"A STUDY OF A SPRING WATER".

Submitted as a thesis towards a
degree of Bachelor of Science
in Chemical Engineering.

May 18, 1915.

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The water under consideration was obtained from a spring near the University Farm. The reason for using this water was the fact that samples could so easily be obtained. The writer considered using some standard water, such as "Tate" water, but the samples would not give correct values in some of the work.*

The examination may be divided into four parts:

I- The mineral analysis.

2- The sanitary analysis.

3- The gases dissolved.

4- The bacteriological examination.

The mineral analysis shows the nature and amount of the solids dissolved in the water.

The sanitary analysis shows the amount of various substances which in quantities above certain amounts indicate that the water is not good.

The determination of the gases dissolved is in this case only of scientific interst.

The bacteriological examination furnishes an important index to the potability of the water.

* Note. The spring got very low on account of dry weather at the time that the bacteriological examination had to be made and on that account the number of bacteria is abnormally high. The count was made only on account of the technique involved.

The mineral analysis.

The general sheme for the analysis of a dolomite has been followed out in this case, with such modification as was neccessary.

The sanitary analysis and the determination of gases dissolved would be wrong.

Control.

250 ccs. of water were evaporated to dryness in a tared platinum dish. After the residue appeared dry, it was placed in a drying oven and dried for one hour at 105° C. The weight of the residue, multiplied by four, gave the weight of solids per liter.

Weight of dish plus residue-	33.5538gms.
Weight of dish alone-	33.4988
Weight of resdue-	.0550

.0550 times 4- .220 gms. per liter.

No. of grains per US gallon is .2200 times .058- 12.76

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For the bases 3Ls. were acidified with 15ccs.* of HCl and evaporated to about 100 ccs. From then on the analysis was made just as in the case of a dolomite. The following constituents were found: SiO_2, Al_2O_3, FeO, CaO, MgO.

The residue of Al_2O_3 and Fe_2O_3 was treated in the following way to separate the FeO so that it could be determined. After ignition, the mass was fused in the pt. cru. with $K_2S_2O_7$. This dissolved the iron which was rinsed into a beaker, acidified with a little H_2SO_4 and reduced with a grain of Zn. It was then titrated with a sol. of $K_2Mn_2O_8$ made by diluting 1 cc. of regular sol. to 100ccs.

Results of analysis for bases.

SiO_2 per L.	.00046	FeO	.00019
Al_2O_3	.00051	CaO	.05470
		MgO	.03050

*This amount was used to keep the bases in solution.

The sodium and potassium were determined according to J. Laurence Smith's method. 4 Ls. were acidified with 20ccs. of HCl and the above method followed out. The % of Na_2O and K_2O were determined by titration with $AgNo_3$.

Residue of NaCl and KCl weighed .0220 gms. per L.

%Cl is 59.2% This represents 90.0%NaCl and 10.0% KCl.

weight of Na_2O per L. .00955gms.

" K_2O .00126

The acid radicals SO_3 and Cl were determined as followes: the SO_3 was determined by evaporating 2Ls. to a small bulk and precipitating with $BaCl_2$.

Chlorine was determined by evaporating 2Ls. to 100ccs. and titrating aliquots with $AgNO_3$.

Weight of SO_3 per L. .00384 gms.

" Cl .00740

Empirical statement of results.

SiO_2 in gms. per L.	.00046
FeO	.00019
Al_2O_3	.00051
CaO	.05470
MgO	.03050
Na_2O	.00955
K_2O	.00126
SO_3	.00384
Cl	.00740

Distribution of the acid radicals and bases.

All of the chlorine was calculated as NaCl, and the remainder of the Na_2O was figured as Na_2SO_4. Allof the K_2O was calculated as K_2SO_4. Since allof the SO_3 was used up as per above, the MgO, CaO, and FeO were calculated as bicarbonates.

*Note. The calculations are omitted because of lack of space.

Statement of results.

	Grammes per Liter.	Grains per U.S. gallon.
SiO_2	.00046	.02668
$Fe(HCO_3)_2$	.00044	.02552
Al_2O_3	.0005I	.02958
NaCl	.0I2I9	.7I702
Na_2SO_4	.00698	.40600
K_2SO_4	.00096	.05568
$Ca(HCO_3)_2$	.II5I9	6.68I02
$Mg(HCO_3)_2$	.07777	4.5I066
	.2I450	I2.45408
Control	.22000	I2.76

The Sanitary Analysis.

The object of the sanitary analysis is to determine those substances which experience has shown to be objectionable if present in any considerable amount. The substances usually determined are: Cl, N as nitrate, N as nitrite, free ammonia, and albuminoid ammonia. It is hard to lay down any arbitrary standard of purity, because a water might contain large amt's.

of some of those substances, and still be potable, depending on the source of the water. Water containing large ~~am~~ amounts of those substances should be regarded with suspicion, however, especially if there is any chance of animal pollution.

The methods of determining these substances, which necessarily are present in very minute quantities, are all colorimetric. They are based on the fact that certain reagents, when added to the water under appropriate conditions, form characteristic colors, whose intensity is a measure of the amounts present. They are compared to a known standard in a "Schreiner" colorimeter. The methods which the writer used are admirably described in "Mason's Examination of Water", published by Wiley and Sons, and will not be described here on account of lack of ~~space~~ time to copy them.

Results of the determination.

Chlorine, in parts per million,	7.40	
N as nitrate,	2.80	
Nas nitrite,	.017	(trace)
Free ammonia,	.020	
Albuminoid ammonia,	.005	(very low)

Interpretation of results.

The spring was not located very near any source of contamination. The figures of the analysis all fall withinallowable limits, as set down in "Mason", by the foremost water analysts in the country. The spring, therefore, appears tobe potable.

The determination of the gases dissolved.

The gases dissolved in this water are CO_2, O and N. They were determined in the following way: the water was placed in flask (a) at the spring. This flask was connected at the laboratory to the receiving vessel(b), which was connected to an "Orsat" gas apparatus. Hot, boiled, distilled water was poured in through the funnel (c), until allof the air in the apparatus was displaced. Then the pinchcock at (c) was closed and the contents of the flask (a) were gradually brought to boiling. After the water had boiled for ten minutes, the pinchcock between (a) and (b)was closed and the flame removed. Water was poured down the funnel (c) to drive all of the gases over into the "Orsat". When the gases had cooled to room temperature, the volume , temperature, and pressure were read, and the volume reduced to 0°C and 760mm. of mercury. The gases were then forced through a solution of KOH, which absorbed the CO_2. After all of the CO_2 had been absorbed, the volume was read and the CO_2 calculated. Then the gases were passed through a solution of pyrogallic acid and KOH, which absorbed the O. The remainder of the gas is N.

The readings were converted to cubic inches per U.S. gallon.

Results of the determination.

Vol. of flask at 20° C.	1189ccs.
Temp. of gases.	25.0°C.
pressure of atmosphere.	739mm.
Vol. of gas.	50ccs.
Vol. of CO_2.	8ccs.

Volume of O. 12ccs.

Volume of N. 30ccs.

Converting volumes to 0° and 760 mm., and to cubic inches per gallon, we get:

1.36 cu. in. of CO_2.

1.99 " " " O

4.95 " " " N

8.30 cubic inches of gas.

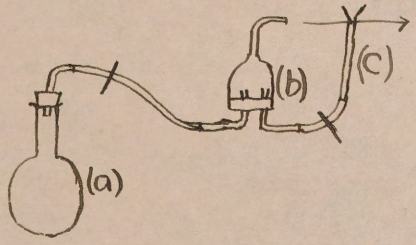
The bacteriological examination.

The water to be tested was subjected to the usual tests, viz., the plate count and the presumptive test for b. coli in dextrose bouillon. The sample was taken in a sterile flask and examined immediately on arrival at the laboratory. Three samples of 1cc. each were plated in standard peptone agar, reaction plus .5, and incubated at 37°C for 48 hrs.

Inthe test for b. coli 6 fermentation tubes were filled with a 1% dextrose bouillon and duplicates of 1ccs., 2ccs. and 3ccs. of the water were added. After 48 hrs. the % of gas was read. B. coli allways forms 50% of gas.

On account of the spring being so low the count means nothing. The count was about 3000 bacteria per cc. The % of gas was about 25%, and therefore b. coli is not present. This fact tends to prove the water good, in spite of the high count.

Diagram of gas apparatus used.



A resume of the work.

The writer considers the water potable for the following reasons:

I- The total solids are very low.

2- In the sanitary analysis the only constituent which was found in quantity near the arbitrary limit was N as nitrate. This might easily come from the soil. All of the other constituents were found in extremely small amounts.

3- In the bacteriological examination b. coli, whose presence indicates faecal pollution, was not found.