IX.—*On deposits of soluble or gelatinous Silica in the lower beds of the Chalk formation.*

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The author described the discovery which, in conjunction with Mr. J. M. Paine, of Farnham, he had made of large deposits of silica in the condition in which it is readily soluble in solutions of caustic potash or soda when boiled with these solutions at ordinary temperatures in open vessels.

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The beds containing this silica are geologically situate at the base of the chalk formation between the upper green sand and the gault clay. At Farnham, where the beds have been most examined, they are very fully developed, coming to the surface over a considerable breadth of land, and extending to the distance of several miles. Judging from the dip of the strata, and from such sections as the quarries in the neighbourhood afford, the author believes that the total thickness of the deposit in question cannot be at this spot less than from 80 to 100 feet in thickness. It is not, however, of uniform character throughout, but consists of beds of yellowish, light, soft rock, intercalated with loose and apparently sandy marls.

The attention of the author was first drawn to this subject during the examination of a series of specimens representing the strata of the chalk formation, which were collected for analysis about three years ago. On examining some of the lower deposits of this series, he was struck with the circumstance that, though of a yellowish-white colour, of small density, and having every appearance of being chalk marls (under which name they are indeed generally used in agriculture), they did not, in many cases, exhibit the smallest effervescence when treated with an acid, and contained merely a trace of lime in any form.

The following results were obtained from the analysis of a specimen of this earth.

Soluble in acids	{	Silica	40·30
		Peroxide of iron	2·26
		Alumina	3·44
		Lime	·61
		Magnesia	·47
		Chloride of sodium	·14
Insoluble in acids	{	Potash	·43
		Silica	41·23
		Alumina, with a little oxide of iron	11·12
		Traces of lime and magnesia	
			<hr/> 100·00

The silica "soluble in acids" is here the total quantity of silica which is soluble in potash after treatment with boiling muriatic acid in the usual way. The quantity of soluble silica directly dissolved out by potash without previous treatment with an acid, is in this case 28·70 per cent. The author observed that the existence of these beds was not altogether unknown before. Since he had been engaged upon this examination, he had found that similar deposits of

soluble silica had been mentioned by Sauvage, in the *Annales des Mines*, as occurring in the Département des Ardennes, in France. Sauvage had found as much as 56 per cent of soluble silica in these deposits; and from their description it was plain that they were the same beds, although somewhat differing from the corresponding strata in England.

Within the last two years, as many as 80 or 100 samples have been carefully collected by the author and Mr. Paine from the land of the latter at Farnham, and examined in reference to the proportion of soluble silica they contain. In all cases the quantity of soluble silica has been determined by boiling the dry and powdered earth in moderately strong solution of caustic potash or soda, which dissolves the free silica without, as is well known, affecting that portion which is combined with alumina as clay or the silica that may exist as sand.

The quantity of soluble silica so ascertained has been found to constitute from 5 to 72 per cent of the dry earths. As a rule, the deposits which are geologically nearest the gault clay contain the smallest proportion, which increases in the beds as they rise towards the green sand. The largest proportion that has been observed hitherto has been above stated as 72 per cent. This particular bed is at Farnham of about 10 or 12 feet of thickness, and close to the surface of the land on the hill-side. It is very remarkable when dry, on account of its extreme lightness, by which and by its porosity it is easily recognized. Very many of the beds have been found to contain as much as 60 per cent of free soluble silica, and 20 or 30 tons have been sent to London, affording, when ground up, an average amount of 64 per cent. There is therefore no doubt of the beds in question being available as a source of soluble silica if it should be found desirable so to employ them.

The author mentions that although many of the beds contain no carbonate of lime, there are others in which both soluble silica and carbonate of lime are associated. These beds are generally of a harder and more compact character, and are used locally as building-stones. The "firestone," which is quarried to a considerable extent at Godstone and Reigate, in Surrey, and used in London to form the backs of fire-places, is from the same deposit, and of similar composition. Mr. Way has found the building-stone to contain about 25 per cent of soluble silica with 50 per cent of carbonate of lime and 25 per cent of clay.

With the exception of the building and firestone rock, which are of considerable hardness, the other beds are easily reduced to powder;

indeed, when first dug up in the moist state they readily crumble between the fingers. When examined by the microscope the silica is found to be amorphous.

With the exception of a few casts of foraminæ the deposit is not infusorial.

Mr. Way proposes to employ these beds as a source of silicate of lime for agricultural purposes. He finds that the silica can be made to combine with lime with great ease in several ways: a mixture of slaked lime with the powdered rock, when made into a thin mortar, and left for several weeks, is found to be entirely converted into silicate of lime. The process is hastened by adding 2 or 3 per cent of carbonate of soda, which becoming caustic, dissolves the silica, forming a soluble silicate, which is subsequently decomposed by the lime; and in this way, the soda acting as a carrier between them, causes a speedy union between the silica and lime.

Another method of producing the silicate of lime, is to mix the slaked lime with the powdered rock and sufficient water to bring the mixture to the thickness of gruel, and to heat to nearly the boiling-point; the combination is complete in about an hour. In all cases the silica is used in the proportion of 3 equivs. to 1 equiv. of lime.

A mixture of the rock with chalk, when heated to low redness in a reverberatory furnace, gives the compound in a very fit condition for agricultural use; but it is necessary that the heat should be carefully regulated, otherwise the silicate becomes altogether insoluble in water.

The author has found silicate of lime produced in either of the above ways soluble to the extent of about 20 grains in the gallon of distilled water; and as the largest portion of the 20 grains so dissolved is silica, he considers this solubility sufficient in relation to the quantity of water passing through plants, to supply all the silica required by wheat, barley and other plants of the silicious class.

He proposes to employ the silicate of lime as a manure for light lands, and he anticipates that it will serve to correct the over-luxuriance and tendency to be "laid," which is so common in well-manured light soils, and that it will render the use of guano and other nitrogenous manures more certain and more admissible on such lands.

Mr. Way, in conclusion, suggests a possible connection between the existence of these beds and the production of the chalk itself. He thinks it certain that the deposits of soluble silica can only have been formed from solution and in the absence of heat. Silicate of lime, derived by disintegration from the older rocks, many of which contain it in abundance and dissolved in water, may be supposed to

be acted upon by carbonic acid derived from the decomposition of animal and vegetable matter or from volcanic sources. The results of such an action would be the production both of carbonate of lime and of soluble silica. The author points out as an interesting fact, that we not only find the chalk closely associated with the silica beds, but that in the case of the building and firestone before described, they are in some cases intimately mixed, which could hardly have occurred if the two deposits were not due to some common origin.