recent deposits of which we have spoken. The blue limestone formation, so celebrated for its excellent wheat lands in Pennsylvania, Maryland, and Virginia, continues through Georgia, comes to the surface near Clarksville, in Habersham county, and extends to the Island of Cuba, where we have traced it again for miles.

The limestone lands of the State of New York are celebrated for their fertility and the magnesian limestone of the great west has prodigious extension.

In closing our observations upon lime, we will remark that of all mineral substances it is among the most extensively diffused, so much so that it would be impossible to find a soil without it. An amateur asked us if we had ever found lime in the soil on which we lived; he thought it absent. We answered that, even if we had failed to detect it with the aid of reagents, there was higher evidence of its presence, which could not be contradicted, namely: the bones of the animals reared upon the place, the eggs of our hens, and the houses which snails carried upon their backs.

Those who desire details upon the green sand marl of New Jersey and Delaware, will do well to consult the reports of Messrs. Rogers and Booth; the former was charged with the geological survey of New Jersey, the latter with that of Delaware.

PLASTER, OR GYPSUM.

It is probable that the "marl" of the ancients was plaster of Paris, or gypsum, but it was not until near the close of the last century that its incontestible utility became known; since that period it has become almost a necessity; nor is it surprising that such should be the case, when we consider its efficacy on certain crops, the small amount required to produce a great increase, and the facility with which it can be procured and prepared. The first authentic experiments of which we have record were made by a German clergyman, named Meyer. These were repeated in France, when it soon grew into extensive use. Sulphate of lime, as its name indicates, is composed of sulphuric acid, lime, and water.

Sulphuric acid	46	
Lime	33	= 100
Water	21	

It is unusually soft, and may be scratched with the finger nail. When pure, it is generally of a whitish color, but according as it is found mixed with foreign matter its color varies. It assumes a variety of forms, compact, granular, fibrous, pulverulent, crystaline, &c. Its crystals are sometimes perfectly limpid. Gypsum is plentifully and widely disseminated throughout the crust of the globe, and is confined to no age or particular formation. In some cases it would appear to owe its existence to the decomposition of the sulphuret of iron in contact with limestone or, again, to the action of sulphurous vapors upon that rock. It is not often fossiliferous; but that which is found at Montmartre, in the environs of Paris, is an exception. At that locality

the remains of mammiferous animals, of birds, and reptiles, are very common. In certain formations the sulphate of lime is usually found accompanying common salt. It is also a constituent of some of the marls, which occur along our sea-coast, but only to a limited amount, comparatively. In the State of New York it is found in large quantities, and also in Novia Scotia, whence it is imported into the United States, forming by far the greater portion of that which is used by the farmers of the Atlantic shore.

Notwithstanding all the experiments that have been made, and all that has been written upon the subject, our knowledge of the action of gypsum is limited and very unsatisfactory.

Sir Humphrey Davy analyzed the ashes of clover, and concluded, from the presence of sulphate of lime, that the application of gypsum acted as direct food. But subsequent investigations show that the amount of sulphate of lime in the ash of clover, grown upon gypsumed land, was not greater than the quantity of the same salt, found in the ash of clover, grown on ungypsumed land.

Professor Liebig explains the action of gypsum, as a means through which ammonia is presented to the plant. It is known that ammonia and nitric acid are found in the atmosphere, and that salt and carbonate of ammonia are brought down by rains. That fact may be easily verified by evaporating snow, or rain water, to which a few drops of muriatic acid have been added; crystals of muriate of ammonia will be found. Indeed, without consulting the agency of electricity for the formation of ammonia, it is a natural consequence of the decomposition of animal matters, which is ever progressing upon the surface of the globe, and many plants emit pungent odors, apparently containing more or less of that alkali. According to the eminent professor, the action of gypsum would be confined to the absorption of that gas, to be held in readiness, according to the wants of the plant. But his ingenious theory is no less satisfactory, for it is stated that gypsum has no action whatever on the natural gases, which are stimulated by organic manures. Nor does it appear, from careful experiments made by M. Boussingault, that gypsum has the least action upon wheat, oats, or rye, upon which it is known that nitrogenous manures act most favorably. Rigaud de Lisle, in a paper read before the Paris Society of Agriculture, in 1843, maintained that gypsum only operates upon vegetation grown upon soils without a sufficient amount of carbonate of lime, and his declaration is borne out by the practice in Flanders of applying slaked lime, instead of gypsum, with equally good results. We have heard the same opinion expressed by practical farmers, who knew nothing of the discussion. Having limed their lands to the full requirement, they would look upon the application of plaster as a useless expense.

SULPHATE OF BARYTES.

Another assertion, which has its advantages, gives the entire credit of the action of gypsum to the sulphuric acid which it contains; and this appears to be supported by the fact that the addition of the sulphate of barytes is followed by as strongly marked results as those that are

derived from the application of the sulphate of lime. Experiments were made some years since in Rockbridge county, Virginia, by Dr. Barton, upon whose farm a deposit of the sulphate of barytes was found. It was ground and applied. We are informed by an intelligent observer that the effect was manifest five years after. A paper was written at the time, and published in one of the agricultural periodicals of Virginia. We have not had access to the article, but Dr. Barton received the award of a gold medal for his investigations. Should the usefulness of sulphate of barytes be confirmed, it will be a notable and important addition to the list of fertilizers. It is sometimes called *heavy* spar, owing to its specific gravity, which is almost double that of gypsum or the sulphate of lime; the first being 4.7, and the latter 2.72. Generally it is found white, or reddish, yellowish, white, grey, and even black, compact, granular, crystaline, &c. Insoluble in water, and when decomposed, as may be done by calcining together powdered charcoal, or sugar, starch, resine, &c., with sulphate of barytes, the barytes will dissolve in nitric or muriatic acid, from which it will always be precipitated by the addition of sulphuric acid. It will be recollected that the sulphate of lime is sensibly soluble in water, more so than lime, for when sulphuric acid is added to limewater no precipitate is thrown; whereas, when a few drops of sulphuric acid are added to a solution of the nitrate, muriate, or to the oxyd of barytes in solution, a white precipitate never fails to fall. The carbonate of barytes may be easily distinguished from the sulphate by its effervescing, as it does slowly on the application of nitric acid. It is composed of—

Sulphuric acid	34.37	= 100
Barytes	65.63	

It is, however, often found mixed with different substances, such as sulphate of strontian, sulphate and carbonate of lime, silex, oxyd of iron, and alumine. It occurs in veins in the primitive and secondary rocks, and is most always found in veins of lead, copper, silver, and mercury; in the metalliferous regions of Europe, in the Hartz, Saxony, Hungary, Almaden, in Spain; in the United States, in New York, Connecticut, New Jersey, Pennsylvania, Maryland, Virginia, Missouri, &c.

Owing to the great analogy that exists between the characters of the salts of strontian and those of barytes, it would be surprising if the fertilizing properties attributed to the one were not common to both, particularly if the acid were found to be the active fertilizing principle as well in the sulphate of lime as that of barytes; other sulphates, such as the sulphate of iron, (green vitriol,) when much diluted with water, without the presence of lime, have extraordinarily advanced the growth of plants, including beans, potatoes, rye, Indian corn, carrots, &c. Weak sulphuric acid has also a favorable effect when applied to clover, but in both cases it may be argued that the sulphate of iron, (which is soluble,) and the sulphuric acid come in contact with lime in the soil, and sulphate of lime is then formed, and may act in that state upon crops; or the acid, in one case or the other, may combine with ammonia, already existing in and combined with the earth, and form sulphate

of ammonia, which is a valuable and well-known fertilizer. But we will here remark that, in our laboratories, the sulphate of barytes is found to be one of the most stable of salts, and its combination is in no instance decomposed by lime or ammonia. Nor does barytes form a constituent of any vegetable or animal organism within our knowledge. A small quantity of the nitrate of barytes will destroy vegetable life very quickly; yet nitric acid is a strong fertilizer, and one of the principal furnishers of nitrogen to plants.

MAGNESIA.

Magnesia is a common substance, largely disseminated, existing in most soils, is one of the constituents of many rocks, and is most always present in vegetables and animal bodies. It is a white, light, and odorless powder, infusible at the highest temperature of our furnaces, and slightly soluble in water. It forms soluble salts, with nitric, muriatic, or sulphuric acid, and may be easily distinguished from lime, by the fact that it is precipitated from its solution by limewater. It is generally found in combination with lime in all calcareous rocks, and in certain varieties it is a constant constituent; such are the dolomites, or magnesian limestones, which are largely developed in Europe, as well as in America, and have received the name of metalliferous limestone, from the mineral substances which they contain. Magnesian limestones are found to an immense extent, in the western States, and constitute the lead and copper-bearing rocks of Missouri, &c. They are also found in New York, Pennsylvania, &c. Magnesia is moreover, one of the constituents of serpentine and talcose slate, which last-mentioned rock extends continuously from Pennsylvania to Georgia, and through the West Indies, to the continent of South America. It is remarkable as being the formation in which gold, silver, copper, chromate of iron, &c., are contained. The carbonate of magnesia and the carbonate of lime have many properties in common, the one replacing the other, and those plants which grow upon magnesian soils, contain the carbonate of magnesia instead of the carbonate of lime. Those two salts being isomorphous, according to Bergmann, magnesia forms an important part of some of the most fertile soils, and of the mud of the Nile. Einoff mentions a marl of extraordinary merit, which yielded him as high as twenty per cent. of the carbonate of magnesia. Stöckhardt says that the most famed lime stone in Saxony is a dolomite; and eighteen analyses, each specimen being from a different quarry, yielded from forty-one to forty-four per cent. of carbonate of magnesia. It is carried from the quarries to a great distance, because these limes, from undoubted and universal experience, act more powerfully and at the same time more permanently than other kinds of Saxon lime, although many of these latter are extraordinarily pure. The same eminent observer states, that well-known recent investigations of the ashes of various kinds of corn grains show a percentage of magnesia of 11.1 grains, against 3.4 of lime; and the analysis of the ashes of twenty kinds of peas, grown in the most varied soils and districts, of 8.3 to 4.5. With very few exceptions, a similar preponderance of magnesia is exhibited by other kinds

of seed, so far as their mineral constituents have yet been examined, for the proportion of magnesia exceeds that of lime, in approximative round numbers, two to one in peas, beans, vetches, quince, buck wheat, linseed, &c.; two and a half or three to one in wheat, rye, oats, coffee, &c.; six or eight to one in maize, millet, and in the seeds of pines, firs, &c.

On the other hand, the opposite condition occurs regularly in the leaves and stems of plants, and in the wood of trees, in which lime has always the superiority over magnesia, and exists in two to eight times greater quantity, whence he deduces the law, that magnesia is especially necessary for the maturation of the seed, and lime for the development of the herbaceous and woody structure.* Lampadius also thinks this substance particularly favorable for the production of rye.

We have dwelt upon this subject, because much injury has been caused to agriculture by the prevalent opinion that the presence of magnesia in limestone, when calcined and applied to land, was followed by bad consequences. Much has been written to explain the cause of this, as we consider it, imaginary evil. Caustic magnesia, or magnesia without carbonic acid, may absorb carbonic acid much more slowly than lime, and in the presence of the latter substance, it will not combine, until the lime has been saturated; yet after all that has been stated, it would appear less than probable, that the presence of caustic magnesia should play so unfavorable a part, and so contrary to experience.

The salts of magnesia may be employed, as the salts of lime, for fixing ammonia, but in that case its application will depend upon its cost. When a salt of that base is added to urine, it produces a precipitate of the phosphate of magnesia and ammonia. Caustic lime, containing magnesia, is used for this purpose; but owing to the bulk of lime, the amount is rendered less portable. The phosphates of magnesia and ammonia, when applied at the rate of one hundred and thirty to two hundred and sixty pounds per acre, had a powerful effect upon the production of Indian corn; at the rate of three hundred weight per acre, it increased the crop of grain six times, and of straw three times.†

Magnesia is a constant and important constituent of sea-water. It is also found in many mineral waters, and to this fact their virtues are attributed. As it usually exists in the ashes of cultivated plants, its presence in the soil is a requisite to fertility, and its addition of manifest necessity wherever it may be wanting.

PHOSPHORUS.

Of the substances with which the farmer has to do we think phosphorus the most important. It is found in all animals and vegetables; without it neither the one nor the other could live. It is detected, if not pure, as has been stated frequently, in combination with a particular organic substance, in the brain, the spinal marrow, the spermatic liquid, in the melt of fishes, certain mollusca, &c. It is also diffused very widely, and is discovered in combination with oxygen in all rocks, in all soils, and

* Stöckhardt's Agricultural Chemistry.
† Johnston's Agricultural Chemistry.

in the flesh, bones, &c., of fish, reptiles, insects, birds, animals, and their secretions. Some of the fossil excrements of extinct animals are extensively and advantageously used as fertilizers. Wherever there are organisms, either vegetable or animal, or their remains, it is very strong evidence of the presence of phosphoric acid. It is detected in almost all limestone rocks, and particularly in those containing fossil remains. Close investigations show its presence in the older crystaline rocks; and where it has not appeared as a constituent in any analysis made hitherto, we do not look upon that as evidence of its absence, for the reason that this substance was not suspected, and the analysis were generally conducted in a manner to ignore its presence. Besides, all who have analyzed much know that phosphoric acid is a great complicator, and requires special attention and care to appreciate. In small quantities (and all analyses of minerals must be made upon small quantities to give exact results) it may be overlooked, and its presence not even suspected. We feel confident that future research will proye what we have stated to be perfectly true.

Organisms exist, procreate, live, and die, wherever there is heat, air, and moisture. They are in the air, in fresh and salt water, in the arable soil; and their remains constitute the principal mass of immense calcareous formations. It would appear that they are found from the equator to the regions of eternal ice; and according to the observations of the learned Ehrenberg, have been discovered at work in certain localities to the depth of twenty or thirty feet.* If they make a portion of all animated bodies, it follows that this interesting substance is omnipresent, and plays a part in fertilization much more important than has hitherto been attributed to it. An alchemist in Hamburg first discovered phosphorus by evaporating urine and calcining the residuum. Though this was done in 1669, by Brandt, it was not known to the public until many years after, when Gahn and Scheele extracted it from animal matters, and explained their process of obtaining it from the bones of animals, a mode pursued up to the present time. It is a simple substance, of a yellow color, tough, and resembling wax. It may be procured in three states, solid, liquid, and gaseous. At the temperature of freezing water, it is hard, brittle, and even friable. It crystalizes, and its density is about 1.77. Phosphorus, when exposed to the air, is luminous, owing to the fact that it absorbs oxygen and undergoes a slow combustion. Hence its name, from two Greek words, which signify light-producer. When inflamed in the air, or in oxygen gas, it produces white fumes, and when collected free from humidity, is white, pulverulent, and absorbs the humidity of the atmosphere, or deliquesces, and becomes liquid. This combination of phosphorus with oxygen is called phosphoric acid. It inflames easily, and produces obstinate wounds; therefore, it is kept under water, and handled with pinchers. In this condition it may be melted without danger, and is purified by distillation and filtration through buckskin under hot water. Phosphorus combines with oxygen in several proportions; but we shall only dwell upon that which

* See Ehrenberg on Infusoria, and his researches as to the cause of the instability of found ations under the city of Berlin.