EFFECT OF GRINDING ON THE LIME REQUIREMENT OF SOILS.*

By R. C. Cook.

In applying the Veitch method for the determination of soil acidity, a question often arises as to the fineness of the soil sample. Obviously, the use of a fine sieve will make necessary the elimination of a large part of the soil and hence give misleading results when calculated to the acre basis. On the other hand, the use of a sieve with meshes too large may be equally objectionable. If, therefore, the soil might be ground so that a representative sample could be obtained, the problem of getting more dependable results would be greatly simplified.

But in the grinding process a modification of the soil reaction undoubtedly takes place. The effect of this treatment on some Iowa soils has been recently recorded by Brown and Johnson.¹ Certain sandy soils were ground and tested for acidity, with the result that in all cases noted the lime requirement was reduced by grinding. In fact, some soils having a high lime requirement before treatment became basic thereafter. It is interesting to note that the finer the soil was ground the more basic it became, and also that the increase in basicity was roughly proportional to the amount of sand contained.

An explanation of this behavior might possibly lie in the assumption that the portions of the soils designated as "sand" were not sand in the chemical sense, but consisted of particles having a basic internal constitution, the surface of which may have become acid from exposure, or other causes. In this case the grinding, therefore, would be expected to increase the basicity. Since the finer particles of the soils are ordinarily composed of the more easily altered minerals it would not seem advisable to change their constitution more than necessary. There would also be no reason for grinding the fine particles which were already of the required fineness. Consequently, only those portions remaining upon the sieve were used in the grinding. Whether this procedure was followed, or the whole sample ground, is not stated in the work done at the Iowa Station.

If the sandy portions were silica, it appears that grinding would expose a greater portion of the acidic material and accordingly increase the acidity. It seems to be an established fact, as well, that for the same

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¹ Brown, P. E., and Johnson, H. W., The effect of grinding the soil on its reaction as determined by the Veitch method. *In* Jour. Amer. Soc. Agron., v. 7, no. 5, pp. 216-220, 1915.

material, that part which is in the finer state of division will usually manifest greater absorptive power. This physical factor strengthens our reasons for believing that the grinding of quartz sand would raise its "apparent acidity."

To test this point a sample of sand was examined for acidity both before and after grinding. The results recorded below seem to agree fully with the statements just made.

	Pounds CaO required per 3,500,000 pounds sand.
Quartz sand, unground	247.5
Quartz sand, ground to pass 100-mesh sieve	412.5
Increase due to grinding	165.0

Now if grinding free sand should increase its acidity there seems to be no reason why sand in soils (which in most sandy soils of New Jersey consists largely of silica and undecomposed silicates acidic in character) should not behave in a similar manner. With this in mind, a sandy soil was secured, put through a three-millimeter sieve, and that portion remaining on a 40-mesh screen was employed in the next determination. Most of this material was distinctly quartz and feldspathic mineral substance. A part of this was ground to pass an 80-mesh sieve, and the acidity of the ground and unground soil was then determined.

	Pounds CaO required per 3,500,000 pounds soil.
Sandy soil, unground	1320
Sandy soil, ground to pass 80-mesh sieve	1815
Increase due to grinding	495

Since this experiment served to corroborate the observation made with the quartz sand it was decided to test a number of soils to see if some, at least, would not react as indicated above. Samples of six different soils were obtained and prepared for determinations of acidity by passing them through a three-millimeter sieve. The soils were then further sieved through an 80-mesh sieve *and only those portions remaining upon it were ground*. When all was reduced to this fineness the ground material and that previously sieved were thoroughly mixed and the lime requirements of this and of the unground soil were determined.

The grinding was accomplished as before in a porcelain mortar. Any of the porcelain which may have been ground off did not seem to appreciably affect the reaction as determined in a blank. However, the estimation of the blank could not be made absolutely true, inasmuch as more porcelain would be taken off when the soil was being ground than when the mortar and pestle were used alone. It is, therefore, not impossible that a slight error was introduced at this point.

The results of the determinations made in each case are averaged and tabulated below :

POUNDS CaO REQUIRED PER 3,500,000 POUNDS SOIL.

Type	Soil No.1	Soil No.2	Soil No.3	Soil No.4 Soil No.5 Soil No.6		
	Sass. Sandy Loam	Norfolk Sand	Colling- ton Sandy Loam	Sassafrass	Gravelly	Loam
Sieved through 3 mm.	3135	1320	1485	Neutral	2970	3052.5
Sieved through 3 mm. and ground to pass 80-mesh	3630	1650	1732.5	412.5	3630	3217.5
Increase due to grinding	495	330	247.5	412.5	660	165.0

Here again there is shown to be an increase in acidity in all cases due to grinding. In one instance, that of Soil No. 4, a neutral soil became acid by this treatment. The increases observed do not appear to be much larger than could be accounted for by the increased surface of the sand particles, assuming them to be made up largely of silica.

There is some variation in the amounts of increases and it seemed worth while to determine if an approximate mechanical analysis would be of any value in explaining these differences.

MECHANICAL ANALYSIS OF SOILS.

Mesh	Soil No.1	Soil No.2	Soil No.3	Soil No.4	Soil No.5	Soil No.6
	%	%	%	%	%	%
3 mm.-20 meshes per inch	12	0	6	15	17	10
20-40 meshes per inch...	30	2	17	22	30	28
40-80 meshes per inch...	30	46	32	43	30	37
80 and above.....	28	52	45	20	23	25

An examination of this table does not offer much enlightenment upon the behavior observed. However, if we eliminate Soil No. 6, we get a correlation between the amount of acidity increase and the proportion of soil remaining above an 80-mesh sieve. Soils Nos. 2 and 3 then, show the lowest increases and show also the least amount of sand to be ground. Conversely, the largest increases are noted for Soils Nos. 1, 4, and 5, where the percentages of coarse particles are large. No explanation is offered for the slight alteration to Soil No. 6.

That diametrically opposite results were obtained at the Iowa station may point to a very interesting difference in the respective soil types. In no case, however, was the increase in acidity in New Jersey soils nearly as marked as the increase in basicity in Iowa soils, but the grinding has a distinct effect in either instance. Both observations point to the fact that soils should not be ground for acidity determinations.

SUMMARY.

The experiments outlined above tend to indicate that:

1. Soils should not be ground if used for determination of lime requirement by the Veitch method;
2. Grinding sandy soils of New Jersey increases their acidity, instead of decreasing it, according to the method employed.