

## 1. GLACIAL PERIOD.

### AMERICAN.

Three subdivisions or epochs, of the Glacial period, are recognized: (1) the EARLY GLACIAL EPOCH, or that of the Advance of the Ice and its maximum extension; (2) the MIDDLE GLACIAL EPOCH, or that of the First Retreat of the ice; (3) the LATER GLACIAL EPOCH, or that of the Final Retreat.

#### 1. Epoch of the Advance.

##### *General Condition of the Continent during the Advance.*

*Topographical and fluvial conditions.* — The continent, when the Ice age began, had its high mountains and full-grown rivers. The elevating of the continental surface that was begun in the Tertiary had covered the land with running waters, and the new and vigorous streams made erosion their first work. The older streams, also, that had reached a level of no work, received new energy and were set to work deepening their channels, leaving the old flood grounds as terraces to mark progress. The time was especially favorable for pre-glacial erosion. In addition to this growth of rivers, forests took rapid possession of the continent, and faunas and floras greatly widened their range.

As the cold and precipitation increased, the time finally came when the heat of summer was not sufficient to melt all the snows of the colder season, and then began glacial accumulation. For a while glaciers were confined to the higher mountains; but gradually all glacier areas became united in one great continental ice-sheet, Greenland-like, with local glaciers only along some of the deeper terminal valleys.

While thus spreading over the land, there were oscillations in the progress of the ice-sheet, as in modern glacier regions, determined by meteorological cycles, — the 11-year cycle dependent on the cycle of the sun's spots, and a longer cycle of 35 to 50 years, as now in the Alps. And besides, there were other sources of meteorological change, causing longer halts and recessions in the ice-sheet, for which no explanation can yet be given.

A large ice-sheet gives a temperature of 32° F. to the air above it, and this favors its perpetuity. But the southern margin, at the time of maximum advance, was in middle temperate latitudes with the tropics not far away; and warm or hot winds, therefore, were at hand to produce large fluctuations in the extension of the ice with the changing seasons.

*Causes determining places of the first ice and of greatest accumulation.* — Since the ice would have accumulated most rapidly where abundant precipitation and low temperature were combined, the region of earliest commencement and maximum accumulation would have been over the eastern portion of the continent toward the Atlantic. Along the coast region of