THE

Mineral Waters of Ky:

BY

L. J. FRAZEE, M. D.,

Read before the

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To the Physician, if to no one else, the character of the water we drink is a matter of acknowledged importance, and one deserving a most careful investigation. Preliminary, then, to a consideration of the Mineral Waters of Kentucky, let me observe that the water in general use for drinking, and for culinary purposes may be divided into three kinds; First: Rain Water, the purest form; Second: Free Stone or Soft Water, containing slight impurities absorbed in its passage through the soil, but containing little or no lime; and Third: Limestone or Hard Water, containing with other impurities, derived from the soil through which it passes, a certain amount of lime

Now, while we are willing to admit that many persons may use the ordinary hard or limestone water for a long series of years without any deleterious results, yet, in other cases, and more especially those predisposed to dyspepsia, and to affections of the urinary organs, we consider its constant use as decidedly injurious. It seems to be very generally admitted that calculous affections are particularly common in limestone regions of country, a very striking proof of which we have in the fact that our great Kentucky surgeon, Professor Dudley, operated for stone in the bladder over two hundred times It is true Doctor Dudley's great reputation, and his extraordinary success in this operation may have attracted some patients from a greater distance, yet, by far the greater number were, no doubt, from the limestone regions of Kentucky and Tennessee. Professor Gross, in his report on Surgery made to this Society in 1852, gives the number of cases of lithotomy positively known to have occurred, up to that time in Kentucky, at three hundred and sixty-five. And this, we think, falls a little short of the full number. As to the effects of hard water upon dyspeptics we will simply appeal to the experience of physicians in Louisville, where we have had most abundant and satisfactory opportunities for making observations touching this matter. It is well known that our pump water is supplied from a bed of gravel underlying the city, and is strongly impregnated with lime. In 1860 our Water Works went into operation, supplying us with river water, which contains so little lime that it may properly be considered soft water We are willing to admit that in some cases the change from hard to soft water, was not followed by any decided relief to the dyspeptic; in other cases, however, and in one or two remarkable ones I could here mention, the improvement was so decided, the surroundings remaining about the same, that we do not hesitate to give it as an opinion that it was due, almost, if not exclusively to the substitution of the soft, for the hard water. Of the many persons among us afflicted with urinary calculi, who found themselves benefitted by the change from hard to soft water, we would particulary notice the case of Mr. B ——, a prominent citizen who had suffered repeatedly and very severely from the passage of calculi;-but who has never had a single

attack since he has commenced the use of the hydrant water We do not pretend to say that dyspepsia of a confirmed character, or calculous affections of an aggravated form, can even *usually* be cured by simply discontinuing the use of hard water—we only maintain that it is a most important element in the treatment, and one that is but too often underrated. May we not as reasonably expect to permanently relieve a case of intermittent-fever while the patient is suffered to remain in a malarious district, as to relieve a case of dyspepsia or a calculous affection while the patient is kept on hard water? Is not every draught of hard water just so much fuel added to the flame? In very many cases we can not doubt that it is. With these few hints in regard to the water we use as a beverage; we pass now to a consideration of our subject proper, viz: The Mineral Waters of Kentucky

When we remember the great variety of soils, subsoils and minerals found in our State, it will readily be comprehended that the rain water, in passing through and over these, becomes more or less impregnated with the soluble portions of their constituents. forming the various mineral waters, with which we are so abundantly supplied, found in various portions of our State.

We are not prepared to enter upon the Herculean task of describing *all* of the mineral springs and wells in Kentucky, which are numbered by the hundreds, if not thousands, but shall content ourselves with noticing simply a few of the more prominent ones, which may serve as types of the rest These waters may be divided into four classes; First, the Chalybeate; Second, the Sulphur; Third, the Salt Sulphur; and Fourth, the Saline. But, instead of noticing each kind of water under its particular head, as to quality. we prefer taking up all the springs of whatever character in one locality, and describing them together. Commencing, then, in the north-eastern portion of the State, let me observe that of all the mineral springs found so abundantly in the counties of Lewis, Greenup and Carter, none are perhaps so well known as those called Esculapia, situated in Lewis county about twenty miles from Maysville, and some twelve miles from Vanceburg on the Ohio river. Here there are two lofty ranges of hills capped with sand stone, running nearly parallel with each other, and from one of which, near its base, issues the Sulphur, and from the other the Chalybeate water. These streams are of about the same strength, each discharging, we should judge, about one hundred gallons of water per hour The water from each is delightfully cool in summer, and when caught in a vessel transparent; but, if suffered to stand long enough. a precipitate is formed, in the case of the Sulphur water, of a white color, and consisting largely of pure sulphur. In the case of the Chalybeate water, the deposit is of a reddish brick dust appearance, and composed mostly of the hydrated peroxide of iron. These deposits may be traced along the course of the streams for some distance from their points of issue, and find a ready explanation in the fact that the excess of carbonic acid gas, by which they are held in solution, escapes when the water comes in contact with the atmosphere.

That the sources of these springs are very deep is sufficiently apparent from the fact, that, in the dryest seasons the supply of water remains about the same. I recollect to have spent some two weeks here in August, 1834 or 35, during the prevalence of a severe drought in this section of the State, when the supply of water, both Sulphur and Chalybeate, seemed to be about as abundant as I have found it on subsequent visits here So far as I now know, the quantitive analysis of neither the Sulphur nor the Chalybeate water here has ever been made. Dr Peter found in the Sulphur spring, free sulphuretted hydrogen gas, bicarbonate of lime, bicarbonate of magnesia, chloride of sodium, chloride of magnesium, sulphate of soda and sulphate of magnesia. While, therefore, it is, strictly speaking, a sulphuretted saline water, it is proper to remark

that most of these saline ingredients are in very minute quantities, so much so, that the chloride of sodium, the sulphate of soda, and the sulphate of magnesia it contains, renders it very slightly, if at all, aperient. Sulphur, in the form of sulphuretted hydrogen gas, with which this water is impregnated, may be considered, by far, its most important ingredient. Its effects are soon seen upon the skin, which it clears up and bleaches, and is eliminated in such quantities as to readily blacken silver worn near the person.

The principle effect of this water seems to be to stimulate the secretory action of the system generally, but more especially that of the skin and that of the kidneys. In fact, the water is so rapidly eliminated by these great emunctories, that usually no inconvenience is felt from taking large draughts of it into the stomach. Six or eight glasses, and some times even a dozen have been taken by persons before breakfast, certainly a very silly practice; for aside from the extra service thrown upon the skin and kidneys to get rid of it, only a limited quantity of the water can be appropriated by the system, any great excess remaining in the stomach at the time of eating only interfering with digestion. The addition of a small quantity of choride of sodium renders this water gently aperient, this addition of salt to be made to the first draught of water taken in the morning, and if possible from half an hour to an hour before eating.

We can most confidently recommend the use of this water where there is torpor of the glandular system, and especially where there is defective action of the skin and kidneys, whether the effect of disease or the result of close confinement and over exertion, especially during the hot months of summer. Various forms of cutaneous disease are often most essentially benefitted by the use of the sulphur water. In a large proportion of those cases in which there is debility of the digestive organs, or of the system at large; a condition so often found among delicate females; the use of the chalybeate water may be combined with that of the sulphur to great advantage. In using the chalybeate water, however, proper caution should always be observed. In the first place, this is what we term a *heavy* water, not as to specific gravity, for this is less than that of many of the saline waters, but in relation to the sensation of weight about the stomach when it is taken in over quantity, it failing to pass off rapidly by the skin and kidneys like the sulphur water. A glassful of this water at a time, taken three or four times in the twenty-four hours, will, we think, usually be quite sufficient, and indeed, in some cases, we would advise but half this quantity. Whenever the use of the water is followed by headache and a sense of oppression about the stomach, let it be discontinued for several days, and when resumed, always in diminished quantity. We need hardly observe that there are certain conditions, such as general plethora, high febrile action, and inflammation of any of the important organs, especially the stomach, which contraindicate the use of chalybeate water in common with all the preparations of iron. Unless previously advised of the cause, persons using this water may become alarmed at the very dark color imparted to the feces.

As to the length of time, either this or any other mineral water should be used, of course no absolute rule can be laid down; perhaps the best advice that can be given to any one visiting a watering place for health, is to continue the use of the water as long as any improvement is manifest. When this ceases, the use of the water may be stopped, for a time at least, to be resumed again at the end of a week or a fortnight if necessary. In the interval the party may return home, or if he remain at the Springs, use only the ordinary drinking water; which here, is a pure limpid freestone.

The pure mountain air, the perfect freedom from malaria or any other local cause of disease, with the superior waters here, have, in

years gone by, rendered this a most delightful and profitable retreat for the invalid. But like many of our other watering places in Kentucky, it has been neglected and suffered to go down.

The Kirk Spring on the opposite side of the mountain, now no longer a place of resort, affords a sulphur water so identical, as to properties and effects on the system, with that of Esculapia, as to demand no special notice.

The Fox Springs, situated on the head waters of Fox Creek in Fleming county, and some ten miles from Flemingsburg, the county seat, is still a place of resort. There is here, both white sulphur and chalybeate water, similar to that of the Esculapian Springs, which, together with a pure bracing atmosphere, and very good hotel accommodations, renders this a pleasant resort during the hot weather of summer. What we have said in regard to the use of the waters of Esculapia, applies to the use of those of the Fox Springs.

The Olympian Springs, situated at the spur of the knobs in Bath county, was once a place of considerable resort, but has now fallen into neglect. There are found here some five or six varieties of mineral water, all containing, in common, carbonate of lime, carbonate of magnesia, and carbonate of iron; the result of percolating through ferruginous magnesian limestone All of them too contain carbonic acid gas, and the sulphur waters, of course, sulphuretted hydrogen gas. The selection of the kind or kinds of water to be used by the visitor to these Springs must be determined by his peculiar condition.

The Epsom water, the predominating salts of which, are sulphate of magnesia, and sulphate of soda is a most efficient aperient, and admirably adapted to cases of constipation of the bowels. This should, however, like the Crab Orchard, Blue Lick. and other active aperient waters, be used with proper discretion, and always in reference to effect rather than quantity. In a large majority of cases, one or two evacuations from the bowels in the twenty-four hours, will, we think, be found quite sufficient. any thing beyond having a tendency to pull down, rather than build up With the erroneous opinion which prevails, that the benefits derived from mineral waters are in proportion to the quantity taken, it is not surprising that those of a more active character are often used too freely. In those cases demanding the use of sulphur water, a choice may be made between the Salt Sulphur and the Black Sulphur. selecting that which is most agreeable to the patient; bearing in mind that in the former, there is a sufficient quantity of salt to make it slightly aperient, while in the latter, there is less salt, but a sufficient quantity of carbonate of soda to render it alkaline; a matter of some importance in a large proportion of cases of dyspepsia, where there is present acidity of the stomach and bowels. We would recommend the use of this water also in those cases in which there is a general acid diathesis, which may usually be detected by the condition of the secretions, especially that from the kidneys. The Chalybeate water here, though feeble, may be regarded as a very important adjunct to the other waters in all those cases demanding the use of iron. As to the Salt water here, especially that near the kitchen, which is very much the strongest, we think its most available use is for bathing purposes. The lower Blue Lick Springs, situated on Licking River near where the Maysville and Lexington turnpike road crosses that stream, was, for some years, one of the most noted watering places in Kentucky. In the early settlement of the State, this was known as a salt spring, and the water extensively used in the manufacture of salt This use of the water was, however, abandoned after the discovery of the Kanawha and other rich salines, followed by a wonderful reduction in the price of this invaluable article. In time the medicinal virtues of the water began to be recognized, and fully half a century ago it was hauled in wagons to the surrounding counties, several neighbors often joining in sending a team for a few

barrels of the water to be distribnted among them for the summer's use. Visitors were attracted here during the summer season, and by degrees this became a place of great resort, reaching its highest popularity under the proprietorship of the Hollidays, who, purchasing the property about thirty years ago, made extensive improvements, and were liberally patronized, but the season was so short and the expense of keeping up the establishment so heavy, that had it not been for the heavy sales of the water, the enterprise would no doubt have proved a loss. So great was the demand for this water, particularly in the South, that these enterprising gentlemen shipped in a single season, some nine thousand barrels. Although this water bears transportation remarkably well, still retaining most of its active properties unimpaired; yet, when convenient, we would prefer using it at the Spring, from the surface of which the gas is constantly escaping To some persons the taste, as well as the smell of this water, is so repulsive, that they never use it, even whilst at the Springs; others, however, seem to relish it exceedingly, especially when taken fresh from the Spring in hot weather From the analysis of this water, which we subjoin, it will be seen that it contains both sulphuretted hydrogen gas, and carbonic acid gas, together with a number of solid constituents, the most important of which, as well as the one in much the greatest abundance, is the chloride of sodium This aided by some of the other salts, gives to the water its aperient properties, while the sulphuretted hydrogen gas renders it diaphoretic and alterative; the alterative effect being undoubtedly enhanced by the bromide and the iodide of magnesium. Taken in sufficient quantity Blue Lick water is actively aperient, producing free watery discharges unattended with griping or other unpleasant symptom. At the same time its effects upon the skin are well marked, the sulphur being so freely eliminated through this channel, that silver worn near the skin soon becomes blackened. It will be very apparent from what we have said, that this water may be used to advantage in a large number of morbid conditions of the system, such as torpor of the bowels, torpor of the secretory process generally, especially that of the skin, and in various forms of cutaneous disease. While the robust healthy person may take the water *ad libitum*, the delicate female or any one worn down by disease, must of course use it with proper caution, the daily allowance being at first small, and the quantity increased with due care. In these cases, especially, we would recommend that the water be taken when the stomach is empty, say half an hour before, or two or three hours after eating. In some cases a draught of the water upon going to bed, and another upon rising in the morning, has acted very well indeed.

Besides the excellent effects following the internal use of this water, it may be most confidently recommended for bathing purposes, much of its virtue in this way being undoubtedly due to the salt, and sulphur which it contains

Since the destruction of the main building at these Springs which occurred some years ago, it has not been a place of much resort. We can not see, however, considering the excellence of the water, the pleasant drives, the freedom from any local cause of disease here, and its easy access by rail-road and turnpike, why it may not soon be revived as a watering place.

The water at the Upper Blue Licks, situated a few miles higher up the Licking River, is so similar to that of the Lower Licks as to need no special notice here.

Estill Springs, situated in the outskirts of the town of Irvine, Estill County, a few hundred yards from the Kentucky River, is another one of our watering places which has gone down. There are here several varieties of sulphur water, the White, the Black and the Red, and also Chalybeate water; the latter not very strong, yet unquestionably containing enough iron in the form of carbonate, to impart to it distinctive

tonic properties. All of the sulphur waters here contain carbonic acid gas and sulphuretted hydrogen gas, also carbonates of lime and magnesia, chloride of sodium, sulphates of magnesia and soda, together with some other salts of less importance. The Red Sulphur contains the largest proportion of chloride of sodium. while the Black Sulphur contains the most iron, even more indeed than the Chalybeate. We have already, when speaking of the Esculapia Springs, indicated the uses of both the sulphur and the chalybeate water, a repetition of which here, is unnecessary. Situated at the base of elevated knobs which overlook the windings of the Kentucky River for many miles, with a cool salubrious atmosphere, and within eighteen miles of Richmond, the terminus of the rail-road, these Springs may again become a summer resort

Thirty years ago the Harrodsburg Springs under the management of Dr. Graham, was one of the most popular watering places in Kentucky. The beautiful grounds. and the fine hotel accommodations presenting the most attractive features of the place. The most important ingredient of the water here, is sulphate of magnesia, which renders it aperient. but aside from this it possesses no very decided medicinal virtues. It may be used in torpor of the bowels, especially when accompanied with dyspeptic symptoms, indeed in almost every case where a gentle aperient effect it desired. This has long since been abandoned as a watering place.

Bedford Springs at the town of Bedford, in Trimble County, still attracts some visitors, being most conveniently reached by the Short Line Rail Road and Omnibus, the latter connecting at Sulphur Station some five or six miles from the Springs The water here resembles so closely, both in composition and effects on the system, that of the principal spring at Harrodsburg. that any special notice of it becomes unnecessary.

The Crab Orchard Springs, situated at the village of Crab Orchard in Lincoln County and immediately on the line of the Louisville and Knoxville Rail Road has become one of the most noted watering places in Kentucky. There are here within a circuit of a few miles, at least a dozen mineral springs, affording three distinct kinds of water: Sulphur, Chalybeate and Epsom. The sulphur and chalybeate waters here approach so nearly in composition, and consequently in their effects upon the system, the same waters of Estill, Bath, Fleming and Lewis Counties, already noticed, as to demand from us no special mention. The Epsom water, of which there are several springs, or rather ditches into which the water oozes, contains carbonate of lime carbonate of magnesia, and a trace of carbonate of iron. The most important salts are the sulphate of magnesia, the sulphate of soda, and the chloride of sodium. The sulphate of magnesia exists in the largest quantity, amounting to from three, to three and a half parts in a thousand, and aided by the sulphate of soda and the chloride of sodium, renders this water a most effective aperient This is certainly the chief, if not the only effect of the water. The iron evidently being in too small proportion to impart any very decided tonic properties, while the specific action on the liver claimed for this water and for the salt manufactured from it, may well be doubted. We are free to admit, that this like other aperients may indirectly promote the secretion of bile, or its discharge from the biliary ducts, by removing conditions calculated to retard these processes. But after many years experience with the Crab Orchard Salt, which embodies the essential ingredients of the water, we are by no means convinced that it possesses any specific cholagogue properties Such an impression may have originated among the non-professional in the fact that the iron contained in this water imparts a dark color to the stools This water acts so pleasantly and yet so effectually as an aperient, that we can most cheerfully recommend it in torpor of the bowels; a condition so very common in dyspepsia, and other serious

disturbances of the digestive organs. In many of these cases the sulphur and chalybeate water, may undoubtedly be used to advantage with the Epsom. The latter always to be used with that caution already indicated as necessary in the use of active saline waters

The variety of waters at Crab Orchard, its healthy situation, and easy access by railroad, would no doubt, with more ample and attractive improvements, render this a still more popular watering place.

Grayson Springs situated in Grayson County and within about four miles of the Elizabethtown and Paducah Rail Road, has, especially since the completion of that road, become a place of considerable resort. In a small valley here, and within a circuit of a few hundred feet, there are a large number of springs, differing slightly in composition, and yet without an exception, we believe, bearing a general analogy, all being sulphur So far as we have been able to learn, a quantitive analysis of these waters has never been made, but the qualitative analysis as given by Dr. Peter in the Geological survey of Kentucky shows the presence of sulphuretted hydrogen gas, carbonic acid gas, sulphate magnesia, chloride of sodium and phosphate of soda The same constituents which are found to predominate in the white sulphur water at Esculapia, Olympian, Estill and the White Sulphur of Virginia. We have already noticed the effects of such waters upon the system, and attempted to indicate their more available uses.

We have been informed that very recently a chalybeate water has been discovered on the Grayson Spring property, which, if it proves true, will of course be a very valuable addition to the excellent waters heretofore in use there.

The Paroquet Springs, situated about eighteen miles from Louisville and within a few hundred yards of the Louisville and Nashville Rail Road have recently been improved and re-opened as a watering place The water here, which is a strong sulphur, possesses very decided medicinal properties, resembling, in some respects, the Blue Lick, and in others, more closely the DuPont Artesian water, though differing somewhat from either of them. It contains both sulphuretted hydrogen gas, and carbonic acid gas. while the salts found most abundant in it are the chloride of sodium, the chloride of magnesium, and the chloride of calcium. By a reference to the analysis of this water it will be seen that it contains twelve times as much sulphuretted hydrogen gas as the White Sulphur of Virginia, nearly six times as much as the Blue Lick; but only about one seventh as much carbonic acid gas, and about two thirds as much chloride of sodium as the last named water. It is very similar in its action upon the system to the Blue Lick water, being aperient, alterative, and having a decided action upon the skin. It may, therefore, be used in the same affections as the Blue Lick water, and with the same precautions. The chief advantages of this as a watering place, are the excellence of the water, which, like the Blue Lick, combines a number of valuable elements; and its convenience of access.

The Drennon Springs, situated in Henry County, and within a few hundred yards of the Kentucky River was once an attractive summer resort, but has long since been abandoned as a watering place Not, however, on account of any defect in the quality of the water, which is a good salt sulphur, the most active ingredients being sulphuretted hydrogen gas chloride of sodium, sulphate of soda, and sulphate of magnesia. This water, like the Blue Lick and the Artesian, bears transportation, losing of course some of its gaseous contents; but still holding in solution its most active salts.

DuPont's Artesian Well, on Tenth Street, Louisville, is remarkable for its depth, the abundant supply of water, and the character of this water. The depth of this well, which was commenced in April, 1857, and finished in August, 1858, is according to Dr J. Lawrence Smith's Report, two thousand and eighty-six feet; being at the time of its com-

pletion, with the exception of the Belcher Well at St. Louis, the deepest artesian well known. The supply of water according to the same Report, is three hundred and thirty thousand gallons in twenty-four hours, containg five hundred bushels of salt. The constant temperature of the water at the bottom of the well is 82½°; showing an increase in temperature as we descend of 1° for a fraction over every sixty-seven feet; which would give us the boiling point of water at a depth of a little over two miles beneath our city. The subjoined analysis of the Artesian water shows it to be very heavy, containing, as it does, over nine hundred grains of solid matter in the gallon, which is nearly fifty per cent more than the Congress, and double that of the Paroquet water It contains double as much chloride of sodium as the Paroquet, thirty times as much sulphate of soda, and a notable quantity of sulphate of magnesia which is not found in either the Paroquet or the Blue Lick water; these salts rendering it very actively aperient. It contains nearly as much sulphuretted hydrogen gas, but not quite one third as much carbonic acid gas as the Blue Lick water While, therefore, the large amount of active salts which the Artesian water contains renders it even more decidedly aperient than either the Blue Lick or the Paroquet; it sets a little heavier upon the stomach than the last named waters. While we would not underrate this water used internally, we would direct attention to its very superior qualities for bathing purposes. which we have tested in person As the water will rise in closed pipes to the height of one hundred and seventy feet it would be easy by means of a reservoir and conducting pipes to supply bath houses in different parts of the city, thus affording delightful baths to both citizens and strangers The bathing establishment erected by the Messrs DuPont near the Well, was a very creditable establishment indeed, but too remote from the centre of the city to come into that general use which it deserved. This is still a flowing well, the water being conducted off beneath the surface of the ground to the river; but the pipes and superstructure being removed, of course the beautiful *jet d'eau* is destroyed. From an examination of the subjoined tables made up from the Geological Survey of the State and other sources, it will be seen that our mineral waters compare very favorably with some of the most celebrated ones found in other States, and in Europe. Take for example the Blue Lick water, and we find it contains at least two and a half times as much sulphuretted hydrogen gas, and more than twenty times as much carbonic acid gas as the White Sulphur Water of Virginia That it contains nearly thirty per cent more of the chloride of sodium than the Congress Water of Saratoga. As a saline water then the Blue Lick is stronger than the Congress water, and as a sulphur water richer than the White Sulphur Water of Virginia. The Congress, the Kissingen and the Seltzer waters all contain a large amount of carbonic acid gas, which renders them light, sparkling and acceptable to the stomach. In this one respect they may be said to be superior even to our Salt Sulphur waters; but it must be borne in mind that the latter waters contain another gas, the sulphuretted hydrogen, which as a remedial agent is of far more importance than the carbonic acid gas, and which is entirely wanting in the Congress, the Kissingen, and the Seltzer waters. With such excellent waters, why it is our watering places have not met with better success, it is not the object of this paper to inquire. As to invalids however, let me suggest that before visiting places of this kind they should be instructed as to what kind of waters to use, and how to use them; further than this to always select a quiet dry and well ventilated room, and if possible with a bath room attached or near at hand, to be temperate in exercise, prudent in eating, and as far as possible, to leave all cares of family and business behind.

GASEOUS AND MINERAL CONSTITUENTS

IN ONE GALLON

of the following Waters.

GASES IN CUBIC INCHES	CHALYBEATE. ESTILL Peter.	BRIGHTON Marcet	TUNBRIDGE Saudamore	SULPHUR. ESTILL Peter.	WHITE SULPHUR Rogers.	AIX LA CHAPELLE Bergmann	SALT SULPHUR. BLUE LICK Peter.	PAROQUET Peter.	ARTESIAN WELL. Smith.	HARROWGATE Hofmann	SALINE. CRAB ORCHARD Peter.	OLYMPIAN Peter.	SARATOGA. Scweitzer.	SELTERS Struve.	KISSINGEN. Liebig.
Oxygen					1.4480										
Nitrogen					3.3520				4.5	2.424					
Carbonic Acid	33.2	20.		44.43	2.0000		44.3293	6.	13.06	18.353			263.34	240.	334.16
Carburetted Hydrogen										4.865					
Sulphuretted Hydrogen				48	2.5000	44.	6.3344	30.	5.49	4.424					
Ammonia										Trace					
Atmospheric Air															
TOTAL	33.2	20.		44.91	9.5	44.	50.0637	36.	23.05	30.066			263.34	240.	334.16
Minerals in Grains															
Oxide of Iron			2.2200		Trace.										
" Manganese							Trace.								
Alumina												Trace	.0699	.0104	
Silica	1.8665	1.1200		.2333			1.0441	3.9	.8832	.204	3.2664	.8749	1.1961	2.4160	.7928
Chloride of Ammonium													.3301		
" Potassium							1.3240	.486	4.2216	53.903			10.4615	2.8640	17.6272
" Sodium	.5250			.5250	1.44	40.	486.8813	309.6	621.5204	721.624	17.7371	48.4122	182.1382	138.3360	332.2064
" Lithium									.1012						1.2296
" Calcium								67.71	65.7287	68.094					
" Magnesium							30.7303	48.03	14.7757	46.399					18.6648
" Aluminum									1.2119						
Iodide of Sodium								.156		Iodine & Bromine 12.893			.0486		Trace.
" Magnesium							.0408	.246	.3547						
Bromide of Sodium								.18		Trace			1.6334		.5152
" Magnesium							.2275	.312	.4659						
Fluoride of Calcium										Trace.				.0144	Trace.
Carbonate of Soda				4.8412		96.		.578					8.3634	49.2264	
" Lithia														Trace.	
" Baryta														.0152	
" Strontia				17.6734									.0805	.1520	
" Lime	9.2742		.2700	17.6734	9.2	38.	224.563	2.4		10.301	33.1931	36.8050	59.2708	14.9488	65.1856
" Magnesia	2.6831			.6416			.1283	1.506		Trace.	7.6410	12.7153	41.6752	16.	1.0472
" Iron	1.8067							.18		Trace.	Trace.	Trace.	.1752		1.94
" Manganese													.2946		Trace.
Nitrate of Soda															.3720
" Magnesia													1.0167		
Sulphate of Potash	.6416			4.1996			8.86		3.2245		9.9158	2.3914	1.3964	3.1760	
" Soda	.6989			2.5081				2.412	72.2952		39.0863	72.3261			
" Strontia															Trace
" Lime	16.6815	32.7200	.4400		61.952		322.729	2.28	294.342	.1508	10.7907	34.0636			23.9232
" Magnesia	9.7091			6.1244	44.704				77.3382		205.3146	151.6528			36.0704
" Alumina								.492	1.8012						
" Iron		14.4000										Trace.			
Bicarbonate of Soda									2.7264						
" Strontia															
" Lime									5.9945						
" Magnesia									2.7558						
" Iron									.3518						
Phosphate of Soda									1.3415					.0336	
" Lime															.3448
" Alumina															Trace
Borate of Soda															Trace
Muriate of Soda		12.2400	2.4600												
" Lime			.3900		1.632										
" Magnesia		0.0000	.2900												
Iodate of Soda															
Hydrobromate Potassa															
Alumina & Trace of Phosphates	Trace.			.9332											
Alumina Phosphate of Lime Oxide of Iron							.3383								
Traces of Manganese Vegetable fibre & Silica			.4400												
Crenic Acid															
Apocrenic Acid															
Organic Matter								2.136	.7082	Trace.					
Organic & Volatile Matters	8.2242			2.9164											
Moisture & Loss											14.5585				
Loss		1.5200.	0.1300		3.28		16.4485		8.1231						
TOTAL	52.2619	68.0000	7.6100	40.3962	122.208	174.	660.7726	442.404	985.5353	914.35798	401.5301	366.2415	331.3911	227.1923	913.571

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