THE MINERAL WATERS OF STEAMBOAT SPRINGS, COLO.

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Steamboat Springs is located in Routt County, Colo., 214 miles northwest of Denver, on the Moffat Road, of which it is the present terminus.

The springs are located within a radius of three-quarters of a mile about the town. There are perhaps 150 of these springs, varying in size and flow with a range in temperature from 40 degrees F. to 103 degrees F. The majority of the springs lie west and south of the town. Some of these are located on the hillsides, while some lie along the bank of the Bear River.

The location of the 12 springs sampled by us will be found on the accompanying map, with the exception of No. 11, which is located about seven miles north and west of the town.

Springs Nos. 1, 2 and 3 are situated along the river bank, about 150 feet east of the county bridge. They are within a radius of 30 feet from each other and are easily reached.

Nos. 4, 5 and 12 are situated in the railroad cut just south of 1, 2 and 3. All three are within a radius of 20 feet of each other, and are also easily reached.

Nos. 6 and 7 are situated about one-half mile from the county bridge and south of the town, above the so-called "Sulphur Cave." These springs are fifty-two inches apart.

No. 8 is situated along the north bank of the Bear River and about three hundred feet west of the county bridge.

No. 9 is situated about 200 feet north of No. 8, while No. 10 is about 100 feet east of No. 9. No. 11 (the Hot Spring) is about seven miles north and west of Steamboat. This spring may be reached by a wagon road, with the exception of the last half mile, which is traveled by trail.

Our samples consisted of four liters of water (contained in two 2-liter bottles) from each spring. These samples were taken at average depths from the springs by the aid of a new tin dipper and funnel, which together with the bottles, were carefully cleaned and rinsed with the water of the spring to be sampled. The bottles were stoppered with glass stoppers which were kept tightly in place with tape, sealed with paraffine, packed with straw in a

wooden crate, 12 to one crate, and the cover tightly screwed on. The crates were shipped by express directly to Bouldr, Colo., and taken direct to the chemical laboratory of the University of Colorado. The samples remained here until analyzed. They were kept in a cool dark locker and touched only by the analyzing chemists.

The analysis was begun Feb. 8, 1909, and completed May 28, 1909.

In taking data for the flow of the springs we used a hook gage, made by a stick graduated to tenths of inches, and a wire. An iron wier with an orifice four inches wide and five inches deep was used.

The wier was first leveled up, the water then dammed and caused to flow through the orifice. The zero reading was taken when water first flowed over the knife edge, and the final reading taken when it had reached its maximum head. In each case three readings were taken and the mean of these taken for the head on the wier.

The methods of analysis used are those given in "Mineral Waters of the United States" Bulletin No. 91, Bureau of Chemistry, U. S. Dept. of Agriculture.

The complete description of the analysis is not given in this thesis, but only an outline.

A liter of water was evaporated to dryness in platinum, with an occasional addition of small amounts of hydro-chloric acid. After evaporation, the contents were dried at 120 degrees F. and the silica determined in the usual manner. The filtrate from the silica was diluted to 100 c.c. and aliquot parts used as follows:

200 c.c. for the determinatiton of iron and aluminum, calcium and magnesium; 200 c.c. for iron (this was titrated with potassium permanganate); 200 c.c. for the determination of Mn; 200 c.c. for sulphuric acid, potassium, sodium and lithium. (The method for determining lithium is that given by Gooch, in which the combined chlorides (Na, K, Li) are treated with amyl alcohol. The remaining 200 c.c. were used for the determination of phosphoric acid.

For the determination of barium and strontium, 200 c.c. of water were taken.

For chlorin, 100 c.c. of water were taken.

Of the twelve springs analyzed, lithium was found in four, namely, Nos. 3, 6, 8 and 12. The analysis of fifty-five different min-

eral waters from all parts of the U. S. are given in Bulletin No. 91, and five of these show as much lithium as spring No. 3 (5.28 parts). Number 12 is a close second with 4.15 parts per million. Smaller, yet very appreciable amounts were found in Nos. 6 and 8.

The analysis shows how widely the composition varies. Most of the springs contain large amounts of chlorin and still larger of sodium. Sulphuric acid is contained in large amounts in all except two.

The most interesting and remarkable features are found in the analysis of Springs No. 6 and 7. They are but 52 inches apart. The temperature of No. 6 is 71.3 degrees F., while that of No. 7 is 41.5 degrees F. The former, being at a greater temperature, carries more substance in solution. The analysis will show how widely the composition varies.

Another interesting feature is shown in Nos. 4, 5 and 12. Spring No. 4 contains only one part of chlorin, while 5 and 12 contain over 1400.

The Hot Spring, No. 11, has the smallest composition of salts. The water tastes practically pure. It contains larger amounts of silica and iron than the others, but the other constituents are smaller in proportion, especially in sulphuric acid and magnesium.

A more detailed descriptiton of each spring is given below, the analyses being given in the tables:

Spring No. 1.

Time of day, 2:00 p. m.

Size of spring mouth, 36 x 40 x 4 inches.

Color, slightly milky.

Hydrogen sulphide gas given off, blackening lead acetate paper.

Temperature, 73.5 degrees F.

Head over Wier, .25 inches.

Bubbling extensive.

Flow, 87.3 gallons per hour.

Spring No. 2.

Date, 1, 31, 1909.

Time of day, 3:30 p. m.

Size of spring mouth, 10 inches in diameter, and 2 inches deep.

Color, black when in spring; clear when out of spring.

Hydrogen sulphide gas given off in bubbles, blackening lead acetate paper.

Temperature, 68 degrees F.

Flow very small, making it impossible to take head.

Spring No. 3.

Date, 1, 31, 1909.
Time of day, 2:45 p. m.
Size of spring mouth, 24 x 12 x 4 inches deep.
Color, clear, with a yellow sulphur deposit on the bottom.
Very strong hydrogen sulphide gas given off.
Temperature, 78.5 degrees F.
Head over wier, .81 inches.
Flow, 483.3 gallons per hour.

Spring No. 4.

Date, 1, 31, 1909.
Time of day, 4:55 p. m.
Size of spring mouth, flow from crevice is limestone formation.
Color, clear with pink and yellow deposit in crevice on stone.
Gas, hydrogen sulphide, but not very strong.
Temperature, 73 degrees F.
Head over wier, .40 inches.
Flow, 242 gallons per hour.
Located in the railroad cut.

Spring No. 5.

Date, 1, 31, 1909.
Time of day, 4:05 p. m.
Size of spring mouth, flow from crevice in limestone formation.
Color, clear, with a pink and yellow sulphur deposit in the crevice.
Gas, hydrogen sulphide, coloring lead acetate paper. Large quantities.
Temperature, 73 degrees F.
Head over wier.
Flow, could not get flow data because of position of crevice. Spring located in the railroad cut.

Spring No. 6.

Time of day, 9:30 a. m.
Size of spring mouth, 12 x 16 x 7 inches.
Color, dirty.
Quantities of hydrogen sulphide gas, which bubbles up.
Temperature, 71.3 degrees F.
Head over wier, .96 inches.
Flow, 611.6 gallons per hour.

Spring No. 7.

Date, 2, 1, 1909.
Time of day, 10:30 a. m.
Size of spring mouth, 12 inches in diameter and 2 inches deep.
Color, dark.
Temperature, 41.5 degrees F.
Head over wier, water seeps into ground and very little flow.
Flow, No. 7 is 52 inches from No. 6.

Spring No. 8.

Date, 2, 1, 1909.
Time of day, 2:00 p. m.
Size of spring mouth, series of small springs.
Color, clear, with sulphur deposit, hydrogen sulphide gas.
Temperature, 48 degrees F.
Head over wier, 2.05 inches.
Flow, 2106.6 gallons per hour.

Spring No. 9.

Date, 2, 1, 1909.

Time of day, 3:00 p. m.

Size of spring mouth, swampy area of about 50 feet in diameter.

Color, clear with vegetable matter in the spring.

Temperature, 52 degrees F. Hydrogen sulphide gas evolved.

Head over wier, flow too great for our calculation.

Flow, surrounding ground loose and undermined.

Spring No. 10.

Date, 2, 1, 1909.

Time of day, 3:20 p. m.

Size of spring mouth, oval, 6 x 9 x 1½ feet.

Color, clear with vegetable matter floating in it.

Gas, hydrogen sulphide, but not in as great quantities as in some of the others.

Temperature, 61 degrees F.

Head over wier, could not get flow. Spring located 100 feet from No. 9.

Flow, ...

Spring No. 11.

Hot Spring is seven miles from town of Steamboat Springs. This spring was divided into two separate parts:

Part A.—Near the creek-bed; water came through a crevice in the solid rock. Temperature 149 degrees F. Head over wier 1.15 inches.

Part B.—Fifty feet up on the opposite side of creek up the hill. This issued from a crevice in a granite formation and ran down the hill to the creek. Temperature, 148 degrees F. Head on wier, 1.9 inches. The water in both parts was perfectly clear. Combined flow 2700 gallons per hour.

Spring No. 12.

Date, 2, 3, 1909.

Time of day, 10:30 a. m.

Size of spring mouth, crevice, 7 feet to right of No. 5, 12 feet to left of No. 4.

Color, clear, in a limestone formation.

Gas, hydrogen sulphide given off with a rumbling sound.

Temperature, 73 degrees F.

Head over wier, could not get flow.

TABLE OF ANALYSES RESULTS EXPRESSED IN PARTS

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Spring No.	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	20.	17.8	24.9	17.1	21.6	24.7	13.	18.4	16.1	14.	92.4	24.9
Fe	Tr.	No	8.13	Tr.	No	4.	16.26	2.62	Tr.	Tr.	12.2	8.13
Al	1.9	Tr.	No	12.0	No	No	No	No	4.60	3.5	No	No
Ca	27.25	4.	176.1	94.5	18.9	95.91	74.93	141.5	113.	153.5	109.12	231.3
Mn	15.94	7.97	4.	No	No	2.90	10.78	4.84	5.	5.6	Tr.	4.
Mg	71.30	53.7	36.6	17.38	43.2	63.2	21.71	33.08	39.4	30.8	4.58	34.9
SO_4	657.9	275.	625.	563.4	551.5	486.55	605.	595.5	74.3	331.	62.8	618.
K	149.83	127.25	119.2	116.01	125.66	92.62	41.98	91.84	76.55	47.52	16.72	125.7
Na	1886.6	2087.0	2164.4	2222.12	2134.8	1759.2	284.5	1650.25	1134.3	1442.29	174.4	2130.3
Li	No	No	5.28	No	No	1.84	No	1.84	No	No	No	4.15
Ba	8.8	14.40	7.6	12.52	29.4	8.23	No	No	Tr.	Tr.	14.2	6.48
Sr	No	No	No	No	No	No	No	No	No	No	No	No
Cl	1445.0	1054.0	1459.5	1.0	1448.	1132.3	189.	1017.	810.	761.	393.0	1420.