or spirit of the forces that accomplish the grinding process may be retained by the very fine particles and ultimately conveyed to the plants and to the whole farm. If a machine is used, this might spread a spirit of mechanical *uniformity*, which would simply be counterproductive if at the same time one were trying to cultivate a biodynamic farm *individuality*. Steiner recognized that in modern society farming cannot be done without machines, but he drew the line when it came to "the most intimate processes of nature," among which he included stirring.[43]

On the other hand, it should be noted that even with grinding bread flour, Steiner was not entirely opposed to using a mill. In this connection he is reported to have said:

> In the process of milling, the etheric forces in the grain must in no way be damaged. Milling is not a purely mechanical process but a biological one comparable with baking and cooking. If one grinds purely mechanically the resulting flour has little nutritive value. Milling should be the joint work of elemental beings and such people who can be befriended by good elemental spirits. The mill is a body built by man of water, stone and wood for well-intentioned elemental spirits who will make grain into flour without reducing its life forces. This is why the interior of a mill bears the character of a temple. In contrast to this, in modern mills with turbines, electric motors, and metal construction as well as in roller mills, a quarter or half of the etheric forces, i.e., the food value of the grain, is lost by the violent mechanical milling.[44]

Steiner evidently believed that if the milling process was gentle, and if the mill itself were in a certain way individualized, the etheric forces of the grain would not be lost. A crystal, of course, does not have the same etheric forces that a wheat grain does, so it may be acceptable to initially subject the crystal to violent mechanical grinding, but when the size of the particles approach the 2-micron threshold, they begin to lose their earthly crystalline structure and become open to the cosmic etheric forces. At or before this point, therefore, it would seem prudent to switch to a gentler method of grinding such as hand grinding.

A convenient method of identifying the 2-micron threshold is the "bite test," i.e., when the silica powder or paste no longer feels the least bit gritty between one's teeth. As mentioned earlier, particles around 1 micron in size will stay in suspension for about a day (i.e., settle about 12½ cm). From the perspectives offered in this article, it would seem ideal to try to grind the silica until it is fully amorphous, yet the 0.06-micron degree of fineness mentioned in Section 2 is only an estimate of when this happens, and at these submicron levels it is difficult to know in the moment just how small the particles are that one is grinding (the settling rate is no longer very practical and other methods require specialized instruments). How much further one grinds, therefore, is largely a question of conscience and intuition. This situation, however, may also be regarded as an opportunity—an opportunity to develop the same kind of "personal relationship" with silica as Steiner explicitly recommended be developed with manure.[45] If grinding were actually to become a kind of meditative activity—literally a kind of "mulling over"—one could then harbor real hope that the silica itself might inspire one with the knowledge of when full amorphousness had been achieved.[46]

7. Conclusion

The attempt has been made here to review the scientific facts related to fine grinding and the significance of fine grinding in the light of Rudolf Steiner's indications. In doing this I have been unable to find any evidence to support Harvey Lisle's idea that finely grinding the silica for the horn silica preparation is detrimental and is counter to Steiner's intentions. On the contrary, from my research it appears that Steiner expected an extraordinary degree of fineness. This is certainly difficult to achieve, especially by hand grinding, and Steiner acknowledged this difficulty, but for him difficulty alone was never a reason not to do something. As he remarked in regard to one of the compost preparations, "It is true that stag bladders may be difficult to obtain—but a lot of difficult things get done in this world!"[47]

Rather than being too finely ground, much of the

horn silica produced in America is probably too coarse. This situation is mitigated, however, by the fact that a silica powder with particles of a given *average* diameter will usually have a considerable *range* of particle sizes. Therefore even a relatively coarse sample of horn silica may still contain a sufficient percentage of extremely fine particles to ensure a certain degree of effectiveness. This is particularly likely if the silica has at least been reduced to the 2-micron level where it no longer feels gritty between one's teeth.

On the other hand, it is a matter of concern to hear occasional reports of plants being "burned" by applications of the horn silica spray. This does not seem to correspond to the effect that Steiner expected from the horn silica, namely, that it would "pull from above, neither too strongly nor too gently." Such episodes of burning are usually attributed to an incorrect timing of the spraying, but they may in fact indicate a qualitative problem with the horn silica itself. If the silica is not ground finely enough in the first place, no further transformation will be possible when the silica is buried in the horn. The silica removed from the horn will be no different from what was put into it. Spraying untransformed silica on plants may still have an effect, and this effect may even be desirable at times, but it will not be the effect that Steiner was seeking. At the very least, a properly made horn silica preparation should have a significantly different effect on plants than similarly ground silica that has not undergone burial. This is a basic test for quality that should have been done many times in the history of biodynamics, but I am aware of only one such test—and its results were somewhat ambiguous.[48]

It is to be hoped that the preliminary investigation contained in this article will stimulate serious reflection on the nature of the horn silica preparation and lead to serious support for basic, well-designed research on the methods of producing it.

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Notes

[1] Lisle, Harvey C., "Taking a Hard Look at Our Horn Silica," *Biodynamics #241* (May-June 2002), p. 19ff.

[2] Lisle, Harvey, "Concerning crystals and their use in BD Preparation 501," *Sixteenth Middle America Newsletter* (Nov. 28, 1985), p. 3.

[3] J.W. von Goethe, *Faust*, Part 2, Act 1, line 6256.

[4] The American Society for Testing Materials (ASTM) defines clay particles as being 5 microns or smaller, but the United States Department of Agriculture (USDA) and most other standard-setting organizations set the limit at 2 microns.

[5] C. Edmund Marshall, *The Colloid Chemistry of the Silicate Minerals* (New York 1949).

[6] *Ibid*., p. 98.

[7] Deanne K. Smith, "Evaluation of the Detectability and Quantification of Respirable Crystalline Silica by X-ray Powder Diffraction Methods," *Powder Diffraction Journal*, vol. 12, no. 14, Dec. 1997 (www.osha-slc.gov/SLTC/silicacrystalline/smithdk/samples.html).

[8] According to calculations by G. Degremont (*Water Treatment Handbook* (New York 1991)), a particle with an effective (average) diameter of 1 micron takes about 8 days to settle through 1 meter of water; similarly, a 0.1-micron particle takes about 2 years, a 0.01-micron particle takes about 20 years, and a 0.001-micron particle takes about 200 years. Below 0.001 microns [= 1 nanometer] the particles approach the size of the water molecules and the suspension becomes equivalent to a solution.

[9] *Warmth Course* (Spring Valley 1988; GA 321), lectures of Mar. 2 & 14, 1920. (GA = *Gesamtausgabe* = Complete Edition of Rudolf Steiner's work in German)

[10] *Spiritual Foundations for the Renewal of Agriculture* (Kimberton 1993; GA 327), Lecture Four, June 12, 1924. This and subsequent quotations from Steiner have been freshly translated from the German.

[11] *Spiritual Foundations*, First Discussion, June 12, 1924. Fresh manure is always in a colloidal condition and often retains this character after it has been buried in a cow horn.

[12] *Spiritual Foundations*, Second Discussion, June 13, 1924.

[13] For further details on Steiner's indications for making plant color pigments, see "Herstellung von Malfarben aus Pflanzenstoffen" in *Farbenerkenntnis* (Dornach 1990; GA 291a); and Günter Meier, *Pflanzenfarben für den Maler* (Dornach 1979).

[14] Alexander Strakosch, cited in *Farbenerkenntnis*, p. 417.

[15] Hilde Boos-Hamburger, *Aus Gesprächen mit Rudolf Steiner über Malerei und einige Erinnerungen an die Zeit des ersten Goetheanums* (Basel 1954), cited in *Farbenerkenntnis,* p. 408.

[16] Johann Simon Streicher, cited in *Farbenerkenntnis,* p. 415.

[17] See Kremer Pigmente, "Über Korngrössen" (http://www.kremerpigmente.de/korngroesse.htm); and Bruce MacEvoy, "How Watercolor Paints are Made" (http://www.handprint.com).

[18] See *Particle Size*, Sigrist Photometer AG (http://www.photometer.com/en/abc/abc_059.htm).

[19] It is not clear from the available documentation of Steiner's work with the chemists, exactly which substances (technically known as "lakes") were used to precipitate the adsorbed plant extracts. Traditional lakes included talc, kaolin, alum and chalk, none of which on the Moh's scale of hardness is harder than 4 and none of which has good fracture toughness (resistance to fracture). Quartz, on the other hand, has a hard-

ness of 7 and has good fracture toughness. (Orthoclase is intermediate; it has a hardness of 6 – 6.5 but has poor fracture toughness and is therefore relatively easy to pulverize.)

[20] On one occasion Steiner also spoke of tiny silica crystals in the human brain and specifically said that these were "much less than one ten-thousandth of a millimeter," i.e., much less than 0.1 microns or 100 nanometers (*The Human Being in Body, Soul and Spirit* (Hudson 1989; GA 347), lecture of Aug. 9, 1922).

[21] See, for example, Christian von Wistinghausen, et al., *Anleitung zur Herstellung der Biologisch-Dynamischen Präparate* (2nd ed., Stuttgart 1996), p. 27.

[22] *Introducing Anthroposophical Medicine* (Hudson 1999; GA 312), lecture of Mar. 29, 1920.

[23] *Course for Young Doctors* (Spring Valley 1994; GA 316), lecture of Apr. 21, 1924.

[24] See *Cosmic Memory* (San Francisco 1959; GA 11), chaps. 12-17; and *Occult Science – An Outline* (London 1979; GA 13), chap. 4.

[25] See *Universe, Earth and Man* (London 1987; GA 105), lecture of Aug. 8, 1908; *Cosmic Memory*, chap. 17; *Anthroposophical Spiritual Science and Medicine* (Spring Valley 1991; GA 313), lecture of Apr. 4, 1921; *From Limestone to Lucifer ... Answers to Questions* (London 1999; GA 349), lecture of Feb. 17, 1923; and *Mystery Knowledge and Mystery Centres* (London 1973; GA 232), lecture of Dec. 1, 1923.

[26] With the human being, for instance, Steiner said that everything mineral that is ingested must be dissolved and raised all the way to the level of pure warmth (warmth ether). See *Man as Symphony of the Creative Word* (London 1991; GA 230), lectures of Nov. 9 & 10, 1923. See also Steiner and Ita Wegman, *Fundamentals of Therapy* (London 1983; GA 27), chap. 12.

[27] *From Limestone to Lucifer*, lecture of Feb. 17, 1923.

[28] *Spiritual Foundations*, Lecture Two, June 10, 1924.

[29] *The Healing Process: Spirit, Nature and Our Bodies* (Hudson 2000; GA 319), lecture of Aug. 28, 1924.

[30] Ibid.

[31] *Spiritual Foundations*, Lecture Five, June 13, 1924.

[32] "[T]he soil functions as a kind of organ within the organism that reveals itself wherever in nature there is growth. The soil is a real organ, an organ we might want to compare to the human diaphragm" (*Spiritual Foundations*, Lecture Two, June 10, 1924).

[33] Louis C. Kervran, *Biological Transmutations* (Binghamton 1972). Nikolaus Remer refers to a "peculiar decrease in silica" when the dandelion preparation is made, but does not give full details of the analysis and does not claim that the decrease is due to transmutation (*Organic Manure* (Chestnut Ridge 1996), chap. 5).

[34] "Nutrition as it is today does not supply the strength necessary for manifesting the spirit in physical life. A bridge can no longer be built from thinking to will and action. Food plants no longer contain the forces people need for this" (*Spiritual Foundations*, Appendix C, private comment to Ehrenfried Pfeiffer).

[35] *Spiritual Foundations*, Lecture Two, June 10, 1924.

[36] *The Healing Process*, lecture of Aug. 28, 1924.

[37] *The Healing Process*, lecture of Sept. 2, 1923.

[38] It is also possible to overcome the crystallinity of quartz through certain chemical processes, but Steiner distinguished between the chemical and mechanical dissolution of silica (*Introducing Anthroposophical Medicine* (Hudson 1999), lecture of Apr. 4, 1920) and always spoke only of the latter in connection with the medical and agricultural silica preparations.

[39] Filters approved by NIOSH (the National Institute of Occupational Safety and Health) catch particles larger than 0.3 microns at three levels of efficiency: 95%, 99% or 100% (99.97%). The last level is also called a HEPA (High Efficiency Particulate Air) filter. The letters N, R or P stamped on newer filters refer to their resistance to oil aerosols, which is not a concern with silica dust.

[40] An easier but more expensive possibility might be to concentrate the colloidal particles with a cross-flow ultrafiltration system.

[41] *Spiritual Foundations*, Appendix B, Part 5A.

[42] *Spiritual Foundations*, First Discussion, June 12, 1924.

[43] Ibid.

[44] *Rudolf Steiner on Nutrition and Stimulants* (Kimberton 1991), Appendix A.

[45] *Spiritual Foundations*, Lecture Four, June 12, 1924.

[46] This is not as far-fetched as it may sound. In Europe there is a remarkable group of homeopathic physicians and patients who have systematically explored the "resonance" that can arise between a person and a substance that he or she is hand grinding (triturating homeopathically). By following a strict protocol and recording all the private feelings, images and impressions that they experience while grinding a specific substance, they have consistently found that different people will have very similar experiences and that these experiences help reveal the healing potential of that substance. They claim, in fact, to have found a new method of making homeopathic provings. For further information (unfortunately only in German), see http://www.c4-homoeopathie.net/ or http://www.ihhf.de/Webseiten/F-erreibungsresonanz.htm. See also the interview with Edith Dörre in the magazine *Novalis,* February 1997, in which she speaks especially about triturating quartz.

[47] *Spiritual Foundations*, Second Discussion, June 13, 1924.

[48] The Koliskos found that both unburied and buried silica powder stimulated the growth of wheat seedlings to some degree, but, according to their criteria, the buried silica had a somewhat greater "inner" light effect. (See E. & L. Kolisko, *Agriculture of Tomorrow* (Bournemouth 1978), part 2, chap. 8, p. 81.)