BULLETIN OF THE GEOLOGICAL SOCIETY OF AMERICA
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PROCEEDINGS OF THE EIGHTEENTH ANNUAL MEETING, HELD AT OTTAWA, CANADA, DECEMBER 27, 28, AND 29, INCLUDING PROCEEDINGS OF THE SEVENTH ANNUAL MEETING OF THE CORDILLERAN SECTION, HELD AT BERKELEY, CALIFORNIA, DECEMBER 29 AND 30, 1905

HERMAN LE ROY FAIRCHILD, *Secretary*

CONTENTS

Session of Wednesday, December 27

The Society was called to order by the President, Raphael Pumpelly, at 10.10 o'cock a m, at the Normal School, where all the sessions were held during the meeting except the evening session of this day.

By vote of the Society the address of welcome and response were postponed to the afternoon.

The report of the Council was called for, and was presented by the Secretary, in print, as follows:

REPORT OF THE COUNCIL

To the Geological Society of America,
in Eighteenth Annual Meeting Assembled:

The stated Annual Meeting of the Council was held at Philadelphia conjointly with the meeting of the Society. It has been unnecessary to hold any special meeting, but some routine business has been done by correspondence.

The following reports of the officers give the details of administration for another prosperous year, the seventeenth, in the history of the Society.

SECRETARY'S REPORT

To the Council of the Geological Society of America:

Meetings.—The record of the Philadelphia Winter Meeting, 1904, will be found in the closing brochure of volume 16 of the Bulletin.

The adoption of the constitutional amendment relating to summer meetings gives the Council and Society liberty in the matter of summer meetings.

Membership.—Since the last publication of the list of Fellows, the names of two Fellows have been removed by death—George H. Eldridge and Albert A. Wright. The names of 15 new Fellows have been added to the list and one removed by resignation. This makes the present enrollment 271, or 12 more than at the last printing. Sixteen nominations are now before the Society and several candidates are awaiting action by the Council.

Distribution of Bulletin.—At this date 446 pages of volume 16 have been distributed and the remaining brochures are approaching completion. The irregular distribution of the Bulletin during the past year has been as follows: Complete volumes sold to the public, 33; sold to Fellows, 25. Brochures sent to supply deficiencies, 38; sold to the public, 34; sold to Fellows, 22. One copy of volume 15 has been donated and 3 copies bound for use of the officers and the Library. One complete set of the Bulletin volumes has been sold to a library and one set to a Fellow.

Bulletin Sales.—Receipts from the sale of the Bulletin during the past year appear in the following table:

Receipts from Sale of Bulletin, December 1, 1904, to December 1, 1905

	Complete volumes.			Brochures.			Grand total.
	Public.	Fellows.	Total.	Public.	Fellows.	Total.	
Volume 1..	$10 00	$9 00	$19 00	....	$0 65	$0 65	$19 65
Volume 2..	5 00	9 00	14 00	$0 50	....	50	14 50
Volume 3..	5 00	8 00	13 00	2 45	....	2 45	15 45
Volume 4..	5 00	7 00	12 00	80	....	80	12 80
Volume 5..	5 00	8 00	13 00	1 45	....	1 45	14 45
Volume 6..	5 00	12 00	17 00	1 00	....	1 00	18 00
Volume 7..	5 00	4 00	9 00	1 00	72	1 72	10 72
Volume 8..	5 00	4 00	9 00	25	40	65	9 65
Volume 9..	5 00	4 00	9 00	45	50	95	9 95
Volume 10..	5 00	4 00	9 00	....	20	20	9 20
Volume 11..	15 00	4 50	19 50	3 05	45	3 50	23 00
Volume 12..	19 95	4 00	23 95	....	1 20	1 20	25 15
Volume 13..	10 00	4 50	14 50	8 50	4 10	12 60	27 10
Volume 14..	50 00	4 50	54 50	2 70	2 75	5 45	59 95
Volume 15..	210 00	4 50	214 50	6 65	3 00	9 65	224 15
Volume 16..	195 00	....	195 00	65	....	65	195 65
Volume 17..	15 00	....	15 00	....	....	....	15 00
	$569 95	$91 00	$660 95	$29 45	$13 97	$43 42	$704 37
Index......	4 50	2 25	6 75	....	.. ..	... .	6 75
	$574 45	$93 25	$667 70	$29 45	$13 97	$43 42	$711 12

Receipts for the fiscal year	$711 12
Previous receipts, to December 1, 1904....................	8,154 97
Total receipts to date..............................	$8,866 09
Charged and uncollected..............................	29 10
Total Bulletin sales to date........................	$8,895 19

The bills for volume 16 to regular subscribers have not been sent, and the above table includes for this volume only the payments in advance.

Exchanges.—The exchange list includes one more address than last year, three being added, two dropped, and one transfer made. The revised list will be found in the closing pages of volume 16.

Expenses.—The following table gives the cost of administration and of Bulletin distribution from the Secretary's office during the past year:

EXPENDITURE OF SECRETARY'S OFFICE DURING THE FISCAL YEAR ENDING NOVEMBER 30, 1905

Account of Administration

Postage and telegrams..	$29 76	
Expressage.......	5 13	
Printing (including stationery)	110 74	
Total		$145 63

Account of Bulletin

Postage	$130 10	
Expressage and freight	66 87	
Wrapping material	50	
Addressograph links	56	
Binding three copies volume 15	3 00	
Bulletin advertising, Moore's catalogue	15 00	
Collection of checks	3 30	
Total		219 33
Total expenses for the year		$364 96

Respectfully submitted.

H. L. FAIRCHILD,
Secretary.

ROCHESTER, N. Y., *December 10, 1905.*

TREASURER'S REPORT

To the Council of the Geological Society of America:

The Treasurer herewith submits his annual report for the year ending December 1, 1905.

Four (4) Fellows were liable to be dropped from the roll for non-payment of dues, in accordance with section 3, chapter 1; five (5) were delinquent for two years, while thirty-one (31) were still delinquent for this year on December 1, 1905. Since December 1 five (5) of them have paid, leaving only twenty-six (26) delinquent for 1905, and only two Fellows liable to be dropped at the present date (December 15).

Seven (7) Fellows—J. A. Bownocker, R. W. Brock, M. S. W. Jefferson, B. L. Miller, A. H. Purdue, S. Shedd, and Lewis G. Westgate—have enrolled for life by the payment of the one-hundred-dollar fee, thus increasing the total number of Life Commutations to seventy-five (75) to date.

The Permanent Publication Fund (only the interest of which can be used for current expenses of publication) has been increased during the year from $8,300 to $9,300 by the purchase of 10 more shares of stock in the Ontario Apartment House Company of Washington, D. C. This purchase was made upon the advice of the Treasurer and Doctor Emmons, two of the three members of the Finance Committee, since Doctor Walcott, the president of the Ontario Company, declined to advise the committee. The Treasurer has no doubt that the investment is a safe one, and that it will, like the other investments of the Society in this class of securities, continue to yield a 6 per cent annual dividend.

The item of annual interest from these investments ($448), together with the interest on monthly balances ($65.64), received on account of deposits in the Rochester Security Trust Company, thus continues to grow

Statement of Receipts and Expenditures

RECEIPTS.

Balance in treasury December 1, 1904			$1,973 68
Fellowship fees 1902 (2)	$20 00		
" " 1903 (9)	90 00		
" " 1904 (29)	290 00		
" " 1905 (160)	1,600 00		
		$2,000 00	
Initiation fees (15)		150 00	
Life commutations (7)		700 00	
Interest on investments:			
Iowa Apartment House Co. stock	$120 00		
Tunnelton, Kingwood and Fairchance Railroad bonds	18 00		
Ontario Apartment House Co. stock	60 00		
Texas and Pacific R. R. bonds	100 00		
U. S. Steel Corporation bonds	150 00		
Interest on deposits with Security Trust Company of Rochester	65 64		
		513 64	
Sales of publications		711 12	
			4,074 76
Total receipts (carried forward)			$6,048 44

Total receipts brought forward			$6,048 44

EXPENDITURES.

Secretary's office:			
Administration	$145 63		
Bulletin	219 33		
Allowance (traveling and clerical expenses)	500 00		
		$864 96	
Treasurer's office:			
Postage	$10 00		
Expressage	1 35		
		11 35	
Librarian's office		8 26	
Photographic account		14 20	
Publication of Bulletin:			
Printing	$1,564 90		
Engraving	725 51		
Editor's allowance, personal and office expenses	250 00		
		2,540 41	
Investments, Ontario Apartment House Co. stock		1,000 00	
Total expenditures			4,439 18
Balance in treasury December 1, 1905			$1,609 .26

and practically offset the loss in fees from deaths and resignations, so that the financial affairs of the Society are in a satisfactory condition, as may be seen from the receipts and disbursements for the past year exhibited by the tabular statement on the preceding page.

The securities now owned by the Society (all of which are deposited in the fire and burglar proof vaults of the Bank of the Monongahela Valley at Morgantown, West Virginia) are as follows:

On Account of Publication Fund

March 17 and 25, 1898, two Texas and Pacific Railroad first mortgage 5 per cent bonds, cost $1,976.25	$2,000
February 6, 1901, 10 shares of the capital stock of the Iowa Apartment House Company, Washington, D. C., cost $1,000	1,000
April 1, 1903, 20 shares of the capital stock of the Ontario Apartment House Company, Washington, D. C., cost $2,000	2,000
May 5 and September 27, 1895, 3 first mortgage 6 per cent bonds of the Kingwood, Tunnelton and Fairchance railroad, cost $304	300
April 11, 1904, 3 second mortgage 5 per cent bonds, United States Steel Corporation, cost $2,366.25	3,000
May 12, 1905, 10 shares of the capital stock of the Ontario Apartment House Company, Washington, D. C., cost $1,000	1,000
Total cost, $8,646.50; total par value	$9,300

The Texas and Pacific and United States Steel bonds are quoted on the New York Exchange at 123 and 96½, respectively, at the date of this report.

Respectfully submitted.

I. C. White,
Treasurer.

Morgantown, W. Va.,
December 15, 1905.

Editor's Report

To the Council of the Geological Society of America:

The Editor regrets to have to report again inability to close the annual volume before the Winter Meeting, owing to the tardiness of members in handing in their papers. The last galleys, and even the illustrations of one paper, were not in the Editor's hands before the middle of December. At this writing all papers are in pages, the last page being 670. The Proceedings Brochure, now in galleys, will add something over 100 pages. From this it will be seen that volume 17 will probably be the largest ever issued by the Society. It is copiously illustrated with over 80 half-tone plates and many text figures.

The Bulletin is certainly appreciated by the members as a medium of publication, the demand for space in its pages steadily growing as time goes on.

The foregoing was the Editor's report to the Council on December 20, 1906. It has seemed to him wise to append the facts concerning volume

17 as well as volume 16, and thus bring the statistical information down to date, rather than to wait for another year to pass.

In text volume 17 is the largest ever published by the Society. It will be seen from the data given below that its cost is proportionately large. It contains 785 pages, 84 plates, and 96 text figures.

	Average. Vols. 1–10.	Vol. 11.	Vol. 12.	Vol. 13.	Vol. 14.	Vol. 15.	Vol. 16.	Vol. 17.
	pp. 544. pls. 26.	pp. 651. pls. 58.	pp. 538. pls. 45.	pp. 583. pls. 58.	pp. 609. pls. 65.	pp. 636. pls. 59.	pp. 636 pls. 94	pp. 785 pls. 84
Letter-press	$1,465 14	$1,815 56	$1,445 73	$1,647 12	$1,657 50	$1,661 21	$1,817 03	$2,087.98
Illustrations	200 40	373 68	414 80	477 27	431 21	457 76	706 97	608.68
	$1,665 54	$2,189 24	$1,860 53	$2,124 39	$2,088 71	$2,118 97	$2,524 00	$2,696.66
Average per page	$3 23	$3 36	$3 45	$3 64	$3 43	$3 33	$3 96	$3.37

Attention is called to the fact that in presenting the analyses of the contents of volumes a change has been made in the divisions of the subject-matter. It is believed that the new classification will be found more satisfactory than the one previously used. The analyses now include volumes 1 to 6, thus making the entire series complete.

Classification

Volume.	Areal geology.	Physical geography.	Glacial geology.	Physiographic geology.	Petrographic geology.	Stratigraphic geology.	Paleontologic geology.	Economic geology.	Official matter.	Memorials.	Unclassified.	Total.
	Number of pages.											
1......	116	137	92	18	83	44	47	.....	60	4	4	593 + xii
2......	56	110	60	111	52	168	47	9	55	1	7	662 + xiv
3......	56	41	44	41	32	158	104	.....	61	15	1	541 + xii
4......	25	134	38	74	52	52	14	.....	47	32	2	458 + xii
5......	138	135	70	54	28	51	107	.....	71	14	9	665 + xii
6......	50	111	75	39	71	99	1	.....	63	25	4	538 + x
7......	38	77	105	53	40	21	123	4	66	28	13	558 + x
8......	34	50	98	5	43	67	58	14	79	8	....	446 + x
9......	2	102	138	.....	44	28	64	16	64	12	....	460 + x
10......	35	33	96	37	59	62	68	28	84	27	17	534 + xii
11......	65	110	21	10	54	31	188	7	71	60	46	651 + xii
12......	199	39	55	53	24	98	5	5	70	2	....	538 + xii
13......	125	17	13	24	28	116	42	4	165	32	29	583 + xii
14......	48	47	48	59	183	118	22	1	80	14	1	609 + xii
15......	26	124	3	94	36	267	.....	.....	77	17	3	636 + x
16......	64	111	78	30	102	141	19	.....	67	22	15	636 + xii
17......	49	161	41	84	47	294	27	.....	71	9	2	785 + xiv

Respectfully submitted.

JOSEPH STANLEY-BROWN,
Editor.

NEW YORK, *March 15, 1907.*

Librarian's Report

To the Council of the Geological Society of America:

The accessions to the library received during the past twelvemonth have been duly catalogued and acknowledged and the list of accessions up to July 1, 1905, prepared and forwarded to the Secretary for incorporation in volume 16 of the Bulletin.

The library now contains some 2,800 numbers, which is an average of about 200 numbers annually since library material first commenced to accumulate. At present the increase is slightly in excess of that figure, owing mainly to an increase in the number of contributing exchanges. The amount of material donated by Fellows shows a steady annual decrease. If it is desirable that the library should contain a full representation of the writings of its members, then it should be stated that at the present time it falls far short of so doing, and in increasing annual amount.

It has never been feasible for the Society to exchange publications with state surveys, but it was thought that the officials of such surveys who are Fellows of the Society would see to it that sets of their publications reach the library shelves. They do so, but in diminishing number. The Librarian does not understand it to be part of his duties to solicit gifts to the library; but he wishes to call attention to the fact that only a small percentage of the annual output of state survey reports reach the library.

The expenses of this office for the past year are as follows:

To postage	$1 76
To express charges	50
To clerk hire	6 00
	$8 26

Respectfully submitted.

H. P. Cushing,
Librarian.

Cleveland, Ohio, *December 1, 1905.*

On motion of the Secretary, it was voted to defer the consideration of the Council report until the following day.

As the Auditing Committee to examine the accounts of the Treasurer, the Society elected W. H. Sherzer and F. D. Adams.

ELECTION OF OFFICERS

The result of the balloting for officers for 1906, as canvassed by the Council, was announced by the President, and officers were declared elected as follows:

President:

I. C. RUSSELL, Ann Arbor, Mich.

First Vice-President:

W. M. DAVIS, Cambridge, Mass.

Second Vice-President:

E. A. SMITH, University, Ala.

Secretary:

H. L. FAIRCHILD, Rochester, N. Y.

Treasurer:

I. C. WHITE, Morgantown, W. Va.

Editor:

J. STANLEY-BROWN, Cold Spring Harbor, Long Island.

Librarian:

H. P. CUSHING, Cleveland, Ohio.

Councillors:

A. C. LANE, Lansing, Mich.
DAVID WHITE, Washington, D. C.

ELECTION OF FELLOWS

The Secretary announced that the candidates for fellowship had received a nearly unanimous vote of the transmitted ballots, and that Fellows were elected as follows:

SYDNEY HOBART BALL, A. B., Washington, D. C. Assistant Geologist, U. S. Geological Survey.

JOHN MASON BOUTWELL, A. B., S. B., M. S., Washington, D. C. Geologist, U. S. Geological Survey.

AMOS PEASLEE BROWN, B. S., E. M., Ph. D., Philadelphia, Pa. Professor of Mineralogy and Geology, University of Pennsylvania.

FREDERICK G. CLAPP, S. B., Washington, D. C. Geologic Aid, U. S. Geological Survey.

HERDMAN FITZGERALD CLELAND, A. B., Ph. D., Williamstown, Mass. Professor of Geology, Williams College.

REGINALD ALDWORTH DALY, A. B., A. M., Ph. D., Ottawa, Canada. Geologist for Canada on the International Boundary Commission.

EDWIN CLARENCE ECKEL, B. S., C. E., Washington, D. C. Assistant Geologist, U. S. Geological Survey.

EDWARD MARTIN KINDLE, A. B., M. S., Ph. D., Washington, D. C. Assistant Geologist, U. S. Geological Survey.

JOHN DUER IRVING, A. B., A. M., Ph. D., South Bethlehem, Pa. Assistant Professor of Geology, Lehigh University; Assistant Geologist, U. S. Geological Survey.

ALBERT PETER LOW, B. S., Ottawa, Canada. Geologist, Geological Survey of Canada.

RUDOLPH RUEDEMANN, Ph. D., State Hall, Albany, N. Y. Assistant State Paleontologist.

ELIAS HOWARD SELLARDS, B. A., M. S., Ph. D., Lake City, Florida. Professor of Geology, etc., in University of Florida.

FRANK ALONZO WILDER, A. B., Ph. D., Iowa City, Iowa. Professor of Economic Geology and Mineralogy, University of Iowa, and State Geologist.

IRA ABRAHAM WILLIAMS, B. Sc., M. Sc., A. M., Ames, Iowa. Teacher, Iowa State College.

JOSEPH EDMUND WOODMAN, S. B., A. M., S. D., Halifax, N. S. Assistant Professor of Geology and Mineralogy, Dalhousie University.

GEORGE ALBERT YOUNG, B. A. Sc., M. Sc., Ph. D., Ottawa, Canada. Geologist, Geological Survey of Canada.

AMENDMENT TO CONSTITUTION

The Secretary announced that the transmitted ballots on the proposed changes in Article VI of the Constitution, as canvassed by the Council, showed an affirmative vote in excess of three-fourths of the total membership of the Society, and were therefore adopted as follows:

Change Article VI, Meetings, section I, by dropping the matter in italics in the following quotation:

I. "The Society shall hold at least *two* stated meetings a year—*a summer meeting at the same locality and during the same week as the annual meeting of the American Association for the Advancement of Science—and a winter meeting.* The date and place of the winter meeting shall be fixed by the Council, and announced *by circular* each year within *a* month after the adjournment of the *summer* meeting." . . .

And by making insertions so that the section shall read as follows:

I. The Society shall hold at least one stated meeting a year, in the winter season. The date and place of the winter meeting shall be fixed by the Council, and announced each year within three months after the adjournment of the preceding winter meeting.

The President called for the necrology, and memoirs of deceased Fellows were presented as follows:

*MEMOIR OF GEORGE H. ELDRIDGE**

BY WHITMAN CROSS

In the death of George Homans Eldridge, which occurred on June 29, 1905, at Washington, D. C., American geology lost one of its most enthu-

* This memoir was not read, on account of the author's absence, but is here inserted in its proper place.

siastic and devoted workers. Those who were fortunate enough to know him mourn his untimely end, both because of the promise, which can not now be fulfilled, of further important contributions to knowledge and of the loss of a friend of singularly attractive and lovable personality. Eldridge possessed many traits worthy of all admiration, and it is befitting to place in the records of this Society a tribute to his memory, both as a geologist and as a man.

The subject of this sketch was born in Yarmouth, Massachusetts, December 25, 1854, the son of Ellery and Sarah (Matthews) Eldridge. His early education was first in the public schools of Yarmouth and later in the Boston Latin School, whence he went to Harvard University, graduating in the class of 1876.

There is nothing in the statements I have seen concerning Eldridge's boyhood to indicate a special predilection for scientific studies; but it is of record that he was greatly interested in the military training given to the Latin School pupils, and he rose from the ranks of the cadets to become lieutenant colonel at graduation. This love of the military work and discipline led him to organize a company of Harvard students, of which he became captain. There can be no question in the minds of all who have known Eldridge's energy and persistence that the boys under his command got a good insight into the meaning of military discipline, and that they received a training that was good for them.

Not long after graduation from Harvard the estate left by Eldridge's father became much involved, through no fault of his, and he resorted to teaching as a means of support. He was first located at Mount Vernon, New Hampshire (1876-1877), and for two years (1877-1879) at Nahant, Massachusetts, as principal of the High school. While at Nahant he passed examinations qualifying him to teach in the Boston Latin and other high grade schools of the Boston system, but at this point circumstances transpired which turned him to his life work in geology.

While it does not appear that Eldridge had specialized in geology in his university studies, he had availed himself of the opportunity afforded by the summer school of geology conducted by Professor Shaler at Cumberland Gap, Kentucky, in connection with the State Geological Survey. Eldridge was a member of that school, both in 1875 and 1876. A general fondness for natural science may be inferred from the courses of public lectures given at Nahant, and that the trend of his interest had been turned toward geology is shown by the fact that, while teaching at Nahant, Eldridge was taking private instruction in geology from Professor Shaler.

The opportunity to take up the profession of geologist came through the demand for young men to study the mining industry of the country in connection with the Tenth Census. That undertaking was placed in charge of the newly formed U. S. Geological Survey, and the study of the iron and coal industries was assigned to Professor Raphael Pumpelly. He applied to Professor Shaler to recommend assistants. Eldridge was one of those chosen, and in the summer of 1879 he entered upon that work. He was assigned to study the deposits of the baser metals in the southern Appalachian region and also the coal fields of northern Montana. The results of this work were published in the Census report, as cited in the appended bibliography (1, 2).

About the time that the Census work was completed the Northern Transcontinental Survey was organized to examine the mineral resources along the route of the Northern Pacific railroad. This survey was placed in charge of Professor Pumpelly, and Eldridge was naturally one of the first to be employed. He was engaged in this work for about four years, studying especially the coal fields of Dakota and Montana. Owing to the abandonment of the Survey in 1884, much of Eldridge's scientific work of this period never came to publication. The discussion of Montana coal fields in the reports of the Tenth Census embodied much of this information.

From the summer of 1884 until his death Eldridge was connected with the U. S. Geological Survey. For the first six years of this period his field of work was in Colorado, as assistant to S. F. Emmons. It was as his colleague during these happy years that the writer of this sketch came to know Eldridge and to love him for his many noble and attractive traits of character.

The principal results of Eldridge's Colorado work, under Mr Emmons, appear in the Anthracite-Crested Butte folio (10); in the monograph on the Geology of the Denver basin (15), and in a sketch of the complex stratigraphy and structure of the foothill belt about Golden (6).

The study of the Cretaceous in Colorado and Montana led Eldridge to propose the union of the Fort Pierre and Fox Hills as the Montana formation or group (5).

In 1890 Eldridge investigated the first productive oil field of the western Cretaceous at Florence, in Colorado, and wrote an account which has served to direct the work of development in that interesting field (7).

In 1891 Eldridge was given independent work, and his first assignment was to the investigation of the phosphate deposits of Florida. That this study was never completed was not the fault of the geologist; the exigencies of Survey work led to his repeated assignment to investigations deemed of more urgent importance. With each postponement of this study the amount of development in the phosphate area increased greatly, so that the field work was never completed. In fact, the last visit to the Florida phosphate diggings was made by Eldridge only a few months before his death. A preliminary report was published in 1893, giving a summary of his observations to that time (8).

The great energy and endurance possessed by Eldridge, as well as his ability to grasp the broad features of geology in a new country, led to several assignments in reconnaissance work. In the seasons of 1893 and 1894 he was engaged in surveys of this character in northwestern Wyoming and northeastern Idaho. Two valuable reports were the results of this work (11 and 12).

Again, in 1898, with the beginning of Alaskan exploration by the Geological Survey, Eldridge was called on for genuine reconnaissance work. He was placed in charge of the work of several parties, and himself conducted one of them through a wild and quite unknown territory north of Cooks inlet, within which is Mount McKinley, the highest point in North America. It is believed by his friends that the exposure and strenuous exertions of this season's work seriously impaired Eldridge's vitality. It was too much for a man of 44 years to undergo without lasting injury. His reports appear in the Survey publications cited in the bibliographic list (16 and 17).

In the summer of 1899 Eldridge was assigned to the comprehensive study of the asphalt and bituminous rock deposits of the country. His investigations were carried on in many states and concerned deposits of various characters. The field work occupied more than a year's time and the report is really a monographic discussion of a class of deposits which had previously received scarcely any attention. This is probably the most important single contribution to science made by Eldridge (18).

Soon after the completion of the asphalt report the investigation of important oil fields in southern California, in a region of much structural complexity, became a matter of great interest, and it was entrusted to Eldridge. After a vast amount of labor, which was rendered doubly difficult by the rapid development of the oil fields, he had nearly completed his report on some important sections of the district when attacked by his last illness. It is to be hoped that some part of the material may appear under the name of the man whose career has unhappily been cut short before he could complete his work. A preliminary statement concerning the field was issued in 1903 (21).

The last fruit of Eldridge's wide experience was dictated from his bed of suffering not long before the end. It was a summary of his views regarding the origin of vein asphalt, one of the singular phenomena investigated some few years ago (22).

The illness which terminated this career, with its promise of still higher achievements, seems to have begun in the autumn of 1904. After several months of uncertainty as to its nature, it became evident that an operation was necessary to remove an internal growth of problematic character. The relief afforded by the operation was not lasting, and with the renewal of the sarcomatous growth the end was inevitable. Almost to the last the patient exhibited his customary cheery courage and had faith in his ultimate recovery.

The scientific work accomplished by Eldridge was of the highest order in many respects. He was not much given to theorizing, choosing to stick close to the firm ground of established fact. His investigations were characterized by thoroughness and by infinite patience in the accumulation of facts bearing on his problem. His aim seemed to be to exhaust the subject so far as time and conditions would permit. To ascertain and make known the exact truth was his ambition. As a result of fidelity to this high ideal, he gathered a vast store of information in each of his more important investigations, and in that it was not granted him to utilize a great part of this knowledge to the full, in mature and well considered discussion, must be a source of keen and lasting regret.

While an adequate tribute to the estimable personality possessed by Eldridge, such as his friends may desire to see put on record, is perhaps not in place in this publication, this sketch would be far from satisfactory without some appreciative notice of the traits which endeared our friend to all who were privileged to know him. His was a character such as all admire, and to know the possessor was to love him; blessed with a fine physique and great strength, Eldridge seemed always in high spirits and overflowing with good cheer. The power to brighten with his presence was felt by all with whom he came in daily contact, and among all ranks of the great organization to which he belonged his death caused the feeling of personal loss, even to many who could not claim direct acquaintance. A fund of anecdote in illustration of this influence for good might be cited.

For many years physical strength and great power of endurance stood Eldridge in good stead in trying circumstances. Professor Pumpelly tells in a personal letter how, during his work for the Transcontinental Survey in Montana, Eldridge rose from his bed after a severe attack of typhoid fever, and, in spite of his physician's orders, proceeded with the task assigned him to find and explore certain coal beds in an undeveloped district. It was early winter and severe snow-storms had driven out railroad surveyors and others, who told Eldridge that the locality he sought to reach was inaccessible; but he continued his journey, found the coal buried under heavy snow-drifts, opened and sampled it, and returned in safety. In the writer's own experience with Eldridge in the field, there have been many illustrations of his phenomenal endurance and grim determination—a combination of qualities making it a hopeless task for one of average powers to compete with him in many undertakings. When engaged in the preparation of reports Eldridge has been known to work without sleep for nearly 48 hours and seem to suffer no ill effects.

A good comrade and loyal friend, Eldridge was also a beautiful example of the devoted son. His aged and infirm mother found with him during her declining years a home of many comforts, such as could be supplied only by cheerful sacrifices. Soon after the death of his mother Eldridge was married to Miss Jessie Newlands, of San Francisco, who survives him.

Eldridge was a man of much modesty, never putting himself forward except as a duty. His ideals were those of the Christian gentleman, and hence his influence for good was always felt by those within his sphere of life. Many will join in the tribute of his old instructor and friend, the late Professor Shaler, who wrote of him:

"He will remain with me as the type of the strong, well-balanced man; brave, steadfast, patient in his duties, ever friendly with his neighbor, helpful with his friends—I feel that my contacts with him served to ennoble my life."

List of Publications

(1) Montana coal-fields. Tenth Census of the United States, 1879-1880, vol. xv, 1886, pp. 739-757.

(2) The industries of the base metals (lead, zinc, and copper) in the census year. Tenth Census of the United States, 1879-1880, vol. xv, 1886, pp. 809-830.

(3) On some stratigraphic and structural relations of the country about Denver, Colorado. Mining industry (Denver, Colorado), vol. iii, no. 3, 1888, pp. 24-25; no. 4, pp. 33-35; no. 5, pp. 44-45.

(4) On some stratigraphical and structural features of the country about Denver, Colorado. Proceedings of the Colorado Scientific Society, vol. iii, 1888, pp. 86–118.

(5) Some suggestions upon the method of grouping the formations of the Middle Cretaceous and the employment of an additional term in its nomenclature. American Journal of Science, vol. xxxviii, October, 1889, pp. 313-321.

(6) On certain peculiar structural features in the foothill region of the Rocky mountains near Denver, Colorado. Bulletin of the Philosophical Society of Washington, vol. xi, 1892, pp. 247-274.

(7) The Florence oil field, Colorado. American Institute of Mining Engineers Transactions, vol. xx, 1892, pp. 442-462.

(8) A preliminary sketch of the phosphates of Florida. American Institute of Mining Engineers Transactions, vol. xxi, 1893, pp. 196-231.

(9) Artesian wells of eastern Dakota. Compte Rendu, International Congress of Geologists, 5th session, 1893, p. 318.

(10) Anthracite-Crested Butte folio, Colorado (in conjunction with S. F. Emmons and C. Whitman Cross). Geologic Atlas of the United States, folio 9, U. S. Geological Survey, 1894.

(11) A geological reconnaissance in northwest Wyoming. Bulletin no. 119, U. S. Geological Survey, 1894, pp. 72.

(12) A geological reconnaissance across Idaho. 16th Annual Report, U. S. Geological Survey, pt. 2, 1895, pp. 211-276.

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(15) Geology of the Denver basin in Colorado (in conjunction with S. F. Emmons and C. Whitman Cross). Monograph no. 27, U. S. Geological Survey, 1896, pp. 556.

(16) Report of the Sushitna expedition (in conjunction with Robert Muldrow); the extreme southeastern coast; the coast from Lynn canal to Prince William sound; the Sushitna drainage area; maps and descriptions of routes of exploration in Alaska in 1898, with general information concerning the territory. Special Publication of the U. S. Geological Survey, 1899, pp. 15-27, 101-102, 103-104, 111-112.

(17) A reconnaissance in the Sushitna basin and adjacent territory, Alaska, in 1898. 20th Annual Report, U. S. Geological Survey, pt. 7, 1900, pp. 7-29.

(18) The asphalt and bituminous rock deposits of the United States. 22d Annual Report, U. S. Geological Survey, pt. 1, 1901, pp. 209-464.

(19) The petroleum industry of California. Engineering and Mining Journal, vol. 73, 1902, p. 41.

(20) Origin and distribution of asphalt and bituminous rock deposits in the United States. Bulletin no. 213, U. S. Geological Survey, 1903, pp. 296-305.

(21) The petroleum fields of California. Bulletin no. 213, U. S. Geological Survey, 1903, pp. 306-321.

(22) The formation of asphalt veins. Economic Geology, vol. i, no. 5, March-April, 1906.

MEMOIR OF ALBERT ALLEN WRIGHT

BY FRANK A. WILDER

Albert Allen Wright, a Fellow of this Society since 1893, died at Oberlin, Ohio, on April 2, 1905, after an illness of a single day. While his health had been somewhat impaired for some time before his death, he was not greatly hindered in his activities as a teacher and investigator till the day before his death.

Professor Wright was born at Oberlin, Ohio, in 1846, and was intimately identified with the interests of that community, both town and college, during his entire lifetime. He was graduated at Oberlin in 1865, and, as a number of scientists have done whose names appear on the roll of Fellows of this Society, he filled out his studies by a course in theology. A degree in theology was given him by Oberlin in 1870, after three years of study at Union and Oberlin seminaries. After two years of teaching, he entered Columbia School of Mines and was graduated from this institution in 1875. In later years his education was broadened by extended travels in regions of geologic interest in Europe and America.

In 1874 Professor Wright was married to Mary Bedortha, and some time after her death, to Mary P. B. Hill, in 1891. A daughter from his first marriage survives him, and a son from his second.

Before he had completed his course at Columbia he was called to the chair of geology and natural history in Oberlin College, a position which he held for 30 years. He directed the development of the work in zoology and botany till separate departments were formed for these sciences, and retained for himself the work in geology, which best fitted his taste in teaching and research. All of the departments of natural science in Oberlin, however, show his capacity as an organizer and owe to him in a large measure their present development.

The greater part of his energies were spent in the class-room and laboratory, where he served as a faithful guide to hundreds of students, many of whom, on account of his leadership, devoted themselves in later life to scientific pursuits. His capacity as a man of affairs was recognized by the community in which he lived, and it looked to him to solve its problems in municipal engineering, or at least to suggest the lines along which solutions might be hoped for. The systems of city water supply and sewerage in Oberlin are wholly his work. After a thorough study of local topography and drainage, he directed the installation of what is regarded in Ohio as the model equipment of the state. He secured for the town perfect sanitation and an abundant and pure supply of water at an expense far below that estimated by capable engineers.

To the persistence and patience of Professor Wright, the cooperative topographic survey now being made in Ohio is due. At first, he labored toward this end almost without assistance. When President of the Ohio Academy of Sciences he brought the matter forward in an address. Few came to his aid, but he persisted in circulating his address, in writing letters, and in speaking on the subject on all suitable occasions. His system of instruction gradually developed a demand for topographic work. In spite of his untiring efforts, he saw his measure defeated at

Columbus. He began again, however, as though he had received no rebuff, and in the end his perseverance was fully rewarded. His efforts were made, not as an officer of the State Geological Survey, but as a private citizen, eager to advance a cause which he regarded as good. His papers urging topographic work have proved helpful in presenting the matter of topographic mapping to the legislatures of a number of states.

Professor A. A. Wright possessed in a very large measure the scientific spirit. He was careful and deliberate. He was slow in forming judgments, yet persistent in accumulating material on which a rational judgment could be based. With such a temperament, it is not surprising that his contributions to the science to which he was devoted are of the highest order in quality. They might have been notable in quantity had he not sacrificed any desire for personal distinction to the welfare of the college to which he gave such a full measure of his time. His more important geological work has to do largely with his native state. In 1874 he began field work on the lake ridges of Lorain county. His published results were valuable, and left nothing to be added concerning the surface features of this portion of Ohio. In 1893 he reported on the ventral armor of Dinichthys for the Ohio Survey, and, aided by excellent specimens secured in Lorain county, he was able to supplement and to modify in a number of important particulars the descriptions of Newberry. His reports of certain coal beds in Ohio and on drift and glaciation in New Jersey are represented by a number of titles in geologic magazines, in the bulletins of this Society, and in the Proceedings of the Ohio Academy of Sciences. At the time of his death he was at work with thin-sections of bryozoans, and hoped to be able to add something of value to the limited literature on these difficult organisms.

Professor Hall, a colleague of Professor Wright for years, sums up his life most justly:

"Outside of Oberlin, he might have made a much larger reputation as an earnest investigator and sound reasoner upon scientific topics, and as a master of an unusually clear and chaste literary style, if he had been willing to take a larger place in the scientific assemblies of his time. He might have written books which would have proved helpful to the thought of his time, especially as bearing on the interpretation of science. As a teacher, he might have attracted larger classes and might have made a superficial impression on a larger number of pupils, if he had cared to make more parade of his learning. But he chose to do his work quietly, with no desire to do anything that should dazzle, but with a fixed purpose to do everything in the most thorough and faultless manner. The true scientific spirit mastered him as it has mastered few minds in his generation, and, slender as might seem his technical training, it made it impossible for him to approach any topic without the most painstaking and careful investigation, seemingly without the least prejudice as to the outcome of his research."

It is not strange, therefore, that his life proves a constant light to the considerable number of his students who have chosen for their life work some form of scientific pursuit.

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Early embryonic stages of Amphioxus, pp. 4.

General Zoology, pp. 4.

Optical properties of rock-making minerals, pp. 8.

Rocks, pp. 17.

Students' collections of fossils, pp. 4.

The dissection of molgula, pp. 7.

Following the reading of the memoirs the Secretary presented letters from several Fellows who were unable to attend the meeting, but had sent their greeting; and Mr H. M. Ami, chairman of the local committee of arrangements, made announcements relating to the evening sessions and the social functions.

The President declared the scientific program in order. The first paper presented was the following:

CHEMICAL EVOLUTION OF THE OCEAN

BY ALFRED C. LANE

[*Abstract*]

If there is any value in the numerous attempts, by Joly and others, to estimate the age of the earth from the accumulation of some salt in the ocean, there must have been a progressive change in the chemical character of the ocean, which might possibly be detected in comparing the waters buried in undisturbed sediments of various ages.

The paper applies this test to the deepest waters known from various geological horizons in the Lower Michigan and Lake Superior basins. Both basins are as permanent and free from recent igneous disturbance or faulting or inverted siphon circulation, etcetera, as are readily found.

The proportions of many ions are likely to be changed by reactions after burial. The ratio of chlorine to sodium seems to be among those least changeable, thus: This ratio is in sea water 25,440 (trillion tons) to 14,151 (trillion tons)=1.77, while in the river waters delivered each year it is 84 (million tons) to 157 (million tons). Whence, *unless there is some large source of chlorine apart from sodium or precipitation of sodium apart from chlorine, n* years ago the ratio must have been about R= (25,440—.000,084*n*)/(14,151—.000,157*n*). For instance, we have from the Upper Subcarboniferous of Big Rapids R=2.14, *n*=20 million years; similarly from the Berea grit at Bay City 45 million years; from the meso-Devonian at Alma 49 million years; from the Silurian at Manistee 65 million years; from the Upper Keweenawan at Freda 72 million years; from the Tamarack mine, Lower Keweenawan, 89 million years. These figures suggest some agreement with the hypothesis, but a more careful examination reveals serious difficulties, as is more fully presented in the paper.

The paper was discussed by J. F. Kemp, A. P. Coleman, and the author.

The second paper was

DIKE OF MICA-PERIDOTITE FROM FAYETTE COUNTY, SOUTHWESTERN PENNSYLVANIA

BY J. F. KEMP

[*Abstract*]

The dike occurs on the surface and in the coal mines on Middle run, a tributary of the Monongahela, in the Masontown quadrangle. It cuts the Carboniferous to and above the Waynesburg coal seam and reveals eruptive rocks in a hitherto unsuspected region. The petrographic details were briefly given and comparisons were made with other similar occurrences. The full paper will be published elsewhere.

The author replied to questions by A. C. Lane.

The last paper of the morning session was

SAPPHIRE; ITS OCCURRENCE AND ORIGIN

BY W. H. COLLINS*

Remarks were made by T. L. Walker. The Society adjourned for the noon recess.

At 2.30 o'clock p m the Society reconvened and an address of welcome was given by Dr Robert Bell, Acting Deputy Head and Director of the Geological Survey of Canada. A brief response was made by President Pumpelly.

Announcement was made that from 4.30 to 7.00 o'clock p m Dr and Mrs Robert Bell would receive the Fellows of the Society at their home.

The scientific program was resumed, and the following paper, in the absence of the author, was presented briefly by J. F. Kemp:

OCCURRENCE OF THE DIAMOND IN NORTH AMERICA

BY GEORGE F. KUNZ

[*Abstract*]

The great advance in the prices of diamonds within a few years past, together with the fact that the demand for diamonds has become so large in this country, has stimulated interest in the question of the possible discovery of diamond mines in the United States. This whole subject has been treated of in some detail in a bulletin by the writer to the U. S. Geological Survey, now about to be issued. Diamonds have been found at various points in our territory, though never of large size or in any abundance; but the facts are of much interest as they are here gathered and presented.

There are four regions where diamonds have been met with in the United States. These are: (1) the Pacific coast, chiefly along the western base of the Sierra Nevada, in the central counties of California, associated with gold in the cement gravels; (2) along the line of the moraine of the ancient ice-sheet of the Glacial epoch of geology, in Wisconsin, Michigan, Indiana, and Ohio; these have been transported from an undiscovered source somewhere in Canada; (3) a few only in central Kentucky and Tennessee; (4) the Atlantic states from Virginia to Alabama, chiefly along the eastern base of the Appalachians, in what is known as the Piedmont region. The actual place of the origin of the diamonds is in all these cases unknown. Those of the Pacific coast and the Atlantic states have been derived by erosion from the adjacent mountain ranges, but the original sources have never been discovered. Those of the northern drift have come from beyond our borders, in Dominion territory, and their exact source is entirely a matter of speculation. The few occur-

* Introduced by T. L. Walker.

rences in Tennessee and Kentucky are not as yet definitely traceable, even in theory. All have been found in loose and superficial deposits and all accidentally; most of those in the Atlantic and Pacific regions have been found in washing for gold.

Historically, the first diamond recognized in the United States appears to have been found in 1830, in central Indiana; it came finally into the hands of the well known artist, the late James W. Beard, who wore it for over 50 years. No others appear to have been found in this region until within the past quarter century, when several were obtained in the glacial drift, and their peculiar transported character began to be understood.

The finding of diamonds in the gold washings of northern Georgia goes back by local tradition to the "forties," but definite records of such discoveries do not begin until some years later, when a few were found in North Carolina. The largest stone ever obtained in the United States, the celebrated Dewey diamond, of 23¾ carats, was found in 1855, by a laborer while digging in a bank, at Manchester, Virginia, nearly opposite Richmond. Two have been met with lately in Alabama, and there may be in all twenty or twenty-five diamonds known from the southern Atlantic states.

The first diamond in California was recognized in 1849, soon after the discovery of gold, but no particular accounts are on record until 1853. Altogether, some 200 small diamonds have been reported from this State, most of them from the four counties of Amador, Butte, El Dorado, and Nevada; the last named has yielded only a few, but one of these is the largest known from California, a stone of 7¼ carats. All have been discovered in connection with gold-mining, and most of them in the hard "cement" gravel, overlain and compacted by beds of lava or volcanic tufa. Of late years but few have been obtained, though many fragments appear in the sluices; but the general use of hydraulic mining and stamp mills causes any diamonds that may exist to be either swept away and buried in the debris or else crushed into bits by the stamps. This seems very regrettable; but the amount of diamonds that might be saved by the use of other methods would not probably compensate at all for the cost of installing different processes from those now employed. Notwithstanding this, it is stated that two companies have been formed for the purpose of searching for diamonds in Amador and Butte counties.

The diamonds of the northwestern drift began to attract attention about fifteen years ago, when several in succession were found in Wisconsin; some of these had been picked up years before and kept as curiosities, without knowledge of what they were. Professor W. H. Hobbs, of the State University at Madison, made a very careful study of these occurrences and established clearly their glacial origin. Then one was found under similar conditions at Dowagiac, Michigan, in 1894, and another soon after near Cincinnati, Ohio. Within a few years past several small stones have been encountered by local gold-washers in the streams of Brown and Morgan counties, Indiana. These likewise are in or associated with the drift moraine, as doubtless was also the first one from this region, found, as above stated, as far back as 1830. A few small stones were also noted from this section in 1878 by the late Professor E. T. Cox, then state geologist, who first recognized their glacial derivation.

The number of diamonds accidentally found in these drift deposits—now some 25 or 30—shows that hundreds or even thousands of them must be lying imbedded in the vast mass of morainal material that stretches across these states. From this fact it is evident that, wherever the source may be where they naturally occur, they must exist in considerable abundance. There must probably be, therefore, a diamond field in Canada that may be important if it can be found, although, from the small or very moderate size of the stones known, it cannot compare in any degree with the wonderful mines of South Africa. Under the direction of Doctor Ami a number of surveying parties along the line of the new Transcontinental railway, from Quebec to Winnipeg, are now on the lookout through all the region north of the Great lakes. But, on the other hand, the source may be farther north, in the unexplored wilderness of Ungawa. This is the view taken by Professor Hobbs, of Wisconsin, based on a careful study of the glacial striations left on the rocks, indicating the direction of ice-movement.

Some years ago there was for a time quite an interest in the suggestion of a possible diamond field in Elliott county, Kentucky. Certain igneous dikes in that region were found to resemble the rock in which the diamonds occur at Kimberley, in South Africa, and to contain some similar associated minerals, such as pyrope garnets ("Cape rubies"), etcetera; but careful examination failed to find any diamonds whatever. Recently the matter has been taken up again, and proposals have been made for extensive operations; but the fact remains that the first diamond has yet to be discovered, and there seems to be no warrant for undertaking such enterprises. W. C. Phelan, geologic aid of the U. S. Geological Survey, visited Elliott county, Kentucky, and spent considerable time in the preparation of an economic bulletin of the Canova quadrangle. Although he located a new dike, he was unsuccessful in finding the diamond itself. Notwithstanding that statements were current in the adjoining city of Grayson that diamonds had been found, yet he could not substantiate the finds.

Professor J. F. Kemp has located a similar dike, penetrating a coal vein in Fayette county, southwestern Pennsylvania, which he is describing at this meeting. Although the coal seam was entirely ruined by the penetration of the peridotite for a distance of some 20 feet, diamonds were not found. Professor Kemp at this meeting gives the petrographic depths of this occurrence on Middle run, a tributary of the Monongahela, in the Masontown quadrangle.

The paper was discussed by Robert Bell, A. C. Lane, J. M. Clarke, A. P. Coleman, H. M. Ami, A. P. Low, and J. F. Kemp.

The second paper was

IGNEOUS ROCKS OF THE EASTERN TOWNSHIPS OF QUEBEC

BY JOHN ALEXANDER DRESSER*

Remarks were made by G. O. Smith, with reply by the author. The paper is published as pages 497-522 of this volume.

* Introduced by Dr F. D. Adams.

The third paper was

NEPHELINE SYENITE IN EASTERN ONTARIO

BY FRANK D. ADAMS

[*Abstract*]

The paper presents briefly some of the results of a detailed study of the occurrences of nepheline syenite in the townships of Monmouth, Glamorgan, and Methuen, in the province of Ontario. The character of the various differentiation products of the syenite magma are considered and the relation of the group to the granite bathylites and to the intrusive rocks of the region are discussed.

Remarks were made by A. C. Lane, R. A. Daly, and the author.

The fourth paper was

ORIGIN OF THE SUDBURY ORE BODIES

BY ALFRED E. BARLOW*

The paper was discussed by A. P. Coleman, J. F. Kemp, Robert Bell, A. C. Lane, and the author.

The next paper was presented by title:

BIBLIOGRAPHY OF THE GEOLOGY, MINERALOGY, AND PALEONTOLOGY OF BRAZIL

BY JOHN C. BRANNER

The following paper was read:

GEOLOGIC RECONNAISSANCE MAP OF ALASKA

BY ALFRED H. BROOKS

[*Abstract*]†

Contents

Introduction

Though geologic observations in Alaska can be said to have begun with the work of Stellar, the naturalist, who accompanied Bering on his ill-fated voyage in 1741, it is only in the past decade that systematic surveys have been madê,

* Introduced by H. M. Ami.

† The geologic maps and sections described in this abstract will appear as illustrations to a paper now in preparation entitled "The geography and geology of Alaska;" professional paper, U. S. Geological Survey, no. 45.

and as yet even reconnaissance mapping has been carried over only about one-fifth of the territory. Those familiar with the conditions met with by the geologist in this field need not be reminded that they are by no means favorable, and this will account for the rather meager results of some of the explorations. It appeared desirable to gather the very incomplete data and to attempt to outline the areas of some of the larger stratigraphic subdivisions, and this has been done on this map. The blanks in the map represent unsurveyed areas, yet the colored parts do not by any means indicate results of equal reliability. Areas like the Seward peninsula and the Copper River basin have been surveyed in considerable detail, while others, like the Kuskokwim and Tanana valleys, have been covered by only the most hurried reconnaissance work.

Stratigraphic Subdivisions and their Description

Ten stratigraphic subdivisions have been made; seven are sedimentary, two igneous, and one metamorphic. The so-called Pelly gneisses include gneisses and crystalline schists, as well as more massive intrusives, and possibly some sediments, which may in part be Archean, but very likely are, for the most part, deformed igneous rocks of a later date. A group of highly altered sediments, embracing many different formations, and probably chiefly Paleozoic, occupies the largest areas in the province. The areas of Silurian are small, because it is only where fossils have been found that they could be differentiated from the other metamorphic terranes. The incomplete data has made it necessary to throw the Devonian and Carboniferous into one group. In most of the field it has been found impossible to make any subdivisions in the Paleozoic which are included in the metamorphic group.

Though all the subdivisions of the Mesozoic have been recognized in Alaska, the data are too fragmentary to permit of mapping them separately, and only two groups are recognized. The one embraces the Triassic and Jurassic, as well as the undifferentiated Mesozoic, and the second the Cretaceous.

The Tertiary, undifferentiated on the accompanying map, is almost entirely Eocene, for Miocene and Pliocene beds have been found at a few localities.

The Quaternary coloring has been extended to only the larger areas. Most of the rivers, except those that traverse the Coast range, are bordered by Pleistocene silts and gravels.

Of the intrusives the scale of the map permitted the representation of only the larger stocks, and even these have been omitted in the Archean areas where the gneisses and igneous rocks are not always easily differentiated. The distribution of the larger areas of the recent and Tertiary volcanics is shown throughout the regions surveyed.

It has been impossible to avoid the crazy-quilt effect due to the fragmentary data, yet some of the larger features of the geology are well illustrated. The general northwest trend of the western cordillera continues into Alaska to about the one hundred and forty-eighth meridian, where it bends abruptly to the west and southwest, as if to meet the northeastern extension of the Asiatic continent. That this is but a topographic reflecion of the dominant structural lines is well illustrated on this map, where you will note that there is a marked change of strike along the central meridian of Alaska. This line, in fact, marks the transition from the American to Asiatic trend of bed-rock structures.

Keeping this fact in mind, it will be possible to trace the stratigraphic subdivisions even on this very incomplete map.

A belt of metamorphic rocks striking parallel to the Pacific coastline has been traced northwestward through the panhandle and appears to find its extension in the Chugach mountains and in Prince William sound. In southeastern Alaska this belt includes various terranes, varying in age from Silurian or older to the Permian, with possibly some Triassic. Some Cretaceous beds are found infolded with it. It is cut off from the Paleozoic rocks of British Columbia by the broad belt of intrusives which make up the Coast range. At the westward extension of the belt Mesozoic beds overlap its inland margin. These Mesozoic beds are continued to the southwest, forming the country rock of the Alaska peninsula.

A second belt of metamorphic sediments is traceable through inland Alaska. This includes highly altered rocks, ranging from Silurian or older to Devonian. This zone ends in the Kuskokwim valley, where a broad belt of Cretaceous sediments mantels the metamorphic terranes. This belt is broken by an area of gneissoid rocks, but these, though first assigned to the Archean, are now believed to be largely altered intrusives. The metamorphic rocks appear again in the Seward peninsula and in northern Alaska and here constitute a third belt.

Little is known of the geology of the Rocky mountains of Alaska, except along the one hundred and fifty-first meridian, where Schrader's studies have shown them to be made up of closely folded Paleozoic terranes.

A belt of Permian beds, made up of slates and limestones, has been identified along the Seward margin of the Coast range and in the Copper River basin. Devonian beds are widely distributed, but the largest areas occur in the Yukon-Tanana region, where they are chiefly limestones and volcanics.

The Mesozoic period is represented by the Jurassic and Triassic rocks of the Copper River region, the Alaska range; also by two broad belts of Cretaceous rocks, one of which stretches northeastward from Bering sea to where it overlaps on the Paleozoic terranes near the southern front of the Rocky mountains, and the other stretches east and west across northern Alaska. The Tertiary period is represented chiefly by Eocene beds, which occur in broken areas along the seaward margins of the province. In the Yukon basin Eocene beds are found far inland, close to the international boundary. These are probably of lacustrine origin.

Intrusive rocks, among which granitic types dominate, are very abundant in southeastern Alaska. A broad belt of granitic rocks forms the backbone of the Alaska peninsula, and smaller rocks occur in the mountains to the northeast. All of these intrusives appear to be of Middle or Upper Jurassic age. The smaller masses of granite, so abundant in the Kuskokwim valley and found in the Seward peninsula, are probably of Tertiary age.

Recent and Tertiary volcanic rocks are widely distributed, and in the Alaska peninsula, Mount Wrangell region, and in the Bering sea littoral cover large areas.

The general stratigraphic succession in Alaska, so far as determined, is as follows: Some gneisses and crystalline schists have been provisionally referred to the basal member of the succession. These are succeeded by a great complex of metamorphic sediments, intruded by many igneous rocks whose age and stratigraphic relations are often undetermined. Though these metamorphic beds have been subdivided into many formations, many of these are ill defined, and much more detailed evidence will be required before a definite statement as regards the succession can be made. Some of the lower members of this great complex have yielded Ordovician and Silurian fossils, while in some of the upper beds Devonian fossils have been found. In the Yukon basin and in the panhandle there appears to be an unconformity near the base of the Devonian, below which the rocks are much more highly metamorphosed. The older and more crystalline sediments are probably Silurian, Ordovician, Cambrian, or possibly pre-Cambrian. The metamorphosed clastics of southeastern Alaska include Devonian and Carboniferous, and elsewhere in the province Devonian and Carboniferous terranes have been found.

Triassic beds have thus far been recognized only in the Copper River basin and in southwestern Alaska, while the Jurassic occurs in this district and also at cape Lisburne, in northern Alaska. The lower Cretaceous is widely distributed and includes the youngest beds known to have suffered any considerable metamorphism. It appears that the unconformity separating the upper and lower Cretaceous horizons was of considerable extent. The upper Cretaceous occurs in the Yukon basin, in southwestern and southeastern Alaska, as well as north of the Rockies.

Of the Tertiary horizons the Eocene coal-bearing beds are the only ones which have been found widely distributed, and these occupy no considerable areas. Miocene and Pliocene beds appear to have relatively small development. The Pleistocene is represented throughout the province by gravels, sands, and silts, and in the regions which have been occupied by ice by various forms of glacial deposits.

Correlation Table.

On the table I have indicated the stratigraphic succession in four of the best known districts and suggested certain correlations between them.

In southeastern Alaska the basal member consists of phyllites and crystalline limestones, in part at least of Silurian age. These are succeeded by crystalline limestones and slates of Middle Devonian age. The next horizon is a chert and limestone series, carrying lower Carboniferous fauna and resting unconformably on the older rocks. These are succeeded by a complex of phyllites and greenstones, with some limestones, in part at least of Permian age. A heavy conglomerate series, resting unconformably on the Paleozoic rocks, represents the oldest Mesozoic of this province, and is probably Cretaceous. These are unconformably overlaid by a soft sandstone and shale series, in part of upper Cretaceous, in part of Eocene age.

The extensive basalt flows have been provisionally assigned to the Miocene, while the Pleistocene is represented by silts, sands, and gravels, as well as by glacial drift.

Highly metamorphosed schists and limestones form the oldest sediments of the Copper River region, and are of pre-Devonian age. These are unconformably succeeded by a massive conglomerate and slate series, associated with volcanic rocks which have been provisionally referred to the Devonian. The Carboniferous is represented by a lower member, made up of heavy crystalline limestone, and an upper consisting of many thousand feet of limestones, shales, and volcanics. These are overlaid by a volcanic and limestone group of Triassic age, and on these the Kennicott formation rests unconformably. The Tertiary in this district is represented by some small areas of lignite-bearing Eocene sandstone, and by a great thickness of volcanics, the latter merging with those of recent date.

The succession in the Yukon region has not yet been well determined. It appears that the so-called Birch Creek schists form the oldest sediments, and these may rest on an older gneissic complex. Within the schistose series occur beds of crystalline limestone. In some areas at least a massive limestone appears to form a higher member of the metamorphic series, but this is not definitely established. A great thickness of greenstones, with which are intercalated some Middle Devonian limestones, form the next higher group, resting unconformably on the older and more highly metamorphosed rocks. In some parts of the basin a massive Carboniferous limestone forms the next higher member of the succession.

The Lower Cretaceous is represented by some calcareous sandstones and black slates. As in southeastern Alaska, the upper Cretaceous and Eocene appear to be represented by an unbroken succession of sandstones and shales. A formation made up of sands, clays, and gravels has been provisionally referred to the Pliocene.

In northern Alaska Schrader found a series of schists forming the basal member of the succession, and this overlaid by a massive crystalline limestone. The latter, on the evidence of a few obscure fossils, has been tentatively assigned to the Silurian. Both Devonian and Carboniferous beds have been found in this region, but the stratigraphic succession is obscure.

Lower Cretaceous rocks overlap the Paleozoics, both north and south of the range, and on the Arctic slope are succeeded unconformably by Eocene beds. These in turn are overlaid by Pliocene silts.

Structure

The parallelism between the bed-rock structures, the mountain ranges, and the shoreline has been pointed out. In southeastern Alaska the dominant structures trend northwest and then, near the one hundred and fifty-first meridian, swing west and south.

Three sections are presented to indicate some of the larger structural features. The first reaches from Controller bay, through the Chugach and Wrangell mountains, to the international boundary. On the coast of the section are indicated the closely folded Tertiary beds, resting unconformably on the metamorphic sediments which make up the Chugach mountains. These latter, which are probably in part Paleozoic, are intensely deformed. They are separated by a fault from the broad syncline which makes up the Wrangell mountains. The basal beds in this syncline are Carboniferous, which are overlaid unconformably by Mesozoic sediments, and these in turn are capped by Tertiary and recent lavas. Another fault cuts off the northern area of the syncline from a broad belt of closely folded Mesozoic sediments. North of the Pleistocene silts, which floor the Tanana valley, the section traverses a belt of schists with which are closely associated some gneissic rocks. A section across the Alaskan range indicates a broad synclinorium of Mesozoic rocks (chiefly Jurassic) resting unconformably on Devonian limestone on the west, which in turn rests on phyllites and cherts, which have yielded some Ordovician fossils. The section in northern Alaska indicates two anticlinal axes, with sharp flexures and faulting, separated by a broad syncline. In the southern anticline the basal schists and a Silurian limestone are exposed. The structure in the northern anticline is complicated by extensive faults. These Paleozoic rocks are succeeded by gently folded Cretaceous rocks on both flanks of the range. On the north the horizontal Tertiary sediments rest on the Cretaceous beds.

Remarks were made by T. A. Jaggar, a visitor.

The last paper of the day was

COAST RANGE OF SOUTHEASTERN ALASKA

BY FRED EUGENE WRIGHT

Session of Wednesday Evening, December 27

At 8.30 o'clock the Society met in formal session in the parlor of the Russell House, and the President of the Society, Raphael Pumpelly, delivered an address entitled

INTERDEPENDENT EVOLUTION OF OASES AND CIVILIZATIONS

The address is printed as pages 637-670 of this volume.

Following the presidential address a "smoker" was given by the Logan Club of Ottawa to the Fellows of the Society.

Session of Thursday, December 28

The Society met at 10.00 o'clock a m, President Pumpelly in the chair.

The Council report was taken from the table and was adopted without debate.

The report of the Photograph Committee was presented, as follows:

SIXTEENTH ANNUAL REPORT OF THE COMMITTEE ON PHOTOGRAPHS

During the year 1905 there has been but little change in the collection of photographs belonging to the Society. No new views have been obtained, but through the kindness of the Director of the Geological Survey about 100 old prints have been replaced by new ones, which are printed in a superior manner and mounted on muslin. By this means the bulk of the collection has been considerably diminished.

The photographs are now stored in glass cases in my office, in the building of the Geological Survey, Washington, convenient for reference. Several members of the Society have obtained prints for use in reports and text books, and it is believed that there ought to be a very much wider use of the photographs for this purpose. It is expected that during the coming year a large number of new photographs will be added to the collection, selected from the vast number of views which have been taken by members of the Geological Survey during the past few years. Contributions for the collection are desired, but care should be taken that they are views of general interest and illustrate geologic phenomena rather than scenery. A high technical standard is also required.

Respectfully submitted.

N. H. Darton,
Committee.

The report was adopted, and the usual appropriation of $15 for the use of the committee was voted.

RESOLUTION CONCERNING INTERNATIONAL GEOLOGICAL CONGRESS

The following resolution was presented from the Council and adopted:

"*Resolved,* That the Geological Society of America gives expression to the sincere feeling that it would be highly appropriate and desirable to hold the International Geological Congress in Ottawa in 1909."

Several announcements were made: By S. F. Emmons and the Secretary, relating to the meeting of the International Geological Congress in Mexico in September, 1906; by H. M. Ami, with reference to the evening program; by J. F. Kemp, with reference to the annual dinner, and by the Secretary, stating that a local photographer would take a photograph of the Fellows at the close of the morning session.

The scientific program was taken up, and the first paper read was

GEOLOGICAL SECTION ACROSS THE CORDILLERA ON THE INTERNATIONAL BOUNDARY LINE (49TH PARALLEL)

BY REGINALD A. DALY

Remarks were made by A. H. Brooks and G. O. Smith.

The second paper was by the same author, and entitled

THE OKANAGAN COMPOSITE BATHOLITH OF THE CASCADE MOUNTAIN SYSTEM

BY REGINALD A. DALY

The paper was discussed by A. C. Lane, A. P. Coleman, J. D. Irving,

J. F. Kemp, F. E. Wright, G. O. Smith, R. W. Brock, T. A. Jaggar (a visitor), and the author.

The paper is printed as pages 329-376 of this volume.

The third and last paper of the morning session was

RECENT CHANGES OF LEVEL IN THE YAKUTAT BAY REGION, ALASKA

BY RALPH S. TARR AND LAWRENCE MARTIN

Remarks were made by A. E. Coste (a visitor), W. H. Sherzer, and A. H. Brooks.

The paper is printed as pages 29-64 of this volume.

The Society adjourned for the noon recess, and reconvened at 2.15 o'clock p m.

Remarks were made by T. L. Walker relating to the place of meeting of the International Geological Congress in 1909, and inquiring as to the purport and effect of the resolution adopted at the morning session.

The scientific program was resumed, and the first paper was the following:

OBSERVATIONS IN SOUTH AFRICA

BY W. M. DAVIS

Remarks were made by David White, with reply by the author. The paper is printed as pages 377-450 of this volume.

The second paper was

DRUMLIN STRUCTURE AND ORIGIN *

BY H. L. FAIRCHILD

[*Abstract*]

Contents

INTRODUCTION

The paper was a brief description, aided by maps and lantern slides, of important drumlin features found in central New York, and a concise statement of conclusions relating to the origin of drumlins.

* By permission of the New York State Geologist.

Distribution

Typical drumlins or drumlin ridges are the most emphatic of a variety of forms produced by the rubbing action of the ground-contact ice under thrustal motion. On the one hand these forms shade off into indefinite flutings or moldings of the drift, and on the other hand are represented by scoured or rounded rock hills (drumloids). The requisite conditions for production of distinct drumlins do not seem to have been commonly fulfilled, as vast areas of glaciated territory seem never to have been subjected to the drumlinizing movement of the ground-contact ice.

The land surface included in the drumlin area of New York is a belt about 35 miles wide, bordering the south side of lake Ontario, and about 140 miles long (from Niagara river to Syracuse), with a total area of about 5,000 square miles. At least half of this area carries numerous well developed drumlins. An eastward extension of the area swings around the east end of lake Ontario as a belt 5 to 10 miles wide, reaching past Watertown into the Saint Lawrence valley.

The New York drumlin area probably includes not less than 10,000 drumlin crests, of which at least 6,000 are indicated on the topographic sheets. On the 216 square miles of the Palmyra quadrangle an actual count shows 955 indicated on the map. Probably hundreds of minor ridges are beneath the recognition of the contour lines, with 20 feet interval.

Orientation

The longer axis of the drumlins indicate the direction of the latest vigorous movement of the ice-sheet in their locality, and their variant directions throughout the New York area prove a radial or spreading flow of the ice-mass during the stage of waning which is represented by the drumlin formation. The angular directions cover nearly a half circle. East of lake Ontario they point east—that is, they were shaped by a movement of the ice from the west. Passing westward around the south side of Ontario the directions of the drumlins gradually shift to southeast, then to south, and in western New York to southwest.

The axial direction is not always uniform along the same meridian, but records any change in the direction of the ice movement due to the topographic control over the waning edge of the ice-sheet in its different positions. A confirmation of this genetic relation between drumlin attitude and ice-flow direction is found in the Pulaski region. As we pass eastward around Mexico bay we find the direction toward which the drumlins point changes from southeast to east; but passing on 10 miles to the north we find the drumlins pointing southwest, or at right angles to those near Mexico. These varied directions represent ice-flow movement during successive stages of the waning ice body.

Relation to Topography and Rock Strata

The most massive development of drumlins is on the low Ontario plain north of the Finger lakes and mainly under 500 feet altitude. They are comparatively absent on the higher ground which faced toward the ice body. This dominant drumlin area is underlain by the Cayugan (Salina), Niagaran, and Oswegan

(Medina) strata, which consist of about 3,000 feet of shale, between 200 and 300 feet of limestone, and 400 or 500 feet of sandstone. The predominance of shale in the outcrops from whence the ice obtained its rock debris supplied a burden of unusually clayey and adhesive drift, and it seems probable that the adhesive and plastic character of the subglacial drift was a contributing factor to the remarkable development of close-set drumlins.

Form and Size

The several types may be distinguished as the mammilla or dome, the oval, the slender oval or short ridge, and the linear or attenuated ridge. The two latter forms include the great majority of the New York drumlins. The dome form is rare in New York. It is an important fact that the different types are not intermingled. Of the ridge form there are two extreme varieties. A large form constitutes broad, low swells or rolls, which may not be recognized as of drumlin nature and are often overlooked by the map contours. These low, broad moldings of the till are the common form over the surface of the Niagara-Genesee prairie. The small variety of the long ridges is abundantly displayed in the Clyde-Savannah district, where between the major drumlins or on their sides lie a secondary or minor order of ridges, often not larger than a railway embankment. These small, attenuated ridges characterize the frontal border of the drumlin belt when faced by a moraine.

The limit to the height of drumlins seems to be about 180 to 200 feet. At some point in the upbuilding process the growth is antagonized by an eroding or leveling tendency and a balance is struck between the opposing forces which limits extreme height, and which apparently results in the production of multiple ridges of moderate size instead of one huge ridge.

Composition and Structure

The New York drumlins are composed of compact till. Only two instances have been found of water-laid drift distinctly within the drumlin mass. The deeper layers are more compact than ordinary sheet till and the included stones of all sizes are more generally abraded.

Along the south shore of lake Ontario a score of drumlins, some of large size, are dissected to their core by wave erosion. More than half of the cliffs show undoubted concentric foliation, and in several it is surprisingly distinct. In cross-section view the layers near the base are only slightly arched, and the arching increases toward the top, where the layers are parallel with the profile. In the different sections it is found that the exposed foliation has the directions corresponding to concentric layers. The constructional origin of these drumlins is beyond question.

Between Palmyra and Syracuse the foundations of the drumlins are Salina shale, the soft red and green beds known as Vernon. Some of the low ridges are probably composed entirely of the shale, with a veneer of drift. On the parallel of Baldwinsville all the drumlin-like forms east of Seneca river are composed of the red shale and are not drumlins, but rocdrumlins.* The hills of Vernon shale (hardened clays, without evident bedding, and easily decomposed) which stood within the zone of drumlin formation, in conflict with the rubbing ice, were more easily shaped into the drumlin form than other rocks;

* The Celtic word for rock is used as a prefix.

but when given that shape they resisted the ice impact better than harder rocks, as the product of the ice rubbing was a lubricant and plastic paste, essentially like clayey till in its mechanical properties. The shale hills were at first compliant, and then resistant to the ice. They became drumlins in effect, though not in origin, being erosional forms, not constructional.

The shaping of hills of the softest rock instead of leveling them is an evidence of erosional weakness of the ice in the drumlin belt. Vigorous abrasion of hard rocks would not be consistent with drumlins in the same locality.

Relation to Moraines and to glacial Lakes

During the stage of ice waning represented by the dominant drumlin area the ice-front was swept by vigorous rivers on the higher ground and was faced by lakes on the lowest ground. The drumlins reach up to the north side of the drainage channels in good strength, but they fade out into attenuated forms in the areas where the ice-front was not swept by streams, and where consequently the drumlin tracts are fronted by moraines. These moraines represent only the superglacial and higher englacial drift, carried to and dropped at the extreme edge of the ice, while the drumlins were forming at the same time from the subglacial and lower englacial drift beneath the ice-sheet, in the rear of the moraine.

Theoretically the moraines should be weak where the drift was largely left in drumlin form, and the facts seem in accord.

Formation; Mechanics

The idea that drumlins represent overridden moraines, or are erosional in origin, may be true of some drumlins, but certainly is not true of the majority of New York drumlins, which were constructed or built up by a plastering-on process.

In the mechanics of drumlin construction three sets of factors are recognized: (*a*) factors pertaining to the ice itself; (*b*) those relating to the drumlin-forming drift; (*c*) the external influences of topography and climate.

The dynamic factors pertaining to the ice body (*a*) include: (1) vertical pressure; (2) horizontal pressure; (3) vigor and velocity of flow; (4) differential flow; (5) plasticity.

The factors relating to the drift (*b*) are: (1) volume of the drift; (2) position of the drift; (3) quality of the drift.

The factors of external control (*c*) are: (1) general land slope; (2) minor features of the topography; (3) temperature and water supply.

The building up of the drumlins is coincident with the rubbing off or shaping effect. As masses, the hills were built by accretion of the drift, but the convex forms are due to the erosional factor. The whole process may be compared to the work of the sculptor on a clay model—a plastering on and rubbing away. The accretion is due to the greater friction between clay and clay than between clay and ice. The hills of accretionary drift resisted the ice impact and rasping effect in the same manner as did the hills of shale. The form possessed by both classes of hills is that which opposed the greatest resistance to removal by the ice or the least resistance to the overriding movement of the ice.

The drumlins were shaped by the sliding movement of the lowest ice, that in contact with the land surface. This fact implies that the whole thickness of the ice-sheet participated in the motion. Such motion was not due to gravitational stress on the ice over the drumlin area, but to effective thrust on the marginal ice by the gravitational pressure of the rearward mass. As the margin of the ice-sheet thinned by ablation, there came a time when the drift-loaded ice in contact with the ground was subjected to less vertical pressure and to relatively greater horizontal pressure by the deep ice in the rear, and was pushed forward bodily. In this fact is believed to lie the key to drumlin formation.

The combination of conditions requisite for effective thrust movement over a belt of country and for considerable time may be rare, and it does not seem so strange that drumlins are uncommon features when we consider the variety of dynamic factors which are concerned directly or indirectly in drumlin formation.

It may be assumed that wherever the ground-contact ice had a vigorous movement of some duration it should be indicated by the molding of the ground surface, specially where this is comparatively level and composed of drift or soft rocks. The absence of drumlinizing of the drift surface may be assumed as indicating lack of movement of the ground-contact ice. Well marked drumlins are not found on the high ground east of Seneca lake, nor on the low ground east of Syracuse. The explanation seems to lie in the relationship of the larger topography to the movement of the ice-sheet. When the glacier was deep over the Finger Lakes region the bottom of the ice in the drumlin area was probably quiescent and served as a bridge over which the upper ice moved, the repose of the lower ice being due to the opposing land slope and to the large volume of drift which the ice had incorporated. Over the nearly level area north of the Finger lakes the waning of the ice-sheet finally brought the ground-contact ice under horizontal thrust; but in the adjacent district of low ground northeast and east of Syracuse we have an example of the non-motion of the bottom ice. The almost bare hills of soft Vernon shales in the district of Canastota have not been subject to rubbing action of ice in any direction. The surface would have been sensitive to any ice movement, but the deeply buried ice was stagnant and the shallow ice was not subjected to push by any thicker ice on the northward.

In the balancing and adjustment of the several dynamic factors in the drift-burdened ice, the two opposing forces of rigidity and plasticity seem to be the most important. The existence of the drumlins implies that the depth of the ice and the vertical pressure were so moderate as to allow the plastic ice to override and to adapt itself to the hills, while at the same time the whole sheet of ice was sufficiently rigid to accept horizontal thrust.

The paper was discussed by R. S. Tarr, I. C. Russell, A. P. Coleman, W. M. Davis, and W. H. Sherzer. The full paper, with ample illustrations, will be printed as a bulletin of the New York State Museum.

The third paper was

DRUMLINS OF MICHIGAN

BY ISRAEL C. RUSSELL

[*Abstract*]

Studies of a drumlin area in the northern peninsula of Michigan, a brief report concerning which was presented at the last winter meeting of this Society, have been continued and additional facts obtained that strengthen the conclusion previously advanced in reference to the drumlins referred to having been produced by ice erosion of a previously deposited till sheet.

A contour map of a characteristic group of drumlins was exhibited, which illustrated one of the several classes of irregularities presented by the drumlins of Michigan. In certain instances they depart from the normal shape and have a straight, steep slope on one side. Drumlins showing this asymmetry are thought to have been complete and symmetric in form at one time, but later were partially removed by ice erosion. In the case of one of the examples represented on the map referred to, about one-half of a drumlin, cut parallel with its longer axis, appears to have been removed.

Attention will also be invited to the smooth surface concave troughs which occur between adjacent drumlins, and in numerous instances are as characteristic features of drumlin topography as the similarly smooth, convex hills they separate. Such "drumlin troughs" are thought to furnish criteria for recognizing the effects of ice erosion in moraine and till covered regions, where the correlative convexities are absent or but poorly defined.

Certain of the drumlins of Michigan are composed of sandy till which is without foliation, while other examples consist of definitely laminated clayey till. The foliation appears to be due to pressure, and is present or absent according to the nature of the material.

The fourth paper was

THE LEFROY, A PARASITIC GLACIER

BY WILLIAM H. SHERZER

[*Abstract*]

At the head of the Lake Louise valley, Canadian Rockies, lies the Victoria glacier, which receives from the southeast a tributary somewhat over a mile in length and from one-third to one-half mile in width. This tributary proves to be double, the Lefroy being superposed on the Mitre and moving across it at right angles. The parasitic Lefroy is formed from the ice and snow avalanched from the eastern shoulder of mount Lefroy, and carries across the Mitre the ground morainic material manufactured beneath the hanging glacier on mount Lefroy. This material is dumped on the eastern margin of the Mitre glacier, by which it is delivered to the Victoria as though it had come from mount Aberdeen. The discovery of this relation of the Lefroy to the Mitre glacier explains the direction of the dirt zones, the presence of the ground morainic material in the right lateral of the Victoria, and its arrange-

ment in ridges parallel with the side of the glacier. It shows, further, that two glaciers may occupy the same region at the same time, nourished differently, with different structure, direction, and rate of motion, and accomplishing different geological results.

The full paper is published in the reports of the Smithsonian Institution.

The fifth paper was by the same author, entitled

ORIGIN OF THE MASSIVE BLOCK MORAINES IN THE CANADIAN ROCKIES AND SELKIRKS

BY WILLIAM H. SHERZER

[*Abstract*]

In the five most accessible valleys along the line of the Canadian Pacific railway, the heads of which are still occupied by glaciers, there occurs a peculiar type of moraine, composed of massive angular blocks, remarkable for the scarcity or absence of fine material. They differ markedly from the moraines of older date and also from those of more recent formation. In the case of three of the glaciers there are two such moraines, and in the other two the double character is indicated. The blocks composing them were carried either on or in the ice and were not pushed along ahead or beneath it. They show no signs of water action by which the finer materials could have been removed. The various possible theories of their origin have been considered, and the conclusion reached that a double seismic disturbance affected the entire region, by which the glaciers became loaded with coarse fragments of the overtowering cliffs. If the theory proves sound we have a means of correlating the position of the main trunk glaciers, which were favorably situated, for determining their actual and relative amount of recession since the time of the disturbances.

Remarks were made by R. S. Tarr. The paper is published in full in the reports of the Smithsonian Institution.

The sixth paper was read by title:

GLACIATION OF MANHATTAN ISLAND, NEW YORK

BY ALEXIS A. JULIEN

The character and extent of plucking action by the continental glacier upon the crystalline schists are shown by jagged, broken surfaces covered by till, fractured slabs often hardly displaced, and angular transported boulders. Semi-lunar grooves are found on the limestone, and the pitting of surfaces on rounded hummocks are referred to the same action. Abundant channels and troughs are attributed to erosion by subglacial running water, connected with moulins through crevasses in the ice-sheet. A new hypothesis is advanced to account for the pot-holes found in vicinity of the island. A sudden bending southward of the directions of glacial furrows, their southward curvature, and peculiar asymmetric form, are presented in evidence of a strong slope of the general surface to south-southwest at the time of its subsidence during the glacial movement. The undercutting of joint planes facing the northeast has created an unusual feature in topography.

The seventh and last paper of the day was read by title:

GLACIAL PHENOMENA OF THE SAN JUAN MOUNTAINS, COLORADO

BY ERNEST HOWE AND WHITMAN CROSS

The paper is printed as pages 251-274 of this volume.

Session of Thursday Evening, December 28

In the assembly hall of the Normal School, at 8.15 o'clock, a public lecture, complimentary to the citizens of Ottawa, was given by Dr John M. Clarke, State Geologist and Director of Science, New York State; the subject was

CONSERVATION OF NIAGARA FALLS

Session of Friday, December 29

The Society met at 9.30 o'clock a m, President Pumpelly in the chair.

The following resolution, offered by A. C. Lane, was passed by majority vote, after discussion:

"*Resolved*, That the Council, if after consideration they find it wise and feasible, employ an expert stenographer to report the discussions in the meetings of the Society, such parts thereof to be published after revision by the speakers as the Committee on Publication and the speakers may deem wise."

AUDITING COMMITTEE'S REPORT

The Auditing Committee reported that the accounts of the Treasurer had been found correct, and the report was adopted.

Professor I. C. Russell suggested that the preparation of a geologic map of North America would be appropriate work for the International Geological Congress. It was voted to appoint a committee to take the matter in hand. The President subsequently named as such special committee I. C. Russell, C. W. Hayes, F. D. Adams, and J. G. Aguilera.

The Secretary announced some details of the arrangements for the annual dinner, to occur in the evening, and the program of papers was taken up.

The first paper presented was

GEOLOGY OF OTTAWA AND ITS ENVIRONS

BY H. M. AMI

[*Abstract*]

For the visiting geologists a series of lantern views were projected, showing the geologic features about Ottawa; the stratigraphic succession, Archean crystallines, Potsdam, Beekmantown, Chazy, Birdseye, Black River, Trenton, Utica, Lorraine, Medina, and the Pleistocene deposits. The faunas of the sedimentaries were briefly considered.

The second paper was

NOTES ON ARCTIC GEOLOGY

BY ALBERT P. LOW

Remarks were made by W. M. Davis and the author.

The third paper was

OLDEST PRE-CAMBRIAN ROCKS

BY C. K. LEITH

The paper was discussed by A. C. Lane, A. P. Coleman, and Arthur Keith. It is published in a bulletin of the U. S. Geological Survey.

The Society adjourned for the noon recess, and reconvened at 2.30 o'clock p m, with S. F. Emmons in the chair.

The first paper of the afternoon session was

GLACIAL HISTORY OF NANTUCKET AND CAPE COD

BY J. H. WILSON*

[*Abstract*]

Late Wisconsin ice-sheet occupied this region with two distinct lobes: First. Nantucket lobe, with three stages: *a*, Nantucket stage; *b*, Cape Cod stage; *c*, Cape Cod Lake stage. Second. Long Island lobe, with two stages: *a*, Marthas Vineyard–Block Island stage; *b*, Elizabeth Islands–Fishers Island stage. The Nantucket lobe is shown to have come probably from as far as Newfoundland, and to have extended at least 150 miles out to sea. Reasons for this are numerous. Especially notable are: character of transported material, evidences of glacial erosion over the area concerned, direction of motion of ice, and character of the interlobate moraine.

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* Introduced by A. W. Grabau.

The following topics are discussed in detail:

Nantucket; preglacial formations; interglacial formations; the Sankaty Head deposits; the late Wisconsin ice-sheet; the four zones (marginal): 1, kame hills; 2, fosse; 3, ice-contact slope, and, 4, apron plain. Detailed description of these and tracing of ice-contact slope; peculiarities of Miacomet valley; postglacial deposits and changes in elevation; associated phenomena of Marthas Vineyard and Block island.

Upper cape Cod and associated phenomena of Elizabeth islands and Fishers island.

Cape Cod lake (third stage of Nantucket lobe); lower cape Cod; the sand plains of Eastham, Wellfleet, Highlands, and Truro; the morainal dam; the cols or outlets, the three stages of the lake: 1, Wellfleet; 2, Highlands; 3, Truro; summary.

The paper has been published as volume i, Geological Series, Columbia University Press.

Remarks were made by A. C. Lane.

The second paper was

ICE BORNE SEDIMENTS IN MINAS BASIN

BY J. A. BANCROFT*

In absence of the author the following paper was presented in abstract by W. M. Davis:

GEOLOGY OF THE LOWER COLORADO RIVER

BY WILLIS T. LEE

Comments were made by Professor Davis. The paper is printed as pages 275-284 of this volume.

The next paper was

CRETACEOUS SECTION IN THE MOOSE MOUNTAINS DISTRICTS, SOUTHERN ALBERTA

BY D. B. DOWLING†

The paper is printed as pages 295-302 of this volume.

The following paper was presented:

GEOLOGY AND PALEONTOLOGY OF NORTHERN CANADA

BY H. M. AMI

The paper contains notes bearing on the collection recently obtained by Commander A. P. Low, of the Geological Survey of Canada, in northern Canada,

* Introduced by F. D. Adams.
† Introduced by H. M. Ami.

during 1903 and 1904; the faunas determined and the geological horizons to which they are referable, together with correlations of results in previous explorations. The paper is illustrated with specimens from Beechy island, Lancaster sound, and other localities.

The following paper was read, in absence of the author, by J. F. Kemp:

TYPES OF SEDIMENTARY OVERLAP

BY A. W. GRABAU

Remarks were made by H. M. Ami and C. W. Hayes. The paper is printed as pages 567-636 of this volume.

The next paper was

*GILBERT GULF (MARINE WATERS IN ONTARIO BASIN)**

BY H. L. FAIRCHILD

That all the shorelines of the extinct glacial lakes in the Laurentian basin have now an upward slant in northward directions is a well known fact of observation. Another long recognized fact is the occurrence of marine deposits of Pleistocene age in the Champlain and Ottawa valleys, a whale skeleton being found as far inland as Welchs siding (near Smiths Falls), some 30 miles northwest of Ogdensburg. If the tilt is due to northward uplift and not to southward downthrow, it follows that the altitude of the land surface at any point was, during the life of those lakes, as much below the present height as the amount of differential uplift. From the above facts and principle it has long been recognized that the carrying down of the deformed planes of the ancient lakes to horizontality would carry the head of the Saint Lawrence valley far below sealevel. The conclusion follows that when the Labradorian ice-sheet melted away from the upper Saint Lawrence valley the sealevel waters spread westward through the straits at the Thousand islands and occupied the Ontario basin; and the studies of Gilbert, Coleman, Spencer, Taylor, and others seem to have made the theoretical conclusion a certainty.

The sequence of events would seem to have been as follows: While the ice-body was blocking the upper Saint Lawrence valley the waters in the Ontario basin were held up to the level of Rome and forced to outflow to the Mohawk-Hudson; but when the ice waned on the north slope of the Adirondacks and opened passes lower in altitude than the Rome outlet, the Ontario waters (lake Iroquois) were diverted to the northern escape and flowed out to the Champlain valley. The rivers draining the sub-Iroquois waters must have washed the ice-front, and must have shifted their position to lower and lower levels as the ice-front backed away on the north-facing slope. The existence of such ice-border or proglacial river channels on the north and northeast flanks of the Adirondack massif was determined by Doctor Gilbert some years ago, and the

* By permission of the New York State Geologist.

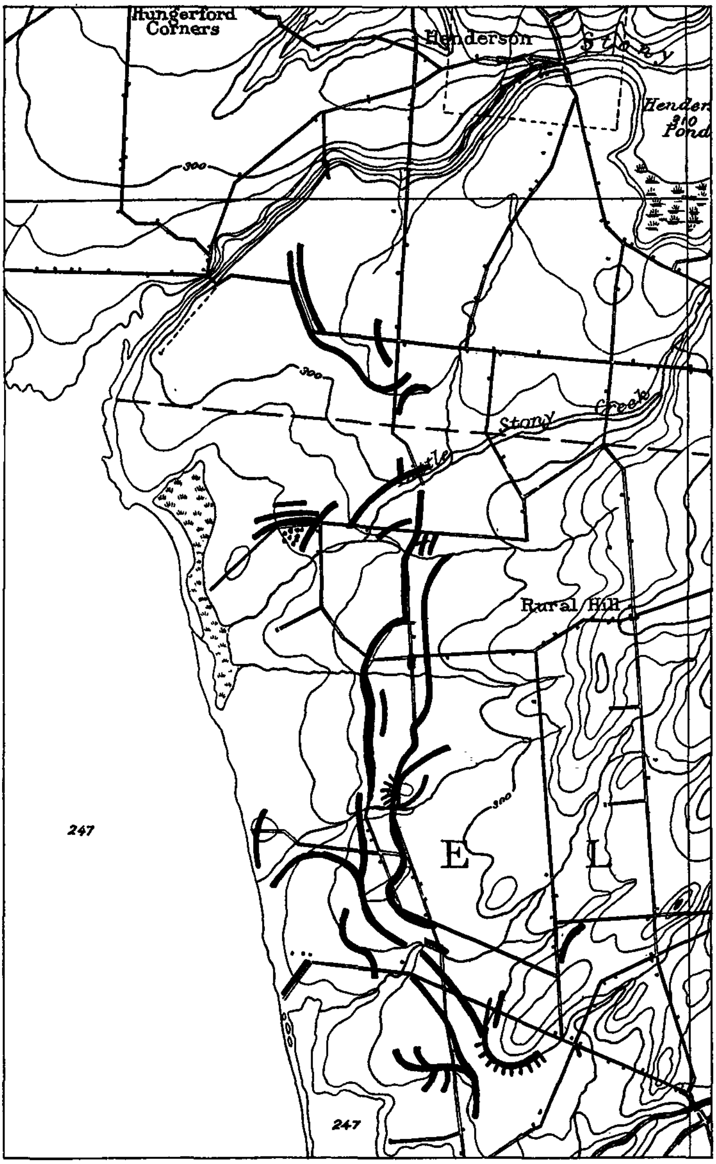


FIGURE 1.—*Gilbert Gulf Shore Features.*

Cliffs, bars, and spits east of lake Ontario, south of Henderson. Part of the Sacketts Harbor topographic sheet somewhat reduced.

features have been described by Professor Woodworth for the Mooers quadrangle.*

Doctor Gilbert had also noted shore phenomena, cliffs and bars, in the district east of lake Ontario which he regarded as the work of the sealevel waters. These were subsequently seen by the writer, and in the summer of 1905 these supposed marine features were traced with some care from a point on the Ontario shore a mile northeast of the hamlet Texas, and about 14 miles northeast of Oswego, northward to near Henderson village, through a stretch of about 21 miles.

Throughout this district the cliffs, spits, and bars are well developed, as shown in figures 1 and 2. The approximate altitudes of the features are indicated by the map contours. The spit near Texas is about 16 feet over the lake, or 262 feet above tide. The highest bars in the region of Henderson are from 310 feet to 320 feet altitude. The lower may not represent the full height of the water surface, as they were built out some distance from the shoreline and are not very coarse material. The spit at Texas is very coarse material and probably is a storm beach; but, taking the features as they lie, the rise of 53 $\pm$ feet in 21 miles of right line distance shows a deformation of at least 2.5 feet per mile.

The bars occur at various levels, beneath the highest one, down to the present lake. This is to be expected of the work of marine waters here, because the change of level in relation to the land surface was due to continental uplift, which was a process sufficiently slow to allow effective wave work at all inferior altitudes. It might not unreasonably be expected that shore phenomena would be found at levels intermediate between the Iroquois beach and these supposed marine beaches, which should represent the long pauses in the lowering of the sub-Iroquois waters while the overflow was cutting the rock channels near the north border of the State; but such features do not occur, though wave-swept areas of limestone are found.† In the beaches under discussion we apparently have the effects of wave-work at planes of water level much more enduring than was possessed by the sub-Iroquois waters with shifting outlets.

The positive proof that these beaches were made at sealevel would be the finding within them of marine fossils. Casual search has not yet discovered any fossils of either fresh or salt water. However, the absence of fossils would not be conclusive; and even the presence of fresh-water shells might not be positive proof against sealevel attitude, as it might be held that the long and narrow Saint Lawrence strait and the outflow of copious glacial waters might prohibit the inflow of salt water. It seems likely, however, that the strait was sufficiently deep (more than 150 over the present river surface) and sufficiently wide (many miles after the ice-front backed away) to allow the waters to become at least brackish.

Whether the waters which produced these beaches were open to the sea or not, they deserve a distinctive name. They are neither Iroquois nor Ontario.

* J. B. Woodworth: Pleistocene geology of the Mooers quadrangle. Bulletin 83 (geology 7), New York State Museum, 1905.

† In the falling of the glacial waters in central New York from the Warren to the Iroquois level, or from 880 to 440 feet, only one pause has been found of sufficient endurance to produce conspicuous shoreline features, that of lake Dana at 700 feet, although capacious rock canyons were cut in the district of Syracuse.

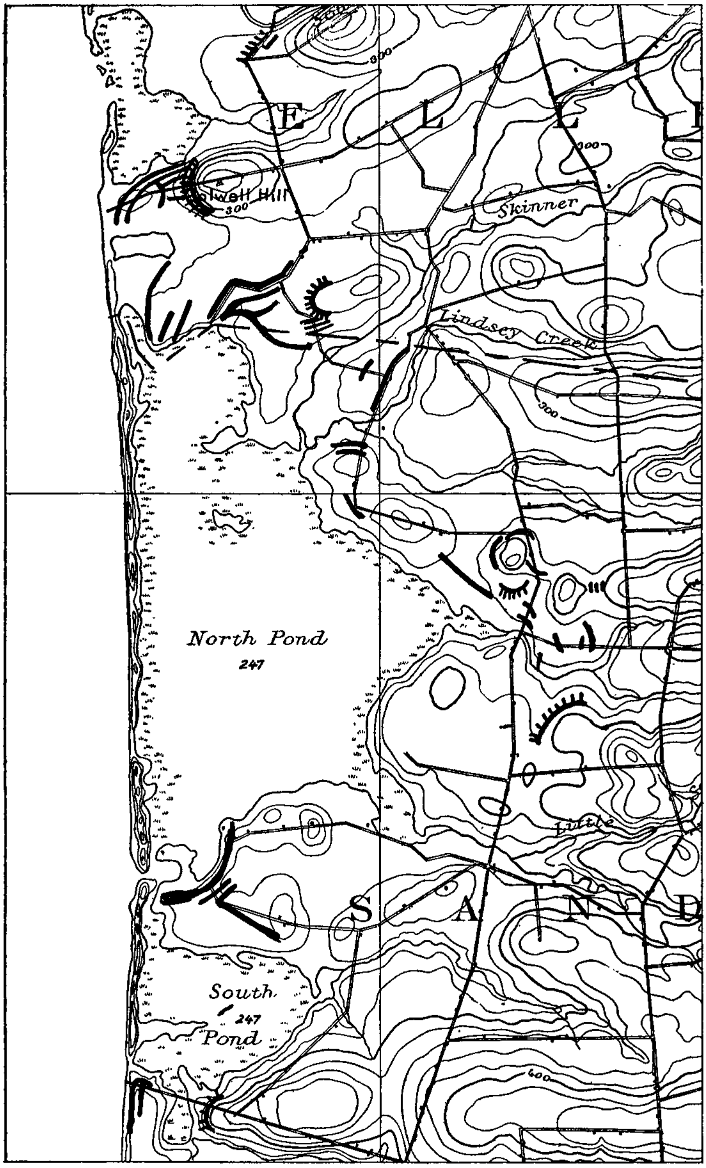


FIGURE 2.—*Gilbert Gulf Shore Features.*

Cliffs and bars east of lake Ontario, west of Mannsville and Sandy creek. Part of the Pulaski topographic sheet somewhat reduced.

The sealevel attitude is so nearly a certainty that the term "gulf" seems appropriate, and the water is named after Doctor Grove Karl Gilbert, who was the first geologist to note the beaches and appreciate their significance, and who has had special interest in and knowledge of the Pleistocene features in the Ontario basin.

After mapping the shore features shown in figures 1 and 2 the plane of the water surface was projected northward, and it was calculated that it would lie on the highest ground near Clayton, and specially on a hill 4 miles southwest of the village. A visit was made to the locality and the shore features found precisely as expected. These are shown in figure 3. The "hogback" hill carries remarkably strong spits and cliffs, and good bars at corresponding levels occur on the east. If the contour of 440 feet on the hill summit is correct, then the shore features have an altitude of about 400 feet. Good bars are found 3 miles south of Clayton on the 400-foot contour. Two miles southwest of the village, on the road to the "hogback" hill, is a hill by the Tiernan corners with good spits and cliffs at about 350 to 360 feet, by the map, and west of the corners is a gravel plain more than a mile long with map altitude of 380 feet.

On the supposition that the highest shore features represent the work of marine waters, we conclude that the total uplift of the land at Clayton has been 400 feet since the initiation of the Gilbert gulf. Taking the altitude of the water plane southwest of Clayton as 400 feet and the distance to the Texas spit as 46 miles, we find the gradient to be 3 feet per mile in direction 6 degrees east of north. This suggests that the tilting is steeper toward the north, which is confirmed by an examination of the planes. The stretch from Texas to near Henderson gives 2.5 feet per mile. The stretch from the latter point to the "hogback" hill gives 400 — 315 ÷ 25.5 = 3.3 feet per mile.

It is important to compare these gradients with those of corresponding sections of the Iroquois shoreline, which lies nearly parallel and only 5 to 9 miles distant on the east. The section from Richland to Adams compares well in direction and position with the Gilbert Gulf beach from Texas to near Henderson, and the gradient is 640 — 566 ÷ 17 = 4.4 feet. It appears that this is nearly twice the tilt of the marine plane. From Adams to Farrs (3 miles east of Watertown), but in a direction more northeasterly, the gradient is 740 — 640 ÷ 14.5 = 6.9 feet per mile. This also is about twice that of the marine plane north of Henderson. The entire distance between Richland Junction and Farrs gives, 740 — 566 ÷ 30 miles = 5.8 feet per mile, which is almost double the grade of the marine plane from Texas to Clayton. Making allowance for uncertainty in the relation of the several datum points to the water planes and for the short distances involved, the harmony in the quantitative relations of the two shorelines is striking. It appears that the deformation of the Iroquois shore is just about twice that of the marine shore. In other words, one-half of the post-Iroquois deformation occurred in the time between the formation of the two beaches, and the other half since the upper marine beaches were deserted. This seems disproportionate, as the fall from Iroquois to Gilbert gulf was only a downdraining of the lake waters through perhaps 230 feet of vertical distance, while the uplift of the land at Clayton has been an exceedingly slow movement through 400 feet. We conclude either that the draining down of the sub-Iroquois waters covered a very long time,

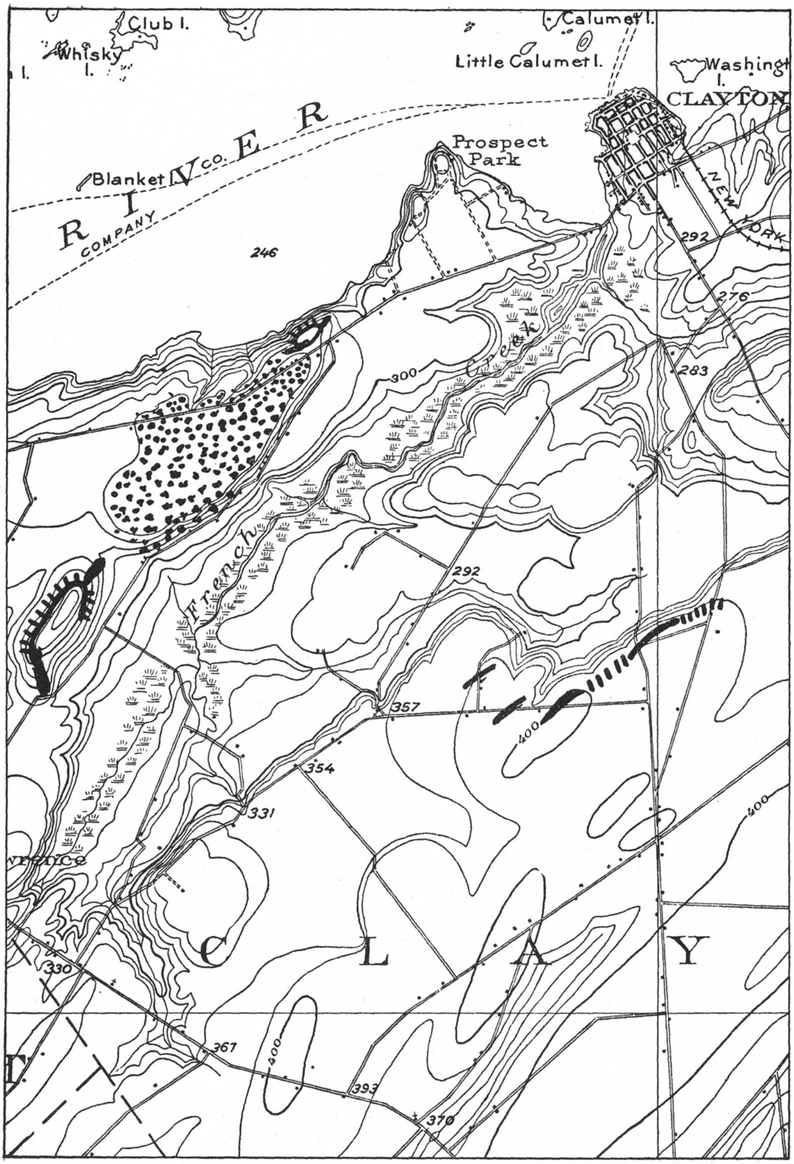


FIGURE 3.—*Gilbert Gulf Shore Features.*

Cliffs, bars, spits, and sand-plain near Clayton. Part of the Clayton topographic sheet slightly reduced.

yet forming no beaches, or that the land tilting was much more rapid during that time than during the later time.

Professor Woodworth concludes that the highest marine level is shown at Covey Hill, on the northern boundary of the state, at 450 feet altitude. This is quite definite, as the higher slopes show only the earlier work of streams carrying the sub-Iroquois waters. In 1882 a whale skeleton was found in a gravel pit at Welchs siding, north of Smiths Falls, in Ontario, and about 30 miles northwest of Ogdensburg. The altitude of the gravels has been given as 440 feet,* and Taylor has told the writer that he estimated the possible upper limit of marine work as about 460 feet. The latter point is only a few miles south of the parallel of Covey Hill, and the altitudes indicate, what has already been inferred from Iroquois and other lake levels in New York, that the isobasal lines in this region trend north of east and south of west.

Welchs siding is 48 miles from the "hogback" hill and in direct continuation of the line from the Texas spit. The uplift between the "hogback" and Welchs, according to the above data, is 1.25 feet per mile. Making all possible allowance for the uncertainty in the figures for the water levels, it seems certain that the rate of uplift diminishes north of Clayton. The deformation of the eastern Ontario region seems to be an irregular warping, with the steepest slopes east of the present lake.

The paper was discussed by H. M. Ami, W. M. Davis, O. C. Lane, J. F. Kemp, and the author.

DISCOVERY OF THE SCHOHARIE FAUNA IN MICHIGAN

BY A. W. GRABAU

[*Abstract*]

During the past season's field work a typical Schoharie fauna was discovered in northern lower Michigan. The locality is at Mill creek, 4 miles east of Mackinac city. The outcrops on the stream are more or less continuous from a short distance south of the mouth of the stream to the top of the terrace along the base of which runs the highway. The lower beds are magnesian calcilutytes, followed by calcarenytes in which the fauna occurs. Two analyses of the rock from different points show:

1. $CaCO_3$	56.12	$MgCO_3$	41.65
2. $CaCO_3$	69.16	$MgCO_3$	27.94

Some of the lowest beds exposed run, however, as high as 94.69 per cent $CaCO_3$ and 2.93 per cent $MgCO_3$.

The outcrops containing the Schoharie fauna are all near the Michigan Central railroad crossing. The fossils, while not well preserved, on the whole are nevertheless characteristic.

The following ten species were obtained:

Trochoceras clio; range, Schoharie.

Atrypa impressa; range, Schoharie.

* A. P. Coleman: Marine and fresh-water beaches in Ontario. Bull. Geol. Soc. Am., vol. 12, p. 133.

Meristella nasuta; range, Schoharie to Onondaga or Hamilton.

Stropheodonta demissa; range, Schoharie to Hamilton.

Pentamerella arata; range, Schoharie to Onondaga.

Rhipidomella alsa; range, Schoharie.

Stenochisma cf. *carolina;* range, Onondaga of northern Ohio and falls of Ohio.

Phacops cristata, Schoharie to Onondaga.

Prœtus latimarginatus, Schoharie.

Dalmanites cf. *anchiops,* Schoharie to Onondaga.

No typical Onondaga species occurs in the fauna, but all are typical Schoharie, though a number range up into the Hamilton. There can, then, be no doubt that this is a typical Schoharie fauna, and that the beds containing it are of Schoharie age, rather than Onondaga, as generally held. These beds are overlain by purer calcarenytes of Onondaga age, ranging 96 per cent or over in $CaCO_3$. The higher beds are brecciated, forming a typical calcirudyte like that of Mackinac island. It is believed that the beds with the Schoharie fauna are the lowest of the series, and that the Monroe (Upper Siluric) beds underlie them. Since the beds of Mackinac island contain an Onondaga fauna, it is evident they can not be lower than those of Mill creek, but the equivalent of the higher (brecciated) beds of that locality. Hence there is a decided flattening of the dip, so that beds at 150 feet above the water level at Mackinac island appear on the main coast at the level of the lake. Instead, then, of a dip of about 30 feet to the mile, or of 40 feet as it is farther east, the dip here is only 15 feet to the mile or even less.

The matter of the paper will be published in the geological reports of the state of Michigan.

The remaining papers of the program were presented by title, as follows:

LITHOLOGICAL CHARACTER OF THE VIRGINIA GRANITES

BY THOMAS LEONARD WATSON

The paper is printed as pages 523-540 of this volume.

RELATION OF CELESTITE-BEARING ROCKS TO OCCURRENCES OF SULPHUR AND SULPHURETTED WATERS

BY EDWARD H. KRAUS

NEW SPECIES OF SODA-ALUMINA PYROXENE

BY S. WEIDMAN

ORIGIN OF LEACHED PHOSPHATES

BY C. H. HITCHCOCK

GRADED SURFACES

BY F. P. GULLIVER

CALABRIAN EARTHQUAKE OF SEPTEMBER 8, 1905

BY WILLIAM HERBERT HOBBS

[*Abstract*]

The Calabrian earthquake of September 8, 1905, was the most severe in that seismically classical region for more than a century, and its relations to the lineaments of the Calabrian peninsula are most interesting. The losses to life and property as reported to the writer by the Ministry of the Interior of the Italian Government* were as given in the following table:

Province.	Number of persons killed	Number wounded.	Property losses in Italian lire.
Cosenza	47	222	20,500,000
Catanzaro	480	1,598	20,500,000
Reggio Calabria	2	57	7,000,000
	529	1,877	48,000,000

Early in the following October all sections of the afflicted region were visited by the writer, and attention was devoted especially to the distribution of damage to determine the relation of the destructive force of the shocks to the topographic features and the geologic structure.

In Monteleone, a city of 13,000 inhabitants, located near the center of the affected region, the buildings along a single street were leveled by the shocks, whereas elsewhere in the city all houses remained standing.* The direction of this street extended intersected ruined villages in the *paese*. With the clue afforded by this interesting observation, application for further information was made at the military headquarters of the forces engaged in succoring the afflicted people. General Ferrario exhibited to the writer a large scale topographic map of the region, upon which had been plotted the data of detailed reports from subordinate commands, and which revealed by spots of two different colors, first, the communes which had sustained damage, and, second, those which had been largely wrecked and in which there was the direst distress. The dense population of Calabria made this map one of very great interest, for a network of destructive zones was apparent and had been recognized by the staff officers. The straight elements of this network were marked topographic features and in many instances well-known fault-lines.

The field work completed, a study of the unusually complete earthquake records of Calabria—records extending over three centuries—was undertaken at Rome and yielded the following general conclusions:

First. The same communes have been either repeatedly damaged by earthquakes or have remained unscathed. To each a figure may be assigned to indicate in a roughly made scale its relative seismicity.

Second. The seismically prominent communes are arranged in lines—*seismotectonic lines*—corresponding in position to those revealed by the damage

* Through the kind offices of the American Embassador at Rome.

† It was afterward ascertained that the houses upon this street had been the first to be leveled by the terrible earthquake of 1783.

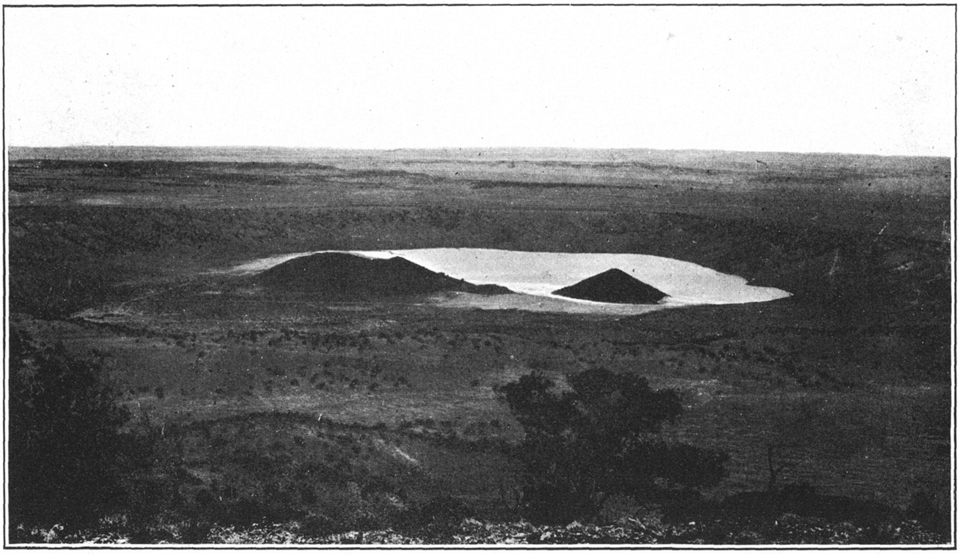


FIGURE 1.—INTERIOR VIEW OF CRATER

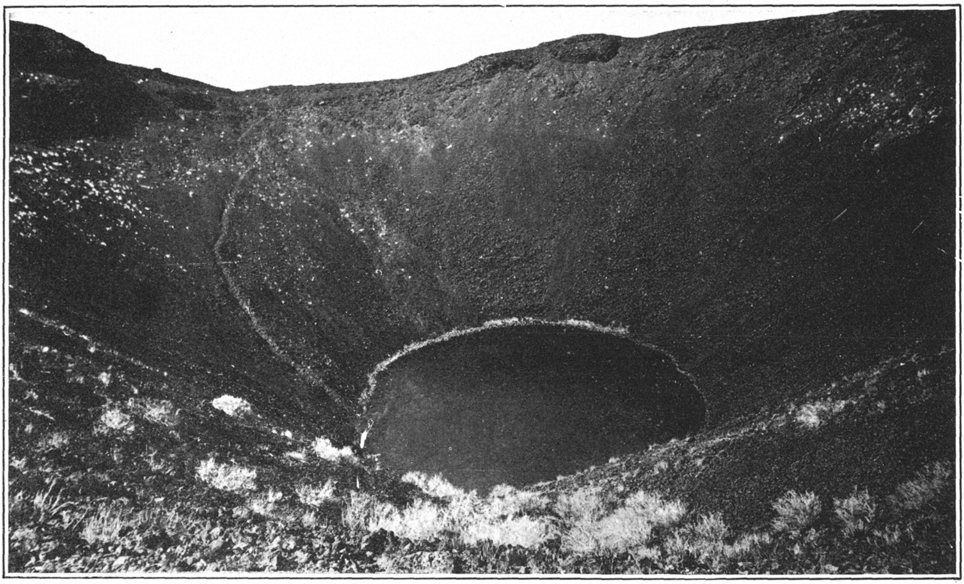


FIGURE 2.—LAKE IN BOTTOM OF CINDER CONE SHOWN IN FIGURE 1

CRATER SALT-LAKE

map of the earthquake of 1905, and these lines are prominent lineaments and in many cases known faults.

Third. The communes of highest seismicity lie at the intersections of seismotectonic lines.

Fourth. Within an area common to the destructive territory of three catastrophic earthquakes (1659, 1783, and 1905) whose "centrums" were widely separated, the distribution of damage was essentially the same—the included communes maintained the same relative position as regards the damage sustained.

From these facts it appears that earthquakes have no centrum as this term is ordinarily understood, but in so far as so-called epicenters are positions of greatest intensity of shocks, they are numerous and habitual and correspond to the intersection of fissure planes projected upon the surface. It also appears that shocks of earthquakes below X in the Rossi-Forel Scale are impotent to wreck well constructed buildings at distances of a mile or more from the fissure planes.

When the investigation was about completed there appeared the epochmaking work of the Count de Montessus de Ballore* upon the distribution of seismicity and its relation to topography and geology—"seismic geography." Upon a large scale adapted to the methods used, Major de Montessus has located the habitual epicenters for all earthquake provinces of the globe. Applying the methods discovered in Calabria to the maps of de Montessus, it is found that almost throughout the habitual epicenters are the intersections of important lineaments.

A special study has been made of the eastern United States and Canada on the basis of data supplied by de Montessus, and it is found that the habitual epicenters of this large region are the intersections of the grand lineaments as they have already been plotted* with others brought to light by a consideration of the steep walls of the continental shelf. The full reports are to appear as heft 2 of volume viii of the Beiträge zur Geophysik, the journal of the International Seismological Association.

GUADIX FORMATION OF GRANADA, SPAIN

BY WILLIAM H. HOBBS

This paper is printed as pages 285-294 of this volume.

VOLCANIC CRATERS IN THE SOUTHWEST

BY CHARLES R. KEYES

Several years ago Mr G. K. Gilbert aroused considerable interest among scientists by the announcement that he had visited in Arizona a large crater, depressed below the level of the plains, about which large numbers of meteoric masses had been found. The main hypothesis considered regarding the origin of the depression was that of a large meteorite striking the earth at this point. The phenomenon is thus described:*

* Les tremblements de terre, Paris, 1906.

* Lineaments of the Atlantic border region. Bull. Geol. Soc. Am., vol. 15, 1904, pp. 483-506, pls. 45-47.

* Presidential address before Geological Society of Washington, 1896.

"In northeastern Arizona there is an arid plain beneath whose scanty soil are level beds of limestone. At one point the plain is interrupted by a bowl-shaped or saucer-shaped hollow, a few thousand feet broad and a few hundred feet deep; and about this hollow is an approximately circular rim, rising 100 or 200 feet above the surface of the plain. In other words, there is a crater; but the crater differs from the ordinary volcanic structure of that name in that it contains no volcanic rock. The circling sides of the bowl show limestone and sandstone, and the rim is wholly composed of these materials. On the slopes of this crater and on the plain round about many pieces of iron have been found, not iron ore, but the metal itself, and this substance is foreign to the limestone of the plain and to all other formations of the region. The features of the locality thus include three things of unusual character and requiring explanation: First, the crater composed of non-volcanic rock; second, the scattered iron masses; third, the association of crater and iron. To account for these phenomena a number of theories have been suggested.

"More precisely, the locality is a few miles south of the station of Canyon Diablo and directly west of Winslow, on the Atlantic and Pacific division of the Santa Fe railroad. The locality is known as Coon butte."

It is unnecessary at this time to go into further detail of Mr Gilbert's interesting discussion. Suffice it to say, while evidences of extensive volcanic action are abundant in the region, there are no lava flows or volcanic materials in the immediate vicinity of Coon butte. The fact of the entire absence of volcanic materials was the chief reason that the falling star hypothesis appeared so attractive.

There are in northeastern Arizona and New Mexico myriads of volcanic cones. Many of these are symmetrical cinder cones; some are low lava cones; some are cinder cones with breached craters from which basalt flows extend for several miles; some are the centers from which the country has been flooded with lava for many miles all around. A number of these volcanic vents display evidences of dry explosive action. To one of these special attention is called, for the reason that it is similar to Coon butte in every respect, as described by Mr Gilbert, except that from the bottom of the crater rise two small cinder cones. This locality is known as Crater salt-lake and is in the western part of Socorro county, in New Mexico (plate 80, figure 1). The bottom of the crater is a salt-lake, whence the name. In this respect it also differs from the Coon Butte crater. A geological cross-section of the Crater salt-lake is represented in the diagram below (figure 1).

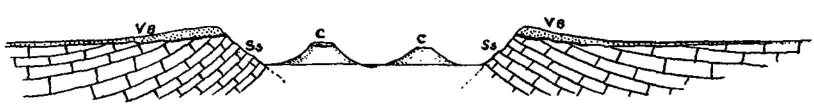
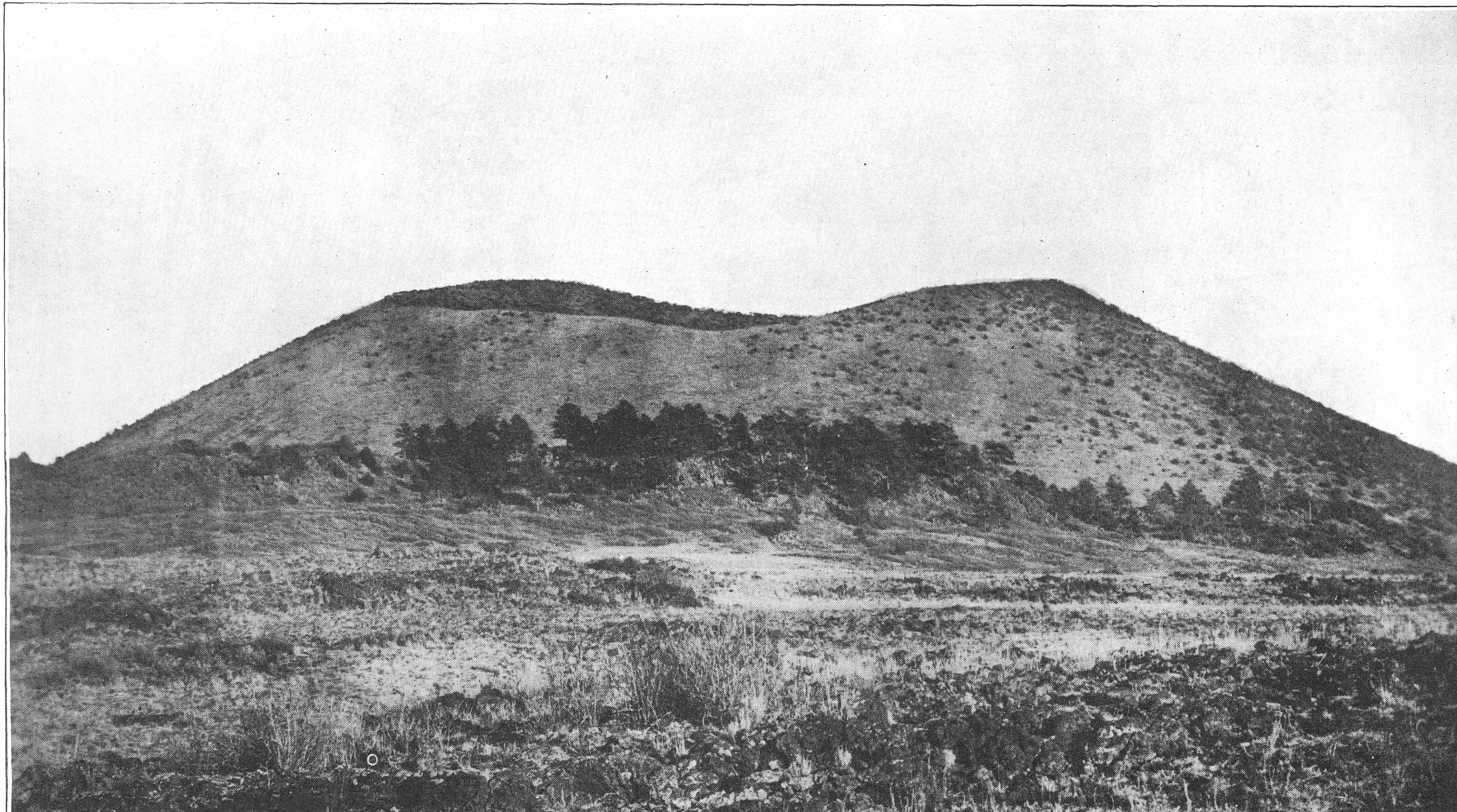


FIGURE 1.—*Geological Cross-section of Crater Salt-lake.*

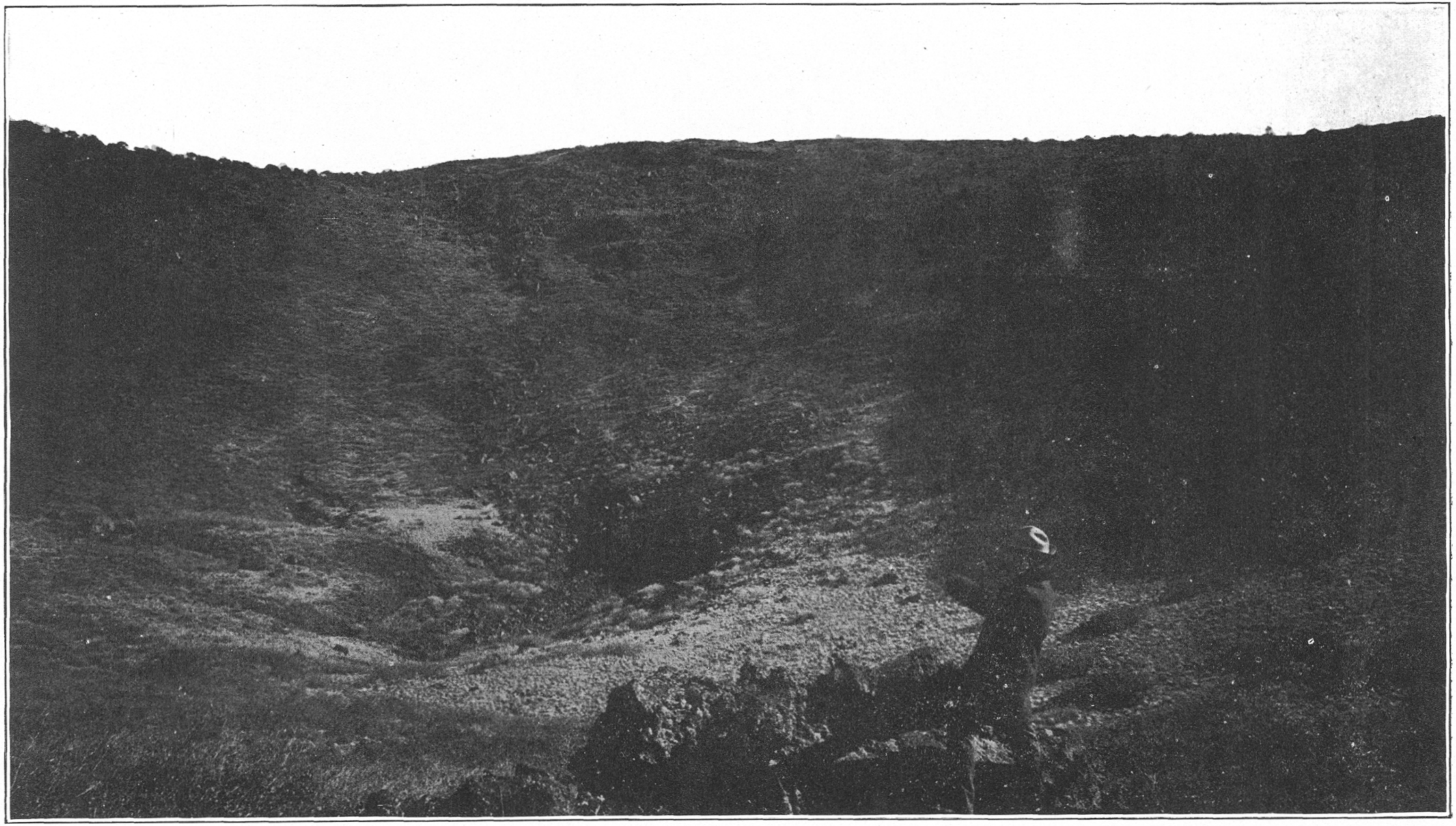
Within the crater of the small cinder cone which rises out of the bottom of the lake there was formerly a diminutive lake, which is shown in the accompanying view (plate 80, figure 2).

The important feature, however, of Crater salt-lake is that it displays a stage in its formation that is wholly wanting in the case of Coon butte. Conclusive evidence is here furnished that the craters in plains are the result of



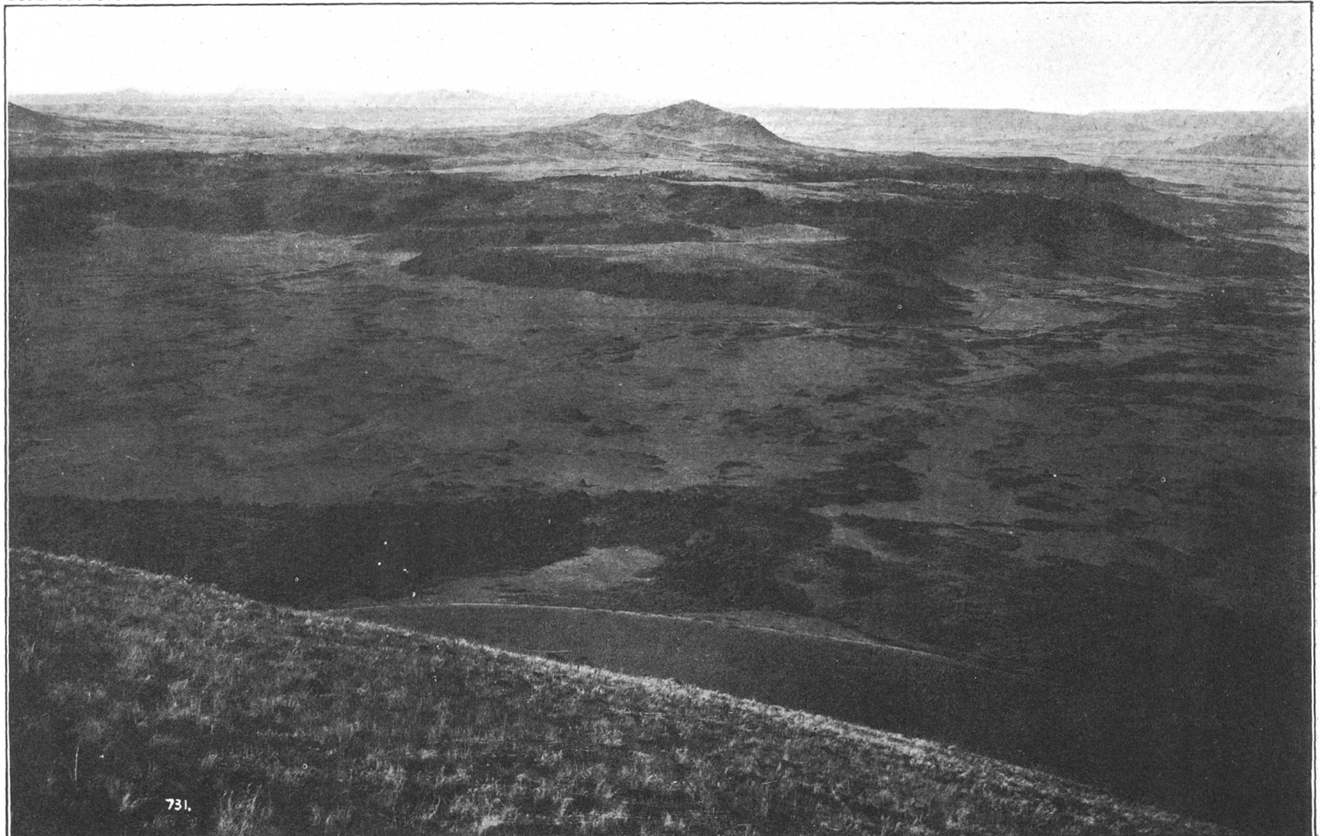
MOUNT CAPULIN, NEW MEXICO

A huge ash cone of very recent formation



INTERIOR OF CRATER OF MOUNT CAFULIN

CENTRAL PLUG OF MOUNT CAPULIN



LAVA FIELDS AND VOLCANIC CONES NEW MEXICO

View from top of mount Capulin. Nearest cone in center of field is 15 miles distant the explosive action of local vulcanism. If they were located anywhere but in an arid region, they would always be filled with water. Now they are either dry or are salt lakes in the last stage of desiccation.

Crater salt-lake lies between 200 and 300 feet below the rim. It is excavated from sandstones of Cretaceous age, while Coon butte crater is hollowed out of Carboniferous limestones. Crater salt-lake is bordered all around by a broad zone of unconsolidated pyroclastic material. From one side also extends a narrow basalt flow.

In the region are other stages of volcano building. There are low volcanic cones in which the amount of fine dry material blown out has nearly covered up all evidences of disturbances in the indurated strata beneath. Some craters of similar cones have also lava flows miles in length. The single basaltic stream from Maxwell cone, north of Las Vegas, extends a distance of 30 miles. From a small crater in the bolson plain lying between the Jicarilla and Oscura mountains, in central New Mexico, a lava stream 2 to 4 miles wide follows the central depression of the plain a distance of over 50 miles.

The most majestic of these dry eruptions is mount Capulin, in northeastern New Mexico (see plate 81). This is a lofty cinder cone 2,500 feet high, with a crater half a mile across and 500 feet deep. Plate 82 is a view taken from one side of the rim, and plate 83 a near view of the central plug of lava at the bottom of the crater. A view of other cones in the vicinity as seen from the top of the mountain and of the lava fields is shown in plate 84.

Mount Capulin is far more imposing than Vesuvius. In the fine, light, scoriaceous material of which it is mainly composed one sinks knee-deep in climbing its steep sides. On the southwest side the crater wall is breached and the heavy lava flow extends for many miles around. In the bottom of the crater the old plug of solid lava is well displayed.

Mount Capulin is as fresh in appearance today as is Vesuvius. There is a local tradition that the mountain was in action as late as 1812. If this is so, it is the latest volcanic eruption in the United States. The twin-cratered Sierra Grande, 15 miles to the east of mount Capulin and rising much higher (11,000 feet above tide), is reported to still show signs of dying activity, and the heat in the craters is sufficient to melt the falling snow.

From Coon butte, through Crater salt-lake and a host of nameless craters, to mount Capulin are represented all the stages of dry explosive action of volcanic forces. Coon butte stands at one extreme, mount Capulin at the other. In Coon butte we find the first stage of volcano construction—a stage rarely met with. Crater salt-lake represents a more advanced stage and is equally unique.

The two following papers, which were presented under the title Hawaiian Notes, are printed as pages 469-496 of this volume.

GEOLOGY OF DIAMOND HEAD, OAHU

BY C. H. HITCHCOCK

MOHOKEA CALDERA

BY C. H. HITCHCOCK

ALGONKIAN FORMATIONS OF NORTHWESTERN MONTANA

BY CHARLES D. WALCOTT

The paper is printed as pages 1-28 of this volume.

PALEOGEOGRAPHY OF SAINT PETER TIME

BY CHARLES P. BERKEY

The paper is printed as pages 229-250 of this volume.

CARBONIFEROUS OF THE APPALACHIAN BASIN

BY JOHN J. STEVENSON

The paper is printed as pages 65-228 of this volume.

OVERLAP RELATIONS ALONG THE ROCKY MOUNTAIN FRONT RANGE IN WYOMING AND COLORADO

BY N. H. DARTON

RED BEDS IN THE LARAMIE MOUNTAIN REGION

BY N. H. DARTON

[*Abstract*]

During the past season many additional observations were made on the Red beds at various localities in central Wyoming, especially in the vicinity of the Laramie and Bighorn mountains. One of the most significant features was the discovery of a fossiliferous limestone 150 feet below the top of the Red beds, containing a Permo-Carboniferous fauna. The locality was on the Bighorn river 3 miles north of Thermopolis, Wyoming, on the west slope of the Bighorn uplift. The Red beds in this region are nearly 1,000 feet thick and lie upon a well defined series of Upper Carboniferous limestones and sandstones. In the basal portion of the Red beds in this vicinity and elsewhere Permo-Carboniferous fossils have been obtained in previous seasons. The occurrence of this same fauna at the higher horizon leaves only 150 feet of red shales which may represent the Triassic. The next succeeding formation is the marine Jurassic, which appears to lie unconformably on the Red beds.

An examination was made of the locality from which Professor Wilbur Knight obtained Carboniferous fossils in the Red beds near Laramie several years ago. His collections were made in vicinity of Red mountain, near the southern margin of the Laramie basin. It was found that on both sides of Laramie mountain the Upper Carboniferous sandstones and limestones in their southern extension grade into and thereby give place to a thick deposit of Red beds. These, along the Rocky Mountain front, become the Lower Wyoming division of Eldridge and the Fountain formation of Gilbert and Cross. The Red beds which overlie the Upper Carboniferous limestones northward continue unchanged into the region of Lower Wyoming-Fountain red-beds as a distinct division, which was recognized by Eldridge as the Upper Wyoming division. The upper division has been designated the Chugwater formation.

This determination, which I made several years ago and announced to the Society, was verified in the region south of Laramie, where we found the lower division represented by a thick mass of red grits with occasional beds of limestone. It was in the upper portion of this series that Professor Knight obtained an extensive collection of Upper Carboniferous fossils, which verified the idea that the lower Red beds represent the southern extension of Upper Carboniferous limestones and sandstones of the region north. The overlying Red beds, which I recognized as the Chugwater formation, are several hundred feet thick, and I learned that in these Professor Williston has obtained, from near Red Mountain, the remains of vertebrates which are regarded as Triassic in age. As from the molluscan remains it would appear that the greater part of the Chugwater formation in the region north is of Permo-Carboniferous age, there is here an apparent contradiction of the evidence. So the matter stands at present, but during the coming season a special investigation will be made to obtain additional paleontologic facts.

TERTIARY TERRANES IN NEW MEXICO

BY CHARLES R. KEYES

[*Abstract*]

In the general survey which has been taken recently of the Tertiary formations of the region much new information has been obtained. The work of a generation ago has been adjusted to the new scheme. Some of the Tertiary formations are typical fluviatile deposits; others were deposited in water. Eocene, Miocene, and Pliocene epochs are represented by depositions. The general section is as follows:

Pliocene	Llano Estacado formation	300 feet.
Miocene	Santa Fe sands	800 "
	Chama clays	300 "
Eocene	Chaco marls	1,000 "
	Canyon Largo sandstones	700 "
	Torreon formation	300 "
	Puerco clays	500 "

The Tertiary deposits of New Mexico are much wider spread than has been supposed. As the period was marked by extensive volcanic action, the lava flows and intrusions have important relationships to many of the formations. The recent ascribing of a fluviatile origin to most of the Tertiary formations of the region is believed to be erroneous, and is due largely to a confusion of Quatenary deposits with the more recent Tertiary beds. The discriminating criteria of fluviatile formations are discussed in this paper.

QUATERNARY HISTORY OF THE UPPER MISSISSIPPI VALLEY

BY WARREN UPHAM

[*Abstract*]

Evidences of preglacial high uplift of this region, as also of all the glaciated area of the continent, are noted; and this altitude, continuing nearly to the end

of the Glacial period, is regarded as the chief cause of its vast accumulation of snow and ice. The several stages of advance or growth of the ice-sheet, interrupted by repeated recessions and readvances, are reviewed, as made known by their series of till deposits, moraines, and stratified or modified drift. Among the peculiar features of the upper Mississippi region are the large driftless area lying mostly in Wisconsin, inclosed on all sides by the glacial drift; the loess, extensively developed west and south of that area; and the falls of Saint Anthony, which, with the gorge extending 8 miles downstream to Fort Snelling, give an estimate of the duration of the post-Glacial period as about 7,000 years. All the Mississippi valley above the mouth of the Ohio is included in this study, but especial attention is directed to its higher part, in Minnesota, from lake Itasca to lage Pepin.

FISH REMAINS IN ORDOVICIAN IN BIGHORN MOUNTAINS, WYOMING, WITH A RESUME OF ORDOVICIAN GEOLOGY OF THE NORTHWEST

BY N. H. DARTON

The paper is published as pages 541-566 of this volume.

DISTRIBUTION OF DRUMLINS AND ITS BEARING ON THEIR ORIGIN

BY FRANK B. TAYLOR

[*Abstract*]

This paper presents a discussion of certain aspects of drumlins and drumlin areas. They are considered with reference to their distribution in the regions of Pleistocene glaciation; in their relation to the larger elements of topography; to the marginal portions of the ice-sheet, and to the successive recessional halts of the retreating ice-front.

Drumlin areas occur typically in association with broad basins or lowlands, such as our Great Lake basins and the lowlands of Scotland, Ireland, and Scandinavia. Certain occurrences of drumlins which are apparent exceptions to this rule are briefly considered. Drumlins are usually classed as forms made under deep ice. The writer's studies indicate that while this is true, there are certain facts which qualify such a statement. The relation of drumlins to the ice-margin, as shown by studies in Ontario and western Massachusetts, seems to support the view that drumlins are submarginal forms, made neither at the edge of the ice nor many scores of miles back under it, but in a submarginal belt varying roughly from five to 20 miles in width and beginning 1 to 5 miles back from the edge of the ice. The elongation of drumlins, or rather the ratio of the horizontal axes, is principally dependent upon the velocity of ice movement during their formation. Drumlins are conspicuous by their absence in certain regions which seem in many ways favorable for their formation, namely, in Ohio, Indiana, Illinois, southern Michigan, and parts of Ontario. No reason has been given for this peculiarity. Some tentative suggestions are made bearing on this point.

GEOLOGICAL MAP OF CONNECTICUT, 1905

BY H. E. GREGORY

[*Abstract*]

A complete and remarkably accurate geological map of Connecticut by James G. Percival was issued by the state in 1842. Since that date maps have appeared in reports and text books—for example, Dana revised 1897, Le Conte revised 1903, Brigham 1903, and McGee 1893—which represent the crystalline rocks of Connecticut as largely granite and Archean in age. A preliminary geological map of Connecticut by Herbert E. Gregory and H. H. Robinson is now ready for publication. The map shows practically no granite or other unmetamorphosed igneous rock except basalt and diabase. No rock of undoubted Archean age has been shown to occur within the borders of the state.

LOESS-CYCLE IN TURKESTAN

BY R. PUMPELLY

The scientific program was declared closed.

RESOLUTION OF THANKS

The following resolution was offered by Professor S. Calvin and unanimously adopted:

Resolved, That the Ottawa meeting of the Geological Society of America will long be remembered as one of great profit and pleasure to all the Fellows of the Society who had the good fortune to be present. For the success of the meeting we recognize our indebtedness to local organizations and individuals more in number than can here be named. We would especially mention the Logan Club and the members generally of the staff of the Geological Survey of the Dominion of Canada, whose thoughtful foresight and painstaking arrangements for our accommodation and comfort left nothing to be desired; Principal J. F. White, to whose generosity we are indebted for the use of commodious rooms in the Normal School building; their Excellencies the Governor General and the Countess Grey, and many citizens of Ottawa, who placed us under lasting obligations for gracious courtesies and kindly expressions of sympathy with the work for which our Society stands. To each and all who have thus contributed to the success of our meeting we express sincere appreciation and extend grateful thanks.

President Pumpelly made brief remarks and declared the meeting closed.

No formal session of the Society was held in the evening, but the customary annual dinner was given, at the Russell House, at which His Excellency the Governor General was present with other guests.

Following the dinner a reception was given by the Logan Club in the Russell House parlors.

Register of the Ottawa Meeting, 1905

The following Fellows were in attendance at the meeting:

F. D. Adams.
José G. Aguilera.
H. M. Ami.
Robert Bell.
R. W. Brock.
A. H. Brooks.
Samuel Calvin.
J. M. Clarke.
A. P. Coleman.
W. M. Davis.
S. F. Emmons.
H. L. Fairchild.
C. N. Gould.
C. W. Hayes.
J. F. Kemp.
H. B. Kümmel.
A. C. Lane.
C. K. Leith.
R. G. McConnell.
William McInnes.
G. P. Merrill.
W. G. Miller.
G. H. Perkins.
Raphael Pumpelly.
Heinrich Ries.
I. C. Russell.
W. H. Sherzer.
G. O. Smith.
R. S. Tarr.
J. B. Tyrrell.
T. L. Walker.
David White.
A. W. G. Wilson.
F. E. Wright.

Fellows-elect

R. A. Daly.
J. D. Irving.
A. P. Low.
F. A. Wilder.
G. A. Young.

Total attendance, 39.

Session of the Cordilleran Section, Friday, December 29, 1905

The seventh annual meeting of the Cordilleran Section of the Society was called to order at 10.30 a m, December 29, 1905, in South Hall, Berkeley.

The Chairman of the Section, President W. G. Tight, presided.

The minutes of the last meeting were read and approved.

The following officers were elected for the ensuing year: J. C. Branner, Chairman; George D. Louderback, Secretary, and W. C. Mendenhall, Councillor.

On the invitation of President Tight, it was resolved to hold the next meeting but one at Albuquerque, New Mexico, if arrangements could be made to that end by the Executive Committee.

The following papers were then read and discussed:

AFFINITIES AND STAGE OF EVOLUTION OF THE JOHN DAY CARNIVORA

BY JOHN C. MERRIAM

TEHACHAPI VALLEY

BY ANDREW C. LAWSON

[*Abstract*]

Tehachapi valley lies on the summit of the southern Sierra Nevada and drains to Mohave desert on the one side and to the San Joaquin valley on the other, in both cases through steep rocky gorges. The valley is about 12 miles long and at its widest part 5 miles or more wide. Its floor is a nearly flat surface of alluviation and the divide for the drainage is in the middle of this flat floor. The paper is a description of this valley and a discussion of its origin as a geomorphic feature. Other similar features in the same region are also discussed in the paper.

The paper was illustrated by lantern slides. It was published as Bulletin of the Department of Geology, University of California, volume 4, no. 19.

MIDDLE KERN RIVER

BY ANDREW C. LAWSON

Published as Bulletin of the Department of Geology, University of California, volume 4, no. 16.

The Section then adjourned for luncheon.

At 2 p m the session was resumed and the following papers were read:

IGNEOUS ROCKS OF THE NORTHWESTERN BLACK HILLS

BY W. S. TANGIER SMITH

[*Abstract*]

The igneous rocks of this region belong to two widely separated periods of time, the first pre-Cambrian, the second probably post-Cretaceous or Eocene. The Eocene (?) igneous rocks form an interesting group of closely related types, all of which have probably been derived by differentiation from a common, somewhat soda-rich magma. They constitute the laccolithic intrusions characteristic of this part of the Black hills, and appear also as associated minor masses.

Brief petrographic descriptions of the more important of these rocks, as well as their general relationships, are given in the paper.

CALCITE FROM TERLINGUA, TEXAS

BY A. S. EAKLE

Published in Bulletin of the Department of Geology, University of California, volume 5, no. 6.

ALTERATION OF SERPENTINE

BY A. KNOPF*

Published as Bulletin of the Department of Geology, University of California, volume 4, no. 18.

PLEISTOCENE PHENOMENA IN THE MISSISSIPPI BASIN; A WORKING HYPOTHESIS

BY W. G. TIGHT

[*Abstract*]

The present hypothesis proposes that prior to the earliest ice invasion of the Pleistocene the drainage of the upper Mississippi basin was to the northward. The early ice movements in occupying this basin were forced to advance against the general slope of the basin, and hence the ice-front advanced upon a rising plane. This produced frontal impounding of the drainage waters, with the development of extensive frontal lakes and accompanying sluggish action of the ice-front, poorly developed moraines, extra morainic drift, and sluggish movement of the gravel trains from the margin of the ice. A new outlet to the basin was developed along the line of the middle Mississippi section, which became well established as the upper Mississippi drainage developed, with the early recession of the ice. Later ice invasions into the basin followed the established gradients, developed into extensive lobate forms, produced only local and minor frontal lake phenomena, almost no extra-morainic drift, show strong morainic development and vigorous action of streams discharging from the ice-front.

The Section then adjourned till next morning.

SESSION OF THE CORDILLERAN SECTION, SATURDAY, DECEMBER 30

The Section was called to order at 10 a m, President W. G. Tight in the chair.

The following papers were read and discussed:

CRECENTIC GOUGES ON GLACIATED SURFACES

BY G. K. GILBERT

Printed as pages 303-316 of this volume.

MOULIN WORK UNDER GLACIERS

BY G. K. GILBERT

Printed as pages 317-320 of this volume.

* Introduced by Andrew C. Lawson.

EXPLORATION OF THE FAMWEL CAVE

BY E. L. FURLONG*

Published in the American Journal of Science, xxii, 235-247 (1906).

EXCEPTIONAL NATURE AND GENESIS OF THE MISSISSIPPI DELTA

BY E. W. HILGARD

[*Abstract*]

This paper discusses the wholly exceptional materials and form of the lower delta of the Mississippi river, as observed by the writer in 1867 and 1869, and described and discussed in the American Journal of Science in 1871. Following out the suggestions of Lyell and the disputed statement of Humphreys and Abbott that the alluvial deposits of the great river are only of slight depth, the writer investigated the extreme mouths of the passes, the "neck," and the similar minor, birdfoot-like arms projecting beyond. It became apparent that the silty river deposit on these narrow dikes or banks is only superficial, and that their resistance to erosion during overflows is due to their being mainly composed of tough, inerodable "mudlump clay." That these mudlumps, observed and described by Lyell, are upheavals of the river bottom, and are formed of such clay as is deposited *outside* of the bar, where the turbid water of the river meets and is clarified by the saline sea water; also, that the mudlump upheavals occur in the *main* outlets or passes of the river, as a direct result of their being the main outlets. No mudlumps then existed in the South pass, but now that it has been artificially made the main channel, *mudlump* upheaval has taken and is taking place. Mudlump formation is thus the normal mode of progression of the delta of the main Mississippi.

No such phenomena are known to occur in any other river of the world; hence no other river has such birdfoot mouths. The Mississippi delta should not, therefore, be longer presented as the type of a normal delta, as is done by Russell in his "Rivers of North America."

The Section then adjourned for luncheon.

At 2 p m the session was resumed and the following papers were read:

INTERREGIONAL ZONES IN THE TRIASSIC OF WESTERN NORTH AMERICA

BY J. P. SMITH *

A NEW AMPHIBOLE

BY W. O. CALRK†

NOTES ON PALEOZOIC CHERTS FROM MISSOURI

BY F. B. LANEY‡

* Introduced by John C. Merriam.
† Introduced by A. S. Eakle.
‡ Introduced by Andrew C. Lawson.

GEOLOGICAL RECONNAISSANCE OF THE COAST OF THE OLYMPIC PENINSULA, WASHINGTON

BY RALPH ARNOLD

Printed as pages 451-468 of this volume.

GRAVITATIONAL ASSEMBLAGE IN GRANITE

BY G. K. GILBERT

Printed as pages 321-328 of this volume.

The Section passed a resolution of thanks to the University of California for having placed the rooms of South Hall at the disposal of the Society for the purposes of the meeting.

The Section then adjourned.

ANDREW C. LAWSON,
Secretary.

REGISTER OF THE MEETING OF THE CORDILLERAN SECTION

The following Fellows were in attendance at the meeting:

F. M. ANDERSON.
R. ARNOLD.
A. S. EAKLE.
G. K. GILBERT.
E. W. HILGARD.
A. C. LAWSON.
G. D. LOUDERBACK.
R. H. LOUGHRIDGE.
W. C. MENDENHALL.
J. C. MERRIAM.
W. S. TANGIER SMITH.
W. G. TIGHT.

The visitors were:

E. P. CAREY.
E. L. FURLONG.
R. S. HOLWAY.
A. KNOPF.
F. B. LANEY.
D. T. SMITH.
J. P. SMITH.
C. E. WEAVER.
H. O. WOOD.

ACCESSIONS TO LIBRARY FROM JULY, 1905, TO OCTOBER, 1906

By H. P. Cushing, *Librarian*

Contents

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2768. Verhandlungen, zweite serie, band xlii, lief. 1–2.
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GEOLOGISKA FÖRENINGENS, STOCKHOLM

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2806. Jahrbuch, band lv, 1906.
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(c) *ASIA*

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2319. Sadowara, Murotozaki, and Toba geologic sheets, with text.
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(d) *AUSTRALASIA*

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2788. New Brunswick, South Alberta, South Saskatchewan, Alberta, Saskatchewan, and Alienated Lands, map sheets.
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(*a*) *AMERICA*

BROOKLYN INSTITUTE OF ARTS AND SCIENCES, BROOKLYN

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(*b*) *EUROPE*

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DANSK GEOLOGISK FORENING, COPENHAGEN

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NATURFORSCHER VEREINS ZU RIGA, RIGA

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(*c*) *ASIA*

TOKYO GEOGRAPHICAL SOCIETY, TOKYO

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IMPERIAL UNIVERSITY OF TOKYO, TOKYO

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WHITMAN CROSS

2957. A New Devonian Formation in Colorado.
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2959. The Development of Systematic Petrography in the Nineteenth Century.
2960. An Occurrence of Trachyte on the Island of Hawaii.
2961. Geology of the Rico Mountains, Colorado.
2962. Geology of Silver Cliff and the Rosita Hills, Colorado.

E. V. D'INVILLIERS

2963. Geological Map of Portion of the New River and Kanawha Coal Fields.

H. L. FAIRCHILD

2964. Ice Erosion Theory a Fallacy.

C. H. HITCHCOCK

2965. The Geology of Littleton, New Hampshire.
2966. Fresh-water Springs in the Ocean.

E. O. HOVEY

2967. The Grande Soufriere of Guadeloupe.

J. H. PRATT

2968. The Production of Graphite in 1904, and twelve other and similar separates.

C. D. WALCOTT

2969. New Term for the Upper Cambrian Series.
2970. The Cambrian Fauna of India.
2971. Cambrian Faunas of China.

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A. GIBB MAITLAND, PERTH

2972. The Salient Geological Features of British New Guinea.

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R. J. LECHMERE GUPPY, PORT OF SPAIN

2974. The Growth of Trinidad.

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ATREUS WANNER

2978. A new Species of Olenellus from the Lower Cambrian of York County, Pennsylvania.

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2837. U. S. G. G. Survey R. M. R., Geology of the Henry Mts.

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CLEVELAND ABBE, JR., Ph. D., Mount Weather, Va. August, 1899.

FRANK DAWSON ADAMS, Ph. D., Montreal, Canada; Professor of Geology in McGill University. December, 1889.

GEORGE I. ADAMS, Sc. D., Corps of Mining Engineers, Lima, Peru. December, 1902.

JOSÉ GUADALUPE AGUILERA, Director del Instituto Geologico de Mexico, City of Mexico, Mexico. August, 1896.

TRUMAN H. ALDRICH, M. E., 1739 P St. N. W., Washington, D. C. May, 1889.

HENRY M. AMI, A. M., Geological Survey Office, Ottawa, Canada; Assistant Paleontologist on Geological and Natural History Survey of Canada. December, 1889.

FRANK M. ANDERSON, B. A., M. S., 2604 Ætna Street, Berkeley, Cal. In California State Mining Bureau. June, 1902.

PHILIP ARGALL, 728 Majestic Building, Denver, Colo.; Mining Engineer. August, 1896.

RALPH ARNOLD, Ph. D., Washington, D. C.; Geologic Aid U. S. Geological Survey. December, 1904.

GEORGE HALL ASHLEY, M. E., Ph. D., Washington, D. C., U. S. Geological Survey. August, 1895.

HARRY FOSTER BAIN, M. S., Champaign, Ill., State Geological Survey. December, 1895.

RUFUS MATHER BAGG, JR., Ph. D., West Springfield, Mass.; Mining Geologist. December, 1896.

S. PRENTISS BALDWIN, 736 Prospect St., Cleveland, Ohio. August, 1895.

SYDNEY H. BALL, A. B., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1905.

ERWIN HINCKLEY BARBOUR, Ph. D., Lincoln, Neb.; Professor of Geology, University of Nebraska, and Acting State Geologist. December, 1896.

JOSEPH BARRELL, Ph. D., New Haven, Conn.; Asistant Professor of Geology, Yale University. December, 1902.

GEORGE H. BARTON, B. S., Boston, Mass.; Curator, Boston Society of Natural History. August, 1890.

FLORENCE BASCOM, Ph. D., Bryn Mawr, Pa.; Professor of Geology, Bryn Mawr College. August, 1894.

WILLIAM S. BAYLEY, Ph. D., Urbana, Ill.; Assistant Professor of Geology, University of Illinois. December, 1888.

*GEORGE F. BECKER, Ph. D., Washington, D. C., U. S. Geological Survey.

JOSHUA W. BEEDE, Ph. D., Bloomington, Ind.; Instructor in Geology, Indiana University. December, 1902.

ROBERT BELL, C. E., M. D., LL. D., Ottawa, Canada; Acting Director of the Geological and Natural History Survey of Canada. May, 1889.

CHARLES P. BERKEY, Ph. D., New York city; Columbia University. August, 1901.

SAMUEL WALKER BEYER, Ph. D., Ames, Iowa; Assistant Professor in Geology, Iowa Agricultural College. December, 1896.

ARTHUR BIBBINS, Ph. B., Baltimore, Md.; Instructor in Geology, Woman's College. December, 1903.

ALBERT S. BICKMORE, Ph. D., American Museum of Natural History, New York; Professor in charge of Department of Public Instruction. December, 1889.

Irving P. Bishop, 109 Norwood Ave., Buffalo, N. Y.; Professor of Natural Science, State Normal and Training School. December, 1899.

John M. Boutwell, M. S., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1905.

John Adams Bownocker, D. Sc., Columbus, Ohio.; Professor of Inorganic Geology, Ohio State University. December, 1904.

*John C. Branner, Ph. D., Stanford University, Cal.; Professor of Geology in Leland Stanford, Jr., University.

Albert Perry Brigham, A. B., A. M., Hamilton, N. Y.; Professor of Geology and Natural History, Colgate University. December, 1893.

Reginald W. Brock, M. A., Ottawa, Canada, Geologist, Geological and Natural History Survey of Canada; Professor of Geology, School of Mining, Kingston. December, 1904.

Alfred Hulse Brooks, B. S., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. August, 1899.

Amos P. Brown, Ph. D., Philadelphia, Pa.; Professor of Mineralogy and Geology, University of Pennsylvania. December, 1905.

Ernest Robertson Buckley, Ph. D., Rolla, Mo.; State Geologist and Director of Bureau of Geology and Mines. June, 1902.

*Samuel Calvin, Iowa City, Iowa; Professor of Geology and Zoology in the State University of Iowa.

Henry Donald Campbell, Ph. D., Lexington, Va.; Professor of Geology and Biology in Washington and Lee University. May, 1889.

Marius R. Campbell, U. S. Geological Survey, Washington, D. C. August, 1892.

Franklin R. Carpenter, Ph. D., 1420 Josephine St., Denver, Colo.; Mining Engineer. May, 1889.

Ermine C. Case, Ph. D., Milwaukee, Wis.; Instructor in State Normal School. December, 1901.

*T. C. Chamberlin, LL. D., Chicago, Ill.; Head Professor of Geology, University of Chicago.

Clarence Raymond Claghorn, B. S., M. E., Tacoma, Wash. August, 1891.

Frederick G. Clapp, S. B., Washington, D. C.; Geologic Aid, U. S. Geological Survey. December, 1905.

*William Bullock Clark, Ph. D., Baltimore, Md.; Professor of Geology in Johns Hopkins University; State Geologist.

John Mason Clarke, A. M., Albany, N. Y.; State Paleontologist. December, 1897.

Herdman F. Cleland, Ph. D., Williamstown, Mass.; Professor of Geology, Williams College. December, 1905.

J. Morgan Clements, Ph. D., 15 William St., New York city. December, 1894.

Collier Cobb, A. B., A. M., Chapel Hill, N. C.; Professor of Geology in University of North Carolina. December, 1894.

Arthur P. Coleman, Ph. D., Toronto, Canada; Professor of Geology, Toronto University, and Geologist of Bureau of Mines of Ontario. December, 1896.

George L. Collie, Ph. D., Beloit, Wis.; Professor of Geology in Beloit College. December, 1897.

Arthur J. Collier, A. M., S. B., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. June, 1902.

*Theodore B. Comstock, Sc. D., Los Angeles, Cal.; Mining Engineer.

*Francis W. Cragin, Ph. D., Colorado Springs, Colo.; Professor of Geology in Colorado College.

Alja Robinson Crook, Ph. D., Springfield, Ill.; State Museum of Natural History. December, 1898.

*William O. Crosby, B. S., Boston Society of Natural History, Boston, Mass.; Assistant Professor of Mineralogy and Lithology in Massachusetts Institute of Technology.

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REGINALD A. DALY, Ph. D., Ottawa, Canada; Geologist for Canada on International Boundary Commission. December, 1905.

*NELSON H. DARTON, United States Geological Survey, Washington, D. C.

*WILLIAM M. DAVIS, S. B., M. E., Cambridge, Mass.; Sturgis-Hooper Professor of Geology in Harvard University.

DAVID T. DAY, Ph. D., U. S. Geol. Survey, Washington, D. C. August, 1891.

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NOAH FIELDS DRAKE, Ph. D., Tientsin, China; Professor of Geology in Imperial Tientsin University. December, 1898.

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*EDWIN T. DUMBLE, 1306 Main St., Houston, Texas.

ARTHUR S. EAKLE, Ph. D., Berkeley, Cal.; Instructor in Mineralogy, University of California. December, 1899.

CHARLES R. EASTMAN, A. M., Ph. D., Cambridge, Mass.; In Charge of Vetebrate Paleontology, Museum of Comparative Zoology, Harvard University. December, 1895.

EDWIN C. ECKEL, B. S., C. E., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1905.

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*BENJAMIN K. EMERSON, Ph. D., Amherst, Mass.; Professor in Amherst College.

*SAMUEL F. EMMONS, A. M., E. M., U. S. Geological Survey, Washington, D. C.

JOHN EYERMAN, F. Z. S., Oakhurst, Easton, Pa. August, 1891.

HAROLD W. FAIRBANKS, B. S., Berkeley, Cal.; Geologist State Mining Bureau. August, 1892.

*HERMAN L. FAIRCHILD, B. S., Rochester, N. Y.; Professor of Geology in University of Rochester.

J. C. FALES, Danville, Ky.; Professor in Centre College. December, 1888.

OLIVER C. FARRINGTON, Ph. D., Chicago, Ill.; In charge of Department of Geology, Field Columbian Museum. December, 1895.

NEVIN M. FENNEMAN, Ph. D., Madison, Wis.; Professor of Geology, University of Wisconsin. December, 1904.

AUGUST F. FOERSTE, Ph. D., 417 Grand Ave., Dayton, Ohio; Teacher of Sciences. December, 1899.

WILLIAM M. FONTAINE, A. M., University of Virginia, Va.; Professor of Natural History and Geology in University of Virginia. December, 1888.

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*HOMER T. FULLER, Ph. D., Fredonia, N. Y.

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Henry Stewart Gane, Ph. D., Santa Barbara, Cal. December, 1896.

Henry Gannett, S. B., A. Met. B., U. S. Geological Survey, Washington, D. C. December, 1891.

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Adam Capen Gill, Ph. D., Ithaca, N. Y.; Assistant Professor of Mineralogy and Petrography in Cornell University. December, 1888.

L. C. Glenn, Ph. D., Nashville, Tenn.; Professor of Geology in Vanderbilt University. June, 1900.

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Charles Newton Gould, A. M., Norman, Okla.; Professor of Geology, University of Oklahoma. December, 1904.

Amadeus W. Grabau, S. M., S. D., Columbia University, New York city; Professor of Paleontology. December, 1898.

Ulysses Sherman Grant, Ph. D., Evanston, Ill.; Professor of Geology, Northwestern University. December, 1890.

Herbert E. Gregory, Ph. D., New Haven, Conn.; Assitant Professor of Physiography, Yale University. August, 1901.

George P. Grimsley, Ph. D., Morgantown, W. Va.; Assistant State Geologist, Geological Survey of West Virginia. August, 1895.

Leon S. Griswold, A. B., Rolla, Missouri. August, 1902.

Frederic P. Gulliver, Ph. D., Norwichtown, Conn. August, 1895.

Arnold Hague, Ph. B., U. S. Geological Survey, Washington, D. C. May, 1889.

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Gilbert D. Harris, Ph. B., Ithaca, N. Y.; Assistant Professor of Paleontology and Stratigraphic Geology, Cornell University. December, 1903.

John Burchmore Harrison, M. A., F. I. C., F. G. S., Georgetown, British Guiana; Government Geologist. June, 1902.

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*Erasmus Haworth, Ph. D., Lawrence, Kans.; Professor of Geology, University of Kansas.

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*Angelo Heilprin, Academy of Natural Sciences, Philadelphia, Pa.; Professor of Paleontology in the Academy of Natural Sciences.

Richard R. Hice, B. S., Beaver, Pa. December, 1903.

*Eugene W. Hilgard, Ph. D., LL. D.; Berkeley, Cal.; Professor of Agriculture in University of California.

Frank A. Hill, Roanoke, Va. May, 1889.

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Arthur Hollick, Ph. B., N. Y. Botanical Garden, Bronx Park, New York; Instructor in Geology, Columbia University. August, 1893.

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Thomas C. Hopkins, Ph. D., Syracuse, N. Y.; Professor of Geology, Syracuse University. December, 1894.

*EDMUND OTIS HOVEY, Ph. D., American Museum of Natural History, New York city; Associate Curator of Geology.

*HORACE C. HOVEY, D. D., Newburyport, Mass.

ERNEST HOWE, Ph. D., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1903.

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LUCIUS L. HUBBARD, Ph. D., LL. D., Houghton, Mich. December, 1894.

JOSEPH P. IDDINGS, Ph. B., Professor of Petrographic Geology, University of Chicago, Chicago, Ill. May, 1889.

JOHN D. IRVING, Ph. D., South Bethlehem, Pa.; Professor of Geology, Lehigh University. December, 1905.

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ROBERT T. JACKSON, S. D., 9 Fayerweather St., Cambridge, Mass.; Assistant Professor in Paleontology in Harvard University. August, 1894.

THOMAS M. JACKSON, C. E., S. D., Clarksburg, W. Va. May, 1889.

MARK S. W. JEFFERSON, A. M., Ypsilanti, Mich.; Professor of Geography, Michigan State Normal School. December, 1904.

ALEXIS A. JULIEN, Ph. D., Columbia College, New York city; Instructor in Columbia College. May, 1889.

ARTHUR KEITH, A. M., U. S. Geological Survey, Washington, D. C. May, 1889.

*JAMES F. KEMP, A. B., E. M., Columbia University, New York city; Professor of Geology.

CHARLES ROLLIN KEYES, Ph. D., Socorro, N. Mex. August, 1890.

EDWARD M. KINDLE, Ph. D., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1905.

FRANK H. KNOWLTON, M. S., Washington, D. C.; Assistant Paleontologist, U. S. Geological Survey. May, 1889.

EDWARD HENRY KRAUS, Ph. D., Ann Arbor, Mich.; Junior Professor of Mineralogy, University of Michigan. June, 1902.

HENRY B. KUMMEL, Ph. D., Trenton, N. J.; State Geologist. December, 1895.

*GEORGE F. KUNZ, A. M. (Hon.), Ph. D. (Hon.), care of Tiffany & Co., 15 Union Square, New York city.

GEORGE EDGAR LADD, Ph. D., Rolla, Mo.; Director School of Mines. August, 1891.

J. C. K. LAFLAMME, M. A., D. D., Quebec, Canada; Professor of Mineralogy and Geology in University Laval, Quebec. August, 1890.

ALFRED C. LANE, Ph. D., Lansing, Mich.; State Geologist of Michigan. December, 1889.

DANIEL W. LANGTON, Ph. D., Fuller Building, New York city; Mining Engineer. December, 1889.

ANDREW C. LAWSON, Ph. D., Berkeley, Cal.; Professor of Geology and Mineralogy in the University of California. May, 1889.

WILLIS THOMAS LEE, M. S., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1903.

CHARLES K. LEITH, Ph. D., Madison, Wis.; Professor of Geology, University of Wisconsin; Assistant Geologist, U. S. Geological Survey. December, 1902.

ARTHUR G. LEONARD, Ph. D., Grand Forks, N. Dak.; Professor of Geology and State Geologist, State University of North Dakota. December, 1901.

FRANK LEVERETT, B. S., Ann Arbor, Mich.; Geologist, U. S. Geological Survey. August, 1890.

WILLIAM LIBBEY, Sc. D., Princeton, N. J.; Professor of Physical Geography in Princeton University. August, 1899.

WALDEMAR LINDGREN, M. E., U. S. Geological Survey, Washington, D. C. August, 1890.

George Davis Louderback, Ph. D., California, Berkeley, Cal. June, 1902.

Robert H. Loughridge, Ph. D., Berkeley, Cal.; Assistant Professor of Agricultural Chemistry in University of California. May, 1889.

Albert P. Low, B. S., Ottawa, Canada; Geologist, Geological Survey of Canada. December, 1905.

Thomas H. Macbride, A. M., Iowa City, Iowa; Professor of Botany in the State University of Iowa. May, 1889.

Hiram Deyer McCaskey, B. S., South Bethlehem, Pa. December, 1904.

Richard G. McConnell, A. B., Geological Survey Office, Ottawa, Canada; Geologist on Geological and Natural History Survey of Canada. May, 1889.

James Rieman Macfarlane, A. B., 100 Diamond St., Pittsburg, Pa. August 1891.

*W J McGee, LL. D., Director Public Museum, Saint Louis, Mo.

William McInnes, A. B., Geological Survey Office, Ottawa, Canada; Geologist, Geological and Natural History Survey of Canada. May, 1889.

Peter McKellar, Fort William, Ontario, Canada. August, 1890.

Curtis F. Marbut, A. M., State University, Columbia, Mo.; Instructor in Geology and Assistant on Missouri Geological Survey. August, 1897.

Vernon F. Marsters, A. M., Bloomington, Ind.; Professor of Geology in Indiana State University. August, 1892.

George Curtis Martin, Ph. D., Washington, D. C.; U. S. Geological Survey. June, 1902.

Edward B. Mathews, Ph. D., Baltimore, Md.; Instructor in Petrography in Johns Hopkins University. August, 1895.

William D. Matthew, Ph. D., New York City; Associate Curator in Vertebrate Paleontology, American Museum of Natural History. December, 1903.

P. H. Mell, M. E., Ph. D., Clemson College, S. C.; President of Clemson College. December, 1888.

Warren C. Mendenhall, B. S., 1108 Braly Building, Los Angeles, Cal.; Geologist U. S. Geological Survey. June, 1902.

John C. Merriam, Ph. D., Berkeley, Cal.; Instructor in Paleontology in University of California. August, 1895.

*Frederick J. H. Merrill, Ph. D., New Rochelle, N. Y.; Consulting Geologist.

George P. Merrill, M. S., U. S. National Museum, Washington, D. C.; Curator of Department of Lithology and Physical Geology. December, 1888.

Arthur M. Miller, A. M., Lexington, Ky.; Professor of Geology, State University of Kentucky. December, 1897.

Benjamin L. Miller, Ph. D., Bryn Mawr, Pa.; Associate in Geology, Bryn Mawr College. December, 1904.

Willet G. Miller, M. A., Toronto, Canada; Provincial Geologist of Ontario. December, 1902.

Henry Montgomery, Ph. D., Toronto, Canada; Curator of Museum University of Toronto. December, 1904.

*Frank L. Nason, A. B., West Haven, Conn.

John F. Newsom, Ph. D., Stanford University, Cal.; Associate Professor of Mining. December, 1899.

William H. Niles, Ph. B., M. A., Boston, Mass.; Professor, Emeritus, of Geology, Massachusetts Institute of Technology; Professor of Geology, Wellesley College. August, 1891.

William H. Norton, M. A., Mount Vernon, Iowa; Professor of Geology in Cornell College. December, 1895.

Charles J. Norwood, Lexington, Ky.; Professor of Mining, State College of Kentucky. August, 1894.

Cleophas C. O'Harra, Ph. D., Rapid City, S. Dak.; Professor of Mineralogy and Geology, South Dakota School of Mines. December, 1904.

EZEQUIEL ORDONEZ, Esquela N. de Ingeneiros, City of Mexico, Mexico; Geologist del Instituto Geologico de Mexico. August, 1896.

*AMOS O. OSBORN, Waterville, Oneida county, N. Y.

HENRY F. OSBORN, Sc. D., Columbia University, New York city; Professor of Zoology, Columbia University. August, 1894.

CHARLES PALACHE, B. S., University Museum, Cambridge, Mass.; Instructor in Mineralogy, Harvard University. August, 1897.

*HORACE B. PATTON, Ph. D., Golden, Colo.; Professor of Geology and Mineralogy in Colorado School of Mines.

FREDERICK B. PECK, Ph. D., Easton, Pa.; Professor of Geology and Mineralogy, Lafayette College. August, 1901.

RICHARD A. F. PENROSE, JR., Ph. D., 1331 Spruce St., Philadelphia, Pa. May, 1889.

GEORGE H. PERKINS, Ph. D., Burlington, Vt.; State Geologist. Professor of Geology, University of Vermont. June, 1902.

JOSEPH H. PERRY, 276 Highland St., Worcester, Mass. December, 1888.

LOUIS V. PIRSSON, Ph. D., New Haven, Conn.; Professor of Physical Geology, Sheffield Scientific School of Yale University. August, 1894.

*JULIUS POHLMAN, M. D., University of Buffalo, Buffalo, N. Y.

JOHN BONSALL PORTER, E. M., Ph. D., Montreal, Canada; Professor of Mining, McGill University. December, 1896.

JOSEPH HYDE PRATT, Ph. D., Chapel Hill, N. C.; Mineralogist, North Carolina Geological Survey. December, 1898.

*CHARLES S. PROSSER, M. S., Columbus, Ohio; Professor of Geology in Ohio State University.

*RAPHAEL PUMPELLY, U. S. Geological Survey, Dublin, N. H.

ALBERT HOMER PURDUE, B. A., Fayetteville, Ark.; Professor of Geology, University of Arkansas. December, 1904.

FREDERICK LESLIE RANSOME, Ph. D., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. August, 1895.

HARRY FIELDING REID, Ph. D., Johns Hopkins University, Baltimore, Md. December, 1892.

WILLIAM NORTH RICE, Ph. D., LL. D., Middletown, Conn.; Professor of Geology in Wesleyan University. August, 1890.

CHARLES H. RICHARDSON, Ph. D., Syracuse, N. Y.; Assistant Professor of Geology and Mineralogy, Syracuse University. December, 1899.

HEINRICH RIES, Ph. D., Cornell University, Ithaca, N. Y.; Assistant Professor in Economic Geology. December, 1893.

RUDOLPH RUEDEMANN, Ph. D., Albany, N. Y.; Assistant State Paleontologist. December, 1905.

*JAMES M. SAFFORD, M. D., LL. D., Dallas, Texas.

ORESTES H. ST. JOHN, Raton, N. Mex. May, 1889.

*ROLLIN D. SALISBURY, A. M., Chicago, Ill.; Professor of General and Geographic Geology in University of Chicago.

FREDERICK W. SARDESON, Ph. D., Instructor in Paleontology, University of Minnesota, Minneapolis, Minn. December, 1892.

FRANK C. SCHRADER, M. S., A. M., U. S. Geological Survey, Washington, D. C. August, 1901.

CHARLES SCHUCHERT, New Haven, Conn.; Curator, Geological Department. Yale University. August, 1895.

WILLIAM B. SCOTT, Ph. D., 56 Bayard Ave., Princeton, N. J.; Blair Professor of Geology in College of New Jersey. August, 1892.

ARTHUR EDMUND SEAMAN, B. S., Houghton, Mich.; Professor of Mineralogy and Geology, Michigan College of Mines. December, 1904.

Henry M. Seely, M. D., Middlebury, Vt.; Professor of Geology in Middlebury College. May, 1899.

Elias H. Sellards, Ph. D., Gainesville, Fla.; Professor of Geology, etc., in University of Florida. December, 1905.

George Burbank Shattuck, Ph. D., Poughkeepsie, N. Y.; Professor of Geology in Vassar College. August, 1899.

Solon Shedd, A. B., Pullman, Wash.; Professor of Geology and Mineralogy, Washington Agricultural College. December, 1904.

Edward M. Shepard, Sc. D., Springfield, Mo.; Professor of Geology, Drury College. August, 1901.

Will H. Sherzer, M. S., Ysilanti, Mich.; Professor in State Normal School. December, 1890.

Bohumil Shimek, C. E., M. S., Iowa City, Iowa; Professor of Physiological Botany, University of Iowa. December, 1904.

*Frederick W. Simonds, Ph. D., Austin, Texas; Professor of Geology in University of Texas.

*Eugene A. Smith, Ph. D., University, Tuscaloosa county, Ala.; State Geologist and Professor of Chemistry and Geology in University of Alabama.

Frank Clemes Smith, E. M., Richland Center, Wis.; Mining Engineer. December, 1898.

George Otis Smith, Ph. D., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. August, 1897.

William S. T. Smith, Ph. D., 749 N. Lake St., Reno, Nev.; Associate Professor of Geology and Mineralogy, University of Nevada. June, 1902.

*John C. Smock, Ph. D., Trenton, N. J.; State Geologist.

Charles H. Smyth, Jr., Ph. D., Clinton, N. Y.; Professor of Geology in Hamilton College. August, 1892.

Henry L. Smyth, A. B., Cambridge, Mass.; Professor of Mining and Metallurgy in Harvard University. August, 1894.

Arthur Coe Spencer, B. S., Ph. D., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1896.

*J. W. Spencer, Ph. D., 2019 Hillyer Place, Washington, D. C.

Josiah E. Spurr, A. B., A. M., U. S. Geological Survey, Washington, D. C. December, 1894.

Joseph Stanley-Brown, Cold Spring Harbor, Long Island, N. Y. August, 1892.

Timothy William Stanton, B. S., U. S. National Museum, Washington, D. C.; Assistant Paleontologist, U. S. Geological Survey. August, 1891.

*John J. Stevenson, Ph. D., LL. D., New York University; Professor of Geology in the New York University.

William J. Sutton, B. S., E. M., Victoria, B. C.; Geologist to E. and N. Railway [illegible] August, 1901.

Joseph A. Taff[illegible] S., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. August, 1895.

James E. Talmage, Ph. D., Salt Lake City, Utah; Professor of Geology in University of Utah. December, 1897.

Ralph S. Tarr, Cornell University, Ithaca, N. Y.; Professor of Dynamic Geology and Physical Geography. August, 1890.

Frank B. Taylor, Fort Wayne, Ind. December, 1895.

William G. Tight, M. S., Albuquerque, N. Mex.; President and Professor of Geology, University of New Mexico. August, 1897.

*James E. Todd, A. M., Vermilion, S. Dak.; Assistant Geologist, U. S. Geological Survey

*Henry W. Turner, B. S., 508 California St., San Francisco, Cal.

JOSEPH B. TYRRELL, M. A., B. Sc., 87 Binscarth Road, Toronto, Canada. May, 1889.

JOHAN A. UDDEN, A. M., Rock Island, Ill.; Professor of Geology and Natural History in Augustana College. August, 1897.

EDWARD O. ULRICH, D. Sc., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1903.

*WARREN UPHAM, A. M., Librarian Minnesota Historical Society, Saint Paul, Minn.

*CHARLES R. VAN HISE, M. S., Ph. D., Madison, Wis.; President University of Wisconsin; Geologist, U. S. Geological Survey.

FRANK ROBERTSON VAN HORN, Ph. D., Cleveland, Ohio; Professor of Geology and Mineralogy, Case School of Applied Science. December, 1898.

GILBERT VANINGEN, Princeton, N. J.; Curator of Invertebrate Paleontology and Assistant in Geology, Princeton University. December, 1904.

THOMAS WAYLAND VAUGHN, B. S., A. M., Washington, D. C.; Assistant Geologist, U. S. Geological Survey. August, 1896.

*ANTHONY W. VODGES, San Diego, Cal.; Captain Fifth Artillery, U. S. Army.

*MARSHMAN E. WADSWORTH, Ph. D., State College, Pa.; Professor of Mining and Geology, Pennsylvania State College.

*CHARLES D. WALCOTT, LL. D., Washington, D. C.; Secretary Smithsonian Institution.

THOMAS L. WALKER, Ph. D., Toronto, Canada; Professor of Mineralogy and Petrograhpy, University of Toronto. December, 1903.

CHARLES H. WARREN, Ph. D., Boston, Mass.; Instructor in Geology, Massachusetts Institute of Technology. December, 1901.

HENRY STEPHENS WASHINGTON, Ph. D., Locust, Monmouth Co., N. J.; August, 1896.

THOMAS L. WATSON, Ph. D., Blacksburg, Va.; Professor of Geology in Virginia Polytechnic Institute. June, 1900.

WALTER H. WEED, M. E., U. S. Geological Survey, Washington, D. C. May, 1889.

FRED. BOUGHTON WEEKS, Washington, D. C.; Assistant Geologist, U. S. Geological Survey. December, 1903.

SAMUEL WEIDMAN. Ph. D., Madison, Wis.; Geologist, Wisconsin Geological and Natural History Survey. December, 1903.

STUART WELLER, B. S., Chicago, Ill.; Instructor in University of Chicago. June, 1900.

LEWIS G. WESTGATE, Ph. D., Delaware, Ohio; Professor of Geology, Ohio Wesleyan University.

THOMAS C. WESTON, 591 Saint John St., Quebec, Canada. August, 1893.

DAVID WHITE, B. S., U. S. National Museum, Washington, D. C.; Assistant Paleontologist, U. S. Geological Survey, Washington, D. C. May, 1889.

*ISRAEL C. WHITE, Ph. B., Morgantown, W. Va.

*ROBERT P. WHITFIELD, Ph. D., American Museum of Natural History, 78th St. and Eighth Ave., New York city; Curator of Geology and Paleontology.

FRANK A. WILDER, Ph. D., Iowa City, Iowa; Professor of Economic Geology, University of Iowa; State Geologist. December, 1905.

*EDWARD H. WILLIAMS, JR., A. C., E. M., Andover, Mass.

*HENRY S. WILLIAMS, Ph. D., Ithaca, N. Y.; Professor of Geology and Head of Geological Department, Cornell University.

IRA A. WILLIAMS, M. Sc., Ames, Iowa; Teacher Iowa State College. December, 1905.

BAILEY WILLIS, U. S. Geological Survey, Washington, D. C. December, 1889.

SAMUEL W. WILLISTON, Ph. D., M. D., Chicago, Ill.; Professor of Paleontology, University of Chicago. December, 1889.

ARTHUR B. WILLMOTT, M. A., Sault Ste. Marie, Ontario, Canada. December, 1899.

ALFRED W. G. WILSON, Ph. D., 197 Park ave., Montreal, Ont., Canada; Mining Geologist. June, 1902.

ALEXANDER N. WINCHELL, Doct. U. Paris, Butte, Mont.; Professor of Geology and Mineralogy, Montana State School of Mines. August, 1901.

*HORACE VAUGHN WINCHELL, St. Paul, Minn.; Geologist for the Great Northern Railway Company.

*NEWTON H. WINCHELL, A. M., Minneapolis, Minn.; editor *American Geologist.*

*ARTHUR WINSLOW, B. S., 84 State St., Boston, Mass.

JOHN E. WOLFF, Ph. D., Harvard University, Cambridge, Mass.; Professor of Petrography and Mineralogy in Harvard University and Curator of the Mineralogical Museum. December, 1889.

JOSEPH E. WOODMAN, S. D., Halifax, N. S.; Assistant Professor of Geology and Mineralogy, Dalhousie University. December, 1905.

ROBERT S. WOODWARD, C. E., Washington, D. C.; President of the Carnegie Institution of Washington. May, 1889.

JAY B. WOODWORTH, B. S., 24 Langdon St., Cambridge, Mass.; Assistant Professor of Geology, Harvard University. December, 1895.

FREDERIC E. WRIGHT, Ph. D., U. S. Geological Survey, Washington, D. C. December, 1903.

*G. FREDERICK WRIGHT, D. D., Oberlin, Ohio; Professor in Oberlin Theological Seminary

WILLIAM S. YEATES, A. B., A. M., Atlanta, Ga.; State Geologist of Georgia. August, 1894

GEORGE A. YOUNG, Ph. D., Ottawa, Canada; Geologist, Geological Survey of Canada. December, 1905.

FELLOWS DECEASED.

*Indicates Original Fellow (see article III of Constitution)

*CHARLES A. ASHBURNER, M. S., C. E. Died December 24, 1889.

CHARLES E. BEECHER, Ph. D. Died February 14, 1904.

AMOS BOWMAN. Died June 18, 1894.

*J. H. CHAPIN, Ph. D. Died March 14, 1892.

*EDWARD W. CLAYPOLE, D. Sc. Died August 17, 1901.

GEORGE H. COOK, Ph. D., LL. D. Died September 22, 1889.

*EDWARD D. COPE, Ph. D. Died April 12, 1897.

ANTONIO DEL CASTILLO. Died October 28, 1895.

*JAMES D. DANA, LL. D. Died April 14, 1895.

GEORGE M. DAWSON, D. Sc. Died March 2, 1901.

Sir J. WILLIAM DAWSON, LL. D. Died November 19, 1899.

*WILLIAM B. DWIGHT, Ph. B. Died August 29, 1906.

*GEORGE H. ELDRIDGE, A. B. Died June 29, 1905.

*ALBERT E. FOOTE. Died October 10, 1895.

N. J. GIROUX, C. E. Died November 30, 1890.

*JAMES HALL, LL. D. Died August 7, 1898.

JOHN B. HATCHER, Ph. B. Died July 3, 1904.

*ROBERT HAY. Died December 14, 1895.

DAVID HONEYMAN, D. C. L. Died October 17, 1889.

THOMAS STERRY HUNT, D. Sc., LL. D. Died February 12, 1892.
*ALPHEUS HYATT, B. S. Died January 15, 1902.
*JOSEPH F. JAMES, M. S. Died March 29, 1897.
WILBUR C. KNIGHT, B. S., A. M. Died July 28, 1903.
RALPH D. LACOE. Died February 5, 1901.
*JOSEPH LE CONTE, M. D., LL. D. Died July 6, 1901.
*J. PETER LESLEY, LL. D. Died June 2, 1903.
HENRY McCALLEY, A. M., C. E. Died November 20, 1904.
OLIVER MARCY, LL. D. Died March 19, 1899.
OTHNIEL C. MARSH, Ph. D., LL. D. Died March 18, 1899.
JAMES E. MILLS, B. S. Died July 25, 1901.
*HENRY B. NASON, M. D., Ph. D., LL. D. Died January 17, 1895.
*PETER NEFF, M. A. Died May 11, 1903.
*JOHN S. NEWBERRY, M. D., LL.D. Died December 7, 1892.
*EDWARD ORTON, Ph. D., LL. D. Died October 16, 1899.
*RICHARD OWEN, LL. D. Died March 24, 1890.
SAMUEL L. PENFIELD. Died August 14, 1906.
*FRANKLIN PLATT. Died July 24, 1900.
*WILLIAM H. PETTEE, A. M. Died May 26, 1904.
*JOHN WESLEY POWELL, LL. D. Died September 23, 1902.
*ISRAEL C. RUSSELL, LL. D. Died May 1, 1906.
*CHARLES SCHAEFFER, M. D. Died November 23, 1903.
*NATHANIEL S. SHALER, LL. D. Died April 10, 1906.
CHARLES WACHSMUTH. Died February 7, 1896.
THEODORE G. WHITE, Ph. D. Died July 7, 1901.
*GEORGE H. WILLIAMS, Ph. D. Died July 12, 1894.
*J. FRANCIS WILLIAMS, Ph. D. Died November 9, 1891.
*ALEXANDER WINCHELL, LL. D. Died February 19, 1891.
ALBERT A. WRIGHT, Ph. D. Died April 2, 1905.

Summary

Original Fellows	62
Elected Fellows	221
Membership	283
Deceased Fellows	48

Geological Society of America Bulletin

Proceedings of the Eighteenth Annual Meeting, held at Ottawa, Canada, December 27, 28, and 29, including Proceedings of the Seventh Annual Meeting of the Cordilleran Section, held at Berkeley, California, December 29 and 30, 1905

Herman Le Roy Fairchild

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Notes