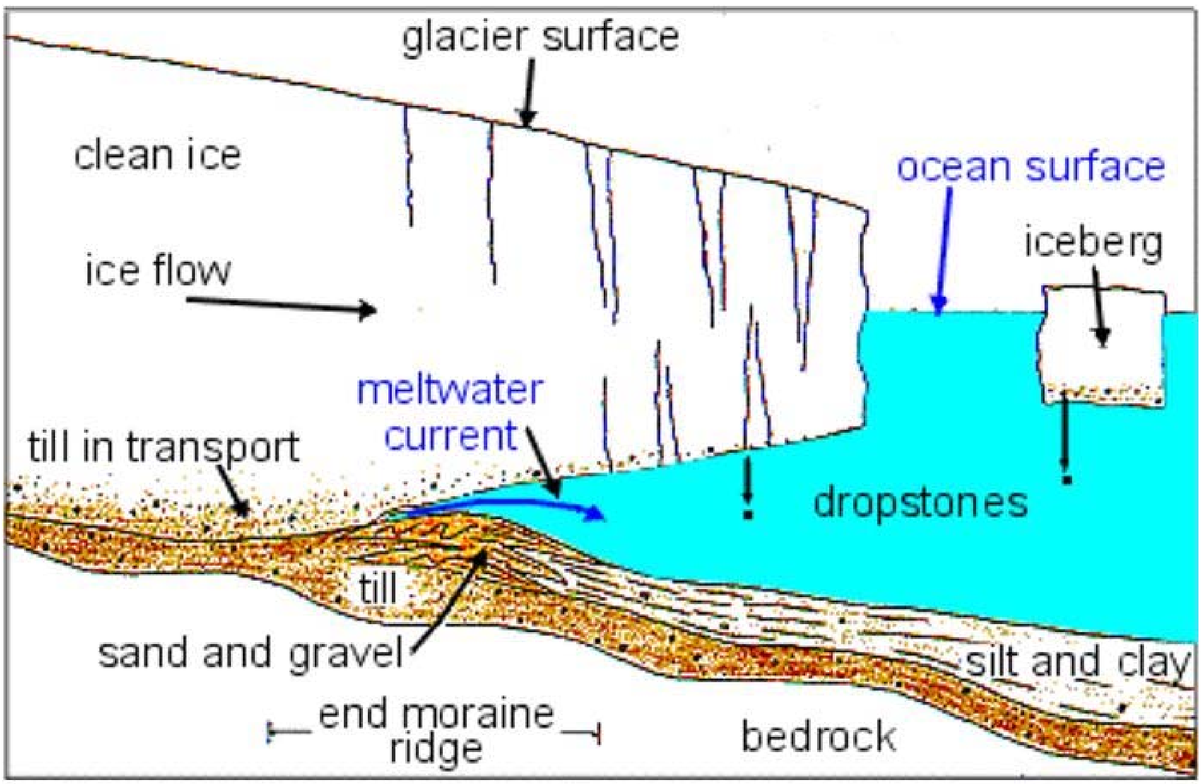
A Bit of McWain's Glacial Legacy and Our Sticky Bottom

By Earl Morse, April 17, 2012

Most of us realize that glaciers covered the state and went well out to sea in a massive ice shelf that extended southeast to beyond Cape Cod. Starting about 16,000 years ago this ice sheet began its retreat, leaving Maine with most of its surface features. The weight of the ice depressed the ground so that what is now about 420 feet in elevation was then at sea level even though the sea level was lower than it is now (since much of the world's water was tied up in ice caps). As the glaciers receded, the ground rebounded much more slowly and downtown Norway, Maine, for example, was under the sea at the head of a great tidal bay. What is now Portland, Augusta, and Bangor were also under the sea at this time. The ice sheet floating above the ocean left easily discerned clay- rich marine muds called the Presumpscot Formation that, along with remnants of marine life, like barnacles, can be found in the soils of downtown Norway. A bit later, the shores of the freshwater Glacial Sebago Lake, too, extended well beyond their present boundary, engulfing the Bear River and Bear pond and extending up Mill Brook to about the point where Mill Hill Road intersects route 35/37. Most of South Waterford was under water, too. Yup, Phil's Garage was once beachfront property!



(The left side of the above diagram illustrates glacial till deposited over land and the right side the sorted marine Presumpscot deposits)

The glacier abrasively streamlined all of the hills in our watershed, orienting them along its north northwest path, the same axis as our lake. It is difficult to imaging the abrasive capacity of the glacier on our bedrock. At its maximum glacial depth the present McWain Pond watershed was covered with over a mile and a half of ice, each square foot of ice exerting a grinding force of over 500,000 lbs on the bedrock beneath it. The ice at the bedrock surface was full of rocks, sand, silt and clay that the glacier picked up as it moved southward from Canada. The grinding effect was tremendous and examples of the tearing down of our bedrock surface is found throughout our watershed, especially in the exposed ground and scratched rocky outcrops on some of our streamlined hilltops.

The clay rich soils of the Presumpscot marine deposits found nearer our present coast arose from the same glacial till (glacial grindings) that covers our watershed. The only difference is that most of the till in our watershed has not been water sorted and is a mix of all particle sizes from big boulders to clay. If you want to see what “water sorting” of glacial till is, simply take a sample of our soil (dig it from below the humus layer of topsoil), place it in a jar, add water, shake it up and let it settle for a few days until the water is again clear. You'll see that the sample now has sorted according to particle size with the gravel on the bottom and a gradient up towards the settled surface with silt and clay uppermost, since they are the last to settle. Now take the same settled sample, add a tablespoon of salt and shake it up and let it settle again. Notice any difference? Since our surface soils are unsorted it means they were deposited directly from the glacier and not through significant fresh or salt water underlying the ice.

Clay is the term given to ground rock with smallest particle sizes, under 16 hundred thousandths of an inch (less than $1/50^{th}$ the diameter of a human hair). Since the particles are so small they have interesting properties. Derived mainly from abraded granite and pegmatite, the ratios of alumina, silica and iron in our clay would probably make it a good candidate for firing into bricks and pottery. Clay particles settle most slowly in the process of sedimentation in water. They tend to be in the uppermost layer in the annual sedimentation cycle of our pond and as long as there is any wind, clay particles will remain suspended in our lake water. Consequently, sticky clay is found on our sediment most abundantly in the spring, the result of our ice covered lake quieting our waters sufficiently to permit these small particles to finally settle out.

A particle's surface area to volume ratio helps determine the solubility of various substances. Smaller particles have higher ratios of their surface area to their volume. For example, a ball of 1 inch diameter has a surface area of 3.14 square inches and a volume of 0.523 cubic inches, a surface area to volume ratio of 3.14/0.523 = 6. This is twice the surface area to volume ratio of a 2 inch diameter ball. When dropped in water the smaller ball has twice its relative volume exposed to the dissolving effects of the water than the larger ball. This is why smaller sugar grains dissolve faster than rock candy crystals in your cuppa tea. A pound of granular sugar has much more surface in contact with the tea than a pound of rock candy crystals, even though they both have the same weight. Consequently, clay particles, the smallest of all solids in our soil, make their minerals more able to be dissolved in our water than when the same minerals are in sand or gravel. When you add the fact that they are also the most long suspended particle and the most easily mixed by wind and waves, it becomes clear that minerals in our clay add most significantly to dissolved minerals, particularly phosphates, in our lake.

McWain pond has an abundance of clay in its glacial till. Anyone who remembers a lake shore construction project will attest to this. Clay becomes more abundant the closer you are to the lake shore. This is because in its early post glacial life McWain Pond was deeper than it is presently and our present shoreland zones were under water. Next time you ride through the erosional valley that goes from Springer's to Route 118, note the height of where the outflow stream would have been immediately post glacier (pre significant valley erosion). That height marked the original lake shore. Silt and clay would have settled into the lake from that point into its original depths. In many areas of our shoreland zone the clay-rich glacial till can extend to 75 feet in depth before bedrock is found. This is well beyond the lake's current maximum depth of 42 feet. Our small watershed (watershed area to lake surface area ratio) has, unfortunately, given McWain Pond's water a 2 plus year flush time. In addition, our watershed's relatively steep slopes mean that clay particles loosened from the soil during rain easily migrate into the pond. This is kind of a double whammy that maximizes clay sedimentation.

One of the biggest physical problems with clay is rain splash erosion. When you park your car on bare soil during a heavy rain storm you'll notice that the soil is thrown vertically up to two or more feet onto the sides of your car. Looking closely, you'll note that the smallest particles are thrown higher upwards. Next time this happens just rub your finger six inches above the highest visible mud stain on your car. Examine your finger and you'll see evidence of the clay and silt thrown during the storm. If there is a leaf canopy above your car you'll notice that the effect is much less pronounced. This is because leaves obstruct the raindrops, slowing their fall and breaking larger, more erosive, drops into smaller drops. Even the duff layer of dead leaves and plant matter on the ground is tremendously helpful in limiting rain erosion. During a heavy rain you may note that our roadways and ditches run turbid or muddy with the results of erosion. While the addition of annually maintained coffer dams in our ditches greatly adds to our ability to limit gravel, sand and silt movement into the lake, dams don't do much to inhibit the movement of clay particles. Once they get suspended in run-off they will usually enter the lake. Obviously, it's best to keep them in the soil by minimizing the impact of direct rainfall. Because of this high clay content, surfaces nearest the shore that are directly exposed to rain are especially problematic. A canopy of trees and shrubs along with a deep layer of duff is our best protection.

Here are just a few ideas to help limit clay disruption and soil movement:

1. Encourage leafy plant growth along roadsides, in drainage ditches, and bare ground.
2. Cover exposed soil with perennial native plantings and leaf mulch.
3. Don't rake driveways and parking areas, particularly if exposed to direct rainfall. Allow soil covering mulch and duff to accumulate.
4. Use geotextile and geocell (geogrid) materials to help stabilize bare soils in roads and driveways. Cover with crushed rock and allow a duff to accumulate to help stabilize the area. Geocells work well to inhibit soil movement and may be planted with grass if you have sufficient light. While some brands of geocells may not withstand plowing very well, those used by many Maine logging companies are durable and can withstand heavy truck traffic and plowing.

5. Build larger water impound areas like water gardens, pools, etc., to allow filtering of drainage before water enters lake. Maintain annually by removing sediment, placing it in protected uphill areas. Cover with leaf litter.
6. Divert surface water so that flow is circuitously deflected into the forest floor's leafy soil.
7. Do not cut or trim vegetation in the shoreland zone except as permitted by Waterford code. Try to keep bare soil covered with leafy plants, duff or mulch.

One additional note: Part of the early summer stickiness of our lake bottom clay deposits is caused by a colonial blue-green bacterium called *Gloeotrichia echinulata* (see microscope photo below). These organisms are the little green-brownish “dots” one sees suspended in the water for 15 to 20 days in late July and August. They then settle into the mud for most of the year where they remain fairly dormant until June and early July when they begin pulling phosphorus out of the mud. By mid July they begin to become buoyant forming the colonial “dots” we see circulating in the uppermost waters. Having already incorporated way more phosphorus than they need from their life in the mud, they are not restricted in their ability to prosper when other plant plankton's growth potential is being limited by the decline of phosphorus dissolved in their watery surroundings. When Gloeotrichia are living in the muds they are encapsulated in a sticky mucilaginous material that adds to the oozy feeling twixt the toes we feel in early summer. They prefer warmer muds with good light penetration and are consequently found in abundance in shallower areas where we swim. Gloeotrichia have caused significant blooms in some Maine lakes and can be problematic, as they have been in Belgrade's Great Pond where they are probably most responsible for the demise of their salmon population. It has been reported that skin irritation similar to “swimmer's itch” can occur in July and August in people with highly sensitive skin.