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LETTER OF TRANSMITTAL.

TO HON. WOODBRIDGE N. FERRIS, *Governor of the State of Michigan:*

SIR—I have the honor to submit herewith the XVIIth Annual Report of the Michigan Academy of Science for publication, in accordance with Section 14 of Act No. 44 of the Public Acts of the Legislature of 1809.

Respectfully,
RICHARD DE ZEEUW,
Secretary.

East Lansing, Michigan, November, 1915,

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GEOLOGY AND GEOGRAPHY.

ICEBERG LAKE.

BY O. W. FREEMAN.

Iceberg Lake is located in Glacier National Park, Montana, about six miles from Many Glacier Camp on Lake McDermott, and is one of the most interesting points to visit in the Park. The chalet camp at Lake McDermott is about fifty miles from Glacier Park station is reached by automobile and stage from there, the good roads and excellent views of lakes and mountains making the journey a pleasant one. Iceberg Lake itself may be reached from Lake McDermott over an interesting mountain trail with close views of many small cascades and waterfalls. On the way, a typical glacial eroded U-shaped valley is traversed, showing that thousands of years ago a mighty glacier, of which that at Iceberg Lake is a small remnant, had occupied the whole valley. This joined others from Swift current, Grinnell and other places forming the Saint Mary Glacier which extended north to Canada where it met the Keewatin continental ice sheet. Iceberg Lake is an unique occurence in this country and hence there is added interest to what would naturally be well worth visiting.

The lake lies in a characteristic glacial cirque, occupying a basin apparently chiefly formed by glacial gouging. It lies on the north side of Wilbur Mountain and just east of the Continental Divide, at an altitude of 6100 feet. On three sides cliffs tower to a height of over three thousand feet above the level of the lake (Pl. I) and it naturally forms one of the most impressive and beautiful scenes in the Park. Due to its location in such a deep pocket on the north side of Wilbur Mountain, the sun melts only a small part of the accumulated snow and ice. To the heavy snow fall is added that blown in by the winds, and by alternate thawing and freezing combined with the pressure of the snow above, the snow is gradually consolidated to ice forming a small glacier. This remnant of a once vastly greater one is at the head of the cirque and descends into the west side of Iceberg Lake. The glacier is easy of approach along the north side of the lake by crossing a talus slope and small moraine. Its surface is dirty with debris; many rocks can be seen that have fallen from the cliffs above and which are entirely unworn by erosion. Besides many crevasses near the front of the glacier, there is a typical gaping crevasse (bergschrund) next to the walls of the cirque, which widens with the advancing summer as the glacier melts and pulls away from the cliffs and snowfields above. The bergschrund is shown in plates I and IIB.

When viewed from across the lake the glacier exhibits a banded structure, and these bands look as though they had been folded like rock strata. These dark bands are due to greater accumulation of rock debris in the glacial ice; this was probably caused chiefly by greater melting in the summer, thus concentrating the rocky material and making a dark band that contrasts with the bluish ice formed by pressure in the winter when the amount of melting is small. If the layers were formed in this way, they might be compared with the annual rings of growth of trees. Another possibility is that much of the material in these belts was picked up by the glacier from its bed and chiefly accumulated in more or less horizontal openings or shear zones. The folding of these bands probably is chiefly the result of shearing, that is the slipping of some of the ice past adjacent portions, as a result of the pressure above combined with the forward movement of the glacier and the resistance to this motion offered by its bed. The rate of movement of the glacier was not measured but it must be quite small.

The glacier rises abruptly from Iceberg Lake to a height of thirty or forty feet; large fields of floe ice are usually frozen to its front. From time to time large blocks of glacial ice break off, forming true bergs, which frequently nearly cover the surface of the lake. (Plate IIB). Near the outlet of Iceberg Lake is a series of falls, but the water is so shallow that none of the larger pieces of ice can float out. The result is that they can disappear only by melting, which is such a slow process due to the lake's location that even in August bergs are very abundant on the lake; most of these bergs are flat topped cakes, but they often also assume various fantastic shapes. Due to the current of water flowing toward the outlet and winds in the opposite directions the bergs frequently move back and forth and often grind against each other in a manner suggestive of the polar zones.

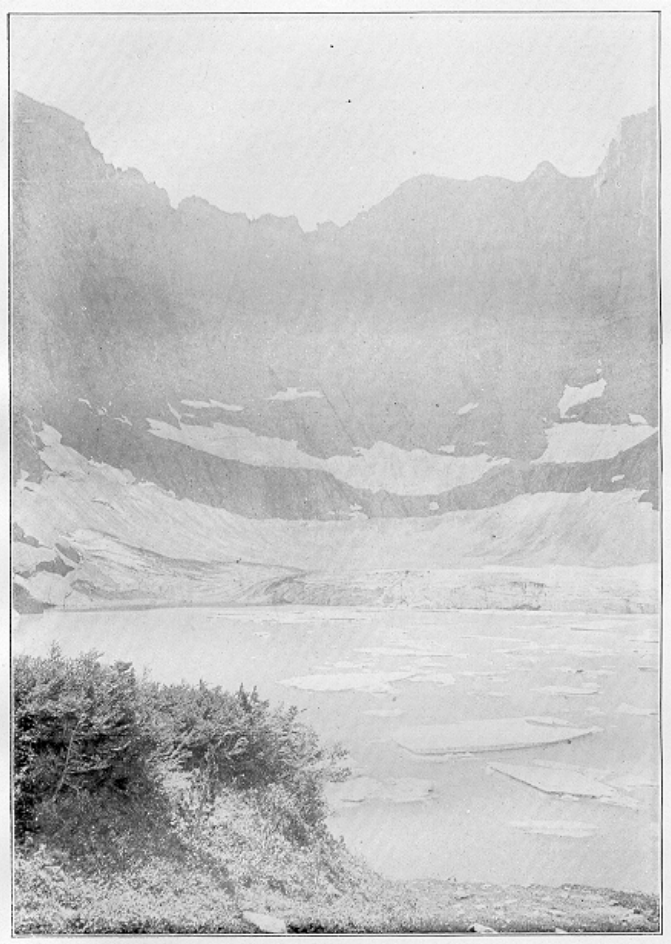
The photographs accompanying this article were taken early in July and open water had been visible only a short time, the lake of course being frozen over solid most of the year. The water, where not ice covered, is deep blue in color; and since it is all derived from melting snow and ice is close to the freezing temperature. The lake is not large, covering probably less than a square mile of surface, much of that being ice covered; it is about one hundred and fifty feet deep in the middle. Rock debris is so constantly falling into the lake from the cliffs and melting glacier that the lake in places is being filled quite rapidly. Small lateral moraines, thirty or forty feet high, are at present being deposited at the sides of the glacier; the terminal deposits are below the level of the lake, considerable debris being carried far out into lake on the ice cakes before they melt.

On the east shore of Iceberg Lake opposite the glacier, there is a very fine example of a "wall" or ice rampart built by ice action. The beach, as shown by Plate IIA is here composed of rocks of all shapes and sizes; it is several feet in height and in many places over thirty in width. This ice rampart was chiefly formed by the stones composing it being frozen in the ice and slowly pushed up on the shore by its movement. Great changes of temperature would be one cause of this movement by causing the ice to first contract by cooling, often opening cracks into which water would penetrate and freeze thus again covering the lake's surface with a solid sheet of

ice; then when the temperature increased the ice would expand and push any rocks frozen to it a little way toward and then upon the beach. The stones thus slowly accumulating would form the ice rampart or “wall." The motion of the glacier may also have been imparted to the ice floes and have caused much of this ice push.

Prof. M. J. Elrod, later in the summer of 1914, found two species of living organisms in the cold water of Iceberg Lake, a mayfly larva and a red entomastracon. As the temperature of the water is thirty six degrees Fahrenheit it is remarkable to find any animals living under such conditions.

The walls of the cirque about Iceberg Lake appear to be unscalable, yet mountain goats are usually to be seen walking unconcernedly along the narrow ledges in search of the scanty grass which rapidly springs up as the snow melts away. In spite of the remoteness of this region and the long winters and short summers, the prospector searched here for minerals years ago and the visitor can nee two of his abandoned prospect tunnels on opposite sides of the lake. All these things add to the interest of a trip to Iceberg Lake, but naturally after all the chief interest is in seeing icebergs and floes floating in a lake in midsummer, and remembering that this is the only occurence of the kind in the United States.



Iceberg Lake in August.

A. Ice rampart or “wall" formed by ice push on shore of Iceberg Lake.

B. Icebergs in Iceberg Lake.