MICHIGAN ACADEMY OF SCIENCE, ARTS AND LETTERS

VOLUME IV
PART 1

CONTAINING PAPERS SUBMITTED AT THE ANNUAL MEETING IN 1923

The annual volume of Papers of the Michigan Academy of Science, Arts and Letters is issued under the joint direction of the Council of the Academy and of the Executive Board of the Graduate School of the University of Michigan. The editor for the Academy is Paul S. Welch; for the University, Eugene S. McCartney.

Previous publications of The Michigan Academy of Science now known as The Michigan Academy of Science, Arts and Letters, were issued under the title, Annual Report of the Michigan Academy of Science. Twenty-two volumes were published, of which those numbered 1, 21 and 22 are out of print. Copies of the other volumes are still available for distribution and will be sent on exchange so long as the editions last. Applications for copies should be addressed to the Librarian of the University of Michigan.

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PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

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New York

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Set up and printed,
February, 1925

PRINTED IN THE U.S.A.

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DATES OF PUBLICATION OF PREVIOUS VOLUMES

VOL. I: April 26, 1923
VOL. II: Jan. 18, 1924
VOL. III: March 15, 1924

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SOME NEW SPECIMENS OF TRIASSIC VERTEBRATES IN THE MUSEUM OF GEOLOGY OF THE UNIVERSITY OF MICHIGAN

E. C. CASE

THE Museum of Geology of the University of Michigan has recently completed the preparation of several most interesting specimens of Triassic vertebrate fossils, from the Dockum beds of western Texas.

The first of these to be described is the lower jaw of a Phytosaur, No. 8855, referable to *Leptosuchus crosbiensis* (Pl. XXII, Fig. 1). The specimen shows the complete left side and the whole of the right side as far back as the symphasis. Its chief interest lies in the fact that a large number of the teeth are preserved, from the most anterior to the last posterior one of the left side. This permits a thorough understanding of the dentition of the mandible. On the left side there are forty-three teeth and sockets posterior to the three large tusks, or forty-six in all; on the same side there are thirty-one teeth and sockets anterior to the symphasis and on the right side there are thirty teeth and sockets in the same space.

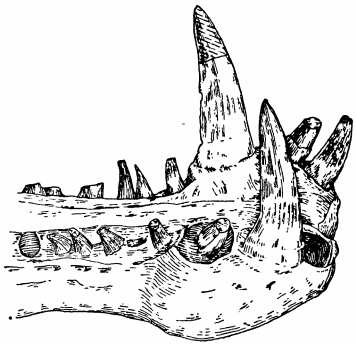

FIG. 9. Anterior end of the mandible of *Leptosuchus crosbienesis*, No. 8855, University of Michigan x ½

The anterior end of the mandible is slightly expanded and has three large tusks or sockets on each side (Text Figure 9). The two posterior tusks on each side are the larger and, as is so common in the primitive reptilian and amphibia, were replaced alternately. Thus the posterior socket on the left side is occupied by a large functional tusk and the anterior one is occupied by a new one about half-grown; on the right side the anterior socket is occupied by a functionally complete tusk and the posterior one by the apex of one which is just appearing. The most anterior tusks are smaller than the two behind and are represented by a complete tooth on the left side and an empty socket on the right side.

The teeth immediately posterior to the tusks are very small and conical, or slightly curved conical. The reduction in size cannot be in correlation with the tusks of the upper jaw as the latter close in front of the lower tusks. The teeth gradually increase in size toward the back of the jaw, retaining the conical form to a point behind the symphasis, but gradually becoming oval in section at the base, with the longest diameter transverse to the long axis of the jaw; this is very marked in the thirtieth tooth. In the thirty-first and thirty-second teeth the height has begun to diminish and the section of the base becomes decidedly elongate-oval with the reappearance of serrate cutting edges. The thirty-fourth tooth on the left side has the low crown and narrow oval section characteristic of the cheek teeth in all the Phytosauria. The greatest diameter of the tooth is still transverse to the axis of the jaw. Posterior to this there are two complete teeth and the broken root of a third, all showing the greatest diameter parallel to the edge of the jaw.

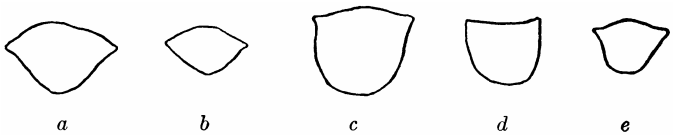

FIG. 10. Cross-sections of various teeth: *a*, base of thirty-fourth tooth of left side; *b*, near top of same; *c*, base of tusk of right side; *d*, near middle of same; *e*, near top of left tusk. All figures x 1.

The anterior tusks are convex externally and more nearly flat internally, near the base, but become more nearly narrow-oval toward the apex. The edge formed by the meeting of the two surfaces is sharp and finely serrate. In Figure 10 is shown the section of the two large tusks; *c* and *d* are from near the base and the middle of the tusk of the right side and *e* from near the top of the left tusk. Figures *a* and *b* are sections from the thirty-fourth tooth on the left side, at the base and near the top. The character of the serrations on the cutting edges is shown in Figure 11.

The anterior tooth of the left side is decidedly fluted from the base to the apex; it is more nearly round than the larger tusks, but has distinct cutting edges. The larger tusks show broad flutings, faintly marked but distinct. The smaller conical teeth are fluted from the base to near the apex; the flutings are low but distinct and are continuous, becoming more crowded near the tip where they disappear either from wear or naturally. Figure 12 shows the flutings on the seventh and eighth teeth of the right side.

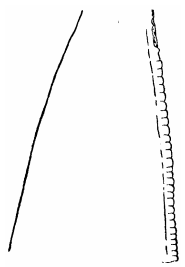

FIG. 11. Cutting edge of one of the large tusks, showing character of the serrations x 2½.

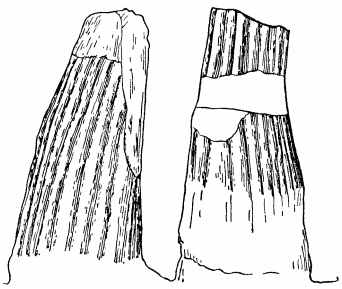

FIG. 12. Seventh and eighth teeth of the right side, showing the character of the fluting x 2½.

The total length of the lower jaw is 82 cm. and the presymphasial portion is 36.5 cm. These measurements correspond very closely with those of the holotype of *Leptosuchus crosbiensis* No. 7522, University of Michigan.

The second specimen to be mentioned is the skull of *Leptosuchus imperfecta*, No. 7523, University of Michigan. This specimen, Plate XXII, Figure 2, is larger than *Leptosuchus crosbiensis*, having a length of 112.5 cm. It was found as a mass of broken fragments and has required a large amount of time to restore; fortunately, from one side or the other there is complete continuity from the posterior end to the tip of the snout. The apparently restored portion near the anterior end of the snout is justified by the continuity of the bone on the under side. The chief interest of the specimen lies in the pathological condition of the anterior end of the elevation of the snout. As shown in Plate XXIII, Figure 1, the nares are in the normal position and the upper edge of the elevation of the snout runs forward nearly horizontally for a short distance and then descends rapidly to the level of the upper surface of the low rostrum. At the angle where the snout begins its descent, there is a heavy rugose swelling of the median bones. The rugosities have a roughly radial arrangement from the top downward and outward; the top of the swollen area is occupied by a nearly hemispherical cavity which would just about accommodate a tennis ball. The sides of the cavity are smooth, but the surface is porous or spongy instead of hard and glistening, as in normal bone.

The presence of this cavity seems explainable only as the result of a pathological condition, the seat either of an abscess of the bone or of a deep-seated tumor. In an abscess caused by infection or by injury, the cavity is very irregular and the accompanying exostoses are equally irregular. The presence of such an abscess would accord well with the suggestions of Abel, who believes that the various forms assumed by the rostra of the Phytosauria can best be explained as the result of injuries inflicted in battles between members of the same species, probably during the mating season.[1] Opposed to this suggestion are the symmetrical character of the cavity, the smooth internal wall, and the rather regular radial arrangement of the rugosities on the outer side of the swelling. Doctor A. S. Warthin, of the Department of Pathology in the University Medical School, has suggested that the smooth cavity may have been the seat of a tumor; an explanation that is much more plausible than that of a simple abscess. It is most interesting to note in this connection that even the Phytosauria of the Mystrioscuhus type, with the low, slender rostra, have very frequently a low swelling on the upper surface; this has been noted by both Von Huene and the author of this paper.

A third specimen of a Phytosaur, No. 8853, University of Michigan, is the posterior end of the lower jaw of an individual nearly a fourth larger than *Leptosuchus imperfecta*; this means a skull nearly four and a half feet long, one of the largest that have been recorded.

The last specimen to be described is the upper portion of the skull of a very large Stegocephalian, No. 8854, University of Michigan, probably specifically identical with the holotype of *Buettneria perfecta*. This skull was found in broken fragments and is in part restored, but the restorations of one side are largely from the preserved parts of the other side; only the tip of the nose is entirely restored and this cannot be wrong by more than a few millimeters, as a part of the rim of the external nares is preserved on both sides. The character of the skull is shown in the photograph, Plate XXIV, and the restored portions are indicated by dotted shading in Plate XXIII, Figure 2. The specimen very closely resembles the skull

of Buettneria perfecta in the position and relations of the bones and grooves for the canals of the dermal sensory system.[2] The slight differences in the sculpture, the deep grooves accommodating the sutures, in places, and the slight differences in the size and relative position of the orbits may easily be the result of age and growth.

The large size of the skull is the most striking feature; in this it approaches some of the largest specimens which have been collected from the European Trias. The existence of an amphibian of this size has been previously indicated only by the very large interclavicle, No. 7265, University of Michigan, figured by the author of this paper in 1923.[3]

[1] Abel, O. *Paleontologische Zeitschrift*, Bd. V, Hft. 1, 1922, s. 26.

[2] Compare with Figure 1, A and B, *Publication 321*, Carnegie Institution of Washington.

[3] *Publication No. 321*, Carnegie Institution of Washington, Plate 3, Figure *a*.

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EXPLANATION OF PLATES

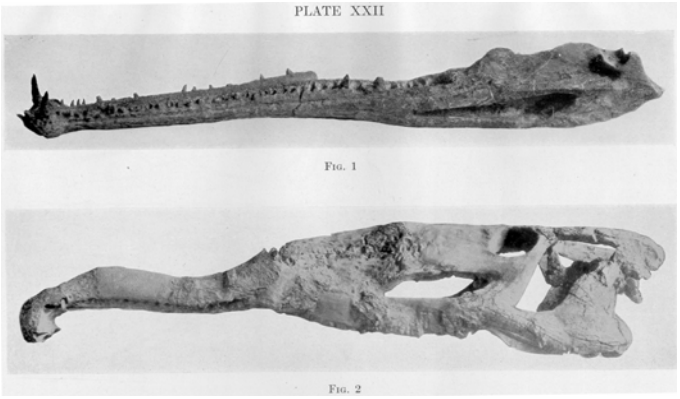
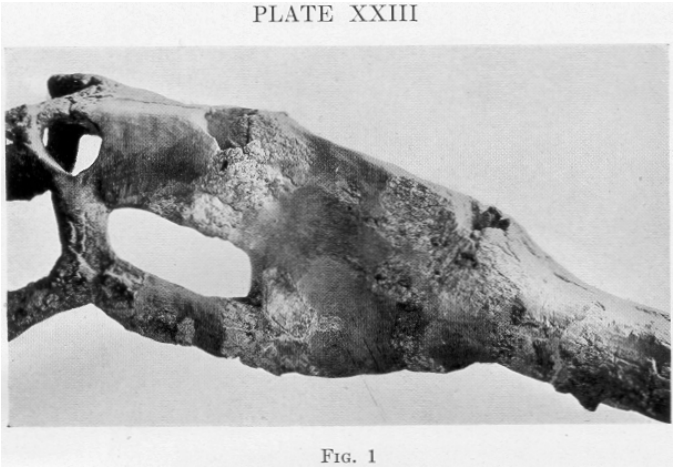


PLATE XXII

FIG. 1. Left side of lower jaw of *Leptosuchus crosbiensis*, No. 8855, U. of M.

FIG. 2. Left side of skull of *Leptosuchus imperfecta*, No. 7523, U. of M.



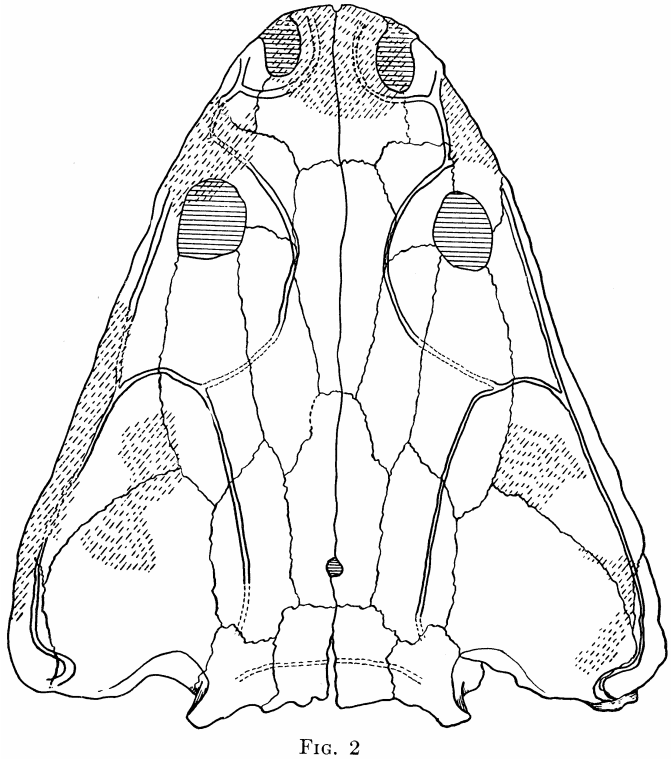


PLATE XXIII

FIG. 1. Narial region of the skull of *L. imperfecta* to show the pathological condition.

FIG. 2. Outline of the skull of *Buettneria perfecta*, second specimen, No. 8854, U. of M. To show the sutures, sensory canals and the restored portions (shaded).

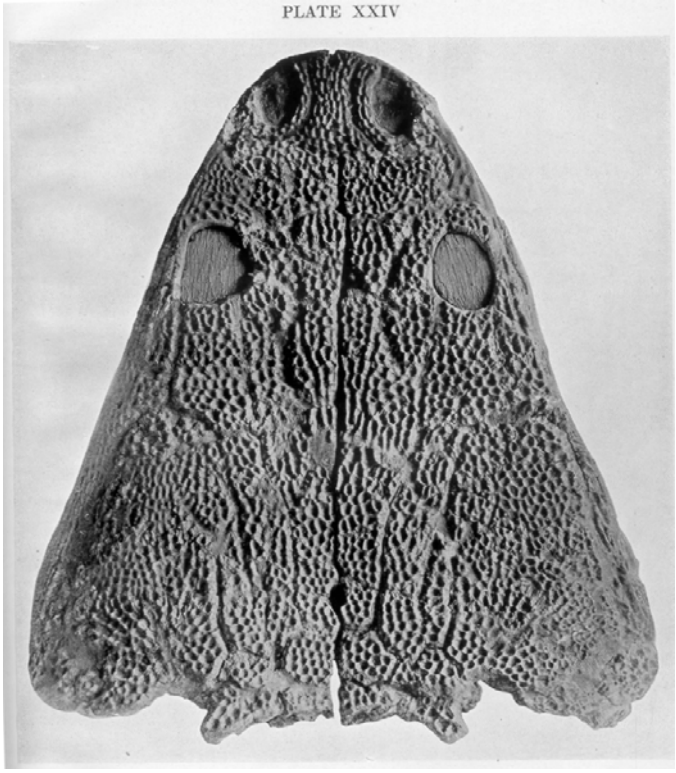


PLATE XXIV

Photograph of the skull of *Buettneria perfecta*, second specimen, No. 8854, U. of M. Total length, as restored, 56.5 cm.

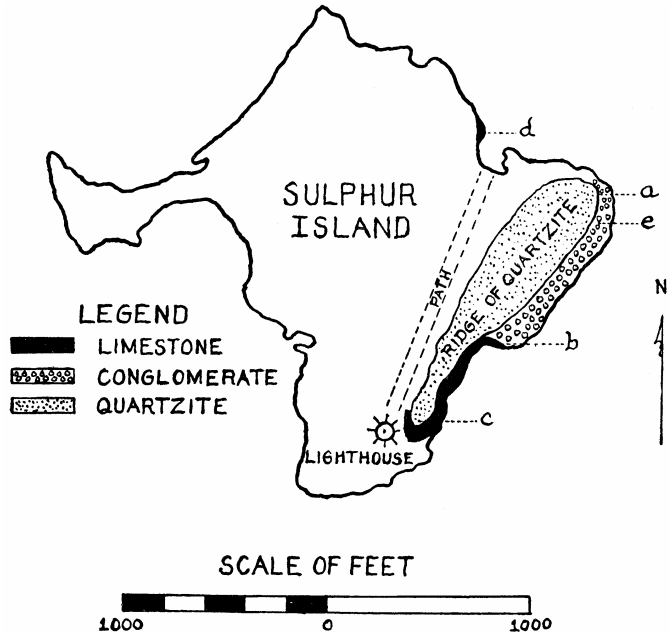
AN ORDOVICIAN REEF ON SULPHUR ISLAND, LAKE HURON

G. M. EHLERS

THE occurrence of an interesting Ordovician reef on Sulphur Island, which is located in the North Passage of Lake Huron about two and three-quarter miles north and nearly one mile east of Poe Point, Drummond Island, Michigan, was briefly described by Dr. Carl Rominger[1] in 1873. Inasmuch as this reef and its associated deposits present some unusual features of wave erosion and of sedimentation, a more detailed description accompanied by illustrations may be of interest.

On the east side of Sulphur Island (See Map III) is a ridge of thick-bedded, well-jointed, greenish-gray to brown Pre-Cambrian quartzite, the top of which is fifteen to twenty feet above the level of Lake Huron. The massive nature and jointing of the quartzite is well shown where it is exposed near the northeast corner of the island (See Plate XXV, Fig. 1).

Most of the eastern side of the ridge originally presented a steep face or cliff to a sea, which transgressed over this area in Mid-Ordovician time. The waves of this sea pounded against the cliff and by undercutting and erosion along joints dislodged huge blocks of quartzite. These large blocks and smaller masses of rock, which were either originally torn from the cliff or reduced in size from the larger ones by wave action, came to rest against the cliff in a rather steeply inclined position. In fissures of the cliff, produced by the grinding action of the waves along joints of the quartzite, Dr. Rominger found rounded, water-worn pebbles of granitic rocks. These probably were carried to the cliff by currents in the sea from near-by ledges, which may now be beneath the surface of the lake or be present on the island covered by other deposits. The grinding action of the waves reduced some of the rock of the cliff to a sand, which was carried seaward by the undertow and shore currents.



MAP III. Sketch map of Sulphur Island showing location of quartzite ridge, associated deposits and erosional and depositional features.
(U. S. Lake Survey base with additions)

At no great distance from the cliff and over most of the surrounding region covered by the sea, calcium carbonate in the finely divided state of a mud was being deposited. Much of the calcareous material or mud became mixed with the sand, which was ground from the cliff and deposited in a relatively narrow zone bordering the debris of quartzite blocks and boulders along the shore.

When the wave action on the cliff was greatest, the level of the sea was probably five to ten feet nearer the top of the ridge than the present level of Lake Huron; the ridge at this time appeared as a small island.

During an encroachment of the sea, the islet became submerged and hence converted into a reef. As submergence progressed, wave action became less and less effective and deposition of sand and calcareous mud took place. The spaces between the blocks and boulders of quartzite, dislodged from the cliff, were filled with sand, calcareous mud and fragmentary remains of bryozoa, brachiopods and echinoderms, which were cast against the reef by storm waves. The conglomerate, composed of the boulders and matrix of sand and

calcareous material, as well as the entire reef, very likely became covered by a fairly thick deposit of calcareous mud.

The basal beds of the calcareous mud conform rather closely to the slopes of the reef and conglomerate and as a result are steeply inclined. This agreement in slope is shown fairly well where thin beds of very fossiliferous limestone — the consolidated calcareous mud — rest upon the inclined surface of the conglomerate a short distance northeast of the lighthouse, situated on the southern shore of the island (See Plate XXV, Fig. 2). It is even more evident where the limestone dips away in several directions from a knoll on the quartzite ridge just east of the lighthouse (See Plate XXVI, Fig. 1).

The limestone at the knoll, except for a few sandy beds at its base, rests directly upon quartzite without the intervention of a coarse conglomerate, such as that exposed along the shore a short distance to the northeast. Such a conglomerate, however, very likely occupies a position between the limestones and quartzite a short distance away from the top of the knoll. That wave action was very effective prior to the deposition of the limestone and could have quarried out large masses of rock for subsequent incorporation into a conglomerate, is indicated by the presence of channels cut along joints of the quartzite, by the rounded, wave-worn surfaces of this rock and by wave-dislodged blocks (See Plate XXVI, Fig. 2). The tools of sand and pebbles, used by the waves in their abrasive work and subsequently cemented together by calcareous material upon the submergence of the knoll, may now be seen in the channels cut along the joints of the quartzite.

As the entire reef became more and more submerged, successively higher and higher beds of limestone were laid down on its sides with a decreasing angle of repose. However, as a result of their partial agreement in slope to those of the reef, the limestones encircling the reef must have assumed the structure of a more or less elongated dome. The subsequent removal of most of these limestones by erosion has largely obliterated the dome structure; nevertheless, its former presence is strongly suggested by the radial dip of the limestones, exposed to the east and northeast of the lighthouse, from the southern part of the quartzite ridge — the core of the dome. The nature of the structure was probably quite similar to that of a small, partially exposed dome, existing in the limestones on the northeast side of the island (See Plate XXVII, Fig. 1). The radial dip of the strata of similar domes would usually be accounted for by pressure; in the case of this dome, however, it certainly results from original deposition on the slopes of a buried knoll of quartzite or possibly granitic rock. Incidentally, the buried rock, if it is a granite, may have been the source of the granitic pebbles found by Dr. Rominger in the fissures of the quartzite cliff. With the increasing submergence of the reef, limestones and perhaps other kinds of sedimentary rocks accumulated over the surrounding area and probably reached the level of the top of the reef. Sediments, possibly of considerable thickness, were then probably deposited in a practically horizontal manner over the reef and its associated, inclined strata.

With little doubt, seas of late Ordovician and certain Silurian and Devonian times also transgressed over the Sulphur Island region and deposited sediments, whose aggregate thickness was considerable. The quartzite ridge may very likely have become buried beneath several hundred feet of these sediments.

Some time previous to the coming of the Pleistocene glacier, perhaps during later Paleozoic and all of Mesozoic and Cenozoic times, the Sulphur Island area — in fact most of the Great Lakes region — was maturely dissected by streams. The sediments, covering the top of the quartzite ridge, were removed by this erosion. Soil, which probably lay upon the ridge just previous to the advance of the ice, and loosened masses of rock on its top and sides were subsequently removed by the glacier. Except for the absence of soil and loosened rocks, the ridge and the inclined beds of conglomerate and limestone on its sides, with little doubt, present much the same appearance today as at the time of the coming of the Pleistocene glacier.

With the passing of the great continental glacier, Lake Huron and the other lakes of the Great Lakes system were formed. The waves of Lake Huron are especially active today on the eastern side of Sulphur Island; there they are quarrying into the firmly cemented conglomerate, formed during Black River time (See Plate XXVII, Fig. 2). Ultimately they will probably tear away the conglomerate and pound against the cliff, exposed long ago to the attack of waves of a marine sea. Even the geologist, accustomed to seeing striking and unusual, geological phenomena, experiences a decided thrill on watching the waves of the present fresh water sea in their nearly accomplished effort to reach the cliff and take up the work of quarrying, abandoned by the waves of a marine sea of several millions of years ago.

[1] Dr. Carl Rominger, *Paleozoic Rocks: Michigan Geological Survey*, Vol. 1 Pt. 3, p. 68. 1873.

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EXPLANATIONS OF PLATES

PLATE XXV

FIG. 1

FIG. 2

PLATE XXV

FIG. 1. Massive and well-jointed Pre-Cambrian quartzite exposed at the northeast corner of Sulphur Island. View taken at *a*, Map III.

FIG. 2. Inclined limestone strata, shown at lower center of view, resting on the comglomerate of Black River age. The bouldery nature and conspicuous dip of the conglomerate are well shown at the center of the view. The quartzite ridge is immediately to the left of the conglomerate but hidden by vegetation. View taken at *b*, Map III.

PLATE XXVI

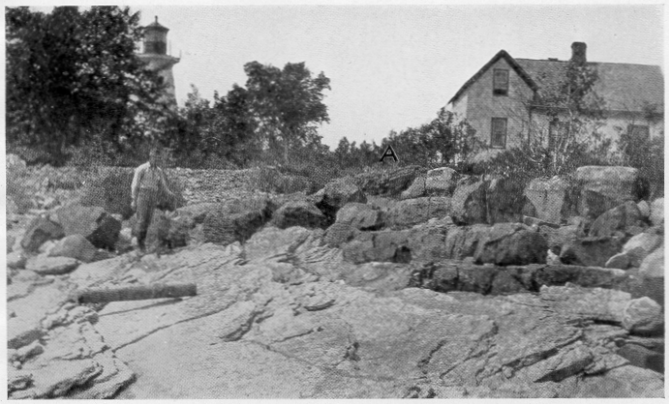

FIG. 1

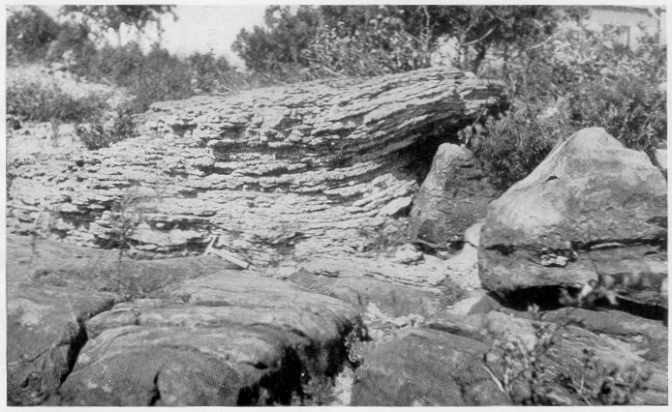

FIG. 2

PLATE XXVI

FIG. 1. Highly inclined limestones resting on Pre-Cambrian quartzite. View taken at *c*, Map III.

FIG. 2. Closer view taken at *A*, Plate XXVI, Figure 1, showing effects of wave erosion and nature of deposition. The channel along one of the joints of the quartzite, shown in the foreground of the view, the two dislodged blocks to the left and the rounded surfaces of the quartzite are the result of wave erosion prior to the deposition of the thin-bedded limestone. The lighter colored material, shown in the channel, is limestone and serves as a cement for sand and gravel, used as tools by the waves in their abrasive work. Note the influence of the block of quartzite on the dip of the large mass of limestone.

PLATE XXVII

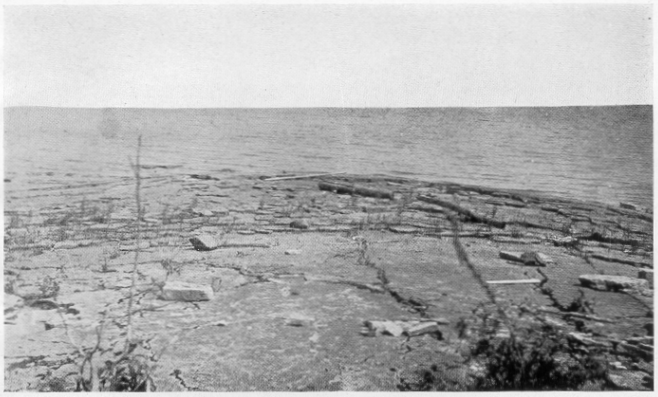

FIG. 1

FIG. 2

PLATE XXVII

FIG. 1. Small dome in Black River limestone, resulting from deposition on inclined surfaces of an underlying knoll of Pre-Cambrian quartzite or granite. View taken at *d*, Map III.

FIG. 2. Section of the Black River conglomerate cut by storm waves of Lake Huron. The cliff, formerly exposed to the pounding waves of the Black River sea, is only a short distance behind the conglomerate. Further cutting by the waves of Lake Huron may again expose the cliff to attack. The rounding and reduction in size of the blocks in the foreground, abandoned by waves of the Black River sea, are now being continued by storm waves of the lake. View taken at *e*, Map III.