INTRODUCTION TO GEOLOGICAL PROCESS IN ILLINOIS

GLACIAL PROCESSES AND LANDSCAPES

GLACIERS

A glacier is a flowing mass of ice. This simple definition covers many possibilities. Glaciers are large, but they can range in size from continent covering (like that occupying Antarctica) to barely covering the head of a mountain valley (like those found in the Grand Tetons and Glacier National Park). No glaciers are found in Illinois; however, they had a profound effect shaping our landscape.

More on glaciers: http://www.physicalgeography.net/fundamentals/10ad.html

Formation and Movement of Glacial Ice

When placed under the appropriate conditions of pressure and temperature, ice will flow. In a glacier, this occurs when the ice is at least 20-50 meters (60 to 150 feet) thick. The buildup results from the accumulation of snow over the course of many years and requires that at least some of each winter's snowfall does not melt over the following summer. The portion of the glacier where there is a net accumulation of ice and snow from year to year is called the zone of accumulation.

The normal rate of glacial movement is a few feet per day, although some glaciers can surge at tens of feet per day. The ice moves by flowing and basal slip. Flow occurs through "plastic deformation" in which the solid ice deforms without melting or breaking. Plastic deformation is much like the slow flow of Silly Putty and can only occur when the ice is under pressure from above. The accumulation of meltwater underneath the glacier can act as a lubricant which allows the ice to slide on its base. Basal slippage occurs primarily in the summer when the largest quantity of meltwater is present; in winter, glaciers often freeze to the underlying materials. Because the top of the glacier is not under pressure it is brittle, and, when the underlying ice moves, the ice on top becomes broken, creating a series of fractures perpendicular to the direction of flow.

The glacier flows to the zone of ablation (or wastage) where any snow that fell on the glacier melts in the summer as does some of the underlying ice. At the front of the glacier, the last of the ice melts and the meltwater from the glacier crosses the landscape. If the ice is in contact with water, pieces of the glacier can break off and float away, a process called calving.

The glacier flow from the zone of accumulation to the zone of ablation. Whether the front moves forward, backward, or remains in one place depends on the glacial budget. If the glacier accumulates more ice in the winter than it loses in the summer, the front of the ice will advance. When accumulation and melting are in balance, the front of the glacier does not move. If the summer melting exceeds the winter accumulation, the front of the glacier will retreat. It is important to note that when the glacier retreats, the ice is still flowing and sliding forward, the melting of the front of the glacier simply exceeds the rate of replacement.

For a more detailed description and figures, visit:
http://www.physicalgeography.net/fundamentals/10ae.html

Glacial Erosion
Landscapes eroded by glaciers commonly show grooves scratched into the bedrock; however, ice, a mineral, has a hardness of value of approximately 3. How can ice erode rocks which are so much harder?

Plucking occurs when meltwater accumulates at the base of a glacier. The water refreezes in cracks, loosening the substrate and then freezes around the now loose materials, attaching them to the bottom of the glacier. These plucked materials turn the bottom of the glacier into sand paper which abrades the rocks below the ice with the embedded sediments that may be as large as boulders. In a mountain valley, the ice undercuts the valley sides, resulting in the deposition of debris on the sides of the glacier. Unlike running water, there is no size limit to the material a glacier can erode and carry. Once a rock is incorporated into a glacier, it can be carried great distances.

Glacial erosion tends to create flat to slightly rolling topography. Where the surface materials have been removed, striations in the bedrock can be observed, parallel to the direction of ice flow. Some striations contain “chatter marks,” small, somewhat evenly spaced nicks, formed when the scraping rock jumps up and down as it carves into resistant bedrock. A roche moutenee is a teardrop-shaped hill with its narrow end pointing opposite the direction of ice flow. A roche moutenee is abraded smooth on the up-glacier side and plucked on the down-glacier side. Deep valleys carved by glaciers can be flooded to form lakes (such as the Great Lakes of North America and the Finger Lakes of upstate New York) and fjords (steep-sided bays found along the coasts of Alaska, British Columbia, Newfoundland, New Zealand, Greenland, and Scandinavia. The most dramatic erosional features are created when glaciers carve mountain landscapes; they include horns, cirques, U-shaped valleys and other features.

Another important erosional process occurs under and in front of the glacier as flowing meltwater erodes in all of the ways discussed in Lesson 3. In some cases, the water under the ice is forced into the underlying rock or sediment by the pressure of the overlying ice, creating deep valleys that are later filled when the water flow decreases.

In Illinois, the erosional features created by the glaciers are, for the most part, buried under glacial sediments. In some places, such as quarries, where the glacial deposits have been removed, striations may be found.

Glacial Deposition
When the ice melts, glaciers can deposit enormous quantities of sediment. The deposits left by the ice are typically diamicton (an unsorted, unlayered mix of gravel, sand, silt, and clay), and often contain very large boulders called erratics. The sediment can be reworked by meltwater and the wind into sorted layers known by stratified drift deposits.

Moraines are diamicton deposited directly by the ice. Ground moraine is deposited under the ice and is generally represented by flat topography called a till plain. End and lateral moraines are deposited, respectively, at the front and sides of the glacier and form a landscape of rolling hills. An end moraine may be classified as terminal or recessional. The terminal moraine represents the farthest advance of the glacier, and the recessional moraines are left as the ice pauses during its retreat. Chunks of ice left behind as the glacier retreats create depressions in the moraine as they melt, these depressions are kettles. If a glacier advances over a moraine, it can rework the material into drumlins, teardrop-shaped hills with their narrow ends pointing in the direction of ice flow.

Stratified drift can form under and in front of the glacier. Meltwater flowing on, in, and under the ice creates valleys and lakes which fill with layers of sediment. When the glacier melts, the layered deposits are set down on the ground moraine as hills of gravel and sand called kames (small and round) and eskers (long and sinuous). In front of the glacier, the water can become trapped behind an end moraine, creating a proglacial lake; proglacial lakes gradually fill with thin layers of silt and clay. The water moving away from the front of the end moraine deposits thick layers of gravel and sand called outwash, which may be confined to a channel or may spread out across a plain. Wind blowing across the outwash will pick up the sand and pile it into dunes along the down wind side of the plain or valley. Silt will be blown far from the outwash and spread out across the landscape as loess; Illinois is blanketed with a layer of loess that thins east of the Illinois and Mississippi Rivers.

More on glacial landforms: http://www.physicalgeography.net/fundamentals/10af.html

PLEISTOCENE ICE AGE

Approximately 2 million years ago, large sheets of ice formed in Canada and moved down across what is now the Great Lakes region and into Illinois

ILLINOIS STATE PARKS AND NATURAL AREAS OF NOTE FOR THEIR GLACIAL FEATURES

Ice-Contact

(note: most of the State Parks and Natural Areas are located on glacial ground moraine)

Chain O' Lakes (Wisconsinan end moraine, kettle lakes)
Fox Ridge (Wisconsinan end moraine)
Franklin Creek (Wisconsinan till dissected by river valleys)
Hennepin Canal (follows filled valley of Mississippi river, from East to West passes through Wisconsinan end moraine onto outwash covered with dunes)
Jubilee College (Illinoisan till plain dissected by river valleys)
Lincoln Trail (Illinoisan till plain)
Middle Fork (Wisconsinan end moraine)
Moraine Hills (Wisconsinan end moraine)
Moraine View (Wisconsinan end moraine)
Red Hills (Wisconsinan esker)
Rock Island Trail (Illinoisan till plain)
Silver Springs (Wisconsinan end moraine)
Spitler Woods (Wisconsinan end moraine)
Volo Bog (Wisconsinan end moraine, kettle hole)
Walnut Point (Wisconsinan end moraine)
Weldon Springs (overlies Mahomet/Teays Valley)

Outwash

Buffalo Rock (Erosional remnant from Kankakee torrent)
Cache River (old Ohio River Valley)
Fort Massac (new Ohio Valley)
Goose Lake Prairie (pro-glacial lake)
Hennepin Canal (follows filled valley of Mississippi river, from East to West passes through Wisconsinan end moraine onto outwash covered with dunes)
Illini (located where Marseilles Moraine broke and released Lake Wauponsee)
Kankakee River (scoured by Kankakee Torrents)
Sand Ridge (sand dunes adjacent to Illinois River Valley outwash)

Sanganois (sand dunes adjacent to Illinois River Valley outwash)
Tunnel Hill (passes down into the old Ohio River Valley, now occupied by the Cache River)