

CHAPTER IX

GENERAL DESCRIPTIONS OF THE MINERAL SPRINGS

BY
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ARVADA, JEFFERSON COUNTY

1. Macalso Sulphate Water, also called Golden Lithia Water, Kearney Ranch, 4 miles northwest of Arvada.

There was formerly a spring, but the digging of a well 65 feet deep diverted the water, and it is now taken from the well. Plans have been made for bottling and shipping the waters and for erecting the necessary buildings for a resort. The surface formation is the Arapahoe of Tertiary Age.

CONUNDRUM SPRINGS NEAR ASPEN, PITKIN COUNTRY

2. The springs are in an area of Carboniferous rocks at timber line, near the head of Conundrum Creek, in the Sopris National Forest. They are about 14 miles south of Aspen, the most convenient railway point. There are two groups of springs issuing from the same limestone ledge, but only the southern group is important. This consists of two fairly large springs and several small ones. The largest spring has a flow estimated at 25 gallons per minute. The temperature of the water is 100° F.

AUSTIN AND VICINITY, DELTA COUNTY

3. *Cold Sulphur Spring* is near the entrance to the Black Canyon, about 450 yards up the river from the State Bridge. The waters issue from a Cretaceous sandstone (probably Dakota), in an area of rounded shale hills. The flow is about 15 gallons per minute. The water is rather strongly mineralized and is accompanied by much carbon dioxide, and some hydrogen sulphide.

4. *Alkali Spring*. This is really a group of small springs between the Sulphur Spring and the State Bridge. The water issues from a sandstone (probably Dakota), at a point about 40 or 50 feet above the Sulphur Spring. The total flow is small, but proper excavation would probably increase it.

4a. *Black Canyon Well*. The well was drilled by the Black Canyon Oil Company on an anticline a short distance up the river from the State Bridge, near Austin. At a depth of 225 feet it developed a strong artesian flow of highly saline water accompanied by much carbon dioxide. The analysis of the brine was made by Von Schulz and Low.

This is the most highly mineralized water analyzed for this report. It is also prominent in the matter of its lithium content.

AVALANCHE AND VICINITY, PITKIN COUNTY

The springs are along the Crystal River in the vicinity of Avalanche, a station on the Crystal River Railway in Pitkin County. The springs are in an area of Carboniferous and Permian sedimentary rocks cut by a diorite intrusion.

The flow of several of the springs is large, and that of the others could be considerably increased by proper excavation.

5. *The Bath House Spring* issues from the diorite on the very bank of the river at Avalanche Station, and is developed by a log bath house and a pool.

6. *The Cold Iron Spring* is located in a swampy area on the east bank of the river, $\frac{1}{2}$ to $\frac{3}{4}$ of a mile below the station. It has formed a large deposit, but now issues at a point nearer the river.

7. *The Hot Iron Spring* is in a meadow about $\frac{1}{4}$ mile up the river on the east bank. Gas accompanies the water. Much salt is deposited in the marshy area about the spring. The content of ferrous bicarbonate is quite large.

8. This spring is about 100 yards above the last, but the notable differences in the basic elements make it clear that they draw their waters from different sources. The iron bicarbonate content is like that of the preceding spring.

9. *River Spring* is on the very brink of the river at Avalanche, and is covered by the river at high water. The flow is small, but could be increased.

10. *Hot Sulphur Spring* is about 50 yards below the Bath House Spring but on the opposite side of the river. The opening has been covered by slide rock from the diorite and the water flows through the base of the talus.

BARR AND VICINITY, ADAMS COUNTY

11. *Colorado Carlsbad Water*. The water comes from a well 90 feet deep, located 6 miles east of Barr. The place was once

203. *The Mound Spring* is about 50 yards up the hill from the Iron Spring. A mound of spring-deposited material 100 feet wide and 10 to 12 feet high represents the work of springs now reduced to mere seepages. There are several openings in the mound and from these water seeps and gas bubbles. The waters of these springs were believed to contain arsenic, but the analysis did not show its presence.

Waters of the Bubbling Spring, the spring across the gulch and the Mound Spring are very similar in composition, and probably have a common origin. The water of Clear Spring is quite similar to these, but much less strongly mineralized. That of the Iron Spring belongs to the same general class, but is comparatively weakly mineralized. It differs in details from all the others.

204. *The Watson Artesian Well* is located 1 mile south and ½ mile east of Siloam post office. The water flows from a 10-inch pipe which stands about 2 feet out of the ground. The yield is very large and the water is used for irrigation. Gas is abundant.

SILVERTON, SAN JUAN COUNTY

205. *Mineral Creek Spring*. This is known as an iron spring and is located about 4 miles up South Mineral Creek. The surroundings of the spring suggest the possibility of developing a considerable flow, but the water is very weakly mineralized. Its most important constituent is ferrous bicarbonate. The water issues from a sandstone.

SOUTH FORK, RIO GRANDE COUNTY

206. *Million's Springs*. The group of cold springs is located on the South Fork of the Rio Grande about 5 miles above South Fork station and post office. Three of the springs have a flow of 8 to 10 gallons each per minute. They issue from a granite cut by porphyry dikes. The waters are weakly mineralized.

SPRINGDALE, BOULDER COUNTY

207-210. The springs are on Lefthand Creek about 8 miles northwest of Boulder, and 2 miles below the mining camp of Jamestown. They are reached by a good automobile road from Boulder.

The country rock is pre-Cambrian granite and gneiss. There are four springs yielding waters very similar in character and probably rising from the same deep source. The differences in

composition are in the proportion of the salts contained. Two are notably higher in iron bicarbonate than the others.

The total flow is sufficient to justify development, and at one time Springdale was a popular health resort. Much water was bottled and shipped. The hotel was burnt and has not been rebuilt. Some water is still used.

These waters are the most highly radioactive in the State.

STEAMBOAT SPRINGS, ROUTT COUNTY

211-224. This is the greatest group of springs in Colorado, and is located along the Bear or Yampa River in Routt County on the western slope of the Park Range. One of the springs which formerly made a noise resembling the puffing of a steamboat gave the name to the whole group and to the thriving town which has grown up about the springs. The Denver and Salt Lake Railway furnishes easy access to this inviting resort.

The waters of the springs vary in temperature from 56° to 104° F. The mineral content is equally variable, and the flow of the springs ranges from 1 to 2 gallons per minute to possibly 100 gallons per minute for the Bath House Spring. As a whole, the waters may be classed as *saline sulphureted*. In the flow of hydrogen sulphide gas, the springs range from a mere trace to a considerable volume. The quantity of carbon dioxide issuing is also remarkably varied from spring to spring.

The flow of several of the springs is immediately increased by rain storms, showing that the surface waters must have ready access to the spring channels. This fact makes it difficult to estimate the salinity of the spring waters proper, or the volume of water compared with the volume of water under normal conditions.

The springs are near the contact of the pre-Cambrian area of the Park Range and the steeply upturned Mesozoic sedimentary rocks flanking the mountains. The lowest and oldest of the stratified rocks are probably of Jura-Triassic age. Following these are the Dakota sandstones and shales, which are, in turn, overlaid by the Mancos group. In the spring zone these sedimentary rocks are charged with sulphur and salts deposited from spring waters. At a distance from the spring area the formations have their normal appearance and composition.

In all the spring waters analyzed sodium is by far the most important base. It appears to occur mainly in the form of bicarbonate and the chloride. Next in importance as bases come potassium and calcium, but they fall far short of the rank of sodium.

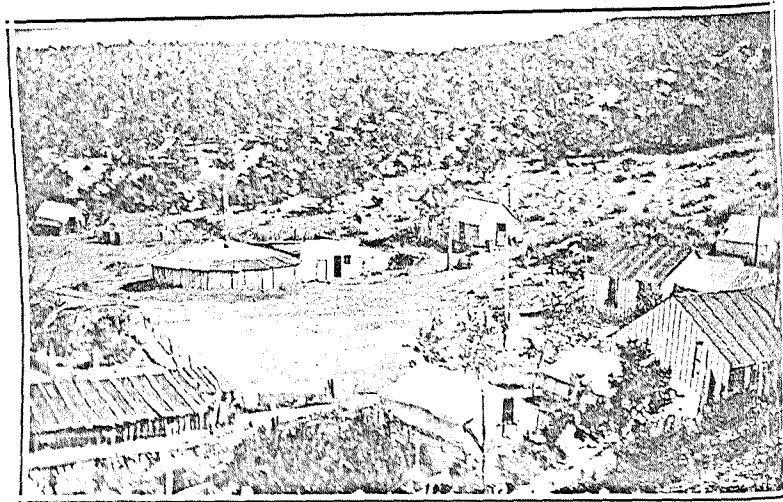


Fig. 31. Poncha Hot Springs.

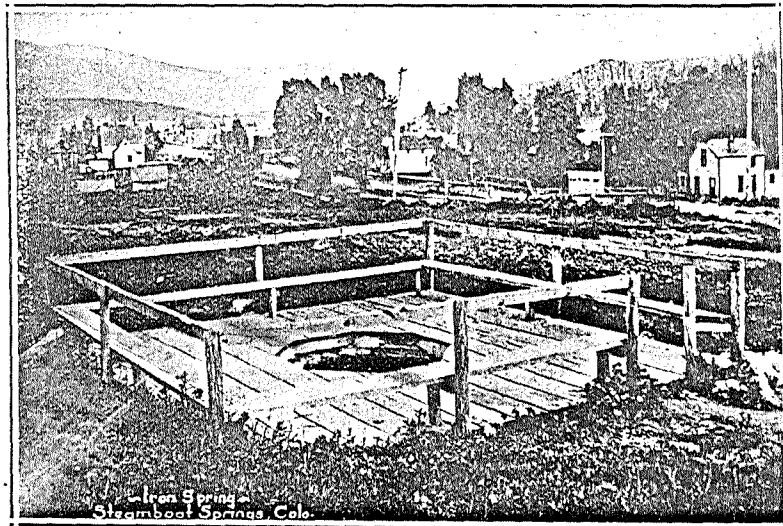


Fig. 32. Iron Spring, Steamboat Springs.

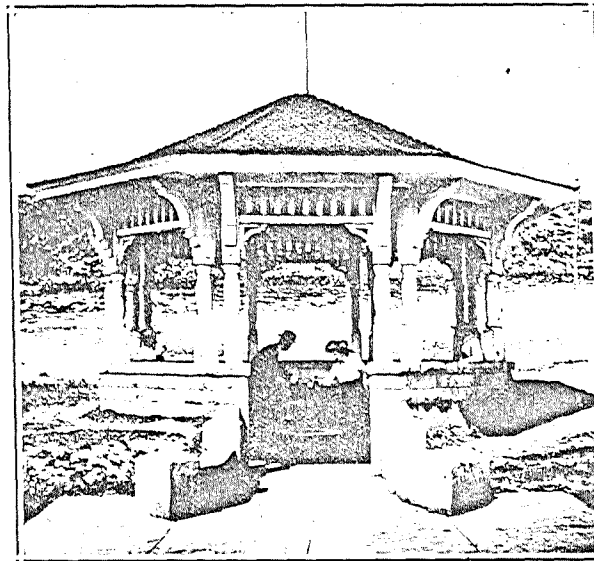


Fig. 33. Soda Springs, Steamboat Springs.

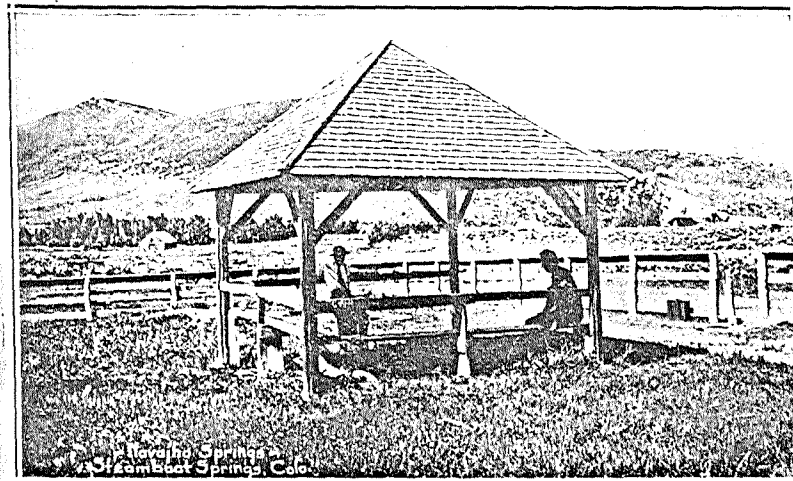


Fig. 34. Navajho Springs, Steamboat Springs.

NUMBER 211

MACALSO LITHIA AND MAGNESIA SPRING

Location—Steamboat Springs, Colo.

Class of Water—Sodic, bicarbonated, muriated, alkaline-saline, ferruginous, potassic, (carbondioxated).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	84.8	.....
Sulphate	SO ₄	485.6	4.99
Bicarbonate	HCO ₃	3252.8	26.28
Carbonate	CO ₃	None	.....
Phosphate	PO ₄	None	.....
Chloride	Cl	1345.5	18.73
Iron	Fe	.....	.07
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	} 5.5	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	.....
Calcium	Ca	112.76	2.77
Magnesium	Mg	31.9	1.29
Potassium	K	155	1.96
Sodium	Na	2047.5	43.91
Lithium	Li	Trace	.....
		7521.36	100.00
Oxygen in Fe ₂ O ₃		1.65	
Total.....		7519.71	

Concentration value	202.8	Excess carbon dioxide	1173
Hydrogen sulphide, H ₂ S	Trace	Iron precipitated	6.81
Arsenic, As	.....	Evaporation solids	6059
Strontium, Sr	None	Oxygen consuming capacity	2.24

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	455.96
Pot. chlor., KCl	295.6	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	.....
Sod. chlor., NaCl	1986.6	Calc. silicate, CaSiO ₃	.....
Sod. sulph., Na ₂ SO ₄	718.11	Silica, SiO ₂	84.8
Mag. sulph., MgSO ₄	.....	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	191.96
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	3774.5
Ferrous bicarb., Fe(HCO ₃) ₂	12.25		
Total			7519.78

Properties of Reaction in Percent

Primary salinity	47.44	Primary alkalinity	44.30
Secondary salinity	.....	Secondary alkalinity	8.26
Tertiary salinity	.....	Tertiary alkalinity	.....

Radioactivity

Temperature, °C, 24.0. Temperature, °F, 75.2.
 Curies Ra Emanation per liter x 10⁻¹⁰, Water, Trace; Gas, Trace, 10.9.
 Mache Units per liter, Water, Trace; Gas, Trace, 1.79.

NUMBER 212

BATH HOUSE SPRING

Location—Steamboat Springs, Colorado.

Rate of Flow—250 to 300 gal.

Temperature—104° F.

Class of Water—Sodic, muriated, carbonated, saline.

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	47.6	.....
Sulphate	SO ₄	141.37	10.13
Bicarbonate	HCO ₃	100.18	5.65
Silicate	SiO ₃	.....	1.34
Carbonate	CO ₃	11.73	1.34
Phosphate	PO ₄	Trace	.....
Chloride	Cl	323.93	31.54
Iron	Fe	.....	.....
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	} 2.25	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	.....
Calcium	Ca	20.96	3.58
Magnesium	Mg	Trace	.....
Potassium	K	16.37	1.45
Sodium	Na	299.9	44.97
Lithium	Li	None	.....
Oxygen to form SiO ₃		3.13	.....
Total.....		967.42	100.00

Concentration value	29.00	Excess carbon dioxide	36.13
Hydrogen sulphide, H ₂ S	Trace	Iron precipitated	None
Arsenic, As	.....	Evaporation solids	884
Strontium, Sr	None	Oxygen consuming capacity	None

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	None	Calc. bicarb., Ca(HCO ₃) ₂	53.04
Pot. chlor., KCl	31.22	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	2.25
Sod. chlor., NaCl	509.6	Calc. silicate, CaSiO ₃	22.76
Sod. sulph., Na ₂ SO ₄	209.06	Silica, SiO ₂	35.81
Mag. sulph., MgSO ₄	Trace	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	.....
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	82.98
Ferrous bicarb., Fe(HCO ₃) ₂	.....	Sod. carb., Na ₂ CO ₃	20.72
Total			967.44

Properties of Reaction in Percent

Primary salinity	83.34	Primary alkalinity	9.50
Secondary salinity	.....	Secondary alkalinity	7.16
Tertiary salinity	.....	Tertiary alkalinity	.....

Radioactivity

Temperature, °C, 39.5, 39.5; °F, 103.0.
 Curies Ra Emanation per liter x 10⁻¹⁰, Water, 1.2; Gas, 13.35, 7.9.
 Mache Units per liter, Water, 0.21; Gas, 3.61, 1.31.
 Remarks—Schlundt.

NUMBER 213

HERON SPRING

Location—Steamboat Springs, Colo.

Class of Water—Sodic, bicarbonated, muriated, alkaline-saline, (carbon-dioxated).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	18.1	.....
Sulphate	SO ₄	214.8	4.85
Bicarbonate	HCO ₃	1760	31.20
Silicate	SiO ₃	.....	.66
Carbonate	CO ₃	None	.....
Phosphate	PO ₄	None	.....
Chloride	Cl	435.8	13.29
Iron	Fe	.....	.....
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	5.0	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	.....
Calcium	Ca	176.43	9.52
Magnesium	Mg	55.27	4.93
Potassium	K	52.62	1.46
Sodium	Na	724.35	34.09
Lithium	Li	None	.....
Oxygen to form SiO ₂		4.80	.....
Total		3447.67	100.00

Concentration value	92.40	Excess carbon dioxide	634.64
Hydrogen sulphide, H ₂ S	None	Iron precipitated	1.41
Arsenic, As	.....	Evaporation solids	2556
Strontium, Sr	None	Oxygen consuming capacity	None

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	.....	Calc. bicarb., Fe(HCO ₃) ₂	666.7
Pot. chlor., KCl	100.34	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	5.0
Sod. chlor., NaCl	639.8	Calc. silicate, CaSiO ₃	34.93
Sod. sulph., Na ₂ SO ₄	317.6	Silica, SiO ₂	.....
Mag. sulph., MgSO ₄	.....	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	332.6
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	1350.7
Ferrous bicarb., Fe(HCO ₃) ₂	.....	
Total	.....		3447.67

Properties of Reaction in Percent

Primary salinity	36.28	Primary alkalinity	34.82
Secondary salinity	.....	Secondary alkalinity	28.90
Tertiary salinity	.....	Tertiary alkalinity	.....

Radioactivity

Temperature, °C, 24.0, 23.8. Temperature, °F, 75.2.
Curies Ra Emanation per liter x 10⁻¹⁰. Water, 9.05, 14.3; Gas, 35.0, 51.5.
Marie Units per liter. Water, 2.44, 2.39; Gas, 9.45, 9.05.
Permanent Acidity. Grams Na per liter x 10⁻². None.
Non-permanent Acidity.

NUMBER 214

BUBBLING SPRING

Location—Steamboat Springs, Colorado.

Rate of Flow—65 to 70 gal.

Temperature—75° F.

Class of Water—Sodic, bicarbonated, muriated, alkaline-saline, ferruginous, (sulphuretted, carbondioxated).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	22.2	.....
Sulphate	SO ₄	551.9	5.81
Bicarbonate	HCO ₃	3135.16	25.90
Carbonate	CO ₃	None	.....
Phosphate	PO ₄	None	.....
Chloride	Cl	1285.7	18.29
Iron	Fe	.....	.06
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	4.75	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	.....
Calcium	Ca	140.83	3.54
Magnesium	Mg	36.05	1.50
Potassium	K	22.0	.29
Sodium	Na	2034.75	44.61
Lithium	Li	None	.....
		7233.34	100.00
Oxygen in Fe ₂ O ₃		1.43	.....
Total		7231.91	

Concentration value	198.3	Excess carbon dioxide	1130.5
Hydrogen sulphide, H ₂ S	14.71	Iron precipitated	None
Arsenic, As	.....	Evaporation solids	5494
Strontium, Sr	None	Oxygen consuming capacity	0.18

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	.....	Calc. bicarb., Ca(HCO ₃) ₂	569.5
Pot. chlor., KCl	41.95	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	.....
Sod. chlor., NaCl	2086.8	Calc. silicate, CaSiO ₃	.....
Sod. sulph., Na ₂ SO ₄	816.15	Silica, SiO ₂	22.2
Mag. sulph., MgSO ₄	.....	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	216.9
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	3468.0
Ferrous bicarb., Fe(HCO ₃) ₂	10.58		
Total	.....		7232.08

Properties of Reaction in Percent

Primary salinity	48.20	Primary alkalinity	41.60
Secondary salinity	.....	Secondary alkalinity	10.20
Tertiary salinity	.....	Tertiary alkalinity	.....

Radioactivity

Temperature, °C, 23.5. Temperature, °F, 74.2.
Curies Ra Emanation per liter x 10⁻¹⁰. Gas, 67.15.
Marie Units per liter. Gas, 17.08.

NUMBER 215

HOT SPRING

Location—8 mi. N. of Steamboat Springs.

Rate of Flow—30 to 35 gal. per min. 12 to 15 gal. per min.
80 to 100 gal. per min. Temperature—148° F.

Class of Water—Sodic, muriated, carbonated, alkaline-saline.

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	88.4	
Sulphate	SO ₄	43.51	5.91
Bicarbonate	HCO ₃	140.7	14.93
Silicate	SiO ₃		3.12
Carbonate	CO ₃	4.69	.97
Phosphate	PO ₄	None	
Chloride	Cl	136.92	25.07
Iron	Fe		
Aluminum	Al		
Iron oxide	Fe ₂ O ₃		
Aluminum oxide	Al ₂ O ₃	2.5	
Manganese	Mn	None	
Calcium	Ca	7.58	2.40
Magnesium	Mg	None	
Potassium	K	11.14	1.82
Sodium	Na	162.2	45.78
Lithium	Li	None	
Oxygen to form SiO ₂		3.88	
Total		601.52	100.00

Concentration value	15.40	Excess carbon dioxide	50.74
Hydrogen sulphide, H ₂ S	None	Iron precipitated	None
Arsenic, As		Evaporation solids	552
Strontium, Sr	None	Oxygen consuming capacity	0.47

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl		Iron and aluminum oxides,	
Pot. chlor., KCl	21.24	Fe ₂ O ₃ , Al ₂ O ₃	2.5
Sod. chlor., NaCl	209.1	Calc. silicate, CaSiO ₃	22.01
Sod. sulph., Na ₂ SO ₄	64.34	Silica, SiO ₂	73.76
Mag. sulph., MgSO ₄		Mang. oxide, Mn ₂ O ₃	
Calc. sulph., CaSO ₄		Mag. bicarb., Mg(HCO ₃) ₂	
Calc. carb., CaCO ₃		Sod. bicarb., NaHCO ₃	193.74
Ferrous bicarb., Fe(HCO ₃) ₂		Sod. carb., Na ₂ CO ₃	8.29
Calc. bicarb., Ca(HCO ₃) ₂		Sod. silicate, Na ₂ SiO ₃	6.57
Total			601.55

Properties of Reaction in Percent

Primary salinity	61.96	Primary alkalinity	
Secondary salinity		Secondary alkalinity	33.24
Tertiary salinity		Tertiary alkalinity	4.80

NUMBER 216

STEAMBOAT SPRING

Location—Steamboat Springs, Colorado.

Class of Water—Sodic, bicarbonated, muriated, alkaline-saline, potassic, (sulphuretted, carbondioxated).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	23.2	
Sulphate	SO ₄	599.6	5.95
Bicarbonate	HCO ₃	3184.2	24.87
Carbonate	CO ₃	None	
Phosphate	PO ₄	None	
Chloride	Cl	1427.7	19.18
Iron	Fe		.09
Aluminum	Al		
Iron oxide	Fe ₂ O ₃		
Aluminum oxide	Al ₂ O ₃	7.25	
Manganese	Mn	None	
Calcium	Ca	121.4	2.92
Magnesium	Mg	28.78	1.11
Potassium	K	162.5	1.98
Sodium	Na	2120	43.90
Lithium	Li	Trace	
Oxygen in Fe ₂ O ₃		7674.63	100.00
		2.18	
Total		7672.45	

Concentration value	210.00	Excess carbon dioxide	1148.2
Hydrogen sulphide, H ₂ S	17.52	Iron precipitated	3.65
Arsenic, As		Evaporation solids	5870
Strontium, Sr	None	Oxygen consuming capacity	3.88

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	490.9
Pot. chlor., KCl	309.9	Iron and aluminum oxides,	
Sod. chlor., NaCl	2110.9	Fe ₂ O ₃ , Al ₂ O ₃	
Sod. sulph., Na ₂ SO ₄	886.7	Calc. silicate, CaSiO ₃	
Mag. sulph., MgSO ₄		Silica, SiO ₂	23.2
Calc. sulph., CaSO ₄		Mang. oxide, Mn ₂ O ₃	
Calc. carb., CaCO ₃		Mag. bicarb., Mg(HCO ₃) ₂	173.2
Ferrous bicarb., Fe(HCO ₃) ₂	16.15	Sod. bicarb., NaHCO ₃	3661.7
Total			7672.45

Properties of Reaction in Percent

Primary salinity	50.26	Primary alkalinity	41.50
Secondary salinity		Secondary alkalinity	8.24
Tertiary salinity		Tertiary alkalinity	

Radioactivity

Curies Ra Emanation per liter x 10⁻¹⁰, Gas, 2.39.
Mache Units per liter, Gas, 0.65.

NUMBER 217

CRAWFORD SPRING

Location—Steamboat Springs, Colo.

Class of Water—Sodic, bicarbonated, muriated, alkaline-saline, (carbon-dioxated, sulphuretted).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	29.9	.....
Sulphate	SO ₄	546.3	5.59
Bicarbonate	HCO ₃	3267.1	26.27
Carbonate	CO ₃	None	.....
Phosphate	PO ₄	None	.....
Chloride	Cl	1310.8	18.14
Iron	Fe	.....	.03
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	} 2.75	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	.....
Calcium	Ca	130.66	3.20
Magnesium	Mg	35.83	1.45
Potassium	K	124.5	1.57
Sodium	Na	2051	43.75
Lithium	Li	Trace	.....
		7498.84	100.00
Oxygen in Fe ₂ O ₃		.83	

Total..... 7498.01

Concentration value	203.8	Excess carbon dioxide	1178.7
Hydrogen sulphide, H ₂ S	19.37	Iron precipitated	0.59
Arsenic, As	.....	Evaporation solids	5869
Strontium, Sr	None	Oxygen consuming capacity	13.99

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	528.4
Pot. chlor., KCl	237.4	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	.....
Sod. chlor., NaCl	1974.8	Calc. silicate, CaSiO ₃	.....
Sod. sulph., Na ₂ SO ₄	807.9	Silica, SiO ₂	29.9
Mag. sulph., MgSO ₄	.....	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	215.6
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	3697.7
Ferrous bicarb., Fe(HCO ₃) ₂	6.1		
Total			7497.8

Properties of Reaction in Percent

Primary salinity	47.46	Primary alkalinity	43.18
Secondary salinity	.....	Secondary alkalinity	9.36
Tertiary salinity	.....	Tertiary alkalinity	.....

NUMBER 218

SODA SPRINGS

Location—Steamboat Springs, Colorado.

Rate of Flow—

Temperature—59° F.

Class of Water—Sodic, bicarbonated, muriated, alkaline-saline, magnesian, (carbondioxated).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	22.7	.....
Sulphate	SO ₄	229.6	5.18
Bicarbonate	HCO ₃	1736	30.84
Carbonate	CO ₃	None	.....
Phosphate	PO ₄	None	.....
Chloride	Cl	457.5	13.98
Iron	Fe	.....	.06
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	} 2.5	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	.....
Calcium	Ca	192.93	10.43
Magnesium	Mg	54.40	4.84
Potassium	K	73	2.03
Sodium	Na	692.5	32.64
Lithium	Li	None	.....
		3461.13	100.00
Oxygen in Fe ₂ O ₃		.75	

Total..... 3460.48

Concentration value	92.26	Excess carbon dioxide	624.6
Hydrogen sulphide, H ₂ S	None	Iron precipitated	2.11
Arsenic, As	.....	Evaporation solids	2274
Strontium, Sr	None	Oxygen consuming capacity	3.31

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	.....	Calc. bicarb., Ca(HCO ₃) ₂	780.1
Pot. chlor., KCl	139.2	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	.....
Sod. chlor., NaCl	645.1	Calc. silicate, CaSiO ₃	.....
Sod. sulph., Na ₂ SO ₄	339.5	Silica, SiO ₂	22.7
Mag. sulph., MgSO ₄	.....	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	327.3
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	1201.0
Ferrous bicarb., Fe(HCO ₃) ₂	5.57		
Total			3460.47

Properties of Reaction in Percent

Primary salinity	38.32	Primary alkalinity	31.02
Secondary salinity	.....	Secondary alkalinity	30.66
Tertiary salinity	.....	Tertiary alkalinity	.....

Radioactivity

Temperature, °C. 15.0, 14.8. Temperature, °F. 59.1.
 Curies Ra Emanation per liter x 10⁻¹⁰, Water, 13.58, 2.55; Gas, 60.30,
 20.5.
 Mache Units per liter, Water, 3.67, 0.43; Gas, 16.28, 3.46.
 Permanent Activity, Grams Ra per liter, x 10⁻¹⁰, None.
 Remarks—Schlundt.

NUMBER 219

MAGNESIUM SPRING

Location—Steamboat Springs, Colorado.

Class of Water—Sodic, bicarbonated, muriated, sulphated, alkaline-saline, potassic, ferruginous, (carbondioxated, sulphuretted).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	32.0	
Sulphate	SO ₄	505.0	6.20
Bicarbonate	HCO ₃	2623.2	25.38
Carbonate	CO ₃	None	
Phosphate	PO ₄	None	
Chloride	Cl	1107.0	18.42
Iron	Fe		.08
Aluminum	Al		
Iron oxide	Fe ₂ O ₃	5.5	
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	
Calcium	Ca	93.52	2.75
Magnesium	Mg	25.12	1.22
Potassium	K	100.6	1.52
Sodium	Na	1731.6	44.43
Lithium	Li	Trace	
		6223.5	100.00
Oxygen in Fe ₂ O ₃		1.6	
Total		6221.9	

Concentration value	169.48	Excess carbon dioxide	945.9
Hydrogen sulphide, H ₂ S	24.19	Iron precipitated	1.06
Arsenic, As		Evaporation solids	5114
Strontium, Sr	None	Oxygen consuming capacity	1.73

Hypothetical Combinations

Milligrams per liter, approximately parts per million			
Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	378.2
Pot. chlor., KCl	191.8	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	
Sod. chlor., NaCl	1674.6	Calc. silicate, CaSiO ₃	
Sod. sulph., Na ₂ SO ₄	746.8	Silica, SiO ₂	32.0
Mag. sulph., MgSO ₄		Mang. oxide, Mn ₂ O ₃	
Calc. sulph., CaSO ₄		Mag. bicarb., Mg(HCO ₃) ₂	151.6
Calc. carb., CaCO ₃		Sod. bicarb., NaHCO ₃	3035.2
Ferrous bicarb., Fe(HCO ₃) ₂	12.2		
Total			6222.4

Properties of Reaction in Percent

Primary salinity	49.24	Primary alkalinity	42.66
Secondary salinity		Secondary alkalinity	8.10
Tertiary salinity		Tertiary alkalinity	

NUMBER 220

MOFFAT SPRING

Location—Steamboat Springs, Colorado.

Class of Water—Sodic, bicarbonated, muriated, sulphated, alkaline-saline, potassic, ferruginous, (carbondioxated, sulphuretted).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	25.3	
Sulphate	SO ₄	591.7	5.83
Bicarbonate	HCO ₃	3263.6	25.24
Carbonate	CO ₃	None	
Phosphate	PO ₄	None	
Chloride	Cl	1421	18.93
Iron	Fe		.05
Aluminum	Al		
Iron oxide	Fe ₂ O ₃	3.75	
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	
Calcium	Ca	111.7	2.64
Magnesium	Mg	31.79	1.24
Potassium	K	124.0	1.50
Sodium	Na	2172.0	44.57
Lithium	Li	Trace	
		7744.84	100.00
Oxygen in Fe ₂ O ₃		1.1	
Total		7743.74	

Concentration value	211.84	Excess carbon dioxide	1177
Hydrogen sulphide, H ₂ S	16.30	Iron precipitated	0.94
Arsenic, As		Evaporation solids	5896
Strontium, Sr	None	Oxygen consuming capacity	1.73

Hypothetical Combinations

Milligrams per liter, approximately parts per million			
Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	451.7
Pot. chlor., KCl	236.4	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	
Sod. chlor., NaCl	2157.4	Calc. silicate, CaSiO ₃	
Sod. sulph., Na ₂ SO ₄	875.0	Silica, SiO ₂	25.3
Mag. sulph., MgSO ₄		Mang. oxide, Mn ₂ O ₃	
Calc. sulph., CaSO ₄		Mag. bicarb., Mg(HCO ₃) ₂	191.3
Calc. carb., CaCO ₃		Sod. bicarb., NaHCO ₃	3798.3
Ferrous bicarb., Fe(HCO ₃) ₂	8.3		
Total			7743.7

Properties of Reaction in Percent

Primary salinity	49.52	Primary alkalinity	42.62
Secondary salinity		Secondary alkalinity	7.86
Tertiary salinity		Tertiary alkalinity	

NUMBER 221

SECOND SPRING

Location—Above Steamboat Spring, Steamboat Springs.

Rate of Flow—15 gal.

Temperature—80° F.

Class of Water—Sodic, bicarbonated, muriated, sulphated, alkaline-saline, potassic, (carbondioxated, sulphuretted).

Constituents	Formula	Milligrams per liter approximately parts per million	Reacting value percentage
Silica	SiO ₂	24.6	
Sulphate	SO ₄	583.8	5.61
Bicarbonate	HCO ₃	3388.2	25.67
Carbonate	CO ₃	None	
Phosphate	PO ₄	None	
Chloride	Cl	1436	18.72
Iron	Fe		.04
Aluminum	Al		
Iron oxide	Fe ₂ O ₃	3.25	
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	
Calcium	Ca	116.0	2.67
Magnesium	Mg	32.11	1.22
Potassium	K	157.5	1.86
Sodium	Na	2200	44.21
Lithium	Li	Trace	
Oxygen in Fe ₂ O ₃		7941.46	100.00
		0.98	
Total		7940.48	

Concentration value	216.36	Excess carbon dioxide	1221.8
Hydrogen sulphide, H ₂ S	24.54	Iron precipitated	0.83
Arsenic, As		Evaporation solids	6183
Strontium, Sr	None	Oxygen consuming capacity	2.55

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	469.1
Pot. chlor., KCl	300.3	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	
Sod. chlor., NaCl	2132.0	Calc. silicate, CaSiO ₃	
Sod. sulph., Na ₂ SO ₄	863.3	Silica, SiO ₂	24.6
Mag. sulph., MgSO ₄		Mang. oxide, Mn ₂ O ₄	
Calc. sulph., CaSO ₄		Mag. bicarb., Mg(HCO ₃) ₂	193.2
Calc. carb., CaCO ₃		Sod. bicarb., NaHCO ₃	3951.0
Ferrous bicarb., Fe(HCO ₃) ₂	7.24		
Total			7940.74

Properties of Reaction in Percent

Primary salinity	48.66	Primary alkalinity	43.48
Secondary salinity		Secondary alkalinity	7.86
Tertiary salinity		Tertiary alkalinity	

NUMBER 222

RUMBLING SPRING

Location—Steamboat Springs.

Rate of Flow—

Temperature—77° F.

Class of Water—Sodic, bicarbonated, muriated, sulphated, alkaline-saline, ferruginous, (carbondioxated, sulphuretted).

Constituents	Formula	Milligrams per liter approximately parts per million	Reacting value percentage
Silica	SiO ₂	29.2	
Sulphate	SO ₄	569.9	5.90
Bicarbonate	HCO ₃	2991.6	24.39
Carbonate	CO ₃	None	
Phosphate	PO ₄	Trace	
Chloride	Cl	1406	19.71
Iron	Fe		.05
Aluminum	Al		
Iron oxide	Fe ₂ O ₃	4.25	
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	None	
Calcium	Ca	109	2.71
Magnesium	Mg	26.76	1.09
Potassium	K	35.0	.45
Sodium	Na	2114	45.70
Lithium	Li	Trace	
Oxygen in Fe ₂ O ₃		7285.7	100.00
		1.3	
Total		7284.4	

Concentration value	201.12	Excess carbon dioxide	1078.8
Hydrogen sulphide, H ₂ S	27.91	Iron precipitated	0.83
Arsenic, As		Evaporation solids	5881
Strontium, Sr	None	Oxygen consuming capacity	0.27

Hypothetical Combinations

Milligrams per liter, approximately parts per million

Lith. chlor., LiCl	Trace	Calc. bicarb., Ca(HCO ₃) ₂	440.8
Pot. chlor., KCl	66.7	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	
Sod. chlor., NaCl	2265.7	Calc. silicate, CaSiO ₃	
Sod. sulph., Na ₂ SO ₄	842.8	Silica, SiO ₂	29.2
Mag. sulph., MgSO ₄		Mang. oxide, Mn ₂ O ₄	
Calc. sulph., CaSO ₄		Mag. bicarb., Mg(HCO ₃) ₂	161.0
Calc. carb., CaCO ₃		Sod. bicarb., NaHCO ₃	3469.0
Ferrous bicarb., Fe(HCO ₃) ₂	9.5		
Total			7284.7

Properties of Reaction in Percent

Primary salinity	51.22	Primary alkalinity	41.08
Secondary salinity		Secondary alkalinity	7.70
Tertiary salinity		Tertiary alkalinity	

Radioactivity

Temperature, °C, 24.5. Temperature, °F, 76.1.
 Curies Ra Emanation per liter x 10⁻¹⁰, Gas, 3.29.
 Mache Units per liter, Gas, 0.89.

NUMBER 223

STEAMBOAT NAVAJO SPRING

Radioactivity

Temperature, °C, 13.5, 13.0. Temperature, °F, 56.3
 Curies Ra Emanation per liter x 10⁻¹⁰, Water, 1.64, 1.9.
 Mache Units per liter, Water, 0.44, 0.32.
 Remarks—Schlundt.

NUMBER 224

STEAMBOAT, LITTLE STEAMBOAT

Location—35 yds. S. W. of Cave Spring Hill Side.

Radioactivity

Curies Ra Emanation per liter x 10⁻¹⁰, Gas, 25.58.
 Mache Units per liter, Gas, 6.91.

NUMBER 225

ARTESIAN WELL

Location—Swallows, Colo.

Class of Water—Sodic, ferruginous, bicarbonated, alkaline, magnesian, carbondioxated).

Constituents	Formula	Milligrams per liter Approximately parts per million	Reacting value percentage
Silica	SiO ₂	13	.....
Sulphate	SO ₄	102.3	4.62
Bicarbonate	HCO ₃	1064.5	38.02
Carbonate	CO ₃	None	.....
Phosphate	PO ₄	.....	.....
Chloride	Cl	120	17.36
Iron	Fe	.....	.26
Aluminum	Al	.....	.....
Iron oxide	Fe ₂ O ₃	} 4.5	.....
Aluminum oxide	Al ₂ O ₃		
Manganese	Mn	.....	.....
Calcium	Ca	34.4	3.72
Magnesium	Mg	66.85	11.97
Potassium	K	46.1	2.57
Sodium	Na	332.5	31.48
Lithium	Li	None	.....
		1784.15	100.00
Oxygen in Fe ₂ O ₃		1.35	
	Total	1782.3	
Concentration value	45.90	Excess carbon dioxide	383.9
Hydrogen sulphide, H ₂ S	None	Iron precipitated	.....
Arsenic, As	.....	Evaporation solids	1289
Strontium, Sr	.....	Oxygen consuming capacity	11.33
Hypothetical Combinations			
Milligrams per liter, approximately parts per million			
Lith. chlor., LiCl	None	Calc. bicarb., Ca(HCO ₃) ₂	139.1
Pot. chlor., KCl	87.9	Iron and aluminum oxides, Fe ₂ O ₃ , Al ₂ O ₃	.....
Sod. chlor., NaCl	128.9	Calc. silicate, CaSiO ₃	.....
Sod. sulphate, Na ₂ SO ₄	151.3	Silica, SiO ₂	13
Mag. sulph., MgSO ₄	.....	Mang. oxide, Mn ₂ O ₃	.....
Calc. sulph., CaSO ₄	.....	Mag. bicarb., Mg(HCO ₃) ₂	402.3
Calc. carb., CaCO ₃	.....	Sod. bicarb., NaHCO ₃	850.3
Ferrous bicarb., Fe(HCO ₃) ₂	10		
Total	.....		1782.8
Properties of Reaction in Percent			
Primary salinity	23.96	Primary alkalinity	44.14
Secondary salinity	.....	Secondary alkalinity	31.38
Tertiary salinity	.....	Tertiary alkalinity	.52
Radioactivity			
Temperature, °C, 21.0. Temperature, °F, 69.9.			
Curies Ra Emanation per liter x 10 ⁻¹⁰ , Water, 2.62.			
Mache Units per liter, Water, 0.71.			