Hints to Farmers,
on the
Analysis of Soils and manures.

The State agricultural Society, in offering a premium for a Manual on this subject, desired one, of course, which intelligent Farmers can practise. It can be of no advantage, to describe the analysis of organic bodies; since few practical Chemists are familiar with the necessary apparatus; and because all sorts of Crops have been fully analyzed; and the results are widely published, in accurate Tables. Any further researches in this field, may be left, to the few Men of Science, who spend their lives in such pursuits. Nor, could much benefit arise, from the practice of quantitative analysis of Soils, by agriculturists, though a Liebig or a Bunsen were among us; willing to prepare what might be deemed the best possible of all Methods.

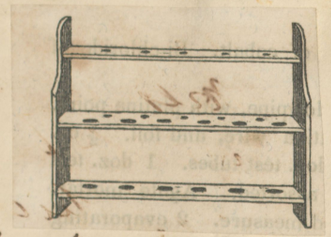
The weights of the respective constituents, which they would obtain, must, necessarily, be far from accurate; unless a costly balance should be employed; and unless such skill should be acquired in its management, as can be reached only by long practice.

It is not probable, moreover, that any two capable Analysts would agree that one particular method *is* the best; the processes being so very various and so numerous; each, in the opinion of some, having its special advantages. Nor, if the Chemist should consent to publish a *model* formula, could the persons for whom it should be designed bring to the work sufficient knowledge of Chemical *Reactions*, and skill in *Manipulation*, to render it available. A reliable quantitative analysis of a single specimen of soil cannot be produced by a member of the Profession, at less expense than from forty to fifty dollars. The present writer does not hesitate to say, that no corresponding benefits are likely to accrue, from such analyses, to justify such an

outlay. It is not ~~many~~ desirable, to make these analyses, at all, even if their cost can be greatly reduced, except in particular instances, of no very common occurrence; and, whenever these are needed, the Farmers are advised to seek professional assistance.

It is proposed, therefore, in this Essay, without pretending to originality, to state what Examinations are indispensable; and to describe methods for making them, which can be used by men of ordinary intelligence.

Persons who undertake this work must receive some practical instruction, before they will be able to perform it successfully; because mere verbal descriptions, aided by Diagrams, cannot guard the Operator against inevitable causes of error. It could only mislead Farmers, as a general thing, to put them upon such practice, without first witnessing and repeating the operations, in the Laboratory. To one however, who has knowledge of Chemistry; a short period spent in this



Tube Rack, Fig 4.
Page 15.

exercise would be a sufficient preparation. It will be necessary, above all things, that the men who undertake it, shall possess habits of exact observation; nice, such and such only, will improve by their experience.

Perhaps the only fact in which well instructed agriculturists are agreed, is, that Lime and Magnesia and Soda, and Potash and Ammonia and Chlorine and Sulphuric & Phosphoric acids, must exist in soils, in sufficient abundance, or they can not be fertile. These are the substances, which it is most important to find; and, fortunately, these are the very substances, which are comparatively easy to be discovered, if they be present, in notable proportions. Both Silica, and Alumina, are nearly certain to be found in every soil, the former, in large amount; but it can be of little use to determine, merely their weight. It is needful to know, in what condition, these two substances exist, or with what Elements they are combined; and, a practicable

Specific Gravity Bottle to contain 1000 Grains of Distilled Water.

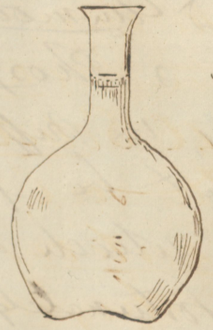


fig. 1

process will be given, for that purpose. Iron, also, belongs to almost every soil; and, provision will be made, to determine the degree of oxidation, in which it may exist; which is of more consequence, than its exact quantity.

Proceeding, then, on the belief that the substances first mentioned above are the primary objects of our search, the general method to be pursued, is that practised in analyzing a Mineral Water of the saline class. A Solution of these constituents in the soil, is prepared; and, then, definite portions of the solution, are treated as if they were waters from the Spring. By using a small flask, of a given size, such as a specific gravity bottle, (Fig. 1.), to measure out the respective portions of the solution, to be subjected to the action of Re-Agents, the Operator can readily discover, whether any one of the necessary ingredients be wanting; and, at the same time, what is the relative amount of those which may be present.

Collection of Specimens.

It is most convenient to cut slices of the soil, sloping, to a depth of twelve inches; and it must be done with a clean spade. Holes should be opened at a dozen spots, in each moderate sized field; and the portions taken from all of them, must be well mixed together, in a clean vessel; when four or five pounds may be taken out, as an average sample. If different kinds of soil occur in the same field, they ought not to enter into this mixture; and in all such cases, a separate sample should be made up, (in the same way), for each distinct class of soil.

The specimens may be gathered, when the fields are in the most suitable condition; and, they should be wrapped, in double papers, or clean bags, when well dried, either in the open air, or by a fire. They should be laid away, accurately labelled, in some place, where they will not be liable to imbibe or to contract impurities. If they are designed to be sent to some distance, for analysis; it is best to put

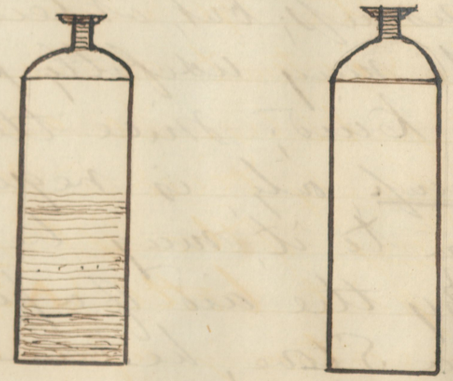
the samples in clean bottles; and to cork them securely.

The farmer is by no means advised to neglect other business; but, at leisure hours, in summer, he may usefully perform much labour of this kind: since the heat of a spirit lamp only is required; and his attention to it may be paid, at intervals. By the aid of a proper sand bath, adapted to a stove, he can easily dispose in Winter, of the specimens that he may have selected, at other seasons, from particular fields, which he wishes to examine. Nor ought Chemistry to feel, that such practice would be an encroachment upon their province. Their business could only be increased, by the more frequent occurrence of difficult cases, which farmers would accumulate, for their determination.

Texture of the Soil.

In preparing a specimen for solution, the attention may be directed to the degree of fineness of its grains, upon which, in a great measure, depends its power

Bottle for Elutriation. Fig. 2d.



A. B.

* Whenever water is mentioned in this Essay, the distilled is always meant; but Rain Water, caught in an open field, about the middle of an ordinary rain, of some length, will answer very well, for some purposes in the Laboratory.

to absorb & to retain moisture. For this purpose, the dry sample may be thrown upon a No. 12 sieve, having 144 meshes in the square inch. This will separate the distinct grains, from the lumps and pebbles. To ascertain the proportion of finely divided matter, one thousand grains of the sifting, may be put into a pint bottle, (A. Fig. 1, 2d) having a flat lip; and containing a few ounces of distilled water. This should stand, with occasional agitation, till the entire mass becomes thoroughly soaked. Then, elutriate the contents, by giving the bottle a rotary motion, till the fine particles are suspended; and, by pouring them off with the water, into a second bottle (B. Fig. 2d) of the same kind, leaving the coarse sand, in the first. Add more water* to the bottle A.; and repeat the elutriation, until all the finely divided matter is removed, to the bottle B.; which, by the repeated additions, will, now, be nearly full; and must be set aside to permit the particles to subside. Next,

wash out the coarse sand, from A. into a dish; dry it thoroughly, and weigh it accurately, when, the weight found, subtracted from 1000 Grains, will give the weight of the finely divided matter in the bottle B. The proportion of this alluvium, should not fall below about 30 or 40 per cent, nor exceed 70 or 80 per cent; because, beyond these limits the soil would be too open, or too close as the case may be.

If the particles of this coarser portion be very unequal in their sizes, a wire-gauze sieve may be used, to separate, half an ounce of the marl, into coarse sand, and fine sand; which should be spread out on separate plates of glass; wet with water, and examined by a microscope. The character of the grains, will be manifest; whether granitic or siliceous, or calcareous, or argillaceous or basaltic or slaty, or of other varieties; and, the principal difference found on an inspection of the two plates, will be, only the larger and smaller sizes of the grains. A drop or two

of acid, may be added to the moist particle; and, if effervescence occurs, it may be supposed that Carbonates are present. If a brown colour is produced by Hydrochloric acid, peroxide of iron, may be inferred; and if the smell of Chlorine be perceived, from the same, it is an indication, that one of the constituents, is Manganese. Any preliminary observations of this sort, ought to be recorded; as they show, beforehand, not unfrequently, of what, the soil is mainly composed.

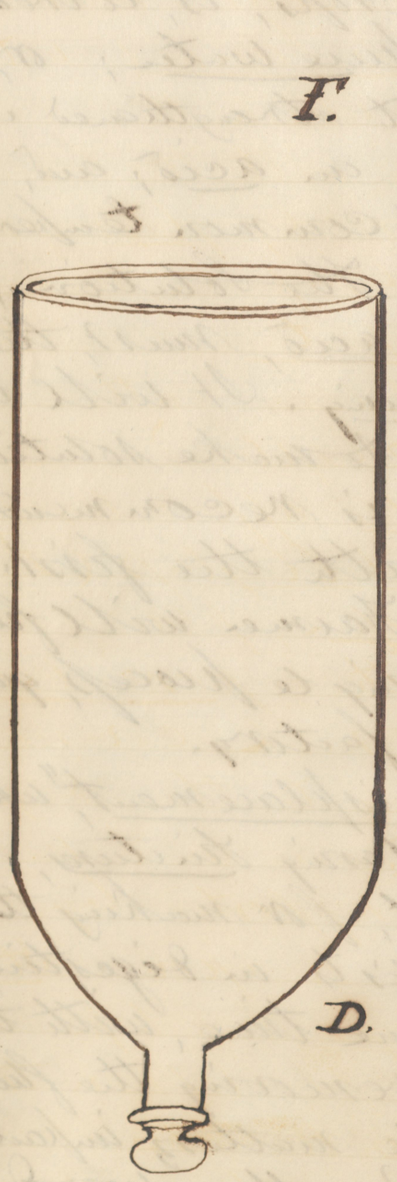
Preparation of Solutions.

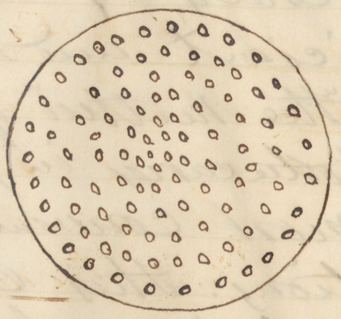
the most rational practice, is, to place the sample, as nearly as possible, in the condition, in which, it is exposed, in the fields, to the Elements. It has, often, been practised, to boil the quantity, in Water, but, Nature does not so conduct her operations. Quite as remote from her work, is a Digestion in strong acids. the ground, is subjected, alternately to rains & snows; to sunshine & darkness; to cold & heat; and, the acids washed from the atmosphere, are only weak dilutions, or,

at most, water slightly acidulated. Hence, the fairest practice, to find what amount of available substance, a soil ordinarily yields for Crops, is, to treat the Specimen with pure water; or, with water somewhat strengthened in its solvent powers, by an acid; and, to continue the action, at common temperatures, for some days. The solution, whether aqueous, or acid, must, then, be removed by filtering. It will be desirable, frequently, to make solutions, of both kinds; but, it is recommended, always, to begin with the first; and, in most cases, the Farmer will find his results, by this single process, quite sufficient and satisfactory.

The method of "displacement" used by Apothecaries in preparing tinctures, is the most convenient, for making the solutions. This consists in digesting the substance, for some time, with the solvent; and then removing the fluid containing the soluble matters, imparted by the operation. In other words,

Figure 3.







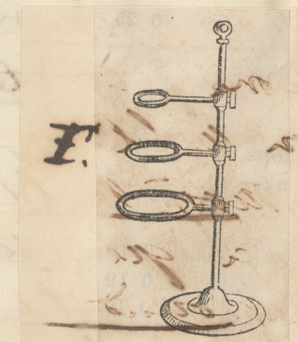


Fig. 3.
Retort Stand with Rings.
Page 12.

pure water, or water with hydrochloric, or nitric acid, is permitted to filter through the entire mass of the specimen. Some may find it convenient to use a capacious glass Funnel, with a ground valve, (Fig. 3. C.), in which the soil may be laid, saturated with the solvent, and kept standing, covered by glass, for a sufficient time, when by opening the valve to the least possible aperture; and by pouring more of the solvent on the surface, the solution will be displaced.

The most suitable apparatus, for a soil, is a quart bell glass, (Fig. 3. D.), having a ground stopper; placed, in an inverted position, with a porcelain Diaphragm (Fig. 3. E.) in its neck, covered by a filter, which adheres to the sides of the Glass all around, and wet with water. It may be supported by a stout glass tumbler, or upon a Stand, (Fig. 3. F.) having iron Rings for such purposes. The lumps of the sample, left on the sieve, should be laid on the filter, first; and then the siftings may be poured on

them; and the Glass gently shaken, to cause the interstices to be closely filled by the finer particles. Distilled water should, then, be poured on the mass, till it is fully saturated; or till drops begin to fall, from the neck below. the ground stopper must, then, be put in its place; a glass plate, laid across the top; and, the whole should stand, in a warm place, for two or three days; one day, in summer being enough, if there be any need of dispatch. the water in the bottle B., may be used, to saturate the sample, as above; if the finely divided matter has subsided so as to admit of pouring it off clear. If the first liquor which is passed, by the displacement or removing the ground stopper, & pouring on more water does not come off clear, it must be caught in the tumbler & returned to the top, before adding fresh portions; and, this must be repeated, again & again if need be till the ~~[illegible]~~ liquor becomes clear. Successive portions, either of distilled

water, or of clean water from the bottle B. may now, be poured on, until a pint of the clean solution has been obtained. When the bottle B. has been emptied, ~~of the water~~ of all the water except a few ounces, a Drachm of pure nitric acid, may be added to it, and it must be set away safely, to be used in a subsequent operation*. The solution obtained may be most conveniently poured for use, into a stock bottle, of the same kind, with A. and B., which is well adapted for accurate pouring into the specific gravity measure, fig. 1. for the following steps of the Analysis.

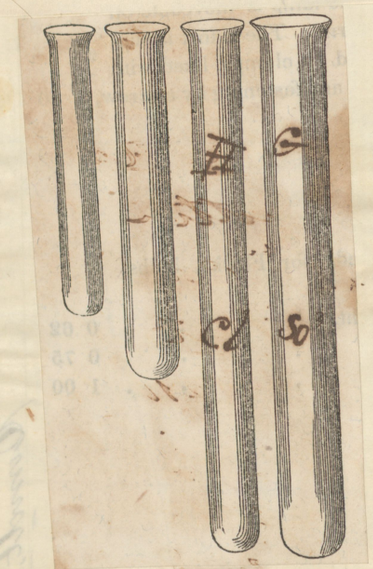
1. Solid contents.

Fill the flask, to the file mark L (a), with the solution, and evaporate it to dryness, on a glass dish, placed upon a cup of boiling water, over a Spirit lamp; and, note the proportion of solid contents remaining on the dish, and the colour. Set the dish away, under cover, for a second operation, to be described below.

* See Note, at the End Page 89.

Figure 4.

Test Tubes. Tube Rack.



Test Tubes
Fig: 4. Page 15.

2d. Sulphuric acid & Chlorine.

Evaporate another measure, as above; adding to it, first, a drop or two of Solution of Carbonate of Soda. Dissolve the contents of the dish, with water; acidulate it with a few drops of Nitric acid; and evaporate, again, to dryness, over a water bath, as before. Then moisten the dry mass, with strong Nitric acid, add about one drachm of water; filter, and pour some of the filtrate into a Test Tube (G.) Fig. 4. containing one or two drops of Solution of Nitrate of Baryta, labelling it (SO^3). and another portion, into another Test Tube (H.) Fig. 4. containing a drop of a solution of Nitrate of Silver, labelled (C2.) — If the test tube Cl. contain a white, curdy precipitate, that becomes dark, on exposure to the Sun, the Soil contains an abundance of Chlorine. If the test tube (SO^3.) exhibit an abundant, heavy, white precipitate; it contains an abundance of Sulphuric acid; and, in that case, it is better to pour off the clear fluid from the precipitate,

and to test it for Chlorine, as in the tube (Cl.)

As nearly the whole of the Soluble Silica will remain in this dish, after the solution in Nitric acid, is poured off, it is well to note its proportion.

3d Lime and Magnesia.

Evaporate a third portion, adding one or two drops of hydrochloric acid. When this portion is reduced, to about one half, remove it from the water bath, cover it, and when cold, add caustic ammonia, (aqua ammoniae), till it smells distinctly. Filter it immediately; and pour the filtrate into a test tube, containing about one grain of oxalic acid, dissolved in a few drops of Water. Note the appearance of a white precipitate, i.e. the Oxalate of Lime.

After a few hours, pour off the clear fluid from the precipitate, or filter it, if necessary, into another test tube, containing a few drops of solution of Phosphate of Ammonia; and a few drops of aqua ammoniae. If a precipitate does not

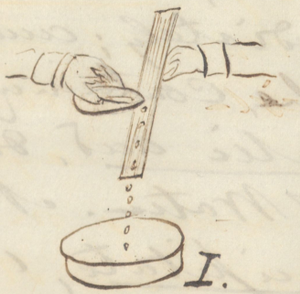


I.

Porcelain Dish.

Fig. 5. 17.

Figure 5.



I.

Pouring off the clear liquor over the surface of a Ribbon of Platina, into an Evaporating Dish.

occur in this test tube; although the fluid restores the blue colour of litmus paper, that has been reddened, by the solution over the Oxalate of Lime, then, Magnesia is deficient in the soil.

4th Soda and Potash.

To the solid residue of the first portion, reserved on the glass dish, above, add a few drops of water; and pour off the clear solution, without disturbing the insoluble part, into a porcelain cap=sule, (I. Figs), by means of a strip of pla=tina, previously moistened in the fluid; and applied at right angles with the edge of the dish, at the point of exit of the fluid. Evaporate the drop of fluid which remains on the platina, slowly; and, then, expose the stain (tache) on the platina, to the blowpipe flame, or to that of a Russian lamp: and, if the flame be bright yellow, note the presence of Soda.

Evaporate to dryness, the few drops of the solution in the porcelain capsule, (I.); and, heat it to low redness. Then,

When nearly cold, add a few drops of water; and pour the Solution upon a glass dish, containing a drop of the Solution of Chloride of Platina; and one drop of Hydrochloric acid. Warm the Solution, for a few moments; or evaporate it, nearly, to dryness; and, then add about one drachm of alcohol. Cover the dish; and, note the appearance, or non-appearance of the beautiful Crystals of Potassio-Chloride of Platina.

5th. Phosphoric acid and Ammonia. Pour two measures of the Solution, by the Specific gravity bottle, into a 4½ inch Berlin porcelain dish; with about 1/4 of an ounce of Solution of Molybdate of Ammonia; and, mark the dish, (PO$_5$); and, evaporate it, as above, over a water bath.

Repeat the same operation, in another dish of the same size; adding to the two measures of the Solution, about half a grain of Molybdic acid, as the re-agent, instead of the Molybdate

of Ammonia; and, mark this dish, (NH_3) — and, evaporate it, in the same way, over the water bath.

Add to each of these dishes, a few drops of Nitric acid, after the contents have been reduced, to about a tea-spoonfull.

Then, cover the two dishes, by inverting over each, a four inch glass funnel; and, reducing the flame of the spirit lamps, to a very small size, digest for three or four hours. Then, note the presence of a beautiful yellow precipitate, or film covering the surface of the fluid; especially, after the addition of a few drops of dilute Nitric acid, to each.

Should no yellow precipitate occur; add to the dish marked NH_3, one drop of the solution of Phosphate of Soda; and, to the other dish, marked PO_5, a few drops of aqua ammoniae. Continue the digestion, as before, 3 or 4 hours. If a yellow precipitate occur, in the dish marked PO_5, the soil contains soluble Phosphates.

If the yellow precipitate, also, occur, in the dish marked, NH_3, the soil contains Ammonia.

Result.

1st. Proportion of alluvium, or true soil.
2d. Amount of substances soluble in pure water.
3d. the presence of SO_3, one constituent of Gypsum.
4th. the presence of Chlorine, one element of Sea Salt.
5th. Proportion of Soluble Silica.
6th. the presence of Lime.
7th. the presence of Magnesia.
8th. the presence of Soda.
9th. the presence of Potash.
10th. the presence of Ammonia.
11th. the presence of Phosphoric Acid.

If any one of these substances be not found, as above; it is an evidence that the next crop may be improved, by an artificial supply; or, in other words, that the disintegration of the soil, is not sufficiently accomplished, to furnish the natural supply. The examination of the coarser particles, at page 10, will have shown,

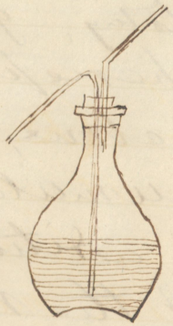
whether felspar, or mica, or other minerals containing alkalies, be present, or not. Indeed, the absence of such minerals would prove, quite as well as quantitative analysis could, that we must not expect a further supply of these substances, by hastening the decomposition of the soil, by soil-burning, liming, or any other means; and, therefore, an artificial supply of any of the number not found, as above, must be applied.

Moreover, in cases where the finely divided matter, which is the true basis of the soil, is yielding, gradually, a small, or an imperceptible proportion of any one of the above, this may be permitted to accumulate, in the soil, by the artificial addition of that particular substance, without the risk attendant upon the liberation of all the salts, that result from the disintegration of the soil, by Lime, &c.; especially in a wet season, when an excess of soluble bases in a soil will as inevitably impair crops, as a deficiency will do it, during a dry one.



Funnel + Filter.
Fig: 6. Page 22.

Figure 6.



L.

This process is what is called a qualitative analysis; but, inasmuch as an Aliquot part of the whole solution, has been used, in each experiment; the results may be considered, in one sense, quantitative, because each thus exhibits the respective amounts derived, from the three or four pounds of the sample; and by an easy calculation, shows what might be expected, from the acre.

Examination of the acid solution.

The coarse sand, left at page 9. i. e. without the part taken for examination by acids, &c., may now be placed in a five inch glass funnel (K. Fig. 6.), having a three inch plain filter fitted to its sides, and wet with water, from the washing bottle (L. Fig 6.) the magma, in the bottle B.; which was reserved, at page 14., may, then, be poured on it; the finely divided matter, in the mean time, having undergone a digestion, in the Nitric acid. Rinse the bottle; and, from the rinsings, also, into the funnel; which, thus, acts

Figure 7.

M.



Precipitating Glass.
Fig. 7. Page 23.

as a "percolator," to pass a clear solution of the properties of the soil. If the fluid be not clear, it must be returned to the funnel, and this must be repeated, if necessary, till a clear liquor is obtained. It may be received in a precipitating glass, (M. Fig 7.), graduated so as to contain 2000 minims. If this measure be not filled, the percolation must be continued, by adding dilute Nitric acid (of one part in ten parts of water), until the 2000 minims are received, or in other words, displaced.

Divide the solution into two parts (a.), and (b.); of 1000 minims, each; and, to the part (a.), add 1000 minims of Water containing one drachm of aqua ammoniae, (Or 9.5); and filter, immediately, whatever may be precipitated.

Next, measure out 1000 minims of this filtrate, (which is supposed to contain all the free alkalies existing in 250 Grains of the soil); and, evaporate it, in a four inch Berlin dish; reducing the flame,

to a minute point, as the evaporation terminates. When reduced to about two drachms, cover it, with a three inch glass funnel; and, then add one drachm of pure Nitric acid. After the effervescence ceases, remove the funnel, and rinse it, (by the washing bottle L.), into the dish, and continue the evaporation, to dryness. Then, heat the dish to low redness. The residuum left on the dish, is composed of all the Lime, & Magnesia, and Potash, and Soda, that have been applied, as manures, to the soil; or that can be depended on, as the available manures, which may result from its oxidation for several years. Elutriation with hot water, will, now, separate these substances, from any Manganese, with which they may have been associated; on filtration through a three inch filter. Carbonate of Ammonia may, now, be added to this filtrate; when, if Lime or Magnesia be present, they will be precipitated; and must be separated, by a second filtration; using,



Platina Capsule.
Fig: 6. Page 25

Porcelain Filter Ring. Platina Capsule.

for this purpose, a filter ring (N. Fig. 8), in both cases. This last filtrate must, then, be evaporated to dryness, in a platina capsule (O. Fig. 8), and, after the Ammonia is expelled, by a low red heat, the alkalies, (Potash & Soda) are converted into Chlorides, and weighed on the balance.

They are, now, to be dissolved in a little water, adding a drop of Hydrochloric acid; and washed into a glass dish; treated with solution of Chloride of Platina; concentrated by evaporation, to a small quantity, over a water bath; and, then, treated with one or two drachms of dilute alcohol. The dish should, then, be covered by another of the same size, or by a glass funnel; and set aside for a few hours: when, if Potash be present, the Potassio-Chloride of Platina will appear. If it be in appreciable quantity, it may be weighed, with great accuracy, on the dish, whose weight is supposed to be known. The supernatant fluid, in the dish, must be poured off, and, the crystals washed with dilute alcohol; and afterwards, with pure

alcohol; collecting the crystals in the centre of the dish, by giving it a rotary motion, when the alcohol is added.

The Lime, and Magnesia, also, may be quantitatively estimated; by dissolving them from the dish; and filtering & separating them, by the usual method. But, generally, this is unnecessary, not only with regard to them, but, also, to the Potash & Soda; more especially if all these bases have been easily found, in the previous analysis by pure water.

If Phosphoric Acid has not been detected, in the aqueous solution, the remaining 1000 Minims, (b), may be treated, as follows, by Molybdate of Ammonia. Since 30 parts of Molybdic acid are required to combine with 1 part of Phosphoric acid; and, since an excess of Phosphoric acid prevents the precipitation of the yellow compound; and, since, moreover, this yellow precipitate is insoluble in Nitric acid; we can approximate, to the proportion of Phosphoric acid, by adding only enough

of the Reagent, at a time, to precipitate one hundredth of a grain of Phosphoric acid; and by repeating this proportion of the Reagent, until we arrive at the point where a precipitate appears, or vice versa. If the soil e.g. contained one millionth of its weight of Phosphoric acid; it would require 30 Grains of Molybdic acid, if we were operating on one million Grains of soil; or 33.000 Grains of soil would require 1 Grain; and two hundredths of a Grain of Molybdic acid, would suffice, to detect Phosphoric acid in five hundred Grains of soil, or the quantity represented by the portion ("b"), of the acid solution, as above. But, on the other hand, we may have a soil containing ten times, or a hundred times, as much Phosphoric acid, as the above; and, to provide against any such case, two hundred minims of the normal solution of Molybdate of Ammonia, may be used representing two tenths of a grain of Molybdic acid, for only ten minims of the acid solution of the soil. If, on

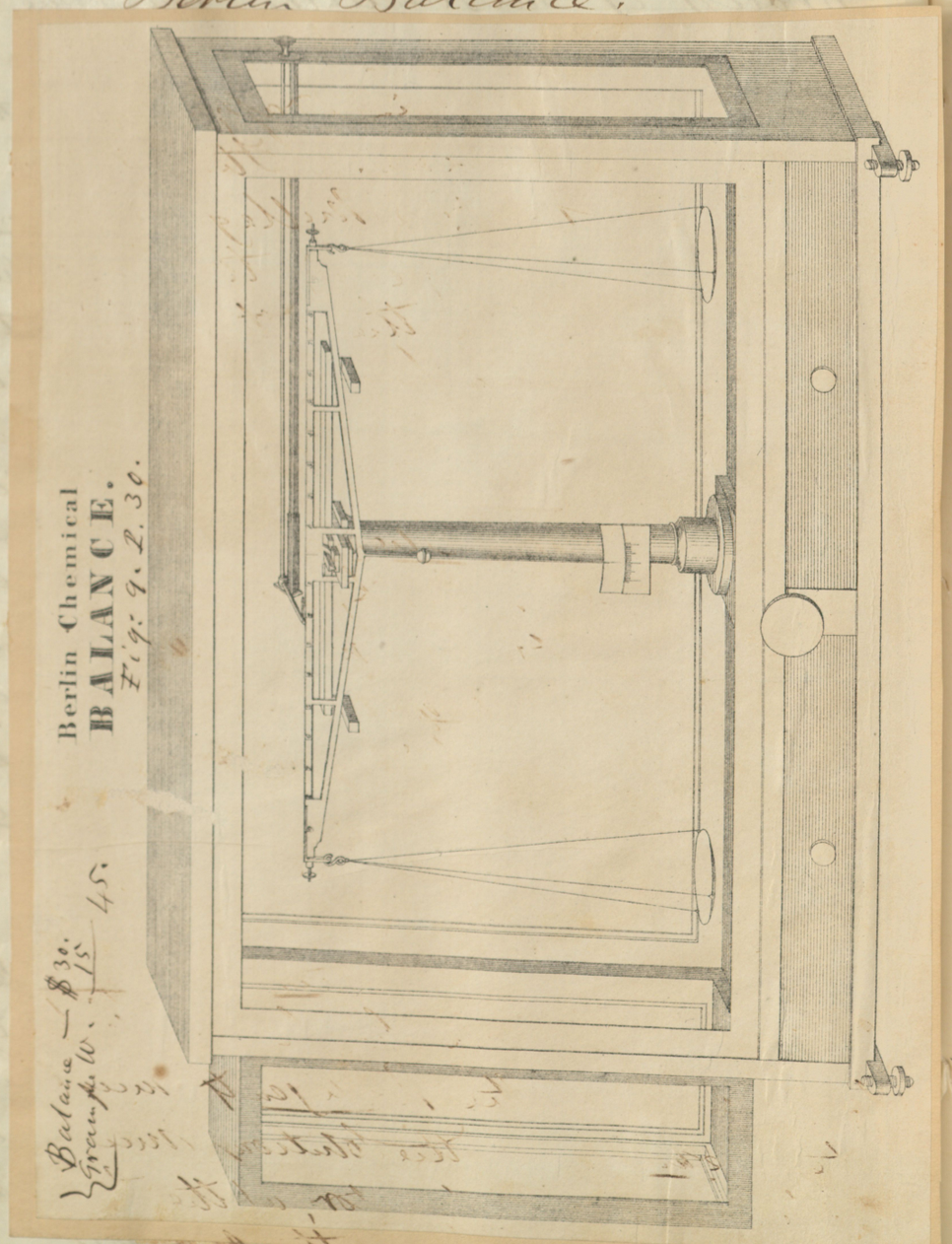
evaporation to dryness, and solution in Nitric acid, no appearance of Phosphoric acid is manifested; it may be inferred, that Phosphoric acid is not in excess; and the remaining 990 Grains of the solution, may be added to the dish, and evaporated slowly, as before; adding one drop of Aqua Ammoniae. If the second evaporation, now, should fail to produce the characteristic yellow precipitate; we may safely conclude, that the soil does not contain one millionth parts weight of Phosphoric acid. Whenever this precipitate is obtained, it is both abundant and well characterized; and contains only three per cent of Phosphoric acid. The Analysis by pure Water, is, however, much more simple and satisfactory.

The composition of the several Normal Solutions, for these methods, will be given to the public, if the present Essay should be printed.

It will be seen, that the foregoing process is substantially, the same that was printed, in the Report of the State Chemist, for 1853, as the best form of Qualitative analysis, with which, he was acquainted; and Dr. David Stewart, a Chemist of Baltimore, has, publicly, acknowledged it to be his work, the result of several years of laborious research and practice. The present writer fully acquiesces, in the opinion of Dr. Higgins; while he is constrained to say, that some parts set forth, for Quantitative analysis, in the same Report, are too elaborate, to be of practical avail to Farmers, except through the labors of professed Chemists. Inasmuch, therefore, as some may be found among those for whom such an Essay, was desired, either enjoying more leisure, or having a stronger bent than usual, for such pursuits; a plain & short method, for a quantitative analysis, will, now, be given, which will indicate the prospective capabilities of a soil.

Figure 9.

Berlin Balance.



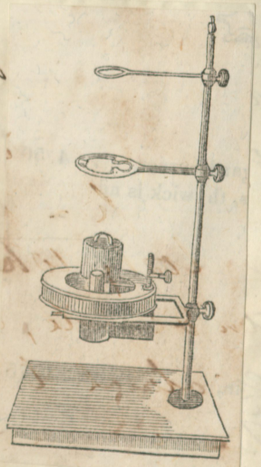
Balance — $30.
Grain W. — 15
45

An accurate Balance, (Fig 9), for such work, is indispensable; also, a complete Set of Grain Weights, from 1000 Grs, to 1 quarter of a Grain, in Brass; and smaller fractions, in Platina. The French Gramme, Cent: & Millegramme weights, may be preferred; and, they are more convenient, than the others, in some respects. Some practical treatise on Analytical Chemistry; containing the necessary Tables, must, also, be at hand. Rose's Chemical Manipulation, is an excellent work, for this purpose. Profs: Morfit's Chemical Manipulations, and Booth & Morfit's Dictionary of Chemistry, are highly valuable books; and, to such as can afford it, Rose's Gen: & Anl: Analysis, (the Edition by Normandy), though a hard book for a beginner, and Prof: Johnston's Lectures on Agricultural Chemistry; will be found important Auxiliaries. The Reagents may be bought, of the Chemist; or, the Solutions may be prepared, by the Operator, at the time, if it be convenient to keep the several salts.

a list of such as are needful, will be put, in the appendix; with a note of their prices cost; together with that of the articles of apparatus, mentioned. The satisfaction, to be derived, from a moderate outlay, of this kind, is incalculable; and, the benefits, in the improved tillage of the land, which must accrue, from a general diffusion of such studies, among Farmers, cannot fail to repay the cost, a hundred fold.

The finely divided matter, only is taken for this analysis. To separate it, a small sieve may be used, such as they have in Dairies, to strain Milk; or, as Dr. Higgins, directs, in the Report of 1853, it may be bolted through fine linen. A lawn sieve answers very well.

c. Weigh 100 Grains of the siftings, into a counterpoised glass dish; and, expose it, to the heat of a sandbath, or a water bath, not over 212°, for half an hour. then dry the dish, if necessary, and weigh it again, when cooled under a glass cover; and, the loss in weight, may be con-



Berzelius Lamp.

Fig. 10. P. 32

5



agate Mortar,
Fig. 10. P. 32.

Berzelius Lamp. agate Mortar



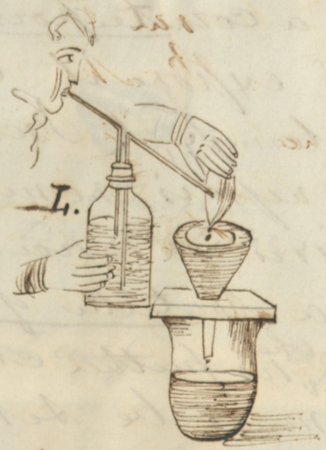
Wedge wood Mortar.
Fig. 10. P. 32.

sidered as Water. Another mode may be preferred, to place 50 Grains, upon a metallic plate, or a piece of glazed paper; and, to subject it to such heat, as will not turn the paper brown; till no more weight is lost; which a second weighing will indicate, by the loss, the quantity of water, natural to the soil.

d. Pulverize, in an agate mortar (Fig. 10.), as finely as possible, a sufficient portion of this dried matter, (c); and weigh 20 Grains, into a counterpoised platina capsule; and, expose it, to a red heat, on a Spirit lamp, (Berzelius, Fig. 10.); till all blackness is removed. the mass should be stirred, occasionally, during the ignition, by a Spatula of platinum, (Fig. 10.); and, when no further change is observed, the capsule must be set under a close cover to cool, and, weighed again, as soon as possible. the loss in weight, may be considered, (as a general thing), as organic matter; and, the numerical result found, multiplied by 5. will show the per cent. The excepted cases, are mentioned, further on.



Beaker Glass,
Fig. 11. P. 33.



Beaker Glass, receiving the Filtrate.

Whether the substances so burned off be animal or vegetable matter, can be pretty well distinguished, by the fumes; but, as both are valuable, the aggregate, only, in most cases, need be determined.

c. Boil, now, a fresh portion of 100 Grains, in strong Hydrochloric acid, in a porcelain dish, with a little water, adding, if need be, fresh portions of acid, till the whole, almost at Dryness, appears of a light gray, or yellowish white colour. Then add more water, and a drop or two of the acid; warm the dish, and filter the whole, into a Beaker Glass (Fig. 11.), on a filter of small size. When the filtrate has all passed through, wash the substance thoroughly, by repeated jets from the washing bottle (L.), allowing the washings to fall into the filtrate. Continue the washing, till the drop which falls from the funnel, will not redden blue litmus paper. If the filtrate was not clear, in the first instance, it must be passed through a second time, or a third, if necessary, before the washing of the filter is begun. Then dry the filter, &

the contents thereon, thoroughly; and burn it into the platina capsule; and, keep the ashes at a redheat, stirring them, now & then, till all blackness disappears. Take the weight, when cold; which will be easy, if the capsule has an exact counterpoise; and the ashes of the filter need not be estimated, when a very small size has been used; or, filters of a given size may, always, be used, & the ashes of one of them may be ascertained once for all, to be deducted, as a constant quantity; not, indeed, with perfect accuracy, but sufficient for the purpose. Where very great exactness is desired, a double filter may be used, i.e. one within the other; and the ashes of the one, when burned, can be weighed against those of the other. The weight found, after this deduction, must be set down as Silica and Silicates; and must be carefully kept for another operation.

f. Add, now, a drop or two of Nitric acid, to the warmed filtrate; which will peroxidize any iron that it may contain; and, then, apply aqua ammoniae, drop by drop, till a

bulky, fleecy precipitate appears, throughout the mass, usually of a brown color, or reddish, which subsides slowly. This will consist of Alumina, Peroxide Iron, and any Phosphate which the Solution may contain. The Ammonia must be added till the Solution is slightly alkaline. The substances thrown down, must be filtered, immediately; the apparatus being screened, as much as possible, from the air, during the operation, by a glass cover. The mass on the filter, when quickly washed, may be dried carefully, and weighed; but, it is of more consequence to determine the amount of the Phosphate, than of the Alumina or Iron; with either of which substances, some of the Phosphoric acid may be combined. An ignition of the mass, or even a thorough drying, might expel some of the Phosphoric acid. If, therefore, the mass be dried, it should be brought only to a cheesy consistency, and reserved, as the Silicate was, for a second process.

If it be preferred, however, the mass

may be dissolved off by Nitric acid, diluted, while it is still wet, on the filter. the filtrate may be received, in a beaker glass; and passed through a second time; and then, the filter should be thoroughly washed, into the beaker. this Solution, may, then, be treated, as before described, by Molybdic acid, by adding to the proper amount, the Solution of Molybdate of Ammonia, as the Reagent: or, the Solution may be reserved, instead of the dry mass, for the second process.

there would be one advantage, not only in drying, but in igniting, this precipitate, besides finding the amount of Alumina and Iron more accurately; and, that is, in redissolving it in by Nitric acid, any Soluble Silica which may have passed through the first filter would, now, be discovered: having become insoluble by the ignition; and by filtering it out, igniting, and weighing it, a very valuable result is obtained. Silica is not made to large a portion of every soil, in vain; and, every method should be observed,

to ascertain, how much of it is in a soluble state, for the immediate use of plants. For this purpose, however, it would be better to take a fresh portion of the soil, of a much larger amount, say 400 Grains; and, also, for the Phosphates; because, the quantities, to be found in 100 Grains, are very often, quite too small to be appreciable. In the previous analysis by Water where 1000 Grains of soil, are used, the Soluble Silica is realized, in a manner far more distinct.

J. The next step, is, to remove the Lime. If the filtrate from f be not alkaline, it must be made so, by aqua ammoniae; when a solution of oxalate of ammonia must be added; and, if lime be present, it will be precipitated, after some hours, if not at once, on warming it, & setting it in a quiet place. The white powder, which subsides slowly, is oxalate of lime; and must be collected on a filter, dried, ignited, and weighed. But, as some portion of the mass, must have been converted into a carbonate, by the

carbon of the filter, in burning; it is better, before weighing, to add a little carbonate of ammonia, to the mass in the capsule, and to convert the whole, to the carbonate. When the weight is found in Grains, & fractions of a Grain, the quantities taken from the Tables (CaO, CO_2), added together give, at once, the amount of pure Lime. Without the Tables, the Operator must calculate 43.71 Grains for every 100 Grains of the Weight.

h. Next, add to the clear filtrate of g, some of a solution of Phosphate of Ammonia, which will remove any magnesia which may be present. It will subside more slowly, than the Lime; as a bulky, whitish deposit; and, often after a considerable interval. This, also, must be collected on a filter, and carefully ignited. When it may be considered as Phosphate of Magnesia; and, the Tables, as before, ($2MgO, P_2O_5$), afford the readiest mode of finding the amount of pure magnesia. In all such cases, the quantity found, multiplied by 5 gives the per cent.

Figure 12.



Flask,
Fig 12.
P. 39.

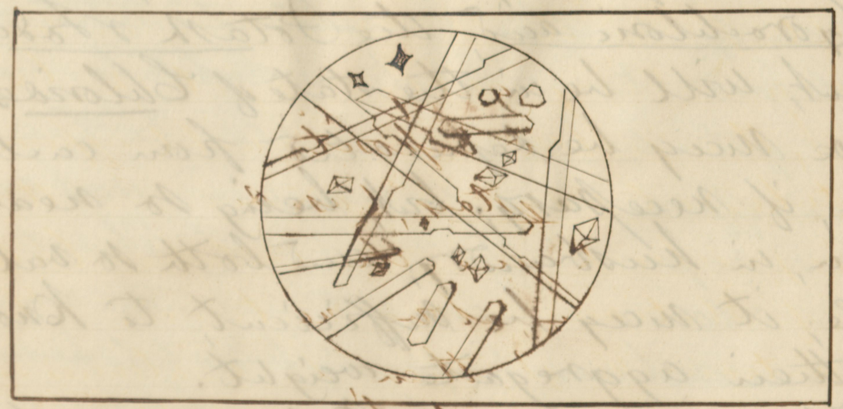
j. the last filtrate may, now, be concentrated by evaporation, in a suitable porcelain dish, over a water bath, placing an inverted funnel over it, of less size; and adding Nitric acid, around the edge, in the proportion of about 3 Grains of acid, for each Grain of the Muriate of Ammonia, supposed to be in the whole solution; as accumulated in the previous steps. If the quantity of the filtrate is considerable, it is far better, to put it into a flask (Fig 12), before adding the Nitric acid, and, then, to heat the flask gently. If the flask is of sufficient size the rapid decomposition, which will take place, before the boiling point is reached, will be accomplished, with perfect safety; and, the evaporation may be, afterwards, continued in the flask, till the quantity has been reduced, to half an ounce; when it must be poured into a Berlin porcelain dish; the glass funnel set in it, as above, and the evaporation continued to dryness, over a sandbath, or over a spirit lamp. This method, was

given by Dr. J. L. Smith, in Silliman's Journal for 1853, page 240; and is very far preferable, to the driving off the salts in fumes, by the heat of a lamp, applied cautiously, to the concentrated solution, transferred to a platina capsule. Some portion of the alkalies is liable to be carried off, in the fumes; and great caution is requisite, to avoid volatilization, at the close. To estimate the amount of the two combined, (supposing both to be present), they must be converted into Chlorides. they are quite likely to be Sulphates, in whole or in part; and, in such a case, the Sulphuric acid must be removed. Dissolve the mass, on the dish, in water, rinsing the funnel into it, as above; and, add, very cautiously, some solution of Chloride of Barium; and any Sulphuric acid, in combination, will be thrown down, by a heavy precipitate, (Sulphate of Baryta), which can be removed by a filter. If any excess of Baryta had been applied, this will be removed, by adding some solution of Carbonate of Ammonia, mixed with a

little aqua Ammoniae, and filtering. The filtrate must, now, be evaporated to dryness; and cautiously brought to a low redheat; when, on redissolving the residue, in water and hydrochloric acid, the Potash & Soda present, will be in the state of Chlorides. These may be separated from each other, if necessary; but, being so near of kin, in husbandry, and both so valuable, it may be sufficient to know only their aggregate weight.

The amount of the Potash may be realized as the double Chloride of Platinum & Potassium, ($PtCl^4 + KCl^2$); from whose weight the Tables readily show the quantity of Potash; and, the Soda may be estimated, directly or indirectly. But, this, ordinarily, would be superfluous. Indeed, it is quite satisfactory, to examine the Crystals, by Dr. Smith's method, Silliman's Journal, XVI. p. 55; by a good microscope; especially if it has the pieces needful to show the power of the several crystals of polarizing light. A very small portion of the dried mass on

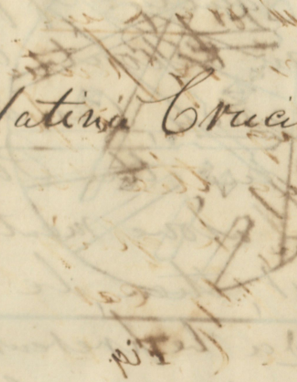
Figure 13.



Glass Slider for the Microscope.

the dish, may be taken off by a platina wire, not enough, indeed, to diminish the weight, sensibly; and placed with a drop of water, Solution of Chloride of Platina, upon a plate of Glass (Fig. 13.); where it will spread itself somewhat; and may be warmed very gently. If potash be present, the yellow deposit will appear, in octahedral crystals, (as seen in the figure); which are the Potassio Chloride of Platinum above mentioned. The evaporation must then be continued very slowly; and, if Soda be present, the Glass will show beautiful needle shaped crystals, forming sformed, having an oblique angle of termination, and, frequently, re-entering angles, as seen in the figure. A still more delicate discrimination, by polarized light, will be obvious, in the beautiful colours, exhibited by the prismatic crystals of chlorid of platinum & sodium; while those of chloride of platinum & potassium, do not show these colours; being of a different form; and not possessing the power to polarize the light.

Figure 14.



Platina Crucible, & Cover.

Horsford's Lamp. Russian Lamp.

Kent's Furnace.

K. Next, rub the Silica Silicates, (C), in an agate mortar, if the particles can be pulverized more finely than before; and put the mass in a platina crucible (Fig. 14), having a close cover of the same; with 4 times its weight of dry Carbonate of Soda, removing every particle from the mortar, by rubbing in it, portions of the soda; and mixing the whole as intimately as possible. Then, keeping the crucible closely covered, apply carefully the heat of a blast lamp (Fig. 14.), till the mixture is entirely fused into a kind of glass. Lay the crucible, with its contents, on a Berlin porcelain dish, in water, with hydrochloric acid in excess; and apply heat, till no more can be dissolved, though fresh portions of acid & water have been added. Then evaporate the whole to dryness, taking care that no lumps are left in the solution, around which a coating of silica might be formed, to prevent the action of the acid. To the dry residue, add water and hydrochloric

Figure 15.

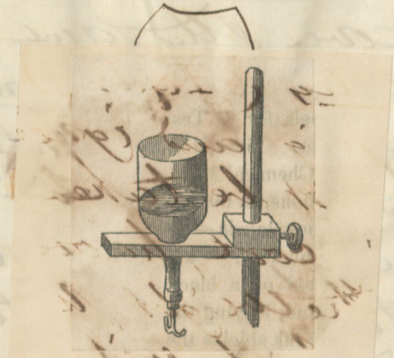


Figure 15.
Page 44.

Both the Bottle, and the funnel holding the filter, are to be supported the first, by one of the Rings on the Stand, and the second by another, or by the glass itself in which the Filtrate is collected.

acid in excess; and heat it, till all the soluble matter has been redissolved. Then, filter the solution; and wash the contents thoroughly; which can be done, without constant attention, by a dropping apparatus (Fig. 15.); and, after subsequent Drying and Ignition, as before; the weight must be taken, as soon as the Crucible is cool, having its cover in its place. The weight now found is pure Silica; which will be less, than before; and, the difference will show what amount of insoluble silicates exist in the soil.

To find the bases, the Lime, Magnesia, Potash, &c., with which the Silicic acid was combined; the filtrate must be treated, by the same steps described before. The quantities that will be separated, will be small; but, they must be added to those previously obtained, for the final results; or rather they should be written opposite to each other, in parallel columns.

First Process. Second Process.

b. Take, now, the reserved pre=
=cipitate (of f.), which contains the
Alumina, Iron, and Phosphate; and
redispolve it in hydrochloric acid water,
and if any remain undispolved, it will be
Silica, which passed through first filter
in a soluble state; and must be removed
by filtering; and if appreciable may be
ignited and weighed. Then add aqua
ammoniae cautiously till the solution
is slightly alkaline; and afterwards,
strong acetic acid, in considerable
q.s. and boil the mixture; when,
Phosphate of the Peroxide of Iron, and
Phosphate of Alumina may be precipi=
=tated. Collect and wash this precipi=
=tate, (reserving the filtrate for another
operation); and, treat the precipitate,
with caustic potash, which will re=
=dispolve the Phosphate of Alumina,
if any be present, and leave the Phos=
=phate of the Peroxide of Iron; when, the latter
can be filtered out, washed, dried, and
weighed. Then, add aqua ammoniae
to the filtrate, which will re= precipitate

the Phosphate of Alumina; which, also must be collected and weighed. These two products may have resulted, in part, from the decomposition effected by the process itself; and, it is possible, that phosphates of Alumina & Iron as such may not have existed in the soil. The Phosphoric acid may have been combined, partly, or entirely, with Magnesia or with Lime. But, this is not of so much moment as to ascertain the exact quantity of the acid.

Divide the reserved filtrate above, into two equal parts; and, to one of them, add a few drops of Solution of perchloride of Iron; and, if any earthy phosphates remain in the Solution, undecomposed, Phosphate of Iron will be precipitated. In such case, continue to add, of the perchloride, till no more is thrown down; and, then treat this precipitate, in the same way, as the one above described. If the perchloride of iron produce no precipitate, add aqua ammoniae to the other half of the reserved filtrate, till it is slightly alkaline,

and, then add hydrosulphuret of ammonia; which will precipitate peroxide of iron, oxide of manganese, and alumina, if present. Collect and wash whatever is thrown down; dissolve it in hydrochloric acid; boil the solution; and add solution of caustic potash, which will throw down peroxide of iron & oxide of manganese, but retain the alumina, in solution. These being separated, by filtering; hydrochloric acid must be added to the filtrate, till it is slightly in excess; when the alumina may be precipitated, alone, by ammonia.

It is not necessary, as a general thing, to separate the Alumina and Iron, in a soil; but, it is of importance, to know, whether the iron is in the condition of Protoxide or of Peroxide; the former being unfriendly to crops; and the latter in reasonable quantity, desirable. For this end the use of Nitric acid, (in f.) must be dispensed with; and, it may perhaps, be sufficient to observe closely the colour and appearance of the precipitate, as it occurs in that step. If it be of a whitish

green; which afterwards, turns red, in the air; it is the Protoxide, that is present. In that event, it will, ordinarily, be enough, to add a drop or two of Nitric acid, to the solution in which the precipitate is formed; which will bring it, to the condition of Peroxide. This may be removed by Caustic Potash; dried, ignited, and weighed; and the Tables (Fe^2O^3) will show the proportion of the Protoxide.

In some soils, the above solution from 100 Grains, will not show any, appreciable quantity of Phosphoric acid; when 400 Grains, treated in the same way, will afford it.

If it be preferred, instead of the above process, for the Phosphates; when the solution has been freed from Silica; and, neutralized by Ammonia; a solution of acetate of Potash may be applied; which will throw down whatever Phosphoric acid may be present, as Phosphate of Alumina, and Phosphate of the Peroxide of Iron. These may not appear till five or six hours have elapsed; but, in twenty four hours, they will

subside; and may be collected, dried, & weighed.

Results.

1st. Process.	2d. Process.
Water.	Silica.
Organic Matter.	Per. Ir. sal. Combined.
Silica & Silicates.	Lime, combined with Silica.
Alumina, Iron, & Phosphates.	Mag. with do.
Lime.	Phosphoric Acid.
Magnesia.	Soluble Silica.
Potash and Soda.	&c.
Loss.	

In almost every analysis, there will be a loss; or, something over; and, it ought, always, to be recorded.

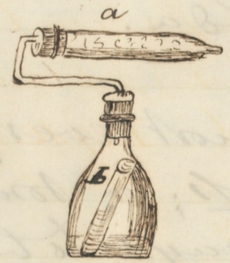
The power of the soil, to absorb water may, with advantage, be further tried, by spreading 1000 Grains of the dried sample, on white paper; and exposing it to the air, for twelve hours. If the second weighing shows an increase, of from 7. to 10 Grains, it is a good indication.

One source of loss, or of error*, if the results be not accurate, may, now, be sought, by searching for Carbonic Acid, in

* This is particularly applicable, to the Organic Matter, as mentioned, at the bottom of page 32, in regard to substances, in the soil, liable to be volatilized.

Figure 16.

Rose's apparatus for CO_2.



The above can be readily made, by the Operator, using a wide mouthed half ounce phial.

the soil; which must be expected, of course, in such as are calcareous; and which must, therefore, be, first, treated, in another method. In common soils, however, the amount must be small, if any; and unless some discrepancy be observed, in the result; or unless effervescence have been observed, when the quantity taken, was treated by the acid; it will not be needful to make this trial. To do this, with sufficient accuracy, for all practical purposes, place 100 Grains, in a small flask (Fig. 16.), having a small tube connected with it, as seen, in the figure, (a.), to contain dry chloride of calcium, for the purpose of arresting the moisture, which the gas would, otherwise, carry off. A small phial (b.), containing a little acid, can be inserted, as seen, in the figure, without spilling any; after the 100 Grains, & a small quantity of water have been placed, in the flask. The whole must now, be weighed; when by inclining the flask, the acid will be poured out, inside, upon the specimen. If there be

much effervescence; only a small part of the acid should be emptied, at once; and after an interval, more should be applied, till all effervescence or decomposition stops. The whole CO2 may, then, be expelled, by setting the flask, in a vessel of boiling water, cautiously, for some time; because the aqueous vapour formed will be absorbed, as above, while the Carbonic acid passes, out at the minute orifice of the tube. On cooling, and drying, atmospheric air, will enter, by the same small opening, and the flask (as to weight) will be, in the condition in which it was, at first, minus the Carbonic acid expelled. A second weighing of the whole apparatus & contents, with the proper precautions, will show the amount of acid so removed.

If it be a Marl, which the Farmer wishes to examine, it can be done, by this piece of apparatus, in the same way; though, if it be rich in Lime, only about 10 Grains, will be a sufficient quantity, to take for the Experiment; and when the Amount of the Carbonic Acid, has been,

so obtained; the contents of the bottle may be thoroughly washed out, ~~of the bottle~~, into a porcelain dish, and boiled with more acid for the separation of the Silica & other constituents, present; by the same steps, which have just been described. If both Lime and Magnesia be found, in this subsequent examination, it may almost always be inferred, that some part of the Carbonic acid was combined with Magnesia, in the Marl; and not all of it with the Lime.

It is particularly desirable, in analyzing marls, to look for Phosphoric acid; since it may be expected in such as contain organic remains. The same is true, of Encrinal Limestone; and such as are rich in Fossils of almost any description.

If, therefore, a Marble be under examination, the same method may be pursued, to separate the Carbonic acid, from a weighed quantity, (say twenty Grains,) of the finely powdered Specimen. In such a case, however, it is hardly necessary to say, that when the Silica & Silicates, have

been removed, as well as the Carbonic Acid, and the Alumina, Iron, & Phosphates, (if any be present); the Solution, when treated for Lime and Magnesia, should yield quantities; which shall agree, in proportion, with the amount of Carbonic Acid found. If more of these bases be found, than is sufficient for combination with the acid, it may be inferred, that some other acid is present, for which, it would be well to examine in the usual way.

It is far preferable, however, to select fair samples of Lime itself, as it is burned at the Quarry; for analysis, than to take the trouble of analyzing the Stone. The owners of such establishments, ought to provide such Certificates of analysis for their Lime, from the Chemist; and to publish them, for their own interest, to establish the character of their products, in the market. Such would be the proper inspection, which is indispensable, in some form to protect the farming interest, from imposition, & loss, in the selection of Lime suited to the various soils.

To examine a Lime, therefore, collect a fair sample of the lot sold; and weigh 100 Grains, into a counterpoised Crucible, and calcine it, for half an hour. If the lime had been freshly burned, any loss of weight can be considered as water with perhaps a very little carbonic acid. If the article be mislaked; and, especially if has been exposed to the atmosphere, it may be well to expose 100 Grains, first, to a heat, not above 212°, till the mass loses no more weight; and, afterward, to calcine 20 Grains of this dried sample, as before; when the first loss might be set down as water, and the second, as carbonic acid. Then, boil 20 Grains in hydrochloric acid; and remove any Silicates, Alumina, and Iron, which may be present; and, then, find the exact amount of the pure Lime and pure Magnesia. It is, particularly, recommended, to separate the Magnesia; because, often, this article has it, in too large proportion. The quantity of Silica, also, in some kinds, is large; and, in the absence of the necessary guaranty, the

farmer can, by this easy method, protect himself.

Plaster of Paris should be scrutinized, perhaps, more frequently than quicklime; because its varieties differ to a greater extent; and the articles sold, are liable to be adulterated. If it effervesce with acids, there must be carbonate, as well as sulphate in the mass; and if the effervescence be brisk; the trial should be made, as before, upon a given quantity. this will be sufficiently evident by putting a little acid water in a test tube, and dropping in a small spoonful of the sample. If many bubbly pap off, the amount should certainly be ascertained; before examining for silica, iron, &c.; when the Lime may be removed in the usual way. By adding to the filtrate from the lime, a solution of Chloride of Barium, the sulphuric acid in the solution can be determined, from the weight of Sulphate of Baryta obtained. the Tables, ($BaO.SO^3$) will give the exact quantity; and this, together with the amount of Carbonic acid, ~~&c.~~ will

be found, on computation, exactly adequate to take all the Lime into combination; unless some Phosphate, also, may have been present.

Guano, still more loudly, demands a short practical method, by which Purchasers, can hold a remedy, in their own hands, for the dishonesty of Dealers in this manure. An exact quantity, say 50 Grains, may be weighed on glazed paper, and dried, at a very gentle heat, for half an hour; when the loss will show the quantity of Water. It will vary, largely, in samples from different countries; and, still more largely, from different Warehouses. The value, of course, will vary, in a similar proportion. The amount may range, from 5 per cent, to 26 per cent. Remove the dried mass, then, to a platina capsule; and burn off, carefully over a Spirit lamp, all that will volatilize, or be consumed by continued heating, till no more weight is lost. Then, add a little Nitrate of Ammonia; and, heat

to redness, till all the organic matter is burned. The loss in weight may be considered as organic matter and salts of Ammonia. The whole may range, from 36 to 66 per cent. If the amount be more than this, it is clear, that light vegetable substances must have been mixed with the Guano, which have diminished its value.

The ashes left, ought to be of a pearly white colour; and, if the asset be dark, no doubt, adulteration by marl or sand, must have been practised. the weight of the ashes should not be ove 36 per cent: and nearly the whole of their mass, should dissolve readily, in hydrochloric acid & water. What remains undissolved after this treatment, must be washed out, by a filter; ignited and weighed. It may be called sand; and ought not to be over 4 or 5 per cent. If more than this be thus found; it may be inferred, that earthy matter has been added; or, at least, that in the original deposit, a larger than ordinary quantity of sand was accumulated. In either case, how-

ever wishes to become better acquainted with an article, which is so important to his business. The filter in this last trial, must have been washed very thoroughly, and the Phosphate will be found in the filtrate. If it be thought however, that the ignition has expelled Phosphoric acid, a fresh portion must be taken, instead of the calcined mass, and treated to obtain the acid filtrate. If phosphates are abundant in this solution, Ammonia will throw down copious flocculent white masses; which are to be treated with acetic acid, added to excess. This will dissolve all the precipitate, unless some iron be in combination; and, if anything remains undissolved, it must be filtered out, ignited, and estimated as Phosphate of Iron. Oxalate of Potash, may, then, be used to separate the Lime; which must be done by a filter. The filtrate may, now, be treated with Ammonia in slight excess, and the Magnesia with Phosphoric acid, as Phosphate of Magnesia, may be removed in the same way. Lastly, a solution of Sulphate



Figure 17.



The Bottle B. should be set in water kept cold by Ice; the end of the Tube should just dip under the surface; and the flame of the Lamp, under the Flask, must be kept constant.

of Magnesia will throw down the Phosphoric acid which was combined with the Lime, some Muriate of Ammonia having added, with this last reagent. The entire amount must now be found by addition.

If it be suspected that Chalk, or powdered limestone, has been added to a Guano; it is, easily, detected by throwing a small spoonfull, into a test tube, containing dilute acid.

If light worthless substances, such as tan bark be suspected as having been mixed with the Guano, they will float in salt water; or perhaps better will be exposed, by the extraordinary bulk, in burning off the organic Matter.

A direct examination can be easily made for the Amount of Ammonia in a Guano, by Means of a Retort (a. Fig. 17), in which a given quantity may be placed with a few ounces of water; a bent tube passing (as seen in the figure), from the beak of the retort, into a close bottle (B.), containing a small quantity of dilute hydrochloric Acid. When this arrangement is made perfectly tight; a little caustic

potash must be put in through the tubu-
-lure of the retort; and a gentle heat ap-
-plied. Decomposition will take place; and
the Ammonia, will pass over with aqueous
vapour, into the acid in the bottle. The
Operation must be continued, till about one
half of the quantity in the retort, has been
distilled over; when the Retort must be
lifted to take the tube out of the fluid in the bottle,
~~[illegible]~~ without removing the lamp,
to prevent a regurgitation. ~~[illegible]~~
~~[illegible]~~ Then, add more hydrochloric acid
to the liquid collected in the bottle, till
it reddens blue litmus paper, i. e. till the
acid is in excess, and, apply the solution
of Chloride of Platinum; by which,
all the Ammonia, will be brought into
combination, as Ammonio-Chloride of
that Metal. Mash out all, into a Berlin
dish; and evaporate, almost to dryness.
Wash the yellow powder, as in a previous
process; and dry it, by a very gentle heat.
In every 100 Grains, there will be 7.69 Grains
of Ammonia. If it be preferred, the mass
on the capsule may be heated to redness;
when a spongy substance will remain; that

can be weighed as Platina; and for each 100 Grains, there must have been 17.39 Grains of Ammonia, in combination. The Tables can be consulted, for the proportion, in the above substance, as found.

Artificial Manures.

It is highly desirable, for Farmers to have some short process, above all for these; because they can be so readily compounded of almost everything, whether useful, worthless, or pernicious; and, it is so easy, by a simple Solution, first in water, and afterwards of the residue, in acid; to discover whether the Buyer has received his money's worth. If Purchasers will only practise these methods, the whole Trade will be made more honest, because a single exposure of any one dishonest transaction, would not lose its effect on the business, for a considerable period. Saline Mixtures, are most frequently sold. Weigh 100 Grains of any one of these, into a Beaker Glass, which has an exact counterpoise, i.e. a phial of small shot, of the same weight; and add, to

the mass two or three Ounces of water; and boil the Mixture. When sufficiently cool, pour off the clear liquor into a precipitating glass, leaving the residue on the bottom & around the sides of the beaker, rinsing it by a little pure water, to be poured off, also, when clear; and then, evaporate whatever moisture is left in the beaker to perfect dryness; and take the weight. The amount dissolved out by water is, thus, at once, known. Then, add dilute acid to the residue in the Beaker and boil the mass, as before, till all that will dissolve, is taken up. Decant the clear liquor, as before, into another precipitating glass; and dry and weigh, what remains in the Beaker; and, by this means, it is known, immediately, how much of the article in question, is not soluble, either in water, or in acid.

The two solutions may, then, be examined by Reagents, according to the steps, heretofore described. By, taking aliquot parts of each solution; or of the two combined;

for the application of the several tests, the separate substances, existing in the solution, can be exhibited; and, it will be seen, whether they are, or are not, what the seller proposed them to be; or, at least, the Purchaser will know, whether anything valuable, as a manure, has been received, for what he has paid.

If a considerable amount of insoluble matter remains, in the Beaker, it must either be sand; or other earthy matter not in such a condition, as to induce him, to pay for the privilege of putting it on his land. Any further check, will scarcely be needed, for the traffic in such Manures; for, these Experiments can be performed, in any village in the State; and, the Merchants, especially in the country, are as much interested, as the Owners of Lime Kilns, and of Gluon Mills, are, to sustain the credit of their Articles.

Mineral Phosphate of Lime is, now, used, to some extent, and should, always, be tried, in a test tube, by dilute acid, to determine, at the outset, if Carbonate of

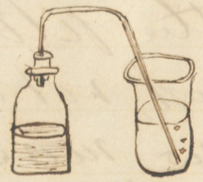
Lime, or inferior Marl, have not been in=
=corporated with it. If the sample stands
this trial, then proceed, as before, to separate
the several substances; and, precipitate
the Phosphoric acid, by Sulphate of
Magnesia; or, by any other convenient
Reagent that may be preferred.

The Waters, employed in a family,
frequently require an examination; for the
preservation of health, and the promotion
of Comfort; which, the Operator, who
has gone with us, thus far, is able to perform,
both with profit & pleasure. A Minikin
evaporation of a considerable quantity,
(say 10.000 Grains), will reveal both the
comparative purity of the Well; and the pro=
=bable substances, present in the Solid contents.
the evaporation ought to be carried to
perfect dryness; and, when the matter
is redissolved in hydrochloric acid, it is
highly probable, that some portion will
not be taken up. Soluble Silica may have
existed in the water; and, if so, it would be
found by this means; and readily removed,
by filtering. If the Solid contents, however,

after being brought to dryness, had been ignited they might have become brown or black; indicating, that organic matter was present, in the water in solution; but, it must not be removed by that method; since some of the inorganic constituents, might go off, at the same time. When such matters are indicated, the amount can be determined, by mixing Carbonate of Soda, with a given quantity of the water (say 1000 Grains); and evaporating it to dryness. The residuum should, then, be treated by boiling water; then filtered; and the filtrate evaporated to dryness, at a heat, not above 284°; till the weight loses no more. The dry residue, must, then, be exposed to a low red heat, until all the black colour in the mass, is destroyed. The difference, of the weight, before & after the ignition, shows the quantity of the organic matter.

Cases of more consequence, are waters for domestic use, which are received through lead pipes; because, under some circumstances, a combination of that metal is so formed, that is poisonous. If this metal exists

Figure 18.



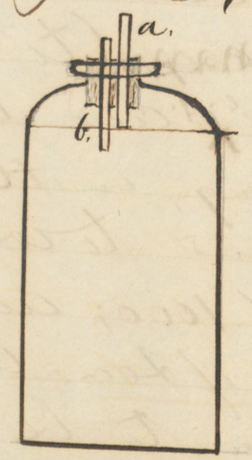
a half ounce phial, and a piece of tube, will make this arrangement. To wash the Gas, (when necessary), it must be passed through some water, in an intervening bottle, before it enters the fluid to be tested.

in a water, even in a very minute quantity, a few drops of solution of Chromate of Potash, will precipitate it, as a beautiful yellow chromate of Lead; or bubbles of Sulphuretted hydrogen, passed through the water, from a very small bottle, as shown in the figure, will blacken it, by producing the Sulphuret of Lead. All that is needed for this latter trial, is to place a little lump of black Sulphuret of Iron, in the bottle (Fig. 18.), and to add a small quantity of dilute Sulphuric acid.

The ordinary waters, from Wells, will often afford a considerable amount of Solid contents, on the evaporation of 1000 Grains. In such cases, after removing the organic matter, (if any be present), and concentration of the solution, freed from Silica; if the dish be set away quietly, about the time when a film begins to form, on the surface of the liquid; on cooling very slowly, under a cover, the Salts present, will crystallize, in a day or two; and, may be recognized, by the sight & the taste.

But, the object of most interest, in this connexion, is, the Mineral Springs which are found on Bore landed estate; and richly deserve such attention as the Proprietor can bestow. By taking a much larger quantity, for evaporation, in a large glass Vessel or evaporating Bowl, (say 70.000 Grains), very good general results can be obtained, to show, whether the Spring is likely to acquire a reputation. It is well to weigh the first 1000 Grains measured; (if it be done by the Specific gravity bottle); because it ~~[illegible]~~ affords, at once, an indication of the probable quantity of solid matter contained. If the flask be filled, ~~[illegible]~~ (to the file mark), with Sea-water, i.e. and be weighed, the counterpoise being, in the opposite scale, it will be found to weigh about 1028 Grains, instead of 1000; and, that is the Specific gravity of Sea-water. Hence, supposing the bottle to be correctly marked, the weight of any mineral water, so found, will be its Specific gravity.

Figure 19.



The longer tube (a.), to project, some four inches out of the bottle.

It is not needful, now, to repeat the steps, necessary for separating the substances which compose the solid contents. The previous pages show the Operator, what he must do. But, a method will, now, be given, for a Spring which may contain Carbonic acid; and for one which may afford sulphuretted Hydrogen; ~~[illegible]~~ because these, substances are ~~[illegible]~~ likely to be found in the Springs of our State, ~~[illegible]~~ ~~often these substances, exist, together, in the same fountain.~~

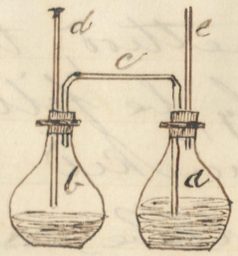
The presence of Carbonic acid, in a mineral water, may be shown, at once, if it be of any amount, by adding to a quantity, fresh from the spring, a little Lime Water; when a white precipitate of carbonate of Lime would be produced. If this indication affords sufficient encouragement to go on with the examination; four or five pint bottles may be prepared to be filled, at the spring; by inserting, in the cork of each, two pieces of quill glass tube, (as shown, in Fig 19.); so as

Figure 20.

* The capacity of the bottle being known, the quantity of the solution and of the ammonia used, must be deducted.

to admit of filling them quietly, by plunging them below the surface, leaving the orifice of the longer tube above it. It is plain, that by this method, the bottle can readily, & quietly, be filled to an exact height, to be marked on the glass, by a file mark, to be on a level with the inner orifice of the longer tube. The capacity of the bottle, when so filled, must have been previously measured, by a graduated glass (Fig. 20.) or by the specific gravity bottle; so that the whole quantity of Spring water taken may be known. Before filling the bottle, an ounce of solution of Chloride of Calcium, and half an ounce of pure aqua ammoniæ, must be put in each bottle; when all may be at once, filled.* All the Carbonic acid which the water may contain, will be precipitated, as Carbonate of Lime; and the quantities, in the several bottles will be the same. The contents of the whole may, then, be raised out, upon a filter; and, afterwards Dried, at a heat of 212°; when the quantity obtained can

Apparatus of Fresenius & Will, for CO.
Figure 21.



The Bottle (a.), may be smaller than (b.), the first 1½ ounce, & the second 2½ ounces; and, the tube (c.), should be somewhat stout, to hold the whole, readily.

be weighed. An easy and accurate method for finding the quantity of Carbonic acid, in the Marl, was devised by Fresenius & Will. The apparatus, is shown in the figure 21.; and the carbonate is placed in bottle (b.), & water poured in to fill about one third of its capacity. Sulphuric acid, is placed in the bottle (a.), to about half its capacity. The whole apparatus, is then put together, tightly, wiped perfectly clean; and then, accurately weighed; the end of the tube (d.), being closed with wax. By applying the mouth to the tube (e.), air will be withdrawn, from both bottles; and, on stopping the suction, Sulphuric acid will pass over, into the bottle (b.), by the tube (c.); and, decomposition, at once, ensues; Carbonic acid being evolved, in the bottle (b.); and, this can pass out, by no other way than through the Sulphuric acid, in (a.); which will, effectually arrest all Moisture, with which it may be connected. Moreover the Sulphuric acid, which first mixed with the water, in (b.), caused it to become hot, and to expand the air, in the bottle.

On cooling, however, a contraction takes place, and another dose of the acid passes over; the first evolution of gas, having ceased. But, suction may be applied, to the tube (c.), to hasten the process, whenever the action in b. stops. As soon as all the carbonate is completely decomposed; i. e. when no more gas is evolved; the operator may cause a larger quantity of the acid from a. to go over, by further suction; and this will increase the heat to such an extent, as to drive out all the Carbonic acid, remaining in (b.), both in the water & the air. The wax may now be removed from the outer orifice of (d.); and, then, suction at (c.), will draw air through the whole apparatus; and so remove all the Carbonic acid, from it, while all the moisture generated, will be retained in the sulphuric acid. As soon as the bottles are cool & clean, as before, they must be weighed; and, the loss, is the Carbonic acid.

If a Sulphurous Spring be found, the same bottle used to collect the water, in the foregoing process, may be used; charging each of them, before filling, with a small quantity of Solution of arsenious acid, in hydrochloric acid. Sulphuret of arsenic will be precipitated, in each of the bottle, if Sulphuretted hydrogen (HS.) exist in the water. This must be collected, on a filter; washed with cold water; dried at a heat of 212°; and weighed. There will be 39.03 Grains of Sulphur, in each 100 Grains of the precipitate.

Professors W. B. and R. E. Rogers, have prepared a beautiful process, to estimate the Sulphur, in a Sulphurous Water; by passing a current of pure Hydrogen, or of washed Carbonic acid, through a given quantity; by which the Sulphur is displaced, whether it exists, as free acid, or in combination, as a Sulphide; and conveyed into a solution of Nitrate of Silver, with Ammonia. It is thus combined with Silver, in a small flask, and, the advantages are obvious. The Sulphuret is realized in a

small compass; the operation is easily performed; it is exact; and, is not attended with the inconveniences of the above. It is published, in Silliman's Journal, 1853. 213.

It may not be superfluous, now, to add a method to discover Iodine, in a Spring. Evaporate 10 Gallons, to a quart; and, then, pass it through a filter. Add Carbonate of Soda to the filtrate; and continue the evaporation to dryness. Treat the residue with alcohol, repeatedly; and, evaporate the alcoholic mixture to dryness. Heat the residue, very cautiously, to destroy the organic matter. Then, dissolve the contents in water and filter the solution. To the clear filtrate, when neutralized by hydrochloric acid, add some solution of proto Chloride of Palladium; and set it aside, for 16 hours. If Iodine be present, the protiodide of palladium, will be produced, as a deep brown black precipitate; which must be collected, on a tared filter, and dried, first, at a heat below 212°, and finished, over a dish containing sulphuric acid, under the Receiver of an Air Pump, exhausted. In

100 Grains of the precipitate, 70.34 grains is Iodine. The Reagent is very costly;* but, by any other mode, it is extremely difficult to separate Iodine, from Chlorine and Bromine; which are quite liable to be found in the same waters. the Precipitate must be dissolved in Ammonia; a few drops of a solution of starch, in cold water poured in; when, on acidifying it, by sulphuric acid, the beautiful blue color, characteristic of the Element, will be produced.

In every instance, in which a landed Proprietor, by any of these methods, discovers sure indication of a valuable Mineral Water, in a copious spring; he should lose, no time to secure the services of a professed Chemist, to make a complete Analysis.

In one word, it is the object of this Essay, to induce Farmers, not to run for the Doctor; when they ought to prescribe, as well as he; but, never to neglect doing so, in a case of real difficulty. Farmers, can, so, save themselves, moreover, from the expense of throwing costly sub-

* This is Lassaigne's Test, and it is sufficiently sensitive, to estimate $\frac{1}{400.000}$ of Iodide of Potassium, in a Solution.

stances, upon soils, which, already, contain the same, in abundance. Such economy is not, merely, in dollars and cents; for, an injudicious outlay, with no suitable return, raises an outcry against the whole theory & practice of scientific agriculture!

Whatever analyzes are made, a Record should be kept; as one of the best Day Book, because it treasures up rich Experience; and, a Register of the Weather, also, is highly desirable. Let the days and hours be economised; and, sufficient leisure will be found, for all these purposes. Even Cicero, the greatest Lawyer of his times, was a well practised Agriculturist; and, Daniel Webster was quite as able, to discourse, on the farm, or in the garden, of one of Nature's Noblemen; as he was, in the Court Room, or in the Senate Chamber.

Of what avail, otherwise, is a premium wheat soil, so long as the Joint worm, the Fly, and the Weevil, are left undisturbed, at their birth; or, while the Farmer's Newspaper, and

the Farmer's Library, do not furnish the Proprietor the experience of others, to improve his own! He must wage a war of extermination upon the Enemies of his crops; and he must protect his Friends, the Birds, that will kill innumerable Insects, if left to do their appointed work.

There are several Classifications of Soils, which may be useful, only in a very general way; because we derive but an indistinct outline, often, from the Rocks. There will be a general resemblance, e.g. in Soils derived from Granitic aggregate; as, also, in those from Shales; and, still further, in such as are formed from Greenstones and Basalts. But, the specific differences will be exceedingly numerous, in each of the Classes. In Maryland, especially, the materials, in many Districts, have been brought from great distances; being unlike any Rocks found in their neighbourhood. It would be thought poor practice, for a Physician, to dose all the members of the family, alike; unless they had the same

disease; and still more, if their constitutions were utterly unlike. It is not necessary, that an Operator should actually, filter dry and weigh, the Lime, in twenty specimens, from as many spots in a hundred acres: unless the sections were really of different kind of soil. He will be satisfied, when he has dropped his test, in each of the Glasses; and, the deposits have subsided. He has a thorough conviction, that Lime is there, in notable quantity; and, if need be, he can prove the lot, as army officers do Guns, by putting two or three of the whole number, to the trial. So, wheat and corn, both, must have soluble Silica; as any Boy can tell, who has cut his finger, by his reed fiddle; and, that same boy, if taught, as every Farmer's son should be, will find Iron, in the Blood, he has shed; and strengthen his arm, to dig into the deepest mysteries of Nature. The Silica is equally essential, to all cereal crops; and, to good grass, and pasture land; and, it is for this reason, that the double

Figure 22.

proces, in analyzing, has been recommended, instead of fusing the soil, at once, as most Chemists do.

Humus, and Humic acid, are supposed, by some, to be actual compounds, of Carbon, Hydrogen, & Oxygen, existing in soils; and, they may be mentioned, here; lest it should be thought an omission. It is of little practical moment, to our present purpose, what names may be given, to forms of fermenting, decaying, & decomposing vegetable and animal matters, in soils; any more than to the manifold compounds of Elements, engaged in the growth of organic bodies.

Digest 500 Grains, in water, with Carbonate of Soda, for some hours, at a gentle heat, say 200°; and, then, filter it. If the liquor be muddy, it must be evaporated, to a smaller bulk, when it will pass through clear; though it may take time. Wash the contents on the filter, very thoroughly, in the way shown in the Figure (22); and, then add, to the clear filtrate, Hydrochloric acid, in excess; and,

Humic acid, will separate, in brown flakes, which must be collected, on a tared filter, washed, dried, and weighed. the dry mass is, then, to be burned; and, the weight of the ashes, subtracted from the previous weight, shows the quantity of Humic acid.

Boil, now, another 500 Grains, in water, with caustic Potash, for some hours; dilute the liquor, if need be, with water, and filter it. then, precipitate, by Hydro-chloric acid, as before; and the whole of the Humus, in the sample, is, by this means, converted into Humic acid; and, must be collected, dried, & weighed. The difference between this weight, and that found, in the trial by Carbonate of Soda, shows, how much organic matter existed, in the soil, in the shape of Humus. This substance, is supposed, as well as Clay, to receive Ammonia, from the atmosphere, and to yield it, again, whenever the heat is sufficient to evaporate the waters. When fields are freshly ploughed, the moist soil, turned to the air, imbibes Ammonia. It is probable, that

lands, very often, fail to produce, as large they ought, because they are not thoroughly worked. the more finely pulverized, the soil is, the more easily are the particles dissolved; and the larger will be the quantities of the gases, which will be absorbed. It is plain, that an average amount of ammonia, e.g. must fall, every year, upon each part of a given district; but, the quantities actually held for use, in various places, will vary greatly with the texture of the soil; and, the different degrees of industry, with which they are tilled.

The lands on our Atlantic border are made up, in so large a degree, of coarse sands; that they are highly porous; except in spots where clays predominate. Soluble manures, accordingly, soon disappear; unless frequently renewed. For this cause, it is wasteful, to apply such manures, in large abundance, in any one season. A moderate supply, will secure the desired results, as readily, for a year or two, as three times the quantity could do it: and, the repetition of the manure, is the surer means of con=

timing the productiveness of the soil. The
just mentioned, however, are compensated, by
their nearness to the Market, both to sell
Products, & to purchase Manures. Horticulture,
therefore obtains, here, the richest rewards;
and, here, the Reaping Machines, move over
their chosen fields. Here, also, Marls are
found, in great richness and variety; but,
it is this very circumstance, which calls
for more thorough, & general examination,
of these resources; by the methods, in
this Essay. These lands were deposited,
originally, under water; and were drifted from
more Northern Latitudes. The Sandstone, the
Slates, the Shales, & the Limestone have con-
tributed to the mass. Indeed, it might
be a good operation, in some parts of our
State, to pound Slates & Shales of rich com-
position, as we do Plaster of Paris, to spread
on the soil. These Rocks abound in Potash
and Soda, as well as in finely divided Silica
and Alumina; and, very often they contain
abundance of Phosphoric acid, derived from
the remains of Animals.

The Gravel of the Tertiary sections, is then

least recommendation. they are the least liable to be disintegrated and decomposed. Fragments from Sedimentary rocks, are more desirable; being more easily abraded and mixed with the soil; and containing, often, Magnesia, in a proportion which will not overdose the land. When the Feldspar and mica in Granite and Gneiss, predominate, the resulting soil is richer, than it is, where they are, comparatively, deficient. Greenstone soils, are valuable; having both Lime & Magnesia, in them; and such rocks, are easily worn down, by the Elements. Where the land is red, from an excess of iron, it is no good sign; but, if the redness, has been derived from the decomposition of Green-stone, or Trap Rock, it is an evidence of higher value.

Thus, the Great Problem, is, to reduce, to mix, & to make complex, all the earthy, animal, and vegetable, matters, in a soil; and to render them soluble, & the proper degree, for Plants. the Spade, the Plough, the Hoe, the Rake, and the Cultivator, are indispensable; to give access, & efficiency,

1.1

to Light, and Heat, and moisture, Air, and to the substances which are washed down from the Skies. Doubtless, the soils are thebest, in which, all the Constituents exist, in suitable amounts; provided they are in a finely divided State. The grand secret is to place them together; and whether their offices be chemical or mechanical; Nature will do the rest; for, She can accomplish, in her Laboratory, what we find impossible in ours. She can combine a few Elements, in some degree, after her fashion; and, by progressive approach, produce humble imitations of her labours. We find pebbles of quartz, in beds of sand, near the Severn, which crumble to atoms, in the hand, by some well known solvent, which water carried there, to soften them; while, in other spots, in the vicinity, we quarry the sandstone that endures the chisel, by reason of a different agent, that water has borne to the pickle grains, for their consolidation.

Alkalies must be furnished to a soil, which does not contain them. It is not

needful to find all these solvents, for ev[illegible] species of growth; for, one will, sometim[illegible] supply the place of another. None need he[illegible]tate to apply common salt; which, besides Soda, affords Chlorine, whose offices are not as yet, all fully understood; but, which decomposes water, in light, though it is not done, in darkness. Nor will any one doubt the need of liberal additions of bone=dust, mineral phosphates, or guano; where the soil has been exhausted.

In regard to Lime, there can be no excuse, either for not ascertaining; or for not supplying; any deficiency. Nor need the Purchaser be imposed upon, by a lime, which contains large quantities of sand, iron, mag=nesia, and water; when his land wants none of them; and, when, with an instructed choice, he might have one, for the same, or less money holding a rich portion of Phosphoric Acid!

It must not be forgotten, that hen=roosts afford Guano, on better terms, than it can be brought from Peru. the Houses should be cleaned, every week; earth being sprinkled,

over the floors, to be swept out with the [illegible]
and, the collections should be mixed with [illegible]
manures; with the addition of Plaster of Pa[illegible]
as a coating for the whole.

The heaps from the Stably ought to be sheltered from the Rains; and the Sun; and, weeds from the Garden; and other substances, animal & vegetable, must be added; and, occasionally powdered, by Plaster of Paris, or by Sulphate of Iron.

Bones however, ought, always to be separated; and dissolved in Sulphuric acid; after being pounded fine; and, there can be no apology, for the almost universal neglect, by which, vast quantities, of this best fertilizer, are, annually, washed away, into the Deep. The operation, it is true, is a troublesome one; but, when the labourer is not, otherwise, employed, he can break them up, ~~[illegible]~~, by a heavy beetle; or, the bones (collected, as they are, without cost,), can be sent to the Crushing Mill; and, so utilized, at very trifling expense. Ashes, of wood, also, though they have been leached, should, by no means, be thrown away: and, even those of an=

-thracite, contain, in moderate quan[illegible] a great number of the Ingredients, which [illegible] useful in Soils: more especially, when [illegible] have been sifted; as they are sure to [illegible] by the best of house keepers. The matters contained, are not only, of intrinsic worth; but, they are in an extremely divided State; and, they, readily, enter into combination, with the compost, and the soil. Of course, in applying ashes, preference should be given, to fields, which are deficient, in alkaline matters. If Magnesia be wanting, and Lime from dolomitic marbles be not at hand; Epsom salts may be employed. Nitrate of Soda, and of Potash, are good applications, where that base is the missing constituent, in retentive soils.

Swamp mud and black deposits of vegetable matter, may be mixed with fish caught along shore; and, the carcases of dead animals should be treated in the same way; only the bones should be reclaimed. The value of any black deposit, can be known, by burning to whiteness a small quantity, in a capsule. Peat should not be

burned, for a manure; unless ashes ca[illegible]
be had, on better terms. The subst[illegible]
should be kept wet, lest, by thorough dry[illegible]
the soluble silica should return to the insol[illegible]
state. It can be made up into heaps, with
ashes, and old mortar, and urine, & straw,
and soot, and sprinklings of Plaster
of Paris, should occasionally be applied. Quicklime
should never be applied to such heaps;
since it would defeat the very object in view.
In one word, manures act, either by
supplying some substance which is not found
in the soil; or by bringing into active
combination, some one that lies inert, in
the mass. In this relation, Carbonic
acid, and Ammonia, are of vital mo=
=ment; and, by a proper study of Tables
which show the composition of Crops;
the Farmer can tell, why some plants
will thrive, only in certain soils. Tobacco
contains a supposed compound, whose largest
proportions are of Carbon & of Hydrogen:
and, it is an exhausting crop. No Chewer
of the Weed, longs, more earnestly, for his
indulgence, when the supply is with=held;

than the over-taxed land thirsts for
Elements (CHN.) of Nicotine.

These few practical Hints may, perhaps,
suffice to put many men upon a course
of intelligible experiment; who, now, deny,
altogether, the advantage of Analyses:
They will, thus, satisfy themselves, that their
prejudices have sprung from wrong uses
of proper remedies; and fewer tears
will be shed over money wasted, in
empirical farming. Analyses of soils
in other States, are of little avail, here.
The necessary work can be done, only by
ourselves; but, every individual experi-
=ment thrown into the common fund,
will be valuable for extensive Districts,
on both Shores. Let the Farmer ascertain,
whether his soil be permanently productive;
or whether it apparent fertility be due
to transitory causes. Let him not rest,
till he is certain, that the Inorganic
matters, are in the proper state; and, of
the adequate amount; and not easily, to
be exhausted. He must, then, consider,
that sufficient animal and vegetable

matters are needful, to supply Organ
and, when he has inquired, whether
or Maize; or whether tobacco or co
roots, are the most certain to rew
his labours; he will be educated,
like by the Plough, as the advocate
is, to do it, by his Pen.

Hector Humphreys.

St. John's College,
Annapolis, March 1st 1854.

Note to Page 14. An acid Solution
may be prepared, at once, instead of the
aqueous one, if the Operator prefer it;
and, the same steps may be taken, with
aliquot parts. A large Bell Glass is best
for the purpose; and, Hydrochloric, or Nitric
acid may be diluted, (say 4 or 5 to 1.);
to saturate the soil; and, the Displacement,
also, may be made by the dilute acid.
It must be remembered, however, that
when the former acid is used, no Starch
could be made for Chlorine. For that

1.1

purpose, Nitric acid must be us
from the Solution.

All will perceive, that the
of substances, dissolved out, by W
alone, must be the Minimum of
what Nature affords for crops. It may
aid our conjectures, as to the Maximum,
to consider, that Carbonic acid, and
Ammonia, and Nitric & Phosphoric
acids are washed from the atmosphere;
and exist in the soil in small pro-
portions, as Reagents. Moreover,
none can properly estimate the effect
of the vital forces of Plants; till Ex-
periments lately pursued, to measure
more accurately than heretofore, the
Gases as developed, under the surface,
have been pushed to final results.

* Throughout this Essay, wherever a vessel is spoken of a put to use in an Operation; it is understood, that it must be perfectly clean. This will, often, call for the use of alkali, or acid, or of both; and, always, last of all, distilled water.

Apparatus, and Re Agents.

the Operator can, readily, make

To be added to the Note, at the End.

The great superiority of the Qualitative analysis, now given, above every other, for the main purposes of the Classes, for whose use, such a Manual, was desired by the Society, must be fully evident, from the subjoined schedule of Articles and cost. All that is needful for this process, will cost, perhaps, $20. or $30; while nothing short of 200 or 300 dollars, according to circumstances, would be required for the other methods.

		$1.25
		.25
		2.50
		1.50
		.25
		1.50
Test Tubes	Fig. 4.	.50
Tube Rack	Fig. 4.	1.00
Porcelain Evaporating Dishes	Fig. 5.	1.00
forw.d		9.7

Apparatus, and Reagents.

The Operator can readily, make
of the arrangements required, with
two pounds of quill glass tube; by
aid of a Spirit Lamp; using any cl
bottles, or Florence flasks, which he may
have on hand. Indeed, a Displacement
apparatus will answer very well,
made, extemporaneously, of a clean bottle,
of sufficient size, by cutting off its
bottom.* the articles cost but little,
however, as ready made, by the In-
strument Manufacturer; and most
persons, may prefer to purchase them.

Specific Gravity Bottle,	Fig. 1st. —	$1.25
Pint Bottles A. & B.	Fig. 2d. —	.25
Glass Funnel, with Ground Valve,	Fig. 3d.	2.50
Bell Glass, with Ground Stopper	Fig. 3d.	1.50
Porcelain Diaphragm	Fig. 3d.	.25
Retort Stand, with Rings	Fig. 3d.	1.50
Test Tubes	Fig. 4.	.50
Tube Rack	Fig. 4.	1.00
Porcelain Evaporating Dishes	Fig. 5.	1.00
		9.75

Forwd

brought forward		9.75
Despian Lamps, (H.),	Fig. 16.	4.00
Glass Funnel, and Filters,	Fig. 6.	0.50
Washing Bottle	Fig. 6.	0.75
Precipitating Glasses	Fig. 7.	1.00
Porcelain Filter Ring	Fig. 8.	.25
Platina Capsule	Fig. 8.	5.00
Berlin Balance, & Weights.	Fig. 9.	45.00
Berzelius Lamps.	Fig. 10.	7.00
Platina Spatula.	Fig. 10.	5.00
Agate Mortar, & Wedgewood.	Fig 10.	5.00
Beaker Glasses.	Fig 11.	2.00
Flasks & Retorts	Fig. 12.	1.00
Glass Sliders, for Microscope.	Fig. 13.	0.50
Platina Crucible & Cover.	Fig. 14.	15.00
Washing bottle, for Current of Gas,	Fig. 15.	0.50
Rose's Apparatus for CO_2	Fig. 16.	1.00
Retort & Tube, for Ammonia.	Fig. 17.	0.50
Little bottle for H_2S.	Fig. 18.	0.25
Bottles with Glass tubes, (water).	Fig. 19.	1.00
Graduated Measures	Fig. 20.	2.00
Apparatus of Fresenius Mill, (CO_2)	Fig. 21.	1.00
Cork Borers, (set).		2.50
Hot air Drying Oven.		1.50
forw.d		112.00

92.

brought forward

acetic acid

Nitric

Hydrochloric

Sulphuric

aqua Ammoniae

Alcohol

Contents.

Selection of Specimens ——— P. 6.
Texture of the Soil ——— 7.
Separation of the Solutions ——— 10.
Qualitative Analysis ——— 14.
Examination of the acid Solution ——— 22.
Quantitative Analysis ——— 29.
Examination of Carbonates ——— 50.
Do. ——— Lime ——— 54.
Do. ——— Plaster of Paris — 55.
Do. ——— Guano ——— 56.
Do. ——— Artificial Manures — 61.
Do. ——— Mineral Phosphate of Lime — 63.
Do. ——— Spring Water ——— 64.
Do. ——— Mineral Springs — 67.
Classification of Soils ——— 76.
Origin of Soils ——— 81.
Common Manures ——— 84.
Apparatus and Reagents ——— 91.