LIST OF FOSSILS

OF THE

CARBONIFEROUS FORMATION

FOUND IN THE

COAL MEASURES, CHESTER, ST. LOUIS, KEOKUK AND KNOBSTONE GROUPS,

OF

HARRISON COUNTY, IND.

CARBONIFEROUS FORMATION.

COAL-MEASURE SYSTEM.

CONGLOMERATE SANDROCK.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternberg.

Caulerpites (resembling) **marginatus**.....Lesquereux.

Genus CHONDRITES, Sternb.

Chondrites colletti.....Lesquereux.

LYCOPODIACEA.

Genus STIGMARIA, Brongniart.

Stigmaria ficoides.....Brongniart.
— (resembling) **undulata**.....Goeppert.
— **stellata**.....Goeppert.

Genus SIGILLARIA, Brongniart.

Sigillaria, 2 sp. inedt.

Genus LEPIDODENDRON, Sternb.

Lepidodendron, 4 sp. inedt.

Genus LEPIDOPHYLLUM, Brong.

Lepidophyllum brevifolium.....Lesqx.
— (like) **imbricata**.....Sternb.

EQUISETACEA.

Genus CALAMITES, Guettard.

Calamites cannæformis.....Schlotheim.
— 2 sp. inedt.

Genus CORDAITES, Unger.

Cordaites borassifolius.....Sternb.
— **angustifolius**.....Lesqx.

FRUITS.

Genus TRIGONOCARPUM, Brong.

Trigonocarpum olivæformis.....Lindley & Hutton.
— **triloculare**.....Hildreth.
— 2 sp. und.

Genus CARPOLITHES, Sternb.

Carpolithes fasciculatus.....Lesqx.

FILICITES.

Fronds and terminal spikes, indt.

ANNELIDÆ.

This list includes only the fossils from the Conglomerate Sand Rock which was deposited in a sea traversed by currents from south-southwest, of sufficient power to transport coarse sand, pebbles, *etc.*; conditions under which animal life would hardly exist, and all remains be worn out and obliterated by abrasion.

SUB-CARBONIFEROUS SYSTEM.

CHESTER GROUP.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternb.

Caulerpites marginatus.....Lesquereux.

Genus CHONDRITES, Sternb.

Chondrites colletti.....Lesqx.

LYCOPODIACEA.

Genus LEPIDODENDRON, Sternb.

Lepidodendron, worn, imperfect trunks.

Genus SIGILLARIA, Brong.

Sigillaria (like) **reniformis**.....Brong.

Genus STIGMARIA, Brong.

Stigmaria ficoides.....Brong.

ANIMALIA.

PROTOZOA.

FORAMINIFERA.

Genus FUSILINA, Fischer.

Fusilina cylindrica.....Fischer.

RADIATA.

CŒLENTERATA.

Genus SYRINGOPORA, Goldfuss.

Syringopora ramulosa ?.....Goldfuss.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis spinulosa .....Edwards & Haime.

Genus CYATHOPHYLLUM, Goldfuss.

Cyathophyllum, 2 sp. undt.

Genus LOPHOPHYLLUM, Edwards & Haime.

Lophophyllum proliferum ?.....McChesney.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus (like) **subspinosus**.....Hall.

Genus DICHOCRINUS, Munster.

Dichocrinus cornigerus.....Shumard.

— **sexlobatus**.....Shumard.

CYATHOCRINIDÆ, Miller.

Genus POTERIOCRINUS, Miller.

Poteriocrinus bisselli.....Worthen.

— **chesterensis**.....Meek & Worthen.

Genus ZEACRINUS, Troost.

Zeacrinus intermedius.....Hall.

— **armiger**.....Meek & Worthen.

— sp. inedt.

Genus EUPACHYCRINUS, M. & W.

Eupachycrinus boydi.....M. & W.

Genus AGASSIZOCRINUS, Troost.

Agassizocrinus conicus.....Owen & Shumard.

— **concideus.**

— **dactyliformis**.....Troost.

— **pentagonus**.....Worthen.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites godoni.....De France.
— **pyriformis**.....Say.
— **globosus**.....Say.
— **obesus**.....Lyon.
— **sulcatus**.....Rœmer.
— **symmetricus**.....Hall.

MOLLUSCA.

MOLLUSCOIDEA.

Genus CYCLOPORA, Prout.

Cyclopora polymorpha.....Prout.

Genus ARCHIMEDES, Le Sueur.

Archimedes swalloviana.....Hall.

Genus SYNOCLADIA, King.

Synocladia biserialis.....Swallow.

BRACHIOPODA.

Genus DISCINA, Lamarck.

Discina (like) **nitida**.....Phillips.

Genus STREPTORHYNCHUS, King.

Streptorhynchus crenistriatus.....Phillips.
— **crassus**.....M. & W.

Genus CHONETES, Fischer.

Chonetes granulifera.....Owen.

Genus PRODUCTUS, Sowerby.

Productus (like) **cora**.....D'Orbigny.
— **punctatus**.....Sowerby.
— **altonensis**.....N. & P.
— **semireticulatus**.....Martin.

Genus SPIRIFER, Sowerby.

Spirifer increbescens.....Hall.
— **leydyi**.....Norwood & Pratten.
— **striatus**.....Miller.
— **setigerus**.....Hall.

Genus SPIRIFERINA, D'Orbigny.

Spiriferina kentuckensis.....Shumard.

Genus ATHYRIS, McCoy.

Athyris sublamellosa.....Hall.
— **subtilita**.....Hall.
— **ambigua**.....Sowerby.

Genus EUMETRIA, Hall.

Eumetria (Retzia) **vera**.....Hall.

Genus RHYNCHONELLA, Fischer.

Rhynchonella osagensis.....Swallow=
— **uta**.....Marcou.
sp. inedt.

Genus TEREBRATULA, Llhwyd.

Terebratula bovidens.....Morton.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten, sp. undt.

Genus ALLORISMA, King.

Allorisma, sp. undt.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras nebrascensis.....Meek.

Genus BELLEROPHON, Montfort.

Bellerophon (like) **carbonarius**.....Cox.
— **hiulcus** (?).....Sowerby.
— sp. undt.

CEPHALOPODA, Breynius.

Genus ORTHOCERAS, Breynius.

Orthoceras, sp. indt.

Genus NAUTILUS, Breynius.

Nautilus sp. indt.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia missouriensis.....Swallow.

CRUSTACEA.

Genus PHILLIPSIA, Portlock.

Phillipsia, sp. ?

VERTEBRATA.

PISCES.

Genus ASPIDODUS, Newberry & Worthen.

Aspidodus crenulatus.....N. & W.

ST. LOUIS GROUP.

PLANTÆ.

LYCOPODIACEA.

Genus LEPIDODENDRON, Sternberg.

Genus SIGILLARIA, Brongniart.

Genus STIGMARIA, Brongniart.

All the specimens of the above-named genera found in this group were water-worn, crushed and broken, with specific characters wholly obliterated.

ANIMALIA.

PROTOZOA.

SPONGIDÆ.

Genus PALÆACIS, Haime.=
SPHENOPOTERIUM, Meek & Worthen.

Palæacis cuneatus.....M. & W.
— **enormis**.....M. & W.

Genus SPONGIA, Linnæus.

Spongis, 3 sp. undt.

FORAMINIFERA.

Genus ROTALIA, Lamarck.

Rotalia baileyi.....Hall.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas.....Rominger.
— sp. ?

Genus SYRINGOPORA, Goldfuss.

Syringopora ramulosa?.....Goldfuss.
— **multattenuata**.....McChesney.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis elliptica.....White.
— **spinulifera**.....Hall.—?
— **spinulosa**.....E. & H.
— **centralis**.....E. & H.
— 3 sp. inedt.

Genus LOPHOPHYLLUM, E. & H.

Lophophyllum, sp. ? undet.

Genus CYATHOPHYLLUM, Goldfuss.

Cyathophyllum, 2 sp. undt.

Genus LITHOSTROTION, Lhwyd.

Lithostrotion canadense.....Castlenau.
— **proliferum**.....Hall.
— **mamillatus**.....Herzer.

Genus AMPLEXUS, Sowerby.

Amplexus, sp. undt.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus saffordi.....Troost.
— sp. undt.

Genus DICHOCRINUS, Munster.

Dichocrinus simplex.....Shumard.
— **ficus**.....Cassedy & Lyon.
— **pisum**.....Meek & Worthen.
— **lineatus**.....M. & W.
— **constrictus**.....M. & W.

ACTINOCRINIDÆ.

Genus ACTINOCRINUS, Miller.

Actinocrinus calyculus ..... Hall.
— sp. indt.

Genus BATOCRINUS, Casseday.

Batocrinus icosidactylus ..... Casseday.
— **irregularis** ..... Casseday.
— **asteriscus** ..... M. & W.
— **inæqualis** ..... Hall.
— 2 sp. indt.

Genus ERETMOCRINUS, L. & C.

Eretmocrinus, sp. indt.

CYATHOCRINIDÆ.

Genus CYATHOCRINUS, Miller.

Cyathocrinus, 2 sp. indt.

Genus POTERIOCRINUS, Miller.

Poteriocrinus missouriensis ..... Shumard.
— sp. ?

Genus ONYCHOCRINUS, L. & C.

Onychocrinus whitfieldi ..... Hall.

Genus ZEACRINUS, Troost.

Zeacrinus armiger ..... M. & W.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites conoideus ..... Hall.
— **koninckianus** ..... Hall.
— **varsouviensis** ..... M. & W.
— **obliquatus** ..... Rœmer.
— **laterniformis** ..... Owen & Shumard.
— **quadrilateralis ?** ..... Hall.?
— **subconoideus** ..... M. & W.

ECHINOIDEA.

PERISCHOECHINOIDÆ.

Genus ARCHÆOCIDARIS, McCoy.

Archæocidaris norwoodi.....Hall.
— **agassizi**.....Hall.
— **wortheni**.....Hall.
— 2 sp. inedt.

Genus LEPIDESTHES, M. & W.

Lepidesthes colletti (plates).....White.

Genus MELONITES, Owen & Norwood.

Melonites (Palæchinus) **multiporus**.....Owen & Norwood.

MOLLUSCA.

MOLLUSCOIDEA.

BRYOZOA.

Genus FENESTELLA, Lonsdale.

Fenestella shumardi.....Prout.
— 2 sp. undt.

Genus SYNOCLADIA, King.

Synocladia biserialis.....Swallow.

Genus POLYPORA, McCoy.

Polypora halliana.....Prout.

Genus ARCHIMEDES, Le Sueur.

Archimides wortheni.....Hall.
— **swalloviana**.....Hall.

Genus STICTOPORA, Hall.

Stictopora (Ptilodictya) **serrata**.....Meek.
— — **carbonaria**.....Meek.
— — sp. inedt.

Genus COSCINIUM, Keyserling.

Coscinium michelinia ..... Prout.
— **asterium** ..... Prout.
— **wortheni** ..... Prout.
— **escharoides** ..... Prout.
— **tuberculatum** ..... Prout.

Genus TREMATOPORA, Hall.

Trematopora sp. ?

BRACHIOPODA.

Genus ORTHIS, Dalman.

Orthis dubia ..... Hall.
— 2 sp. indt.

Genus STREPTORHYNCUS, King.

Streptorhynchus crenistriatus ..... Phillips.

Genus CHONETES, Fischer.

Chonetes, sp.?

Genus PRODUCTUS, Sowerby.

Productus (like) **cora** ..... D'Orbigny.
— **tenuicostus** ..... Hall.
— **punctatus** ..... Sowerby.
— **semireticulatus** ..... Martin.
— **altonensis** ..... N. & P.

Genus SPIRIFER, Sowerby.

Spirifer lateralis ..... Hall.
— **pseudolineatus** ..... Hall.
— **subcardiformis** ..... Hall.
— **suborbicularis** ..... Hall.
— **rostellatus ?** ..... Hall.
— **fultonensis** ..... Worthen.
— **tenuicostatus** ..... Hall.

Genus SPIRIFERINA, D'Orbigny.

Spiriferina spinosa ..... Norwood & Pratton.

Genus ATHYRIS, McCoy.

Athyris royissi.....L'Eveille.
— **subquadrata**.....Hall.
— **hirsuta**.....Hall.
— **planosulcatus**.....Phillips.
— **trinuclea**.....Hall.

Genus EUMETRIA, Hall=RETZIA, King.

Eumetria verneuiliana.....Hall.
— **vera**.....Hall.
— sp. indt.

Genus RHYNCHONELLA, Fischer.

Rhynchonella subcuneata.....Hall.
— **grosvenori**.....Hall.
— **mutata**.....Hall.
— **ricinula**.....Hall.

Genus TEREBRATULA, Llhwyd.

Terebratula formosa.....Hall.
— **turgida**.....Hall.
— **inornata**.....McChesney.
— 2 sp. ined.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten, sp. undt.

Genus MYALINA, Koninck.

Myalina keokuk.....Worthen.
— sp. ined.

Genus ALLORISMA, King.

Allorisma sinuata ?.....McChesney.

Genus CONOCARDIUM, Bronn.

Conocardium cuneatum.....Hall.
— **carinatum**.....Hall.
— **constrictum**.....Hall.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras uncum.....Meek & Worthen.
— **nebrascense ?**.....Meek.
— sp. ined.

Genus EUOMPHALUS.

Euomphalus spergenensis.....Hall.
— **planispira**.....Hall.
— **planorbiformis**.....Hall.
— sp. ined.

Genus CYCLONEMA, Hall.

Cyclonema leavenworthana.....Hall.

Genus NATICOPSIS, McCoy.

Naticopsis shumardiana.....Hall.

Genus MURCHISONIA, D'Arc & Vern.

Murchisonia insculpta.....Hall.
— **vermicula**.....Hall.
— 2 sp. indt.

Genus PLEUROTOMARIA, De France.

Pleurotomaria wortheni.....Hall.
— **concava**.....Hall.
— sp. ined.

Genus BULIMELLA, Hall.

Bulimella, 2 sp. undt.

Genus BELLEROPHON, Montfort.

Bellerophon sublævis.....Hall.
— **marcouanus ?**.....Geinetz.

Genus DENTALIUM, Linnæus.

Dentalium primarium.....Hall.
— **venustum**.....M. & W.
— sp. undt.

Genus CHITON, Linnæus.

Chiton carbonarius.....Stevens.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia missouriensis.....Swallow.

CEPHALOPODA.

Genus ORTHOCERAS, Breynius.

Orthoceras expansum.....Meek & Worthen.
— 2 sp. indt.

Genus NAUTILUS, Breynius.

Nautilus, (casts) indt.

Genus TEMNOCHEILUS, McCoy.

Temnocheilus niotense.....M. & W.
— **coxanum**.....M. & W.

Genus GONIATITES, De Haan.

Goniatites, sp. inedt.

ARTICULATA.

ANNELIDÆ.

Genus SPIRORBIS, Lamarck.

Spirorbis annulatus.....Hall.

CRUSTACEA.

Genus CYTHERE, Muller.

Cythere carbonaria .....Hall.

Genus PHILLIPSIA, Portlock.

Phillipsia seminifera.....Morrison.
— sp. inedt.

VERTEBRATA.

PISCES.

Genus TRIGONODUS, Newberry & Worthen.

Trigonodus minor.....N. & W.

Genus ANTLIODUS, N. & W.

Antliodus minutus.....N. & W.

Genus CHOMATODUS, Agassiz.

Chomatodus selliformis (sp. nov.).....Newberry.
— **angustus** (sp. nov.) .....Newberry.
— **pusillus**.....N. & W.
— **obliquus** (sp. nov.).....Newberry.

Genus LISGODUS, St John & White.

Lisgodus affinis (sp. nov.).....Newberry.

Genus ORODUS, Agassiz.

Orodus colletti (sp. nov.) .....Newberry.

Genus HELODUS, Agassiz.

Helodus lævis (sp. nov.) .....Newberry.
— **coniculus** .....Newberry & Worthen

Genus THRINACODUS, St. J. & W.

Thrinacodus bicornis (sp. nov.).....Newberry.

Genus DELTODUS, Newberry & Worthen.

Deltodus grandis.....N. & W.
— **cinctus** (sp. nov.).....Newberry.

KEOKUK GROUP.

ANIMALIA.

PROTOZOA.

SPONGIDÆ.

Genus PALÆACIS, Haime.=
SPHENOPOTERIUM, Meek & Worthen.

Palæacis obtusus.....M. & W.

SPONGIA?

Genus and species inedt.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas.....Rominger.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis dalii.....Edwards & Haime.
— **spinulifera**.....Hall.

Genus LOPHOPHYLLUM, Edwards & Haime.

Lophophyllum proliferum?.....McChesney.

Genus AMPLEXUS, Sowerby.

Amplexus fragilis.....White & St. John.

ECHINODERMATA.

CRINOIDEA.

PLATYCRINIDÆ.

Genus PLATYCRINUS, Miller.

Platycrinus planus.....O. & S.
— **lodensis**.....H. & W.
— **discoideus**.....O. & S.
— **halli**.....Shumard.

Genus DICHOCRINUS, Munster.

Dichocrinus ficus.....C. & L.
— **lineatus**.....M. & W.
— **striatus**.....O. & S.
— **simplex**.....Shumard.
— **expansus**.....M. & W.

ACTINOCRINIDÆ.

Genus ACTINOCRINUS, Miller.

Actinocrinus indianensis.....L. & C.
— **biturbinatus**.....Hall.
— **agassizi**.....Troost.
— **ramulosus**.....Hall.
— **bronteus**.....Hall.
— **lowii**.....Hall.
— **nashvillæ**.....Troost.
— **magnfica**.....Troost.

Genus STROTOCRINUS, Meek & Worthen.

Strotocrinus perumbrosus.....Hall.

Genus AGARICOCRINUS, Troost.

Agaricocrinus wortheni.....Hall.
— **tuberosus**.....Troost.
— sp. inedt.

CYATHOCRINIDÆ.

Genus CYATHOCRINUS, Miller.

Cyathocrinus magister.....Hall.
— sp. indt.

Genus BARYCRINUS, Wachsmuth.

Barycrinus hercules.....N. & W.
— **hoveyi**.....Hall.
— **pentagonus**.....Worthen.
— **spectabilis**.....M. & W.
— **magister**.....Hall.
— sp. indt.

Genus POTERIOCRINUS, Miller.

Poteriocrinus indianensis.....M. & W.
— sp. indt.

Genus SCAPHIOCRINUS, Hall.

Scaphiocrinus decadactylus.....Meek & Worthen.
— **unicus**.....Hall.
— **æqualis**.....Hall.

Genus ZEACRINUS, Troost.

Zeacrinus troostianus.....M. & W.
— **ramosus**.....Hall.
— sp. indt.

Genu FORBESOCRINUS, De K. & Le H.

Forbesocrinus meeki.....Hall.
— **wortheni**.....Hall.
— **shumardi**.....Hall.
— **ramulosus**.....Hall.

Genus TAXOCRINUS, Phillips.

Taxocrinus shumardi.....Hall.

Genus SYNBATHOCRINUS, Phillips.

Synbathocrinus dentatus.....O. & S.
— ? **robustus**.....M. & W.
— **swallovi**.....Hall.
— **wachsmuthi**.....M. & W.

Genus GRAPHIOCRINUS, De K. & Le H.

Graphiocrinus, sp. indt.

BLASTOIDEA.

Genus PENTREMITES, Say.

Pentremites wortheni.....Hall.
— **pyramidatus**.....Hall.
— **woodmani**.....M. & W.
— **conoideus?**.....Hall.
— **lineatus**.....Troost.
— **burlingtonensis**.....M. & W.

ECHINOIDEA.

PERISCHOECHINOIDEA.

Genus LEPIDESTHES, Meek & Worthen.

Lepidesthes sp.? (detached plates).

Genus ARCHÆOCIDARIS, McCoy.

Archæocidaris wortheni.....Hall.
— **agassizi**.....Hall.
— **norwoodi**.....Hall.
— sp. ined.

Genus MELONITES, Owen & Shumard.

Melonites multiporus?.....O. & S.
— sp.?

Genus OLIGOPORUS, Meek & Worthen.

Oligoporus nobilis.....M. & W.

ASTEROIDEA.

Genus ONYCHASTER, Meek & Worthen.

Onychaster flexilis.....M. & W.

Genus EVACTINOPORA? Meek & Worthen.

Evactinopora sexradiata.....M. & W.
— **grandis**.....M. & W.

EDRIOASTEROIDEA.

Genus AGELACRINUS, Vanuxem.

Agelacrinus squamosus.....Meek & Worthen.

MOLLUSCOIDEA.

BRYOZOA.

Genus FENESTELLA, Lonsdale.

Fenestella shumardi.....Prout.
— 2 sp. undt.

Genus POLYPORA, McCoy.

Polypora discoideus?

Genus ARCHIMEDES, Le Sueur.

Archimides oweniana.....Hall.
— **reversa ?**.....Hall.

Genus PTILOPORA, McCoy.

Ptilopora prouti.....Hall.

Genus STICTOPORA, Hall,
? loq. PTILODYCTIA, Lonsdale.

Stictopora carbonaria.....Meek.
— **serrata**.....Meek.

Genus COSCINIUM, Keyserling.

Coscinium asterium.....Prout.
— **elegans**.....Prout.
— **escharoides**.....Prout.
— **michelinia**.....Prout.
— **wortheni**.....Prout.

Genus TREMATOPORA, Hall.

Trematopora, sp.?

Genus ORTHIS, Dalman.

Orthis dubia.....Hall.
— **michelina**.....L'Eveille.

Genus STREPTORHYNCHUS, King.

Streptorhynchus crenistriatus.....Phillips.

Genus CHONETES, Fischer.

Chonetes logani.....Norwood & Pratton.
— **planumbona**.....Meek & Worthen.

Genus PRODUCTUS, Sowerby.

Productus (like) **cora**.....D'Orbigny.
— **punctatus**.....Sowerby.
— **semireticulatus**.....Martin.
— **vittatus**.....Hall.
— **alternatus**.....N. & P.

Genus SPIRIFER, Sowerby.

Spirifer striatus.....Miller.
— **keokuk**.....Hall.
— **fastigiata**.....Meek & Worthen.
— **suborbicularis**.....M. & W.
— **subcuspidatus**.....Hall.
— **neglectus**.....Hall.
— **grimesi**.....Hall.
— **lateralis**.....Hall.
— **pseudolineatus**.....Hall.

Genus ATHYRIS, McCoy.

Athyris lamellosa.....L'Eveille.
— **royissa**.....L'Eveille.
— **incrassata**.....Hall.

Genus RHYNCHONELLA, Fischer.

Rhynchonella mutata.....Hall.
— sp. ined.

Genus TEREBRATULA, Llhwyd.

Terebratula hastata.....Sowerby.
— **inornata**.....McChesney.

Genus CAMAROPHORIA, King.

Camarophoria subtrigona.....Meek & Worthen.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus AVICULOPECTEN, McCoy.

Aviculopecten indianensis.....Meek & Worthen.
— **winchelli**.....Meek.
— sp. ined.

Genus MYALINA, De Koninck.

Myalina keokuk.....Meek & Worthen.

Genus PINNA, Linnæ.

Pinna subspatulata.....Meek & Worthen.

Genus LITHOPHAGA, Lamarck.

Lithophaga lingualis.....Phillips.

Genus CYPRICARDELLA, Hall.

Cypricardella nucleata.....Hall.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras equilateralis.....Hall.
— **fissurella**.....Hall.
— **uncum**.....Meek & Worthen.
— **infundibulum**.....M. & W.
— sp. inedt.

Genus PLEUROTOMARIA, DeFrance.

Pleurotomaria shumardi.....M. & W.
— sp. indt.

Genus BELLEROPHON, Montfort.

Bellerophon, sp. indt.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia subcarbonaria..... Meek & Worthen.
— **micronema**..... M. & W.

CEPHALOPODA.

Genus ORTHOCERAS, Breynius.

Orthoceras expansum.....Meek & Worthen

ARTICULATA.

CRUSTACEA.

Genus PHILLIPSIA, Portlock.

Phillipsia bufo.....Meek & Worthen.
— **portlocki**.....M. & W.

VERTEBRATA.

PISCES.

Genus PETALODUS, Owen.

Petalodus knappi, (sp. nov.).....Newberry.

Genus ANTLIODUS, N. & W.

Antliodus similis.....Newberry & Worthen.

Genus ORODUS, Agassiz.

Orodus ornatus.....N. & W.
— **elegantulus**.....N. & W.

Genus DELTODUS, N. & W.

Deltodus spatulatus.....N. & W.

BURLINGTON GROUP.

In the lower Keokuk beds, although fossils of that age predominate, yet as all indications point to the synchronism of these strata with the Burlington Group in Illinois and Iowa, the following list of fossils found in Harrison and Clark counties is parenthetically added. Many of them are exclusively Burlington.

Platycrinus halli, (plates and stems) .....Shumard.
— **discoideus**.....Owen & Shumard.
— **planus**.....Shumard.
Dichocrinus striatus.....O. & S.
— **lineatus**.....M. & W.
Actinocrinus unicornis.....O. & S.
Synbathocrinus wachsmuthi.....M. & W.
— **dentatus**.....O. & S.
Zeacrinus ramosus.....Hall.
— **troostianus**.....M. & W.
Strotocrinus perumbrosus.....Hall.
Pentremites burlingtonensis.....M. & W.
Productus burlingtonensis.
— **flemingi**.....Sowerby.
Spirifer grimesi.....Hall.
Orthis michelina.....L'Eveille.
Athyris increassata.....Hall.

KNOBSTONE GROUP.

PLANTÆ.

ALGÆ.

Genus CAULERPITES, Sternberg.

Caulerpites (resembling) **marginatus**.....Lesqx.

Genus CHONDRITES, Sternb.

Chondrites colletti.....Lesqx.

ANIMALIA.

RADIATA.

CŒLENTERATA.

Genus AULOPORA, Goldfuss.

Aulopora gigas.....Rominger.

Genus ZAPHRENTIS, Rafinesque.

Zaphrentis, 2 sp. indt.

Genus LOPHOPHYLLUM, E. & H.

Lophophyllum proliferum ?.....McChesney.
— 2 sp. inedt.

ECHINODERMATA.

CRINOIDEA.

Actinocrinus cassedayi.....Lyon.
Forbesocrinus wortheni.....Hall.
Synbathocrinus wortheni.....Hall.
— **swallovi**.....Hall.
Catillocrinus bradleyi.....Meek & Worthen.

MOLLUSCA.

MOLLUSCOIDEA.

BRACHIOPODA.

Genus ORTHIS, Dalman.

Orthis michelini.....L'Eveille.

Genus CHONETES, Fischer.

Chonetes logani.....Norwood & Pratten
— **planumbonum**.....M. & W.

Genus STREPTORHYNCHUS, King.

Streptorhynchus keokuk.....Hall.

Genus PRODUCTUS, Sowerby.

Productus magnus.....Meek & Worthen.
sp. ined.

Genus SPIRIFER, Sowerby.

Spirifer carteri.....Hall. (See Syringothyris.)
— **peculiaris**.....Shumard.
— **mucronatus**.....Conrad.
— **marionensis**.....Shumard.
— **aspera**.....Hall.

Genus SPIRIFERINA, D'Orbigny.

Spiriferina (resembling) **kentuckensis**.....Shumard.

Genus SYRINGOTHYRIS, Winchell.

Syringothyris textus.....Hall.

Genus LEIORHYNCHUS, Hall.

Leiorhynchus quadricostatus.....Vanuxem.

Genus TEREBRATULA, Llhwyd.

Terebratula calvini.....Hall & Whitfield.

MOLLUSCA VERA.

LAMELLIBRANCHIATA.

Genus MYALINA, Koninck.

Myalina keokuk.....Worthen.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras unoum.....Meek & Worthen.
— **infundibulum**.....M. & W.
— sp. indt.

Genus PLEUROTOMARIA, DeFrance.

Pleurotomaria, 2 sp. indt.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia newberryi.....Winchell.

ARTICULATA.

ANNELIDÆ.

Annulated vermiform markings. Vermiform fucoides.

VERTEBRATA.

PISCES.

Bones and teeth of fishes, not determined.

SCHOOL OF MINES, COLUMBIA COLLEGE,
NEW YORK CITY, DEC. 10, 1878.

PROF. JOHN COLLETT,
Assistant State Geologist,
Indianapolis, Ind.:

DEAR SIR:—I find among the specimens of fish teeth, which you have sent me, the following species:

1. Aspidodus crenulatus, N. and W. (op. cit. p. 93, pl. VIII., Figs. 3 to 11,) Chester limestone, Grayson county, Kentucky.

2. Trigonodus minor, N. and W. (op. cit. p. 93, pl. VIII., Figs. 7, 7 a,) St. Louis beds, Harrison county, Ind. Prof. John Collett.

3. Antliodus minutus, N. & W. (op. cit., p. 43, pl. III., Figs. 3, 3 a,) St. Louis group, Harrison county, Ind. Prof. John Collett.

4. Chomatodus selliformis, n. sp. Tooth quadrangular, with salient angles; one inch or more in length, by a quarter of an inch wide and high, crown surface showing a rounded, triturating edge, bordered on one side by a slightly excavated, smooth, enameled surface; on the other by a flattened face marked by four broad enamel plaits; root forming a thin, roughened wing.

The collection contains numerous fragments of this interesting tooth, which at first sight resembles the quadrangular, transverse tooth of some of the Rays. On closer examination, however, it will be seen that it was set obliquely on the jaw, so as to make one of its angles serve for contusing or triturating food. In its general plan of structure it is

not unlike many other species in the ill-defined genus Chomatodus, in which the teeth sometimes present a cutting edge; at others a flat, triturating surface. Doubtless some of these diversities of form have generic value, but the subdivision of the group can only be intelligently done by those having a large amount of material for study. A section of the tooth before me is, in one attitude, almost precisely the shape of the backless chairs so much used among the ancients, a resemblance which suggested the name. St. Louis beds, Harrison county, Ind. Prof. John Collett.

5. Chomatodus angustus, n. sp. Teeth of medium size, largest 30 millimeters long by 11 millimeters high; crown surface narrow, flat or obliquely excavated, 4 millimeters long, coarsely punctate throughout; the body of the tooth is constricted in the middle, expanded below and terminates inferiorly in a sharp, central edge.

In a general way this resembles the other flat-topped species of Chomatodus, such as *C. molaris, C. angulatus,* etc., but differs from any yet described in the symmetry of its section. The upper surface is plain or slightly excavated, and about twice as wide as the constricted middle portion of the tooth which supports it; below the middle it again expands symmetrically and terminates in an edge which is central, instead of lateral, as in *C. molaris* and other species. Not uncommon in the St. Louis beds of the lower carboniferous limestone in Harrison county, Ind. Prof. John Collett.

6. Chomatodus obliquus, n. sp. Teeth small or of medium size, largest 20 or 30 millimeters long by 8 to 10 in hight; crown triangular in section with a sub-acute edge above, from which the enameled surface declines at an angle of 45° to a lateral edge, beneath which the tooth is much constricted, but expands again into a rounded, irregular

ridge, which borders the acute terminal margin. The opposite side of the tooth is concave vertically, but nearly plain; is enameled above and shows faint enamel folds along the middle. In general form this species resembles that last described, but differs notably in having one side of the enameled crown raised into an acute edge. St. Louis beds, Harrison county, Ind. Prof. John Collett.

7. *Lisgodus affinis,* n. sp. Teeth very broad, 4 millimeters high and broad, crown elliptical in outline, compressed, with an obtuse, arched upper edge, inclined backward, and in worn specimens roughened by the exposed calcigerous tubes; enamel fold continuous around the base of the crown; strong and double; root tongue-shaped, narrower than the crown, rounded below where it is deflected backward. This little tooth is evidently closely allied to that described by Mr. St. John in the Rep. Geo. Sur. Ill., Vol. VI., p. 366, pl. 10 a, figs. 16 a, 16 b, but the crown is less conical and the root more rounded. St. Louis beds, Harrison county, Ind. Prof. John Collett.

8. *Orodus colletti,* n. sp. Teeth small, maximum breadth about one inch; crown consisting of several low, pointed cones, of which one, central or sub-central, is largest; three are marked with divergent raised lines, which are elegantly beaded, and one or two more delicately beaded lines pass over the crown in the interval between the conical prominences, root thick and strong, pitted on the sides, flattened below. This elegant little species resembles *O. ornatus,* cited above, but will be at once distinguished from it, and from all others hitherto described, by the elegant beading of the raised lines. St. Louis beds, Harrison county, Ind. Prof. John Collett.

9. *Helodus lævis,* n. sp. Teeth small, 20 to 25 millimeters long, 4 to 5 broad and high; outline linear, slightly

curved; crown surface arched from front to rear; uniformly smooth and polished, but finely punctate; root as high as crown, flat below and on the sides, as broad as high, slightly oblique. This species, seen from above, resembles smaller specimens of *H. angulatus*, N. and W. (op. cit. Vol. II., p. 83, pl. V., Figs. 9, 9 a,) but differs strikingly from that in its broad, flat, angular, slightly oblique root. St. Louis beds, Harrison county, Ind. Prof. John Collett.

10. Helodus coniculus, N. and W. (op. cit. p. 75, pl. IV., Figs. 19, 19 a,) St. Louis beds, Harrison county, Ind. Prof. John Collett.

11. Thrinacodus bicornis, n. sp. A single specimen of a minute tooth, with excavated, spatulate base, and two recurved denticles, occurs in the collection, and it plainly belongs to the same genus with that described in the Illinois Report under the name of *Diplodus incurvus*, which Mr. St. John subsequently, and very properly, placed in his genus *Thrinacodus.*

The form of the base and denticles and the tissue of the teeth are the same in both, and the only perceptible difference is that the specimen under consideration has but two denticles. This may prove to be but an exhibition of the variety of forms which is so frequently seen in the dentition of a single individual among plagiostomus fishes; but until proof of identity with the described species is produced it will be better to consider them as distinct. St. Louis beds, Harrison county, Ind. Prof. John Collett.

12. Deltodus grandis, (?) N. and W. (op. cit. Vol. II., p. 100, pl. IX., Figs. 9, 9 a,) St. Louis limestone, Harrison county, Ind. Prof. John Collett.

13. Deltodus cinctus, n. sp. Tooth of medium size, spatulate in outline, with rounded angles; much arched in both directions, thick and strong; greatest breadth, 25 mil-

limeters; length, 55 millimeters; upper surface marked transversely by a series of shallow sulci which curve downward and terminate in the lateral margins, causing these to be slightly crenulated. In the middle portion of the crown these furrows are about five millimeters apart; near the lower margin they more closely approximate, and are somewhat irregular; surface uniformly enameled, and rather closely punctate.

This species somewhat resembles *D. undulatus* and *D. cingulatus* (op. cit., pp. 98, 99), but differs from the first in its narrower form, arched surface, and in having the undulations over all parts of the crown surface. The tooth of *D. cingulatus* is narrower in outline, and the transverse sulci, by which it is cingulated, are much broader. St. Louis limestone, Harrison county, Ind. Dr. Knapp.

14. Petalodus knappi, n. sp. Tooth of medium size; a little broader than high; vertical length, 28 millimeters; breadth of crown, 30 millimeters; root semi-circular, marked with obscure, vertical and radiating ridges and furrows, by which the lower edge is obscurely crenulated; crown long, elliptical in outline, with rounded angels; vertical hight on concave surface, 15 millimeters; enamel folds at base distinctly marked; convex face of crown marked centrally by a prominent transverse ridge formed by a single enamel fold, which is bent abruptly downward at the extremities.

This species bears a general resemblance to *P. linguifer*, N. & W. (op. cit. p. 37, pl. II., fiig. 4), having, like that, a rounded, tongue-like root, and a low and transversely broad crown; but it differs from that species in its shorter root, which is just half the entire hight of the whole tooth, and in the absence of a point at the center of the cutting edge, visible in unworn specimens of that species. A number of specimens of this species occur in the collection; two entire

ones from the Keokuk beds, Bono, Lawrence county, Ind., collected by Dr. Knapp; others from Clark and Harrison counties, obtained by Prof. John Collett.

15. Antliodus similis(?) N. & W. (op. cit. p. 41, pl. II., figs. 10, 10a.) Keokuk beds, Harrison county, Ind. Prof. John Collett.

16. Orodus ornatus, N. & W. (op. cit., p. 65, pl. IV., fig. 7.) Keokuk beds, Harrison county, Ind. Prof. John Collett.

17. Orodus elegantulus, N. & W. (op. cit., p. 64, pl. IV., figs. 6, 6a.) Keokuk beds, Harrison county, Ind. Prof. John Collett.

18 Deltodus spatulatus, N. & W., Geo. Sur. Ills., Vol. II., p. 100, pl. 9, fig. 7. Keokuk limestone, Harrison county, Ind. Dr. Knapp.

To the foregoing catalogue I add the following notice of some enormous and specially interesting fish teeth recently obtained from the Sub-carboniferous limestone of Indiana:

ARCHÆOBATIS, nov. gen. Dentition flat and pavement-like; teeth of large size, thick and massive, in several rows, the different series arched and increasing in size from behind forward; under surfaces somewhat excavated to fit the curvature of the cartiliginous jaw; upper third of teeth formed by a coat of enamel, transversely corrugated and punctate.

The teeth, on which the above description is based, have the general form of those of *Psamnodus,* but they are many times larger, and are distinguishable from them by the beautifully regular corrugation of the enameled surface like that of the teeth of Rhina. A number of teeth, found in juxtaposition, show that the dentition was much like that of the living Rays, especially *Mylorbatis;* and there can be little doubt that they represent the oldest and most gigantic members, yet known, of the Ray family.

19. Archæobatis gigas, n. sp. Teeth numerous, nearly flat, forming rows from front to rear, and diminishing in size from the second tooth backward; all quadrangular in form, with the longest diameter transverse; largest specimen six inches wide, by four inches from front to rear; thickness of the largest teeth, one inch and a half. The corrugation of the surface is strong, and very regular, resembling that on the teeth of *Rhina ancylostoma,* and doubtless had the same function—to prevent objects from slipping while being crushed. From the Lower Carboniferous limestone (St. Louis beds), Greencastle, Ind.; collected by Rev. H. Herzer.

From the Coal-Measures of Vermillion county, Ind., I have received specimens of the remarkable spines of two species of *Edestes,* which, with others obtained from Mr. Alexander Butters, of Carlinsville, Ills., show much more of the structure and mode of growth of these peculiar organs than was known before. The species referred to are *Edestes heinrichii,* N. (op. cit., Vol. IV., p. 350, pl. I., figs. 1a, 1b.) (Of the latter species a better figure is given on pl. 1, Vol. IV., but is credited wrong on the fly-leaf to *E. vorax,* Leidy, a larger and quite different species.)

Numerous spines of both these species have come into my hands in such a state as to show that they were partially decomposed before fossilization. The numerous segments which are united to form the massive spines being easily separated one from another. I also have a young spine from *E. heinrichii,* from Vermillion county, Ind., which is composed of the single and first formed segments. It is complete, and in a beautiful state of preservation. Its outline is spatulate, and the narrower end bears a single, triangular, enameled, coarsely crenulated denticle, about an inch on the base, and half an inch high. The enameled portion of this denticle extends over and caps the summit

of the spine. The other specimens which I have, show that other segments were added in succession, each one sheathing the previously formed ones, and extending beyond them far enough to carry a new denticle on the extremity. When complete, there were ten or twelve of these placed in succession along the upper margin of the spine, constituting a saw, of which the teeth are one and a half inches high—equilateral triangles in outline, about half an inch thick at the center, thinning down to an acute and coarsely crenulated edge before and behind.

In *E. minor* the spine is much compressed, and two and a half inches wide to the base of the denticles, which rise obliquely to the length of one and a half inches above this; they are narrower and more curved than those of *E. heinrichii*, of which the spine is thicker, straighter and larger, reaching the length of a foot or more.

Taken altogether, these are perhaps the most peculiar defensive organs known among the class of fishes, and among the most formidable. Though first described as jaws set with triangular, crenulated, shark-like teeth, there can be no question but that they are spines, analogous in their functions to the defensive fin spines worn by so many of the ancient sharks. The absence of an articulating surface at the base shows that they belong to cartilaginous fishes of the shark family, and were implanted in the integument of the body without connection with the skeleton. Their perfect bi-lateral symmetry shows that they were worn on the median line, but where on that line is not yet known, since all other portions of the fish—soft parts and cartilaginous skeleton—have disappeared. From their mode of growth, additions being constantly made to the distal extremity, instead of the base—as is the case in the growth of most such organs—it is evident that all but the denticles were constantly or generally covered with integument, and

nothing but the cruel saw-edge was exposed. If planted as an appendage to the posterior dorsal fin, or near the tail, where the flexibility of the body would be considerable, this formidable organ might be directed by the will of the possessor, and used with destructive effect upon his foes.

A great number of fragments of teeth of *Petalodus* and *Cladodus* are contained in the collection which you sent. They represent several species, but all are too imperfect for description.

Yours truly,

J. S. NEWBERRY, M. D.

LOCAL DETAILS.

To the foregoing general description of the Connected Section of the rocks, and the list of fossils by which they are identified, details will now be added for local information.

Corydon is the seat of justice, and commercial center of the county. It was founded by General Harrison, (afterward President of the United States,) about the year 1808, and presents many evidences of its early date—as large shade trees in some of the lawns, and the rows of trees planted along Indian creek to protect the banks, now presenting an unique appearance as they guard and protect the boundaries of farms, and evincing an age of improvement not elsewhere seen in the State. An air of permanent thrift prevails, indicating a well-founded prosperity; but, save the residences of the earliest period, and the utter destruction of their park-like grounds, are almost sad reminders of the past.

In 1813 Corydon became the seat of government of the

Territory of Indiana under Gov. Posey, and subsequently from 1816, when this State was organized, until 1825, it was the capital of Indiana.

The "ancient capitol" of the State was erected by the county for a court-house, in 1811. It is forty feet square, two stories high, and built of blue limestone in irregular courses, from four to ten inches thick. The window sills are of a buff or yellow stone, quarried at Salisbury, which comes from the quarry so soft that it may be hewed with an ax or cut with a hand-saw, but which hardens on exposure to the air.

In this pioneer period some of the most enterprising soldiers of the Revolution and of the War of 1812, with cadets representing the bravest energy of the Eastern States, became citizens of Harrison county. Mention is almost invidious, but among the many who came was the tall soldierly patriot—General Posey—friend and companion of Washington. Familiar with the views, plans and maxims of his great friend, he imitated closely all that was pure and noble in his character.

Gov. Jennings, with a *personnel* like Agamemnon, walked "a king of men," honest, pure, with heroic courage for the right, lives in history a peer of the noblest in patriotism.

Harbin Moore, a meteor of brilliant thought and speech, and princely in courtly elegance of manners and conversation.

The Boones, unrivalled in pioneer daring that never quailed before their savage enemies, and "in whose lexicon there was no such word as fail."

The classic Harrison—a true friend, kind neighbor, gallant soldier, magnanimous conqueror, victor on every battlefield, sagacious statesman and President of the Republic, held unchallenged the highest human title—"an honest man."

Such were the early models who deeply impressed their character on their descendants. The effects survive in the deeds and actions of the generations to this day, and give origin to the enviable appellation so often bestowed on the county of "Patriotic Harrison."

Ignoring the valleys of the streams, as Big and Little Indian creeks, we find the great "Barrens" plain, already mentioned, spread out from 140 to 160 feet above town.

It extends to north, northwest, east and southeast, or from the northern boundary of the county to Ohio river. The plain thus established slopes gently to the southeast, contains hundreds, or rather thousands, of "sink-holes," on its surface; and the soil, as already mentioned, consists of an immense mass of insoluble residuum of the materials composing the St. Louis limestone, degraded and removed to a depth of 250 or 300 feet, giving existence to the great Pre-glacial valley. By this process, and exposure to rain water charged with gases, the lime is almost wholly removed, consequently injudicious cropping soon removes the small alkaline remainder, and the crops are unsatisfactory until lime or some other fertilizer is applied.

The "Barrens" are so-named from the fact that when first visited by white men there were no trees on such areas as had been swept by autumnal fires; but, on the contrary, could offer only a wild growth of annual weeds, prairie grass and low "stool brush." Since the fires have been prevented by settlements, farms, etc., some fifty years ago, quite a forest has sprung up, and the former prairie plains are crowded in places with a young growth from twelve to eighteen inches in diameter.

Immediately west of town is the commanding hill named "Pilot Knob." In an early day it was a landmark by which white and savage hunters and travelers determined

their position and route. The knob is 290 feet high above town. An ancient river bench was observed at the hight of 140 feet, and a lacustral bench or terrace at 160 feet above Indian creek.

SECTION OF PILOT KNOB.

	Ft.
Soil	2
Laminated Chester sandstone	14
Heavy ferruginous sandstone	11
Compact argillaceous limestone, with chert	15
Argillaceous limestone and buff shales	30
Buff shales, with plates and bones	25
Gray St. Louis limestone, with chert, bryozoans and lithostrotion	10
White oolitic limestone	9
Massive, blue, clinky, St. Louis limestone and cherty shales, partly covered to Big Indian creek	176
	292

At the base of this section is a dark bituminous limestone, which, by false bedding and included vegetable matter, shows that a great tidal disturbance occurred in the Sub-Carboniferous sea. Fossils were not abundant, and in some of the rocks wholly absent. The limestones in the knob were sharp and angular, but the hard, ferruginous sand rock at the top was rounded, planished and moulded on the edges, indicating that a violent current of water of great volume had, in the beginning of the time when it was above ocean level, and subject to ærial influences, eroded a way around this hill-top, and that degradation alone would not account for the phenomenon. Again, the abrupt water-worn declivity on the northern face, with a well-rounded pebbly talus to the southeast, plainly showed the direction from which the great current of water came, and toward which it flowed.

Half a mile north of Corydon, on the southeast quarter,

section 25, township 3, range 3 east, stone was being quarried for the piers of the new bridge, giving the following exhibit:

SECTION AT JUDGE SLAUGHTER'S QUARRY.

	Ft.	In.
Slope, shale and chert (covered)	30	0
Blue limestone, in beds 12 to 18 inches thick	8	0
Thinly laminated limestone	16	0
Bituminous limestone, with annulated vermiform fucoidal? markings	2	6
Carbonaceous slate in Indian creek	0	4
	56	10

The product, although hard to work, was obtained in good blocks, and, judging from past experience, will prove durable.

During the petroleum excitement a well was commenced at Corydon in September, 1871, and bored to a depth of 1200 feet, in the fall of 1873, at a cost of $5,451.

I am indebted to Major Thomas McGrain, one of the officers of the Corydon Artesian Well company, for the following accurate statement of material passed through.

The geological determinations are made, as a rule, from well-known and easily recognized strata, which outcrop within the county or in adjoining territory, measuring from an average of many outcrops when stratigraphy alone was relied upon. The starting point was a known exposure, while the Knobstone shales and sandstones, and the Black Slate, did not admit of error from their well-known character:

SECTION OF CORYDON ARTESIAN SALT WELL.

	Ft.	Ft.
Soil and fluviatile drift	12	.....
Blue St. Louis limestone	36	48
Blue St. Louis limestone, with saline sulphur water	9	57
Gray limestone, with clay partings	66	123
Soapstone	5	128
Limestone	3	131

	Ft.	Ft.
Siliceous shale (sandstone?)	4	135
Blue limestone, Keokuk	15	150
Limestone, with geodes and chert	40	190
Gray limestone	40	230
Knob shale and soapstone, "Bloom of Oil"	136	366
Knob shale and soft sandstone	18	384
Knob shale and hard sandstone	9	393
Knob shale and soft sandstone	18	411
Knob shale and tough sandstone	106	517
Knob shale and soapstone with carburetted hydrogen gas	33	550
Knob siliceous shale and sandstone	24	574
Knob shale and soft sandstone	9	583
Knob sandstone, light colored	12	595
Knob sandstone and shale, gas	57	652
Devonian Black Slate, Genesee shale with strong brine, gas and petroleum.		
Dark limestone	113	765
Hard sandstone?	24	789
Siliceous limestone, reported	29	818
Upper Silurian argillaceous limestone	15	833
The same, harder and darker	46	879
The same, with sulphur water and little gas	21	900
The same, dark limestone, harder	6	906
The same, very hard (chert)	12	918
Lower Silurian, soft blue stone	24	942
The same, harder	44	986
The same, softer, sulphur water	2	988
The same, very hard	30	1018
The same, dark, hard stone	182	1200

This section, with the exposure at Pilot Knob, gives a connected section of nearly fifteen hundred feet, and, besides the importance of so long a section over usually inaccessible strata, shows the gradual thickening of strata as they dip deep below the surface, and, *vice versa*, a thinning out as they approach the rim of the basin which is so well exhibited in the Sub-Carboniferous and Coal-Measure strata in the central and western parts of the State.

The capacity of the well was tested by pumping, and gave a little show of oil, enough gas to use in part for fuel, and, for two hours at a time, a two-inch stream of brine, strong enough to yield one and a quarter pounds of salt per gallon.

The White Sulphur well, Zenor & Co., proprietors, is half a mile east of Corydon. The grounds are well fitted up for the comfort and pleasure of visitors, with arrangements for using the water in any desired way. An analysis by T. E. Jenkens, M. D., of Louisville, shows the total salts in a wine gallon to amount to 450.88 grains, consisting of bi-carbonate of soda, bi-carbonate of magnesia, sulphate of soda, sulphate of magnesia, sulphate of lime, chloride of sodium, chloride of magnesium, chloride of calcium, and silica with carbonic and sulphydric acids. The efficacy of this water is well known and appreciated by hundreds of invalids who have been benefitted by its use. It has been found especially effective in chronic dyspepsia, rheumatism, gout, neuralgia, dumb ague and other malarious affections, scrofula, skin, kidney and female diseases. Cures, almost magical in their results, are vouched for by those who have been raised from beds of suffering. The town is healthy, the scenery romantic and full of the natural wonders of cave, spring and stone life. Wide views may be enjoyed. Excellent piked roads for drives, with Kintner's hotel, which is equal to the best.

Many natural springs of great volume breaking out at the fair grounds, and the reported "bottomless blue spring," on the pike in the eastern part of town, indicates the cavernous condition of the underlying rocks. Wells sometimes pierce these hidden streams of water, from which the usual ghostly blind fish and crustaceans are drawn. The well of B. P. Douglas is a museum of cave life.

Two steam mills, one water mill, several manufacturing

establishments, drug, hardware and dry goods stores, with well appointed stocks, indicate the thrifty business and commerce of the county seat.

Martin's knob, two miles south of town, is one of the highest points in the neighborhood, giving a grand view along and across the great valley plain. The northern and northeastern faces are bare and abrupt, with talus to south and southwest, containing water-worn, rounded gravel from local rocks.

SECTION OF MARTIN'S KNOB.	Ft.
Soil	10
Chester sandstone	30
Chester limestone and chert	60
St. Louis limestone and clay, with good oolitic stone, partly covered	196
Blue bituminous limestone	14
	310

On land of Clark Highfill, two miles west of town, on section 25, township 3, range 3 east, is a fine outcrop of oolitic limestone, and easily accessible. The following was observed:

SECTION AT HIGHFILL'S OOLITIC QUARRY.	Ft.
Chester sandstone	35
Chester limestone	40
St. Louis gray limestone	20
White oolitic limestone	10
Cherty argillaceous shale, plates of limestone	80
	185

Big Indian creek, at its confluence with Little Indian, flows off with a current of two and a half to three miles an hour, with a breadth of thirty to sixty feet, and depth of one to two feet, largely increased by spring and winter floods, and somewhat reduced by summer droughts. It passes through a wild, narrow gorge or canon, with steep,

precipitous bluffs, from one hundred to two hundred feet high, and little or no valley "bottoms." If long exposed, the limestone bluffs would have been rounded by action of air and rain to gentle slopes, and the valley widened; but that not being the case, we know that the valley and stream are of recent origin, compared with the surrounding well-rounded knobs and hills and the very gentle slopes about the more ancient Pre-glacial river valley and the old, sunken areas of Brushy, Grassy and Ripperden valleys. The origin of this, as well as every similar phenomena, may be attributed to the cavernous nature of the St. Louis rocks through which its course lies. The stream is now seeking another route and lower level for a short distance below town, on section 2, township 4 south, range 3 east, known as "Sink of Indian creek." In dry times the water gradually sinks for days to the lower new channel, then suddenly disappears with a whistling sound and forcible suction, which lasts for only a few minutes. After an unexplored subterranean passage of eight or ten miles, it again makes its appearance from the "Blue hole" or "Rise of Indian creek."

Within the distance above mentioned, samples of fair to poor lithographic stone were observed at several outcrops. The white oolitic limestone was seen at a few localities, marked on the map, varying in thickness from one to nine feet. At numerous exposures the argillaceous bed, beneath the oolitic limestone, was seen crowded with flint-balls. One of the ancient flint quarries, locally known as "Indian silver mines," and of importance to students of the Stone Age, will be further treated under the head of Archæology.

Ascending Big Indian creek on the west bank, on section 5, township 4, range 3, at the residence of Frederick Cline,

which was found to be 460 feet above Blue river, 577 feet above Ohio river and 357 feet above Corydon, the following strata were seen:

SECTION AT CLINE'S.	Ft.	In.
Sandy soil	20	0
Red, ferruginous, conglomerate sandstone	18	0
Gray and red Kaskaskia limestone, with *Productus, Spirifera, Archimedes,* etc	12	0
Red and blue Chester shales and sandstone	40	0
Hard gray Chester limestone	16	0
Sulphurous argillite	4	0
Black, slaty "coal bone"	0	4
Bright, resinous coal in brook	0	2
St. Louis limestone in brook	0	0
	110	6

At another locality on the same tract the Kaskaskia limestone is rich in Chester fossils, in fact an almost complete suite of the fossils of this group might be collected here.

From the residence of Levi Cline, on the same section, and at about the same elevation, Pilot and Martin's Knobs could be seen and identified; and dimly, sixteen miles to the east, can be seen the bluffs of Floyd county, also, a range of hills in Kentucky, twenty-two miles to the south. In Levi Cline's well, twenty-one feet deep, near the bottom, a thin parting, indicating the place of coal A, was observed, but no remarkable seam of coal can be found here. Sections very similar to the foregoing were observed on lands of L. Cline, F. Windle and Philip Snyder.

On the farm of Rev. Jacob Keller, section 32, township 3, range 3, is an outcrop of the lower Coal Measures and Chester beds, of great interest. The following section includes the space by barometric measurement to the level of the creek at Corydon, four and a half miles east.

SECTION AT KELLER'S HILL.	Ft.
Loess soil	2
Conglomerate sandrock	10
Dark carbonaceous shale, place of coal A	20

	Ft.
Heavy grit stone	15
Soft sandstone	7
Blue Kaskaskia limestone, with Chester fossils	25
Argillaceous limestone, with chert	15
White limestone	6
Slope to sink	20
Space by barometer to creek at Corydon	240
	360

Mr. Ezra Keller, while pursuing his studies in geology, has gathered at this locality, which is wondrously rich, a remarkable collection of Coal Measure fossils, including great trunks of *Lepidodendron*, forked, strangely strangulated, from two to two and a half feet in diameter, but short and stumpy, as if of such weak or herbaceous growth as to forbid tall, erect stature. *Stigmaria* of different species, *Knorria*, with ferns and fruit-like seeds of Coal Measure plants, a stony herbarium of the age of coal. His collection includes, also, almost a complete set of Chester and St. Louis fossils.

The Coal Measure strata continue west, increasing with the dip in thickness in a great trough to Blue river. On section 34, township 3, range 2 east, the river has barely escarped a steep, almost inaccessible bluff.

SECTION AT ROTHROCK'S CLIFF, BLUE RIVER.

	Ft.
Soil and fluviatile drift	60
Laminated soapstone	14
Massive quarry sandstone, conglomerate	8.
Soft ferruginous sandstone	11
Place of coal A	0
Shale and fire clay	7
Chester limestone and siliceous shales	120
St. Louis limestone, covered to Blue river	180
	400

The massive sand rock is easily quarried, breaking in

great cubes, as if cut by hand, from two to eight feet square, and larger, and from evidence of exposure, is of unlimited endurance; as a grit stone it is first-rate, and should command the attention of manufacturers desiring very large grindstones. Beds of excellent paving stones are exposed in the lithographic member of the Chester group.

Borden's cave, on section 36, adjoining the above, is a new discovery, and of unrivalled beauty.

A friend who lately visited this interesting and new discovery, kindly furnished us with the following:

"BORDEN'S CAVE.

"The cave contains four rooms, each differing from the rest in the shape and number of its formations. The first room is about fifty feet high, and contains many stalactites, which are slender, tolerably clear, and from two to five feet long. The stalagmites are, also, numerous and beautiful; the stalactitic folds on the sides of the room depend in masses that, no doubt, weigh many tons. The most noted formations in the second story are: 1. Very white, clear stalagmites, covered with points of calc spar, that give them the appearance of being covered with frost. 2. A mass of broken stalagmites that have fallen from the walls of the room; this mass attracts much attention from those who do not understand the process of its formation. 3. A large branching stalagmite in the left side of the room.

"A large pile of rocks, resembling Jug rock in Martin county, partly separates the second and third rooms. Beyond it is a shelving rock, twenty-five feet long and ten feet wide, that contains, probably, 5,000 stalactites, from an inch to two feet long, and from one-fourth of an inch to two inches thick. Some of these stalactites have been broken off, perhaps, by an earthquake, and as they fell they lodged among others, and have been cemented to them in many different positions.

"The fourth room is entered by ascending a ladder. It is smaller than the others, and the most interesting object it contains is a huge stalagmite, eight feet high. One half of it has been removed by a small stream of water, so the present specimen is only a part of what was formerly there.

"Mr. Borden has labored industriously to improve the cave. He has made and put in place a ladder fifty-four feet long, by which the cave is entered, and also put up three smaller ones at places inside. He has graded some of the rough places, and is at present engaged in opening a narrow channel through which there is a strong current of air. The cave is worth a visit from all who enjoy subterranean rambles."

The Blue Spouter is a geyser-like spring in Walnut valley, a quarter of a mile east of Blue river. A circular hole, filled to overflowing with clear blue water, gives discharge to the great cavernous region adjoining. During and after a wet season the water rushes out with a roaring violence, sometimes spouting up four or five feet above the basin, in a column four or five feet in diameter, silvered with foam, and carrying out the fish peculiar to the open streams of that region, indicating a connection with some of them at no great distance.

Rhodes' cave, on section 29, township 3, range 3, near the road from Corydon to Harrison valley, has its entrance, almost like a well, in a corn field. The door is eight by twelve feet. A rapid descent over angular, fallen rocks, leads by a passageway, seven to ten feet high, to the lake, ninety-three feet below the surface. The lake is fed by permanent springs, and never diminishes much, if any, in size. It is reported to have a measured depth of over forty feet. A small spring, dripping from the limestone walls, fringes the south side with clusters and sheaves of slender

stalactites, and falls into a basin-shaped stalagmite. The lake contains a great many white, blind fishes and crayfishes, but the floor and water was so muddy from a late rain that none could be taken at the time of our visit. Swarms of bats, very social in their habits, resort to the cave, arranging themselves, in summer months, in family circles of six or eight. In winter they hybernate here, hanging by the feet to the roof, with heads down, in great clusters of thousands, remaining in a semi-torpid condition until the warmth of spring recalls them to active life.

The cool, dry air of the cave has high antiseptic properties, preserving fruit, fresh meat, etc., in perfection.

On section 30, adjoining, on land belonging to Messrs. Rhodes, Rothrock and 'Squire Hausenfluck, six miles west of Corydon, is a massive band of Coal-Measure sandstone, which is reached with very little or no stripping. The natural cleavage breaks it into blocks and columnar masses four to six feet square on the end and ten feet or more in length. On the exposure was seen hundreds of cubes, almost mathematically true, four to five feet square, and a column twenty-three feet long and four by five feet transversely. The stone may be readily split or broken by workmen to any required size or shape. Exposed in and on Blue river during the ages required to erode a valley 400 feet deep, it still presents sharp, square corners and edges, indicating remarkable resistance to the action of the elements through indefinite time. It is a superior grit-stone, and, tested at a Louisville edge-tool factory, was found equal to any they had used. Suitable grits may be had of any practicable dimensions. The quarry is on the summit of the table-land, 400 feet above Blue river. The product may be rolled down the steep bluff to the river without danger of breaking. The point offers favorable

conditions for a mill site, with a great abundance of cheap material for the construction of a permanent dam, with good water power.

The bar of Blue river at this point, by barometer, is 102 feet lower than Corydon, and 480 feet above the ocean.

Passing from the top of the hill near P. P. Sonners', down Hickman's brook to Blue river, the following was observed:

SECTION AT HICKMAN'S BROOK.	Ft.
Sandy loam	40
Heavy sandstone	50
Blue Chester limestone	20
Argillaceous limestone and shale	30
Banded limestone	20
Heavy limestone	30
Limestone (covered to brook)	230
	420

In the rocky bed of the brook, besides a variety of common St. Louis fossils, there was observed many specimens of *Lithostrotion proliferum*, solitary, and in clusters some of which were over two feet in diameter; amorphous geodes, and coarse chert, filled with bryozoans, indicated the upper member of the St. Louis limestone.

Harrison valley is a rich sunken area, once owned by President Harrison when Governor of Indiana Territory. Every locality and plat of land calls up some historic reminescence of its original owner; one plat is known as the "Governor's field," another as the "General's meadow." The valley is almost a grand amphitheater walled by limestone hills, wrought by time into a gentle slope. In the middle of the level central area is a basin rimmed with a natural stone wall, scarce two feet high, filled with pure clear water. The ebullition in the center of the basin shows in ordinary times a great flow of water. In flood times a furious torrent, ten to fifteen feet in diameter, rolls up three

to six feet above the surface level, and flows in a wondrous river one hundred feet wide, and ten to fifteen deep. Even in seasons of protracted drought the flow is reported as a constant stream, thirty feet wide and eight inches deep. From the spring to Blue river, a few hundred yards distant, there is a fall of eight feet, and the power is used to run a saw mill. In the earliest times a distillery was located near the great fountain, cold water being pumped thence.

By ascertaining the location of summer showers in the adjoining regions, and the character and color of the soils, whether yellow, red, brown or black, and carefully noting the color of the water at the time, in the great Harrison fountain, it has been ascertained that the drainage is from the "Barrens" and valley areas, eight to ten miles north and northwest.

Interesting and beautiful as the valley view is, and no tourist has seen America without seeing this spring, it was far more beautiful and attractive robed in nature's garb of forest, vines and sward; a favorite resting place to the mystery-loving savages, it at once attracted the attention of the pioneer General from economic, as well as other reasons. Mills were a necessity, and to insure a rapid influx of friends and defenders, for every man and woman must be at once farmer and soldier, mills must be erected at such localities where they could be built quickly and at the least expense, so the Governor secured the valley, and in 1805–6 erected a mill, and employed himself, between campaigns, as a farmer and actual miller. Persons now living in the vicinity remember, when boys, being sent to mill on horseback with a sack of corn or wheat, which General Harrison would receive with his own hands and carry to the hopper.

The old residence is gone; some shrubbery remains, and the orchard planted by the American Cincinnatus survives in

vigorous growth and fruitage—the trees, now seventy years old, are from two to two and a half feet in diameter.

In Bogard's valley, a short distance north on section 18, township 3, range 3, the noted "Bogard spring" flows out of the east bluff and gives origin to a brook three feet wide and two to four inches deep. After heavy rains, white, sightless fishes and crayfishes, are cast out by the violent torrent. Close by is a "Reformed" church, with the significant dates on the gable, 1538–1861.

By reference to Table of Altitudes hereinafter given, it will be seen that the tops of the hills and table-lands of the Chester group, in the southwest and western part of the county, attain a hight of nine hundred and fifty to nine hundred and sixty feet above the ocean, or the western bluff of the Pre-glacial valley is almost identical in level, although of widely different geological position with that of the eastern bluff, which is also near the Floyd county line, nine hundred and sixty feet above same datum plane. In this valley, as before said, is the "Barrens" plains, ten to fifteen miles wide, and from two hundred and fifty to three hundred feet deep, cut out of solid St. Louis and lower Chester limestones. The Barrens being from one hundred and thirty to one hundred and sixty feet above Corydon and the present recent streams.

The Chester Group region being capped with sandstone, which is not affected by the elements, but is only worn by attrition or erosion, is very hilly or almost mountainous. At Buckhardt's, about one mile east of Winnsboro, a fine, thick bed of snow-white oolitic limestone was observed, with the following strata:

SECTION AT BUCKHARDT'S, (FRENCHTOWN, ONE MILE EAST OF WINNSBORO).

	Ft.
Covered (clay soil)	39
Heavy bedded Chester sandstone	10
Argillaceous limestone	15
Argillaceous limestone, with bands of chert	25
Flaggy limestone, with argillaceous St. Louis limestone.	40
Massive gray limestone	20
Oolitic limestone	4 to 8
Gray limestone and clay	50
	207

In the soil at the upper part of this section were found many well-preserved fossils of the Kaskaskia and upper members of the Chester Groups, especially *Pentremites pyriformis, Zaphrentis spinulosa*, axes of *Archimides*, with abundance of crinoid stems.

Near the base of the hills in this vicinity, one to two miles east of southeast from Winnsboro, especially on the land of Amos Burger, northwest quarter section 7, township 3, range 3, is found the thin coal and coal bone which characteristically occurs near the base of the Chester and top of the St. Louis Groups.

Frenchtown is an unique village, established by the Buckhardt (Bogard) family, who induced the settlement at this point of some fifty families from *La Belle France*. The citizens are quiet, industrious, and retain the courtesy characteristic of their nation. Many cultivate vineyards and make wine. Some of the vineyards are productive and profitable.

Going north there is a descent of 220 feet to Brushy valley. It contains many sinks, which receive and conduct the rainfall to the hidden brooks and rivulets which discharge so grandly at the Harrison spring, before described. The valley is level or gently undulating, with considerable black, mucky soil, indicating a pond or lacustral origin.

The hilly bluffs are rounded and gently sloped in such a way as to indicate an age reaching back to an early period in Quaternary times. Many well-improved farms and home-like residences were noticed.

SECTION AT BRUSHY VALLEY.		Ft.
Clay soil	10 to	20
Chester sandstone and limestone		110
St. Louis Group		95
		225

Hancock's valley is very similar in character, but more undulatory. The land produces good crops of corn, wheat, oats and grass. As a result, the farmers appeared prosperous and happy in their well-appointed homes.

Palmyra is a well located village on the New Albany and Vincennes turnpike, surrounded by a level or gently undulating plateau of well cultivated land, with fine pastures and meadows, interspersed with funnel-shaped sinks and residual beds of chert (locally called "niggerheads") occasionally showing on the surface; but these "Barrens" peculiarities are, as a rule, pretty deeply covered with lacustral or alluvial loam. Many of the "sinks" have been puddled, forming permanent water pools for stock, fish, etc., and adding to the beauty of the landscape; others, with good subterranean drainage, are silent, empty amphitheatres. The vicinity is noted for reliable crops of corn and wheat and superior product of grazing and meadow lands. Fruit is abundant. The orchards are highly productive, the trees being annually loaded with apples and peaches of excellent quality.

Palmyra lake, on land of Jonathan Tarr, is a picturesque sheet of water—a mirror in a setting of emerald verdure. It still retains in its vegetation, survivors of the old Lacustral age or Loess loams, as persimmons on the banks, and *Nelumbium* and *Nymphæ* in the water. The area of this lake

is estimated at twelve to fifteen acres, and the depth at fourteen feet.

It is the favorite resort of muskrats, wild ducks and geese; thrushes, in great numbers, nest on bushes growing in the shallow borders, and, with sagacious foresight, building just above the permanent water line. Yellow catfishes, fourteen inches long, have been caught here. After heavy rains the lake overflows and gives origin to a small streamlet, the water from which is swallowed by a sink, and is afterwards discharged at Kinney's big spring on Blue river, near Fredericksburg.

The old Indian trail from Louisville, via Paoli, to Vincennes, passes by the south side of the lake, and many arrow points and flint chips show that this was a favorite resort of the aborigines.

The depth of the Loess beds increase passing southeast on the pike. The orchards were loaded with bright, luscious fruit. Especial mention may be made of the orchards of W. B. Harper, and of many well improved farms.

The elevated region at the northwest corner of the county, surrounded in every direction by deep valleys, is noted for healthfulness, and especially for freedom from malaria. The vegetation characteristic of the Loess, as persimmon, gum and fruits, was preserved. In this vicinity are beds of white glass sand used at the works at New Albany. Similar beds of sand are found along the whole of the eastern edge of the black mucky region, locally known as the "Flat woods," which I have provisionally referred to as the flood plain of the pre-glacial river. The beds are not continuous, but in pockets, and are not restricted to the Indiana side of the Ohio river, but, where reported or observed, extended along the equivalent ancient depression across the State of Kentucky in the direction of Nolin valley and Nolin fork of Green river. In many places it is a massive rock,

with much stratification and false bedding; ordinarily, by exposure, it has passed from this condition to that of loose sand. A close examination shows that it is later than the adjacent rocks, and seems to show that part of the materials are not earlier than the beginning of the Glacial epoch; for, with fragments and fossils from the Chester, St. Louis and Keokuk groups, were found small well-worn pebbles, alternating with beds of clay and sand, that could only have been transported by water having some current, say two to four miles an hour, and as the hardest of the fragments indicated a northern origin, the current must have been from north to south. Fine beds of sand, although when of considerable extent carrying impurities, were noticed on S. 34 and 35.

Descending from the higher Loess plateau to the village of Bradford, the peculiar debris of the "Barrens" was observed with a deep red soil, highly ferruginous.

New Salisbury is on the line of the proposed Louisville, New Albany and St. Louis railroad. An argillaceous, magnesian stone occurs here in good quarry beds, mentioned by Dr. D. D. Owen, in the first Indiana Geological Report, as having been used for window caps and sills in the Corydon court house. It comes from the quarry so soft that it may be hewed with a common broad axe, but hardens on exposure so as to be suitable for building purposes. It fairly withstands exposure to weather, but will not bear much wear and friction. Door-steps to residences were seen at Corydon, from this quarry, which had been in use over forty years.

From New Salisbury, Indian creek valley is bounded on each side with broad, gently undulating "barrens," dotted with the characteristic "sinks," and composed, beneath the surface, of fragments of broken chert, irregular geodes, and

nuggets of quartz which, when fresh from their beds, generally present worn or partly rounded angles, as if at some time exposed to running water. This residual bed is from thirty to forty feet thick, and the siliceous fragments are as three or four parts to one of clay.

King's Cave, about four miles east of Corydon, on the New Albany turnpike, is interesting and easily accessible. A spring or small stream of water is the key to this excavation, the chisel which tunneled and hollowed out this narrow cavern. At low water it would pass through a four-inch orifice, and is constant in seasons of drought; after a rain a torrent pours out of the gothic doorway six by three feet. This beautiful doorway, much older than the present entrance, is inaccessible except by ladder; above, a dome-shaped portico is well rounded to lines of beauty. The vestibule is sixty feet long, twelve feet wide, and five to ten feet high, with a rippling brook at one side. Beyond, the roof becomes lower, and at places is but two and a half to three feet high. Half a mile from the entrance is a lake thirty feet long, of no great width or depth, containing blind fish and crustaceans; bats, 'coons and muskrats frequent the cave for rest and hibernation. The grand hall near the lake is reported to be one hundred and twenty feet long, sixteen feet wide, and eight feet high, with many beautiful stalactites. Beyond the lake the roof is so low that progress can be made in a stooping posture only, or by crawling.

A noted quarry bed of buff oolitic limestone overlies and surrounds the cavern. It is equivalent to the other St. Louis quarry stones of Lawrence, Monroe and Owen counties, being composed of marine animal remains, finely comminuted and well cemented together. It comes soft from the quarry bed, and hardens on exposure. It is reliable, first-class building material, and needs only means of trans-

portation to insure a good demand. The following strata are seen:

SECTION AT KING'S CAVE.

	Ft.
Soil and slope	35
Argillaceous limestone	22
Laminated limestone	20
Buff quarry limestone (good)	12
Blue argillaceous limestone	9
Calcareous argillite	7
	105

Yocum's Cave, on the south side of Little Indian creek, in southwest quarter, section 25, township 3, range 4, is full of attractions, and is a labyrinth of winding passages. It has been but partially explored, and to a distance of about half a mile.

On the Myers farm north of the pike, and part of the same section, was seen an outcrop of the St. Louis beds, full of well preserved fossils. The shells were mostly silicified, and the locality is almost equal to the famous fossil beds at Spergen hill. This outcrop closely overlies the top of the Keokuk group.

Lanesville is a prosperous village, nestled in the deep valley of Little Indian creek. The citizens are mostly Germans, and, with many mechanics, are a self-supporting, self-reliant community. When first visited by explorers it was a favorite resort of our savage predecessors. Colonel B. Gresham points out the location of five Indian villages at this point. It was even then famous for its little saline spring or seep. This attracted the attention of General Harrison, when a surveyor, who opened a primitive well and tested the water. It was afterwards owned by Dennis Remington and Dr. James Lane, father of General Lane, in whose honor the village was named. A few years ago the old pioneer fixtures, a hollow tree "gum," were removed,

and, although covered with mud, were found in good condition after a burial of half a century.

At that time it was found that one gallon of the brine would, on evaporation, yield three-quarters of a pound of salt. Another lick, both in the Keokuk beds, occurs on the land of Uriah Davis, in the west part of town. The small amount of brine will prevent the profitable production of salt; nor is there a probability of an increased supply of brine by boring.

The valley bluffs of Little Indian creek are composed of gray oolitic limestone, containing a wonderful variety of St. Louis fossils. No point in the State visited by the writer can so nearly furnish a complete suite of fossils of this group, and this is largely due to the untiring search and skill of George K. Green, to whom credit has already been given for his researches in the palaeontology of this and neighboring localities. In the bed of the creek, and in a branch half a mile north of town, the Keokuk rocks are exposed from nine to thirty feet in thickness. The St. Louis exposures on Panther creek are rich in well preserved fossils, but, in their collection, care and patient industry are required.

SECTION AT LANESVILLE.

Slope covered	70 to 30 ft.
Argillaceous limestone, with plates of chert	41 ft.
Warsaw division—equivalent of Spergen hill beds—with silicified fossils and fish teeth	21 ft.
Gray limestone, with fish teeth	9 ft.
Thick bedded blue limestone—Keokuk	10 ft.
	111 ft.

Half a mile north of town is a bed of buff magnesian argillite similar to that quarried at New Salisbury. Soft in the quarry, it hardens on exposure. Here it is about seventy feet above the Keokuk limestone.

At the west end of the pike bridge over Little Indian creek, half a mile east of town, is a notable bed of fossils. A gray, rough limestone twelve feet thick contains a remarkable number of fish teeth. In an exposure of sixty feet about three thousand specimens are reported to have been found, comprising at least twenty species. All the teeth are well preserved, still retaining the well worn enamel. Some of the defensive spines were of such size as to indicate animals of great strength and warlike character.

In the orchard of Iverson Lynn, a little over a mile east of town, is a fossil locality, which, while rich in many characteristic St. Louis forms, presents an anamoly not occurring elsewhere. Pentremites, as their name indicates, should have five sides or ambulacral spaces; but eleven specimens have been collected here having but four sides, for which the provisional specific name of *quadrilateralis* has been suggested by Prof. Hall.

Ascending the steep southern bluffs of Little Indian creek, we soon enter upon the rich, black soil of the "flat woods." The timber is entirely different from that of the "Barrens" and hill lands, consisting of hickory, beech, poplar, walnut, ash, white, red, black, burr and post oak, linn, sugar, etc. The amount and long continuance of ancient eroding currents of water may be inferred from the existence of the Husung cave on this nearly level plateau. Also, the big spring on the farm of George Henry, section 1, township 4, range 4, which, although on a level loamy plain, pours up, filling a basin thirty feet in diameter with clear, cold water, discharging a stream two feet wide and two inches in depth. On the adjoining farm of Conrad Bickell the following section was found in digging a well through fluviatile deposits.

SECTION IN "FLAT WOODS."

	Ft.	In.
Black soil	1	6
Yellow clay and gravel	15	0
Gravel and sand	8	0
Plastic blue clay	4	0
Sand to limestone	4	0
	32	6

Statements of experience in digging other wells show that similar fluviatile deposits occur characteristically in the flat woods district of this county, and inquiries subsequently made as far south as Elizabethtown, in Kentucky, showed that the same or similar causes have produced the same results, only on a deeper and larger scale.

Middletown is just east of the eastern boundary of the Barrens, and on a higher level. It is a growing village; the citizens generally German or of German descent, industrious, thriving and economical. The village is surrounded by a rich, prairie-like plain, divided into good-sized, well arranged farms, yielding choice fruits and wheat, and fair crops of corn and hay.

Farmers pay attention to the cultivation of clover and the grasses, which explains their agricultural prosperity. The soil is a buff or ash gray loam with considerable sand, and is from ten to twenty feet deep, resting upon beds of loose chert, geodes, etc., characteristic of the barrens, and is clearly of lacustral as well as fluviatile origin. Sink holes are a constant feature, and many of them, puddled by rains and wash, have become permanent water ponds, valuable for stock purposes, and susceptible of much higher value if stocked with fish, especially the German carp, recently introduced into this country by Prof. Spencer F. Baird, United States Fish Commissioner. This carp, so highly recommended by Prof. Baird for land locked waters, is a rapid grower and ranks high as a food fish; it will sur-

vive in stagnant water almost as long as a catfish, and feeds on confervæ and aquatic plants.

To the cultivation of fish for healthful and economical food for home table and for market, the attention of farmers and others is urgently invited. Actual experiment has shown that an acre of water, under control of the owner, is from five to twenty times more profitable in this way than for agriculture.

Elizabeth is situated in the valley of Sand branch of Buck creek, surrounded on either side with gently undulating or level continuation of the prairie like "flat woods." The village contains the usual manufacturing and mechanical establishments necessary for the accommodation of the vicinage.

A band of black, bituminous limestone in the hill south of town is the northern outcrop of the hydraulic beds which obtain remarkable development in the extreme southern part of the county; it will furnish material for good water-lime, but the thinness of the strata (two feet) will forbid economical preparation on a large scale.

Bridgeport, situated at the point where the eastern boundary of the county diverges from Ohio river, is located in the river valley, near high water level. The narrow valley is backed by grand, steep hills of Knob Sandstone, capped with limestone of the Keokuk and St. Louis groups, over five hundred feet high. The sharp conical knobs tower up, seeming to almost touch the clouds, and from their tops an interesting view, filled with picturesque beauty, is spread out, that rivals scenes in other lands, famed in song and story, and includes Louisville and Jeffersonville, eleven miles distant, Bardstown, forty miles away, and twenty-five miles of river valley. Just north is a very high pinnacle, noted as a landmark to pilots on the river. Well up on the steep side of the bluff is the sandrock stratum from which

stone was quarried for the locks and canal around the Falls at Louisville. The stone is accessible and in heavy beds. It comes from the quarry soft and hardens on exposure, and is eminently adapted for foundations and underground work, on account of the facility with which it may be worked.

SECTION AT BRIDGEPORT.

St. Louis limestone and fluviatile drift	80 to 110 ft.
Keokuk limestone and shale	66 ft.
Knob shale	20 ft.
Knob sandstone, quarry rock	40 ft.
Knob shale and sandstone	210 ft.
Alluvium to low water in river	67 ft.
	513 ft.

Many interesting Keokuk fossils were observed in descending the creek, which has hewed its way through the heavy limestone on the Lafollet farm, a mile and a half north of the village. Almost a complete suite of the representatives of that group were collected there; also of the Knob shales, which, generally barren, contain at this point some shells with chondrites and annulated vermiform markings.

Glaze's landing, on section 25, township 4, range 5, is noted as the point from which most of the white sand is shipped for the New Albany Plate Glass Works. The road over which the sand is hauled to the river winds along the sides and around the sharp points of the steep bluff, at which point the following section was noted:

SECTION AT GORE'S HILL.	Ft.
Common soil	30
Dark irregular St. Louis limestone	11
Yellow Niagara shale	18
Cherty shale	13
White, fissile, sandy shale	7
Hard siliceous limestone	9
Argillaceous limestone	18
Geodiferous shale	20
Keokuk limestone with argillaceous parting	77
Knob shales and sandstone	180
Alluvium to low water in river	67
	450

The St. Louis shales above are rich in characteristic corals, shells and bryozoans, while the Keokuk rocks exhibit a few well preserved fossils.

Glass sand occurs here as elsewhere in the county, as well as north in Floyd county, and south across the state of Kentucky in separate deposits or basins along the east or west bank of the depression provisionally named the preglacial river bed. This depression trends, in this county, by a gentle curvature, and the sand banks are at the most easterly or eddy point of the curve, and just in the eastern edge of the "flat woods" flood plain of the supposed river. Just what connection their existence had with that river is not clearly seen, but their peculiar location in reference to it, and the fact that in the lower beds of sand and kaolin clays beneath it are fossils which had their origin to the north, it seems at least probable, if not reasonably certain, that the current of water, which deposited them, flowed from the north of Washington and Floyd counties with no great current but in great volume. The deposits, commencing two miles south of Bridgeport, are in regular series, though variable in extent, down to near the extreme southern extremity of the county, near the mouth of Mosquito creek, or twelve miles long by a half to one mile wide, and 400 to 450 feet above Ohio river. The geological horizon, of course, is not constant. In this vicinity it lies upon Keokuk rocks, further north on a St. Louis bed, and at one point in Kentucky it caps the Chester hills; in the beds and under them are found pieces of chert and silicified fossils from each one of the groups. At Captain Lawson's mine, owned by Wash. C. DePauw, Esq., proprietor of the New Albany Glass Works, the sand is coarse, in massive strata of rough sandstone, with somewhat regular layers, but generally striated by false bedding; from the bottom of

the pits fine specimens of white and yellow kaolin (Indianaite) were obtained.

SECTION AT DEPAUW'S SAND MINE.

Loamy sand and soil	1 to 3 ft.
Indurated sand in strata, one to two feet thick, containing spangles of mica and a few quartz pebbles..	18 to 30 ft.
Kaolin and clay, with St. Louis fossils	0 to 4 ft.
	37 ft.

After disturbance by quarrying a slight exposure causes the stone to disintegrate. It is then washed, or, rather, wetted, and thrown on a platform to drain, which removes all the iron coloring matter, and the snow-white product is ready for market. Captain Knight, who has worked these mines for eight years, says that at two of them he found streaks of black magnetic sand carrying fine gold dust in the bottom layers. On account of water I was not able to see this horizon, but such being the case it would at once settle the extreme northern origin of such drift material. The kaolin pockets, he reports, are of frequent occurrence, varying from white to yellow, green and sometimes red; when semi-crystalline it is pale blue or chalk white. Other beds of sand are worked by J. F. Irwin and Fred Shuck.

Glass sand has been opened and a few boat loads shipped from the land of Lydia Peters and R. Krow, section 15, township 5, range 5. Beneath the sand kaolin was here found white as snow. In the flat prairie area to the east, on the road to Stoner's hill, is a large extent of red, yellow and green kaolin in persistent beds two to three feet thick, which would be of immense value if free from coloring matter, and is eminently adapted to the manufacture of ordinary pottery, ornamental terra cotta and tile products.

SECTION AT STONER'S HILL.

(Sec. 11, Town. 5, Range 5.)

	Ft.
Soil	40
Barrens—chert, etc.	15
Siliceous shales and bands of amorphous geodes	15
Dark siliceous shale	12
Heavy Keokuk limestone	20
Heavy cherty limestone	45
Geodiferous argillite	11
Black, white and blue flint, in bands of one to two feet, with clay partings	14
Red encrinital limestone	8
Knob shales	60
Knob, yellow sandrock	9
Knob shales, with plates of sandstone, to low water level of Ohio river	110
	359

On the farm of W. S. Eversol, section 13, township 5, range 5, is a boldly escarped bluff, precipitous or overhanging, which presents a wild ragged front to the river, and shows the following section:

SECTION AT EVERSOL'S CLIFF.

	Ft.
Soil	11
Keokuk, crinoidal limestone	39
Keokuk, clay, shale and geodes	7
Keokuk, blue, fossiliferous limestone	3
Keokuk, siliceous argillite, with geodes	14
Keokuk, flint in bands of six to twenty inches, with partings of argillite	12
Knobstone, siliceous shale, small geodes	25
Knobstone, thin bands of red encrinital limestone	15
Knobstone shale, with bands and plates of sandstone and clay iron-stones, partly covered to low water in river	190
	316

The cliff is over three hundred feet high; the blue Ohio quietly rolls at its base, or at flood-tide, sixty-seven feet above low water, surges against its sides. Gay steamers, the finest in the world, sweep like great white swans upon the river, giving scenes like Rhineland, enlivened with practical interests of prosperous thrift. The bottoms bordering the banks of the stream are three to four miles wide, a vast level plain of highly productive garden soil, dotted with farmer's homes and clumps and groves of shade and fruit trees; also, forests of maple, elm, beech, poplar, oak, walnut, etc. On the Kentucky shore the bottoms are traversed by a turnpike and railway; the trains on the latter, when first seen, two miles away, come around a point of the bluff, and although running at express speed, seem to creep over the plain, hiding at intervals behind clumps of trees, until, at eight miles away, they appear not larger than the toy cars of our childhood.

Up the river, sixteen miles distant, are seen the spires of the cities of Louisville and New Albany, hooded with a canopy of black smoke—banner and emblem of industry—telling of the vast iron and glass furnaces, the products of which reach all the markets of the continent. Still beyond, and to the east, the "rock ribbed and eternal" hills of Kentucky, world-famed for its fair women and brave men, meet and melt into the azure-tinted sky. Directly north, the Bridgeport knob is a prominent landmark, overlooking the long stretch of valley and river.

The summit of the cliff is sharp and conical, with steep sides, by which the sudden changes of temperature are so modified that sub-tropical plants formerly flourished, some of which still survive. Chestnut, black, white and chestnut oaks, black and white gums, sugar, ash, beech, cherry and walnut trees compose the forests, the first two named not growing one hundred feet below the hill tops. In Autumn

the well-ripened foliage of these clumps of trees presents a brilliant, fluttering, quivering kaleidoscope of colors—brown, russet, purple, crimson, vermillion and orange, shading to delicate tints of pink, yellow and gold, rendered brilliantly conspicuous by a background of the richest emerald green—nature, draped for the harvest, in her regal robes of glory.

The southern cane (*Phragmites communis*) which is generally confined to the bottoms, formerly covered this hill with a rank growth from ten to fifteen feet high, in which the horse thieves of 1810 corraled their stolen property, affording them a hidden and almost inaccessible retreat.

At the time of the New Madrid earthquake, in 1811, a pioneer had built his cabin near the foot of the cliff. The mother, who still survives, often tells of that terrible night of fear and suspense, when massive blocks of limestone, eight to twelve feet square, loosened by the tremor, came thundering and crashing down the steep cliff. Many of the larger blocks, the work of that night's disruption, remain to this day.

A quarter of a mile northwest from the cliff is a natural rock-house, a shed thirty feet long by eighteen feet wide and twelve feet high, formed by the disintegration of a pyritiferous argillite just under the quarry sandrock of the Knobstone group. The latter is the equivalent of the quarry beds worked at Bridgeport for the stone used in the Louisville canal locks. At the point of the hill eighty feet above the rock-house, the flint band at the base of the Keokuk group crops out. Exposure to the weather has riven the band into cubes and oblong prisms, in which a vivid fancy could discern an ancient stone wall, partly overthrown; it is only the natural effect of moisture and freezing on such materials.

The gas flow, a mile below Eversol's, and half a mile

above Rosewood postoffice, on Captain Strong's land, northwest corner section 25, township 5, range 5, is peculiar and of importance. All along the Ohio river, for a space of half a mile or more, whenever the water is not more than two to ten feet deep, bubbles may be seen hurrying upward. Near the edge of the river it pushes its way through the muddy deposit with a restless motion; in deeper water the discharge is greater, a continuous flow of small or large bubbles, and at places, in time of low water, Captain E. Knight informs me, in sufficient volume and force to give a rocking motion to a skiff, and in some instances threatening to overturn his row-boat. On the shore line small springs, with gas, break out. Confined in a tube or clay chimney, the gas is often gathered and ignited; these jets burn night and day until extinguished by wind, storm or overflow, like the Ghebers' holy light in the Sun Worshipers' land of fire, exciting the fear of boatmen, who could only wonder at a "hole on fire." It is a very pure carburetted hydrogen, burning with a white flame of high illuminating power and evolving great heat. The flow of gas is on a part of the river about half a mile long and trending from northeast to southwest. It is not confined to the river bed alone. In time of high water the ebullition of gas is noticed in the back water over the low lands, and is traced by the gas well near Buena Vista in a southwesterly direction across the country by Boone's landing, to a similar phenomenon in the bed of the river, and at the Gas-salt works at Brandenburg, Ky.

An imaginary line has been drawn across the county connecting the points inclosing the probable area over which gas may be found by boring from 500 to 800 feet, and accompanying the gas will be a flow of salt water, but it must not be expected that a good supply of either will be found in every bore that may be made in the area.

This vast supply of gas, of inestimable value as a fuel for evaporating salt brine, generating steam and other economic purposes, sufficient to propel the machinery of and illuminate the streets and dwellings of a city, is now suffered to go to waste. Over the whole territory where it occurs it ought to be utilized for the purposes mentioned, as it is at Brandenburg, Ky.

The gas area is noted for the many pre-historic stone implements found, including not only the flints of the savage race, but also the highly wrought and polished gorgets and ornaments of their predecessors—the Mound Builders—who are supposed to have been the American sun and fire worshippers.

Buena Vista precinct of Taylor township is situated in the rather deep valley of Mosquito creek, and is surrounded by a hilly country. The hills are built up of St. Louis limestone, which, by decomposition, produce the yellow and red soils characteristic of this group. Choice oak timber is abundant; good crops of wheat and grass are prodnced, and the farmers, especially on the upland plateau of ancient fluviatile loam, are prosperous and full handed. Many good orchards in full bearing were noticed. In fact, this region of elevated land is peculiarly adapted to the growth of fruit, and will bring satisfactory returns. The St. Louis limestone in the bed of Mosquito creek is fossiliferous, offering several species of *Zaphrentis, Orthis, Rynchonella, Lythostrotion, Pælœacis* and *Dichocrinus,* with many crinoid stems. A well bored during the oil excitement a short distance south of the village, yields burning gas, showing that it is near the gas line.

Buena Vista is perhaps most widely known as the locality around which the Harrison county aerolite fell in 1859. About four o'clock in the afternoon on the 28th of March a slight glare was observed by a few of the residents,

although such phenomena are usually noticed only from ten to fifteen miles away; this was followed by loud bursting reports, succeeded by continuous reverberations along and across the deep valleys and high ridges, which seemed to some of the hearers to equal the discharge of many batteries of heavy artillery in continued succession. On the spot the terror was intense; the flash of fire and frightful explosion, followed by a rushing, rattling noise in the air, and the crashing and tearing of the fragments against the trees, are to this day vivid in the memory of the older inhabitants. Mrs. Goldsmith saw one of the pieces fall on the road in front of her house and picked it up while still warm. She said that not only the men, women and children were frightened, but dogs ran howling to their masters for protection; birds were first paralyzed and then driven in furious flight; horses snorted in agony of fear, and cattle bellowed in wild confusion. A small piece of this aerolite, belonging to the writer, is all of it that is known to remain in the State. Any one wishing to see the larger pieces can do so, I am informed by Hon. B. E. Rhoades, by calling for the "Indiana Meteorite" at the British Museum in London.

I am indebted to Dr. E. S. Crozier, Surveyor of the Port of Louisville, for the privilege of making the following extract from his account, written on the spot immediately after the fall of the meteorite:

"On the 28th of March, 1859, about 4 o'clock P. M., three loud reports, in rapid succession, resembling the discharge of artillery, were heard in Harrison and adjoining counties. The reports were preceded by a sudden glare of light, peculiar and by no means like a flash of lightning. There was a dark cloud overhead at the time, and the reports were followed by a long rumbling sound, which proceeded in a southwest direction, lasting probably a minute and a half.

"The peculiar reports were matters of conversation with

every one, and we were not surprised to hear that a fall of aerolites had occurred in Taylor township, Harrison county. I at once resolved to investigate the matter and secure specimens, if possible; many and marvelous were the stories in circulation in the neighborhood. Such a superstitious dread prevailed among the people that but little effort was made to recover the fragments, most of which had penetrated some little distance into the earth.

"Several pieces fell in the door-yard of John Lamb; a small boy saw one of them fall and dug it out of the ground. It was about three inches long and of an oblong shape. A fragment, picked up by Mrs. Kelly near Buena Vista, was brought to me; it had been broken after the fall, and presented a very peculiar appearance. It was covered externally with a thin crust resembling a coating of bitumen, the inner portion was of a light gray color, and interspersed with bright, metallic specks. It possessed magnetic properties in an eminent degree, the external coating appearing to attract the magnet with greater energy than the internal portion. It weighed 167.5 grains, troy, and had a specific gravity of 3.438.

"Robert Somers procured for me a much larger piece, which weighed one pound and three ounces, avordupois; it was 4.4 inches long and 2.3 inches through its shortest diameter. It also attracted the magnetic needle, which proved the presence of iron. This piece was dug up at Buena Vista by Mr. Goldsmith, and had the same external dark crust and internal gray appearance as the small fragment first described. But four pieces were found, although a great number must have fallen, as over an area of about four miles square, almost every individual testified to having heard the hissing noise made by the falling fragments, it having

occurred at a very favorable time in the day for observation—about 4 P. M.

"Three or four loud reports, like the bursting of bomb-shells, were the first intimation of anything unusual; a number of smaller reports followed. The stones were seen to fall immediately after the first loud explosion. Some who were in the woods distinctly heard the stones striking among the trees. A peculiar hissing noise was heard, during the fall of the stones, for miles around. As a lady described it, 'the air seemed as if it had, at once, become filled with thousands of hissing serpents.' Mr. and Mrs. Josiah Crawford were standing in their door-yard at the time, and hearing a loud hissing sound, looked up and saw an aerolite fall just before them, burying itself four inches in the ground. They immediately dug it up. It did not possess any warmth, but had a sulphurous smell. Another, which they did not find, fell near them.

"Two sons of John Lamb were out near the barn, when their attention was attracted by a loud, hissing noise, and immediately a stone fell near them, penetrating some three or four inches into the hard earth. This was of an oblong shape, about three inches in length, and not more than a half inch thick, and was quite warm when first taken from the ground. The general appearance and composition of this was the same as those above described. Another fell in newly plowed ground near by, but they were unable to find it."

Dr. J. C. Clark, at Buck creek bridge, eight miles north of Buena Vista, and B. P. Douglas, Esq., at Corydon, in describing the meteoric occurrence, say there was a rushing, whistling, windy noise, then a rattling, roaring sound, like the stampede of General Pope's wagon train driving recklessly over a wooden bridge, then the explosion for a minute, like the rapid discharge of a park of artillery, followed by

the prolonged, rolling reverberations, passing from the southwest to the northeast.

The following notes and analyses by Dr. J. Lawrence Smith, of Louisville, Ky., a distinguished chemist and naturalist, shows the compositions of this "unbidden messenger from another world:"

ANALYSES OF THE HARRISON COUNTY METEORITES.

"Nos. 1, 2, 3, and a fragment of No. 4, were placed in my hands for examination. Nos. 1, 2 and 4 are cuboidal in shape; No. 3 was considerably elongated. They are all covered by a very black vitrified surface, equally intense on every one, and on every part of each one, and, when broken, show the usual gray color of stony meteorites, interspersed with bright metallic particles.

"The mean specific gravity is 3.465. When broken up and examined under a glass, four substances are distinguishable—metallic particles, dark glossy mineral, dark dull mineral, and white mineral matter.

"Examined as a whole, the following elements were found in it: Iron, nickel, cobalt, copper, phosphorus, sulphur, silicon and oxygen. By the action of the magnet it was separated into:

	Per Cent.
Nickeliferous iron	4.91
Earthy minerals	95.09
	100.00

"The earthy minerals, acted on by warm, dilute, hydrochloric acid, thrown on a filter and thoroughly washed, then treated with dilute, caustic potash, to dissolve any silica of the decomposed portion that was not dissolved by the acid, gave:

	Per Cent.
Soluble portion	62.49
Insoluble portion	37.51

"The metallic portion separated from the earthy portion, gave:

	Per Cent.
Iron	86.781
Nickel	13.241
Cobalt	.342
Copper	.036
Phosphorus	.026
Sulphur	.022

"The earthy portion freed from metal, gave:

	Per Cent.
Silica	47.06
Oxide of iron	26.05
Magnesia	27.61
Alumina	2.35
Lime	.81
Soda	.42
Potash	.68
Protoxide of manganese	trace.

"It is clear, from the analyses made out, that these meteoric stones contain the constituents frequently found in similar bodies, namely, nickeliferous iron, phosphuret of iron and nickel, sulphuret of iron, olivine, pyroxene and albite, and in about the following proportions:

	Per Cent.
Nickeliferous iron	4.989
Schreibersite	.009
Magnetic pyrites	.001
Olivine	61.000
Pyroxene and albite	34.000

"I have no intention to enter into any speculations in relation to these meteoric stones, although I have accumulated some additional matter on the subject since my memoir on Meteorites, published in the *Amer. Jour. Science and Arts*, Vol. xix., pp. 152 and 322, intending to reserve their publication for a future occasion."

The high alluvial table lands extend west to and beyond Laconia, and south to near the bluff adjoining Boston, where the following section was observed:

SECTION AT DUG HILL.

(Sec. 5, Town. 6, Range 5.)

	Ft.
St. Louis limestone and shales, with *Productus, Zaphrentis, Ptilodyctia, Athyris,* etc., mostly in hydraulic bed	120
Keokuk limestone, with crinoids	30
Buff argillite, with geodes	6
Argillaceous shales and plates of sandstone	40
Knob shale and coarse crinoidal limestone, with *Platycrinus halli, Spirifer grimesi,* etc	12
Knob shale and sandstone, partly covered	95
	303

At Brown's Landing, near the mouth of Mosquito creek, the Knobstone group, still dipping to southwest at the average rate of thirty-nine feet to the mile, passes from sight beneath the low water mark of the river. The ocean in which it was deposited was subjected to new conditions. The long reign of muddy deposits in a tideless sea was ended. Fresh currents of clear water swept over the soft bottom, and with strong tidal waves sweeping up from the deep central areas to the west moulded the surface into a succession of wave-like undulations which are well preserved in the Keokuk rocks exposed at low water for nearly a mile just below the mouth of Mosquito creek. These alternations or changes of conditions were disastrous to life. The rocks along the beach are profusely filled with long, bending, plumed crinoid stems, and with them are found, more rarely, their medusæ-like heads, with *Archæocidaris* and plates of *Melonites.*

The road cut in the hill leading from the landing affords a good opportunity for seeing the great hydraulic bed lying

above the grandest, most compact, homogeneous, gray limestone I have seen. The latter is unique; it deserves the attention of engineers, especially for piers which are intended to resist the destructive action of ice and violent currents of water, and for break-waters in the ocean, such as the jetties at the mouth of Mississippi river.

HYDRAULIC SECTION.

(Shackleford's Land, Sec. 14, Town. 6, Range 4.)

	Ft.
St. Louis beds, loose cherts, etc	55
Heavy blue argillaceous limestone	50
Buff soapstone	10
Hydraulic cement rock	30 to 55
Thick bedded, dark limestone	20
Massive, compact, choice limestone	50
Keokuk blue limestone	70
Covered to low water	35
	345

The river bank on this tract of land is precipitous, and is noted as a "buzzard roost." The birds gather every evening, from eight hundred to twelve hundred in number, from a radius of thirty to forty miles, and hold their daily evening consultation before going to roost, which is mostly on the limbs of the trees, but often on the sheltered benches of the banded limestone. They very successfully and effectually defend themselves against enemies and assailants by vomiting and ejecting the filthy contents of their stomachs. At early dawn they depart in search of food. This tract of timber has been the scene of their nightly gatherings for over thirty years, certainly, and probably for a much longer time.

At Kintner's Landing, a few miles below, was a noted rookery, or roosting place for crows; and below Rockhaven, an eagle roost, at which the eagles gather at nightfall from over an area of about one hundred miles square.

The St. Louis cherts, in the upper part of the Hydraulic section, given above, are the loose residual materials equivalent to the sub-stratum of the "Barrens," and contain *Productus punctatus, P. altonensis, P. semireticulatus, Bellerophon, sublævis, Allorisma sinuata, Dentalium venustum, Orthoceras sp.? Euomphalus spergenensis, E. plano-spira, Orthis dubia, Rhynchonella mutata, R. grosvenori, Hemipronites crenistriatus, Zaphrentis, Fenestella, Retzia verneuilanum, Athyris royissi, A. hirsuta, A. subquadrata, Pentremites conoideus, Palæacis cuneatum, Aulopora gigas,* etc., etc.

In the cement bed were noticed *Lingula, Discina, Fenestella, Ptilodyctia, Spirifera fastigiata* and *Aviculopecten hertzeri.*

The Keokuk rocks below contain a multitude of larger fossils: *Spirifera, Dorycrinus, Synbathocrinus, Platycrinus, Strotocrinus, Archeocidaris, Melonites, Nautilus* and *Zaphrentis,* are common in this group.

A mile below, the Keokuk rocks are exposed on the Kentucky side of the river, and are rich in *Crinoids,* etc., and pass below the water level at the cement warehouse.

Rockhaven, on the Kentucky side of the river, furnishes a first-rate open view of the strata which are partly covered on the Indiana bluffs. A quarter of a mile below the landing is a perpendicular cliff, boldly ribbed with massive belts of limestone more than three hundred feet high. Two hundred feet above low water in the river, an orifice or doorway, ten feet high and four feet wide, opens into a cave, described by Major Wright as more than a mile in length, containing a lake three hundred feet long and thirty feet wide; also a river on which is a fall fourteen feet high, a natural bridge, and rooms ten, twenty and thirty feet high and wide. It is inhabited by sightless fishes, cray fishes, bats, rats, 'coons, striped squirrels, ground hogs and mice; buzzards shelter and nest in the first room, which is difficult

of access. In summer a small stream of water trickles from the doorway; after a heavy rain a torrent of water, four feet in diameter, is hurled from the doorway in a single leap of sixty feet to the rocks below, landing in a sheet of foam. In winter the cliff is cased in a shining armor of ice, with pendants and columns of snow-white brightness.

The most important interest is the hydraulic cement, found here in immense beds on the Indiana side of the river. In 1872, Major J. H. Wright, of Louisville, tested a dark, bituminous clay limestone, and found it possessed of high cementing properties. A company, under his direction, organized for work. The bed was found to be thirty-six feet thick, almost uniform in quality, and situated so high up the hill that the stone may be cast from the quarries to the kilns, drawn from the kilns into the mill, and thence, a step down at each manipulation, to the wharf for shipment. Five of Page's perpetual flame kilns are in use, each thirty-six feet high, eighteen feet square on the outside, with a diameter of eight feet inside the cupola; average capacity of each, per day, two hundred barrels, drawing the lime every four hours. Ordinary kilns fail on account of bursting of the stone, which packs the material and smothers the fire. The flame kiln obviates this difficulty, and is in all respects a success.

The stone is highly impregnated with petroleum and bitumen, which assists in calcining. The stone is burned at a bright red heat only; a higher degree renders the lime inert. It does not contract much in burning, and loses but little of its weight. Drawn from the kilns, the stone is reduced by a crusher to fragments about the size of hulled walnuts; it is then ground by three run of burrs, each pair of the extraordinary weight of 60,000 pounds, the whole being driven by a forty-horse power engine. After grinding, the cement is carefully cooled, screened and packed in barrels. The

cost of manufacture ought not to exceed fifty cents per barrel, not including packages. Either wood or coal may be used in calcining the stone.

Fixtures, including kilns, mill, engine, tenements, shops, warehouse, tramway, tools, etc., is estimated at $15,000 to $35,000, and has a producing capacity of one hundred thousand barrels of cement per year. The largest day's work done produced five hundred barrels, and the heaviest year's production, in 1875, was thirty-five thousand barrels. The cement meets with ready sale, and the result of four years' test under sharp competition indicates that it is equal, if not superior, to the ordinary commercial article. It sets slowly, and is therefore peculiarly adapted to brick and stone masonry, as in cellars. It sets well under water, and has been used for steps, pavements, roads, vats, cisterns, mill-races, etc. When salt water is used as a solvent it hardens more slowly, but equally well.

In a competitive test in a mill-race at Georgetown, Ky., Major Wright informs me that fifteen barrels were used of each of the following brands: Black Diamond, Louisville, Common Louisville, Rosendale, N. Y., and Rockhaven. The work was under a rapid current of water. The Rockhaven is still good, superior to some of the others and equal to the best. This particular notice seems due from the fact that the very extensive and easily accessible beds on the Indiana side of Ohio river invite the attention of capitalists, and ought to be worked.

Hydraulic limestone occurs in the same vicinity, on the Ellis farm, easily accessible, with a thickness of twenty to forty feet, and on the Craven Lane farm, a mile above the ferry, where it seems saturated with petroleum, and forty to fifty feet thick; on John Briggs' farm, where it is easy of access and twenty-two feet thick, and on the magnificent

"Cedar Grove" farm of Kintner there is twenty-two feet of cement in the bluff.

The vicinity produces excellent fruit in large quantities. Kintner's orchard covers twenty-five to thirty acres, with a thousand apple trees in full bearing, peaches, pears, cherries, berries, etc.

The well stocked nursery of W. H. Lane, at the extreme southern point of the promontory of Harrison county, was in excellent condition and contained a good assortment of acclimated fruit trees.

This vicinity was a favorite home of the Indians; the site of an extensive village, formerly occupied by some fixed people, was noticed half a mile north of the ferry. Stone hammers, arrow points, flint chips, etc., were very abundant; at Cedar Grove a *cache* of leaf-shaped flint spear points was discovered a few years ago, in which more than a hundred specimens were found. From the top of this southern promontory of the State, 410 feet above Ohio river, a fine outlook is enjoyed; the ever beautiful Ohio river circles in a broad sweep, comprising miles of river scenery equalling the historic waters of the Rhine; sometimes a mad, rushing torrent, at others a quiet, sleeping expanse. Beyond, in Kentucky, the Muldraugh range of hills are built up against the sky ten to thirty miles away, while six great, sharp, conical, isolated, monument-like knobs, the result of past erosive energy, seem to pierce the blue heavens, solemn in their silent loneliness, and a measure of the ages necessary to remove, by denudation, a thousand feet of overlying strata.

Tobacco Landing was, in early times, intended by some speculative proprietors as one of the most important trading posts on the river. Warehouses and other appointments were prepared sufficient for the transaction of all the business of the neighboring region; but trade would not come. Its

chief notoriety is for having been the boyhood home of the traveler and author, J. Ross Brown. His mind was educated to an appreciation of natural scenes of beauty by the outlook above mentioned, but more by the dreary scenery of the dark chasm of Falling-spring brook. The walls are steep or precipitous, of banded limestone, over three hundred feet high. Remote from the intrusion of domestic animals, the original growth of plants, feathery ferns flourish in profusion on the shaded benches and caves. Each escarped band of rock was festooned with trailing creepers and clinging lichens, while the steep face of Douglass' pinnacle would always excite a boy's dreams of romance. In this solitude was nurtured the longings which were embodied in his first published sketches. The neighbors, in kind remembrance, have named his favorite retreat, "Ross Brown's Gulch."

Laconia is on the dividing plateau between Mosquito and Buck creeks. The surface is level or very gently undulating. The soil is black, rich, and a good example of ancient alluvium, and although over four hundred feet above low water in the Ohio river, is so nearly level that swamps and ponds occur which should be thoroughly drained by open or tiled ditches. With such improvements the results will be equal to any in the southern part of the State. Fair crops of corn, wheat and tobacco are produced. Red-top grows well. J. L. Kintner, after a fair trial, has found that orchard grass is fully twice as profitable as any other, and is one of the surest crops the farmer may cultivate. The orchards were in good condition, the apples were free from imperfections, and a full yield seldom or never fails. It would seem that these conditions would invite the attention of persons who desire to engage in the business of canning, drying and permanently preserving fruit for market. There is a bone mill in the town, and much bone dust is used for fertilizing, with remunerative results.

West and northwest of Laconia, as will be seen by the map, there are four small creeks or brooks, which, after gathering the surface drainage of from two to four miles, suddenly sink in the ground to the cavernous St. Louis limestone. After an underground course of less than two miles they are collected together and burst forth from an opening in the limestone bluff of Buck creek in sufficient volume to turn an old-fashioned overshot wheel and mill. This region is historic ground, on the verge of the battle-land which divided the semi-civilized Indians of the south from the savages of the north, and subject to incursions from these irreconcilable enemies and from predatory parties from other tribes. It was inhabited by wild animals—a land of game—bears, deers, turkeys, etc., were abundant. Notwithstanding the danger of the situation, this hunting-ground soon attracted the attention of the Boones and others of the chivalrous pioneers of Kentucky. Every excursion was a scouting expedition, and every trail a "war path." The foemen neither asked or gave mercy. On one of their hunting expeditions, Squier Boone, brother of the famous Daniel Boone of Kentucky history, in passing along the eastern bluff of Buck creek, noticed a small cave-like opening in the rocks, partially hidden by bushes. It appeared to be a good hiding-place for large, wild game. A few miles further on he was attacked by three Indians; his only chance for life was to fly. The pursuit was immediate and earnest. Although he had then thrown away his arms their nearer approach was constant, and it was evident they would soon overtake him. He remembered the hiding-place discovered a few hours before, and reached it when his pursuers were less than a hundred yards behind him. Throwing himself into the cave, he heard the Indians pass over his head. The little cavern had saved his life. To him it was holy ground; he selected it as his final resting-place—a

sepulcher carved out by the hand of nature. He required that, after his death, his body should be entombed in this cave. Going to the spot, a rough, flat stone was shown us —the door to "Boone's Grave Cave." Removing the stone, a small opening is exposed in the side of the hill; a descent of about seven feet led to a room six by eight feet on the floor, and a little less than five feet high. The coffin had been broken away, and the exposed bones showed that this intrepid pioneer had been a man of stalwart frame and great muscular power, at least six feet two inches high. The skull was gone. A decent regard for the family and memory of a man who contributed so much to the pioneer history of the Ohio valley, and gave name to so many counties, towns and villages in the Garden of America, demands that a suitable memorial column or block of stone should be placed over this grave, not only to mark the spot, but to preserve his mortal remains from the vandal hands of relic hunters.

Squier Boone spent his latter days in this vicinity. The great cave spring poured its torrent down the side of the hill, having a fall of eighteen feet. Boone built a mill, preparing the material almost wholly with his own hands. The building was of stone. Many of the blocks were ornamented with figures and emblems, displaying some degree of artistic skill, and all by the hand of the old hunter. A trailing vine in full leaf and laden with fruit was cut upon the lintels, and figures of deer, fishes, a horse, a cow, a lion, a human face, and stars, and many texts from the bible were sketched upon the stone in different parts of the building. Over a door-way was this inscription:

"The . Travelers . Rest . consecrated . By . Squier . Boone . 1809."

Over another door is the following:

"I . Set . And . Sing . My . Souls . Salvation .
And . Bless . The . God . OF . My . Creation ."

A broken stone says:

"My . goode . frind."

BOONE'S MILL CAVE.

Dr. Potts and some friends, in 1870, determined, if possible, to explore the cave which gives egress to the stream that drives the Boone mill. Near the mouth of the cave, which is twenty feet wide and ten feet high, the water rushes out with a violent current, and for one hundred and fifty yards was found to be waist deep; thence for half a mile the stream was smaller, a mere tunnel four and a half feet high, where they found interesting waterfalls, one ten and the other twelve or fourteen feet high; passing these, they entered a dry hall-way, for nearly a mile averaging twenty feet wide and sixteen feet high, the sides highly ornamented with snow-white or translucent stalactites, and numerous stalagmites built up from the floor, which, in many cases, nearly approach the pendants from the roof. Dr. P. was delighted with the beauty of the scenes. Sightless fishes and bats were the only observed inhabitants.

Returning to Boone's Landing on Ohio river, the line of "Gas Springs," the ebullition of which has been mentioned in the bed of the river, a short distance above Rosewood postoffice, and which was found in the oil well bore near Buena Vista, is again noticed, entering the river a short distance below Tobacco Landing and trending obliquely to the southwest, until, at Morvin, the phenomena of the bubbling gas was seen from the Indiana shore to the Brandenburg wharf. In time of overflow the ferryman reports that

for many years he has noticed the same occurrence at many points on the Indiana bottoms back of Morvin, where the discharge of gas was in great volume, but where it is scarcely to be noticed when not so confined by the water. The immense amount of this gas, and the possibility of its economical use for illuminating, heating, cooking and steam purposes, induced a visit to Brandenburg, on the Kentucky side of the river. Immediately adjoining the town, and thence east to Doe run, eight wells are reported as having been bored to depths varying from 478 to 800 feet, and from seven of them gas and salt water were discharged; in more than half of them the gas was in considerable quantity, and in at least two of them the brine was strong and in reasonable quantity.

The principal well, belonging to Mr. Alonzo Moreman, named the "Glen Font Salt Works," was bored in 1864 for oil. It is 527 feet deep, at which point the auger struck a sloping crevice. On account of the inclination of the sides of the crevice the drill could not be made to bore deeper. Further search for oil was abandoned and attention given to the flow of gas and salt water, containing a small amount of petroleum. The brine measured 31° by the salometer, which is equal to the best Kanawha or Pomeroy wells; ten gallons of the brine yielded one gallon, or seven and a half pounds, of salt. The gas is the only fuel used for evaporating the brine; but about one-third the amount discharged is needed for this purpose and for lighting the dwellings and doing the cooking in the neighborhood. They are now making over twenty 280-pound barrels of salt per day. The gas and water come from the well in strong pulsations about every minute, with many weaker ebullitions between. This carburetted hydrogen gas is gathered in an iron tank ten feet deep by eight feet in diameter (holding 502.6 cubic feet of gas at atmospheric pressure).

Allowing the gas to pass through a two and a half inch discharge pipe, it filled the tank in a little over three minutes, and exerted a lifting force of 4,300 pounds, which would indicate a discharge of nearly two hundred cubic feet of gas per minute. The brine is evaporated in two large pans; each fire-box is supplied with two gas-pipes, one and a quarter inches in diameter, which make a vivid sheet of flame five feet wide and filling the fire space to a depth of eight inches. The supply of gas is believed by the proprietor to be ample to evaporate the amount of salt mentioned, drive a steam-mill, and light, warm and cook for the town of Brandenburg. An experienced glass manufacturer declares the amount ample to carry on extensive glass works.

An analysis by Dr. J. P. Barnum, gives the following as the composition of the salt:

	Per Cent.
Chloride of sodium (table salt)	99.45
Chlorides of calcium and magnesium, sulphate of soda, organic matter and loss	0.55

The cost of manufacturing this salt is forty cents per barrel, and it sells at $1.45.

The following section in bore was given by David Miller:

SECTION AT BRANDENBURG WELLS.

	Ft.
St. Louis and Keokuk limestone	220
Knob-stone shale	200
Knob-stone silicious argillite	50
Knob-stone shale with nodular iron stones	130
Devonian shale	130
	730

Busey's burning well is in the low river bottom, half a mile above town. It discharges brine and carburetted hydrogen gas in large quantities, and also large quantities of sulphuretted hydrogen gas and sulphur water, which injure the quality and lessen the quantity and purity of the salt.

The gas constantly bubbles up from a basin of water, eight feet in diameter, and when ignited covers the basin with a waving mantle of fire. In times of high river the locality is covered with back water to a depth of seven to fifteen feet. The gas, divided into small streams, bubbles through the water over a space ten or fifteen feet in diameter, making a sulphurous, red sheet of flame, writhing and twisting before the wind, and in the still, dark hours of the night the goblin-like flames dance upon the water like lost spirits hovering over the sulphurous pits in Dante's Inferno.

Mauckport is situated on the bank of Ohio river, and is surrounded by extensive, rich, alluvial bottom lands. It is also the entrepot for the products of the fertile uplands on either side of Buck creek, but is especially notable from the fact that extensive beds of Oolitic limestone crop out in thick strata in the hills from two to four miles north of town, the product of which is shipped from this port. Maple Grove, on southwest quarter, section 21, township 5, range 3, the residence of Captain Jacob Stockslager, one of the venerable pioneers of this region, was visited under the guidance of Hon. S. M. Stockslager. Ascending the hill south of the residence, the flint quarry-bed was noticed, with evidences of much work by Indians and earlier prehistoric races. The ground was covered with broken nodules, spawls, chips, splinters and broken or imperfect implements—unsuccessful attempts of the apprentices to ancient arrow-pointers.

Still higher up the hill a massive stratum of Chester lime and sandstones reach well toward the top. From here a grand view is enjoyed, reaching across the Ohio valley to the Knobs of Kentucky—pinnacles of the Muldraugh hills, fifteen to twenty miles away, with Brandenburg, Bards-

town and other points of interest—a mere outline-tracing in the dim, blue distance.

To the east the rough valley of Buck creek and its tributaries is leveled by distance, to appear as a valley plain, sloping eastward.

East of the residence is the well-known Stockslager Oolitic quarry. The stone is in a broad band, cropping out on the side of this and several adjoining knobs, varying from six to eight feet thick. It is almost snow-white, homogeneous, composed of small concretions like the eggs of fish, and, from this peculiar structure and its almost perfect purity, is believed to owe its origin to precipitation from solution by some chemical action in the old St. Louis sea.

The quarry has been opened on a face of more than a quarter of a mile, at every opening showing a stone unsurpassed for uniformity of color, texture and quality. The product is fine-grained, compact and strong; saws well, is easily dressed or ground, and on account of fine texture and pure white color, is one of the most attractive limestones known on the globe, unsurpassed if not unequaled.

In the table of crushing resistance, by General Gilmore, in this volume, it shows strength ample to sustain heavy burdens. Specimens seen after fifty years' exposure to the elements show no sign of yielding, the only wear being a slight roughening of the surface. The quarry has been worked only enough to obtain the exposed or surface samples, which come out, from diagonal cleavage, in angular blocks. As the entry is deepened, the superintendent reports that larger masses are obtained, and he confidently expects that, as the work proceeds, the whole thickness of the strata may be made available. Stone from this quarry has been burned, and yields a fine, pure white lime of superior quality for masonry, plastering and whitewashing.

A valley leading from the quarry to Ohio river offers a gently declining grade for rail or tramway.

SECTION AT STOCKSLAGER'S OOLITIC QUARRY.

	Ft.
Loamy clay	70
Massive Chester sandrock (Hay's farm)	6
Siliceous Chester limestone	30
Cherty Chester argillite	10
St. Louis, argillaceous limestone	40
St. Louis, gray, fossiliferous limestone	5
St. Louis, snow-white *oolitic* limestone	8
St. Louis, banded limestone	8
Massive, gray, limestone	10
Cherty argillite, with bands of limestone	80
Flint balls	10
Argillaceous limestone	30
	307

On W. G. Hay's land, adjoining, a quarry has been opened on the same strata. The product is a little coarser, and contains a few fragments of fossils, but is of excellent quality for building purposes and for burning into caustic lime. Jackson's Knob, adjoining, is supposed to be the highest in the vicinity, and, by barometer, its top is five hundred and sixty-nine feet above low water in Ohio river.

Ohio river is subject to great floods as well as very low stages. The river men at Mauckport gave the following figures to show the greatest hights attained by the floods since the historic period:

	Ft.	In.
January, 1832, above low water mark	73	0
January, 1847, above low water mark	72	6
March, 1867, above low water mark	72	0

On all the hillsides, for several miles north and northeast of Mauckport, flint balls and concretions were abundant, and many broken and partially worked specimens were seen. These flint balls vary from two to eighteen inches in diameter.

Huffman's hill, southwest quarter, section 23, township 5, range 3, is a Knob-like elevation, a monument of the solid rocks which once built up, as a level plain, this now broken and hilly region; its companion strata have been eroded and carried away. A solid band of flinty chert, fourteen to sixteen inches thick, was seen near the base and on the sides, the rocks containing many characteristic St. Louis fossils, including a delicate *Lithostrotion*, for which Prof. Herzer has proposed the name *L. mammillare*. The view from the summit will interest the geologist as well as those seeking the beautiful. In addition to the picturesque knobs of Kentucky, gaps in the Muldraugh range may be recognized, through which Salt river flows, and the broad, continued depression of the barrens plain which led the preglacial river by Elizabethtown to Nolin valley. To the north this great valley, for miles in length and breadth, is well exposed to view—better than at any other point except Pilot Knob—with its high, stony Chester bluff to the west, and, dimly in the distance, the Floyd county knobs near New Albany may be seen, composing the eastern bluff of the same valley plain. To any one interested in dynamical geology, a view from this point can not fail to be of great interest.

New Amsterdam is pleasantly located on a dry loam soil, and is a trading point for the farmers who cultivate the rich lands of Ripperden and Grassy valleys, a few miles to the east. The underground drainage of these sunken lands—they have no surface outflow of water—is by the "Blue spring," adjoining the village, where a creek boils up from a hidden channel, clear, pure and cold, and in sufficient volume to turn a mill. To the tourist this region is full of interest, and will well repay a visit, including the beautiful sunken valleys already mentioned.

Blue Island cliff, just below Kendall's Landing, is known to river pilots as "Hole in the Cliff," on account of a heavy bedded rock projecting a few feet, which casts a strong shadow and forms a shed-like recess. The following section was taken up the precipitous face of the hill:

SECTION NEAR KENDALL'S LANDING.	Ft.
Sandy loam	33
Shale and sandstone	17
Thin bedded sandstone	40
Massive sandrock, gritstone	7
Soft gritstone	5
Calcareous shale and soft sandstone	20
"Keil" (red pudding stone)	5
Massive crystalline limestone	30
Shale	15
Gray and red laminated limestone	11
Fissile argillaceous limestone	25
Massive, gray, St. Louis limestone	25
Flinty, argillaceous limestone	26
White oolitic limestone	4
Argillaceous limestone with plates of chert	40
Cherty limestone, covered with great blocks of sand rock from the top of the cliff	75
	378

The red "Keil" was worked at McCullen's lick, near Ray's Chapel, about the year 1833. It was sawed into pencils and supplied to the limited western market, but the pocket was soon exhausted; careful search will doubtless discover more on the same horizon.

In the valley of Potato creek several outcrops of *oolitic* stone were observed, where extensive lime-kilns were formerly operated. At John Brown's mill, on section 10, township 4, range 2, two miles above the mouth of the creek, the following strata outcrop:

SECTION AT BROWN'S MILL.	Ft.
Conglomerate and Chester sandrock	100
Kaskaskia beds of Chester group	22
Shaly clay (marl?)	18
Argillaceous limestone	15
Shaly clay	11
Argillaceous limestone	35
Flinty limestone	30
St. Louis gray limestone	40
St. Louis hard limestone	15
St. Louis white oolitic limestone	4
Cherty limestone	12
Oolitic limestone, fractured	6
	308

In passing over the county a barometer was carried and notes made of elevations, corrected, where possible, by repeating the observations, but without the aid of a station instrument or other corrections. Careful leveling may detect errors as great sometimes as fifty feet for stations remote from Ohio river or the line of railway surveys. The datum plane assumed is the elevation above mean tide of the mud-sill of the lower lock in the Louisville canal, which was determined by Stansbury and Williams (U. S. Engineers) in 1832, to be 353 feet above the ocean.

TABLE OF ALTITUDES.

Points of Observation.	Datum Planes.	
	Ocean.	Ohio R
New Albany, low water, canal sill	353	.....
Corydon	593	240
Frenchtown	741	388
Lanesville, east of	743	390
Knob summit, east of county line	960	607
Edwardsville	843	490
Palmyra, loess	711	358
Barrens	690	340
Barrens above Corydon, average, 150 feet	.....	.....
Oakland, Floyd county	983	630
Mouth of Blue river	303	.....
Mouth of Blue river, high water	373	.....
Loess loam, southwest part of county	771	468
Keller's hill, above mouth of Blue river	956	653
Keller's hill, highest summit	963	666
Brackenridge	723	370
L. & St. L. R. R. tunnel, Edwardsville	785	432
Knob at Edwardsville, above tunnel	980	527
Georgetown, on line of railroad survey	684	331
Crandell's branch, on line of railroad survey	625	272
Big Indian creek, on line of railroad survey	571	218
Big Indian creek, proposed railroad bridge	650	297
Salisbury, on line of railroad survey	683	330
Fair Dale, on line of railroad survey	673	320
Arnold's Hill	719	366
Blue river, Milltown	492	139
Milltown, bridge grade	535	182
Middletown	700	347
Elizabeth	683	330
Buena Vista	602	249
Buena Vista summit	722	369
Evans' Landing	330	.....
Mauckport	310	.....
Amsterdam	306	.....

ECONOMIC GEOLOGY.

AGRICULTURE.

In a state of nature Harrison county offered features that fairly invited the early pioneer. To the brave hunter it was a land of wild plenty. Large game was abundant. The flesh and skins fed and clothed, and, as currency, supplied every want. The fertile bottoms, "tickled with a hoe, smiled a harvest." The barrens, almost prairies in contour and freedom from trees, clothed in a luxuriant coat of grass, gave abundant pasture and forage without labor, except the gathering. Wild fruits, as the plums, grapes, haws and persimmons, walnuts, hickorynuts and chestnuts, were everywhere abundant. No wonder it was deemed a second Paradise by the fathers of our State.

Sixty years' cultivation has robbed the soil of its virgin fertility. The river bottoms, consisting of deep alluvial loam, annually recruited by spring overflows, still produce fair crops. An estimate by a well informed agriculturist places the annual return per acre from the better land as follows:

Corn, forty bushels at forty cents per bushel	$16 00
Wheat, twenty-two bushels at one dollar per bushel	22 00
Hay, two tons at fifteen dollars per ton	30 00
Potatoes, one hundred and fifty bushels at seventy-five cents per bushel	112 50
Cabbages, one thousand five hundred heads at five cents per head	75 00

On the uplands the yield is less satisfactory, and by the same authority is estimated as follows:

Corn, twenty bushels at forty cents per bushel	$8 00
Wheat, eight bushels at one dollar per bushel	8 00
Potatoes, one hundred bushels at seventy-five cents per bushel	75 00
Hay, one ton at fifteen dollars per ton	15 00

This statement includes some new, good tracts lately brought under cultivation. There are many farms long and exhaustively cropped, which yield fifty per cent. less than the above. Such minimum returns are not remunerative, and will not support the farmer and his family. For some years the question has been anxiously discussed whether it was not best to abandon "barrens" land. A few experiments with bone dust showed that to be a sure source of relief. After a continued use for several years this fertilizer is found to nearly double the crop of corn, wheat or grass, and leave in the ground the elements, in part, of other crops. Four bone mills are established in the county and doing a good business, and large quantities are also taken into the county from the mills at New Albany and Louisville. Bone dust is applied at the rate of 125 to 250 pounds per acre. A careful estimate of its benefits by a thoughtful farmer gives the following showing: In the fall of 1877 there was bought and applied to the wheat crop an aggregate of 3,330 tons, costing $30 per ton, or nearly $100,000. This was applied to 33,300 acres of wheat; with the low estimate of an increase of four bushels of wheat per acre we find the farmers who applied the bone dust have an aggregate net profit of over $33,000. With such results it is apparent that the use of such fertilizers will pay and should be encouraged. It may not be improper to suggest that the use of commercial manures, when farm products bring no higher prices than they do in this county, should be only a temporary expedient. A farm should be self-sustaining. As soon as the fertility of the soil is partly restored attention should be given to the culture of clover and the grasses, by which, with a fair rotation of crops, the fertility of the soil may be indefinitely sustained. Blue grass and timothy, which succeed so well in the center of the State, fail in parts of this county by reason of the

drought and hot sunshine. Experience in Southern Indiana, Kentucky and Tennessee has shown that orchard grass (*Dactylus glomerata*), when closely seeded, will withstand drought in partly shaded ground or open fields far better than any grass above mentioned; that where a drought of four or five weeks would cause the blue grass to wilt and dry crisp, the orchard grass would be comparatively green and luxuriant. The advantage of this over other grasses are: "It can be grazed two weeks earlier in the spring; its fattening qualities are equal or superior; it affords more grazing or hay to the acre; in summer it will grow more in a day than blue grass will in a week, five or six days being generally sufficient for a good bite; it makes a permanent sward for pasturage or hay, and does not run out." A field on Blue river has furnished good pasture for twenty-five years, and in adjoining states fields of orchard grass have been continuously pastured or mowed for forty or fifty years. Not less than two bushels of seed should be sown per acre to prevent it from growing in bunches or stools.

With a mixed husbandry incident to grazing and the rearing of sheep and cattle the future of the farmer will be bright.

FRUIT.

The earliest settlers in Harrison county planted apple trees; many old apple trees were seen from two to two and a half feet in diameter. Their descendants have kept up the practice until nearly every farm has its orchard of well selected varieties. The apples are highly colored, well ripened, and the crop usually exceeds the demand. It is suggested that a canning and drying establishment would be profitable at some river point. On the elevated table lands and "flat woods" district the apple crop is usually very large, and rarely fails. Peaches bear fairly in the

sandy regions and on the loamy hill tops. Grapes and the small fruits succeed well.

SUMAC.

This shrub, so extensively used for tanning, and so largely imported from Europe, is indigeneous in this locality. The leaves are gathered by women and children, dried, beaten with flails or tramped to separate the stems, and then sacked and sold at one cent per pound. The crop of 1860 was the largest ever gathered in this county, and brought about one thousand dollars.

ROAD MATERIALS.

No people can expect fair returns from their labor without commerce and means of transportation for exchanging their commodities. Good roads are indispensable for social intercourse and the enjoyment of progressive civilization. The limestones of this county furnish good materials for stone roads; they are abundant and easily accessible at all points, and should be utilized. The partially decomposed ferruginous cherts, forming the under beds of the "barrens," the remains of the eroded limestones, have been used with best success on the splendid Corydon and New Albany turnpike. No better material could be desired. Beds of the same chert transported from this region ages ago by the Ohio are eagerly sought after and utilized at Evansville and Paducah. The streets of these cities are models, and the stone with which they are covered is the common eye-sore of this its native region. It breaks into small, angular fragments, which wedge together, forming, theoretically, an arch which is compact, waterproof and almost frostproof, elastic, and in process of pulverization and disintegration the iron oxide in some degree re-cements the particles. Good roads and their economic value can not be too highly commended and urged.

BUILDING STONE.

When the developments of the future create a demand the great staple of this county will be building stone, which occurs here in every variety, comprising the ornamental as well as those of sterling useful qualities.

The buff calcareo-magnesian beds at New Salisbury were mentioned by Dr. D. D. Owen in the first report on the geology of the State. The quarry has been worked at intervals ever since. The color is a subdued, neutral tint. Directly from the quarry it is soft, and may be hewn with a broad ax or cut with a common saw, but on exposure to the air becomes hard. Samples seen in the old Capitol at Corydon and in use as door-sills and steps to residences show the satisfactory hardness and endurance of this stone after sixty years' exposure and use. The well defined, creamy, buff tint will, by harmony as well as contrast, be found desirable for ornamental work in artistic edifices.

The light gray limestone at King's Cave Quarry, and many other points in the county, is, practically as well as geologically, equivalent to the famous quarries at Salem, Bedford, Bloomington, etc. It is an elastic, compact, homogeneous limestone, capable of sustaining heavy burdens and, from the boldly escarped bluffs and exposure, known to absolutely resist for ages the action of the elements. When facilities for transportation exist this stone, equal to the best heretofore offered in the markets, will meet a good demand.

The snow-white oolitic limestone has been opened at the Stockslager quarry, near Mauckport, although it occurs in thinner ledges in other parts of the county. A chemical precipitate from an aqueous solution, it is of almost perfect purity. In color it is more brightly white than marble. It is susceptible of a high polish, and the egg-like concretions add a signal beauty and variety to the peculiar structure.

In color, beauty and uniformity it is unique, and is believed to be unsurpassed if not unrivaled. Tested by General Q. A. Gilmore, it was found to weigh nearly 150 pounds per cubic foot, and to have a crushing strength per square inch of 10,250 pounds, or more than eighteen times as strong as good bricks. The ratio of absorption is 1 to 27. An analysis made in the laboratory of the State Geologist gave the following result:

ANALYSIS OF STOCKSLAGER'S WHITE OOLITIC LIMESTONE.

	Per Cent.
Water expelled at 212° F	0.50
Insoluble silica	0.31
Ferric oxide	0.18
Alumina	0.14
Lime	54.93
Carbonic acid	43.17
Sulphur	0.25
Chlorides of alkalies	0.40
Combined water and loss	0.12
	100.00

This analysis shows it to contain 98.10 per cent. of carbonate of lime, being remarkably pure, as it contains less than two per cent. of impurities.

Colonel S. M. Stockslager furnishes the following estimate of the product of his quarry in cubic feet of stone for the years named: 1875, 500 feet; 1876, 1,000 feet; 1877, 2,000 feet; 1878, 5,000 feet.

When burned, this stone yields pure white lime, a superior article for plastering, white-washing, etc. It works cool under the trowel, giving ample time for ornamental finish. On account of its purity it is in good demand for defecating sugar and other chemical purposes on the lower Mississippi river.

At ordinary stone quarries, spawls and broken debris are a serious and costly encumbrance; here, every rejected frag-

ment is in demand for calcination and adds to the value of the quarry, and almost insures profitable results to operators.

A dark gray limestone is seen just below the mouth of Musquito creek, near the extreme southern promontory of the county. It is homogeneous, massive, and shows in solid stratum a full thickness of fifty feet. I have never seen a stratum of limestone so much resembling granite in external appearance; from indications on the outcrop, it is almost equal to granite in strength and endurance. This stone deserves the careful attention of engineers having in charge the construction of piers, walls and foundations exposed to ice, floods and surging ocean waves. It is believed that it would fully meet the requirements of the general government improvements at the deltas of the Mississippi river. When burned it makes a strong white lime.

The sandstones of the Chester group cap the hills in the western and southwestern parts of the county. The massive beds which crop out on the bluffs of Blue river and Ohio river in Washington and Scott townships, when undermined, sometimes break off and dash down the steep bluffs, especially in the spring, when the thawing frost renders the underlying rocks weak and yielding. Many of the fallen masses still retain their sharp, well-cut angles, although the surroundings indicate an exposure to storm and ice for centuries. It is a choice stone for exposed foundations, frost and water-proof. A good grit stone, large sized grindstones, four to five feet in diameter, were obtained from Rhodes & Rothrock's quarry on Blue river, and used in manufactories in Louisville, and found to be first-class.

BRICK MATERIAL.

Clay for bricks is abundant throughout the county. At every town and village, and at many farms, kilns have been burned. The product ranges from fair to good, and some samples observed were of superior quality.

LIME.

In addition to the special mention of this important item under the head of "Building Stone," lime has been burned by log-heap and other primitive methods in every part of the county. Formerly, when flat-boats carried the commerce of the West to New Orleans, kilns for calcining the white oolitic stone lined the banks of Ohio and Blue rivers wherever that stone was obtainable along those streams, from which the burned lime was shipped as "Blue River Lime," on "Broad-horns" (flat-boats,) to the southern planter and merchant. The trade, stopped by the "late unpleasantness," has not been revived. The lime is good; none other in the valley of the West surpasses it, and if enterprise and capital could be enlisted in preparing and putting it on the market, it would soon stand at the head of the brands.

For home uses it is necessary to ask the attention of the farmers of Harrison county. Acidulous gases in water decompose limerocks, leaving insoluble siliceous materials as a residuum; of this and a small per cent. of clay the soil is composed. A few years cultivation exhausts the soluble silica of which the "bone" and bark of plants is composed, and a weak, spindling plant and barren harvests result. Sand is made soluble plant-food by the alkalies. Lime is here omnipresent and the cheapest alkali within reach. The farmer may test for himself by pouring vinegar, or any other acid, on a specimen of his farm soil; if lime is present in quantity, an effervesence will take place; without lime there will be no ebullition of gases. It will be found that the "barrens'" weak soils are, although in a limestone country, almost entirely without alkaline matter. The first step in restoring the fertility of such soils is to apply lime at the rate of fifty to one hundred bushels to the acre.

CEMENT OR HYDRAULIC LIME.

The immense beds of highly bituminous shaly limestone exposed in the bluffs reaching across the great bend of Ohio river from Brown's Landing to Cedar Grove, have already been mentioned in local details. This stratum is here thirty to forty feet thick, and at localities on the river bank, so situated that cartage and elevators are unnecessary; all the costly and heavy work may be chiefly done by downcasts. For burning this rock wood is plenty and cheap; coal may be had from barges at a low figure. With these advantages, cement, which sells from one to two dollars per barrel, may be prepared for less than fifty cents. It is believed that a fairly organized company with well devised fixtures could successfully meet the river market if not defy competition.

At the same locality materials abound which, if properly manipulated, would produce an artificial cement equal to the celebrated English Portland, thus combining every department of the cement trade.

The following table gives the results of careful analyses by Dr. G. M. Levette, of the Geological Survey:

ANALYSES OF HYDRAUIC CEMENT STONES.

NAME OF QUARRY OR OWNER.	Insoluble Silica.	Soluble Silica.	Ferric Oxide.	Alumina.	Lime.	Magnesia.	Carbonic Acid.	Sulphuric Acid.	Chloride of Alkalies.	Moisture at 212° F.	Combined Water and Loss.	Ratio of Bases to 100 of Silica.
Briggs	25.40	0.10	2.50	2.80	36.46	tr.	28.64	tr.	.....	1.00	3.10	144.
Kintner	26.20	1.00	3.25	5.45	35.14	1.67	28.06	0.80	.....	0.80	.....	131.
Natural Cement	27.45	1.40	tr.	4.75	23.50	2.98	21.76	.....	2.80	0.60	14.76	113.
Shackleford	10.25	1.13	1.95	2.00	46.65	0.50	36.55	0.14	.....	0.25	0.58	468.
Rock Haven, top	31.00	0.35	4.20	4.40	28.60	0.43	22.47	1.20	.....	1.00	6.30	114.
Rock Haven, bottom	27.10	1.10	6.75	2.40	31.00	0.66	24.35	1.80	.....	0.75	4.09	151.

GLASS SAND.

These beds are marked upon the map; they are so extensive as to be practically inexhaustible. Large quantities have been used in the manufacture of plate glass at New Albany and Louisville with satisfactory results. When exposed and slightly washed it is pure and white.

KAOLIN.

In working the sand banks, pockets and beds of white Kaolin were discovered. The sand miners were not searching for porcelain clay, and disregarded the "white putty," as they termed it, from its plastic nature. At the time of my visit the deeper excavations, near the reputed horizon of the Kaolin pockets, were filled with water and inaccessible. Small fragments were seen at the banks east of Elizabeth, and at the Peters farm near Eversole Cliff. These were pure white, and almost entirely free from iron. Just east of the last point an immense stratum of Kaolin was noticed, more than fifty acres in extent; the bed is nearly continuous, and from three to five feet thick. At the exposed points it varies in color from ash gray to pale green, pink, red and dark brown, the first colors predominating. A sample of the green variety, analyzed by Dr. Levette, gave the following result, and, for comparison, the analysis of a remarkable pure specimen from Lawrence county is also given:

ANALYSES OF KAOLIN.

	Harrison Co.	Lawrence Co.
Water	9.00	14.00
Silica	58.70	46.00
Alumina	26.00	36.00
Ferric oxide	5.50	3.00
Magnesia	0.80	1.00
Lime	None	

This extensive bed will, it is believed, prove of value for making yellow ware, tiles, water-tubes, fire-bricks, ornamental terra cotta ware, and, perhaps of more importance, as an addition in manipulating artificial cements.

The beds of glass-sand and kaolin are found along the margin and deeply sunk in the "flood plain" or "flat woods" border of the pre-glacial river valley. The rule is so persistent that the inference seems irresistible that their origin is due to the circumstances which gave rise to that valley. This rule prevails southward in Kentucky as well as here, indicating a great breadth of energy, somewhat analogous to the very ancient river channels filled with gold-bearing gravel in California, which, with many windings, run in general direction north and south, and at right angles to the present rivers, but whose waterless beds are now elevated on the sides and crests of the mountains high above the actual water courses.

GAS SPRINGS AND SALT BRINE.

Gas springs are noted as being found in the bed of Ohio river at two points, having a well defined line or trend from northeast to southwest; the scanty information available fosters the inference that this line is continuous between these points. A line of dots is marked on the map of Harrison county approximating the trend of gas springs. It is probable that bores to a depth of 600 to 800 feet along this line will, in many cases, discharge salt water, together with more than enough gas to evaporate the brine. In every case thus far tested the supply of gas is largely in excess of the quantity needed for that purpose, and may be utilized for generating steam, light, heat, burning lime and cement, baking pottery, etc. It is a grand and inexhaustible fund of power and wealth, and should be utilized. Special points

on this matter are given on a preceding page under local details.

WHITE SULPHUR WATER.

The white sulphur well at Corydon merits, and has for many years maintained a high reputation. Hundreds of visitors bear unqualified testimony to its remedial powers. It is believed to be a specific in cases of dyspepsia, rheumatism, chronic neuralgia and other diseases which owe their origin to malaria. Certificates from persons of repute show that it is remarkably efficacious in scrofula, sore eyes, affections of the skin, liver and kidneys; ladies, after years of suffering, are happy in advising the use of this water.

A qualitative analysis by T. E. Jenkins, M. D., shows the following constituents:

ANALYSIS OF CORYDON SALINE SULPHUR WATER.

Specific gravity, 1.0077; salts in one wine gallon, 450.88 grains.

Gasses in solution: Carbonic acid and sulphuretted hydrogen.

Salts in solution: Bicarbonate of soda, bicarbonate of magnesia, sulphate of soda, sulphate of magnesia, sulphate of lime, chloride of sodium, chloride of magnesium, chloride of calcium and silica.

Springs of a similar water are found in the bed of Buck creek, three miles southwest from Middletown, and may be reached by bores at many points in Taylor and Boone townships.

CAVERNS, ETC.

The caverns of this county, although not extensive, are full of interest and beauty, and will fully repay the tourist or pleasure seeker for a trip during vacation. In fact, residents of cities could enjoy, without much expense, a week

of rambling among the health giving hills and valleys, surrounded by ever changing scenes of interest and beauty, in this county in a much more profitable manner than in long, expensive wanderings in more distant regions.

On the excellent turnpike from New Albany to Corydon the naturalist will be interested in the fossil beds at Edwardsville, Lanesville, Myers' Hill, near Breckenridge, as well as Yocum's and King's caves. At Corydon, Pilot Knob and Martin's hill afford extensive outlooks; Keller's Hill is a first-class illustration of coal measure life. Rhodes' and Borden's caves, and the Harrison and the Blue spouting springs, on the road to Wyandotte Cave, are attractions which no Indianian can afford to ignore.

ARCHÆOLOGY.

No earthworks characteristic of a pre-historic race were seen in this county. The only evidence of their presence, and that not conclusive, was the finding of a single beaten copper implement, with a few totums, ornamental gorgets and pendants wrought from the chloritic slate or "striped stone" of the northwest, so much affected by that race, and a few arrow points which, from their aged appearance and form, are peculiarly "Mound Builder."

To the second or intermediate race between our savage, nomadic Indians and the Mound Builders is attributed the bone or shell banks below New Amsterdam, the stone graves at Kendall's Landing, the village site long occupied as a permanent residence by an agricultural people, and the peculiar flint implements attributed to the race of "bow-legged fishermen."

One mile below the village of New Amsterdam, and immediately below the mouth of Indian creek, is a mound containing human bones, flint chips, broken pottery and

burned stones. Half a mile down the river is one of the large shell mounds, a mass of river and land shells, with a few nearly decayed bones of buffalo and other wild animals common to this country at that date. It is one hundred and seventy yards long, ten yards wide at one end and eighty-five yards wide at the other end, which was least disturbed by undermining currents of the river, and two to six feet deep. At places the bank is nearly a clean mass of shells, but the bed is generally throughout profusely sprinkled with flint chips, spawls, cores, broken knives and various implements, with many rounded mallets and pounders of granitic stone, and occasionally a pick-hammer of hard, specular iron ore for splintering flints. Many of the pounders and other stones had been reddened by fire, and at several points the shells showed that fire had been built upon them. The whole mass plainly indicated the hand of man; many of the mussel shells showed an old fracture at the edge, made in opening. Mr. George Wolf, of New Amsterdam, has known this locality for half a century, and says that from fifty to one hundred and twenty feet of the river side of the heap has been undermined and removed by high water in Ohio river. Back of the mound is a perfectly level area of two and a half acres, over which were seen many flint and stone implements, defaced or broken, as if relics of tools in daily use.

The large amount of shells, bones, etc., but particularly of broken flints, seem to indicate the permanent village of a resident people; the locality accommodated them with cold spring water, good fishing, rich, alluvial loam for cultivation, with forests of game immediately adjoining in the high hills along Indian creek.

The last race of savages were skilled artizans in working flint; on every hillside and plain their implements of war and the chase are found, the latter especially adapted to

killing the kind of game sought or expected. To their implements, judging from the known and probable effects of exposure and time, we may estimate an age varying from two hundred to eight hundred years.

FLINT QUARRIES.

The question has been well asked, "Where did the Indians get the material for their flint implements?" Evidences seen in this county offer direct and conclusive answers. Alleged silver and lead mines, garnished with all the unreliable embellishments of the red man's traditions, were confidently believed in. The fact that, after their migration to the west, delegations had been known to return light and go back loaded, seemed proof of hidden wealth. Their habits were secretive. Secrecy is mystery, and mystery more alluring and seductive than unveiled fact.

Visiting the reported "diggings" on the farm of Ph. Blume, northwest quarter, section 19, township 4, range 3, on the west side of Indian creek, Scott township, a line of pits, one to three feet deep, nearly connected, and four to ten feet long, were discovered. The sides of these pits having crumbled and fallen in under the action of frost and rain, they were no doubt at one time, much deeper and wider than at present. The horizon is in the upper half of the St. Louis limestone and twenty feet below the oolitic bed, and at outcrops shows a band of clay crowded with slightly flattened balls of dark flint. A careful examination showed this to be the article sought. Around the pits and in the debris were found great quantities of flint balls with pale brown or bluish-gray interiors. Taken fresh from the quarry and tested with a smart blow from a hammer, it was found to break away in level cleavage, first from top and bottom, then, with some practice, this flattened section of a sphere could be cleaved in straight lines perpen-

dicular to the plane of deposition. The miners had been governed by these facts. A blow on the upper or lower surface would disclose any existing imperfections, and if any were found, as a white or crystalline core, it was thrown aside. Such rejected specimens, showing imperfections, were numerous. Geodes and hard pieces of granitic or porphyritic stone were used as hammers. Thin plates and spawls of limestone, found in the pits, were evidently used as hoes or picks in the excavation. At a little distance flint chips and splinters were so abundant as nearly to cover the ground. Some cores were seen showing the cleavage of from five to seven splinters for their angular sides, and indicating the mode of preparing the strips from which knives, awls and points were made by the skilled flint-worker. Many of the spawls and imperfect implements exhibited chafed or serrated edges, showing use as scrapers by the workers in wood. The overshadowing forest was principally of oak, from 100 to 400 years old, without scar or mutilation, indicating a new growth since mining was carried on. Blocks of limestone adjacent, judging from the amount of spawls surrounding them, had been used as anvils. Select materials were carried to their village homes in the shape of sectional blocks and cores, to be wrought into spears, knives, daggers, drills, rimmers, hoes, arrow-points, etc., etc., by masters in the art. At the village site, around a spring in Blume's bottom field, the fine chips and splinters cover the ground and may be measured by the wagon-load. This material can be worked successfully only when fresh from the quarry, while it still retains an excess of water, which is soon dissipated on exposure to the air. On losing its moisture the flint becomes obdurate and difficult to work. To prevent the escape of moisture the blocks and cores, when carried away, were buried in damp earth until the workmen were ready to chip them into desired shapes.

The quarry pits cover a space three rods wide, and extend half a mile around on the foot of the hill. Another row of pits of equal extent occurs on the neighboring Kintner farm. From the evidences seen one might infer that flints enough to satisfy the wants of the savage hunters and warriors of the interior of the continent for a century had been mined here. Similar quarries were noticed near Mauckport.

THANKS.

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CRAWFORD COUNTY.

Crawford county is bounded north by Orange and Washington counties, east by Harrison county and Ohio river, south by Ohio river and Perry county, and west by Perry and Dubois counties. It was organized in 1818, and contains 320 square miles, or 204,800 acres.

Leavenworth, the seat of justice, is situated on the alluvial bottom of Ohio river, just within the high water line, and is 126 miles south from Indianapolis. The great curve of Ohio river, on which Leavenworth is situated, is known to steamboat men as "Horse Shoe Bend."

The surface is very uneven and broken. The bluffs of Ohio river are generally steep or precipitous, rising 300 to 500 feet above the bottom lands, which are very narrow. Great Blue river washes the eastern border, and furnishes valuable mill sites and water power. Little Blue river and its many irregularly diverging tributaries drain the central areas from north to south. Patoka river and Anderson creek have their rise in the high north-south ridge of conglomerate table lands, with drainage to the west, and empty their waters into Wabash and Ohio rivers. Each of these streams have their beds in narrow, canon-like valleys, with steep or precipitous bluffs from 100 to 400 feet high.

The principal villages are Magnolia, Milltown, Springtown, Brownstown, Hartford, Grantsburg, Marietta, Alton and Fredonia. The narrow bottoms which border the streams are extremely fertile, producing good crops of corn, wheat, grass, potatoes and cabbages. The Loess plateau, which stretches out an almost level, unbroken area of table land from below Fredonia to Springtown on the north, and from near Grantsburg to the bluffs of Blue river on the east, has a peculiar soil; with careful husbandry, attention to drainage and rotation of crops, good returns of hay, corn and wheat reward the farmer. In the sandstone hills the soil is thin, and the best crops are none too good. Over all the uplands fruit trees are healthy, bear well, with rarely a failure.

GENERAL GEOLOGY.

The rocky exposures in this county belong to the carboniferous age, and comprise the lower or conglomerate member of the coal measures and the Chester and St. Louis groups of the sub-carboniferous period. Bores and deep wells cut through the Keokuk and Knobstone groups, and have pierced the black slate or upper member of the Devonian formation. The different beds and outcrops,

brought together in connected section from widely separated stations and from bores, give the following stratigraphic exhibit:

CONNECTED SECTION OF CRAWFORD COUNTY.

QUATERNARY AGE.

Alluvium	70 to 150 ft.
Fluviatile drift and terraces	30 to 400 ft.
Lacustral beds—Loess	10 to 40 ft.
Glacial drift	0 to trace.

CABONIFEROUS AGE—CARBONIFEROUS PERIOD.

COAL MEASURES.

Conglomerate sandrock	10 to 120 ft.
Ferriferous, pebbly sandstone	0 to 5 ft.
Shale with plant remains	0 to 1 ft.
Coal A	1 to 4 ft.
Stigmarial fire-clay	3 ft.
Bituminous, pyritous shale	25 ft.

SUB-CARBONIFEROUS PERIOD.

CHESTER GROUP.

Kaskaskia limestone, upper bed	2 to 10 ft.
Black pyritous shale (marl?)	1 to 25 ft.
Kaskaskia limestone, lower bed	5 to 20 ft.
Massive sandrock, passing to shales and flagstones	20 to 98 ft.
Argillaceous limestone in bands, with pockets and partings of gray and blue flint	10 to 26 ft.
Coal-bone	trace to 1 ft.
Siliceous limestone and argillite	2 ft.

ST. LOUIS GROUP.

Brown pyritous limestone	2 ft.
Argillaceous limestone, with flint	11 ft.
Gray limestone and silicious argillite	8 ft.
Buff magnesian limestone	3 to 8 ft.
Buff and gray limestone in thin beds	39 ft.
Hard brown limestone in massive layers	38 ft.
White *oolitic* limestone	3 to 15 ft.
Gray and brown limestone	35 ft.
Argillaceous limestone	40 ft.
Limestone in bores	150 ft.

KEOKUK GROUP.

Keokuk limestone in bores	80 ft.

KNOBSTONE GROUP.

Knob shales and sandstone in bores	450 ft.

DEVONIAN AGE.

HAMILTON GROUP.

Black slate in Ott's bore	110 ft.
Total	1,916 ft.

RECENT GEOLOGY.

The recent geology shows the energetic erosive and denuding agencies at work since the surface was elevated, as a great, nearly level plain, above the surface of the Paleozoic sea. It exhibits many valleys cut out of solid rock 200 to 500 feet deep, with side deposits, and although they may not be of pronounced type, yet they give an interesting chronological abstract of the history of this part of the earth during vicissitudes incident to periods of extreme arctic cold, great precipitation of moisture, alternating with temperate and tropic warmth.

ALLUVIUM.

The river and creek bottoms which border all the watercourses are due to causes now in action. They are composed of materials more or less comminuted, derived by disintegration and pulverization of the older rocks, mostly from the strata in the immediate neighborhood, but still largely imported from the head-waters of rivers and smaller streams. Soil composed wholly of materials from a single rock formation is, as a rule, not remarkable for fertility, while a soil made up from many different formations is, as a rule, fertile; hence the remarkable productiveness of bottom lands. Each overflow builds up the flood plain and adds to the deposit.

While ancient flood plains of dead rivers and creeks are found on high levels, as in Harrison county, adjoining on the east, it was found in boring the artesian well at Louisville, that at one period the channel of Ohio river was where the city now stands, south of and around the present falls. This channel, now filled up with alluvial sands, gravel and earth, was over 100 feet deep. From a number of test bores, it is known that Ohio river, from near the mouth of Salt creek to its upper tributaries, runs in a valley which has been cut more than 150 feet below the present river bed.

FLUVIATILE DRIFT AND TERRACES.

These deposits form benches on the bluffs of creeks and rivers, and mark the standpoints where for a considerable period such streams flowed at a single level. They range from near the present water level, decreasing in magnitude, to the tops of the highest plateaus, where such streams began their existence in poorly defined channels. Although these terraces are but slightly developed here, on the upper river and in regions covered with heavy deposits, they form remarkable landmarks, and have been noticed as parallel roads on opposite sides of valleys, or as ancient earthworks.

LACUSTRAL BEDS OR LOESS.

The Glacial Period was followed by an oscillation in the earth's crust, depressing areas to the north or elevating those to the south, forming a series of great lakes.

The great southern lake covered considerable sections in Southern Indiana and larger districts to the southwest. A shallow arm reached over part of Crawford county. The peculiar deposit called *Loess* was formed in the waters of this lake or along its shores, and on the banks of quiet, almost currentless rivers which flowed into the lake. This Loess bed consists of impalpable siliceous material and sand,

containing a very small amount of clay, ferric oxide, etc. It is an ash gray color when dry, and forms a compact, retentive soil, well adapted to the growth of grasses; when drained good crops of corn, wheat, oats, etc., are produced. It is especially suited to fruit. Persimmon trees flourish on this soil. Animal and vegetable remains found in this deposit indicate a tropical warmth similar to the present climate of Cuba and Central Mexico.

GLACIAL DRIFT.

Preceding the Lacustral period occurred the Glacial or "Great Ice Age." Intense cold prevailed, accompanied with heavy precipitation of moisture. Existing facts show that the northern and central parts of the State were covered with a great sheet of ice, hundreds of miles in width, more than a thousand miles long, and from one hundred to four hundred feet thick. Alternations of temperature, slight warmth and intense cold, gave this glacier a motion from the center of extreme cold toward the south. Having its initial impetus among the granitic rocks of northern British America, it carried, clasped firmly to its icy bosom, immense rocks or boulders, gravel, sand and clay. These, thrown off or dropped at the southern, melting foot of the glacier, formed beds ranging in thickness from a few feet to two hundred and fifty feet. This deposit is termed the Boulder Drift. In this county but few indirect evidences exist of the ice age; they consist of minute, well worn pebbles found in the bed or on the banks of Blue river, rolled by the running water along the bottom of that stream, and the dark, hard granitic stones and pebbles found near Ohio river. Still back of the Glacial Age was a long period which, from evidence elsewhere reported, was of temperate if not tropical warmth. The data for the geological history of that period are not well ascertained or studied. A few

facts and deductions may be seen in the Geological Report on Harrison county in this volume.

PALEOZOIC GEOLOGY.

CARBONIFEROUS AGE AND PERIOD.

COAL MEASURES.

The paleozoic rocks have been deposited in an ocean varying from the shore line to miles in depth. The animal remains are almost exclusively marine. The coal measures existing in this county comprise only the Conglomerate Sandrock or lowest bed of that formation. They are the surface rocks in the western part of the county, extending eastward across the center to and into Harrison county. They fill a paleozoic sub-aqueous valley or gulf terminating in a point at the east, but broadly widening and becoming deeper in its western extension.

The Conglomerate (equivalent of the Millstone grit) of English geologists is here a massive or laminated sandstone containing few or none of the pebbles usually characteristic. The material is coarse-grained, requiring a current of some velocity to transport the particles; it generally exhibits much false bedding, indicating a stormy sea with strong waves breaking over the shallows of the shore line. The conditions were unfavorable for the perfect preservation of animal and vegetable remains. Several trunks of *Sigillaria*, *Lepidodendron*, *Stigmaria* and *Calamites* were observed in imperfect condition. Fern fronds and the broad striated leaves of *Cordaites* in fragments were noted, with an excellent specimen of *Trigono-carpum*, by some recognized as the frint of Sigillaria.

Coal A is found near the base of the Conglomerate; it varies from a mere trace to a little over one foot in thickness; is of medium quality, burning with a yellow flame

and sulphurous odor to a red ash, containing much cinder. At other localities it is so impure and pyritous as to be utterly worthless. The outcrops are thin, and can be worked only by stripping. There is no probability of the seam being found of workable thickness in areas of any extent. The supply can only meet a small local demand. At a few points a limestone, carrying fossils, overlies this coal, and generally the superimposed bituminous slate is filled with nodules which contain a few fossils of the Coal Age, as *Productus longispinus, P. semireticulatus, P. cora, Spirifer cameratus, S. lineatus, Athyris subtilita,* with a few gasteropods, etc. In Dubois county, adjoining on the west, a fragment of a giant fish was found at this horizon, and is mentioned by Dr. Newberry in his description of fishes on page 347 of this volume, and known as *Edestes vorax.*

The fire clay, underlying coal A and the occasional seam B, will furnish good material for bricks, tiles and terra cotta work. The scenery is wild, and the surface is a succession of high, steep hills and deep valleys, clothed with a medium sized growth of oak timber.

CHESTER GROUP.

This group is well exhibited. It lies beneath the Coal Measure series with a wide margin extending beyond and bordering them. The rocks vary much at different stations. Two sections nearly alike could not be taken at any stations a few miles apart. The connected section gives the average strata at the southern line of the county and along the northern line of the deep sea valley mentioned heretofore in the extreme northeastern part of this county and in the southern part of Orange. A little north of the center, and especially in the vicinity and east of Mt. Prospect, and thence in the direction of Pilot knob, the Kaskaskia is the only limestone present; the other limerocks and the massive

ledges of sandstone are replaced with soft mud shales. This circumstance shows that limestone forming animals prevailed only along the shore lines in water of a suitable depth, as is the law in the present seas, while the deep central areas were built up more slowly by sedimentary deposits. It will be seen in comparing the thickness of strata here with those of Harrison county that the rocks of each group are here thicker than in that county; or, as we pass from the original shore line near Cincinnati, each succeeding stratum thickens up as it dips to the central ocean depths in south Central Illinois.

The Kaskaskia limestone is everywhere persistent, and is usually rich in characteristic fossils. *Productus, Spirifera Athyris* and *Pentremites* are abundant, as *P. godoni, P. pyriformis, P. obesus, P. sulcatus* and *P. symmetricus. Zaphrentis spinulosus* and the central axes of *Archimedes* are common, with a few Crinoid heads and stems, including specimens of *Poteriocrinus* and *Dichocrinus*. For a more complete statement reference is made to the full list given in report on Harrison county, page 313 of this volume, which includes vegetal as well as animal remains.

Immediately above and below the Kaskaskia rocks are beds of black pyritous shale, which readily and quickly disintegrate on exposure. The destruction or pulverization of these beds forms a dark, tenaceous material, pulverulent when dry, so fully charged with copperas (ferrous sulphate) and other salts that the deposits are quite barren of vegetal growth. These barren spots are locally named "glades." The black, decomposed shale was supposed by some persons to contain a large amount of potash (eighteen per cent.,) and hence would be valuable as a fertilizer for thin soils. Analysis discovers no appreciable amount of alkali in this shale, and on trial it was found to benefit sandy soils just as any clay would, and no more.

The sandstone division is well developed in the outcrop on the river bluff west of Leavenworth, at Indian Hollow. Many of the strata are heavy-bedded or massive. It is an excellent building stone; fresh from the quarry it works soft and hardens on exposure, and may, by skillful workmen, be broken or split in cubes or blocks of any shape and of any desired size. It is a superior grit-stone, and should be utilized.

The limestones at the base of the Chester are argillaceous, contain but few fossils, and are of no great economic value. A coal-bone at this horizon is of great persistence, showing itself in Orange, Lawrence, Owen and other counties. It has attracted the attention of many persons who wished to find coal, and much money has been wasted in shafting and drifting on this stratum. It is of no economic value, and is only useful in pointing out, pretty nearly, the dividing line between the Chester and St. Louis rocks.

ST. LOUIS GROUP.

The heavy-bedded limestones with intercalated beds of clay, belonging to this group, form the lower part of the bluffs of Great Blue river and its tributaries, exposing a considerable thickness at Milltown; thence southwest the exposure is gradually thinned as the strata dips toward the centre of the synclinal axis of the trough in which is deposited the Conglomerate Sandrock, between Wyandotte Cave and Cole's Bridge on Blue river, from whence, rising with the reversed dip, the thickness exposed to view is increased to Ohio river. Passing down the river, around the great Horse Shoe Bend, the St. Louis rocks descend below the level of the water, by reason of the river having its course turned back, or southeastwardly, against the dip of the rocks. It reappears above and below Sheckel's bar, finally disappearing at low water mark at Alton. The strata vary

greatly in thickness and character. A section taken at one point can not be duplicated at any other. At many stations the rocks are so exactly similar to the overlying Chester or the underlying Keokuk limestones, that, from their structure, it will be almost impossible to determine to which group they belong. They are distinguished and determined alone by their fossils. But few of the Coal Measure fossils reach down into the Chester. But few of the Chester animals survived until the coal age, nor are they found in the lower beds. A majority of the St. Louis fossils are peculiar to the conditions which prevailed during that period, and are not found, in any case whatever, in more recent or older rocks—in higher or lower strata.

The buff magnesian limestone which is found twenty to forty feet below the top of the St. Louis is equivalent to the New Salisbury quarry in Harrison county, mentioned by Dr. David Dale Owen, on account of the facility with which it may be cut or sawed when fresh from the quarry. Specimens seen in use at Corydon Court House indicate that it hardens on exposure and wears well. It has been suggested that it would, with proper manipulation, make a natural cement without burning; for chemical composition see "Natural Cement," in "Table of Analyses," page 83 of this volume.

The white oolitic limestone has long been well known for the superior pure white lime it yields when burned. Chemical analysis shows this to be an almost absolutely pure carbonate of lime. Its most valuable quality is for building purposes. It is homogeneous, elastic, capable of bearing heavy burdens, and the delicate creamy white color will effectively contrast with other available material.

In years gone by, when flat boats were the principal means of transportation, large quantities of this stone were

calcined and shipped to New Orleans for clarifying sugar and other purposes on the southern plantations. At present this highly remunerative business is entirely neglected.

The fossils of this group are not abundant as they were found in Harrison county, in the report of which a full list is given.

Aulopora, Syringopora, Zaphrentis and *Lithostrotion proliferum* were common, while *L. canadense* was but rarely seen; many *Bryozoans* and *Favestella* were observed, all in fragmentary condition; crinoid heads were not abundant, but included the following genera: *Dichocrinus, Batocrinus, Zeacrinus* and *Poteriocrinus missouriensis, Pentremites conoideus* and *P. koninckianus,* which are peculiar to this group, were found in almost every outcrop. *Streptorhynchus, Orthis, Productus cora, P. punctatus, P. altonensis, Spirifer keokuk, S. pseudo-lineatus, S. suborbicularis, Athyris hirsuta, A. royissii, Retzia, Rhynchonella,* and *Terebratula; Lamellibranchs* were uncommon; *Allorisma* were found only in a broken condition; and, in fact, all frail shells, especially *Gasteropods,* were seen only in minute pieces.

A single well preserved specimen of a tribolite (*Phillipsia*) was exhibited by Dr. Hawn from the St. Louis division of the Leavenworth bluff. The paucity of fossils, compared with Harrison county, may possibly be attributed to the fact that these rocks were deposited farther from the shore line to the east, of the St. Louis ocean, in a sea rapidly deepening toward the central areas, and that here the depths were too great for the survival of many animals which flourished in a zone or level nearer the surface.

The rocks of the Keokuk and Knobstone groups and the Hamilton beds of Devonian age are not exposed, but occur in regular descending sequence, as noted in the Connected section, and as found in the different deep wells bored at many different stations throughout the county.

The following table of altitudes is based on the levels of Ellett's survey of Ohio river and other western streams. The altitudes given are calculated from a single set of uncompensated barometric observations and are, therefore, liable to error. Those on the line of the proposed Air Line Railroad are exceptions, and were copied from the field-notes of the engineers of the railway:

TABLE OF ALTITUDES.

Points of Observation.	Low Water.	Ocean
Leavenworth, low water in Ohio river	.....	303
Leavenworth, high water	70	373
Leavenworth, Kelso Knob	425	728
Milltown, Blue river	89	392
Milltown, west bank	120	323
Milltown, railroad grade	132	485
Whisky run, second crossing	170	473
Thirty-mile summit	168	471
Hartford	92	395
Little Blue river valley	75	378
County line, west side, railroad crossing	397	700
County line, west side, on hill top	415	718
Knight's hill	525	828
Ott's well	197	500
Pilot Knob	587	890
Tar Spring	303	606
Fessler Knob	497	800
Chestnut oak ridge	570	873
T. Robinson's, Loess	420	723
Eaton sulphur well	80	383
W. P. Everden's residence	453	756
Lacustral loess	.....	735
Lacustral loess	.....	725
Lacustral loess	.....	750
Lacustral loess	.....	710
Wyandotte Cave House	270	573
Loess ridge north of cave	440	743

LOCAL DETAILS.

Leavenworth, the seat of justice and commercial centre of the county, is situated on the north bank of Ohio river, and is a landing point for the mail and packet steamers. Wharf-boats and warehouses are arranged for receiving and

shipping merchandise and farm products. The principal articles of export are staves, oak lumber, corn, wheat, hay, onions, potatoes and nuts.

A bold, precipitous bluff presents a mural background, and from a little distance seems to overhang the town. The river approaches with a northwesterly course and, striking against a sandrock wall at Indian Hollow and Fredonia, sharply turns about to southeast, so that the signals of ascending steamers may be heard for hours before they are in sight. The bluffs on each side are equally marked and precipitous, and so closely approach as to show that Ohio river is here presented flowing in a canon-like valley, so narrow that in time of high water the confined river rises to an extreme hight. Nathan M. Morgan, Esq., who has resided here since 1824 and observed the periodic overflows, reports that the flood of 1832 was the highest known, and that it reached a point sixty-nine feet eight inches above low water of September, 1833. The high water of 1828 was eight feet lower, that of 1851–2 seven feet six inches, and that of 1847 ten inches lower than that of 1832. The low water point during the drought of 1848 was ten inches above the extreme low water of 1833. At a medium stage, ten feet above low water, the width of the river at Leavenworth is 1920 feet, and of the valley, from bluff to bluff, 3,960 feet.

During the oil excitement a bore was put down in the eastern part of the town to a depth of 235 feet, which discharges a small amount of sulphuretted, chalybeate water; if the bore had been continued to a greater depth it is probable that it would have reached the level of the white sulphur water, so delightful and healthful for drinking and bathing. In the western part of the town, in a secluded cove, a blue spring boils up from its cavernous home in the underlying rocks, forming a well over three feet in diameter,

and flows away with a rapid current. After a heavy rain the spring is changed to a violent spouting torrent. The banks of the Cave spring and adjoining alluvial lands are shaded with black walnut and honey locust trees, which are covered with the parasitic mistletoe in sufficient abundance for all lovers' escapades.

The outcrop on the hill above the Blue spring, taken at the best exposed points, gives the following:

SECTION AT LEAVENWORTH.

		Ft.
	COAL MEASURES.	
1.	Sandy soil	6
2.	Conglomerate shaly sandstone	43
3.	Conglomerate, massive, ferruginous sandstone	9
	CHESTER GROUP.	
4.	Kaskaskia limestone, with fossils	17
5.	Covered clay shale	11
6.	Clinky red limestone	9
7.	Pyritous shale	19
8.	Sandstone, with much false bedding	8
9.	Blue argillaceous limestone, with fossils	21
10.	Shales and thin sandstone	18
11.	Coarse and fossiliferous limestone	9
12.	Siliceous and clay shale	18
13.	Sandstone, good grits	6
14.	Siliceous and clay shale, with fossils	19
15.	Brown argillaceous limestone, with Chester fossils	11
16.	Siliceous shale, with plates of sandstone	5
17.	Soft, coarse, yellow sandstone	6
18.	Argillaceous limestone, with bands and pockets of chert and fossils	25
19.	Coal bone	2 inches
20.	Siliceous limestone and argillite	2

ST. LOUIS GROUP.

21.	Brown pyritiferous limestone	1
22.	Gray limestone, with pockets of flint	14
23.	Buff magnesian limestone	3
24.	Gray limerock	3
25.	Brown limerock, with plates of flint	23
26.	Buff argillite	4
27.	Siliceous argillite	5
28.	Gray lithographic stone	21
29.	Buff magnesian limestone	4
30.	Hard brown limerock	48
31.	White *oolitic* limestone	3
32.	Covered to low water in river	45
	Total	436

No. 4 of the above section contains *Pentremites sulcatus, P. pyriformis, P. Globosus, Productus cora, Zaphrentis spinulosus* and *Archimedes.*

No. 9 contains *Pentremites pyriformis, P. sulcatus, P. godoni, Zaphrentis spinulosa, Chonetes, Spirifer keokuk, S. kentuckensis, S. lineatus, Productus punctatus, P. cora, P. semireticulatus, Athyris subquadrata, Terebratula bovidens, Archimedes* and *Bryozoans.*

No. 18 contains *Athyris, Spirifera, Terebratula, Producta* and *Streptorhynchus.*

A good bed of Chester fossils are exposed at the top of Cole's hill, west of the cemetery, and near the graded school. The following named St. Louis fossils were observed in the white oolitic bed and adjoining strata: *Streptorhynchus crenistriatus, Orthis dubia, Productus cora, P. punctatus, Spirifer keokuk, S. pseudo-lineatus, Athyris hirsuta, A. royissi, Terebratula formosa, Euomphalus spergenensis, Cyclonema leavenworthana, Phillipsia, Cythene, Pentremites conoideus* and *P. koninckiana.*

The summit of Leavenworth hill is known as Kelso's Knob. The soil is warm and sandy and well adapted to

the growth of tender fruits and flowers. The view comprises the great ox-bow bend, where the river seems mapped on the deep valley, over 400 feet below, and the isolated knobs, ten miles distant, are so relieved by contrast with the sky as to appear close at hand.

East of the town, 215 feet above low water in the river, the parting of "coal bone," which occurs so persistently near the junction of the Chester and St. Louis groups, is exposed. About the year 1851 the citizens made up a subscription and employed a practical miner to drivé an entry two hundred feet back on the seam, hoping, without reason, that it would thicken up under the hill, but, to their disappointment, it nowhere reached a greater thickness than two inches. There is no workable coal at this horizon.

On the land of O. S. Leavenworth, on the high bluff at the mouth of Blue river, the massive sandstone of the Chester group furnished choice blocks of stone for the piers of a bridge over Dry run. The following section was taken at this point:

SECTION AT O. S. LEAVENWORTH'S.

	Ft.
Slope	30
Hard limestone	11
Shale	10
Red limestone	3
Blue and red shale	18
Chester limestone	12
Clay and shale	3
Quarry sandrock with Stigmaria	8
Limestone and shale	12
Coal bone	trace
St. Louis limestone and clays	226
	333

At Indian Hollow, over a mile below town, the Chester sandstone, which at Leavenworth is only a few feet thick or scattered in thin strata of siliceous shales, are here brought

together and form a cliff of valuable sandrock, which opens to deep, navigable water of Ohio river. The dip of the rocks from Leavenworth to this point is at the rate of sixty feet to the mile, so that the equivalent strata are here more than eighty feet nearer the water level. The following strata were seen:

SECTION AT INDIAN HOLLOW.

	Ft.
Sandy loam	15
Conglomerate sandstone and shales	50
Kaskaskia limestone and shales	65
Laminated sandstone in quarry beds	30
Chester limestone and shale	46
Massive, quarry sandrock—gritstone	40
Shaly sandstone	12
Chester limestone	77
St. Louis, covered	25
Total	360

This bed of sandrock is of excellent quality for foundations, piers, breakwaters, and makes good grindstones. It may be readily broken or split to any desired shape. Exposed surfaces of this rock, 100 to 150 feet above the present level of the streams were heavily cut and moulded ages ago. The faithfulness with which they are preserved show the enduring qualities of this stone under a diversity of circumstances and ages of time; not less significant is the fact that perpendicular faces are covered with mosses and clinging lichens, not seen on perishable rocks.

The Hollow was a favorite resort of the Indians, and at the top of the hill treasure hunters have opened many stone graves. Broken flint implements are strewn over the ground.

Needham's quarry, on section 1, township 4, range 1 east, just below, presents nearly the same outcrops. It opens its massive bed of sandrock, forty feet thick, immediately upon the navigable waters of Ohio river. It is excellent stone, and may be sawed, split or broken into blocks from one to twenty or more feet square. It was formerly worked by

chisel, saw and lathe, by a Louisville firm, and has been used for grindstones on farms and in machine shops, in sizes from one to ten feet in diameter, and gave good satisfaction. The lower bed is slightly ferruginous, and, although soft in the quarry bed, soon hardens on exposure. Its fire and waterproof qualities make it of great value as a building material. The precipitous bank retains corrugations made by Ohio river at points 160 to 190 feet above its present level, which are unimpeachable witnesses of the enduring nature of the stone.

Fredonia was formerly the county seat. It is surrounded by a fertile *Loess* plain, level as a prairie, and extends with scarcely a break to Grantsburg, Springtown, Milltown and Wyandotte. A high bluff separates the village from the river, in which many well preserved fossils occur. Near the top of the hill the Conglomerate Sandrock exhibits much false bedding with water-faces to the southwest, indicating that the deep center of the sea in which it was deposited to have been in that direction. The Chester sandstone near the base of the bluff has long been worked by Mr. Chandler, who manufactures grindstones of excellent quality.

SECTION AT FREDONIA.

	Ft.
Soil	12
Soft, flaggy, Conglomerate sandstone	33
Kaskaskia limestone	20
Sandstone	16
Shaly sandstone	25
Shale	5
Argillaceous limestone	13
Siliceous shale	25
Hard, blue limestone	7
Shale and sandstone	28
Fossiliferous shale	7
"Nigger-head" limestone	14
Coal bone	trace
Black slate	1
Siliceous shale	3
St. Louis limestone to low water	90
	299

From the bluff near Schooner point three notches or low places were observed cut across the narrow promontory which here juts out into Ohio river; on examination these were found to be water worn, and were probably once the beds, respectively, of Blue river, Indian and Potato creeks, when all these streams flowed at a much higher level than now. From stratigraphic reasons it was believed that from fifteen to twenty feet of St. Louis limestone was exposed at this place above the medium stage of the river, but not one fossil was seen to determine the question.

Alton, at the mouth of Little Blue river, is the trading point for a large region north and west. The St. Louis beds were observed at extreme low water line, passing below the water surface. The following section occurs a little over half a mile below the village on the river bluff:

SECTION AT ALTON.

	Ft.
Conglomerate sandrock and soil	50
Kaskaskia limestone, with *Pentremites* and *Dichocrinus*	39
Black shale (marl?)	45
Yellow argillaceous limestone	13
Siliceous shale and flagstones	40
Flaggy limestone	21
Massive red sandrock	32
Gray limestone, with *Athyris, Producta, Spirifera, Terebratula* and *Rhynchonella*	22
Shaly slope	20
Brown limerock	28
Heavy sandstone	27
Blue shale	9
Heavy gray limerock	18
Shale, with fossils	3
Sandrock, with *Stigmaria*	3
Coarse red limestone	8
Coal bone	4 inches
Siliceous limestone to low water in Ohio river	6
	384

The upland soil in this vicinity, as well as much of that on the rolling land in the west part of the county, being composed wholly of siliceous material derived from decomposition of the local sandstones, contains little else than sand more or less pulverized. It is therefore deficient in soluble silica, and can be made available as plant food only by preparation of organic matter or by the addition of alkalies. Limestone is present in all deep vallies, with plenty of wood for burning. It offers a cheap fertilizer. Mr. H. B. Maylin, of Alton, applied forty bushels of lime per acre on a valley field which had produced eight to ten bushels of wheat to the acre. Although no marked increase was apparent the first year, the second crop after liming was more than double, or twenty-five bushels, with a similar improvement in the corn crop. Repeated trials show that such increased productiveness is reliable. The lime is equally remunerative when applied to grass or clover.

At the point where the road leading west from Leavenworth crosses Little Blue river the following section was seen:

SECTION ON LITTLE BLUE RIVER.

	Ft.
Conglomerate sandrock	40
Kaskaskia limestone	12
Chester sandstone and shale	80
	132

Eaton's white sulphur well, on section 35, township 3, range 1 west, was bored in the years 1862–3. It is four inches in diameter and 284 feet.

SECTION IN EATON'S SULPHUR WELL.

	Ft.
Soil, level of Kaskaskia limestone	21
Chester sandstone and shale	175
Chester and St. Louis limestone, with many clay partings	88
	284

The water from this well bursts up with violence; when tubed it raised to the top of the derrick, thirty-five feet, and could not be forced through a two inch pipe. It is highly charged with sulphuretted hydrogen and deposits a white sulphurous sediment. Temperature, 59° F. For medicinal purposes it is best fresh from the well, when charged with accompanying gases. The curative qualities of the water have been thoroughly tested for more than ten years. A resident physician declares it to be a specific for dyspepsia, rheumatism, incipient scrofula, constipation and skin, kidney and womb diseases. The flow of water is sufficient for bottling and other uses for five thousand persons. The present accommodations have a capacity to accommodate only from fifty to sixty persons. The well is eight miles west of Leavenworth and nine miles northwest of Alton. Half a mile west from the hotel is a good exposure of strata above the top of the bore.

BLUFF SECTION AT EATON'S WELL.	Ft.
Conglomerate	40
Shale	8
Kaskaskia limestone, with fossils	4
Chester sandstone and shale	20
	72

Mr. J. J. Clark gives the following statement of strata passed through in Clark's well on section 28, township 3, range 1 west, near Marietta:

SECTION IN CLARK'S WELLS.	Ft.
Kaskaskia limestone	6
"Red keil"—decomposed shale	7
Blue Chester limestone	20
Gray shale	8
White flint	3
Limestone, with clay partings	6
Coal bone and bituminous slate	1
Soft clay shale	7
Limestone, with siliceous and argillaceous shale	350
Burning gas	.....
Knob shale and sandstone	240
Salt water and small quantity of petroleum	.....
	648

The ascent from Sulphur Well post office to Fessler's Knob and Chestnut Oak ridge is steep; the scenery mountainous, with a wide view south and east. The elevation of 570 feet above Ohio river mitigates changes of temperature so as to insure tender fruits against sudden cold snaps. On all knobs and elevations having a hight of 400 to 500 feet above the river the trees were loaded with fruit. Few or no peaches were seen lower than 300 to 350 feet above the river.

SECTION AT CHESTNUT OAK RIDGE.

	Ft.
Conglomerate sandrock	110
Kaskaskia limestone	12
Chester sandstone and shale	90
	212

The "Tar Springs," on land of L. D. Parker, southeast quarter of section 15, township 3, range 1 west, is one of the noted localities of Indiana. During the oil excitement of 1862–66 it was the Mecca of petroleum seekers. Two weak springs have outlets from beneath the Kaskaskia limestone, just below a bed of Conglomerate, in a deep, wild valley. The west spring discharges with its waters coal tar and carburetted hydrogen; the outlet is in a basin trough, built up on the rocks, of earth cemented with the deposited asphaltum. The east spring, thirteen feet distant from the last, discharges water and petroleum, with a small quantity of carburetted hydrogen gas. Both are strong flowing fountains during rainy weather, but are weak during dry seasons.

Some instinct of nature, or reason attracts all domestic animals to these springs; in malarial seasons hogs and cattle will break from enclosures and go miles to obtain the water, while pure spring and brook water is plentiful nearer by. There is no saline taste perceptible, but we may infer

that there is some remedial effect experienced by the animals after drinking it. I am informed by Mr. T. Roberson that domestic animals not only drink the water greedily, but when foot and mouth diseases are prevalent they manifest a desire to bathe the diseased parts in the oily fluid. It is probable that this spring and other "oil seeps" induced the boring of the six wells which were put down during the "oil fever."

Near Union precinct the hills are Conglomerate, the Kaskaskia division of the Chester generally showing in the valleys with characteristic fossils. The table lands are of brown Loess soil, and the fine farms of Warren Roberson and E. Finch showed good cultivation and fair crops; their orchards were in good condition and loaded with fruit. Evergreen laurel (?) was seen growing luxuriantly on the steep, conglomerate hills.

Orchard grass flourishes well on this soil. Thomas Roberson, Esq., settled here in 1836, and in 1857 seeded eight acres with this grass; it produces good hay, gives extra early, continued pasture, and withstands drought; this plat of grass has been closely cut for twenty-one years, and indicates a permanent sward, which no other grass can form here. He finds it necessary to sow at least two bushels of seed per acre.

Johnson and Patoka townships occupy the extreme western part of the county. The surface rocks are Conglomerate sandstone. Nearly all the creeks and brooks of any size cut their deep valleys through the surface rock down to and sometimes through the Kaskaskia division of the Chester group and at several stations, as on section 15, north of Down Hill, and on section 31, northwest of Brownstown, characteristic fossils are abundant, such as axes of *Archimedes, Athyris subquadrata, Zaphrentis spinulosa,* crinoid stems and plates, *Dichocrinus sexlobatus, Pentremites obesus,*

P. pyriformis, P. godoni, P. sulcatus, P. cervinus, P. symmetricus, etc. The fossils are often in an excellent state of preservation, and of unusual size and beauty.

The Conglomerate contains, as a rule, only the trunks of *Lepidodendron, Sigillaria* and *Stigmaria,* presenting casts of the curious external markings with perfect fidelity. A single specimen of *Trigonocarpum olivæformis,* from the vicinity of Down Hill, exhibited by Dr. Hawn, showed the tri-lobed husk and stem attachment of this fruit of the Carboniferous age. Thin outcrops of coal A, the lowest seam in the Indiana series, have been opened in the district south of Wickliffe, but at no point did they find an area of workable thickness. This seam is not reliable; if thick at one point it soon thins out, and does not average anywhere in the Indiana coal field a thickness of more than six inches. Labor or money expended in pursuit of this coal will bring little or no return. At the openings examined the seam was from six to twelve inches thick. Coal A has been worked for local use at the following places in this county:

	Ft.	In.
Knight's, on S. 25, T. 2, R. 2 W., thickness	0	6
Knight's, on S. 25, T. 2, R. 2 W., thickness	1	0
Mullen, on S. 26, T. 2, R. 2 W., thickness	0	8
Speedy, on S. 3, T. 2, R. 2 W., thickness	1	0
Denbo, on S. 12, T. 2, R. 2 W., thickness	0	6
Average thickness, nearly		8½

The following section was taken on southwest quarter, section 25, township 2 south, range 2 west:

SECTION AT KNIGHT'S.

	Ft.
Slope and Conglomerate sandrock	120
Pebbly flagstones	5
Shale and plant remains	5
Coal A, glossy, caking, with cubical fracture	1
Fire clay, or potters clay, with Stigmaria	3
Bituminous and pyritous shale	35
Place of Kaskaskia limestone	9
Chester shale and sandstone to creek	100
	278

Ott's well, at Mifflin, was bored for oil in the years 1864–5, to a depth of 1,165 feet, where a strong brine was found, which flows out, carrying with it a small quantity of petroleum. In settled weather the stream of water will pass through a one-inch orifice, but at low barometer, just before a storm or change in the weather, the gas rushes up, and with a loud, blowing noise, throws out several spurting spouts of water a few feet upward. The petroleum is used locally as a specific for cutaneous diseases on man or beast, as itch, grubs, scratches and sore eyes. Twelve gallons of the salt water made nine pounds of salt, and when pumped the amount of water was 22,400 gallons per day, which, if evaporated, ought to have yielded 16,800 pounds of salt. The actual result was only ten barrels of salt a day, with well arranged evaporating pans and fixtures.

Malachi Ott, Esq., furnished the following statement of the bore:

SECTION AT OTT'S WELL.

	Ft.
Chester limestone and sandstone	120
Petroleum and coal bone	4 inches
Chester limestone	70
St. Louis limestone	250
St. Louis black cement	30
St. Louis gray limestone	30
Keokuk and Burlington (?) rocks	80
Knob shale and sandstone, with ironstones	490
Black Devonian slate, with gas and petroleum	110
	1,180

A short distance north of the village is a boldly escarped outcrop of Conglomerate sandstone, projecting far enough to form a wide rock-house cave, which, from the ashes, flint and stone implements found within, has been used as a shelter by the Indians. Evergreen laurels along the pathway concealed the approach as well as the occupants.

ROCK HOUSE SECTION.

	Ft.
Slope and sandstone	80
Massive Conglomerate	50
Place of coal A	...
Pyritous shale	25
Kaskaskia limestone	22
Chester shale and limestone	40
	216

The Rock House was found to be three hundred feet long and averaged fifteen feet deep. The Indian use of this house is indicated by the great number of flint chips, broken knives, scrapers, etc. Along the front edge were many large blocks of sandrock, fallen from the roof, in which were pit holes, called "Indian mortars," drilled by grains of sand and dripping water; they were from two to seven inches deep. One drilled through the stone eight inches deep showed a side discharge or waste for the cutting water; another, fourteen deep and seven inches in diameter at the top, tapered to less than two inches at the bottom.

Benham's salt well, a short distance away, was bored about the same time as Ott's, and for the same purpose. The brine showed a fair strength, and a full plant for evaporation was put up, but after a thorough test it was found that the returns would not pay expenses, and the project was abandoned.

SECTION AT BENHAM'S WELL.

	Ft.
Soil	12
Chester and St. Louis sandstone	488
Knob shale and sandstone	350
	850

The first symptoms of gas and petroleum were met at a depth of 135 feet, and salt brine at about 690 feet.

The artesian flow of water is continuous, accompanied with fine bubbles of gas and oil in small quantities. Continued pumping did not increase the flow of brine or oil. From the many carefully conducted tests made in this county we may infer that the quantity of petroleum is limited, and that further search for it will be attended with loss of time and money. Analyses of these mineral waters will be given in the economical geology of this county.

Grantsburg is a thrifty village on the high eastern bluff of Little Blue river. The valley hills are built up of Chester shales and limestone. The Kaskaskia limestone, with *Archimedes, Zaphrentis, Athyris* and *Pentremites,* is seen near the surface. Sipes' Knob, adjoining on the east, is capped with Conglomerate sandrock carrying coal A in isolated pockets. From this knob a good view is had of the Loess plain to the east, north and southeast, and of distant landmarks.

Hartford is pleasantly situated in the deep valley where two streams unite to form Little Blue river. The town is surrounded by a rich agricultural region. The narrow valleys of the streams, walled with precipitous or overhanging bluffs, gives many wild scenes full of romantic beauty. The forests contain a good proportion of beech, sugar maple and oak trees, indicating an excellent soil, while, towering above all, giant poplars add beauty and value.

The sulphur well, adjoining the town, is worthy of the high character it has justly earned. Almost every citizen and neighbor will bear witness to its efficacy in chronic diseases. For an analysis of this water see analyses of Crawford county mineral waters in this volume.

The table-land and elevated plateaus are capped with Conglomerate sandrock. The surface limestones are of the upper division of the Chester group, with *Archimedes, Zaph-*

rentis, Athyris, Productus, Terebratula, Bellerophon, Pentremites godoni, P. pyriformis, and sharks' teeth.

SECTION AT HARTFORD.

(Sec. 24, Town. 2 south, Range 1 west.)

	Ft.
Slope	20
Soft Conglomerate sandstone	40
Dark shales, place of coal A	20
Kaskaskia limestone, with fossils	10
Red and black shales (*marl?*)	20
Brown limestone	4
Chester sandstone and limestone to creek	30
	144

The Kaskaskia limestone of the above section contains *Zaphrentis spinulosus, Pentremites pyriformis, P. globosus, Spirifer striatus, S. lineatus* and *Dichocrinus corniger.*

Brownstown (Mt. Prospect post office) is at the bottom of a deep cross valley eroded in the shaly strata of the Chester group, which here replaces the massive bands of sandstone seen elsewhere. This change is remarkable, and seems to indicate that near the central depths of the Chester sea only mud deposits were made, and that limestone was found only in moderate depths along the shore or shallow water line at the north and south sides of this Carboniferous gulf, which crosses this county from west to east, and extending a short distance into Harrison county.

Three miles west of the village, on A. L. Whitcomb's land, on section 1, township 2, range 2 west, is a bed of fine whetstone grit, similar and equal to the Hindostan stone of world-wide reputation.

SECTION AT KING'S WHETSTONE QUARRY.

	Ft.
Conglomerate sandrock	80
Grindstone bands	10
Blue calcareous oil stone (iron ore)	2
Fine whetstone bed in thin laminæ	6
Shale	12
Coal A	2 inches
	110

The whetstone deposits, by lamination, separate naturally into divisions most suitable for use and reduces the labor of manufacture to the lowest cost. The whetstone grits were noticed extending along an east-southeast line for over two miles.

A bed of yellow, white and red sand was seen in the southwest quarter of section 34, east of town, which shows a thickness of ten feet. It is formed from soft, coarse, Conglomerate sandrock in a state of disintegration; it is used for plastering, and with transportation could be utilized for glass making. Several beds of white, plastic, potter's clay, free from grit, also occur in this vicinity.

Lambden's peak is a high, sharp, conical hill, a witness of former denuding forces, which removed the great mass of companion rocks, leaving this isolated monument. The outlook from the peak is grand, embracing part of the Loess plain and distant valleys of this and Orange county. It is capped with Conglomerate sandrock, supported by Chester shales and soft sandstone. The strata, beginning at Brownstown and continuing to the summit, is given:

LAMBDEN'S PEAK—BROWNSTOWN SECTION.

(Sec. 31, 32, 35, 36, Town. 15, Range 1 east and 1 west.)

	Ft.
Sandy slope	10
Soft Conglomerate	20
Pyritous black shale	12
Kaskaskia limestone, with *Pentremites obesus*	15
Pyritous black shale	18
Chester shale and thin plates of sandstone	140
Massive Chester sandrock	35
Chester and St. Louis limestone	70
	220

This peak gave name to the post office—Mt. Prospect—on account of the extensive and picturesque view afforded from the top.

Springtown—Marengo postoffice—is a thriving village on Whisky run. Stores, mills, mechanical and manufacturing establishments are well represented. A well-conducted academy for students of both sexes receives, as it deserves, good attendance. The village takes its name from the grand springs which flow out from cavernous openings on the north side of Main street, the central feature of the community. The principle cave has an entrance six and a half feet high and thirty feet wide, and has been explored by a good passage-way in dry weather, a distance of half a mile. The are several large pillared stalactites, with many smaller ones. The lower cave gives discharge to a large stream of water, in which many goggle-eye fishes stay during winter. The temperature is pretty uniform at 52° F.; on this account, and because of the antiseptic quality of the dry atmosphere, the cave is the village storehouse for fruits, potatoes, meats, etc. The surface rocks of the vicinity are Chester shales and sandstone, with St. Louis limestone in deep valleys and in the bed of Whisky run. The coal noticed on Parker's land is an outlier of no economic value. Pankey's cave contains interesting forms of subterranean life worthy the attention of visitors.

Milltown owes its importance to the well equipped mill which is driven by the full power of Blue river. The Chester sandstone caps the tops of the surrounding hills, 300 feet above the river, and is of good quality for piers and heavy masonry. Some of the strata afford excellent gritstones. The St. Louis limestone forms the bed-rock of the river; the exposed rocks below the mill contain pockets and bands of chert and flint, and were in places crowded with *Lithostrotion canadense* and *L. proliferum*, the latter with solitary or clustered calyces. Fine specimens of fluor spar and calcareous spar were seen, and on many of the flints the green stain of copper.

SECTION AT MILLTOWN.

	Ft.
Chester limestone and sandstone	25
Brecciated limestone	5
Brecciated limestone, St. Louis fossils, including *Bellerophon*, *Athyris*, *Zaphrentis* and *Pentremites conoideus*	6
Gray clay shale	9
Brittle columnar limestone	7
Buff, clay shale	8
Lithographic flagstone	7
Massive, gray, argillaceous limestone	14
Massive, buff, or argillaceous limestone	6
Gray oolitic limestone	5
Hard vermicular limestone	6
Argillaceous limestone	5
Clay shale, covered	15
Blue cherty limestone	18
	136

The blue cherty limestone in the bottom of the above section contains *Producta, Spirifera, Retzia, Athyris, Myalina, Streptorhynchus, Pentremites conoideus, Zeacrinus armiger* and *Lithostrotion.*

On land of George D. Gibbs, section 32, township 2 south, range 2 east, Chester sandrock caps the hills, and St. Louis limestone forms the slopes and bedrocks of the valleys. At the road-side there is a magnificent bed of oolitic limestone, apparently twelve to fifteen feet thick; and at several neighboring points similar beds, ten to twelve feet thick, were reported. This stone is of excellent quality, and were transportation at hand it would command a large market and good prices.

Pilot Knob was an island in the ancient lake, in the bed or on the sides of which the Loess was deposited. From evidences found in counties to the north, this grand sheet of still water, covering southwestern Indiana and more extensive regions to the west and southwest, was later than the great Ice Age, for its deposits superimpose the true Boulder

Drift. The animal and vegetal remains indicate a tropical temperature. The knob overlooks much of the Loess plateau and affords, from its isolated and monumental position, a highly interesting view from its summit. The Muldraugh (Ky.) knobs are seen like cones piercing the sky twenty-eight miles distant. Seven huge peaks guard the west line of the county, twelve to fifteen miles to the southwest; and on a clear day another range, twelve to twenty miles away, rises up in Perry county; and other peaks, north of Grantsburg, are recognized, although nine miles distant. It is a favorite resort for picnic parties.

SECTION AT PILOT KNOB.

(Sec. 36, Town. 2 south, Range 1 east.)

	Ft.
Soft, disintegrating, Conglomerate sandrock	60
Bituminous shale, with clay iron stones	18
Place of coal A	
Fire clay and shale	12
Kaskaskia limestone	8
	98

The Conglomerate is so nearly resolved to coarse grains of sand that on exposure it is at once reduced and affords superior, sharp, clean sand, and is largely used for masonry and plastering.

From Pilot Knob to Leavenworth the road passes by White Oak Hill, section 1, township 3 south, range 1 east, which is nearly as high as the Pilot, over the fine lacustral lands, so marked a feature in this elevated table land. The farm of W. P. Everden is a choice specimen of this soil, under intelligent and vigorous management. Good crops of hay, wheat and grass are annually secured; he has an orchard of thirty-one acres, including the best varieties of budded apples and peaches; his 1,500 bearing trees yield a handsome income.

The oolitic limestone crops out on Dry run, and on Mrs. Humphrey's land, adjoining, is an excellent bed of paving stones, two to four inches thick; they contain enough siliceous material to prove very enduring; many of the flags are curiously mottled with ripple marks.

At Magnolia several outcrops of coal A occur at the base of the overhanging Conglomerate sandrock. The seam is here from four to ten inches thick. There is no seam of coal below this, and no probability of finding this one of workable thickness, even in small pockets.

SECTION AT MAGNOLIA.

	Ft.
Stratified sandstone	70
Massive Conglomerate	30
Coal A	1
Chester and Kaskaskia limestones	11
	112

WYANDOTTE CAVE.

The history of caves verges on the realm of mystery. The unknown is always full of wonder; solemn silence, utter darkness and a chilly atmosphere have weird attractions. In song, tradition, story and religious teachings every age has borrowed illustrations and incidents from such dim, uncertain homes of darkness, peopling them with all that a wild imagination can create or desire.

The Ecclesiastical Encyclopedia says "the geological formation of Syria is highly favorable to the production of caves. It consists of limestones of different degrees of density, and abounds with subterranean rivulets. The subordinate strata, sandstone, chalk, basalt, natron, etc., favor the formation of caves, consequently the whole region abounds in subterranean hollows of different dimensions. Strabo speaks of a cavern near Damascus capable of holding four thousand men; it is seen at this day. Modern travels

abound in descriptions of the Syrian caves, and the Crusaders relate the marvels of the land of caves. One, near Aleppo, it is said, would hold three thousand horse. Another, near Sidon, is described as containing two hundred smaller caverns and dens. Holes and caves were numerous in the sea coast mountains, extending through a long range on each side of Joppa.

The first mention of a cave, in Scripture, relates to that into which Lot and his family retired from Zoar after the destruction of Sodom and Gomorra. The next is the cave of Macpela, which Abraham purchased to sepulture his dead, in which his ashes rest with that of Rebecca, Leah and Jacob."

The caves of every quarter of the globe have been used as habitations, places of retreat, temples for religious worship, or sepulchres for the dead.

The poetry of ancient Greece and Rome placed some of their holiest shrines and oracles in the shadowy realms whose "conditions" were darkness and obscurity.

The oracles of the Sibyl's cave will live as long as classic story, and Virgil's glimpses of the land of shadows are among the brightest pictures of Augustan story. Some of the most interesting events in the history of Asia, America and Europe are connected with caves—deeds of heart-rending disaster and violence or acts of high faith and devotion.

The St. Louis is called the cavernous limestone on account of the numerous caves which occur in it, and similar calcareous deposits at various places, among which are not only the caverns of Indiana, but also Mammoth Cave in Kentucky, Weyer's Cave in Virginia, Howe's Cave in Scoharie county, New York, Kirkdale in Great Britain, the Grotto of Antiparos in Greece, and the noted caves of Franconia.

Owing to the great thickness of the strata of this group of rocks in America, the caverns are here on a grand scale. This limestone forms the surface rocks in the county of Harrison, adjoining Crawford on the east; dipping at the rate of from ten to forty feet to the mile to the west, it runs below the surface, and is seen only in the hill sides along Big Blue river and the deep valleys of its tributaries. Throughout this region nature has excavated a multitude of underground avenues and canals of all forms and dimensions, branching in endless variety. They did not always exist. The rock is of marine origin and was deposited in the bottom of the Sub-carboniferous ocean, having a probable depth of 1,000 to 2,500 feet. Under the pressure of such a depth of water the material, consisting of comminuted shells of animals and debris, was perfectly compressed before hardening. In the process of upheaval through a space of 2,000 to 3,000 feet, which was over large if not continental areas, checks, cracks and cleavage of the rocks was established. The surface water first found open drains, as rivers, creeks, etc., which cut their channels deeply in the rocks, at many points one hundred to two hundred and fifty feet below the level of the present streams. Then the excavation of the underground seeps and rivulets was begun. A drop of water charged with carbonic acid and other gases from the atmosphere, creeping through the slightest fissure, enlarged it by removing a film of carbonate of lime by forming a soluble bicarbonate. This process, in constant action through ages, enlarged the crevices until drops were followed by seeps, these by imperceptible growth became rivulets, which in the ceaseless round of untiring time expanded to the volume of creeks, and when eons of cycles had grown dim upon the recorded page, that which started as a drop upon the surface, had become a mighty subterranean river.

When such passages become enlarged so that water did not entirely fill the cavernous space, the funnel shaped "sink holes," which dot the whole surface, collected heavy air charged with carbonic acid gas and continued the process already begun. At remote parts of a cave this gas is sometimes found pervading the atmosphere to an almost dangerous extent, hence the "air action" within the cave is more powerful than at the mouth, where pure air has access. Running water, carrying mud or clay, has, at some period in the life of these caves, given its mechanical aid in wearing away the insoluble detritus.

The standpoint of the different stages of these streams may often be seen recorded as niches and mouldings on the walls; round pebbles are also often found on the floorways.

At many localities these pebbles and their matrix of clay indicate the direction which the water flowed and the rate of motion; well rounded pebbles and stones indicate a rapid current; where sand is found the current did not exceed four to five miles an hour, and a bed of clay tells of a slower current or still water. Much of the loose, rocky debris, fallen from the roof or sides, is covered with a coating of carbonate or sulphate of lime.

"When water holding bicarbonate of lime in solution drops slowly from the ceiling, by which it is exposed to the air sufficiently long to allow the escape of one equivalent of carbonic acid gas, the lime is deposited in the form of monocarbonate. If the deposit occurs in such a manner that the accumulation takes place from above, downward, in the form of an icicle, it constitutes what is termed a *stalactite;* but if it forms on the floor of a cave and accumulates from below, upward, it is known as a *stalagmite.* Stalactites and stalagmites frequently meet and connect the roof with the floor, and form a pillar or column of support.

"If the solution which forms the stalactite is free from oxide of iron or mud, it will be translucent, or milk white; the presence of any of the salts of iron gives a dirty yellow, red or dark brown color."

By the decomposition of pyrites (sulphide of iron), gypsum (sulphate of lime) is formed. Gypsum, when calcined and ground, forms the plaster-of-paris of commerce. When it occurs in crystals it is known among mineralogists as *selenite*, and when it occurs in translucent or finely tinted masses it is known as *alabaster*, and is quarried and wrought into vases and other parlor ornaments for the art-loving denizens of the larger cities of this and the old world.

"The decomposition and recombination exerts a marked influence on the appearance of a cave. The chambers or avenues in which gypsum occurs are dry. When rosettes of alabaster are formed in rooms containing stalagmites, the water, which furnished the solid material for the latter, has for ages ceased to flow, as rosettes can not form in a damp atmosphere. The force exerted by gypsum in the act of crystallization is thought to be about equal to that of water when freezing. The formation of saltpetre (nitrate of potash) is by absorption of nitrogen by the dry, porous earth from the atmosphere, assisted by the decomposing remains of bats and other animals. It is in the form of nitrate of lime, which, when reacted upon by the carbonate of potash, forms nitrate of potash or saltpetre."*

Many caves give discharge at their entrances to a strong current of air, in winter warm and in summer cold; that is, at a temperature varying but little from the permanent temperature of the rocks. Such caves are fed with air through open sink-holes, and the heavier cold air sinks to the floor and passes away at the outlet.

*Wright's Guide Manual.

Large caves, which do not have openings by sink-holes, inhale cold air during winter, and on the slight rarifaction of summer heat an outward current is noticed. At the equinoxes there is no current because the internal and external temperature is about the same degree.

The process of enlargement of the caves, already mentioned, by atmospheric action, although slow, is constant. In the course of ages, when the caves became so extended as to be beyond the supporting capacity of the roof, it breaks, and with slow, gentle motion the roof settles down, making a depression on the surface. To such a cause the curious, isolated depressions in Harrison county, named Ripperden, Harrison and Grassy valleys may be referred.

Wyandotte cave is five miles northeast of Leavenworth, the county seat of Crawford county, which is fifty miles below Louisville, Ky., and 126 miles south of Indianapolis, the State capital. For the benefit of persons desiring to visit the cave, it may be well to state that a daily coach starts from New Albany, opposite Louisville, for Corydon, the old State capital. The twenty-mile route is through a country abounding in wild and interesting scenery, including several small caves on the way. From Corydon hacks can be had at all times for the remaining ten miles of the route, so the cave may be reached before night. The Louisville and Evansville line of river packets pass up and down Ohio river daily, with regular landing at Leavenworth, from whence carriages are always ready to carry visitors to the cave. Visitors should be prepared with stout shoes or boots and thick clothes, of sufficient strength and warmth to endure rough treatment and resist the chilling air of the cave, which varies from 55° to 58° F. Ladies would feel more comfortable in a semi-bloomer outfit, as some such protection is necessary when climbing the steep cliffs or crawling through the low avenues.

The road from Leavenworth to the cave winds along the foot of the precipitous, wall-like bluff of Ohio river, which towers up 425 feet above low water, the sides corrugated or banded with massive beds of St. Louis limestone and intercalated partings of clay shale and shaly sandstone, which, by decomposition, give prominence and relief to the mighty cornices and mouldings.

The summit of this bluff, capped with fifty to two hundred feet of sand and limerock, belongs to the Chester group. On the opposite—Kentucky—shore of Ohio river, similar precipices wall the whole valley, which from the hill-tops looks like a narrow canon, but which really comprises the fine farms and beautiful homes of the Leavenworth family, who were early New England pioneers in this region.

At the mouth of Big Blue river are two islands, on one of which occurred the Hines defeat during the late civil war.

To this beautiful silver-rippling stream a former tribe of Indians gave their own poetic name, WYANDOTTE; and although the name will live with American history, the last vestige of that once powerful tribe long since embarked for the "happy hunting ground."

The stream was subsequently called "Blue river," because of the singular purity of the water, which gives, at great depths, that peculiar azure tint which the immense depths of air give to the sky. The water owes its purity to the fact that much of it is from cave springs which are fed by subterranean streams, flowing across pools and basins in the caverns, and comes out free from sediment, sparkling and bright. Every pebble and shell may be seen in the deepest water, and the fish seem to glisten and flash like silvered life in a stream of air.

At the barn of Mr. O. L. Leavenworth was a watering pool filling an ancient sink hole, which for years had been a constant convenience; suddenly, after a thunder storm, it

was found empty, and although the line of overflow was to the south toward the adjoining valley bottoms, it was discovered that, following the dip, the water had found a long obstructed channel to the north beneath the cliff-like promontory, more than four hundred feet high, and was discharged into Dry run.

About one hundred yards south of the west end of Cole's bridge, on a level bench, twenty-five impressions were observed in the solid rock made when in a plastic condition, apparently of the feet of a herd of horses, mules, colts, deer or sheep. The resemblance is very perfect, and calculated to excite wonder. They are the remains of a peculiar *fucoid* or sea-weed, seen in the Chester and St. Louis rocks of Indiana, Kentucky and Arkansas.

Three and a half miles from Leavenworth the road passes along the base of the lower massive sandrock of the Chester beds. On the west side of the road is one of the wonders of the vicinity, known as "Giant Castle ruins," a depression, such as might be proper for the basement or cellar of an extensive edifice, is filled with a confused mass of clean cut cubes and rhombs of hard, ferruginous, sandstone, of great size; square and columnar masses lie scattered about the rim of the depression, or stand upright as monolithic sentinels. Many a curious spectator has wondered at this phenomenon, and speculated as to the agency, whether human, volcanic or otherwise. It is a sink funnel, beginning at the level of the Chester sandstone, which, from the silicio-ferruginous nature of its material, adopts under earthquake motion such rhombic cubes as its lines of cleavage; these, undermined by a cavernous sink, which washed away the underlying clay and detritus, left the rocks clean cut and bare, as if done by the hand of man. Similar masses of well-shaped rocks, from one to fifty feet square, are seen

perched along the steep bluffs of Oil Creek, Penn., especially near Petroleum Centre.

At a "sink hole" on the bluffs of Blue river, one mile south of the cave, was seen a tree splintered to ribbons by lightning. The surrounding hills tower from one hundred to one hundred and fifty feet higher; under the "sink" was damp earth, if not a stream of water, through which the charge of electricity passed—a good conductor, and a more direct route than through the dry, cavern-drained hills. The tree was minutely shivered near the ground, which seemed to indicate an upward burst of electricity.

At the first arrival of the Rothrock family in Crawford county, Wyandotte Cave was known as the old "Indiana Saltpetre Cave." Dr. Adams had pre-empted the land, and during the war with England, or from 1812 to 1818, he manufactured saltpetre, after which he relinquished his claim. Many remains of leaching hoppers, troughs, etc., show the extensive character of his works. One of the old saltpetre kettles is still used on the farm, a curious relic of the metallurgic art of a hundred years ago.

Soon after Dr. Adams retired Mr. H. P. Rothrock, father and grandfather of the Rothrocks now living in the vicinity, entered the land, or bought of the government a tract of four thousand acres, which he supposed included the cave and all of its subterranean ramifications. The cave was open to every one who wished to enter, and was somewhat mutilated by vandal visitors; in fact, it was considered rather a nuisance, as the Indiana Legislature enacted a law compelling the owner to fence up the entrance and prevent cattle from licking the epsom salts.* This, with the west branch, is known as the old cave.

*Statutes 1843, Chapter 53, Section 67.

In 1850 Messrs. Cummins, Collingwood and O'Bannon observed a flat stone, which seemed out of place, at the side and bottom of the pit at the end of "Bandits' Hall," where the old cave turns abruptly to the left. A small opening, when enlarged, led the way by "Fat Man's Misery" to the extensive "new cave." Later in the same year Mr. Rothrock noticed, near "Sulphur spring," a very small, descending, pit-like opening, ten by five inches, which examination showed had once been larger, but was now nearly closed by ages of stalagmitic deposits. This opening, enlarged to eighteen by twenty-four inches, forms the "Augur Hole," through which visitors enter to the northern extension of the "new cave."

Since that time Wyandotte has been open to visitors, with skillful guides and proper equipments. It was visited in early times by President Harrison and the officers of his gallant army, and since by many noted travelers and scientists, editors, professors, professional gentlemen, priests and statesmen, with a goodly host of the fairer sex, all expressing themselves delighted with the grandeur and magnificence of this truly wonderful cavern, to go away fully compensated for their toil and trouble by the curious and entrancing scenery which meets the eye at every turn.

The door of "Fat Man's Misery" is in a dark pit; the opening, hid by a flat stone, as it was when discovered, might have been passed a thousand times unobserved. Up to 1850 this was the extent of white men's explorations. On entering the explorers were surprised to find that this hidden part of the cave had formerly been occupied, including the spacious areas of "Bat's Hall," "Sandy Plain" and "Rothrock Cathedral." Hundreds of poles, six to twelve feet long, and from one to two and a half inches in diameter, were found scattered in all parts, probably used for

carrying burdens of food or skins, or for aggressive or defensive purposes. Significant, too, of the Stone Age, the poles were of such soft, brittle wood as sassafras, poplar, pawpaw, etc., as might be readily obtained by breaking; many having been twisted off at the ground, others torn from the earth with part of the roots attached, while a few had been cut with some dull implement, indicating the use of stone axes and flint knives. It was not a house of darkness; the charred remains of torches, made of shell-bark hickory, tell of the mode of illumination. The ceilings of several of the rooms are still sooty from the smoke of flambeaus and fires for cooking.

Sulphur spring was apparently the farthest limit of the explorations of the more recent Indians; but still beyond, on breaking away the slowly growing stalagmite which had so nearly closed the "Augur Hole," it was found that a party—one large man, two smaller men or women and three children—had been there, leaving the prints of their moccasined feet in the plastic clay on the floor. These tracks or, "Indian foot prints," were there in good condition, and if they had not been obliterated by white men tramping over them they would have remained for ages. In "Sheep Cave" are tracks made by a lost sheep, thirty-five years ago, as distinct as if made but yesterday.

The wandering or lost band, above referred to, were brave or earnest explorers; they examined carefully every nook, cranny or crevice of the long north cave on one side, and returned with the same close examination on the opposite side. The lapse of time since these tracks were made, may be approximately inferred from the fact that there being no other known entrance, they must have gone in by the "Augur Hole," which, to have admitted a full-grown person of average dimensions, must have had an area of twelve by eighteen inches; white men found this closed to a space

of ten by five inches; now the deposit made by water holding lime in solution, on the same spot, since the opening in 1850, a period of twenty-eight years, is a mere film, not one-hundredth of an inch in thickness, so that, inferentially, more than one thousand years must have elapsed since those tracks were made. The more rapidly dropping water at the "Pillar of the Constitution" has deposited a film of less than one-fiftieth of an inch during five years, or at the rate of one inch in two hundred and fifty years, and as the water drops at the "Pillar of the Constitution" ten times as rapidly as it does at the "Augur Hole," and provided the supply of water at the latter place has not from any cause decreased, it is fair to infer, from these imperfect data, that the tracks were impressed in the soft clay eighteen hundred or two thousand years ago. The tracks were seen by many visitors, including Dr. Hawn, Prof. Hovey, Prof. Richard Owen, Josephus Collett, and others, up to the year 1855.

The cave is situated south of the southern limit of the Drift. Three smooth glacial boulders were discovered by the writer and Washington Rothrock in 1877, at the "Senate Chamber," which, from indications, such as wear and bruises, had been used as hammers or grinding pestles, and proved conclusively that that part of the "old cave" had been visited, if not occupied, by men of the Stone Age.

The Cave House is situated on a commanding eminence, 573 feet above tide water, 270 above low water in Ohio river, and 220 above Blue river. The air is free from malarial impurities and the pests incident to overflowed lands. Blue river, sparkling with crystal brightness, flows in a narrow valley, across which Greenbrier mountain, with sharp conical peak and steep faces belted with massive rings of rock, variegated with evergreen cedars, affords a scene of quiet, stately beauty. The mountain is capped with Chester rocks, and in the background knobs are seen reaching from

two hundred to two hundred and fifty feet higher than the hotel. Roaming through the forests in search of game, or climbing the steep hills gathering plants, fossils, shells or insects, is invigorating exercise, while the romantic scenery and charming views fully repay this healthful toil. Blue river affords good bathing and infinite sport for the disciples of Isaac Walton.

On the occasion of the sudden, intense cold of December 2d and 3d, 1876, which closed navigation on the river, and for several consecutive days, a thermometer at the Rothrock residence in the valley, marked 10° lower than at the hotel; or during sudden "cold snaps" elevation, or the proximity of deep valleys, to which heavy cold air is withdrawn, modifies the temperature on the hills at the rate of one degree for every twenty-two feet of hight. The same fact has been observed in other parts of this and the adjoining county of Clark. The hotel is situated, geologically, near the base of the Chester group, or at the top of the St. Louis, so that the hills which ascend to the northward to the great Lacustral plain, which stretches across the county from north to south, are of partly covered Chester sandstone and limestone.

SECTION AT WYANDOTTE CAVE.

	Ft.
Slope and Loess	20
Buff sandstone with fossil plants	75
Gray limestone, with *Archimedes*, etc	6
Brown limestone and shale	40
Gray limestone and shale	50
Lithographic bands	34
White oolitic St. Louis limestone	4
Gray, cherty, encrinital limestone	220
Blue river	
	449

The "outer door" of the cave, thirty feet lower than the hotel, admits to the subterranean world by an entrance twenty feet wide and five feet high. A sharp, short descent

conducts visitors by the "Arched entrance" to "Faneuil Hall," a spacious corridor forty feet wide and eighteen to twenty feet high; here daylight ends and darkness begins. Here, too, we see the first of cave life; clusters of bats, which hibernate in myriads, were seen attached to the sides and roof by their hind feet, with heads down. The surface of the stone being slightly porous affords good attachment for their tiny claws. During the winter they remain in a semi-torpid condition, and on the return of spring scatter over the surrounding country.

The London *Naturalist* gives the following on

"BATS AND THEIR WAYS."

"Bats live their active lives in the night; when sunlight comes they fly away to their holes, there to sleep until twilight comes again, when they resume their occupation of insect killing. The female bat has a hard time of it; she is the nest, and has to procure the food for her young until they are themselves able to fly. Often I have seen a female bat with her young clinging to her breast, flying about in search of food, and the little ones were not so small either. How else could they get along? The old ones make no nest; if they wanted to ever so much they could not, and the chances are that from their wandering habits they spend the day in one place and the next in another two or three miles distant, just as that happens to be when day overtakes them, and if they left their young behind them the exact locality might be forgotten. When the young ones are to shift for themselves their mother's life is easier, and until winter comes to kill insect food she lives luxuriously. Then, when all nature is preparing to put on the livery of winter, instead of leaving the scenes where they have passed the summer, repair to their haunts in the caves and walls,

and hanging by their hind feet in little groups, pass the dreary season in sleep."

Next we enter the "Normal School," twenty feet wide and fifteen high, and through the "Columbian Arch," an almost perfect semi-cylindrical tunnel, we enter "Washington Avenue," 450 feet long, thirty to forty wide and twenty to seventy high, with a slightly descending floor. "Bandits' Hall," 210 feet long, with a roof ninety feet high, encrusted with a starry fresco of gypsum, away up in the black darkness, contains blocks and masses of stone for hiding places, and is guarded by the "Falling Rock," which seems so loosely poised as to be ready to leap from its bed, and by its threatening position tells the story of the cave's formation. The "rock," a cube of solid limestone, twenty feet square, torn by the hand of time from the roof of the cave, stands like a monolithic altar of giant worshippers; just above is dimly seen the recumbent form of the princely "Chief of the Wyandottes," still guarding the fireless altar of his extinct race and forgotton Manitou.

The "Old Cave" from "Bandits' Hall," 130 feet below the hotel, leads almost abruptly to the left; from this depression an abrupt ascent is made by "Jacob's Ladder," a fixture of three steps placed there in 1812, and doubtfully supposed to be emblematic of "Friendship, Love and Truth." The succeeding passway leads over nitrous earth by "Pigmy Dome," "Coral Gallery" and "Debris Dome" to the "Canopy," a room describing almost a circle, ten feet high and twenty-five feet in diameter, with a flat, clean cut ceiling.

The "Continued Arch" is a glorious tunnel, 600 feet long, with an arched roof symmetrically covering the roomy passage. "Lucifer's Gorge" is a dark chasm, forty feet deep, with precipitous or overhanging sides from eight to twenty-five feet apart; the bottom of this chasm is on a

level with that of "Bandits' Hall." After a sharp ascent the visitor reaches the "Natural Bridge," which gives a climbing or stooping passage to the "Grecian Bend," a low room, through which one is compelled to crawl upon the knees.

Climbing the "Angel Hill," twenty feet of sharp ascent, the "Temple of Honor" is reached, through which we pass to "Odd Fellows' Hall;" this is one of the royal subterranean rooms of the world, 210 feet long, 100 across and eighty feet high; the walls are built up of massive ledges of limestone, thinning toward the top, and thus, by perspective, exaggerating the dim hight. The elliptical crown of the dome is smooth as if purposely made ready for the fresco artist, and is bordered with heavy mouldings ten feet deep; the whole, illuminated by magnesium light, is imposing, massive, grand and coldly beautiful. On the side near the greatest depths of "Atræus" is the white "Phantom Ship, Millie," with sails spread and rudder set for the unknown realms of darkness.

Near the entrance to the hall, in a narrow crevice, is "Rothrock's Straits," through which we pass by a low, tortuous course to "Monument Mountain," in the new cave. The explanation of these great domes and halls is that smaller caves or crevices, as "Rothrock Straits," crossed under the main old river, undermining its bed, widening its sides and receiving and hiding in the lower channel the fallen rocks and debris from above.

Soon, by "Pharaoh's Stairs," we pass over "Pyramid Hill," then descend to the dark "Valley of the Shades," and quickly ascend the "Hill of Humility," where walking on the knees again becomes necessary. The succeeding incline leads to "Conrad's Hall," 200 feet long, 25 wide and 20 feet high, where the ceiling is exceptionally dark, and seems, from its peculiar color, to be lifted up and exag-

gerated in hight. After a short ascent a mighty crevice is seen, ragged with angular sides and walls; the entrance is by "Jolter's Hole," where a plethoric attorney was once arrested and held in durance vile until discharged. At the bottom is a prism-shaped, columnar mass of stone, twelve by five feet, leaning against the wall, called the "Leaning Tower." Crossing over another good hill, we pass into the "Abyss" by a decent of sixty feet; the north wall is slightly overhanging and, although now dry, was once wet with flowing water, which, by evaporation, has whitened "The Cliff" with stalactite incrustations and fringed projecting ledges with clusters of delicate, white pendants; this marble cascade is called the "Falls of Minnehaha." Below the abyss, a crevice called "Talbot's Pit," proves the existence of a lower unexplored cave, for stones cast down may be heard to leap and roll full fifty feet in the black depths. "Uncle Sam's Stairway" is an Alpine ascent of about fifty feet, from which the path leads under the "Dead-fall," where a huge slab, held by a point, is suspended over the way, and seems to threaten those who dare to enter the "Cyclopean Chasm." In the sides of the chasm is the quarry fossil bed of St. Louis limestone four feet thick, with crinoid and pentremite stems and plates in abundance, and also *Zaphrentis spinulosa*, beautifully weathered. "Fossil Avenue," six hundred feet long, roomy, but mountainous, has several beds of fossils, indicating the line separating the St. Louis and Chester groups. The top of the highest rock in this "avenue" is ten feet below the house; the temperature 66° F.

The farther end, estimated as over two miles from the outer door, is the crowning glory of the old and new caves; passing the "Archimidean Screw Hole," a narrow, difficult, bewildering, twisted way, a sharp, rough descent leads to the "Senate Chamber," a vast elliptical amphitheatre, esti-

mated at six hundred feet long and one hundred and fifty feet wide. The sides are built up with massive ledges of limestone, thinning and converging upward into a monster dome, with a flat elliptical crown, fifty by twenty feet in diameter. The centre of this vast room is piled up with a great mass of rocky debris fallen from the immense cavity above. Ascending to the top of this hill it is found to be composed of one immense stalagmite or incrustation of white, lustrous spar, from one to six feet thick, and is called "Stalasso Mountain." From the breast of this mountain hundreds of lesser stalagmites have grown up, varying from a few inches in diameter and hight to three feet high and a foot in diameter; one of the latter is named "Ben Butler," and another "Stalasso Monument."

From the top of the "Mountain" springs the pre-eminent glory of cave formation, the "Pillar of the Constitution," a monster fluted stalactite, twenty-five feet in diameter and about thirty-five feet high, pendant from near the center of the dome, composed of bundles of smaller stalactites, sheaved together like the Roman *fasces*, with regularly butressed pediments; it is extended downward until the base rests in "Union" on the crystal mountain below, and becomes "E pluribus unum," or one united whole. On one side a stalactitic fringe-work is thrown around as if an attempt at a composite capital, and close by hangs the "Bell of Independence," which, with gentle stroke, proclaims liberty, as of old, in clear, musical notes. The "Chair of State" is canopied with snowy curtains in marble folds. The cornice behind the Pillar is garlanded with sprigs, leaves, twining tendrils and mosses, all wrought most exquisitely by the hand of nature, in calcite and alabaster; some parts are hoar and russet with age, while others are of bright, pearly crystal, in the lamplight flecked with the iridescent nacre of a

sea shell. Drops of water from the roof preserve the perennial freshness and lustre to this cluster of jewels.

A little basin, cut in the top of a stalagmite, receives the drops which are unceasingly emitted from a stalactitic tube, pendant from the ceiling, and furnishes cool water to the thirsty visitor, so thoroughly charged with carbonate of lime that it soon forms a filmy coating over a glass or other article left on the surface. An estimate, based on quasi observations, places the rate of this stalagmitic growth at one inch in one hundred to one hundred and fifty years. Still beyond, over two miles from the entrance, "Pluto," in a dark, gloomy ravine, holds court at the finale of this shadowy subterranean world.

To explore the third* or southern route, the entrance is as before. In the year 1850 a small circular hole was noticed at the north end of "Bandit's Hall; on being opened, to admit a passage by crawling, the "New Cave" was discovered.

The entrance called "Fat Man's Misery" is a steeply inclined, narrow, slickened slide, best accomplished feet foremost, with closed eyes, let all holts go, and a most unclassic translation is experienced of "*facilis est descensus Averni.*" The descent seems long, but is only about eight feet to the second story of the cavern. A wooden door is placed here to prevent a draught of air at the semi-annual expirations or inhalations (breathing) of the cave at the change of external temperature which follows the vernal and autumnal equinoxes.

"Bats' Lodge" is a spacious room in which the bats delight to assemble for sleep as well as council; the ceiling was largely covered with clusters of the animals, closely

*To make the narrative conform to an easy comprehension of the map, the description of the third route precedes that of the second.

crowded together; the room was filled with their slight whining, whispering voices and the odor of their bodies. Beyond this the roof so closely approaches the floor that "Counterfeiters' Trench" was dug through the earthy deposit which had silted up the way; advancing by wide, roomy passages, with nearly level floors and the ceilings neatly whitened with shining crystals of lime and soda, the steep ascent of "Rugged Mountain" is found filling a fine, dome-shaped cavity called the "Rotunda," built up with circular layers of living stone in massive strata. At the top of this mountain were seen banks of white, needle-shaped or hairy crystals of epsom salts; handfuls were gathered two inches long, and if not removed for twelve months they continue to exude from the porous matrix until they attain a length of three to five inches; the pure, nitrous air at this point is said to give instant relief to gasping sufferers from asthma.

The "Rotunda" and "Coons' Council Chamber" are in keeping with the grand character of the cave. "Delta Island" is a pillar fifty feet long, twenty feet wide at one end and tapering to a point, in the bed of the ancient subterranean river; here the routes again divide. Proceeding on the southern route, you turn first to the right and then to the left, and enter the broad way which leads around the "Australian Continent." "Creeping Avenue" has a wide, smooth, clean floor for sixty or seventy yards, but the roof is scarcely two and a half feet high, and hands and knees are useful or necessary. The visitor is at once rewarded by enjoying one of the most brilliant and interesting of cave scenes. The "Pillared Pallace" is entered by a broad doorway, flanked by stalacto-stalagmites, while within, ceiling, cornices and shelves are fringed with stalagmites and frosted with a never ending medley of strange, crooked, writhing, twisting, unsymmetrical sprigs of white limestone, pushed

out of the solid rock, and still growing by propulsion from the bottom; one cluster is a realization in stone of the horrible, snaky tresses of Medusa. Stalactites, large and small, are suspended centrally along the whole length of the room, and the plain-like floor is occasionally relieved with round, conical stalagmites, resembling cypress knees of southern swamps; the weird and interesting scenery is continued through the "Palace of the Genii," the roof of which is spangled with glittering crystals and a pendant stalactite resembling a "hornet's nest" may be so illuminated as to disclose the translucent material. "Caliope Bower" is broad, and the ubiquitous resonance with which every movement fills the cave seems to authorize the common belief of a hollow floor; the noise is due to repeating echoes developed and magnified by the great width of the adjoining room.

The chambers just mentioned, which by far exceed in beauty anything and everything that I have seen in exploring more than fifteen miles of the best reputed cave formations in Kentucky and Iowa, nature guards well by the difficult access of "Creeping Avenue," and just beyond by another creep, between a smooth floor and level roof, of seventy or eighty yards. This creep is somewhat tiresome, and readily suggests its name, "Purgatory." The "Mound" is next, with a block of stone on top, both typical rather of our pre-historic races and their ever-blazing altars than the "Hippopotamus," as it is named; an oblong piece of stone prone upon the floor, to an eye searching in the dim light for monsters, is an "Alligator."

To the left you approach the "Audience Chamber," and ascending a steep rocky incline "The Throne" is seen, unique, beautiful and petite, as if for the queen of fairy land; heavy fringed draperies of stone hang in graceful folds about the seat, supported on either side by an undu-

lating cornice. Royalty offers at its banquets here only sparkling, pure water in a drop-fed basin. Beyond is a long stretch of partly explored avenues, branches, etc., with many ramifications, but being damp and in many places muddy, it is not often visited.

Returning on the west side of the "Continent," the "Alligator" sleeps with open eyes, watching for the "Nest Egg," an extraordinary concretion nearly three feet long, lying loose in its bed. Here, as elsewhere in much of the cave, the sides are belted with massive strata of limestone and alternating beds of shale, in which are bands and balls of black flint in clusters. The flints show the sharp, clean cleavage at right angles to the line of deposition, so useful to the Indian race in the manufacture of flint knives, awls, gouges, arrow-points, spears, hoes, spades, etc.

The "Hall of Representatives," about one hundred and eighty-five feet below the hotel, is a grand rotunda, well arched up, surmounted by a striking dome.

The "Wyandotte Council Chamber" is an enlargement of "Starry Hall;" in the dome of the latter a number of dark concretions are fixed, which, contrasted with the matrix, give a fine illusion of a starry canopy. A flat stone is the "Card Table" upon which visitors usually leave their cards, and among the hundreds accumulated since the custom was established, nearly every visitor will recognise some well-known name or familiar friend.

The second route is from the outer door by "Delta Island," already mentioned, northward. Passing the "Island" you traverse "Sandy Plain," nine hundred feet long, forty feet wide and ten feet high, over a good, smooth floor. Sand bars were deposited here by the ancient cave river, and are first observed on the right, and then on the left. The barometer indicates this point to be one hundred and eighty feet below the hotel, and the air has a tempera-

ture of 64° F.;* toward the further end the ceiling approaches to within five feet of the floor, but in it are reversed pot-holes and trenches in which a tall man may straighten up and rest.

From the "Plain," passing on the left the narrow entrance to "Rothrock Straits" on the lowest of the three floors of the cave, you ascend the "Hill of Difficulty;" massive cubes and blocks of stone, fallen from the hollow dome, obstruct the way; the hill is fifty feet high, and gives access, by a difficult incline, to "Monument Mountain," over which expands "Wallace's Grand Dome," fifty feet above the top of the mountain, and one hundred and eighty-five feet above the foot of the hill; the mountain path requires alpenstock and cane; the outlook from the top is a narrow opening between craggy masses of stone, fallen from above, which seem loosely wedged together in a confused heap, startling the timid with a sense of danger so they naturally seek the hand of guide or protector.

The laborious ascent is repaid by the glorious view at once realized, embracing the mountain and dome, which, together, form a grand chasm, named in honor of the discoverer and worthy citizen, "Rothrock Cathedral," two hundred feet in diameter; the mighty dome springs from the very floor, like the auditorium of the proposed Mormon temple, and ascends with arched sides, heavily corrugated with massive bands of limestone, to a flat elliptical crown, so garnished with fugitive lines of pearly crystals that it seems frescoed with fickle scrolls of silver mirage. The sharp conical sides of the upper dome are of thin-bedded limestone in regular well-defined courses or bands, which by perspective exaggerate the hight; those just below the capstones are ornamented with heavy fringes of robust stalac-

*September, 1877.

tites closely clustered, with an outer belt of delicate, slender, ice-like tubes in relief, each point bright with drops of water, which, in the brilliant illumination usual at this point, flash and sparkle like diamonds.

The interior of this grand dome is pretty well occupied with "Monument Mountain;" from the ceiling drops of water, charged with lime and continuously falling, on evaporation deposit a pure white film which forms a stalagmitic incrustation all over the top. The sharply conical pinnacle is crowned with a monumental obelisk, five feet high and eighteen inches in diameter, surrounded by white and dusky pillars known as "Lot's Wife and Daughters," ranging from two to six feet in hight, and from one and a half to two feet in diameter.

The "Sulphur Spring," in a reniform basin at the foot of the mountain, furnishes good cold water, and is the usual dining spot.

At the side of the spring is a small hole in the floor, which would be observed only on close inspection; the guide calls all to prepare for a new mode of locomotion, and making profound obeisance to visitors, with face to the floor, first feet, then legs, disappear, and soon a voice from the lower regions invites all to follow. This is the "Augur Hole," in which an edition of the Indianapolis *Herald* tightly fixed the ponderous body of Dr. Hawn, and kept him there, holding the world in anxious suspense until the next issue of the paper, when, according to the editor, the Doctor's rotundity had collapsed as fully as did the circumstantial picture which had been telegraphed and reprinted in the public journals of America and Europe.

The "Augur Hole" is one and a half by two feet in cross section, and seven feet deep. "Liliputian Hall" is one hundred yards in length, and low enough for Gulliver's spunky little friends. "Spades' Grotto" is one hundred feet long,

fifty feet wide and twelve feet high, with flat roof seamed by earthquarke partings, through which lime water seeps, forming nests and fringes of stalactites—some straight, others strangely twisted, strangulated or rounded, all tipped with bright drops of water, which lengthen the stalactites and repair broken ones. This hall formerly extended to the northwest, but is now banked up with mud deposited when the old, dead, cave river passed this way.

The "Hall of Ruins," two hundred and twenty-five feet long, forty wide and twenty high, contains many angular and cubical blocks of stone; the temperature was 71° F. for some unknown reason, the warmest spot in the cave, and, in fact, so exceptional, as to be contrary to every other observation.

The "White Cloud Room," three hundred feet long, thirty wide and twenty high, is one of the largest and most beautiful areas in the cave. The roof is symmetrically arched and fretted with incrustations of lime, rounded by depositions into billowy masses of fleecy clouds. Parts of the walls were coated with snow-white gypsum, and several exquisite rosettes were observed still growing by out-thrust from minute crevices or pores in the rock, as plastic ice oozes from the ground on sharp frosty nights. The two most prominent political newspapers in the State, supposed to be typified in some obscure way by angular blocks and fragments of stone in a badly confused condition, if not "pied," flank the "Bishop's Rostrum," which is a level platform, eight by ten feet square and twenty feet above the floor, ornamented with white incrustations pendant from the platform and altar. Sophomoric declamations have often vexed the echoes of the "Bishop's" quiet little amphitheatre.

The visitor passes to the right of "Calypso Island," returning on the opposite side. "Calypso Avenue," three

hundred feet long, fifty wide and forty feet high, has a whitened ceiling and perpendicular sides, ornamented with boquets of rosettes and spherical bosses. The "Aerolite," a triangular block of stone, lies near the centre of the avenue; in the ceiling the cavity is plainly visible from which the ponderous mass fell. "Cerulean Vault" gives entrance to "Rugged Pass," consisting of four hundred yards of rough ascent and descent. "Milroy's Temple" was discovered in April, 1878, by students from Wabash College. In it are found some interesting novelties: a "frozen cataract, creamy curtains and musical stalactites." The "Chapel" is crowned with a dome of rare perfection and beauty, fretted with heavy circular cornices; the "altar" is built up by visitors, each casting a stone of remembrance.

"Josephine Arcade" is a rough and toilsome path, but to the left her bower, a garden of rosettes and leaf-like sprigs of gypsum, rewards the visitor with a feast of beauty. The "Lone Chamber," or "Ball room," is one hundred and fifty feet long, forty wide and twenty high; merry dancers, with gay music, have often filled this room with festive joy. The ceiling is of white, rounded, cloud-like masses, and near the end is the "Arm Chair," which, though small, is unique; it was supposed to be the "Chair of State," now vacant, but once occupied by the "Queen of the Fairies" at their midnight festivals; since, it has seated many a queen fairer to western hearts than brightest dreams of elfin lore. At the "Dry Branch" were seen fragments of sandrock, indicating beds of the overlying Chester group.

The "Islands of Confusion" are large and small pillars in the bed of the dead river; on each side are large, roomy halls, ten to thirty feet high, with whitened walls and ceilings; horizontal recesses along the floor and sides are filled with gypsum in powder and hairy crystals. Still beyond

are long stretches of cave, not fully examined, leading to "Crayfish Spring," and by "Wabash Avenue" to "Butler Point," one and a half miles farther. In this distant part evidences of former occupation are most common; Indian footprints were preserved by stone walls as late as 1855; still yet may be seen, burden poles and charred fragments of hickory bark; these pieces of wood were not rotten, for timber never decays in this dry, antiseptic air, but was simply worn to attenuation by the silent breath of the cave during ages of time. Beyond "Crayfish Spring" and "Butler Point" the large, dry halls give place to low, muddy passages.

Circumnavigating the "Islands," the left hand strait has white walls, and from the ceiling hangs curious, pendant forms; one resembles a plow-share; another thin plate, hanging obliquely from above, is named the "Silver Bell," which at gentlest touch gives out soft, musical notes, quivering like the vesper anthems of happy spirits in the still, pure air. The roof is low, but being slightly inclined allows the visitor to walk erect. The white, smooth-walled entrance is used as the "Cave Register," and here are found many familiar as well as strange names.

The passage leading southwest from the "Arm Chair" gives entrance to "Ewing Hall" and "Frost King's Palace," a grand assembly room, six hundred feet long, ten to forty wide and twenty feet high; the roof and sides are covered with white incrustations spangled with sparkling facets. From the center a "Carpet Bag" of unique pattern is suspended; the whole is beautiful, and readily suggests a palace cased in crystal by the ice king's wondrous art. The "Ice House" is a rough room where water dripping from the roof covers the surfaces of the rocks on the floor with a white, translucent film resembling ice. A sharp descent leads to the "Snowy Cliffs," four hundred feet long, thirty

wide and fifteen high; the walls are massive ledges of lime-rock, covered with gypsum, resembling drifted snow and frost; in the ceiling you notice "flint balls" or boulders from one to fourteen inches in diameter, which are partly exposed, as if ornaments of jet were set in a living matrix.

"Morton's Marble Hall" is a continuation of the last, and is six hundred feet long, twenty-five to forty wide, and fifteen to twenty high; the sides and roof are completely dressed in snowy whiteness, equalling the brightest marble halls of dreamland, song or story. United, these two halls make a grand thoroughfare over one thousand feet long, and more like a railway tunnel than an ordinary cavern. Allowing eighteen inches square for the standing-room of each, 20,000 men might be massed in these halls. All minor details are lost sight of in the wonder and interest aroused by a comprehension of the grand extent and massive stability of this hall, the largest recorded cave room in the world. Just beyond is "Beauty's Bower," a prolongation of the grand avenue. But what a change! Near the floor rocky shelves project; the "Queen's Garden," the lower sides of which are covered with boquets, clusters and beds of rosettes,* leaves, lilies and sprigs of white or translucent gypsum. From the garden a low way guards the entrance to the "Fairy Palace." Here the fairies were communists, occupying together a long, low, unsightly room; but smaller bevies had made their homes along the low sides or under the projecting ledges, always covering the under side of the shelves, their elfin roof trees, with budding roses and lilies in crystal; the full-blown or opening flowers were poised in pearl, with every weird variation that the wildest imagination could compass, yet perfect in their strange, grotesque attractiveness. The exquisite beauty of these translucent

*Oulopholites.

or opalescent gems must be seen to be appreciated, as no description can give an adequate conception of the "Fairy Palace Home."

"Queen Mab,"* herself, would delight to hold court and revel here.

The great amount of gypsum in this part of the cave shows that it is old, and long protected from access of water or air laden with moisture; sulphate of lime being soluble, these tiny forms would be dissolved and removed were the contrary the case. This tunnel suddenly terminates, but the excavation required the existence of one large or many small streams of water. The presence of sand and rounded pebbles, known as "Wyandotte Potatoes," proves that the stream acted with violent current; that river has long been lifeless or found lower routes, while the eddies or still current once existing at this spot has silted up the continuation to the north; future exploration may find new routes by excavating such obstructed avenues.

Returning from the "Ice House" a passage leads southward to "Queen Mab's Retreat," which for a time was supposed to be the end of this branch; a narrow outlet was discovered, which added many miles to the cave, over a long lower story or floor; this has been but imperfectly examined, and many of the passage-ways leading from it have never been visited. The floor is covered with gypsum, obstructing the passage, and presenting the appearance of drifted snow.

The "Round Room" reminds one of a railway round-house for locomotives; going northwest from this the "Dead Sea" is a pool of bright, clear water, and "Heman's Bower" is a large room brightly decorated with gypsum rosettes and flowers.

*Shelley's poems.

Here the cave divides. The northern route has not been fully explored. The southern way leads by "Hines Cliff" and "Lonigan Pass," to "Diamond Labarynth," immediately under the old cave heretofore visited.

"Rode-rock" No. 1, is a back bone or prism shaped rock filling the bottom of the narrow passage; you must mount, best astride, and by alternate leap and spring the "rode rock" is ridden. Next is a wide, low, mud-floored room named "Wild Cat Avenue." At the northeast and southwest corners the roof approaches the floor, indicating a silted up tunnel of great extent. Passing beneath "Calypso Island" of the new cave, "Maggie's Grotto," "Lama Bower," "Marble Rivulet," "Marble Hall," "Miller's Reach," "Andrew's Retreat," "Rode-rock No. 2," still longer than No. 1, a sharp turn at "Devil's Elbow" and "Wash. Rothrock's Island" succeed, and the wide unknown beyond for limited time did not admit the name of exploration. It is almost certain that further examination, assisted by excavation of the banked up termini at a dozen points, will develop routes and distances which will show that the present explorations are only a beginning. So that future maps will exhibit many avenues and rooms in addition to the estimated extent of twenty-three miles.*

The following analyses and observations are quoted from the report of Prof. E. T. Cox, on pages 162–4 of this volume; they solve many important questions on the chemistry of the subjects under discussion.

Analysis of red plastic clay, unctious to the touch, and without grit, cuts very smooth:

* The accompanying map of Wyandotte Cave was prepared from the best attainable data, and has been revised and corrected by the proprietor and guides. The dotted lines indicate the lower story or floor. The dimensions are generally estimated.

	Per Cent.
Loss at red heat	11.70
Silicic acid	48.50
Ferric oxide	12.30
Manganic oxide	1.05
Alumina	19.50
Lime	1.79
Magnesia	0.52
Carbonic anhydride	1.97
Sulphuric anhydride	1.11
Phosphoric acid	0.44
Chloride of alkalies and loss	1.12
	100.00

"Magnesian earth" is more properly a combination of gypsum and ferruginous clay. Analysis:

	Per Cent.
Loss at red heat	24.10
Silica	31.60
Ferric oxide	10.70
Manganic oxide	trace
Alumina	3.90
Lime	8.28
Magnesia	1.54
Carbonic anhydride	8.22
Sulphuric anhydride	11.00
Phosphoric acid	0.41
Chloride of alkalies and loss	0.25
	100.00

"Nitre earth." This is a red clay similar to that used for the manufacture of saltpetre during the war of 1812. A large amount of this earth was lixiviated during that period, and owing to the high price of nitre the manufacture was conducted with profit. It contains in 100 parts:

	Per Cent.
Loss at red heat	16.50
Silica	20.60
Ferric oxide	6.03
Manganic oxide	0.75
Alumina	20.40
Lime	8.06
Magnesia	4.58
Carbonic acid	10.38
Sulphuric acid	6.55
Phosphoric acid	2.43
Nitric acid	3.50
Chloride of alkalies and loss	0.32
	100.00

The 3.5 per cent. of nitric acid would unite with 3.05 per cent. of potash to form 6.55 per cent. of nitre, or 100 pounds of the earth would yield 6.55 pounds of nitre. The large amount of phosphoric acid present is probably due to the clay containing some decomposed animal bones.

"Bat guano." In portions of both the old and new caves there are deposits of bat guano, but it is possible that the expense of bringing it out through some very narrow and rugged passages will be too great to render it available for fertilizing purposes. Composition:

	Per Cent.
Loss at red heat	44.10
Organic matter	4.90
Ammonia	4.25
Silica	6.13
Alumina	14.30
Ferric oxide	1.20
Lime	7.95
Magnesia	1.11
Sulphuric acid	5.21
Carbonic acid	3.77
Phosphoric acid	1.21
Chloride of alkalies and loss	5.87
	100.00

"Analysis of water from the "Sulphur spring" in Wyandotte Cave. An imperial gallon contains 55.3 grains of solid matter, composed of:

	Per Cent.
Insoluble silicates	0.200
Ferrous oxide	0.144
Calcium oxide	4.170
Magnesium oxide	9.830
Sulphuric anhydride	25.180
Carbonic anhydride	8.160
Sodium oxide	1.127
Potassium oxide	5.560
Chlorine	0.350
Loss and undetermined	5.679
Total solid matter	55.300

This is a sulphate of magnesia water, and might be more properly called an epsom spring.

The above substances are probably combined to form the following salts:

	Per Cent.
Carbon dioxide, free	5.6946
Silicic acid	0.2000
Ferrous carbonate	0.2319
Calcium carbonate	3.8899
Calcium sulphate	6.4537
Magnesium sulphate (epsom salts)	29.4929
Potassium sulphate	1.0366
Sodium sulphate (glauber salts)	2.2088
Sodium chloride (common salt)	0.5757
Loss and undetermined	5.5149
Total solid matter	55.3000

Medical properties, diuretic and tonic.

Of seeing animals, the raccoon, fox and opossum are known to visit and roam through the cave in winter. Bears formerly retired to the cave, and their wallows and beds are still pointed out. Bats are always present, but more numerous in winter than in summer. Cave rats are

abundant; they are of a light gray color, with long, slim, weasel-like bodies; the sensitive whiskers or feelers about the mouth are nearly twice as long, the ears longer and larger, and the eyes much larger than in the common rat. The flesh of dead animals dries up and does not decay in the cave. The body of an opossum, found twenty-five years ago in "Counterfeiter's Trench," still testifies to the antiseptic character of the dry cave air.

The following observations on the fauna of Wyandotte Cave and its companion, the Little Wyandotte, were prepared by Prof. E. D. Cope, for the Rep. Ind. Geo. Survey, 1872, and have been carefully revised and corrected by the author of this Report:

OBSERVATIONS ON WYANDOTTE CAVE AND ITS FAUNA.

BY PROF. E. D. COPE.

The Wyandotte Cave traverses the St. Louis limestone of the carboniferous formation in Crawford county, in southwestern Indiana. I do not know whether its length has ever been determined, but the proprietors say that they have explored its galleries for twenty-three miles, and it is probable that its extent is equal to that of the Mammoth Cave in Kentucky. Numerous galleries which diverge from its known courses in all directions have been left unexplored.

The Wyandotte Cave is as well worthy of popular favor as the Mammoth. It lacks the large bodies of water which diversify the scene in the latter, but is fully equal to it in the beauty of its stalactites and other ornaments of calcite and gypsum. The stalactites and stalagmites are more numerous than in the Mammoth, and the former frequently

have a worm or maccaroni-like form, which is very peculiar. They twist and wind in masses like the locks of Medusa, and often extend in slender runners to a remarkable length. The gypsum rosettes occur in the remote regions of the cave, and are very beautiful. There are also masses of amorphous gypsum of much purity. The floor in many places is covered with curved branches, and what is more beautiful, of perfectly transparent acicular crystals, sometimes mingled with imperfect twin-crystals. The loose crystals in one place are in such quantity as to give the name of "Snow Banks" to it. In other places it takes the form of japanning on the roof and wall rock.

In one respect the cave is superior to the Mammoth—in its vast rooms, with step-like domes, and often huge stalagmites on central hills. In these localities the rock has been originally more fractured or fragile than elsewhere, and has given away at times of disturbance, piling masses on the floor. The destruction having reached the thin-bedded strata above, the breaking down has proceeded with greater rapidity, each bed breaking away over a narrower area than that below it. When heavily-bedded rock has been again reached, the breakage has ceased, and the stratum remains as a heavy coping stone to the hollow dome. Of course the process piles a hill beneath, and the access of water being rendered more easy by the approach to the surface, great stalactites and stalagmites are the result. In one place this product forms a mass extending from floor to ceiling, a distance of thirty or forty feet, with a diameter of twenty-five feet, and a beautifully fluted circumference. The walls of the room are encrusted with cataract-like masses, and stalagmites are numerous. The largest room is stated to be 245 feet high and 350 feet long, and to contain a hill of 175 feet in hight. On the summit are three large stalagmites, one

of them pure white. When this scene is lit up, it is peculiarly grand to the view of the observer at the foot of the long hill, while it is not less beautiful to those on the summit. There is no room in the Mammoth Cave equal to these two.

An examination into the life of the cave shows it to have much resemblance to that of the Mammoth. The following is a list of sixteen species of animals which I obtained, and by its side is placed a corresponding list of the species obtained by Mr. Cooke and others at the Mammoth Cave. These number seventeen species. As the Mammoth has been more frequently explored, while two days only were devoted to the Wyandotte, the large number of species obtained in the latter suggests that it is the richer in life. This, I suspect, will prove to be the case, as it is situated in a fertile region. Some of the animals were also procured from caves immediately adjoining, which are no doubt connected with the principal one.

Of the out-door fauna which find shelter in the cave, bats are of course most numerous. They are probably followed into their retreat by owls. The floors of some of the chambers were covered to a considerable depth by the castings of these birds, which consisted of bats' fur and bones. It would be worth while to determine whether any of the owls winter there.

I believe that wild animals betake themselves to caves to die, and that this habit accounts in large part for the great collections of skeletons found in the cave deposits of the world. After much experience in wood craft, I may say that I never found the bones of a wild animal which had not died by the hand of man, lying exposed in the forest. I once thought I had found the place where a turkey vulture (*Cathartes aura*) had closed its career, on the edge of a

wood, and it seemed that no accident could have killed it, the bones were so entire as I gathered them up one by one. At last I raised the slender radius; it was broken, and the only injured bone. I tilted each half of the shaft, and from one rolled a single shot! The hand of man had been there. One occasionally finds a mole (*Scalops* or *Condylura*) overcome by the sun on some naked spot, on his midday exploration, but if we seek for animals generally, we must go to the caves. In Virginia I found remains of very many species in a recent state; in a cave adjoining the Wyandotte I found the skeleton of a gray fox (*Vulpes Virginianus.*) In a cavern in Lancaster county, Pennsylvania, in an agricultural region, I noticed bones of five or six box turtles (*Cistudines,*) as many rabbits, and a few other wild species, with dog, horse, cattle, sheep, etc., some of which had fallen in.

LIST OF LIVING SPECIES IN THE TWO CAVES.

WYANDOTTE.	MAMMOTH.
Vertebrata.	
Amblyopsis spelæus, DeKay.	Amblyopsis spelæus, DeKay.
	Typhlichthys subterraneus, Girard.
Arachnida.	
Erebomaster flavescens, Cope.*	Acanthocheir aramanta, Telk.
	Phrixis longipes, Cope.†
Anthrobia.	Anthrobia monmouthia, Telk.
Crustacea.	
Orconectes pellucidus, Tellk.	Orconectes pellucidus, Tellk.
Cæcidotea microcephala, Cope.‡	Cæcidotea stygia, Pack.
Cauloxenus stygius, Cope.‖	Stygobromus vitreus, Cope.§

*Ann. Report Geol. Survey Indiana, 1872, p. 176.
†L. c., p. 180.
‡L. c., p. 174.
‖L. c., p 175.
§L. c., p. 181.

Insecta.

Anophthalmus tenuis, Horn.**	Anophthalmus Menetriesii, Motsch.
Anophthalmus eremita, Horn.††	Anophthalmus Tellkampfii, Erichs.
Quedius spelæus, Horn.	Adelops hirtus, Tellk.
Lesteva sp. nov. Horn.	
Raphidophora.	Raphidophora subterranea, Scudd.
Phora.	Phora.
Anthomyia.	Anthomyia.
Machilis.	Machilis.
Campodea sp.	Campodea Cookei, Pack.
Tipulid.	

Myriopoda.

Spirostrephon cavernarum, Cope.	Scoterpes Copei (Pack.) Cope.

The blind fish of the Wyandotte Cave is the same as that of the Mammoth, the *Amblyopsis spelœus*, DeKay. It must have considerable subterranean distribution, as it has undoubtedly been drawn up from four wells in the neighborhood of the cave. Indeed, it was from one of these, which derives its water from the cave, that we procured our specimens, and I am much indebted to my friend N. Bart. Walker, of Boston, for his aid in enabling me to obtain them. We descended a well to the water, some twenty feet below the surface, and found it to communicate by a side opening with a long low channel, through which flowed a lively stream of very cool water. Wading up the current in a stooping posture, we soon reached a shallow expansion or pool. Here a blind crawfish was detected crawling round the margin, and was promptly consigned to the alcohol bottle. A little further beyond, deeper water was reached, and an erect position became possible. We drew the seine in a narrow channel, and after an exploration under the bordering rocks secured two fishes. A second haul secured another. Another was seen, but we failed to catch it, and on emerging

** L. c., p. 177.
†† L. c., p. 178.

from the cave I had a fifth securely in my hand, as I thought, but found my fingers too numb to prevent its freeing itself by its active struggles.

If these Amblyopses be not alarmed, they come to the surface to feed, and swim in full sight like white aquatic ghosts. They are then easily taken by the hand or net, if perfect silence is preserved, for they are unconscious of the presence of an enemy except through the medium of hearing. This sense is, however, evidently very acute, for at any noise they turn suddenly downward and hide beneath stones, etc., on the bottom. They must take much of their food near the surface, as the life of the depths is apparently very sparse. This habit is rendered easy by the structure of the fish, for the mouth is directed partly upwards, and the head is very flat above, thus allowing the mouth to be at the surface. It thus takes food with less difficulty than other surface feeders, as the perch, etc., where the mouth is terminal or even inferior; for these require a definite effort to elevate the mouth to the object floating on the surface. This could rarely be done with accuracy by a fish with defective or atrophied visual organs. It is therefore probable that fishes of the type of the *Cyprinodontidæ*, the nearest allies of the *Hypsœidæ* and such *Hypsœidæ* as the eyed *Chologaster*, would possess in the position of the mouth a slight advantage in the struggle for existence.

The blind crawfish above mentioned is specifically the same as that of the Mammoth Cave, though presenting slight differences from it. Its spines are everywhere less developed, and the abdominal margins and cheles have slightly different forms. I call it *Orconectes pellucidus*, separating it generically from *Cambarus*, or the true crawfishes, on account of the absence of visual organs. The genus *Orconectes*, then, is established to include the blind crawfishes of the Mammoth and Wyandotte Caves. Dr. Hagen, in his monograph

of the American Astacidæ, suspects that some will be disposed to separate the *Cambarus pellucidus* as the type of special genus, but thinks such a course would be the result of erroneous reasoning. Dr. Hagen's view may be the result of the objection which formerly prevailed against distinguishing either species or genera whose characters might be suspected of having been derived from others by modification, or assumed in descent.

The prevailing views in favor of evolution will remove this objection; and for myself I have attempted to show* that it is precisely the structural characters which are most obviously, and therefore most lately, assumed on which we have been in the habit of depending for discrimination of genera. The present is a case in point. So far also as the practice of naturalists goes this course is admissible, for the presence or absence as well as the arrangement of the eyes have long been regarded as generic indications among the Myriopoda and Arachnida. Without such recognition of a truly structural modification our system becomes unintelligible.

Dr. Packard described in his article already quoted an interesting genus of Isopoda allied to the marine form *Idotœa*, which Mr. Cooke discovered in a pool in the Mammoth Cave. He called it *Cœcidotea*. I obtained a second species in a cave adjoining the Wyandotte, which differs in several important respects. The head is smaller and more acuminate, and the bases of the antennæ are more closely placed than in *C. stygia* Pack. I call it *Cœcidotea microcephala*. Both species are blind. The new species is pure white. It was quite active, and the females carried a pair

Fig. 109.

Cœcidotea microcephala Cope, magnified 6.5 times.

*Origin of Genera, p. 41.

of egg pouches full of eggs. The situation in which we found it was pecular. It was only seen in and near an empty log trough used to collect water from a spring dripping from the roof of one of the chambers.

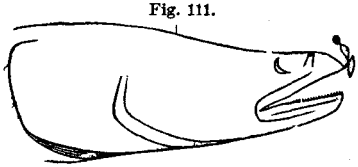
The Lernæan *Cauloxenus stygius* Cope is a remarkable creature. It is a parasite on the blind fish, precisely as numerous species near of kin, attach themselves to various species of marine fishes. The Wyandotte species is not so very unlike some of these. It is attached by a pair of altered fore-limbs, which are plunged into the skin of the host and held securely in that position by the barbed or recurved claws. The position selected by the blind fish *Lernæan* was the inner edge of the upper lip, where she hung in a position provocative of attempts at mastication on the part of the fish, and reminding one of the picture of the man on the ass' back, holding a fork of fodder before the animal's nose, in illustration of the motto that "persuasion is better than force." The little creature had an egg pouch suspended on each side, and was no doubt often brought in contact with the air by her host.

Fig. 110.

Cœcidotea microcephala Cope. The mandible and palpi of right side more enlarged. The outer palpus lies above the lateral plate, and its origin was not seen.

This position would not appear to be a favorable one for long life, as the body of the *Cauloxenus* would be at once caught between the teeth of the fish, should its direction be reversed or thrown backwards. The powerful jaw-arms, however, maintained like a steel spring a direction at a strong angle with the axis of the body, which was thrown upward over the upper lip, the apex of the cephalo thorax being between the lips of the fish. This position being retained, it becomes a favorable one for the sustenance of the parasite, which is not a sucker or devourer of its

Fig. 111.



Cauloxenus stygius in position on the lip of *Amblyopsis spelæus*, enlarged.

host, but must feed on the substrances which are caught by the blind fish and crushed between its teeth. The fragments and juices expressed into the water must suffice for the small wants of this crustacean.

But if the supply of food be precarious, how much more so must be the opportunities for the increase of the family. No parasitic male was observed in the neighborhood of the female, and it is probable that as in the other *Lernæopodidæ*, he is a free swimmer, and extremely small. The difficulty of finding his mate on an active host-fish must be augmented by the total darkness of his abode, and many must be isolated owing to the infrequent and irregular occurrence of the fish, to say nothing of the scarceness of its own species.

Fig. 113.

Cauloxenus stygius. Antennal processes and muzzle more enlarged.

The allied genera, *Achtheres* and *Lernæopoda*, present very distinct distributions, the former being fresh water and the latter marine. *Lernæopoda* is found in the most varied types of fishes and in several seas; *Achtheres* has been observed on perch from Asia and Europe, and in a South American *Pimelodus*. It is to the latter that *Cauloxenus* is most nearly allied, and from such a form we may perhaps trace its descent; modification being consequent on its wandering into subterranean streams. The character which distinguishes it from its allies, is one which especially adapts it for maintaining a firm hold on its host, *i. e.*, the fusion of its jaw arms into a single stem.

Fig. 112.

Cauloxenus stygius. The animal viewed from below, with an infero-lateral view of the cephalothorax.

Whether the present species shared with the *Amblyopsis* its history and changes, or whether it seized upon the fish as a host at some subsequent period, is a curious speculation.

Its location at the mouth of the fish could scarcely be maintained on a species having sight, for if the host did not remove it, other individuals would be apt to.

I may here allude to another blind Crustacean which I took in the Mammoth Cave, and which has been already mentioned in the Annals and Magazine of Natural History as a Gammaroid. Mr. Cooke and myself descended a hole, and found a short distance along a gallery, a clear spring covering, perhaps, an area ten feet across. Here Mr. Cooke was so fortunate as to procure the *Cœcidotea stygia*, while I took the species just mentioned, and which I name *Stygobromus vitreus*. The genus is new, and represents in a measure the *Niphargus* of Schiodte found in the caves of Southern Europe. It resembles, however, the true *Gammarus* more closely, by characters pointed out at the close of this article. This genus has several species in fresh waters, which are of small size, and swim actively, turning on one side or the other.

Of insects I took four species of beetles, all new to science, two of them of the blind carniverous genus *Anopthalmus*, and two *Staphylinidæ*, known by their very short wing-cases and long, flexible abdomen. Dr. George H. Horn has kindly determined them for me. One of them, the *Quedius spelœus* Horn, is a half inch in length, and has rather small eyes.* It was found not far from the mouth of the cave. Dr. Horn furnishes me with the following list of Coleoptera from the two caves in question:

Anopthalmus Tellkampfi, Erichs.	Mammoth Cave.	
Anopthalmus Menetriesi, Motsch, *anagulatus* Lec.	Mammoth Cave.	
Anopthalmus erimita, Horn.	Wyandotte Cave.	
Anopthalmus tenuis, Horn.	Wyandotte Cave.	
Anopthalmus striatus, Motsch.	Mammoth Cave.	Unknown to me.
Anopthalmus ventricosus, Motsch.	Mammoth Cave.	Unknown to me.
Adelops hirta, Tellk.	Mammoth Cave.	

*See Proceed. Amer. Entom. Soc., 1871, p. 332.

These are the only true cave insects at present known in these fauna. Other species were collected within the mouths of the caves, but which can not be classed with the preceding, as cave insects proper.

Catops n. sp.?	Wyandotte Cave.
Quedius spelæus, Horn.	Wyandotte Cave.
Lesteva n. sp.	Wyandotte Cave.

And another, Alæocharide Staphylinide, allied to Tachyusa, also from Wyandotte Cave. No names have as yet been given to any of these excepting the second. A monograph of Catops has already appeared containing many species from our fauna, and as the work is inaccessible at present, I have hesitated to do more than indicate the presence of the above species.

Two other species of true cave insects are known in our fauna; *Anophthalmus pusio* Horn, (Virginia) Erhart's Cave, *Anophthalmus pubescens* Horn, (Illinois) Cave City Cave.

The cricket of the Wyandotte Cave is stouter than that of the Mammoth, and thus more like the *Raphidophora lapidicola* of the forest. There were three species of flies, one or more species of *Poduridæ* and a *Campodea* not determined.

Centipedes are much more abundant in the Wyandotte than in the Mammoth Cave. They especially abounded on the high stalagmites which crown the hill beneath the Mammoth dome, which is three miles from the mouth of the cave. The species is quite distinct from that of the Mammoth Cave, and is the one I described some years ago from caves in Viginia and Tennessee. I call it *Spirostrephon cavernarum*, agreeing with Dr. Packard that the genus* to

* *Pseudotremia.*

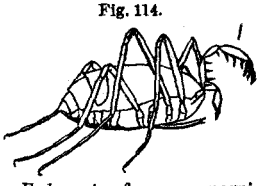
which it was originally referred is of doubtful validity. The species is furnished with a small triangular patch of eyes, and is without hairs, but the antennæ are quite elongate. Its rings are quite handsomely keeled. The allied form found by Caleb Cooke in the Mammoth Cave has been described by Dr. Packard as *Spirostrephon Copei*. It is eyeless, and is, on this account alone, worthy of being distinguished generically from *Spirostrephon*, though the absence of pores asserted by Dr. Packard, would also constitute another character. *Spirostrephon* possesses a series of lateral pores as I have pointed out in accordance with Wood's view.† This genus may be then named *Scoterpes*. I look for the discovery of *S. cavernarum* in the Mammoth Cave.

Two species of Arachnidans were observed, one a true spider, the other related to the "long-legs" of the woods. A species, similar to the former, is found in the Mammoth Cave, and others in other caves, but in every instance where I have obtained them, they have been lost by the dissolution of their delicate tissues in the impure alcohol. The other forms are more completely chitinized and are easily preserved. They are related to the genus *Gonyleptes* found under stones in various portions of the country. Dr. Wood describes a species from Texas, and I have taken them in Tennessee and Kansas. In the Wyandotte Cave I found a number of individuals of a new species at a place called the Screw Hole. This is a narrow passage between masses of rock, which rise from the end of a gallery to the floor of a large room called the Senate Chamber. Though living at a distance of four or five miles from the mouth of the cave, this species is furnished with eyes. Its limbs are not very long, but its palpi are largely developed, and armed with a

† Proceed. Amer. Entom. Soc., 1870.

double row of long spines pinnately arranged, like its relative of the Mammoth Cave, the *Acanthocheir*. This species is described at the end of the article as *Erebomaster flavescens* Cope. In its relationships it may be said to stand between *Acanthocheir* and *Gonyleptes*.

Fig. 114.



Erebomaster flavescens, magnified 7.6 times.*

Besides *Acanthocheir*, another blind Gonyleptid exists in the Mammoth Cave, which I found several miles from the mouth. It is blind like the former, but differs in having many more joints to the tarsi, approaching thus the true *Phalangia*, or long-legs. There are six joints and terminal claws, while *Acanthocheir* is said to have two and *Erebomaster* three joints. It is larger than *A. armata*, and has much longer legs. Its palpi are also longer and their spines terminate in long hairs. I have named it *Phrixis longipes*.

Dr. Packard and Mr. Putnam have already discussed the question of the probability of the origin of these blind cave animals by descent from outdoor species having eyes. I have already expressed myself in favor of such view, and deem that in order to prove it we need only establish two or three propositions. First, that there are eyed genera corresponding closely in other general characters with the blind ones; second, that the condition of the visual organs is in some cave type variable; third, if the abortion of the visual organs can be shown to take place coincidentally with general growth to maturity, an important point is gained in explanation of the *modus operandi* of the process.

Fig. 115.

Erebomaster flavescens. Male organ from below.

First, as to corresponding forms; the *Typhlichthys* of the

* Our engraver has not correctly represented the posterior lateral border of the large dorsal scutum. The mandible should also have been represented as terminating in a pair of nippers.—EDS.

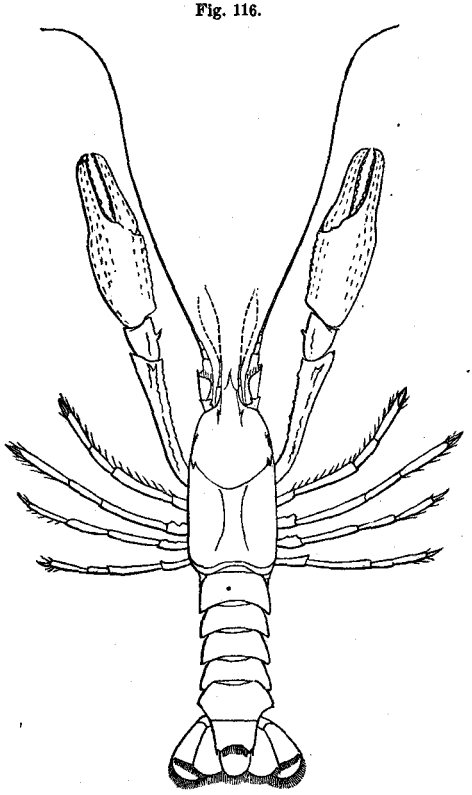
Mammoth is identical* with *Chologaster*, except in its lack of eyes. *Orconectes* bears the same relation to *Cambarus; Stygobromus* bears nearly the same to *Gammarus*, and *Scoterpes* is *Spirostrephon* without eyes, and no pores.

Secondly, as to variability. I have already shown that in *Gronias nigrilabris*, the blind Silurid from the Conestoga in Pennsylvania, that while all of several specimens observed were blind, the degree of atrophy of the visual organs varies materially, not only in different fishes, but on different sides of the same fish. In some the corium is imperforate, in others perforate on one side, in others on both sides, a rudimental cornea being thus present. In some the ball of the eye is oval and in others collapsed. This fish is related specifically to the *Amiurus nebulosus* of the same waters, more nearly than the latter is to certain other Amiuri of the Susquehanna river basin, to which the Conestoga belongs, as for instance the *A. albidus;* it may be supposed to have been enclosed in a subterranean lake for a shorter time than the blind fishes of the Western caves, not only on account of the less degree of loss of visual organs, but also in view of its very dark colors. A feature on which I partly relied in distinguishing the species has, perhaps, a different meaning. The tentacles or beards were described as considerably shorter than those of allied species. On subsequently examining a number of individuals I was struck with the irregularity of their lengths, and further inspection showed that the extremities were in each case enlarged, as though by a cicatrix. I have imagined that the abbreviation of the tentacles is then due to the attacks

*Mr. Putnam shows that the known species of *Chologaster* differ from those of *Typhlichthys* in the lack of the papillary ridges, which is probably another generic character similar to the loss of eyes. The absence in *Chologaster* of minute palatine teeth, and the presence of an additional pair of pyloric cæca, which he mentions, will be apt to prove only specific

of carnivorous fishes which inhabit the subærial waters into which the *Gronias* strays, from whom its blindness renders it unable to protect itself.

Fig. 116.



Orconectes pellucidus var., nat. size.

Thirdly, it is asserted that the young *Orconectes* possess eyes, and that perhaps those of the *Typhlichthys* do also. If these statements be accurate, we have here an example of what is known to occur elsewhere; for instance, in the whalebone whales. In a fœtal stage these animals possess rudimental teeth like other Cetacea, which are subsequently absorbed. This disappearance of the eyes is regarded with

reason by Professor Wyman as evidence of the descent of the blind forms from those with visual organs. I would suggest that the process of reduction illustrates the law of "retardation," accompanied by another phenomena. Where characters which appear latest in embryonic history are lost we have simple retardation; that is, the animal in successive generations fails to grow up to the highest point, falling farther and farther back, thus presenting an increasingly slower growth in this special respect. Where, as in the presence of eyes, we have a character early assumed in embryonic life, the retardation presents a somewhat different phase. Each successive generation, it is true, fails to come up to the completeness of its predecessor at maturity, and thus exhibits "retardation;" but this process of reduction of the rate of growth is followed by its termination in the part long before growth has ceased in other organs. This is an exaggeration of retardation. Thus the eyes in the *Orconectes* probably once exhibited at maturity the incomplete characters now found in the young, for a long time a retarded growth continuing to adult age before its termination was gradually withdrawn to earlier stages. Growth ceasing entirely, the phase of atrophy succeeded, the organ becomes stationary at an early period of general growth, being removed, and its contents transferred to the use of other parts by the activity of "growth force." Thus for the loss of late assumed organs we have "retardation," but for that of early assumed ones, "retardation and atrophy."

In comparing the list of animals from the Wyandotte with that of the Mammoth Cave, it will be observed that the representatives in the former of two of the blind genera of the latter, are furnished with eyes. These are the *Erebomaster* and *Spirostrephon*, which correspond with the *Acan-*

thocheir and *Scoterpes* respectively. In the outer part of a branch of tbe Wyandotte I took two eyed beetles, the *Quedius spelœus* and a *Platynus.*

The outdoor relatives of the blind forms are various. Those having congeners outside are the *Spirostrephon, Campodea, Machilis Phora, Raphidophora.* Those with near but few allies, the *Scoterpes, Amblyopsis* and the three *Gonyleptidæ.* Species of the latter are much more rare in this country than those of *Phalangiidæ,* which are not known from the caves. The *Orconectes* is mostly fresh water in kindred, while Packard shows that those of the *Cœcidotea* are marine. Those of the *Cauloxenus* are partly marine, and those of the *Stygobromus* fresh water and marine.

The mutual relations of this cave life form an interesting subject. In the first place, two of the beetles, the crickets, the centipede, the small crustaceans (food of the blind fish) are more or less herbivorous. They furnish food for the crawfish, *Anopthalmus,* and the fish. The vegetable food supporting them is in the first place fungi, which in various small forms, grow in damp places in the cave, and they can always be found attached to excrementitious matter dropped by the bats, rats and other animals which extend their range to the outer air. Fungi also grow on the dead bodies of the animals which die in the caves, and are found abundantly on fragments of wood and boards brought in by human agency. The rats also have brought into fissures and cavities communicating with the cave, seeds, nuts, and other vegetable matters, from time immemorial, which have furnished food for insects. Thus rats and bats have, no doubt, had much to do with the continuance of land life in the cave, and the mammals of the post-pliocene or earlier period, which first wandered and dwelt in its shades were introducers of a permanent land life.

As to the small crustaceans, little food is necessary to support their small economy, but even that little might be thought to be wanting, as we observe the clearness and limpidity of the water in which they dwell. Nevertheless the fact that some cave waters communicate with outside streams is a sufficient indication of the presence of vegetable life and vegetable debris in variable quantities at different times. Minute fresh water algæ no doubt occur there, the spores being brought in by external communication, while remains of larger forms, as confervæ, etc., would occur plentifully after floods. In the Wyandotte cave no such connection is known to exist. Access by water is against the current of small streams which discharge from it. On this basis rests an animal life which is limited in extent and must be subject to many vicissitudes. Yet a fuller examination will probably add to the number of parasites on those already known. The discovery of the little Lernæan shows that this strange form of life has resisted all the vicissitudes to which its host has been subjected. That it has outlived all the physiological struggles which a change of light and temperature must have produced, and that it still preys on the food of its host as its ancestors did, there is no doubt. The blindness of the fish has favored it in the "struggle for existence," and enabled it to maintain a position nearer the commissariat, with less danger to itself than did its forefathers.

SALTPETRE CAVE.

Half a mile northwest from the Wyandotte House, and about one hundred feet lower down, in a ravine, a doorway, five or six feet high and thirty feet wide, spanned by heavy ledges of limestone, gives entrance to a room two hundred and twenty-five feet long, seventy-five feet wide and fifteen to thirty high, with flat, clean ceiling. The contents and nitrous earth of the floor was removed for the manufacture of saltpetre during the war of 1812; fragments of the lixiviating hoppers, vats, troughs and furnaces still remain after a lapse of more than sixty years, showing the extent and importance of the work carried on by Dr. Adams.

Near the door, on the right, are two columnar stalactites, ten feet long and fifteen to twenty inches in diameter, which have become united from the center downwards—they are known as the "Siamese Twins;" heavy fringes of stubby stalactites ornament a few of the rocky ledges. In the right hand corner two enormous inverted funnel-shaped chimneys loom up out of sight and light, through the rock, about fifteen feet in diameter—a "Cyclopean furnace." Many pebbles and rounded stones of various sizes, show the volume and velocity of the current of water which once flowed here and excavated this cavern.

LITTLE WYANDOTTE CAVE.

This is close to the hotel, and from parallelism of direction, it is probable that it was once connected in some way with the main cavern, and that passages which once existed are now banked up with silt or fallen rocks; the separation is not great, for on one occasion, when a military band was playing in the latter, the music was distinctly heard in the inner chamber of Little Wyandotte. The whole length is about two thousand feet; it is entered by descending a ladder

in a well-shaped opening about three feet in diameter, situated on the side of a sink funnel. After recovering from the sudden darkness, on entering, the vestibule is found to be twenty by forty feet, and ranging from two to fifteen feet high, with a few round or flat stalactites pendant from the roof. Proceeding north the narrow passage is almost obstructed by a huge columnar stalagmite, five feet high and two and a half in diameter, wonderfully symmetrical in form, called "Pompey's Pillar," which guards the entrance to the house of the "Star Eyed Egyptian"—"Cleopatra's Palace"—which is a gem of beauty; hundreds of stalactites, from snowy white to brown, hang from the roof, isolated or clustered in sheaves and fringes. The recesses are draped in wave-folded stone, hanging at places as heavy as damask and at others light as silk. Many of the stalactites are short resonant tubes, while others reach from roof to floor, with little or no variation in size; the floor is encumbered with stalagmites from a few inches to two feet high, and from one to three feet in diameter, finely illustrating Southey's picture of "stone drops from the cavern's fretted hight." On the right stalagmites reach up and blend with stalactites and form a pillared recess, draped about the top with clusters of needle-shaped pendants in sheaves. Close by a broken column, the work of some vandal Anthony, lies prone, and is called "Cleopatra's Couch" and "Bower." The Egyptian department is thirty feet long, twenty feet wide, and from five to twenty high. A pit succeeds, in which flows the "River Styx" at flood time; the violence of this winter torrent is indicated by the extent of the chasm, which is dark as Phlegethon and reported as sixty feet deep; but, happily for moderns, is bridged with a slippery, rough stone beam; crossing this "Natural Bridge," a massive, fluted, monolitic column blocks the way; crawling around and under the inclined side, it is found to be a

great stalactite, thirteen and a half feet long and three to six feet in diameter, which has fallen from a dark recess in the ceiling; it leans against and partly covers its opposing stalagmite, an obtusely conical monster, ten feet in diameter and eleven feet high, decked with shelly plaits along its fluted sides, which, when gently struck, give out soft, musical notes, Immediately beyond this passage is a fluted stalagmite, eighteen feet high and two and a half in diameter, which supports or opposes a succession of stalactites reaching seven feet back, connected by a heavily folded stone curtain fretted with white coral work; behind this curtain some exquisite cave decorations are seen on the "Corinthian Column," a straight, symmetrical shaft which springs from floor to ceiling, nine and a half feet long and scarce three inches in diameter; a number of slender, tubular stems cluster around the capital of this column, each terminated with a drop of water, which glistens in the artificial light like a well cut diamond. The remainder of the room is crowded from floor to roof with a profusion of lime work, representing curtains, fringes, columns, mouldings, cornices, etc. Twenty yards beyond is a small chamber forty feet long, twelve wide and high, containing a single stalactite and two stumpy stalagmites, succeeded by a long, low passage, once the lair of beasts. In the vault beyond is the "Tomb of Moses," a coffin-shaped mass of rock twelve feet long, four wide and three feet high; stalagmitic tapers have grown up at the head, and from above is suspended a cluster of points all tipped with water, which, in the lamplight, glow like fire. With the conviction that there is no mistake about Moses or the reality of his alleged tomb you pass on to the most brilliant illustration of dreamy cave life, a combination of all the peculiar, weird, startling, fascinating forms, pillars, columns, obelisks, spires, minarets

and domes, built up in Parian whiteness or opalescent alabaster, promiscuously crowded into a space sixty feet long, fifteen to thirteen feet wide and ten to fifteen high.

Some of the ornaments are colossal, with robust strength, others are delicate and slender, as if a mere snow line, all enriched with fringes of pearly tubes, tipped with the ever-present, sparkling drops; crystal alcoves, elfin recesses and fairy bowers are hidden in every nook. The name of "Pantheon" has been suggested for this "Crystal Palace." "Jupiter" reigns on the "Pillar of Clouds," "Venus" sleeps in Parian marble, "Diana" aims at a shadowy doe, "Ceres" waves her golden sheaves, but dearer to Saxon hearts are the elfs and fays that hold festival in a hundred nooks and crannies; last "Cupid," with his arrows tipped with fire, is ever ready to transfix twin hearts and register troths plighted before his pearly shrine.

The whole of the Pantheon is a group of wonders, demanding long study to be fully understood and appreciated.

ECONOMIC GEOLOGY.

There is room for improvement in the agriculture of this county. The river bottoms are highly productive, and with judicious rotation of crops will prove fertile for years to come; the level plateau covering the elevated region on the eastern side of the county may be referred to lacustral origin. It has a close, cold soil, which in dry seasons, or when well drained, shows great strength, producing good crops of hay, wheat, etc. This may be greatly enlarged, and the crops wonderfully increased by a judicious system of tile and open-air drains, and thus the value of the farms brought up to an average with more favored regions. The soil in the hilly regions of the western part of the county is, as a rule, composed of fine siliceous material, easily exhausted, and requires careful management. Exhaustive crops should be avoided,

the stalks, straw and chaff of all the crops should invariably be returned to the soil as manure, and a large area devoted to fruit and orchard grass for permanent pastures and clover. Exhausted fields may be profitably treated every five years with a dressing of thirty to fifty bushels of lime to the acre. Experiments through a series of years in adjoining counties show that the application of 150 to 200 pounds of bone dust per acre, costing from twenty to twenty-two dollars per ton, gives an increase of 75 to 100 per cent. in the yield of wheat, corn, etc., and its use proves remunerative.

The following was reported as average crops:

Wheat, upland	5 bushels per acre.
Wheat, bottoms	11 bushels per acre.
Corn, upland	20 bushels per acre.
Corn, bottom	30 bushels per acre.
Onions	200 to 300 bushels per acre.
Potatoes	150 to 300 bushels per acre.

From Leavenworth the following shipments of farm products were reported for 1876:

Onions, 4,000 bushels, at 50 cents per bushel	$2,000
Potatoes, 4,500 bushels, at 50 cents per bushel	2,750
Dried apples, 5,000 bushels, at $1 per bushel	5,000
Apples, 30,000 barrels, at $1 per barrel	30,000
Apple brandy, 20,000 gallons, at $1.40 per gallon	28,000
Sorghum syrup, 18,330 gallons, at 33 cents per gallon	6,100
Cider, 1,100 barrels, at $4 per barrel	4,400
Cabbages, 40,000 heads, at 5 cents per head	2,000
Chestnuts, 25 bushels, at $2.50 per bushel	62
Total	$80,312

Small fruits and the peach seem well adapted to the hilly uplands, and with fair culture a failure is rare. Apple orchards are numerous, produce well, and with diligent management are highly remunerative. At the county seat an establishment for canning and drying fruit, with im-

proved steam fixtures, would, with reasonable certainty, prove profitable to farmers and operators.

The following exhibit of the production of apples in 1877 is made up from reports of Messrs. Roberson, Ellsworth and Panky:

APPLE CROP OF 1877.

	Barrels.
Union township	50,000
Johnson township	8,000
Patoka township	12,000
Sterling township	65,000
Liberty township	20,000
Whiskey-run township	60,000
Jennings township	100,000
Ohio township	150,000
Boone township	15,000
	480,000

Much of this fruit is consumed by stock on the farm; it is sold on the trees for fall and winter feeding at ten to fifteen cents per bushel, and when delivered at Leavenworth the price ranges from fifteen to twenty cents per bushel; not more than ten per cent. of the crop is shipped out of the county.

Either the nature of the soil is injurious to burrowing grubs, or the sulphurous character of the atmosphere, derived from sulphur springs, gas seeps and the decomposition of pyritous shales, protects fruit from many pests, elsewhere so injurious to such crops. A vineyard of sixty acres has been planted by Brown & Co. on the summit of the high knob near Leavenworth, with good prospects.

BUILDING MATERIALS.

Building materials are abundant; clay of excellent quality is found and used in almost every part of the county; sand for plastering and mason's uses is obtained from bars along the creeks and river, and beds, furnishing excellent samples

for this purpose and for the manufacture of glass, occur at Pilot Knob, near Brownsville, and other places, where the lower strata of the Conglomerate is in a disintegrating condition.

The massive beds of Chester sandrock may be recommended as furnishing, at low prices, good material for foundations, piers, rouble masonry, grindstones and whetstones; this stone is of good quality, and may be more readily quarried and shipped than any other rock observed in this part of the State.

Paving stones, so ripple-marked as to give adhesion to the foot, are easily accessible and of remarkable endurance.

Beds of oolitic limestone are of great thickness near Milltown, and thinner ledges occur on Little Blue river and at Leavenworth; it is almost snow white or of a creamy tint, nearly pure, and capable of a high finish, and of sufficient strength to bear the heaviest burdens. Samples from a neighboring quarry give the resistance to crushing weight at 10,250 pounds per square inch, a cubic foot weighs 149.59 pounds, and the ratio of absorption is 1 to 27.

This limestone has no equal for making quick-lime; on account of its superior purity the attention of lime burners is called to this stone.

ANALYSIS OF OOLITIC LIMESTONE.

	Per cent.
Water dried at 212° F	0.50
Silicates	0.31
Ferric oxide	0.18
Alumina	0.14
Lime	54.93
Magnesia	None.
Carbonic acid	43.17
Sulphuric acid	0.25
Chlorides	0.40
Combined water and loss	0.12
	100.00

The timber supply is good. Large quantities of oak, hickory, poplar and walnut lumber are shipped; the forests are extensive and can supply a large demand.

The water power is largely in excess of local necessities, and many valuable sites are unoccupied, and those on Blue river are worthy of examination by millers and manufacturers; the river is fed by cave springs, hence the summer stream is reliable, and the pure water is admirably adapted to the manufacture of white paper and chemical products.

DOMESTIC ANIMALS.

The breeding of improved stock does not receive that attention in this county that is given to it in regions where large areas are devoted to permanent pastures. The horses, as in all hilly countries, are hardy, patient and well muscled. Hogs are extensively grown, the large biennial crop of acorns accounts for the immense productions of pork for the favored years, a difference of $50,000 to $75,000 being reported.

MINERAL SPRINGS.

These springs have an enviable local character for curative power. The White Sulphur waters are declared, by resident physicians, to have specific efficacy in diseases of the kidneys, skin, liver and mucous membranes, and also highly remedial in cases of dyspepsia, rheumatism, scrofula and kindred diseases.

The following analyses of waters from Crawford county were made by Dr. G. M. Levette in the laboratory of the Geological Survey, and show the chemical value of these waters:

ANALYSIS OF WATER FROM EATON'S WHITE SULPHUR WELL.

(Southeast quarter Sec. 35, Town. 3 south, Range 1 west.)

One imperial gallon (ten pounds) contains 316.241 grains of solid matter.

The water was transported from the spring to the laboratory in stone jugs, and at the time of examination had lost a portion of sulphydric acid and carbonic acid gases originally in it. Sulphydric acid found at the time of examination, 2.35 cubic inches per gallon.

The mineral constituents found are given in grains in one imperial gallon:

	Grains.
Ferric oxide	1.480
Lime	27.830
Magnesia	23.890
Potash	3.500
Soda	5.700
Sodium	59.190
Sulphuric acid	53.693
Carbonic acid	49.615
Chlorine	91.343
	316.241

The above constituents are probably combined as follows:

	Grains.
Carbonate of protoxide of iron	2.384
Bicarbonate of lime	57.021
Bicarbonate of magnesia	20.160
Sulphate of lime	13.744
Sulphate of magnesia	52.775
Sulphate of soda	13.145
Sulphate of potash	6.479
Chloride of sodium	150.533
	316.241

For medicinal qualities of the above water see page 444.

ANALYSIS OF WATER FROM THE "TAR SPRING."

(Southeast quarter Sec. 15, Town. 3, Range 1 west.)

This water had a slight odor of petroleum, with a few globules of oily matter floating on the surface. It contained no sulphydric acid or chlorine.

Total solid matter in one imperial gallon, 50.003 grains, composed of the following:

	Grains.
Ferric oxide	2.800
Lime	10.080
Magnesia	4.380
Potash	1.100
Soda	1.850
Sulphuric acid	10.522
Carbonic acid	19.271
	50.003

The above constituents are probably combined as follows:

	Grains.
Carbonate of protoxide of iron	4.511
Bi-carbonate of lime	25.925
Bi-carbonate of magnesia	2.495
Sulphate of magnesia	10.799
Sulphate of soda	4.237
Sulphate of potash	2.036
	50.003

For medicinal properties of the above water see page 445.

ANALYSIS OF WATER FROM OTT'S SALT WELL, AT MIFFLIN POSTOFFICE.

(Sec. 32, Town. 2 south, Range 1 west.)

This water has a strong smell of sulphydric acid, and still held 3.2 cubic inches to the gallon after standing in a jug for four or five weeks.

Total solid matter in one imperial gallon: 5328.75 grains.

Quantitative analysis gave the following:

	Grains.
Ferric oxide	9.100
Lime	235.460
Magnesia	65.220
Potash	6.000
Soda	12.660
Sodium	1846.760
Sulphuric acid	65.444
Carbonic acid	238.105
Chlorine	2850.001
	5328.750

The above constituents are probably combined as follows:

	Grains.
Carbonate of protoxide of iron	14.661
Bi-carbonate of lime	401.089
Bi-carbonate of magnesia	107.035
Sulphate of lime	26.347
Sulphate of magnesia	42.754
Sulphate of soda	28.996
Sulphate of potash	11.107
Chloride of sodium	4696.761
	5328.750

For description of the above well and water see page 448.

ANALYSIS OF WATER FROM BENHAM'S CARBURETTED SALINE WELL.

(Sec. 4, Town. 3 south, Range 1 west.)

Total solid matter in one imperial gallon 7240.8 grains, consisting of:

	Grains.
Ferric oxide	6.650
Lime	323.790
Magnesia	102.100
Potash	15.160
Soda	11.280
Sodium	2461.800
Sulphuric acid	117.632
Carbonic acid	638.495
Chlorine	3563.893
	7240.800

The above constituents probably exist in the water in the following combinations:

	Grains.
Carbonate of protoxide of iron	10.713
Bicarbonate of lime	795.910
Bicarbonate of magnesia	215.232
Sulphate of lime	34.818
Sulphate of magnesia	104.537
Sulphate of soda	25.836
Sulphate of potash	28.063
Chloride of sodium	6025.691
	7240.800

For description of the above well and water see page 450.

ANALYSIS OF WATER FROM HARTFORD SULPHUR SPRING.

(Sec. 13, Town. 2 south, Range 1 west.)

This water, as received from the spring with those above described, had a slight odor of sulphydric acid, and yielded 0.785 of a cubic inch per gallon.

Total solid contents in one imperial gallon, 144.2 grains, consisting of:

	Grains.
Ferric oxide	1.400
Lime	12.500
Magnesia	8.480
Potash	0.850
Soda	4.220
Sodium	28.648
Sulphuric acid	20.151
Carbonic acid	23.741
Chlorine	44.210
	144.200

The above constituents are probably combined in the water as follows:

	Grains.
Carbonate of protoxide of iron	2.255
Bicarbonate of lime	24 691
Bicarbonate of magnesia	11.355
Sulphate of lime	7.042
Sulphate of magnesia	14.761
Sulphate of soda	9.665
Sulphate of potash	1.573
Chloride of sodium	72.858
	144.200

For medicinal qualities of this water see page 450.

COAL.

The coals of this county are outcrops of coal A, the lowest seam in the Indiana coal field. They are generally thin, and the coal, as a rule, is impure and sulphurous. A few openings were exceptionally pure, as that at Knight's bank, which is a rich, caking coal, excellent for stove and blacksmiths' use; banks of similar quality may be expected in neighboring localities. There is no surplus for shipment. The under clays of this coal will furnish abundant supplies of fire clay for bricks, potteries, tiles and terra cotta wares.

SALT.

Salt was formerly made at the Ott and Benham wells; the brine was rich, producing twenty barrels of salt per day, and the salt was pure, but not in sufficient quantity to defray the expense of the fixtures for evaporation, etc. Boring to a greater depth will not increase the quantity of brine, but probably reduce its strength by dilution and decomposition.

PETROLEUM.

Petroleum, or mineral tar, has been found on the surface at springs and seeps in small quantities at more than twenty localities. During the "oil excitement," from 1864 to '68, ten wells were bored in this county, and almost every one yielded a "show" of oil, but in no case could a yield of more than a pint a day be heard of, and in some cases only a few oily drops upon the surface of thousands of barrels of water was found to reward the toil and capital of enthusiastic seekers after "more light." The oil supplying rocks of this vicinity are so limited that there is hardly a possibility of striking a paying well, and money invested in such an enterprise will be literally "sunk." Some of the white sulphur fountains now running from wells bored for oil are more valuable than any oil well possible in the county.

MARL.

A pyritous shale of considerable thickness has been noted on preceding pages, lying above and beneath the Kaskaskia or upper limestone of the Chester group. On exposure it is pulverulent, and in this condition, on account of the sulphurous gases in the air and sulphates in the water, it is intolerant of vegetal life, and such exposures are black, barren spots, locally called "glades."

Strata of the same horizon in Grayson county, Kentucky, were examined by A. J. Norwood, who says:* "The shales or marls are valuable. Their position is in the Chester group, and are found, when developed, over a large portion of the western part of the State. The marls are wonderfully rich in potash and soda, and for that reason possess properties which should render them unexcelled for fertilizing worn out tobacco lands.

*Kentucky Geol. Rep., 2d series, Part VIII, Vol. IV.

"ANALYSIS OF CHESTER MARLS.

(After being dried at 212° F.)

	Per cent.
Oxide of iron, alumina, etc.	27.811
Carbonate of lime	0.880
Magnesia	0.824
Phosphoric acid	0.109
Potash	5.554
Soda	0.667
Silica and insoluble silicates	59.920
Water and loss	4.235
	100.000

Tested by farmers and gardeners in Crawford county, this decomposed shale is of little or no more value than an equal amount of common clay; applied to a worn, sandy soil, it acts mechanically to retain moisture, rather than as a fertilizer.

ROADS.

The highways and roads are not first-rate, they ought to be made better; there is great room for improvement. There can be no high realization of civic life, no full enjoyment of property and the fruits of labor without free social and commercial intercourse; this is impossible without improved highways, passable at all seasons of the year. Limestone makes good, durable roads, when broken and applied to well-drained road-beds. The great abundance and cheapness of this material in the region under discussion, would seem to insure, in a short time, its almost universal application. The citizen who constructs the first mile of stone road in this county will be, by example, a public benefactor.

The streets of Leavenworth might be raised above high water mark and piked. A practicable route commencing near the seminary, and gradually winding around the ravine leading by the cemetery to the summit, may be located by a

competent engineer. From the top of the bluff, the great level plateau invites the construction of a good pike to Marengo, with branches to Milltown, Wyandotte, Grantsburg and Hartford. Such an enterprise, easily accomplished under intelligent direction, will largely increase the trade and importance of the county-seat, and be of unspeakable value and convenience to the farmers along the route, and citizens of interior villages. Experience shows that a beginning is often the herald of success.

It is proper to add that the lands of this county offer inducements to emigrants. Homes can be had very cheap. A thousand families could each secure a forty acre tract at less than two hundred dollars per tract, generally bearing enough timber to pay for the farm and improvements. The citizens earnestly invite attention to their cheap lands.

THANKS.

Acknowledgments are due to all the people of the county for uniform courtesy and assistance. My heartiest thanks are returned for hospitality, guidance and special favors, to the Louisville, New Albany & Chicago Railway Company, W. P. Everdone, W. M. Ellsworth, Dr. E. R. Hawn, the Messrs. Rothrock, S. T. Mann, H. W. Conrad, R. H. Sands, J. T. Crecilius, Samuel Mix, E. and O. Leavenworth, Hon. John Benz, E. Hostetter, M. T. Knight, A. M. Sipes, Judge McMikle, N. M. Morgan, Malachi Ott, J. J. Clark, H. B. Meylin, Messrs. Roberson, Edwin Finch, and many others whose names I do not now recall.