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 - Portland cement, its definition, composition and constitution, raw materials for Portland cement, combinations of raw materials, origin and general characters of limestone, raw materials actually in use, argillaceous limestone, pure hard-limestone, soft limestone, chalk, fresh-water marls, alkali waste, blast-furnace slag, clays and shales, slate.
 - Factors determining the value of deposits for cement materials, methods and costs of excavation of the raw materials, cost of raw materials at the mill.
 - Methods of manufacture, preparation of the mixture for the kiln, drying the raw materials, grinding and mixing, dry methods, slag-limestone mixtures, wet methods, composition of the mixture, burning the mixture, theoretical fuel requirements, losses of heat in practice, actual fuel requirements and output, effect of composition on burning, character of kiln-coal, clinker grinding, addition of gypsum, constitution of Portland cement, cement materials in Iowa, calcareous marls, chalk deposits, limestones, Ordovician limestones, Devonian limestones, Wapsipinicon limestones, Cedar Valley limestones, Lime Creek shales, Carboniferous lime-

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- Geology of Des Moines county. C. R. Keyes. (Iowa Geol. Surv., III, 409-492, 1894.)
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- Hall, C. W.**, and F. W. Sardeson. Paleozoic Formations of Southeastern Minnesota. (Bull. Geol. Soc. America, Vol. III, pp. 331-368, Rochester, 1892.) Incidental references to Iowa stratigraphy are included.

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- Hall, James.** Contributions to Palæontology of Iowa; being Descriptions of Crinoidea and other Fossils. (Geology of Iowa, Vol. I, Supp., pp. 1-92, Albany, 1859.) Descriptions of new species of fossils from Iowa are given.
- Hall, James.** Description of New Species of Crinoidea from Carboniferous Rocks of Mississippi Valley. (Boston Jour. Nat. Hist., Vol. VII, pp. 251-328, Boston, 1861.) The majority of the species described are from Iowa.
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- Hall, James.** Description of New Species of Fossils from Hamilton Group of Western New York, with Notices of others from same Horizon in Iowa and Indiana. (New York State Cab. Nat. Hist., 13th Ann. Rep., App. F, pp. 76-94, Albany, 1860.)
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- Hall, James.** Geological History of North American Continent. (Pamphlet, pp. 1-24, Albany, 1869.) General allusions are made to geology of the Iowa region.
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- Hall, James.** Notes upon Geology of Western States. (Am. Jour. Sci., (1), Vol. XLII, pp. 51-62, New Haven, 1842.) General statement of the correlation of the rocks in the Mississippi valley is given.
- Hall, James.** Observations on Genus Archimedes, or Fenestella, with Descriptions of Species, etc. (Proc. American Assoc., Adv. Sci., pp. 170-180, Cambridge, 1857.) Species are noted from Keokuk.
- Hall, James.** Observations upon Carboniferous Limestones of Mississippi Valley. (Am. Jour. Sci., (2), Vol. XXIII, pp. 187-203, New Haven, 1857.) This is essentially a report of progress of the Iowa Geological Survey. A classification of the Iowa Carboniferous rocks is also given; the paper is practically all given in his report on the Geology of Iowa.
- Hall, James.** On the Carboniferous Limestones of Mississippi Valley. (Proc. American Assoc. Adv. Sci., Vol. X, pp. 51-69, Cambridge, 1857.) Statement is made that the Coal Measures were deposited unconformably upon strata beneath, whether they were Carboniferous lime-

stone, Devonian, Upper and Lower Silurian, the unconformity differing only in degree; and that the Coal Measures were laid down over a much greater area than they now occupy.

- Hall, James.** On the Occurrence of an Internal Convolute Plate within Body of Certain Species of Crinoidea. (Proc. Boston Soc. Nat. Hist., Vol. X, pp. 33-34, Boston, 1866.)
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- Hall, James.** Organic Remains of Niagara Group and Associated Limestones. (Geol. Sur. Wisconsin, 1859-1863, pt. iii, pp. 1-194, 18 plates, Albany 1871.) A number of species from Iowa are described.
- Hall, James.** Paleontology of New York. (Nat. Hist. New York, Paleontology, Vol. IV, 422 pp., Albany, 1867.) A number of references to fossils occurring in Iowa are made.
- Hall, James.** Preliminary Notice of *Newberria*, a New Genus of Brachiopods; with Remarks on its Relations to *Rensselæria* and *Amphegenia*. (Tenth Ann. Rep. State Geologist of New York, pp. 91-102, Albany, 1891.) Species from Iowa are noted.
- Hall, James.** Report of Geological Survey of the State of Iowa. (Vol. I, pp. i-xv and 1-724, Albany, 1858.)

PART FIRST (GEOLOGY).

- Chapter I is a description of the physical geography of the State. (See J. D. Whitney, 1858.)
- Chapter II treats of the general geology of the State, and the relations of the formations to those of the East.
- Chapter III describes in detail the different geological formations of the State from observations made during the years 1855-1857.
- Chapter IV deals with the geology of Des Moines valley. (See A. H. Worthen, 1858.)

Chapter V is a detailed account of the geology of certain counties in southeastern Iowa. (See A. H. Worthen, 1858.)

Chapter VI is an account of the geology of various counties in the central and northern part of eastern Iowa. (See J. D. Whitney, 1858.)

Chapter VII is a chemical and economical report. (See J. D. Whitney, 1858.)

PART SECOND (PALEONTOLOGY.)

Chapter VIII is made up of descriptions accompanied by illustrations of the numerous fossils of the different horizons as found in Iowa.

Hall, James. Report of Geology of State of Iowa. (Vol. I, pp. 474-724, Pt. Second, Paleontology, 29 plates, Albany, 1858.) This forms Chapter VIII of Vol. I, and is made up entirely of descriptions of fossils. A large number of genera and species are described as new.

Hall, James. Report of James Hall in Relation to Geological Survey. (Iowa Legislative Doc., 1859-60, 15 pp., Des Moines, 1860.) This is a **brief statement** of reasons for continuing the geological work of the state.

Hall, James, and R. P. Whitfield. Description of New Species of fossils from Devonian Rocks of Iowa. (New York State Cab. Nat. Hist., 23d Ann. Rep., pp. 223-239, Albany, 1873.) A brief sketch of the Devonian formations of Iowa and descriptions of new fossils are given.

Hall, James, Whitney, J. D., and Worthen, A. H. Geological Map of Eastern Half of State of Iowa; by Legislative Authority. (Geology of Iowa, Vol. I, Albany, 1858.)

Hamilton County.

Artesian wells of Iowa. W. H. Norton. (Iowa Geol. Surv., VI, 113-428, 1897.)

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- Geology of Lee county. C. R. Keyes. (Iowa Geol. Surv., III, 305-407, 1894.)
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- Variation of a gasteropod. C. R. Keyes. (American Geologist, III, 329-333, 1889.) Specimen from Keokuk is figured.
- Wood. C. H. Gordon. (Proc. Iowa Acad. Sci., I, pt. i, 97-98, 1890.)
- Keokuk limestone** of Iowa, *Ctenacanthus* spines. C. R. Eastman. (American Jour. Sci., (4), IV, 10-12, 1897.)
- Keyes, Charles.** Aboriginal Use of Mineral Coal; and its Discovery in the West. (Annals of Iowa; an Historical Quarterly, Vol. X, pp: 431-434, Des Moines, 1912.) The lignites of the north are shown to have been used by the Aïouez Indians at the time of the earliest visits by the French.
- Keyes, Charles.** Administrative Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. I, First Annual Rep., pp. 7-9, Des Moines, 1894.) This report contains summaries of the investigations carried forward on the coal deposits, clays, gypsum and of several reconnoissances in the state.
- Keyes, Charles.** Administrative Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. III, pp. 29-38, Des Moines, 1894.) Short statements are made of the progress made in the personal investigations on the gyp-

sum, coal, Sioux quartzite and areal work; and of the works of the various assistants engaged upon other topics.

- Keyes, Charles.** Administrative Report of Assistant State Geologist. (Iowa Geological Survey, Vol. IV, pp. 27-28, Des Moines, 1895.) The work of the year is summarized; and a brief statement is made of the publications issued during the year.
- Keyes, Charles.** Age of Certain Sandstones near Iowa City. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, p. 25, Des Moines, 1892.) Owing to the recent discovery of fossils in the sandstones near Iowa City the suggestion is made that their age may be Kinderhook instead of Missourian as has been heretofore regarded.
- Keyes, Charles.** Alternation of Fossil Faunas. (Proc. Iowa Acad. Sci., Vol. XIII, pp. 199-201, Des Moines, 1907.) In the coal-measures of Iowa, Missouri and Kansas there is an alternation of faunas corresponding to the alternation of lithographic units. These have not been heretofore clearly distinguished.
- Keyes, Charles.** Aluminum in Iowa. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, pp. 29-30, Des Moines, 1892.) Announcement is made of the establishment of a plant for the manufacture of aluminum in Franklin county.
- Keyes, Charles.** American Homotaxical Equivalents of Original Permian. (Journal of Geology, Vol. VII, pp. 321-341, Chicago, 1899.) The lower part of the American section compared with the Russian sequence includes beds represented in Iowa. There are numerous references to Iowa rocks.
- Keyes, Charles.** American Species of Polyphemopsis. (Proc. Acad. Nat. Sci., Phila., 1889, pp. 299-302, Philadelphia, 1889.) This is a revision of the species that have been referred to this group of gasteropods.
- Keyes, Charles.** Annotated Bibliography of Iowa Geology and Mining. (Iowa Geol. Surv., Vol. XXII, Des Moines, 1913.) The list of publications relating to the geology of Iowa is brought down to the end of 1912.

- Keyes, Charles.** Annotated Catalogue of Minerals. (Iowa Geol. Surv., Vol. I, pp. 181-196, Des Moines, 1893.) The more important minerals are noted and their peculiarities described. The crystallographic features of several kinds are outlined. A notable occurrence of the sulphide of nickel is mentioned and photographs of the most perfect groups of crystals reproduced.
- Keyes, Charles.** Annotated Catalogue of Mollusca of Iowa. (Bull. Essex Inst., Vol. XX, pp. 61-83, 1889.) In addition to notes on the live mollusca of the State numerous references are made to the species collected in the loess; and a list of these species known to occur within the limits of the State is appended.
- Keyes, Charles.** Arkansan Series: A New Terrane of the Carboniferous in the Western Interior Basin. (Proc. Iowa Acad. Sci., Vol. VII, pp. 123-128, Des Moines, 1901.) The relative magnitude of the section of coal measures deposited in Iowa and that represented elsewhere by the unconformity-plane at the base are given in diagram. The term Arkansan-series is proposed for the exact depositional representation of the gap; and in Iowa the term Arkansan unconformity becomes a proper and useful title.
- Keyes, Charles.** Attachment of Platycerata to Palæocrinoids; and its Effects in Modifying the Form of the Shell. (Proc. American Philosophical Soc., Vol. XXV, pp. 231-248, Philadelphia, 1888.) A statement is made of the cases heretofore observed and of the opinions concerning the sedentary habits of Platyceras. There is also given a brief historical review, with remarks on the known examples. Detailed descriptions of numerous specimens recently found in which the gasteropods are attached to various species of crinoids; together with a list of the species of Platyceras which have been found attached are given. Four species are described as new.

- Keyes, Charles.** Attachment of *Platyceras* to Fossil Crinoids. (American Naturalist, Vol. XXII, p. 924, Philadelphia, 1888.) A preliminary Synopsis of the intimate associations of the two organisms is given.
- Keyes, Charles.** Bethany Limestone of Western Interior Coal-field. (Am. Jour. Sci., (4), Vol. II, 221-225, 1896.) The value of the Bethany limestone, the Winterset limestone of Iowa, as a guide-horizon limiting the productive coal-measures, or Des Moines series, above is emphasized. Synonym is discussed in detail.
- Keyes, Charles.** Betterment of our Public Highways. (The Annals of Iowa; Historical Quarterly, Vol. V, pp. 372-379, Des Moines, 1902.) In the immediate betterment of Iowa highways it is urged that by selecting for improvement the heaviest parts of a road first, since the worst stretches are often caused by the presence of the best material when burned of road-metal, five years would find every principal highway in a country as passable the year around as a paved street in a city, and at very little more cost than is now usually squandered on "working the roads."
- Keyes, Charles.** Biographical Sketch of Charles Wachsmuth. (American Geologist, Vol. XVII, pp. 161-173, Minneapolis, 1896.) To this biographical account of a distinguished Iowa scientist is added a complete list of his published memoirs on the crinoids. There is also a recent portrait reproduced.
- Keyes, Charles.** Bibliography of Iowa Geology. (Iowa Geol. Surv., Vol. I, pp. 209-464, Des Moines, 1893.) The plan followed is essentially that of a dictionary catalogue of the geological literature, comprising (1) an author's list with full titles of subjects and the place of publication, (2) a title index, (3) subject entries, and (4) cross-references. For convenience the whole is arranged alphabetically.

- Keyes, Charles.** Bibliography of North American Paleontology, 1888-1892. (U. S. Geol. Surv., Bull. 121, 250 pp., Washington, 1894.) Contains annotations on articles relating to Iowa and published during the period.
- Keyes, Charles.** Brick and Other Clays of Des Moines. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, p. 29, Des Moines, 1892.) A brief statement of the clay industries at Des Moines is made.
- Keyes, Charles.** Burnt Clay for Roads in the West. (American Monthly Reviews of Reviews, Vol. XXV, pp. 72-74, New York, 1902.) The use of burnt gumbo for road improvement is shown to be cheap and lasting. Its use by Iowa railroads for ballast presents many commendable features. Singularly where highways are the worst the best clays for burning are found. The advantages of utilizing this road-metal are enumerated.
- Keyes, Charles.** Carbonic Column of the Rio Grande. (Proc. Iowa Acad. Sci., Vol. XVI, pp. 159-163, Des Moines, 1909.) Comparison is made with the stratigraphic sequence of the upper Mississippi valley.
- Keyes, Charles.** Carboniferous Echinodermata of Mississippi Basin. (Am. Jour. Sci., (3), Vol. XXXIII, pp. 186-193, New Haven, 1889.) This is a brief description of the lower Carboniferous rocks of the Mississippi basin, with suggestions as to the geological classification as indicated by crinoidal remains. A synopsis of the genera and the distribution of the species in the various formations are given; also a sketch of the evolution of the crinoids during this time.
- Keyes, Charles.** Carboniferous formations of New Mexico. (Journal of Geology, Vol. XIV, pp. 147-154, Chicago, 1906.) Serial comparison is made with the Iowa, Missouri, Kansas sections of the Carboniferous sequence. There are also other references to the Iowa formations.
- Keyes, Charles.** Carboniferous Formations of Southwestern Iowa. (American Geologist, Vol. XXI, pp. 326-350, Minneapolis, 1898.) The typical section of the Missouri series of eastern Kansas is shown to be fully represent-

- ed in southwestern Iowa, with the exception of the Cottonwood formation and the Iola limestone. Nine terranes are thus for the first time in the state recognized.
- Keyes, Charles.** Certain Faunal Aspects of the Original Kinderhook. (*American Geologist*, Vol. XXVI, pp. 315-321, Minneapolis, 1900.) Since the Kinderhook section at Burlington has been pronounced to be mainly pre-Louisianian exceptions to the interpretations are taken. Other explanations to the anomalous assemblage of fossils and their vertical distribution are made. This later faunal correlation is shown to be closely in agreement with the stratigraphical interpretation.
- Keyes, Charles.** Certain Forms of *Straparollus* from Southeastern Iowa. (*American Geologist*, Vol. V, pp. 193-197, Minneapolis, 1890.) The generic characters of *Straparollus* and *Euomphalus* are discussed; and the various species found at Burlington are considered.
- Keyes, Charles.** Character and Stratigraphical Peculiarities of Southwestern Iowa Coal-fields. (*Eng. and Mining Jour.*, Vol. LXXIII, p. 661, New York, 1902.) Special attention is directed to the Nodaway coal. Results of the chemical analyses of this coal are given, the samples being from the principal mines in this state.
- Keyes, Charles.** Classification of Crinoidea. (*American Naturalist*, Vol. XXIII, p. 153, Philadelphia, 1889.) A statement is made on the classification of the crinoids and the changes necessitated by the discovery of the ventral structure of *Taxocrinus* (from the Kinderhook, near Marshalltown, Iowa).
- Keyes, Charles.** Classification of Lower Carboniferous Rocks of Mississippi Valley. (Pamphlet, 24 pp., Washington: Judd and Detweiller, printers, 1892.) Sections and details of the lower Carboniferous rocks in southeastern Iowa are described; frequent allusion is made to the coal measures of the central part of the State.
- Keyes, Charles.** Coal deposits of Iowa. (*Iowa Geol. Surv.*, Vol. II, 536 pp., XVIII pls., Des Moines, 1894.) As introductory, Chapter I takes into account the general as-

pect of coal and its relations to industrial activities of mankind.

Chapter II discusses the origin of coal-beds, the source of the carbonaceous materials, the conditions under which they were deposited, and the various strata usually associated with coal. Detailed references are made to the Iowa field as illustrating the different features.

In Chapter III the carboniferous basin of the Mississippi valley is especially considered with respect to its stratigraphical characteristics, its geotectonics, its local structures and its subdivisions. The productive coal-measures as a series of limited coal-basins are especially described.

The broader geological features of the coal-fields are considered in chapter III; and the stratigraphical relations of coal-beds to the other geological formations of the State are pointed out.

By way of contrast the lithological characters of the lower, or productive, coal-measures and of the upper, or barren, coal-measures are described separately. The relative development of the several kinds of rocks comprised in the coal-measures is considered with reference to the occurrence of coal-beds.

Under the title of "Stratigraphy of the Coal-measures" (Chapter VI) the general geological cross sections in different parts of the coal-fields are described, the form of the coal-basins is noted, the remarkable variability of the strata is emphasized, the significance of the unconformities is pointed out, typical vertical sections of the coal strata are given. The broader deformations are outlined, and the general conclusions are given regarding the local stratigraphy of the Iowa coal-measures. A special section on the nature of coal-horizons is intended to direct attention to certain features which are to be taken into account in prospecting and mining coal.

In Chapter VII, the descriptions of the coal-beds, the extent of individual coal seams is especially considered. The irregularities in original deposition, the effects of erosion in cutting out the coal, the interruptions owing to faulting and kindred features are noted in their bearings upon mining operations. Limitations to the mining of coal owing to insufficient thickness, and to excessive depths are described in all their various aspects. In the five succeeding chapters are given detailed descriptions of the coal-beds mined in North-central, Central, Southeastern, Southwestern and Eastern Iowa.

Composition of Iowa coals is considered in Chapter XIII. A large number of special chemical analyses are tabulated with special reference to the commercial properties and values of the different coals of the State.

A brief consideration of the waste in coal-mining is given in Chapter XIV. The most serious factors are inefficient methods of mining, lack of care in the removal of the coal, and the production of fine coal.

Chapter XV discusses the extent of the coal industry, the growth of production, the number of mines, the value of the product, the present territory supplied with Iowa coals, and the possible markets.

Keyes, Charles. Coal-floras of Mississippi Valley. (Science, N. S., Vol. XI, pp. 898-900, New York, 1900.) Something of the great richness of the coal-floras of the State is noted. It is estimated that there are 150 localities and 30 different horizons where coal-plants have been reported in Iowa. The recent finds of nodules bearing plant-remains finely preserved, similar to those of the famous Mazon creek, Illinois, of specimens preserving the woody structure to perfection, and immense slabs covered by ferns are mentioned.

Keyes, Charles. Coal Measures of Central Iowa; and Particularly in vicinity of Des Moines. (American Geologist, Vol. II, pp. 396-404. Minneapolis, 1888.) The sketch is accompanied by descriptions of sections of the geological

formations near Des Moines, with references to the fossils in the middle coal measures. Incidental reference is made to the eastern extension of the Cretaceous in central Iowa.

- Keyes, Charles.** Coal Measures of Iowa. (Eng. and Mining Jour., Vol. LVII, pp. 269-297 and pp. 317-318, New York, 1894.) The Western Interior coal-field is described and the conditions under which the coal-beds were formed are discussed at length. A number of sketches illustrate the various features emphasized. The larger structural characteristics of the coal-measures are graphically represented.
- Keyes, Charles.** Collector; a Journal of Natural History. (Two Volumes, 144 pp., Des Moines, 1881-2.) Contains many short notes on Iowa geology.
- Keyes, Charles.** Comparative Values of Different Methods of Geologic Correlation. (Proc. Iowa Acad. Sci., Vol. X, pp. 105-107, Des Moines, 1903.) Attention is called to the application of several methods of correlation at once. This procedure was adopted in the course of geologic work in Iowa and Missouri. This paper is a summary of results.
- Keyes, Charles.** Complexity of Glacial Period and Iowa's Role in its Establishment. (Annals of Iowa, Historical Quarterly; Vol. XI, Des Moines, 1913.) A brief editorial describing McGee's work in connection with glacial studies in Iowa.
- Keyes, Charles.** Contribution to Fauna of Lower Coal Measures of Central Iowa. (Proc. Iowa Acad. Sci., Vol I, pt. ii, pp. 22-23, Des Moines, 1892.) Description and notes are given on three species, which, however, were previously described as new.
- Keyes, Charles.** Correlative Relations of Certain Subdivisions of Coal-Measures in Kansas. (American Geologist, Vol. XXV, pp. 347-353, Minneapolis, 1900.) The much discussed Kansas section of the Carboniferous rocks is compared with the sections of other parts of the western Interior coal-basin, including Iowa, and the bearing of

the classifications thus represented upon other parts of the region is noted. Special attention is called to Swallow's early names for various subdivisions of the coal-measures.

- Keyes, Charles.** Cretaceous Formations of Iowa. (Proc. Iowa Acad. Sci., Vol. I, Part iv, pp. 25-26, Des Moines, 1894.) Announcement is made of the discovery of what appears to be Fort Pierre shales in Iowa, thus showing that four out of the five great terranes of the Cretaceous rocks of the Northwest are present in the state. The areal distribution and thickness of the several numbers, as shown by recent deep well-borings, are discussed.
- Keyes, Charles.** Crustal Adjustment in Upper Mississippi Valley. (Bull. Geol. Soc. America, Vol. V, pp. 231-242, Rochester, 1894.) From the recent investigations concerning the coal it is shown that there exist small faults the number and extent of which have never been fully realized. Sundry sketches illustrating the phenomena are introduced. Several distinct types are noted. In the case of many of the faults of small throw the stresses may have been superinduced by the diminution in bulk of lenticular coal-beds at horizons somewhat lower than those in which the dislocations are manifested.
- Keyes, Charles.** Des Moines River and origin of the Name. (Annals of Iowa: Historical Quarterly, Vol. III, pp. 554-559, Des Moines, 1898.) In the first decade following 1700 the present Des Moines river was thought to be the principal stream heading to the northwest fur-country. On the maps of the day it is represented as longer and larger than either the Mississippi or the Missouri rivers. It was possible for the French voyagers to leave the Lower Mississippi by canoe or long-boat and proceed up the Des Moines through the Minnesota river and Red River of the North to Hudson Bay without getting out of their boats. The Sioux

name of the Des Moines river is shown to be derived from the red sandstone cliffs in Marion county. Several early maps are reproduced.

Keyes, Charles. Depositional Equivalent of Hiatus at Base of Our Coal Measures. (Proc. Iowa Acad. Sci., Vol. VIII, pp. 119-123, Des Moines, 1901.) The true significance of the unconformable relations between the coal measures of Iowa and the underlying rocks has never been fully appreciated. By figures and diagrams it is shown that this stratigraphic gap is represented farther south by several thousands of feet of strata.

Keyes, Charles. Depositional Measure of Unconformity. (Bull. Geol. Soc. America, Vol. XII, pp. 173-196, Rochester, 1901.) The stratigraphy of the Western Interior coal-field is described, typical geological sections considered in the several states, and an exact correlation of their sections suggested. In the northern part of the field the unconformity at the base of the coal-measures is considered in its various phases. It is shown that the coal-measures of the region find greater development than in any other locality in America. In the Arkansas part of the coal-field 18,000 feet of sediments were deposited during the interval represented by the basal unconformity planes in Iowa. Diagrams accompany the paper.

Keyes, Charles. Depositional Phases of Eolation under the Stimulus of Aridity. (Proc. Iowa Acad. Sci., Vol. XVIII, pp. 101-103, Des Moines, 1911.) Special reference is made to the features of the Great Plains.

Keyes, Charles. Description of Two New Fossils from Devonian of Iowa. (Proc. Acad. Nat. Sci., Philadelphia., pp. 247-248, Philadelphia, 1888.)

Keyes, Charles. Devonian Hiatus in Continental Interior; Its Character and Depositional Equivalents. (Proc. Iowa Acad. Sci., Vol. IX, pp. 105-112, Des Moines, 1902.) Near the Osage river in southwestern Missouri the en-

tire Devonian section is missing. The sections on either side are compared with the great Devonian sequence of Iowa.

Keyes, Charles. Devonian Interval in Missouri. (Bull. Geol. Soc. America, Vol. XIII, pp. 267-292, Rochester, 1902.) Comparison is made of the unimportant section represented in northern Missouri with the varied and extensive section of Iowa. A graphic correlation of typical sections from northern Iowa to Arkansas is made.

Keyes, Charles. Distribution of Certain Loess Fossils. (American Geologist, Vol. VI, p. 119, Minneapolis, 1890.) The geographic range of certain of the loess fossils found in Iowa; and the adjoining parts of the neighboring states is discussed.

Keyes, Charles. Diverse Origins and Diverse Times of Formation of Lead and Zinc Deposits of Mississippi Valley. (Trans. American Inst. Mining Eng., Vol. XXXI, pp. 603-611, New York, 1901.) Special reference is made to the formation of the lead and zinc deposits of the Dubuque region.

Keyes, Charles. Dual Character of Kinderhook Fauna. (American Geologist, Vol. XX, pp. 167-176, Minneapolis, 1897.) At Burlington and southward the two-fold character of the fauna of the Kinderhook beds is emphasized; and its significance in classification pointed out.

Keyes, Charles. Earliest Explorations of Iowa-land. (Annals of Iowa; an Historical Quarterly, Vol. X, pp. 265-272, Des Moines, 1912.) Accounts are given of several French explorers who visited the region now included within the boundaries of the state of Iowa before the appearance of Marquette and Joliet.

Keyes, Charles. Eastern Extension of Cretaceous in Iowa. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, p. 21, Des Moines, 1892.) Announcement is made of the discovery of certain Cretaceous fossils in the drift near Des Moines; the probable eastern limits of the Cretaceous rocks in the state are discussed.

- Keyes, Charles.** Economic Aspects of Work in Pure Science. (The Annals of Iowa: Historical Quarterly, Vol. V, pp. 292-293, Des Moines, 1902.) Some of the advantages of applied geology are set forth with special reference to the utilitarian trend of scientific investigation by geological surveys.
- Keyes, Charles.** Elston Holmes Lonsdale, Memorial. (American Geologist, Vol. XXI, pp. 264-265, Minneapolis, 1898.) In the biographical sketch of Mr. Lonsdale his work in Iowa, while assistant geologist, is especially considered.
- Keyes, Charles.** Eolian Origin of Loess. (Am. Jour. Sci., (4), Vol. VI, pp. 299-304, New Haven, 1898.) Dust-storms on the Missouri river are described and are thought to be the direct origin of the loess deposits covering the bluffs. Observations are recorded on the western border of Iowa as far north as Council Bluffs. The rate of deposition is estimated; and the retention of the wind-borne materials is shown to be accomplished by the vegetation.
- Keyes, Charles.** Epoch in History of American Science. (Annals of Iowa, Historical Quarterly, (3), Vol. II, pp. 345-364, Des Moines, 1896.) There are given a brief account of their work, and biographical sketches of the late Charles Wachsmuth, and of Frank Springer, two of Iowa's most distinguished scientists, and authors of a monumental work on the fossil remains comprised in a monograph on the Crinoidea Camerata of North America. A portrait of each author and several pen-and-ink drawings showing characteristic forms which the authors had under consideration are given. A list of the authors' most important publications is appended.
- Keyes, Charles.** Fauna of Lower Coal Measures of Central Iowa. (Proc. Acad. Nat. Sci. Philadelphia, 1888, pp. 231-247, Philadelphia, 1888.) A brief sketch is given of the

geological formations, together with notes on many of the fossils occurring in the rocks of the region. Three species are figured and described as new.

Keyes, Charles. First Recorded Use of Mineral Coal in America. (Scientific American, Supp., LXXIV, p. 34, New York, 1912.) Abstract is given of a more extended account under the same title.

Keyes, Charles. First Reported Use of Mineral Coal in America. (Eng. and Mining Jour., Vol. XCIV, pp. 27-28, New York, 1912.) The discovery of coal in the upper Mississippi valley preceded that in the east by 50 years. It was probably used by the Ioway Indians before the advent of Europeans.

Keyes, Charles. Formational Synonymy of Coal-Measures of Western Interior Basin. (Proc. Iowa Acad. Sci., Vol. VII, pp. 82-105, Des Moines, 1900.) A standard section of the geological terranes represented in the coal-measures of Iowa is given. To it are referred all the known formations. The recognized subdivisions are briefly described. A general cross section along the Missouri river from Kansas City to Council Bluffs is represented. The outcropping edges of the several terranes are drawn on a sketch-map of Iowa, Missouri, Kansas and Nebraska. A complete synonymic list follows.

Keyes, Charles. Fossil Faunas in Central Iowa. (Proc. Acad. Nat. Sci., Phila., pp. 242-265, Philadelphia, 1891.) The biological relations of the fossils are summarized; a general section of the rocks of the region and a list of the fossils found in the middle coal measures are given, together with notes and bibliographic references to many of the forms found in the rocks near Des Moines. A synoptical table of the genera and species thus far recognized is appended.

Keyes, Charles. Genesis of American Actinocrinoidea. (American Naturalist, Vol. XXIV, pp. 243-254, Philadelphia, 1890.) This is a discussion of the evolution of sundry characteristic forms of erinoids, chiefly found in Iowa rocks.

- Keyes, Charles.** Genesis of Certain Cherts. (Proc. Iowa Acad. Sci., Vol. X, pp. 103-107, Des Moines, 1903.) It is stated that the evidence recently obtained indicates that the cherts of the Early Carboniferous formations of Iowa and Missouri were formed long after the rocks were laid down. The process of formation is analogous to that of ore-genesis under similar conditions, or through metasomatism.
- Keyes, Charles.** Genesis of Ozark Lead-Zinc Deposits. (Mining World, Vol. XXX, pp. 431-433, 481-485 and 543-546, Chicago, 1909.) Numerous references are made to the Iowa deposits of lead and zinc.
- Keyes, Charles.** Geographic Distribution of Lead and Zinc Deposits of Mississippi Valley. (Eng. and Mining Jour., Vol. LXXXVI, pp. 1004-1005, New York, 1908.) The localization of ore deposits in synclines appears to apply to the Dubuque region as well as in the Ozarks.
- Keyes, Charles.** Geological Age of Certain Gypsum Deposits. (American Geologist, Vol. XXX, pp. 99-102, Minneapolis, 1902.) Evidence is adduced for a Cretaceous age of the Fort Dodge gypsum. The assignment of a Permian age as recently advanced appears to be precluded by all direct testimony available; in fact a Permian age seems entirely impossible.
- Keyes, Charles.** Geological Formations of Iowa. (Iowa Geol. Surv., Vol. I, pp. 11-161, Des Moines, 1893.) The history of opinion regarding the various geological formations represented in the state is brought down to date. New personal observations are recorded. The Carboniferous terranes are especially considered and described, because of recent extensive field-work in this and neighboring states. A separation of the coal-measures into two divisions is made—the Des Moines and the Missouri. The stratigraphy of the coal-beds is discussed in considerable detail.
- Keyes, Charles.** Geological Map of Iowa. (Annals of Iowa, Historical Quarterly, (3), Vol. I, pp. 294-297, Des Moines, 1894.) This article is a brief popular statement

on the geological mapping methods being followed by the new survey. The significance of the various colors is also explained.

- Keyes, Charles.** Geological Mapping of Iowa. (Mon. Rev. Iowa Weather Serv., Vol. V, No. 2, pp. 4-6, Des Moines, 1894.) The construction of a geological map of the state is explained, and its service as a soil-index is pointed out. A properly constructed map thus puts in the hands of every citizen in every locality the means by which he may readily know just what mineral substances he may expect to find and for what it is useless to search.
- Keyes, Charles.** Geological Position of Trans-Mississippian Coals. (Eng. and Mining Jour., Vol. LXIX, pp. 528-529, New York, 1900.) A table indicates all the geological formations of the coal-measures of the region. In Iowa the terranal percentages of coal-production are calculated to be for the Cherokee shales 83.4 per cent., for the Appanoose limestones and shales 15.4 per cent., for the Marais des Cygnes 1.0 per cent., and for the Atchison shales 0.2 per cent. The coal-beds are also briefly described.
- Keyes, Charles.** Geological Structure and Relations of Coal-bearing Strata of Central Iowa. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, pp. 27-28, Des Moines, 1892.) A summary is given of observations made along the Des Moines river, chiefly in the vicinity of Des Moines.
- Keyes, Charles.** Geological Survey of Iowa. (Annals of Iowa: Historical Quarterly, (3), Vol. III, pp. 111-121, Des Moines, 1897.) There are given brief accounts of the organization and work of the several attempts to carry on the geological surveys of the state. Portraits of former State Geologists accompany the sketch.
- Keyes, Charles.** Geology of Des Moines County. (Iowa Geol. Surv., Vol. III, pp. 409-492, Des Moines, 1894.) The principal features described are:
Situation and extent, previous work.
Physiography, surface relief, table of altitudes, drainage.

Stratigraphy, general geological relations, classification of formations, general section, standard section, Prospect Hill, Augusta, southwest corner of county, southwest of Danville, Mississippi river sections, Huron section, Dolbee creek section, Oak creek section, Patterson sections, Skunk River sections, Flint River sections, Knotty creek, Big Hollow, Pleasant Grove; geological formations, Mississippian series, Kinderhook, correlations of Kinderhook, useful deposits; Augusta, lower Burlington, upper Burlington, Montrose cherts, Keokuk limestone; St. Louis; upper Carboniferous or coal-measures, Des Moines; Pleistocene, general character, lower till, loess, terraces, glacial markings; geological structure, general arrangement; geological cross section, Mississippi river section, Skunk river section; unconformities. Building stones, Burlington township, Union, Augusta, Danville, Flint River, Pleasant Grove, Franklin, Yellow Springs, Huron, and Benton townships; clays, minerals, polishing materials, limes, road-metals, sands, waters and water-powers.

The geological mapping and reporting on Des Moines county was the first areal work completed by the new Iowa geological survey. A large part of the district, however, had been investigated several years previous, and the boundaries of the various geological formations and their delimitations determined.

Keyes, Charles. Geology of Lee County. (Iowa Geol. Surv., Vol. III, pp. 305-407, Des Moines, 1894.) The following features are discussed:

Introduction, area and location, previous geological work. Physiography, surface relief, table of altitudes, drainage. Stratigraphy, geological relations of formations, table of strata, general geological section, typical exposures; standard sections, Mississippi River sections, Skunk River sections, Des Moines River sections, other sections; geological formations, Mississippian series, Kinderhook shales, Augusta limestone, Lower Burlington limestone, upper Burlington limestone, Montrose

cherts, Keokuk limestone, Goede bed, Warsaw shales, St. Louis limestone, Concretionary limestone, brecciated limestone, white limestone; Upper Carboniferous, Des Moines shales; Pleistocene deposits, lower till, blue boulder-clay, yellow boulder-clay, loess, terrace formations; geological structure; general relations, geological cross section, Mississippi River section, Skunk River section, Des Moines River section; deformation of strata; unconformities, coal measures and Saint Louis limestone, drift and indurated rocks; coal, building-stones, limestones, sandstones, clay deposits, character and distribution, clay industries; sands, road-materials, macadam, gravels, clay; cements, lime, minerals, soils, waters, surface, artesian, mineral.

Keyes, Charles. Gigantic Orthoceratite from American Carboniferous. (Science, N. S., Vol. III, pp. 94-95, New York, 1896.) A short summary is given of the forms of *Orthoceras* known from the Carboniferous strata of the country, and attention is called to the recent finding in Guthrie county of a very large shell, probably originally over six feet in length. It is called *Orthoceras fanslerensis*.

Keyes, Charles. Glacial Scorings in Iowa. (Iowa Geol. Surv., Vol. III, pp. 147-165, Des Moines, 1894.) The known localities are listed where in Iowa glacial striæ have been observed; and the determined directions of the striæ are tabulated. A number of unusually fine striated surfaces newly discovered are described and several photographs are reproduced showing the ice-flutings and other markings.

Keyes, Charles. Growth of Iowa's Coal Industry. (Mon. Rev. Weather Serv., Vol. V, No. 12, pp. 5-7, Des Moines, 1894.) The growth of Iowa's principal mining industry is traced from the time when coal was first taken out of the ground for commercial purposes. The state's output is also compared with that of neighboring states. By counties the tonnage mined during the year previous

to making the report on the coal deposits is tabulated. The production is also grouped according to the several sections of the state.

Keyes, Charles. Gypsum Deposits of Iowa. (Iowa Geol. Surv., Vol. III, pp. 257-304, Des Moines, 1894.) In describing the geological features of the region the unconformable relations with the coal-measures and St. Louis limestone are especially emphasized. The outcrops are considered in detail. Origin and geological age of the gypsum are discussed at some length; and the evidence adduced seems to point to a Cretaceous age. From similar shales further north Lesquereux described leaves which he assigned to the Dakota stage.

The composition, present uses and probable future uses of the gypsum are described; also the character of the beds, their extent and value; their general availability, the production and markets. The milling and preparation of the gypsum for market are entered into in considerable detail.

An important fact brought out is that the gypsum is a long basin having its main axis trending northeast and southwest instead of northwest and southeast as formerly supposed. Predictions of extensive deposits far beyond the known limits of the gypsum have since been fulfilled by the disclosures made by extensive boring explorations.

Keyes, Charles. Horizons of Arkansas and Indian Territory Coals compared with those of other Trans-Mississippian Coals. (Eng. and Mining Jour., Vol. LXXI, pp. 692-693, New York, 1901.) The industrial aspects of a knowledge of the exact stratigraphic horizons of the coal beds are emphasized. Differences between the southern and northern sections of the coal-measures are pointed out by diagrams.

Keyes, Charles. Iowa Coal Beds. (Mon. Rev. Iowa Weather and Crop Service, Vol. IV, No. 1, pp. 3-5, Des Moines, 1893.) The general geology, production and availability of the coal deposits of Iowa are described.

- Keyes, Charles.** Iowa Coal Beds. (Coal Trade Journal, Vol. XXXII, p. 133, March 1, 1893.)
- Keyes, Charles.** (Iowa Gypsum. (The Mineral Industry, Vol. IV, pp. 379-386, New York, 1896.) The industrial aspects of the Iowa gypsum interests are described at some length. Geology, chemical composition and extent of the deposits are considered. The present uses of gypsum and the methods of its preparation for market are also described. Photographs of the gypsum deposits are given.
- Keyes, Charles.** Iowa's Gypsum Deposits. (Mon. Rev. Iowa Weather and Crop Service, Vol. IV, No. 3, pp. 2-4, Des Moines, 1893.) The geology of the gypsum region is described, with special reference to the amount and availability of the gypsum deposits of the state.
- Keyes, Charles.** Iowa Mineralogical Notes. (Proc. Iowa Acad. Sci., Vol. I, pt. iii, pp. 19-22, Des Moines, 1893.) A description is given of certain recent finds of minerals in the state. Some unusually perfect crystals of pyrite are figured. The Keokuk millerites are described in detail. Announcement of the presence of eruptive rocks in northwestern Iowa is also made.
- Keyes, Charles.** Iowa's Contribution to Glaciology. (Annals of Iowa, Historical Quarterly, Vol. IV, pp. 394-396, Des Moines, 1900.) Statement of the part Iowans have played in advancing knowledge concerning the Great Ice Age. Particular attention is directed to the recent voluminous writings of Frank Leverett.
- Keyes, Charles.** Iowa Scientist and His Work. (Annals of Iowa, Historical Quarterly, Vol. IV, pp. 383-392, Des Moines, 1900.) An outline of the great work on glacial geology by Frank Leverett, an Iowan, is given, together with a biographical sketch and a portrait. The volume reviewed comprises some 800 pages and is regarded as one of the notable contributions to American geology. The subject matter covers mainly the southeastern part of the state.

- Keyes, Charles.** Iowa Volcano. (Mon. Rev. Iowa Weather and Crop Service, Vol. IV, pp. 5-6, Des Moines, 1893.) Eruptive rocks in northwestern Iowa are described.
- Keyes, Charles.** Kinderhook Stratigraphy. (Journal of Geology, Vol. VIII, pp. 315-321, Chicago, 1900.) Regarding the Iowa part of the memoir special attention is called to the great development of the shale beneath the limestone at Burlington as indicating a mingling of Devonian and Carboniferous faunal elements. By diagram the commonly recognized basal number of the Mississippian series is shown to fade out northward, leaving the supposed base in the middle of the great shale-section. The basal shale at Burlington represents much more than the Hannibal shale of Missouri.
- Keyes, Charles.** Lime Creek Fauna of Iowa in Southwestern United States and Northern Mexican Region. (Proc. Iowa Acad. Sci., Vol. XIII, pp. 197-198, Des Moines, 1907.) Comparison of certain Devonian faunas of southwestern United States is made with that occurring in the Lime Creek shales. A list of a score or more of the most characteristic Lime Creek species is given. The wide geographic relations of this peculiar fauna are discussed.
- Keyes, Charles.** List of Carboniferous Fossils from Des Moines. (Iowa Geol. Surv., Vol. VII, pp. 330-335, Des Moines, 1897.) The components of a remarkable fauna composed mainly of minute gasteropods are here enumerated. Only from one other locality is this assemblage of fossils reported.
- Keyes, Charles.** Lower Carbonic Gasteropoda from Burlington, Iowa. (Proc. Acad. Nat. Sci. Philadelphia, 1889, pp. 283-298, 1889.) This is an annotated list of the species of gasteropods found in the Kinderhook beds and Burlington limestone at Burlington, Iowa.
- Keyes, Charles.** Marked unconformity between Carboniferous and Devonian Strata in Upper Mississippi Valley. (Am. Jour. Sci., (4), Vol. XXXVI, pp. 160-164, New Haven, 1913.) Recent recognition for the first time of sections

in which the two groups of strata are seen in juxtaposition enables wide generalization to be made concerning the exact relationships.

- Keyes, Charles.** Memorial of Charles Wachsmuth. (Proc. Iowa Acad. Sci., Vol. IV, pp. 13-16, Des Moines, 1897.) A biographical sketch of one of the state's most distinguished scientists is given, with portrait.
- Keyes, Charles.** Methods of Determining Natural Resources of a Region. (Mon. Rev. Iowa Weather Serv., Vol. VI, No. 3, pp. 5-7, Des Moines, 1895.) The work of the geological survey is briefly outlined and some of the important results summarized. Among the things attained for the state are provisions of a suitable foundation for detailed and intelligent search for mineral wealth, the assurance of permanency and development of the resources already known, the establishment of an official guaranty respecting the natural wealth of the state, the formulation on a scientific basis of a standard by which the geological features of the region may be compared with those of other districts, and an advancement of agricultural and horticultural interests and the placing of them upon a firmer basis.
- Keyes, Charles.** Mid-Continental Eolation. (Bull. Geol. Soc., America, Vol. XXII, pp. 687-714, New York, 1912.) Origin of the Great Plains through eolation is discussed in its various phases. This region forms a vast area of deposition for the exported dusts of the western deserts. The features of the region are analyzed in accordance with eolic principles. Objections to the lacustran theory and the weaknesses of the fluvatile hypothesis are pointed out.
- Keyes, Charles.** Missourian Series of Carboniferous. (American Geologist, Vol. XXIII, pp. 298-316, Minneapolis, 1899.) A general section of the Upper Coal-measures of Missouri is given, with the grouping of the various strata into ten formations which are designated by special names. Southwestern Iowa is especially consid-

ered in this connection. Over 1,000 feet of strata are ascribed to the Missourian series in this part of the state. The upper part of the series is not represented within the limits of Iowa.

- Keyes, Charles.** Names of Coals West of the Mississippi River. (Proc. Iowa Acad. Sci., Vol. VII, 128-137, Des Moines, 1901.) A standard terranal classification of the coal-measures of the Western Interior region is given, to which are referred all the known coal-horizons. The three serial subdivisions recognized are Arkansan, Des Moines and Missourian.
- Keyes, Charles.** Naticoid Genus *Strophostylus*. (American Naturalist, Vol. XXIV, pp. 1111-1117, Philadelphia, 1890.) Some of the forms described are from Iowa rocks. The definition of the genus is based largely upon Iowa species.
- Keyes, Charles.** Natural Gas and Oil in Iowa. (Proc. Iowa Acad. Sci., Vol. I, pt. iii, pp. 15-18, Des Moines, 1893.) Statement is made of the various conditions necessary for a successful flow of natural gas and mineral oil and an application of the principles involved to Iowa.
- Keyes, Charles.** Nature of Coal Horizons. (Journal of Geology, Vol. I, pp. 178-186, Chicago, 1894.) The basin-shaped character of the coal deposits is analyzed and the cross sections in different directions compared. The various conflicting theories are thereby shown to be in harmony with one another. Diagrams accompany the explanations. The discussion is applicable particularly to the Iowa and Missouri coal-fields.
- Keyes, Charles.** Nether Delimitation of Our Carbonic Rocks. (Science, N. S., Vol. XXXVI, p. 569, New York, 1912.) Announcement is made of the finding of the unconformable juncture of the carboniferous and devonian rocks in Iowa.
- Keyes, Charles.** Nether Delimitation of Our Carbonic Rocks. (Proc. Iowa Acad. Sci., Vol. XIX, pp. 151-154, Des Moines, 1912.) The base of the carboniferous sequence in Iowa has never been open to inspection. Neither has

the top of the devonian section been recognized with certainty. Recently recorded facts go to show that there is a marked unconformity in places between the two great rock-successions. The basal member of the carboniferous is the Grassy shale of Missouri heretofore regarded as Devonian in age. The Sweetland Creek beds of Muscatine county are the northward extension.

- Keyes, Charles.** New *Conocardium* from Iowa Devonian. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, pp. 23-24, Des Moines, 1892.) Description is given of *Conocardium altum*, which is regarded as new.
- Keyes, Charles.** New Locality for Millerite. (American Geologist, Vol. XI, p. 126, Minneapolis, 1893.) Description of some unusually fine examples of the mineral recently found at Keokuk is given.
- Keyes, Charles.** "Nickel Ore" from Iowa. (Eng. and Mining Journal, Vol. LIV, p. 634, New York, 1892.) A statement is made in regard to the recent finds of the sulphide of nickel, or millerite, from Keokuk.
- Keyes, Charles.** North American Fossil Crinoidea Camerata. (Journal Geology, Vol. IV, pp. 221-240, Chicago, 1896.) This is an extended and critical review of Wachsmuth and Springer's monograph on the crinoids appearing in two large volumes and an atlas of 83 plates. To this are added certain personal observations and the discussion of sundry aspects of the subject of wide morphological interest. The subject matter is largely based upon material from Iowa.
- Keyes, Charles.** Northward Extension of Lake Valley Limestone. (Proc. Iowa Acad. Sci., Vol. XII, pp. 169-171, Des Moines, 1905.) Notice is taken of the occurrence of the typical Burlington (Iowa) fauna at Lake Valley and the recent finding of similar forms much farther north in the Magdalena mountains of New Mexico.
- Keyes, Charles.** Note on Carboniferous Fauna of Mississippi Valley in Rocky Mountain Region. (Proc. Iowa Acad. Sci., Vol. XI, pp. 258-259, Des Moines, 1904.) A com-

parison of the carboniferous fossils from the Rio Grande province is made with those occurring at Burlington, Iowa.

- Keyes, Charles.** Note on Correlation of Clarinda Well-section with the Schematic Section of the Carboniferous. (Iowa Geol. Surv., Vol. XI, pp. 461-463, Des Moines, 1901.) The record is shown to be that of a typical section of the Missourian series in which all the numbers recently named as belonging to that series are recognizable. Only the Iola limestone is missing, since it is known to thin out northward from Kansas City.
- Keyes, Charles.** Note on Distribution of *Helicina Occulta*. (The Nautilus, Vol. III, pp. 18-19, Philadelphia, 1889.) Notes are given on the distribution of these fossil forms recently found living in Iowa.
- Keyes, Charles.** Note on Nature of Cone-in-Cone. (Proc. Iowa Acad. Sci., Vol. III, pp. 75-76, Des Moines, 1896.) Recently a number of unusually fine specimens of this remarkable structure were obtained. They are shown to be crystalizations of calcic carbonate which have incorporated more or less clay as impurities. The structure is due therefore to the strong crystallizing process of the mineral calcite.
- Keyes, Charles.** Notes on Redrock Sandstone. (Proc. Iowa Acad. Sci., Vol. I, pt. ii, pp. 26-27, Des Moines, 1892.) Preliminary reference is made to the stratigraphical relations of an extensive sandstone formation in Marion county.
- Keyes, Charles.** Nous Avons Eu de Grandes Richesses Houillères. (La Chronique Industrielle, Trente-cinquième Année, No. 102, pp. 1-2, Paris, 1912.) A brief history is given of the discovery, by the French, of coal in the Upper Mississippi valley.
- Keyes, Charles.** Observations on Classification of Mississippian Series. (American Geologist, Vol. XXII, pp. 108-113, Minneapolis, 1898.) Reasons are advanced for retain-

ing the term Augusta in preference to that of Osage for a subdivision of the Mississippian series. The latter name is shown to be preoccupied several times.

- Keyes, Charles.** Occurrence of Natural Gas in Iowa; and its Probable Future. (Mon. Rev. Iowa Weather and Crop Service, Vol. III, No. 12, pp. 3-4, Des Moines, 1892.) A general account of the conditions necessary for a successful flow of oil and gas, and an account of how these conditions are satisfied within the limits of Iowa so far as is known, are given.
- Keyes, Charles.** Old Volcanic Eruption in Iowa. (Science, Vol. XXI, p. 132, New York, 1893.)
- Keyes, Charles.** Opinions Concerning Age of Sioux Quartzite. (Proc. Iowa Acad. Sci., Vol. II, pp. 218-222, Des Moines, 1895.) All the articles published on the Sioux quartzite are reviewed and summarized. The evidence upon which the varied opinions is based are weighed and compared with more recent personal observations. The conclusion reached is that the formation is Huronian in age.
- Keyes, Charles.** Origin of Anthracite. (American Geologist, Vol. XIII, pp. 411-415, Minneapolis, 1894.) The discussion of the subject is based upon a remarkable variety of coal known as the Mystic seam in southern Iowa. The coal is of bituminous variety but in all physical properties except hardness it would easily be mistaken for anthracite. A question arises as to the different modes of the origin of coal.
- Keyes, Charles.** Origin of the Great Plains. (Science, N. S., Vol. XXXIV, pp. 352, New York, 1911.) Their formation is ascribed to eolative influences chiefly. The other hypotheses are reviewed.
- Keyes, Charles.** Origine Eolienne du Loess. (Bull. de la Société Belge de Géologie, de Paléontologie et d'Hydrologie, Tome XII, pp. 14-21, Bruxelles, 1901.) The origin of the loess deposits of the Missouri River valley

in Iowa and Missouri by wind-storm dusts is advanced, and the data upon which the argument is based are given.

- Keyes, Charles.** Orotaxical Correlation of Geological Terranes and Diastrophism. (Proc. Iowa Acad. Sci., Vol. XVI, pp. 153-157, Des Moines, 1909.) This is an application of local principles worked out in Iowa to general geological classification.
- Keyes, Charles.** Orotaxis: A Method of Geologic Correlation. (American Geologist, Vol. XVIII, pp. 289-302, Minneapolis, 1896.) The plan had its inception in the stratigraphic consideration of the Iowa coal-measures, and some of the illustrations are derived from this source.
- Keyes, Charles.** Ozark Lead and Zinc Deposits: Their Genesis, Localization and Migrations. (Trans. American Inst. Mining Eng., Vol. XL, pp. 184-231, New York, 1909.) In considering the localization of ore-bodies in synclines special note is made of the formation of the latter in Iowa of an unequal change in volume of the underlying rocks.
- Keyes, Charles.** Paleontology of Missouri, Part I. (Missouri Geol. Surv., Vol. IV, 271 pp., Jefferson City, 1894.) In the general chapter on the geological section numerous references are made to Iowa formations. The descriptions of the detailed cross section along the Mississippi river includes the Iowa boundary as far north as the Iowa river. Many Iowa fossils are described and illustrated.
- Keyes, Charles.** Paleontology of Missouri, Part II. (Missouri Geol. Surv., Vol. V, 266 pp., Jefferson City, 1894.) Many forms of organic remains from Iowa localities are described and illustrated.
- Keyes, Charles.** Paleozoic Fossils of Maryland. (Johns Hopkins University Circulars, Vol. XI, pp. 28-29, Baltimore, 1891.) A number of Iowa species are identified for the first time in the Appalachian region.

- Keyes, Charles.** Perisomic Plates of Crinoids. (*American Geologist*, Vol. VII, pp. 255-258, Minneapolis, 1891.) The discussion of the subject is based upon descriptions of certain Iowa forms.
- Keyes, Charles.** Permian Rocks of Eastern Russia. (*Proc. Iowa Acad. Sci.*, Vol. VI, pp. 229-231, Des Moines, 1899.) The standard Carboniferous sections of eastern Russia and of the original Permian are compared with that of Iowa, Missouri and Kansas. A remarkable parallelism of formations is displayed.
- Keyes, Charles.** *Platyceras* Group of Palæozoic Gasteropods. (*American Geologist*, Vol. X, pp. 273-277, Minneapolis, 1892.) A revision of the group with special reference to the forms from Iowa, is outlined.
- Keyes, Charles.** Pre-Glacial River-channels of Central Iowa. (*The Annals, Historical Quarterly*, Vol. VIII, pp. 13-17, Des Moines, 1907.) Special description is given of Tertiary river-lines in the present Des Moines valley. Des Moines and Keokuk are noted. Sketches of the structure represented accompany the article and a sketch-map of the glacial deposits is given.
- Keyes, Charles.** Preliminary Note on Sedentary Habits of *Platyceras*. (*Proc. Iowa Acad. Sci.*, Vol I, pt. ii, p. 24, Des Moines, 1892.) A preliminary account is made of the attachment of gasteropods to crinoids.
- Keyes, Charles.** Present Basal Line of Delimitation of the Carboniferous in Northeastern Missouri. (*American Geologist*, Vol X, pp. 380-384, Minneapolis, 1892.) A special bearing of the observations upon the rock-succession of southern Iowa is noted. It is predicted that a marked line of unconformity will be found to exist between the Devonian and Carboniferous strata of this region.
- Keyes, Charles.** Preservation of the Color in Fossil Shells. (*The Nautilus*, Vol. IV, pp. 30-31, Philadelphia, 1890.) Particular attention is directed to the original coloration of certain snail-shells from the loess of central Iowa.

- Keyes, Charles.** Principal Mississippian Section. (Bull. Geol. Soc. America, Vol. III, pp. 283-300, Washington, 1892.) The leading section along the Mississippi river, a historical consideration of the various terms applied to rocks and a detailed description of the different formations are given. A classification of the Mississippian series is proposed in accordance with the observations recently made.
- Keyes, Charles.** Probable Stratigraphical Equivalents of Coal-measures of Arkansas. (Journal of Geology, Vol. VI, pp. 356-365, Chicago, 1898.) The attempt is made to show that the enormously thick section of coal-measures displayed in Arkansas is not the equivalent of the coal-measures further north (Missouri and Des Moines series) as represented in Iowa.
- Keyes, Charles.** Process of Formation of Certain Quartzites. (Proc. Iowa Acad. Sci., Vol. I, Part iv, 29-31, Des Moines, 1894.) Thin slices of rock under the microscope show that the quartzite under consideration was formed by the secondary enlargement of the sand-grains, the added silica of the rock-grains being in optical continuity with them. Notice is also taken of the occurrence of diabase dikes in the Sioux quartzite beyond the Iowa boundary.
- Keyes, Charles.** Proposed Economical Geological Survey of Iowa. (Pamphlet, 8 pp., Des Moines, 1891.) Statement is made of the need of a geological survey of the state and of the various lines of work which especially require investigation, together with comparisons with other states; and an outline of how the work should be conducted is given. Portions appeared in various newspapers throughout the state.
- Keyes, Charles.** Redrock Sandstone of Marion County, Iowa. (Am. Jour. Sci., (3), XLI, pp. 273-276, New Haven, 1891.) There is described a section of a thick sandstone formation exposed on the Des Moines river in Marion county, showing a remarkable unconformity

- in the Cherokee shales. Extension of the sand-rock is pointed out and the opinions regarding its age considered.
- Keyes, Charles.** Relations of Devonian and Carboniferous in Upper Mississippi Valley. (Trans. St. Louis Acad. Sci., Vol. VII, pp. 357-369, St. Louis, 1897.) Results of a detailed comparison of fossil faunas of the Mississippian series in northeastern Missouri are also applicable to southeastern Iowa. The conclusions reached are partly the outcome of the observations made at Burlington.
- Keyes, Charles.** Relations of Missouri River Loess Mantle and Kansan Drift Sheet. (American Jour. Sci., (4), Vol. XXXIII, pp. 32-34, New Haven, 1912.) The loess mantles are believed to be eolian formed sheets interlocking with the ice formed glacial drift sheets. The materials of the first were derived from the southwest; those of the second from the northeast.
- Keyes, Charles.** Relations of *Platyceras* and *Capulus*. (American Geologist, Vol. III, pp. 6-9, Minneapolis, 1890.) The generic distinctions made are based upon forms collected mainly from the Mississippian rocks of southeastern Iowa.
- Keyes, Charles.** Remarkable Fauna at Base of Burlington Limestone in Northeastern Missouri. (Am. Jour. Sci., (3), Vol. XLIV, pp. 247-252, New Haven, 1892.) References are made to the rocks of southeastern Iowa.
- Keyes, Charles.** Remarks on Perisomic Plates of Crinoids. (American Jour. Sci., (3), Vol. XLI, pp. 247-248, New Haven, 1891.) The comments on the important morphologic memoir are based upon specimens from the rocks of Marshall and Des Moines counties.
- Keyes, Charles.** Review of Progress of American Invertebrate Paleontology for 1889. (American Naturalist, Vol. XXIV, pp. 131-138, Philadelphia, 1890.) A number of the important papers of the year relating to Iowa are reviewed.

- Keyes, Charles.** Review of Progress of American Invertebrate Paleontology for year 1890. (American Naturalist, Vol. XXV, pp. 327-333, Philadelphia, 1891.) Special notice is taken of several memoirs published during the year on Iowa geology.
- Keyes, Charles.** Revised List of Loess Fossils from Des Moines. (Iowa Geol. Surv., Vol. VII, p. 344, Des Moines, 1897.) A complete list of the forms thus far discovered in Polk county is given.
- Keyes, Charles.** Schematic Standard for American Carboniferous. (American Geologist, Vol. XXVIII, pp. 299-305, Minneapolis, 1901.) A table of formations constituting the Carboniferous sequence in the Mississippi valley is given and the various phases discussed.
- Keyes, Charles.** Sedentary Habits of *Platyceras*. (Am. Jour. Sci., (3), Vol. XXXVI, pp. 269-272, New Haven, 1888.) Notes are given on the habits of various species found in Iowa, especially those attached to crinoids.
- Keyes, Charles.** Serial Nomenclature of Carboniferous. (American Geologist, Vol. XVIII, pp. 22-28, Minneapolis, 1896.) Three of the four serial subdivisions of the Carboniferous are defined upon Iowa and Missouri delimitations.
- Keyes, Charles.** Sketch of Coal Measures of Iowa. (U. S. Geological Survey, Mineral Resources for 1892, pp. 398-404, Washington, 1894.) This is a concise account of the geological characters of the productive coal-measures of the state. The relations of the Iowa field to the great Interior coal-basin are noted. Thickness, variability, extent and character of individual coal-beds are particularly described.
- Keyes, Charles.** Sketch of Coal Deposits of Iowa. (Coal Trade Journal, Vol. XXXIII, pp. 954-957, New York, 1894.) The salient characters of the Iowa coal-bearing formations are considered and their commercial aspects are especially noted. The paper is illustrated by reproduced photographs showing the top-works of some of the most completely equipped mines.

- Keyes, Charles.** Sketch of Geology of Iowa. (Handbook of Iowa, World's Columbian Exposition at Chicago, pp. 18-28, Dubuque, 1893.) This is a popular résumé of what is known of the geological formations of the state. The various terranes are briefly characterized and their principal economic values pointed out.
- Keyes, Charles.** Soleniscus: its Generic Characters and Relations. (American Naturalist, Vol. XXIII, pp. 420-429, Philadelphia, 1889.) Description of the generic characters of the group is given, and several of the species belonging to the section are figured from Iowa.
- Keyes, Charles.** Some Fossils from Lower Coal Measures at Des Moines, Iowa. (American Geologist, Vol. II, pp. 24-28, Minneapolis, 1888.) A brief account is given of the relations of the coal horizons; with a list of 54 species of invertebrates and 2 of fishes found at Des Moines. The biological relations of the forms also receive notice.
- Keyes, Charles.** Some Physical Aspects of General Geological Correlation. (Proc. Iowa Acad. Sci., Vol. VI, pp. 131-154, Des Moines, 1899.) Diastrophism is the chief cause of sedimentary changes and its physical expression is the unconformity. For the major subdivisions of terranal sequence unconformity should therefore be the main criterion. The Iowa coal-measures form an admirable basis for outlining a general classification and the principles of geological correlation.
- Keyes, Charles.** Spanish Mines; an Episode in Primitive American Lead-Mining. (Annals of Iowa; an Historical Quarterly, Vol. X, pp. 539-546, Des Moines, 1912.) The financial methods of Julian Dubuque are recounted.
- Keyes, Charles.** Sphærodoma: a Genus of Fossil Gasteropods. (Proc. Acad. Nat. Sci. Phila., 1889, pp. 303-309, Philadelphia, 1889.) This is revision of the species formerly referred to Macrochilus; part of the species is placed under Soleniscus and others to the new genus Sphærodoma.

- Keyes, Charles.** Stages of Des Moines, or Coal-bearing, Series of Kansas and Southwestern Missouri, and their Equivalents in Iowa. (Proc. Iowa Acad. Sci., Vol. IV, pp. 22-25, Des Moines, 1897.) Subdivisions of the Des Moines series in Missouri are shown to be recognizable in the Iowa portion of the Western Interior coal-field. Their names are Cherokee shales, Henrietta limestones and Pleasanton shales. The last two terranes are more properly called in Iowa the Appanoose limestones and the Marais des Cygnes formation. These are briefly characterized.
- Keyes, Charles.** Stratigraphical Location of named Trans-Mississippian Coals. (Eng. and Min. Jour., Vol. LXXII, p. 198, New York, 1901.) A complete schematic section of the Carboniferous rocks of the Mississippi valley is given for the first time. The coal-beds known in each terrane are listed, with their localities.
- Keyes, Charles.** Stratigraphy of Carboniferous in Central Iowa. (Bull. Geol. Soc. America, Vol. II, pp. 277-292, Washington, 1891.) A full description is given of the various sections exposed along the Des Moines river in the central part of the state, with special reference to the lithological characters of the strata, and the stratigraphical relations of various beds. Several marked unconformities are described and illustrated and the leading faunal aspects of the region are tabulated.
- Keyes, Charles.** Structure of Coal Deposits of Trans-Mississippian Field. (Eng. and Mining Jour., Vol. LXV, pp. 253-254, and 281, New York, 1898.) In summarizing the salient facts concerning the geological features of the Western Interior coal-field the following topics are particularly discussed: Principal rock-series recognized, extent and thickness of the productive coal-veins, general geological structure of the coal region, character of the rocks, natural subdivisions of the productive measures, description of the coal-beds, thickness and availability of the coal-beds, prospects of coal outside

of the surface areas occupied by the main-body of productive coal-measures and nature of the coal-pockets and outliers.

- Keyes, Charles.** Sundry Provincial and Local Phases of General Geological Section of Iowa. (Science, N. S., Vol. XXXVI, p. 569, New York, 1912). The urgent need of a radical revision in the nomenclature of Iowa formations is pointed out; and a working scheme is presented.
- Keyes, Charles.** Sundry Provincial and Local Phases of the General Geological Section of Iowa. (Proc. Iowa Acad. Sci., Vol. XIX, pp. 147-151, Des Moines, 1912.) Certain features of the stratigraphy of the state are briefly discussed in the light of recent advances of geological classifications. A careful revision of the nomenclature of the geological formations now recognized is needful. There should be a detailed study of some of the larger groups with a view of a more satisfactory subdivision. One of these sections is the Cedar Valley limestone. A time subdivision should apply only to the major groups and a space subdivision to the minor groups.
- Keyes, Charles.** Surface Geology of Burlington, Iowa. (American Naturalist, Vol. XXII, pp. 1049-1054, Philadelphia, 1888.) A sketch of the topography and surface geology of the district, with topographical map and cross sections is given.
- Keyes, Charles.** Synopsis of American Carbonic Calyptræidæ. (Proc. Acad. Nat. Sci., Phila., 1890, pp. 150-181, Philadelphia, 1890.) There are given full descriptions of the generic characters and relations of the genus *Capulus* found in the carboniferous rocks of America; also a tabular statement of the association of crinoids and gasteropods. The stratigraphical reference of all species found in the American carboniferous to their proper horizons is made, and all species are described in full, with bibliographic references. The memoir is illustrated by a plate of 22 figures.

- Keyes, Charles.** Synopsis of American Paleozoic Echinoids (Proc. Iowa Acad. Sci., Vol. II, pp. 178-194, Des Moines, 1895.) The principal species are from the Mississippi valley. Some unusually fine material is reported from Iowa rocks. An annotated list of the forms from the state is given. New species are described and figured.
- Keyes, Charles.** Taxonomy of Crinoids. (American Naturalist, Vol. XXX, pp. 292-295, Philadelphia, 1896.) A brief discussion is given of the zoological relations of the crinoids as brought out by Wachsmuth and Springer's monograph. The basis is chiefly Iowa materials.
- Keyes, Charles.** Thickness of Paleozoic in Mississippi Valley. (American Geologist, Vol. XVII, pp. 161-173, Minneapolis, 1896.) Special reference is made to the thickness of the coal-measures, which in Iowa is shown to be very much more than has been hitherto regarded. Sixteen hundred feet are suggested as the most reliable figures.
- Keyes, Charles.** Time-values of Provincial Carboniferous Terranes. (Am. Jour. Sci., (4), Vol. XII, pp. 305-309, New Haven, 1901.) The total thickness of the Carboniferous strata of the Mississippi valley is estimated at 25,000 feet. As the rocks are now subdivided into six series the time-ratio of their deposition appears to be very nearly equal, the Mississippian and Missouri being probably a little longer than the other.
- Keyes, Charles.** Two Remarkable Cephalopods from Upper Paleozoic. (Proc. Iowa Acad. Sci., Vol. III, pp. 76-78, Des Moines, 1896.) Descriptions are given of two rather remarkable fossils found recently in the Iowa coal-measures: They are *Nautilus ponderosus*, and *Orthoceras fanslerensis*. The latter was a shell which probably attained a length of six feet; and the former was 12 to 15 inches in diameter.
- Keyes, Charles.** Ueber das Carbon des Mississippithales. (Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Jahrg. 1896, Bd. I, pp. 96-110, Berlin, 1896.) There

is given a classification of the terranes in accordance with the indications of the most recent investigations. The various subdivisions are briefly characterized. The foundation of the terranal sequence as recognized and named is the Iowa section.

- Keyes, Charles.** Use of Term Augusta in Geology. (*American Geologist*, Vol. XXI, pp. 229-235, Minneapolis, 1898.) The name was suggested for one of the principal stratigraphical subdivisions of the Mississippian series; it is not synonymous with the section covered by the time-unit Osage, as has been thought. The argument covers all the disputed points which have been brought up from time to time.
- Keyes, Charles.** Variation Exhibited by a Carbonic Gasteropod. (*American Geologist*, Vol. III, pp. 329-333, Minneapolis, 1889.) Great variation is shown in a single species from the Keokuk limestone. Outlines of specimens from Keokuk are given.
- Keyes, Charles.** Vertical Range of Fossils at Louisiana. (*Proc. Iowa Acad. Sci.*, Vol. IV, pp. 26-41, Des Moines, 1897.) [with R. R. Rowley.] The range of the fossils in northeast Missouri is shown to have an important bearing upon the subdivisions of the Mississippian series to be recognized in Iowa.
- Keyes, Charles.** W. J. McGee; Geologist, Anthropologist, Hydrologist. (*Annals of Iowa; an Historical Quarterly*, Vol. XI, Des Moines, 1913.) There is given a brief account of his scientific work in general and in Iowa in particular.
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- Underground water resources of Iowa. W. H. Norton. (Iowa Geol. Surv., XXI, 29-1214, 1912.)
- Underground water resources of Iowa. W. H. Norton. (U. S. Geol. Surv., Water Supply Paper No. 293, 994 pp. 1912.)
- Use of term Augusta in geology. C. R. Keyes. (American Geologist, XXI, 229-235, 1898.)
- Variation of gasteropod (from Keokuk). C. R. Keyes. (American Geologist, III, 329-333, 1889.)
- Weathered zone (Sangamon) between Iowan loess and Illinoian till-sheet. F. Leverett. (Proc. Iowa Acad. Sci., V, 71-80, 1898.)
- Weathered zone (Yarmouth) between Iowan and Kansan till-sheets. F. Leverett. (Proc. Iowa Acad. Sci., V, 81-86, 1898.)
- Weathered zone (Yarmouth) between Illinoian and Kansan till-sheets. Frank Leverett. (Journal of Geology, VI, 238-243, 1898.)
- × Wood found in Keokuk limestone. C. H. Gordon. (Proc. Iowa Acad. Sci., I, pt. i, 97-98, 1890.)
- Lee county**, geology. C. R. Keyes. (Iowa Geol. Surv., III, 305-407, 1894.)
- Lees, James H.** Bibliography of Iowa Coals. (Iowa Geol. Surv., Vol. XIX, pp. 659-687, Des Moines, 1909.) Complete author's and county lists of references are given.

- Lees, James H.** Bibliography of Iowa Peat. (Iowa Geol. Surv., Vol. XIX, pp. 731-733, Des Moines, 1909.) There is given a very full list of the publications on the subject.
- Lees, James H.** General Section of Des Moines Stage of Iowa. (Iowa Geol. Surv., Vol. XIX, pp. 598-604, Des Moines, 1909.) Three subdivisions are recognized: Cherokee shales, Appanoose beds and Pleasanton shales. The complete descriptive section embraces thirty-two numbers.
- Lees, James H.** History of Coal Mining in Iowa. (Iowa Geol. Surv., Vol. XIX, pp. 521-586, Des Moines, 1909.) The development of the mining in each of the coal-producing counties is fully considered. The historical summaries are especially complete in regard to early mining.
- Lees, James H.** Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. XVII, pp. 7-10, Des Moines, 1907.) Summarizes the year's work; gives a list of exchange publications.
- Lees, James H.** Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. XVIII, pp. 6-9, Des Moines, 1908.) The personal work of the year is reviewed.
- Lees, James H., and A. W. Hixson.** Analyses of Iowa Coals. (Iowa Geol. Surv., Vol. XIX, pp. 476-519, Des Moines, 1909.) The laboratory methods of analysis are described. A complete list of analyses of Iowa coals is compiled.
- Leidy, Joseph.** Fossil Remains of Caribou. (Proc. Acad. Nat. Sci. Philadelphia, Vol. XXXI, pp. 32-33, Philadelphia, 1879.) Announcement is made of *Rangifer caribou* from the loess, and *Cervus muscatinensis*, supposed to be extinct, from Muscatine, Iowa.
- Leonard, Arthur G.** Geology of Clayton County. (Iowa Geol. Surv., Vol. XVI, pp. 213-317, Des Moines, 1906.) The features described are here enumerated:
Introduction, location and area, previous geological work.

Physiography, topography, the driftless area, Iowan drift area, drainage.

Stratigraphy, general relations of strata, synoptical table, comparative table; Cambrian system, Saint Croix sandstone; Ordovician system, lower magnesian limestone, Saint Peter sandstone, Galena-Trenton limestone, Trenton limestone, lithological character, distribution and thickness, Galena limestone, distribution and thickness, Maquoketa stage; Silurian system, Niagara limestone, residual materials; Pleistocene system, Kansan stage, Kansan drift, Buchanan gravels, Iowan stage, Iowan drift, loess, terraces, alluvium; deformations; unconformities.

Economic geology; soils, building-stones, clays, limes, glass-sands, road-materials, lead; water-resources, water-power, clams.

Leonard, Arthur G. Geology of Dallas County. (Iowa Geol. Surv., Vol. VIII, pp. 51-118, Des Moines, 1898.) The topics treated are as follows: Introduction, situation and area, previous geological work.

Physiography, topography, table of elevations, drainage.

Stratigraphy, general relations of strata; standard sections, Booneville section, Van Meter section, Van Meters Mill section, Desoto section, Panther creek, Cottonwood, Redfield, County Line, Linden, Adel, Sugar creek, High Bridge, Dawson; Missourian Limestone sections, well-records.

Geological formations, Upper Carboniferous, Des Moines, Missourian; Pleistocene, Kansan drift, loess, Wisconsin drift, alluvium and terraces.

Geological structure, deformations, Redfield section.

Economic products; coal, Raccoon Valley mines, South Raccoon Valley mines, Middle Raccoon Valley mines, North Raccoon Valley mines, Des Moines River mines; clays, Van Meter, Adel, Redfield, De Soto, Minburn, Perry, Dawson, Madrid; building-stones, road-materials, natural gas, water-supplies, soils.

Leonard, Arthur G. Geology of Wapello County. (Iowa Geol. Surv., Vol. XII, pp. 439-499, Des Moines, 1902.) The following features are described:

Introduction, location and area, previous geological work. Physiography, topography, drainage.

Stratigraphy, synoptic table of geological formations, deeper strata; Carboniferous system, Saint Louis stage, Des Moines stage, coal measures; Pleistocene system, Kansan drift, loess, alluvium and terraces.

Unconformities.

Economic products, coal, building-stone, clays, water-supplies, soils, and road-materials.

Leonard, Arthur G. Lansing Lead Mines. (Proc. Iowa Acad. Sci., Vol. II, pp. 36-38, Des Moines, 1895.) An unusual deposit is described. The novel features are the great extent of a vertically disposed galena-sheet, and its occurrence in the Oneota limestone, a geological horizon far beneath that in which the workable lead deposits of the region commonly occur. There are three to four inches of solid galena. An annual production of 400,000 pounds is attained.

Geol. Surv., Vol. VI, pp. 9-66, Des Moines, 1897.) The topics discussed are mainly as follows:

Leonard, Arthur G. Lead and Zinc Deposits of Iowa. (Iowa Chief source of world's supply of lead and zinc, history of lead and zinc mining in Iowa.

Upper Mississippi lead and zinc region, limits and extent of area, general geological sketch of region, principal formations, Saint Croix sandstone, Oneota limestone, Saint Peter sandstone, Trenton limestone, Galena limestone, Maquoketa shales, Niagara limestone.

Mode of occurrence of lead and zinc deposits, ore deposits usually in area of disturbance, Iowa deposits an exception, lead and zinc deposits mostly in limestone, comparison of upper Mississippi mines with Missouri region.

- Lead and zinc ores and associated minerals; lead minerals, glance, cerussite; zinc minerals, smithsonite, sphalerite; associated minerals, pyrite and marcasite, limonite, calcite, satin-spar, gypsum, dolomite; mode of occurrence of the Iowa ores, crevices, direction, extent, openings, mode of occurrence in crevices, as vertical sheets, in openings, vertical distribution of lead and zinc.
- Special description of mines, Dubuque county mines, Clayton county mines, Buena Vista, Guttenberg, Allamakee county mines, Lansing, New Galena.
- Origin of deposits, original sources of lead and zinc, localization of deposits, ocean-currents, surface decomposition, formation of crevices, filling of crevices, different views as to origin of the ore deposits, general ascension theory, lateral secretion theory, replacement theory, objections to ascension theory for Iowa deposits, proof of origin by lateral secretion.
- General methods of working the mines, statistics.
- The subjects of wide interest which deserve special consideration are the **mode of occurrence** and genesis of the ore deposits.
- Leonard, Arthur G.** Lead and Zinc Deposits of Iowa. (Eng. and Mining Journal, Vol. LXI, p. 614, New York, 1896.) Occurrence and mining of ores in the Galena limestone of the Dubuque district are considered.
- Leonard, Arthur G.** Lead and Zinc; Description of Mines of Iowa in Upper Mississippi Region. (Colliery Engineer, Vol. XVII, pp. 121-122, 1896.) The geologic peculiarities of the region are explained and the distribution of the ore-bodies is described.
- Leonard, Arthur G.** Natural Gas in Drift of Iowa. (Proc. Iowa Acad. Sci., Vol. IV, pp. 41-47, Des Moines, 1897.) The opinion is given that the gas is simply the product of the decomposition of vegetable remains buried in the drift.
- Leonard, Arthur G.** Occurrence of Zinc in Northeastern Iowa. (Proc. Iowa Acad. Sci., Vol. I, pt. iv, pp. 48-52, Des Moines, 1894.) Zinc mines around Dubuque are de-

scribed. The manner of occurrence, the geology and the character of the ores are especially noted. The development of zinc-mining in the district is said to date from 1880.

Leonard, Arthur G. Origin of Iowa Lead and Zinc Deposits. (American Geologist, Vol. XVI, pp. 288-294, Minneapolis, 1895.) The occurrence and manner of deposition are described and the various theories of formation are reviewed.

Leonard, Arthur G. Recent Developments in Dubuque Lead and Zinc Mines. (Proc. Iowa Acad. Sci., Vol. III, pp. 64-66, Des Moines, 1896.) The openings of some new mines are described.

Leonard, Arthur G. Report of Special Assistant. (Iowa Geol. Surv., Vol. V, p. 31, Des Moines, 1896.) A short statement is made of the work done on the lead and zinc deposits.

Leonard, Arthur G. Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. VII, pp. 29-30, Des Moines, 1897.) The results of the season's work are noted.

Leonard, Arthur G. Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. XI, pp. 31-32, Des Moines, 1901.) The results of the year are enumerated.

Leonard, Arthur G. Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. XII, pp. 28-32, Des Moines, 1902.) Summary of the work done during the year is given.

Leonard, Arthur G. Report of Assistant State Geologist. (Iowa Geol. Surv., Vol. XIII, pp. 13-15, Des Moines, 1903.) The personal work of the year is summarized.

Leonard, Arthur G. Satin-spar from Dubuque. (Proc. Iowa Acad. Sci., Vol. I, pt. iv, pp. 52-55, Des Moines, 1894.) Some unusually fine examples recently obtained are described.

Leonard, A. G., and H. F. Bain. Middle Coal-measures of Western Interior Coal-field. (Journal of Geology, Vol. VI, pp. 577-588, Chicago, 1898.) There are contrasted the conditions under which the sediments of the Des Moines and Missouri stages were deposited.

- Leonard, A. G.**, and H. F. Bain. Middle Coal-measures of Western Interior Coal-field. (Bull. Geol. Soc. America, Vol. X, pp. 10-12, Rochester, 1899.) This is an abstract of another paper of similar title.
- Lepidostrobus**, American. J. M. Coulter and W. J. G. Lund. (Botanical Gazette, LI, 449-453, 1911.)
- Lepidostrobus**, American. J. M. Coulter and W. J. G. Lund. (Trans. Illinois Acad. Sci., IV, 107-108, 1912.)
- Lepidostrobus**, first reported petrified American, is from Warren county, Iowa. J. L. Tilton. (Proc. Iowa Acad. Sci., XIX, 163-165, 1912.)
- Lepidostrobus**, first reported, is from Warren county, Iowa. J. L. Tilton. (Science, N. S., XXXVI, 569, 1912.)
- Lesley, J. P.** Dictionary of Fossils of Pennsylvania. (Geol. Surv., Pennsylvania, Rep. P4, Vols. I-III, pp. 1-1283, Harrisburg, 1890.) Numerous reproductions of figures of Iowa fossils are given.
- Leverett, Frank.** Illinois Glacial Lobe. (Mon. U. S. G. S., Vol. XXXVIII, 817 pp., Washington, 1899.) The margin of the drift sheet extends into the eastern Iowa region. The phenomena presented are described in detail.
- Leverett, Frank.** Lower Rapids of Mississippi River. (Journal of Geology, Vol. VII, pp. 1-22, Chicago, 1899.) Drainage features of the Upper Mississippi valley during the glacial epoch are outlined, and the recent diversion of the river to the eastward of Keokuk is explained.
- Leverett, Frank.** Lower Rapids of Mississippi River. (Proc. Iowa Acad. Sci., Vol. VI, pp. 74-93, Des Moines, 1899.) The present and pre-glacial channels of the Mississippi river at Keokuk are compared and the various questions concerning the exact date of the diversion of the river-course are discussed.
- Leverett, Frank.** Old Channels of Mississippi in Southeastern Iowa. (Annals of Iowa, Historical Quarterly, (3), Vol. V, pp. 38-51, Des Moines, 1901.) The transgressions of the several ice-sheets are described, and their influence on the former drainage lines is noted.

Leverett, Frank. Pre-Glacial Valleys of Mississippi and Tributaries. (Journal of Geology, Vol. III, pp. 740-763, Chicago, 1895.) The present course of the river is on the same lines as the preglacial one except north of Muscatine and north of Keokuk. At these two points there was a diversion of the pre-glacial streams westward.

Leverett, Frank. Weathered Zone (Sangamon) between Iowan Loess and Illinoian Till-sheet. (Journal of Geology, Vol. VI, pp. 171-181, Chicago, 1898.) The interglacial soil is characterized.

Leverett, Frank. Weathered Zone (Sangamon) between Iowan Loess and Illinoian Till-sheet. (Proc. Iowa Acad. Sci., Vol. V, pp. 71-80, Des Moines, 1898.) The till sheets are described and the characters of the Sangamon zone are noted in some detail. A description of the proper terminology follows.

Leverett, Frank. Weathered Zone (Yarmouth) between Illinoian and Kansan Till-sheets. (Journal of Geology, Vol. VI, pp. 238-243, Chicago, 1898.) The interglacial deposits are characterized and the typical locality of the Yarmouth soil, in Lee county, is described.

Leverett, Frank. Weathered Zone (Yarmouth) between Illinoian and Kansan Till-sheets. (Proc. Iowa Acad. Sci., Vol. V, pp. 81-86, Des Moines, 1898.) Typical exposures in Lee county are described.

Light, more, on origin of Missouri river loess. J. E. Todd. (Proc. Iowa Acad. Sci., XIII, 187-194, 1906.)

Lignite.

Geology of Plymouth county. H. F. Bain. (Iowa Geol. Surv., VIII, 315-366, 1898.)

Geology of Woodbury county. H. F. Bain. (Iowa Geol. Surv., V, 241-299, 1896.)

Lime Creek Shales.

Additional evidence of unconformity between Cedar Valley and Lime Creek stages of Devonian of Iowa. A. O. Thomas. (Science, N. S., XXXVI, 569-570, 1912.)

- Artesian wells of Iowa. W. H. Norton. (Iowa Geol. Surv. VI, 113-428, 1897.)
- Brachiopods from various localities in Iowa. J. Hall. (Nat. Hist. New York, Pal., VIII, 1-269, 1892.)
- Devonian fishes of Iowa. C. R. Eastman. (Iowa Geol. Surv., XVIII, 29-360, 1908.)
- Distribution of Rockford shales. C. L. Webster. (Proc. Davenport Acad. Sci., V, 100-109, 1887.)
- General preliminary description of devonian rocks of Iowa, which constitutes typical section of devonian formation of Interior continental area of North America. C. L. Webster. (American Naturalist, XXIII, 229-243, 1889.)
- Geology of Cerro Gordo county. S. Calvin. (Iowa Geol. Surv., VII, 117-195, 1897.)
- Geology of clays. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XIV, 377-552, 1904.)
- Geology of Butler county. M. F. Arey. (Iowa Geol. Surv., XX, 1-59, 1910.)
- Geology of Franklin county. I. A. Williams. (Iowa Geol. Surv., XVI, 453-507, 1906.)
- Geology of Louisa county. J. A. Udden. (Iowa Geol. Surv., XI, 53-126, 1901.)
- Geology of northeastern Iowa. W J McGee. (Eleventh Ann. Rep. U. S. Geol. Surv., 314, 1892.)
- Lime Creek fauna of Iowa in southwestern United States and northern Mexican region. C. R. Keyes. (Proc. Iowa Acad. Sci., XIII, 197-198, 1907.)
- Marked unconformity between carboniferous and devonian strata in upper Mississippi valley. C. R. Keyes. (Am. Jour. Sci., (4), XXXVI, 160-164, 1913.)
- Nether delimitation of our carbonic rocks. C. R. Keyes. (Proc. Iowa Acad. Sci., XIX, 153-156, 1912.)
- Notes on shales. C. L. Webster. (American Naturalist, XXII, 444-446, 1888.)
- Pachyphyllum from Rockford shales. C. L. Webster. (American Naturalist, XXIII, 621-625, 1889.)

Relation of Lime Creek shales to Cedar Valley limestone of Floyd county, Iowa. A. O. Thomas. (Science, N. S., XXXVII, 459, 1913.)

Sundry provincial and local phases of general geologic section of Iowa. C. R. Keyes. (Proc. Iowa Acad. Sci., XIX, 147-151, 1912.)

Two unique spirifers from devonian strata of Iowa. S. Calvin. (Bull. Lab. Nat. Hist., State Univ. Iowa, II, 165-167, 1893.)

Lime Creek fauna of Iowa in southwestern United States and northern Mexico region. C. R. Keyes. (Proc. Iowa Acad. Sci., XIII, 197-198, 1907.)

Lime Creek shales, relation to Cedar Valley limestone of Floyd county, Iowa. A. O. Thomas. (Science, N. S., XXXVII, 459, 1913.)

Lime Creek stage of devonian of Iowa, additional evidence of unconformity between Cedar Valley. A. O. Thomas. (Science, N. S., XXXVI, 569-570, 1912.)

Lime-burning dolomites and dolomitic building-stones from the Niagara of Iowa. G. L. Houser. (Iowa Geol. Surv., I, 197-207, 1893.)

Limes.

Geology of Allamakee county. S. Calvin. (Iowa Geol. Surv., IV, 35-111, 1895.)

Geology of Benton county. T. E. Savage. (Iowa Geol. Surv., XV, 125-225, 1905.)

Geology of Black Hawk county. M. F. Arey. (Iowa Geol. Surv., XVI, 407-452, 1906.)

Geology of Buchanan county. S. Calvin. (Iowa Geol. Surv., VIII, 201-253, 1898.)

Geology of Butler county. M. F. Arey. (Iowa Geol. Surv., XX, 1-59, 1910.)

Geology of Cedar county. W. H. Norton. (Iowa Geol. Surv., XI, 279-396, 1901.)

Geology of Cerro Gordo county. S. Calvin. (Iowa Geol. Surv., VII, 117-195, 1897.)

Geology of Chickasaw county. S. Calvin. (Iowa Geol. Surv., XIII, 255-292, 1903.)

- Geology of Clayton county. A. G. Leonard. (Iowa Geol. Surv., XVI, 213-317, 1906.)
- Geology of Clinton county. J. A. Udden. (Iowa Geol. Surv., XV, 369-431, 1905.)
- Geology of Davis county. M. F. Arey. (Iowa Geol. Surv., XX, 487-524, 1910.)
- Geology of Decatur county. H. F. Bain. (Iowa Geol. Surv., VIII, 255-314, 1898.)
- Geology of Delaware county. S. Calvin. (Iowa Geol. Surv., VIII, 119-199, 1898.)
- Geology of Des Moines county. C. R. Keyes. (Iowa Geol. Surv., III, 409-492, 1894.)
- Geology of Dubuque county. S. Calvin and H. F. Bain. (Iowa Geol. Surv., X, 379-651, 1900.)
- Geology of Fayette county. T. E. Savage. (Iowa Geol. Surv., XV, 433-546, 1905.)
- Geology of Hamilton and Wright counties. T. H. Macbride. (Iowa Geol. Surv., XX, 97-138, 1910.)
- Geology of Humboldt county. T. H. Macbride. (Iowa Geol. Surv., IX, 109-154, 1899.)
- Geology of Iowa county. S. W. Stookey. (Iowa Geol. Surv., XX, 151-186, 1910.)
- Geology of Jackson county. T. E. Savage. (Iowa Geol. Surv., XVI, 563-649, 1906.)
- Geology of Johnson county. S. Calvin. (Iowa Geol. Surv., VII, 33-116, 1897.)
- Geology of Jones county. S. Calvin. (Iowa Geol. Surv., V, 33-112, 1896.)
- Geology of Keokuk county. H. F. Bain. (Iowa Geol. Surv., IV, 255-311, 1895.)
- Geology of Lee county. C. R. Keyes. (Iowa Geol. Surv., 305-407, 1894.)
- Geology of Linn county. W. H. Norton. (Iowa Geol. Surv., IV, 121-194, 1895.)
- Geology of Mahaska county. H. F. Bain. (Iowa Geol. Surv., IV, 313-380, 1895.)
- Geology of Madison county. J. L. Tilton and H. F. Bain. (Iowa Geol. Surv., VII, 489-539, 1897.)

- Geology of Marion county. B. L. Miller. (Iowa Geol. Surv., XI, 127-157, 1901.)
- Geology of Marshall county. S. W. Beyer. (Iowa Geol. Surv., VII, 197-262, 1897.)
- Geology of Mitchell county. S. Calvin. (Iowa Geol. Surv., XIII, 293-352, 1903.)
- Geology of Montgomery county. E. H. Lonsdale. (Iowa Geol. Surv., IV, 381-449, 1895.)
- Geology of Plymouth county. H. F. Bain. (Iowa Geol. Surv., VIII, 315-366, 1898.)
- Geology of quarry products. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XVII, 189-588, 1907.)
- Geology of Sac and Ida counties. T. H. Macbride. (Iowa Geol. Surv., XVI, 509-548, 1906.)
- Geology of Scott county. W. H. Norton. (Iowa Geol. Surv., IX, 389-519, 1899.)
- Geology of Tama county. T. E. Savage. (Iowa Geol. Surv., XIII, 185-253, 1903.)
- Geology of Webster county. F. A. Wilder. (Iowa Geol. Surv., XII, 63-235, 1902.)
- Geology of Winneshiek county. S. Calvin. (Iowa Geol. Surv., XVI, 37-146, 1906.)
- Hydraulic limes. C. A. White. (Geology of Iowa, II, 318-322, 1870.)
- Hydraulic, materials. J. D. Whitney. (Geology of Iowa, I, 392, 1858.)
- Mineral production in Iowa in 1906. S. W. Beyer. (Iowa Geol. Surv., VIII, 11-25, 1907.)
- Mineral production in Iowa in 1907. S. W. Beyer. (Iowa Geol. Surv., XVIII, 11-28, 1908.)
- Mineral production in Iowa in 1908. S. W. Beyer. (Iowa Geol. Surv., XIX, 1-20, 1909.)
- Mineral production in Iowa in 1909 and 1910. S. W. Beyer. (Iowa Geol. Surv., XXI, 1-28, 1912.)
- Physical tests of Iowa limes. S. W. Beyer. (Iowa Geol. Surv., XVII, 91-150, 1907.)
- Quick-lime. C. A. White. (Geology of Iowa, II, 316-318, 1870.)

- Some lime-burning dolomites and dolomitic building-stones from the Niagara of Iowa. G. L. Houser. (Iowa Geol. Surv., I, 197-207, 1893.)
- Work and scope of the geological survey. C. R. Keyes. (Iowa Geol. Surv., III, 47-98, 1894.)
- Limes**, Iowa, physical tests. S. W. Beyer. (Iowa Geol. Surv., XVII, 91-150, 1907.)
- Limestone**, Bethany, of western interior coal-field. C. R. Keyes. (Am. Jour. Sci., (4), II, 221-225, 1896.)
- Limonite.**
- Annotated catalogue of minerals. C. R. Keyes. (Iowa Geol. Surv., I, 181-196, 1893.)
- Geology of Allamakee county. S. Calvin. (Iowa Geol. Surv., IV, 35-111, 1895.)
- Geology of Des Moines county. C. R. Keyes. (Iowa Geol. Surv., III, 409-492, 1894.)
- Geology of Lee county. C. R. Keyes. (Iowa Geol. Surv., III, 305-407, 1894.)
- Geology of Montgomery county. E. H. Lonsdale. (Iowa Geol. Surv., 381-451, 1895.)
- Geology of Webster county. F. A. Wilder. (Iowa Geol. Surv., XII, 63-235, 1902.)
- Lead and zinc deposits of Iowa. A. G. Leonard. (Iowa Geol. Surv., VI, 9-66, 1897.)
- Lindahl, Josua**, Description of Devonian Ichthyodorulite, *Heteracanthus uddeni*, N. Sp., from Buffalo, Iowa. (Jour. Cincinnati Soc. Nat. Hist., Vol. XIX, pp. 95-98, Cincinnati, 1897.)
- Linn and Quarry**, Iowa, glaciated rock-surfaces near, with table of bearings of glacial striæ in Iowa. W. H. Norton. (Proc. Iowa Acad. Sci., XVIII, 79-83, 1911.)
- Linn County.**
- Analysis of a meteorite. J. Torrey and E. H. Barbour. (American Geologist, VIII, 65, 1891.)
- Artesian wells of Iowa. W. H. Norton. (Iowa Geol. Surv., VI, 113-428, 1897.)
- Catalogue of recorded meteorites. O. W. Huntington. (Proc. American Acad. Arts and Sci., XV, 37-110, 1887.)

- Certain devonian and carboniferous outliers in eastern Iowa. W. H. Norton. (Iowa Geol. Surv., III, 115-133, 1895.)
- Chemical analyses of a meteoric fall. C. U. Sheppard. (Am. Jour. Sci., (2), VI, 402-417, 1848.)
- Coal deposits of Iowa. C. R. Keyes. (Iowa Geol. Surv., II, 536 pp., 1894.)
- Cretaceous fossils in drift. [S. Calvin.] (American Geologist, I, 237, 1888.)
- Devonian fishes of Iowa. C. R. Eastman. (Iowa Geol. Surv., XVIII, 29-360, 1908.)
- Fall of meteoric stones. C. U. Sheppard. (Am. Jour. Sci., (2), IV, 288-289, 1847.)
- Geological notes. J. D. Whitney. (Geology of Iowa, I, 260-266, 1858.)
- Geological section of Y. M. C. A. artesian well at Cedar Rapids. W. H. Norton. (Proc. Iowa Acad. Sci., II, 194-196, 1895.)
- Geology of Linn county. W. H. Norton. (Iowa Geol. Surv., IV, 121-194, 1895.)
- Geology of quarry products. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XVII, 189-588, 1907.)
- Glaciated rock-surfaces near Linn and near Quarry, Iowa, with table of bearings of glacial striæ in Iowa. W. H. Norton. (Proc. Iowa Acad. Sci., XVIII, 79-83, 1911.)
- Notes on lower strata of devonian series in Iowa. W. H. Norton. (Proc. Iowa Acad. Sci., I, pt. iv, 22-24, 1894.)
- Some Iowa waters. N. Knight. (Proc. Iowa Acad. Sci., XV, 109-110, 1908.)
- Some recent analyses of Iowa building-stones; also of potable waters. N. Knight. (Proc. Iowa Acad. Sci., VIII, 104-109, 1901.)
- Underground water resources of Iowa. W. H. Norton. (Iowa Geol. Surv., XXI, 29-1214, 1912.)
- Underground water resources of Iowa. W. H. Norton. (U. S. Geol. Surv., Water Supply Paper No. 293, 994 pp., 1912.)

- Variation in position of the nodes on the axial segments of pygidium of a species of *Encrinurus*. W. H. Norton. (Proc. Iowa Acad. Sci., III, 79-81, 1896.)
- Linn county**, geology. W. H. Norton. (Iowa Geol. Surv., IV, 121-194, 1895.)
- List** of carboniferous fossils from Des Moines. C. R. Keyes. (Iowa Geol. Surv., VII, 330-335, 1897.)
- List**, revised, of loess fossils from Des Moines. C. R. Keyes. (Iowa Geol. Surv., VII, 344, 1897.)
- Lithographic Stone.**
Discussion of requisite qualities of lithographic limestone, with report on tests of lithographic stone of Mitchell county, Iowa. A. B. Hoen. (Iowa Geol. Surv., XIII, 339-351, 1903.)
Geology of Mitchell county. S. Calvin. (Iowa Geol. Surv., XIII, 293-352, 1903.)
- Lithographic** limestone, discussion of requisite qualities with report on tests of lithographic stone of Mitchell county, Iowa. A. B. Hoen. (Iowa Geol. Surv., XIII, 339-351, 1903.)
- Living** plants as geological factors. B. Shimek. (Proc. Iowa Acad. Sci., X, 41-48, 1903.)
- Local** geology of Davenport and vicinity. W. H. Barris. (Proc. Davenport Acad. Nat. Sci., II, 261-269, 1877.)
- Local** geology. W. H. Barris. (Proc. Davenport Acad. Nat. Sci., VII, 14-32, 1900.)
- Localities** of minerals. E. S. Dana. (Text-book of Mineralogy, 15th ed., App. C., Iowa, 445, 1889.)
- Location**, stratigraphical, of named Trans-Mississippian coals. C. R. Keyes. (Eng. and Mining Jour., LXXII, 198, 1901.)
- Localization** and migrations, Ozark lead and zinc deposits. C. R. Keyes. (Trans. American Inst. Mining Eng., XL, 184-231, 1909.)
- Loess.**
Aftonian sands and gravels in western Iowa. B. Shimek. (Science, N. S., XXVIII, 923, 1908.)

- Aftonian sands and gravels in western Iowa. B. Shimek. (Bull. Geol. Soc. America, XX, 399-408, 1909.)
- Burlington. C. R. Keyes. (American Naturalist, XXII, 1049-1054, 1888.)
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- Sketch of geology of Iowa. C. R. Keyes. (Hand-book of Iowa, World's Columbian Exposition at Chicago, 18-28, 1893.)
- Some variant conclusions in Iowa geology. J. E. Todd. (Proc. Iowa Acad. Sci., XIII, 183-186, 1906.)

Underground water resources of Iowa. W. H. Norton
(Iowa Geol. Surv., XXI, 29-1214, 1912.)

Underground water resources of Iowa: W. H. Norton. (U.
S. Geol. Surv., Water Supply Paper No. 293, 994 pp.,
1912.)

Lyon and Sioux counties, geology. F. A. Wilder. (Iowa Geol.
Surv., X, 85-184, 1900.)

Macbride, Thomas H. Certain Fossil Plant-remains in Iowa
Herbarium. (Proc. Davenport Acad. Sci., Vol. X, pp.
153-162, 12 plates, Davenport, 1907.) A number of fos-
sils from the coal measures are described as new, and
the microscopic structures noted.

Macbride, Thomas H. Geology of Cherokee and Buena Vista
Counties. (Iowa Geol. Surv., Vol. XII, pp. 303-353,
Des Moines, 1902.) The following topics are consid-
ered:

Introduction, location and area, previous geological work.
Physiography, topography, drainage.

Stratigraphy, table of geological formations; the Pleistocene
deposits, Kansan drift, the loess, Wisconsin gravels,
Wisconsin clays, alluvial deposits, margin of the Wis-
consin drift.

Economic products, soils, brick and tile, gravels, water sup-
plies, forestry notes.

Macbride, Thomas H. Geology of Clay and O'Brien counties.
(Iowa Geol. Surv., Vol. XI, pp. 461-508, Des Moines,
1901.) The following subjects are described in detail:

Introduction, location, previous study of these counties.

Physiography, topography, constructional valleys, drainage.

Stratigraphy, synoptical table; alluvium, Wisconsin loess,
Wisconsin gravels, Wisconsin clays, pre-Wisconsin
sands, Kansan drift; Cretaceous sandstone.

Economic products, soils, sands and gravels, brick-clays,
fuel, water-supplies.

Forestry notes for Clay and O'Brien counties.

Macbride, Thomas H. Geology of Emmet, Palo Alto and Poca-
hontas Counties. (Iowa Geol. Surv., Vol. XV, pp. 227-
276, Des Moines, 1905.) The following topics are con-
sidered:

Introduction, location and area, previous geological work.
Physiography, topography, drainage.

Stratigraphy, formations represented, synoptical table,
geological formations; Pleistocene series, the alluvium,
Wisconsin gravels, Wisconsin drift, Buchanan gravels,
Kansan drift, the blue clay, Pre-Kansan strata, sands,
etc.; Carboniferous system, the Saint Louis limestone.

Economic products, clays, building-stones, gravels, water-
supply, fuel, peat.

Macbride, Thomas H. Geology of Hamilton and Wright Counties. (Iowa Geol. Surv., Vol. XX, pp. 97-138, Des Moines, 1910.) The following topics are considered:

Introduction, location and area, previous geological work.
Physiography, topography, drainage.

Stratigraphy: synoptical table, Carboniferous system, Mississippian series, St. Louis limestone, Pennsylvanian series, Des Moines stage. Quaternary system, Pleistocene series, Kansan drift, Wisconsin drift, soils.

Economic products, limestones, sands and gravels, fuels,
coal, brick and tile manufacturers, water-supplies.

Forestry notes.

Macbride, Thomas H. Geology of Humboldt County. (Iowa Geol. Surv., Vol. IX, pp. 109-154, Des Moines, 1899.)

The following topics are discussed in detail:

Introduction, physiography, topography, drainage.

Stratigraphy, formations represented, synoptical table,
geological formations, Mississippian series, Kinderhook, St. Louis, Upper Carboniferous, Des Moines, Pleistocene, Kansan drift, Wisconsin drift, soils.

Economic products, building-stones, limes, sands, clays,
fuels, water-supplies, water-powers.

Forestry notes of Humboldt county.

Macbride, Thomas H. Geology of Kossuth, Hancock and Winnebago Counties. (Iowa Geol. Surv., Vol. XIII, pp. 81-122, Des Moines, 1903.) The following topics are briefly discussed:

Introduction, location and area, previous geological work.
Physiography, topography, drainage.

Stratigraphy, formations represented, synoptical table;
Kansan drift, Wisconsin drift.

Soils.

Economic products.

Water supplies.

Forestry notes.

Macbride, Thomas H. Geology of Osceola and Dickinson Counties. (Iowa Geol. Surv., Vol. X, pp. 185-239, Des Moines, 1900.) The following subjects are considered in detail:

Introduction, location, previous geological work.

Physiography, topography, lakes, Spirit lake, Okoboji, East Okoboji, Gar lake, Center lake, smaller lakes, drainage.

Stratigraphy, formations represented, synoptical table, Kansan drift, Wisconsin drift.

Economic products, soils, sands, gravels, brick-clays, fuels, water-supplies.

Forestry notes.

Macbride, Thomas H. Geology of Sac and Ida Counties. (Iowa Geol. Surv., Vol. XVI, pp. 509-548, Des Moines, 1906.) The subjects discussed are:

Introduction, location and area, previous geological work.

Physiography, topography, drainage.

Stratigraphy, general relations of strata, synoptical table: Cretaceous system, Dakota sandstone, Colorado stage, Fort Benton shales; Pleistocene system, Kansan stage, Kansan drift, Buchanan gravels, Iowan stage, loess, Wisconsin stage, Wisconsin drift, Wisconsin gravels and gravel trains, alluvial deposits, soils.

Economic products, clays, gravels, limes, building-stones, coal, oil, gas, water-supplies, water-powers.

Forestry notes.

Macbride, Thomas H. Pre-Kansan Peat-bed. (Proc. Iowa Acad. Sci., Vol. IV, pp. 63-66, Des Moines, 1897.) The plants composing the peat are described.

- McGee, W J.** Additional Observations on Iowa Kames and Aasar. (Proc. Iowa Acad. Sci., 1875-1880, p. 25, Iowa City, 1880.) This is an abstract of a paper read before the Iowa Academy of Sciences, June 25, 1880.
- McGee, W J.** Complete Series of Superficial Geological Formations in Northeastern Iowa. (Proc. American Assoc. Adv. Sci., Vol. XXVII, pp. 198-231, Salem, 1878.) A description of the surface geology of northeastern Iowa is presented.
- McGee, W J.** Description of Quarries and Quarry Regions of Iowa. (Tenth Census of U. S., Vol. X, Report on Building Stones, pp. 256-265, Washington, 1883.) A résumé of the geological formations of Iowa, with special references to the leading building stones is given.
- McGee, W J.** Drainage System and Distribution of Loess of Eastern Iowa. (Bull. Philosophical Soc. Washington, Vol. VI, pp. 93-97, Washington, 1883.) An abstract of a general description of the drainage system is presented.
- McGee, W J.** Drainage System and Distribution of Loess of Eastern Iowa. (Pamphlet, pp. 1-14, Ft. Dodge, 1884.) A description of the general drainage system and topography, with explanations of the phenomena, are given.
- McGee, W J.** Geologist, Anthropologist, Hydrologist. Charles Keyes. (Annals of Iowa; An Historical Quarterly, XI, 1913.)
- McGee, W. J.** Ice Caves and Frozen Wells. (National Geog. Mag., Vol. XII, p. 433, New York, 1901.) The Decorah ice cave is described.
- McGee, W J.** Iowa Kames and Aasar. (Proc. Iowa Acad. Sci., 1875-1880, p. 19, Iowa City, 1880.) Abstract is given of a paper read before the Iowa Academy October 10, 1879.
- McGee, W J.** Notes on Geology of Part of Mississippi Valley. (Geological Magazine, (2), Vol. VI, pp. 353-362 and 412-420, London, 1879.) A description of the quaternary deposits of northeastern Iowa is included.

McGee, W J. *Ovibos Cavifrons* from Loess of Iowa. (Am. Jour. Sci., (3), Vol. XXXIV, pp. 217-220, New Haven, 1887.) Notice is given of a specimen of extinct Musk ox found near Council Bluffs, and its bearing upon the nature of the climate during the deposition of the loess.

McGee, W J. Pleistocene History of Northeastern Iowa. (Eleventh Ann. Rept. U. S. Geol. Surv., pp. 190-577, Washington, 1893.)

Chapter I is a very full description of the landscape and general topography of northeastern Iowa.

Chapter II forms a statement of the principles involved in the description of the geological history of the region, with full definitions.

Chapter III includes a general account of the stratified rocks of the state. A classification and description of the different formations are given, with the different kinds of disturbances recognized.

Chapter IV is a detailed account of the drainage and topography of the different quaternary formations.

Chapter V treats of the post-glacial phenomena, alluvium and terraces.

Chapter VI is a detailed account of the loess and its occurrence in different places.

Chapter VII is a description of the drift and an account of many well sections.

Chapter VIII considers the ice-markings—glacial striæ and surface moldings.

Chapter IX treats of the residuary products and the history indicated by them.

Chapter X is a general summary of the geological history as recorded in Iowa.

McGee, W J. Prairies: Itinerary from Kansas City, Missouri, to Chicago, Illinois. (International Cong. Géol., Comptes Rendus, 5me Sess., pp. 449-452, Washington, 1893.) References are made to features of the southeastern part of the state.

- McGee, W J.** Relations of Geology and Agriculture. (Trans. Iowa State Horticultural Soc., Vol. XVI, pp. 227-240, 1881.) An address given before the society in which the bearing of agriculture upon geology is fully described with special reference to Iowa.
- McGee, W J.** Relative Position of Forest Beds and Associated Drift Formations in Northeastern Iowa. (Am. Jour. Sci., (3), XV, pp. 339-341, New Haven, 1878.) A number of sections at Farley are given, and special references are made to the forest-bed in Dubuque county.
- McGee, W J.** Superposition of Glacial Drift upon Residuary Clays. (Am. Jour. Sci., (3), Vol. XVIII, pp. 301-303, New Haven, 1879.) A section in Delaware county is described showing the relations of the two formations.
- McGee, W J.** Topographic Types of Northeastern Iowa. (Proc. American Assoc. Adv. Sci., Vol. XXXVII, pp. 248-249, Salem, 1890.) Abstract is made of more extended paper. Half a dozen distinctive types of topography are recognized.
- McGee, W J,** and R. Ellsworth Call. Loess and Associated Deposits of Des Moines. (Am. Jour. Sci., (3), Vol. XXIV, pp. 202-223, New Haven, 1882.) The topographic features of the region are outlined, with an accompanying sketch-map; the different sections of surface deposits are described in detail, with lists of fossils and a synoptical table showing the distribution of the fossils occurring.
- McKissick Grove Shales** (Atchison).
Carboniferous section of southwestern Iowa. G. L. Smith. (Iowa Geol. Surv., XIX, 605-657, 1909.)
- McWorther, Tyler.** Beds of Carboniferous Drift in Bluffs of East Davenport. (Proc. Davenport Acad. Nat. Sci., Vol. III, pp. 129-130, Davenport, 1882.)
- Machine** coal-mining in Iowa. H. F. Bain. (Mineral Industry, IV, 195-200, 1896.)
- Macrouran** decapod crustacean, *Palæo-palæomon Newberryi*, discovery of second example. R. P. Whitfield. (American Geologist, IX, 237-238, 1892.)

Madison County.

- Analyses of coal. Rush Emery. (Geology of Iowa, II, 386-387, 1870.)
- Coal deposits of Iowa. C. R. Keyes. (Iowa Geol. Surv., II, 536 pp., 1894.)
- Coal deposits of Iowa. H. Hinds. (Iowa Geol. Surv., XIX, 21-396, 1909.)
- Contribution to Madison county geology. F. A. Brown. (Proc. Iowa Acad. Sci., XIII, 203-206, 1906.)
- General geological description. C. A. White. (Geology of Iowa, I, 305-316, 1870.)
- Geological section along middle river. J. L. Tilton. (Iowa Geol. Surv., III, 135-146, 1895.)
- Geology of clays. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XIV, 377-552, 1904.)
- Geology of Madison county. J. L. Tilton and H. F. Bain. (Iowa Geol. Surv., VII, 489-539, 1897.)
- Geology of quarry products. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XVII, 189-588, 1907.)
- Results of recent geological work in Madison county. J. L. Tilton. (Proc. Iowa Acad. Sci., IV, 47-54, 1897.)
- Short notes on geology. C. A. White. (First Ann. Rept. State Geologist, 70-73, 1868.)
- Strata between Ford and Winterset. J. L. Tilton. (Proc. Iowa Acad. Sci., I, pt. iii, pp. 26-27, 1893.)
- Supplementary report on Portland cement materials in Iowa. S. W. Beyer. (Iowa Geol. Surv., Bull. No. 3, 36 pp., 1906.)
- Underground water resources of Iowa. W. H. Norton. (Iowa Geol. Surv., XXI, 29-1214, 1912.)
- Underground water resources of Iowa. W. H. Norton. (U. S. Geol. Surv., Water Supply Paper No. 293, 994 pp., 1912.)
- Madison county, geology.** J. L. Tilton and H. F. Bain. (Iowa Geol. Surv., VII, 489-539, 1897.)
- Madison county geology, contribution.** F. A. Brown. (Proc. Iowa Acad. Sci., XIII, 203-206, 1906.)

Madison county, results of recent geological work. J. L. Tilton. (Proc. Iowa Acad. Sci., IV, 47-54, 1897.)

Magnesian Limestone (Ozarkian, Cambric). (*See also Canadian Series.*)

Chemical analyses. J. D. Whitney. (Geology of Iowa, I, 332-337, 1858.)

Description of new trilobites. D. D. Owen. (Rept. Geol. Surv. Wisconsin, Iowa and Minnesota, App., art. i, 573-577, 1852.)

Description of rocks in northeastern Iowa. D. D. Owen. (Rept. Geol. Surv. Wisconsin, Iowa and Minnesota, 58-69, 1852.)

Fossils from northeastern Iowa. S. Calvin. (American Geologist, X, 144-148, 1892.)

General description. C. A. White. (Geology of Iowa, I, 172-174, 1870.)

Geology of Winneshiek county. S. Calvin. (Iowa Geol. Surv., XVI, 37-146, 1906.)

Magnesian Oxide.

Annotated catalogue of minerals. C. R. Keyes. (Iowa Geol. Surv., I, 181-198, 1893.)

Magnesian series of northwestern states. C. W. Hall and F. W. Sardeson. (Bull. Geol. Soc. America, VI, 167-198, 1895.)

Magnetite.

Annotated catalogue of minerals. C. R. Keyes. (Iowa Geol. Surv., I, 181-198, 1893.)

Mahaska County.

Analyses of coal. Rush Emery. (Geology of Iowa, II, 370-375, 1870.)

Analyses of Iowa coals. J. H. Lees and A. W. Hixson. (Iowa Geol. Surv., XIX, 476-519, 1909.)

Artesian wells of Iowa. W. H. Norton. (Iowa Geol. Surv., VI, 113-428, 1897.)

Brief allusion to its geology. C. A. White. (Second Ann. Rept. State Geologist, 91-93, 1868.)

Coal deposits of Iowa. C. R. Keyes. (Iowa Geol. Surv., II, 536 pp., 1894.)

- Coal deposits of Iowa. H. Hinds. (Iowa Geol. Surv., XIX, 21-396, 1909.)
- Crustal adjustment in upper Mississippi valley. C. R. Keyes. (Bull. Geol. Soc. America, V, 231-242, 1894.)
- General description. C. A. White. (Geology of Iowa, II, 265-267, 1870.)
- Geology of clays. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XIV, 377-552, 1904.)
- Geology of Mahaska county. H. F. Bain. (Iowa Geol. Surv., IV, 313-380, 1895.)
- Geology of quarry products. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XVII, 189-588, 1907.)
- History of coal mining in Iowa. J. H. Lees. (Iowa Geol. Surv., XIX, 521-586, 1909.)
- Mississippian rocks of central Iowa. H. F. Bain. (Proc. Iowa Acad. Sci., II, 174, 1895.)
- Sketch of coal deposits of Iowa. C. R. Keyes. (Coal Trade Journal, XXXIII, 954-957, 1894.)
- Underground water resources of Iowa. W. H. Norton. (Iowa Geol. Surv., XXI, 29-1214, 1912.)
- Underground water resources of Iowa. W. H. Norton. (U. S. Geol. Surv., Water Supply Paper No. 293, 994 pp., 1912.)
- Mahaska county, geology.** H. F. Bain. (Iowa Geol. Surv., IV, 313-380, 1895.)
- Mahaska Limestone.**
Distribution and relations of St. Louis limestone in Mahaska county, Iowa. H. F. Bain. (Iowa Geol. Surv., I, 171-179, 1893.)
- Mammalian fauna, Aftonian.** S. Calvin. (Bull. Geol. Soc. America, XX, 341-356, 1909.)
- Mammalian fauna, Aftonian age.** S. Calvin. (Proc. Iowa Acad. Sci., XVII, 177-180, 1910.)
- Mammalian fauna, II, Aftonian.** S. Calvin. (Bull. Geol. Soc. America, XXII, 207-216, 1911.)
- Mammals.**
Aftonian mammalian fauna. S. Calvin. (Bull. Geol. Soc. America, XX, 341-356, 1909.)

- Evidence that fossiliferous gravels and sands of Iowa and Nebraska are Aftonian. B. Shimek. (Bull. Geol. Soc. America, XXI, 119-140, 1910.)
- Megalonyx found in Mills county. J. E. Todd. (Proc. American Assoc. Adv. Sci., XXXVII, 202-203, 1889.)
- Ovibos cavifrons from loess of Iowa, found at Council Bluffs. W J McGee. (Am. Jour. Sci., (3), XXXIV, 217-220, 1887.)
- Some notes on Aftonian mammals. A. O. Thomas. (Science, N. S., XXXVI, 570, 1912.)
- Manufacture** of Portland cement, and materials. S. W. Beyer and I. A. Williams. (Iowa Geol. Surv., XVII, 29-85, 1907.)
- Map of Iowa**, geological. C. R. Keyes. (Annals of Iowa, Historical Quarterly, (3), I, 294-297, 1894.)
- Maple Mill Shales** (Hannibal).
Geology of Louisa county. J. A. Udden. (Iowa Geol. Surv., XI, 53-126, 1901.)
Geology of Washington county. H. F. Bain. (Iowa Geol. Surv., V, 115-173, 1896.)
- Mapping** of Iowa, geological. C. R. Keyes. (Mon. Rev. Iowa Weather Serv. V, No. 2, 4-6, 1894.)
- Maps (Geological)**.
Artesian wells of Iowa. W. H. Norton. (Iowa Geol. Surv., VI, 113-428, 1897.)
Coal deposits of Iowa. C. R. Keyes. (Iowa Geol. Surv., II, 536 pp., 1894.)
Description of Lancaster and Mineral Point quadrangles, Wisconsin-Iowa-Illinois. U. S. Grant and E. F. Burchard. (U. S. Geol. Surv., Folio 145, 14 pp., 1907.)
Diagrammatic map of drift currents adjacent to driftless area. T. C. Chamberlin and R. D. Salisbury. (Sixth Ann. Rept., U. S. Geol. Surv., plate xxix, Washington, 1886.)
Fifteenth annual report of state geologist. S. Calvin. (Iowa Geol. Surv., XVII, 1-6, 1907.)

- General map of drift of northeastern United States. T. C. Chamberlin and R. D. Salisbury. (Sixth Ann. Rep., U. S. Geol. Surv., plate xxiii, Washington, 1886.)
- Geological chart of part of Iowa, Wisconsin and Illinois. D. D. Owen. (Report of a Geological Exploration of Part of Iowa, Wisconsin and Illinois, made in the autumn of the year 1839, [Washington], 1844.)
- Geological map of eastern Iowa. James Hall. (Geology of Iowa, I, 1858.) A colored sectional map outlines the different geological formations in the eastern part of the state.
- Geological formations of Iowa. C. R. Keyes. (Iowa Geol. Surv., I, 11-161, 1893.)
- Geological map of Iowa. D. D. Owen. (Rep. Geol. Sur. Wis., Iowa and Minn., 1852.) The large colored map shows the geological formations in the Mississippi valley.
- Geological map of Iowa. C. A. White. (Geology of Iowa, II, Des Moines, 1870.) This is a sketch-map showing the general geological formations.
- Geological map of Iowa. C. R. Keyes. (Annals of Iowa, Historical Quarterly, (3), I, 294-297, 1894.)
- Geological map of lead region in states of Wisconsin, Illinois and Iowa. J. D. Whitney. (Geol. Surv. Wisconsin, I, 1862.)
- Geological map of state of Iowa. C. A. White. (Geology of Iowa, II, 1870.)
- Geological map-model of Iowa. C. A. White. (Geology of Iowa, I, 1870.)
- Geological map of Iowa. F. A. Wilder. (Iowa Geol. Surv., 1906.)
- Geological mapping of Iowa. C. R. Keyes. (Mon. Rev. Iowa Weather Serv., Vol. V, No. 2, 4-6, 1894.)
- Geological section from mouth of Rock river through the Blue Mounds to Wisconsin river, in connection with a geological chart of part of Iowa, Wisconsin and

- Illinois. (Report of Geological Explorations of Parts of Iowa, Wisconsin and Illinois, made in the autumn of the year 1839, plate iii, [Washington], 1844.)
- Geology of Allamakee county. S. Calvin. (Iowa Geol. Surv., IV, 35-111, 1895.)
- Geology of Appanoose county. H. F. Bain. (Iowa Geol. Surv., V, 361-437, 1896.)
- Geology of Benton county. T. E. Savage. (Iowa Geol. Surv., XV, 125-225, 1905.)
- Geology of Black Hawk county. M. F. Arey. (Iowa Geol. Surv., XVI, 407-453, 1906.)
- Geology of Bremer county. W. H. Norton. (Iowa Geol. Surv., XVI, 319-405, 1906.)
- Geology of Buchanan County. S. Calvin. (Iowa Geol. Surv., VIII, 201-253, 1898.)
- Geology of Butler county. M. F. Arey. (Iowa Geol. Surv., XX, 1-59, 1910.)
- Geology of Carroll county. H. F. Bain. (Iowa Geol. Surv., IX, 49-106, 1899.)
- Geology of Cedar county. W. H. Norton. (Iowa Geol. Surv., XI, 279-396, 1901.)
- Geology of Cerro Gordo county. S. Calvin. (Iowa Geol. Surv., VII, 117-195, 1897.)
- Geology of Cherokee and Buena Vista counties. T. H. Macbride. (Iowa Geol. Surv., XII, 303-353, 1902.)
- Geology of Chickasaw county. S. Calvin. (Iowa Geol. Surv., XIII, 255-292, 1903.)
- Geology of Clay and O'Brien counties. T. H. Macbride. (Iowa Geol. Surv., XI, 461-508, 1901.)
- Geology of Clayton county. A. G. Leonard. (Iowa Geol. Surv., XVI, 213-317, 1906.)
- Geology of Clinton county. J. A. Udden. (Iowa Geol. Surv., XV, 369-431, 1905.)
- Geology of Dallas county. A. G. Leonard. (Iowa Geol. Surv., VIII, 51-118, 1898.)
- Geology of Davis county. M. F. Arey. (Iowa Geol. Surv., XX, 487-521, 1910.)

- Geology of Decatur county. H. F. Bain. (Iowa Geol. Surv., VIII, 255-314, 1898.)
- Geology of Delaware county. S. Calvin. (Iowa Geol. Surv., VIII, 119-199, 1898.)
- Geology of Des Moines county. C. R. Keyes. (Iowa Geol. Surv., III, 409-492, 1894.)
- Geology of Dubuque county. S. Calvin and H. F. Bain. (Iowa Geol. Surv., X, 379-651, 1900.)
- Geology of Emmet, Palo Alto and Pocahontas counties. T. H. Macbride. (Iowa Geol. Surv., XV, 227-276, 1905.)
- Geology of Fayette county. T. E. Savage. (Iowa Geol. Surv., XV, 433-546, 1906.)
- Geology of Franklin county. I. A. Williams. (Iowa Geol. Surv., XVI, 453-507, 1906.)
- Geology of Grundy county. M. F. Arey. (Iowa Geol. Surv., XX, 61-95, 1910.)
- Geology of Guthrie county. H. F. Bain. (Iowa Geol. Surv., VII, 413-487, 1897.)
- Geology of Hamilton and Wright counties. T. H. Macbride. (Iowa Geol. Surv., XX, 97-138, 1910.)
- Geology of Hardin county. S. W. Beyer. (Iowa Geol. Surv., X, 243-305, 1900.)
- Geology of Harrison and Monona counties. B. Shimek. (Iowa Geol. Surv., XX, 271-483, 1910.)
- Geology of Henry county. T. E. Savage. (Iowa Geol. Surv., XII, 237-302, 1902.)
- Geology of Howard county. S. Calvin. (Iowa Geol. Surv., XIII, 21-79, 1903.)
- Geology of Humboldt county. T. H. Macbride. (Iowa Geol. Surv., IX, 109-154, 1899.)
- Geology of Iowa county. S. W. Stookey. (Iowa Geol. Surv., XX, 151-186, 1910.)
- Geology of Jackson county. T. E. Savage. (Iowa Geol. Surv., XVI, 563-648, 1906.)
- Geology of Jasper county. I. A. Williams. (Iowa Geol. Surv., XV, 277-367, 1905.)
- Geology of Jefferson county. J. A. Udden. (Iowa Geol. Surv., XII, 355-437, 1902.)

- Geology of Johnson county. S. Calvin. (Iowa Geol. Surv., VII, 33-116, 1897.)
- Geology of Jones county. S. Calvin. (Iowa Geol. Surv., V, 33-112, 1896.)
- Geology of Keokuk county. H. F. Bain. (Iowa Geol. Surv., IV, 255-311, 1895.)
- Geology of Kossuth, Hancock and Winnebago counties. T. H. Macbride. (Iowa Geol. Surv., XIII, 81-122, 1903.)
- Geology of Lee county. C. R. Keyes. (Iowa Geol. Surv., III, 305-407, 1894.)
- Geology of Linn county. W. H. Norton. (Iowa Geol. Surv., IV, 121-194, 1895.)
- Geology of Louisa county. J. A. Udden. (Iowa Geol. Surv., XI, 33-126, 1901.)
- Geology of Lyon and Sioux counties. F. A. Wilder. (Iowa Geol. Surv., X, 85-184, 1900.)
- Geology of Madison county. J. L. Tilton and H. F. Bain. (Iowa Geol. Surv., VII, 489-539, 1897.)
- Geology of Mahaska county. H. F. Bain. (Iowa Geol. Surv., IV, 313-380, 1895.)
- Geology of Marshall county. S. W. Beyer. (Iowa Geol. Surv., VII, 197-262, 1897.)
- Geology of Mills and Fremont counties. J. A. Udden. (Iowa Geol. Surv., XIII, 123-183, 1903.)
- Geology of Mitchell county. S. Calvin. (Iowa Geol. Surv., 293-352, 1903.)
- Geology of Monroe county. S. W. Beyer and L. E. Young. (Iowa Geol. Surv., XIII, 353-433, 1903.)
- Geology of Montgomery county. E. H. Lonsdale. (Iowa Geol. Surv., IV, 381-449, 1895.)
- Geology of Muscatine county. J. A. Udden. (Iowa Geol. Surv., IX, 247-380, 1899.)
- Geology of Osceola and Dickinson counties. T. H. Macbride. (Iowa Geol. Surv., X, 185-239, 1900.)
- Geology of Page county. S. Calvin. (Iowa Geol. Surv., XI, 397-460, 1901.)
- Geology of Plymouth county. H. F. Bain. (Iowa Geol. Surv., VIII, 315-355, 1898.)

- Geology of Polk county. H. F. Bain. (Iowa Geol. Surv., VII, 263-412, 1897.)
- Geology of Pottawattamie county. J. A. Udden. (Iowa Geol. Surv., XI, 199-277, 1901.)
- Geology of Poweshiek county. S. W. Stookey. (Iowa Geol. Surv., XX, 237-269, 1910.)
- Geology of Sac and Ida counties. T. H. Macbride. (Iowa Geol. Surv., XVI, 509-548, 1906.)
- Geology of Scott county. W. H. Norton. (Iowa Geol. Surv., IX, 389-519, 1899.)
- Geology of Story county. S. W. Beyer. (Iowa Geol. Surv., IX, 155-245, 1899.)
- Geology of Tama county. T. E. Savage. (Iowa Geol. Surv., XIII, 185-253, 1903.)
- Geology of Van Buren county. C. H. Gordon. (Iowa Geol. Surv., IV, 197-254, 1895.)
- Geology of Wapello county. A. G. Leonard. (Iowa Geol. Surv., XII, 439-499, 1902.)
- Geology of Warren county. J. L. Tilton. (Iowa Geol. Surv., V, 301-359, 1896.)
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Marston, A. Tests of Iowa building-stones. (Iowa Geol. Surv., Vol. XVII, pp. 541-557, Des Moines, 1907.) Tables are given of the transverse, crushing, absorption, freezing and thawing tests of a number of the more widely used building-stones.

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- Meek, F. B.** Remarks on Prof. Genitz's Views Respecting Upper Paleozoic Rocks and Fossils of Southeastern Nebraska. (Am. Jour. Sci., (2), Vol. XLIV, pp. 170-187, New Haven, 1867.) Numerous incidental references are made to the geology of western Iowa.
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- Meek, F. B.** Report on Paleontology of Eastern Nebraska, with Remarks on Rocks of that District. (Final Report, U. S. Geol. Surv. Nebraska, pt. ii, pp. 83-245, pls. i-ix, 1872.) Numerous incidental references are made to the occurrence of carboniferous fossils in Iowa.

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