Comstock

PROCEEDINGS OF THE COLORADO SCIENTIFIC SOCIETY.
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THE WATER SUPPLY OF COLORADO.

By CHARLES W. COMSTOCK.

A CRITICAL DISCUSSION OF THE PRINCIPLES OF THE RICHARDS PULSATOR CLASSIFIER

By LEWIS B. SKINNER.

DENVER,
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REPORT OF THE EXECUTIVE COMMITTEE OF THE COLORADO SCIENTIFIC SOCIETY FOR THE YEAR 1911.

Denver, Colorado, December 16th, 1911.

By the Secretary.

During the past year the proceedings of your Society show that nine regular meetings were held, with an average attendance of 26-2/3, and that nine papers were presented and read. The papers read, with their titles and authors, were as follows:

"A Discussion of Rock Streams with Special Reference to the Rock Streams of Veta Peak, Colorado," by Dr. Horace B. Patton.

"Description of a Tin Deposit in Texas," by Dr. Regis Chauvenet.

"Genesis of Ore Deposits," by Mr. George J. Bancroft.

"A Recent Trip to Honduras," by Mr. Rensselaer H. Toll.

"Asbestos Deposits of Casper Mountain, Wyoming," by Mr. Henry C. Beeler.

"The 105th Meridian and the Mile High Level, in Denver," by Dr. Herbert A. Howe.

"Eskimo Dogs, Their Origin, and an Example of Reversion," by Mr. J. D. Figgins.

"The Occurrence and Origin of Nitrates in Colorado Soils; Some of Their Effects and What They Suggest," by Dr. William P. Headden.

"Screenless Sizer," by Mr. James M. McClave.

There were nine papers published this year, the same number having been published last year.

The lowest attendance at any meeting was 14 in September, while the highest was 37 in April. The average attendance for the nine meetings was 26-2/3. In 1910 the lowest attendance at any meeting was 23 in December, and the highest was 108 in April, the average being 40.3.

During the year 24 members have been elected. The loss has been 21; 6 by death and 15 by resignation, leaving a net gain of 3. Those lost by death were as follows: Mr. Robert Forrester, who died December 20th, 1910; Mr. John E. Chapson, who died January 20th, 1911; Mr. Samuel F. Emmons, who died March 28th, 1911; Mr. James B. Grant, who died November 1st, 1911; Mr. Charles B. Kountze, who died November 17th, 1911; and Judge Carlton M. Bliss, who died November 27th, 1911.

Of the present total membership of 252, 154 reside in Denver; 46 outside of Denver, in Colorado; 41 outside of Colorado, in the United States, and 11 in foreign lands. The roll consists of 4 life members, 9 honorary fellows, 13 fellows, 173 members, 38 associates, and 15 who have not as yet been graded.

The Executive Committee held 5 regular meetings, with an average attendance of 6-1/5, besides several informal meetings.

There have been 6 exchanges added during the past year, viz.: American Brass Founders' Association, Australian Mining and Engineering Review, Colorado School of Mines, Economic Geology, Carnegie Library of Pittsburgh, and the Patent Office Library of London.

The number of visitors to the museum and library during the past year was 1,321, the number last year being 1,336.

Books added to the library during 1911 were as follows:

By Purchase —

American Society of Mechanical Engineers, Volumes 29, 30 and 31.

By Gift—

Annual Report of the Smithsonian Institution for 1909.

Annual Report of the United States National Museum for 1910.

Twenty-seventh Annual Report of the Bureau of American Ethnology for 1905 and 1906.

Twenty-fourth Annual Report of the Interstate Commerce Commission for 1910.

Biennial Report of the State Historical and Natural History Society of Colorado for 1909 and 1910.

Bureau of American Ethnology, Bulletin Number 40, Part 1; also Bulletin Numbers 43, 44, 50 and 51.

Colorado Geological Survey Bulletin, Numbers 1 and 2, presented by Mr. W. F. R. Mills.

Congressional Records—Index to Volume 41, Parts 1–5; also Volume 42, Parts 1, 3, 7 and 8.

Geological Survey of Ohio, Fourth Series, Bulletin Numbers 2, 12 and 13.

Geological Survey of Iowa, Volume 20, and Annual Report for 1909.

Library of Congress Report for 1910.

Mineral Resources for 1909, Parts 1 and 2.

Oklahoma Geological Survey, Bulletin Numbers 2, 5 and 8.

Proceedings of the Iowa Academy of Science for 1910, Volume 17.

Proceedings of the United States National Museum, Volumes 30, 39 and 40.

Records of the Geological Survey of New South Wales, Volume 9, Part 1.

The Mineralogy of Pennsylvania, presented by Mr. John Eyerman.

The Railway Library for 1910.

Wisconsin Geological and Natural History Survey, Bulletin Numbers 21 and 22; also Scientific Series Numbers 6 and 7.

During the past year the Society has been organized into 5 sections, viz.:

1—Technical Chemistry and Metallurgy. Secretary, Mr. H. O. Bosworth.

2—Economic Geology and Mining Engineering. Secretary, Mr. S. A. Ionides.

3—Mechanical and Electrical Engineering. Secretary, Mr. H. S. Sands.

4—Irrigation and Civil Engineering. Secretary, Mr. F. W. Bosco.

5—Pure Science. Secretary, Mr. G. M. Butler.

These Sections have held meetings during the year as follows:

April 8th—Section 1 held its first regular meeting, at which Mr. Lewis B. Skinner presided. He gave the address of the evening on "The Practical Versus the Theoretical Man."

April 21st—Section 2 held its first regular meeting, Mr. S. A. Ionides presiding. Mr. George J. Bancroft read a paper on "The Superficial Appearance and Alteration of Ore Deposits."

September 9th—Section 1 held its second regular meeting, Prof. Herman Fleck acting as chairman. The chair read a paper which had been prepared for this meeting by Mr. F. L. Clerc on "The Utilization of the Zinc Carbonates and Silicates of Leadville, Colorado."

November 18th—Section 1 held its third regular meeting, Mr. Howard C. Parmelee presiding. Dr. Bain read a paper entitled "Methods of Ore Treatment."

November 25th—Section 5 held its first regular meeting, Mr. George E. Collins acting as chairman. The following papers were read: "Recent Developments in Physics," by Prof. L. F. Miller; "Recent Developments in Chemistry," by Dr. J. B. Ekeley, and "Recent Developments in Geology," by Prof. G. M. Butler.

In addition to these, under the auspices of this Society and the State School of Mines, meetings have been held at Idaho Springs, Leadville, Telluride and Ouray, for the purpose of stimulating the mining industry of the state by "Practical Talks" by well known scientific engineers to the miners, mine and mill operators of these towns. These meetings have met with much encouragement from the mining communities and the expectation of good results along the line of more economic management of mines and mills is well warranted.

With the view of broadening the usefulness of this Society and obtaining a fuller measure of benefit of the scientific labor of the community, in the spring of this year, sections were organized. It was considered that these sections would allow for specialization under one organization, which would result in economy in many ways; affording a common meeting place for members, devoting special attention to different branches of scientific investigation, a better fraternizing of these specialists, a more beneficial interchange of ideas and a greater promotion of useful knowledge. These sections are just now getting into working order, and there is every reason to expect the most satisfactory results from the experiment.

On account of threats of increased rental at our former headquarters at 1510 Court Place, it was considered advisable by the Executive Committee to make a change, and after much painstaking labor by the committee appointed for the purpose, the present quarters for our library and meeting rooms were obtained at a rental of $50 per month, which includes light and janitor services. Our museum, which occupies a large floor space, with the kindly consent of the school authorities, was placed in the North Side High School Building, where it is open to the public and will, in addition, serve as a stimulus to the students of the geological classes of that school.

The assistant secretary, Miss Riddle, has rendered good and efficient service, especially to the secretary and treasurer, and for her zeal and ever loyal interest to the welfare of the Society I wish to express, on behalf of all its members, our grateful appreciation.

DR. WILLIAM A. JOHNSTON,
Secretary.

REPORT OF THE TREASURER OF THE COLORADO SCIENTIFIC SOCIETY FOR THE YEAR ENDING DECEMBER 16TH, 1911.

418 Boston Building, Denver, Colo., Dec. 16th, 1911.

RECEIPTS.

Balance from statement of 1910	$ 351.11	
Annual dues	1,805.00	
Rent	455.00	
Annual dinner	189.00	
Sale of Proceedings	25.00	
Life memberships	300.00	
Cancelled fire insurance	16.80	
Miscellaneous	10.30	
	$3,152.21	$3,152.21

DISBURSEMENTS.

Rent	$1,100.00	
Printing Proceedings	384.65	
Printing Notices, Ballots and Stationery	233.75	
Lighting	28.95	
Illustrating lectures	41.70	
Postage and Envelopes	133.68	
Fire insurance	86.20	
Salary of assistant secretary	580.00	
Petty cash	73.55	
Periodicals, books and binding	39.00	
Library furnishings and repairs	29.70	
Exchange	.75	
Annual dinner	261.45	
Moving to present quarters	99.10	
Engraving resolutions	6.00	
Miscellaneous	18.50	
	$3,116.98	$3,116.98
Cash on hand		35.23
		$3,152.21

This report shows a total collection of $2,801.10 as against $2,819.00 in 1910, a falling off of $17.90. The total disbursements as shown, were $3,116.98 as against $2,861.53 for 1910, an increase of $255.45.

In analyzing and comparing the expenditures with those of the previous year, you will find the comparison as follows:

DECREASE.

Rent account	$100.00
Printing of Proceedings	80.55
Periodicals, books and binding	26.05
Exchange	1.20
Annual dinner	24.35
Miscellaneous	51.00
	$283.15

INCREASE.

Printing Notices, Ballots, Circulars, etc.	$ 90.05
Lighting	6.20
Postage and envelopes	10.80
Insurance	17.40
Salary of assistant secretary	270.00
Petty cash	18.55
Library repairs and furnishings	12.80
Illustrating lectures	7.70
Moving	99.10
Engraving resolutions	6.00
	$538.60
	$283.15
	$255.45

The chief items of increase fall on cost of printing notices, ballots and stationery, which is due largely to the extra notices and circulars sent out in connection with organizing of the "Sections." The other two important items are the increase in the salary of the assistant secretary, and the cost of moving.

Respectfully submitted,

J. W. RICHARDS,
Treasurer.

Attest:

RICHARD A. PARKER, Chairman.
FRANK E. SHEPARD.
Auditing Committee.

December 18th, 1911.

PROCEEDINGS OF THE COLORADO SCIENTIFIC SOCIETY.
VOL. X, pp: 123-130.

THE WATER SUPPLY OF COLORADO.

By CHARLES W. COMSTOCK.

Address of the Retiring President read at the meeting of the Society, December 16, 1911.

There is a well established custom among societies devoted to the advancement of learning, in accordance with which the retiring presiding officer outlines a field wherein his confreres may labor with advantage for the discovery of principles and the accumulation of facts which are needed in the work-a-day world. Thus, while the papers and discussions of the year are contributions toward the solution of problems previously presented, the function of the address at the annual meeting is to state another problem which has been forced to the front amid the changing conditions and which demands our attention.

Conforming to this custom, which I think an admirable one, I have chosen to discuss a subject which has occupied most of my attention for a number of years just past, viz.: "The Water Supply of Colorado."

At the risk of being thought elementary, I must revert to first principles and consider the source of all water, i. e., precipitation from the atmosphere. Rain or snow falls and immediately divides itself among a number of channels. A portion is again evaporated directly from the surface of the ground or from the snow surface. Another portion sinks into the ground, is absorbed by vegetation, and either becomes a part of the plant itself, or is evaporated from its foliage. Still another part finds its way into the ground far enough to be beyond the reach of atmospheric influences and becomes part of the great body of ground water. This third portion itself may be subdivided into two, one becoming part of what is ordinarily known as "ground water," and the other joining the deeper subterranean flow. Finally, a fourth portion runs off the surface of the ground and finds its way into the channels of surface streams.

All of this water, except that absorbed by vegetation, or evaporated, may under proper conditions, become available for use. The subterranean flow supplies artesian wells, of which there are many in Colorado, particularly in the San Luis Valley.

The ground water is in sufficient quantity in some parts of the state to irrigate small tracts of land. The surface flow, although probably only a small fraction of the total precipitation, is relied upon to supply nearly all our demands for domestic, agricultural and industrial purposes.

The division of the water among these various modes of distribution varies widely with the geology, the topography and the climate of the region in which the water flows, as well as with the distribution in time of the precipitation itself.

To cite extreme cases: In the heart of the mountain ranges where there is little soil, where the rocks are bare and the slopes steep, where the altitude is high and the rocks generally of a crystalline character, nearly all the water which falls divides itself into two classes—the first, covered by evaporation, and the last covered by surface run-off. Although temperatures are generally low in such localities, the winds blow almost constantly, frequently with great violence, and the tension of the aqueous vapor in the atmosphere is very low. These two conditions do more to increase evaporation than a high temperature. Vegetation is scant or entirely absent, and, therefore, plays no part in the distribution of the water. There is little or no soil, and the rocks are crystalline and compact. Therefore, the quantity absorbed is relatively insignificant. On the other hand, the slopes are steep and water runs very rapidly to the natural drainage lines of the country.

Per contra, in the open prairie, such as forms the eastern forty per cent. of this state, all the conditions are changed.

The topographical relief is small and the slopes are slight. There is a considerable quantity of vegetation, even on our most barren plains. The soil and sub-soil are deep and often very porous. Even the rocks themselves which underlie the soil, or which outcrop in places, are sedimentary and capable of absorbing large quantities of water. The temperatures are higher, but the winds, as a rule, less constant, and the tension of aqueous vapor generally greater.

We here find one condition which makes for greater evaporation than in the mountains, and two which tend to decrease it. The net result we do not know. The water falling on porous and absorbent soil with gradual slopes does not run off readily, but is absorbed in large quantities. The precipitation itself comes mostly in the form of rain in the warmer portions of the year, whereas in the mountains it is chiefly in the form of snow during the fall and winter months. The vegetation directly absorbs some water and facilitates the evaporation of more.

Thus we find that while in the mountains very little water is absorbed by soil or rocks, on the plains a great deal is disposed of in this way. The quantity evaporated on the plains, as compared with the mountains, is unknown, but is known to be very great, and some is absorbed by vegetation, which is not the case at extremely high altitudes.

The general result is that the run-off from the plains areas to the channels of the natural streams is insignificant, except on those rare occasions of very great precipitation within a short time. This distinction is so marked in what is known as the "arid" or "semi-arid" region that the drainage area of a stream is quite commonly divided into two portions which are known respectively as "contributing" and "non-contributing" areas.

To be enabled to make the best use of the water which falls to our lot, we should know with accuracy the total quantity supplied and the proportion of it which is disposed of in these various ways, under the great variety of conditions which exist in the state.

Three of the elements mentioned are capable of direct measurement, viz.:

Precipitation;

Surface run-off;

Evaporation.

Some work has also been done in attempts to measure the absorption by and percolation through various soils. The results so far, however, have not been such as to warrant any generalizations.

What do we know about precipitation in Colorado?

The Monthly Weather Review, for September, 1911, an official publication of the United States Weather Bureau, gives a list of 156 rainfall stations in this state. Of these, forty-five are in the Platte River drainage basin; thirty-nine in the Arkansas; two in the water-shed of the Cimarron; ten in the Rio Grande basin, and sixty-two in the Colorado River drainage. This totals 158, but two of these stations are counted twice; that at Corona is common to the South Platte and the Colorado drainage, while that at Marshall Pass is common to the Arkansas and the Colorado.

The area of Colorado is 103,948 square miles. We thus have on the average one rainfall station to each 666 square miles, or, say, one to an area of twenty-six miles square. This number might be considered adequate, if the conditions upon which precipitation depends were even approximately uniform throughout the state, which, however, they are not.

By way of comparison, we may note the distributions of these stations in some other parts of the world.

In France the drainage basin of the Seine is 30,327 square miles. The government there maintains 423 precipitation stations, or one to each seventy-two square miles. This is as one for each two townships, as compared with one for each eighteen townships in Colorado.

In the valley of the Rhone there is a precipitation station for each ninety-six square miles; in Switzerland, one for each forty-four square miles.

The entire area of France is less than twice that of Colorado, and if we would maintain precipitation records comparable with those abroad, we must have not less than 1,400 precipitation stations in the state of Colorado. Even the very large number established in the basin of the Seine is deemed insufficient by the engineers charged with the improvement and maintenance of the water-ways in that region, and in the most elaborate and exhaustive report on the flood of January, 1910, prepared by the government engineers and recently issued by authority of the French government, a substantial increase in the number of these stations is proposed.

At the present time, the practice in Colorado among those who are not trained to scientific modes of thought, is to apply the records of the nearest station to whatever area may be under consideration, whether it be large or small, thus unconsciously assuming a uniformity in the distribution of rainfall which the most casual observer knows does not exist.

The question is frequently asked: What is the ratio of run-off to rainfall in this or that drainage area? This question is not answerable for any drainage area in the state of Colorado, for the obvious reason that we do not know how much water falls in any such drainage area.

Meagre and unsatisfactory as our run-off records may be, we know more about the total run-off than we do about the total precipitation.

A second element directly measurable is the run-off, and on this more money has been spent and more work done than on any other, although the records and results are far from satisfactory, partly because some of the work has been poorly done, but chiefly because of lack of continuity.

Not counting stations maintained by private parties, the records of which are not accessible to the public, there are now seventy-three stream gauging stations in Colorado. Of these, eighteen are located in the Platte water shed, twelve in the Arkansas, nine in the Rio Grande, and thirty-four in the drainage area of the Colorado. This last, of course, includes more than one-third of all the state, being the entire area west of the main range except that tributary to the Rio Grande.

This number, small as it is, is five times as great as it was three years ago. It means an average of one stream gauging station for each 1,424 square miles in the state.

In the basin of the Seine the French government maintains 120 stream gauging stations, or one for each 253 square miles.

Concerning this phase of the water supply question, there is little to be said except that there is need for greatly extending it, and strenuous efforts must be made to avoid any break in the continuity of the records.

In the matter of evaporation measurements, almost nothing has been done. Observations have been desultory and scattered. Diligent search has failed to reveal more than one record extending through an entire year. Such observations as have been made have been made without uniformity of method or procedure and are hardly comparable.

So far from being able to know the comparative evaporation in the mountains and on the plains, we are not even in position to state with definiteness the average annual evaporation at any one place in Colorado. This is without doubt a task which should be undertaken by the State Hydrographic Service, but it is a formidable one for several reasons.

Evaporation stations depend for their value upon measurements which must be made with great precision and at frequent intervals. This means the expenditure of a considerable sum for the equipment of each station, and the attendance of a skilled observer. The work cannot be entrusted to such observers as happen to be resident near the station, as is done with a fair degree of satisfaction with stream gauging stations. Our legislature should be asked to provide for an equipment of this kind, and for the proper conduct of these observations.

With accurate knowledge of the total precipitation, the total run-off, and the total evaporation, we can ascertain by difference the quantity of water absorbed by the soil and the vegetation. No method is apparent by which any direct measurement of this quantity can be made.

Valuable work in the direction of the measurement of ground water flow has been done during the past ten years by a number of engineers following in the footsteps of Prof. Charles S. Slichter. It is not unlikely that this may lead sooner or later to some method by which we can determine directly the quantity of water absorbed by the soil and its ultimate disposition. Along this line, I have nothing to suggest.

As said in my opening paragraph, I have only attempted to state some problems demanding solution. The demand is real, and the necessity for definite answers to some of these questions is very great. For these reasons, it has seemed proper and appropriate that they be called to the attention of The Colorado Scientific Society.