



The University of Iowa Libraries



IOWA. GEOLOGICAL SURVEY,

VOLUME XXIX

Annual Reports, 1919 and 1920

with

Accompanying Papers

GEORGE F. KAY, Ph. D., State Geologist
JAMES H. LEES, Ph. D., Assistant State Geologist

Published by
THE STATE OF IOWA
Des Moines

1. The first part of the document is a list of names and addresses of the members of the committee.

2. The second part of the document is a list of names and addresses of the members of the committee.

Geology
v. 29
1919-20
cop. 5

Geological Survey Organization

GEOLOGICAL BOARD

HIS EXCELLENCY, W. L. HARDING.....GOVERNOR OF IOWA
HON. FRANK S. SHAW.....AUDITOR OF STATE
DR. WALTER A. JESSUP.....PRESIDENT STATE UNIVERSITY
DR. RAYMOND A. PEARSON.....PRESIDENT STATE COLLEGE
DR. T. C. STEPHENS.....PRESIDENT IOWA ACADEMY OF SCIENCE

ADMINISTRATIVE OFFICERS

GEORGE F. KAY.....STATE GEOLOGIST
JAMES H. LEES.....ASSISTANT STATE GEOLOGIST
NELLIE E. NEWMAN.....SECRETARY

GEOLOGICAL SECTION

GEORGE F. KAY.....PLEISTOCENE GEOLOGY
JAMES H. LEES.....AREAL GEOLOGY
WM. H. NORTON.....UNDERGROUND WATERS
B. SHIMEK.....AREAL GEOLOGY
F. A. WILDER.....ECONOMIC GEOLOGY, GYPSUM
JOHN L. TILTON.....AREAL GEOLOGY
SIDNEY L. GALPIN.....ECONOMIC GEOLOGY, CLAYS
F. M. VAN TUYL.....STRATIGRAPHIC GEOLOGY
WALTER H. SCHOEWE.....AREAL GEOLOGY
A. O. THOMAS.....STRATIGRAPHIC GEOLOGY
JOHN E. SMITH.....ECONOMIC GEOLOGY, CLAYS
RUDOLPH H. JORDAN.....AREAL GEOLOGY
EDWIN RODDEWIG.....CHEMIST, CLAYS
J. N. PEARCE.....CHEMIST, PLEISTOCENE CLAYS
MISS CLEMENTINA S. SPENCER.....BIOLOGIST, HAWKS AND OWLS

TOPOGRAPHIC SECTION

W. L. MILLER.....TOPOGRAPHIC ENGINEER
J. M. RAWLS.....ASSISTANT TOPOGRAPHER
FRANK J. McMAUGH.....ASSISTANT TOPOGRAPHER
WALTER G. CARSON.....ASSISTANT TOPOGRAPHER
ROY J. MORTON.....CHAINMAN
ARCHIE A. STRANE.....CHAINMAN
J. D. McNAMARA.....CHAINMAN
H. R. SWANSON.....RODMAN
REALINO V. McCANN.....RODMAN
T. H. KEMPLEY.....RODMAN
PAUL M. BARTON.....RODMAN

WATER GAGING SECTION

R. H. BOLSTER.....HYDROGRAPHIC ENGINEER
L. F. REINER.....ASSISTANT ENGINEER
FRANK VREELAND.....WATER GAGER
JAMES TOWNSEND.....WATER GAGER
S. C. FULLER.....WATER GAGER

B. S. BEEHLE.....	WATER	GAGER
JOHN STROTHOFF.....	WATER	GAGER
MRS. H. H. SHEBURN.....	WATER	GAGER
GEORGE COTTON.....	WATER	GAGER
FRANK SCHRECKENGAST.....	WATER	GAGER
C. W. WARREN.....	WATER	GAGER
I. E. WILLIAMSON.....	WATER	GAGER
J. W. RICKS.....	WATER	GAGER
ALBERT KOSTAL.....	WATER	GAGER
MRS. LYDIA MATZ.....	WATER	GAGER
J. A. SCHROEDER.....	WATER	GAGER
D. M. COLEMAN.....	WATER	GAGER
MRS. LIZZIE ULRICH.....	WATER	GAGER
MRS. MINNIE B. BLOKER.....	WATER	GAGER
S. A. ELLIOTT.....	WATER	GAGER
W. P. COON.....	WATER	GAGER
MRS. FERN BURCHARD.....	WATER	GAGER

CONTENTS

	PAGE
REPORTS OF THE DIRECTOR, GEORGE F. KAY.....	i
MINERAL PRODUCTION IN IOWA IN 1919 AND 1920, JAMES H. LEES.....	xxi
PETROLEUM AND NATURAL GAS IN IOWA, JESSE V. HOWELL.....	1
THE ORIGIN AND HISTORY OF EXTINCT LAKE CALVIN, WALTER H. SCHOEWE.....	49
THE MISSOURI SERIES OF THE PENNSYLVANIAN SYSTEM IN SOUTHWESTERN IOWA, JOHN L. TILTON.....	223
NEW ECHINODERMS FROM THE MAQUOKETA BEDS OF FAYETTE COUNTY, IOWA, ARTHUR WARE SLOCOM AND AUGUST F. FOERSTE.....	315
ECHINODERMS OF THE IOWA DEVONIAN, A. O. THOMAS.....	385

ILLUSTRATIONS

PLATE		PAGE
I.	Map of Iowa showing carbon ratios of Pennsylvanian coals	11
II.	Columnar section of Iowa rocks	20
III.	Geological map of Iowa	21
IV.	Structure map of Iowa	25
V.	Sketch map of area of Iowa which offers some chance of success	37
VI.	Map showing the location and extent of extinct Lake Calvin.....	56
VII.	Geologic sketch map of the Lake Calvin region	70
VIII.	Map showing drift sheets in Lake Calvin basin	In Pocket
IX.	View in northeastern Washington county, showing mature erosion of the Kansan drift plain	111
X.	The flat surface of the North Liberty plain	119
XI.	The erosional topography of the Kansan near the North Liberty plain	121
XII.	Steep and rocky bluffs of the Lake Calvin basin along Cedar river.....	127
XIII.	Map showing Lake Calvin at Iowa City	132
XIV.	Map showing the difference in the escarpment of the high terrace where it is in contact with the low terrace and with the flood plain	191
XV.	Diagrams showing types of spurs developed at the junction of two normal stream valleys	196
XVI.	Map showing the abrupt disappearance of sand dunes along the Illinoian upland border	204
XVII.	Sketch maps illustrating the draining of Lake Calvin	212
XVIII.	Sketch maps illustrating the draining of Lake Calvin	214
XIX.	Sketch maps illustrating the draining of Lake Calvin	216
XX.	The cross section along Missouri river from Hamburg to Crescent; to face	258
XXI.	Section across Adair county, south of the Thurman-Wilson fault, from Briscoe, Adams county, to the "Backbone", Madison county	267
XXII.	The cross section along East Nishnabotna river from Hamburg to Atlantic; to face	268
XXIII.	The cross section from Nebraska City, Nebraska, to Decatur City and Leon, Iowa; to face	272
XXIV.	The cross section along Grand river from Middle river to Davis City	278
XXV.	The cross section along Middle river; to face	296
XXVI.	Outline map giving locations of measurements of dip and strike and of directions of joints	304



PLATE	PAGE
XXVII.	Map of area near Stuart, showing distribution of strata308
XXVIII.	Map showing distribution of the Missouri series in southwestern Iowa; to face314
XXIX.	Figures 1-4, <i>Dendrocrinus kayi</i> ; 5-9, <i>Ectenocrinus raymondi</i> ; 10-13, <i>Archaeocrinus obconicus</i> ; 14-22, <i>Porocrinus fayettensis</i>371
XXX.	Figures 1, 2, Crinoid column "Aa"; 3-7, Crinoid column "Ac"; 8-10, Crinoid column "Ab"; 12, 13, <i>Maquoketocrinus ornatus</i> ; 14, <i>Porocrinus fayettensis</i> ; 15-17, <i>Heterocrinus</i> ?; 18, 19, <i>Lich-enocrinus minutus</i> ; 20-31, <i>Atactocrinus</i> ? columnals.....375
XXXI.	Figures 1-10, <i>Carabocrinus slocomi</i> ; 11, 13, 14, <i>Carabocrinus huronen-sis</i> ; 12, <i>Pleurocystites beckeri</i>377
XXXII.	Figures 1, 7, 8, 9, 11, 12, 13, 14, <i>Carabocrinus slocomi</i> ; 15-18, 21-25, <i>Carabocrinus slocomi costatus</i>379
XXXIII.	Figures 1, 6, <i>Pleurocystites beckeri</i> ; 2, 3, <i>P. multistriatus</i> ; 4, <i>Pleuro-cystites</i> sp.; 5, <i>P. slocomi</i> ; 7, <i>P. clermontensis</i>381
XXXIV.	Figure 1, <i>Pleurocystites beckeri</i> ; 2, <i>P. multistriatus</i> ; 5, <i>P. slocomi</i> ; 7, <i>P. clermontensis</i>383
XXXV.	Figures 1-11, 13, 18, <i>Strobilocystites calvini</i> ; 12, 19-21, <i>S. schucherti</i> ; 14-17, <i>S. polleyi</i>506
XXXVI.	Figures 1, 6-9, 16, 17, <i>Nucleocrinus obovatus</i> ; 2-5, 12, 18, <i>N. bondi</i> ; 10, 11, <i>N. meloniformis</i> ; 13, 14, <i>Codaster gracilis</i> ; 15, <i>Codaster subtruncatus</i>508
XXXVII.	Figure 1, <i>Melocrinus nodosus</i> ; 2-4, <i>M. nodosus irregularis</i> ; 5, <i>M. tiffanyi</i> ; 6-8, <i>M. calvini</i> ; 9, 10, <i>M. (?) linderi</i> ; 11-16, <i>M. belanski</i>510
XXXVIII.	Figures 1-3, <i>Stereocrinus triangulatus</i> ; 4, 5, <i>S. littletonensis</i> ; 6-12, <i>Megistocrinus farnsworthi</i>512
XXXIX.	Figures 1-5, <i>Megistocrinus robustus</i> ; 6, 7, <i>M. fitzpatricki</i> ; 8, <i>M. concavus</i>514
XL.	Figures 1-8, <i>Megistocrinus clarkei</i>516
XLI.	Figure 1, <i>Megistocrinus latus</i> ; 2-4, <i>M. nodosus</i> ; 5-23, <i>M. pernodosus</i>518
XLII.	Figure 1, <i>Hexacrinus occidentalis</i> ; 2-9, <i>H. springeri</i> ; 10-13, <i>H. iowensis</i> ; 14-18, <i>Arthracantha mamelonifera</i> ; 19-34, <i>Clidochirus iowensis</i> ; 35-37, <i>C. maximus</i>520
XLIII.	Figures 1-9, <i>Hexacrinus springeri</i> ; 10-44, <i>Clidochirus iowensis</i>524
XLIV.	Figures 1-5, <i>Daelyocrinus stellatimbasalis</i> ; 6, 7, <i>D. concavus</i> ; 8, <i>Euryocrinus barrisi</i> ; 9, <i>Synbathocrinus matutinus</i> ; 10, <i>Tax-ocrinus interscapularis</i> ; 11-16, <i>Cyathocrinus rockfordensis</i> ; 17, 18, <i>Eutaxocrinus gracilis</i> ; 19, <i>Poteriocrinus buffaloensis</i> ; 20, 21, <i>Deltaocrinus barrisi</i>526
XLV.	Figure 1, <i>Decodocrinus vintonensis</i> ; 2, crinoid arms and pinnules; 3, <i>Megistocrinus latus</i> ; 4-6, 8-10, crinoid stems and fragments; 7, <i>Megistocrinus merrilli</i> ; 11, crinoidal limestone; 12, <i>Euryo-crinus</i> cf. <i>barrisi</i>528
XLVI.	Figures 1-5, <i>Agelacrinites hanoveri</i> ; 6, <i>Agelacrinites</i> sp.; 7, 8, crinoidal limestone; 9, <i>Megistocrinus clarkei</i> ; 10, 11, <i>M. fitz-patricki</i>530
XLVII.	Figures 1-7, <i>Nortonechinus welleri</i>532
XLVIII.	Figures 1-49, <i>Nortonechinus welleri</i>534
XLIX.	Figures 1-6, 8-23, <i>Nortonechinus welleri</i> ; 7, part of modern sea-urchin; 24-33, <i>Nortonechinus welleri latus</i> ; 34-43, <i>N. stain-brooki</i>536
L.	Figures 1-25, <i>Xenocidaris americana</i> ; 26-35, <i>Nortonechinus</i> (?) <i>owenensis</i> ; 36, <i>Devonocidaris jacksoni</i>540
LI.	Figures 1-26, <i>Devonocidaris jacksoni</i>542
LII.	Figures 1-4, <i>Devonocidaris jacksoni</i>546
LIII.	Figures 1-7, <i>Devonocidaris jacksoni</i>548
LIV.	Figures 1-6, <i>Devonocidaris jacksoni</i>550

FIGURE

PAGE

1. Cross section showing the occurrence of oil and gas in an anticline.....	14
2. Structure contour map of a dome and a syncline.....	14
3. Structure contour map of a nose and a terrace.....	15
4. Sketch showing how faulting of the strata may cause accumulation of petroleum.....	15
5. Section showing how oil and gas may accumulate in lenses on a monocline.....	16
6. Generalized cross section of the Lake Calvin basin.....	57
7. Relations of strata of drift seen on the Iowa river bluff in Louisa county.....	90
8. Diagram showing comparative areas of Muscatine county and the Lake Calvin basin.....	110
9. The incised valley in the Kansan upland in Louisa county.....	114
10. Characteristic sand dune topography on the Illinoian border.....	117
11. The northern line of bluffs in Muscatine county.....	129
12. Diagram of exposure in Muscatine county.....	139
13. Terrace material at same exposure as figure 12.....	140
14. The highly cross-bedded sands in the terrace in Muscatine county.....	141
15. The irregular stratification in the same exposure as shown in figure 14.....	143
16. The flat surface of the high terrace in Johnson county.....	148
17. Gently undulating topography in the high terrace, Johnson county.....	149
18. Knoll on the high terrace in Johnson county.....	150
19. Outcrop of fine sands and silts in the high terrace, Johnson county.....	152
20. Relation of gumbo-like material in high terrace, Johnson county.....	153
21. Cross-bedding in high terrace sands, Johnson county.....	155
22. Slablike igneous boulders in Washington county.....	155
23. Interrupted profiles of Wilton Valley and Intermediate terraces.....	156
24. Wilton Valley terrace near Wilton Junction.....	157
25. The finely laminated silts exposed in the Wilton Valley terrace in Muscatine county.....	157
26. The laminated silts shown in figure 25.....	158
27. Typical outcrop of terrace deposits of the Wilton Valley terrace.....	159
28. Diagram of materials in the low terrace, Johnson county.....	164
29. Sketch map showing the blocking of the Mississippi and lower portion of the Wapsipinicon river valleys.....	170
30. Goose Lake Channel in Jackson county.....	175
31. Map showing the course of Mississippi river north of the Lake Calvin basin during Illinoian times.....	176
32. Map showing the course of Mississippi river south of the lake basin during Illinoian times.....	178
33. Map showing location of two typical outcrops.....	184
34. Diagram showing how depth and slope of lake bed may result in different elevations of lake floor.....	187
35. Comparison of bluff lines in the Lake Calvin region.....	195
36. Diagrams showing the development of rounded bluff lines at the junction of two streams.....	197
37. Sketch map showing the rounded bluff lines on both sides of English river.....	198
38. The base of the DeKalb limestone above the Cherryvale shale near Westerville.....	275
39. The top of the DeKalb limestone near Westerville.....	276
40. Bethany Falls limestone near Winterset.....	281
41. Winterset limestone close to Winterset.....	283
42. Cherryvale shale west of Winterset.....	284
43. DeKalb limestone northwest of Osceola.....	287
44. Strata in a ravine, in Grand River township, Adair county.....	290
45. Section in a ravine in Harrison township, Adair county.....	291
46. The old dam at Port Union Mill, Adair county.....	294
47. Deer Creek limestone below the dam at Port Union Mill.....	294
48. Topeka and Deer creek limestones near Hawleyville, Page county.....	295
49. Diagram of conditions across the fault plane, from Reno to Briscoe.....	297
50. Winterset limestone northwest of Osceola.....	298

FIGURE	PAGE
51. Winterset limestone at bridge west of Decatur City	299
52. Diagram illustrating directions of joints	303
53. Section from Bridgewater to Glendon	309
54. Section from Glendon to Winterset	309
55. Diagram of a monocyclic camerate crinoid.....	321
56. Diagram of a dicyclic crinoid.....	321
57. Diagram of <i>Maquoketocrinus</i>	330
58. Diagram of <i>Ectenocrinus</i>	337
59. Diagram of <i>Carabocrinus slocomi</i>	350
60. Table to show range and distribution of the Devonian echinoderm genera of Iowa	404
61. Table of the Iowa Devonian formations	409
62. Contact of Nora limestone and Mason City dolomite	411
63. Analysis of plates of the cystid <i>Strobilocystites polleyi</i>	417
64. Diagram showing arrangement and number of ambulacral branches in two species of Iowa Devonian cystids	418
65. Deltoid plate of an Iowa Devonian blastoid	428
66. Diagram of the plates of the anal interrays of three species of <i>Melocrinus</i>	437
67. Analysis of the calyx of the type specimen of the crinoid <i>Melocrinus cal-</i> <i>vini</i>	439
68. Analysis of the calyx of the type of <i>Stereocrinus littletonensis</i>	444
69. Analysis of one of the type specimens of <i>Megistocrinus farnsworthi</i>	445
70. Plan of one of the radial series of the type of <i>Megistocrinus clarkei</i>	449
71. Nodose plates and stem segments of the crinoid <i>Megistocrinus pernodosus</i> from Brandon	457
72. Analysis of the calyx of the type specimen of <i>Hexacrinus springeri</i>	461
73. Analysis of the calyx of the type specimen of <i>Dactylocrinus stellatim-</i> <i>basalis</i>	469
74. Tracing of the plates of the type specimen of <i>Nortonechinus welleri</i>	484
75. Diagram of an interambulacral plate of the echinoid <i>Nortonechinus</i> <i>welleri</i>	485
76. Meridional section of an interambulacral plate of <i>Nortonechinus</i> , greatly enlarged	486
77. Diagram of a primary spine of <i>Nortonechinus welleri</i>	488
78. Drawing of an interambulacral plate and primary spine of <i>Nortonechinus</i> <i>welleri</i>	489
79. Two views of the modern sea urchin <i>Colobocentrotus</i>	493
80. Interambulacral plate of <i>Nortonechinus stainbrookii</i>	495