**Ice Shove Ridging at Harding Lake**

**Winter 2015 - 2016**

***Referencing the winter shoreline ridging only, not the wind-driven ice at breakup.***

**The mechanism - It is a complex process with many interacting variables depending on the conditions in a particular winter, but in brief:**

As a sheet of lake ice cools, it contracts. As it warms as a result of solar input and air temperature, it expands.

When the ice sheet contracts as it cools, cracks form and are filled with water. The water entering those cracks freezes. The total area of the frozen surface is restored.

When that modified ice sheet warms, it expands. The additional surface area of ice-filled cracks creates pressure on shorelines, and can result in either **shoreline ice shove ridging** or **pressure ridging out in the ice sheet**, or both. There may be other adjustments.

If the weather cools off, contracting and cracking begins another potential cycle.

Whether the ice "shoves" at the shoreline or creates pressure ridges or other adjustments elsewhere can depend on how well the lake ice is **"anchored"** at the shoreline by the **slope** of the shoreline bottom and/or **depth of the freezedown** of the lake ice attached sediment at the shoreline. So in colder winters with thicker ice and deeper frozen sediment at the beach, shoreline shoving may be less likely. This varies with the characteristics of the shoreline.

Snow cover **insulates** the ice, moderating the temperature change responses and the rate of response. **Without snow cover, an ice sheet responds more rapidly and more completely to temperature change**.

Thinner ice responds more rapidly to external heating and cooling than thicker ice.

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There was a major wind event in early November, before the lake was frozen. The wind blew primarily from the northeast, and may have destabilized parts of the windward shorelines.

In early January, another high wind event - a chinook - blew off and melted the snow cover on the ice. There went the insulation. The ice was 18" thick at that time - about 82% of normal. A round of expansion and shoreline shoving probably occurred. On the windward shoreline, the wind probably helped to push the expanding ice shoreward along with the expansion pressure.

With the snow cover insulation gone, the ice sheet likely subsequently responded to the maximum extent possible in response to fluctuations in temperature. By February 13, there was a lot of cracking and frozen overflow, and shoreline ridging was occurring. By February 29, there was more overflow and ice cracking. And so on until breakup. So the ice jacking continued.

Some of the pictures of the shoreline ice shoving showed wrinkles well away from the lake. At the end of September there was heavy snow, which then melted. But the meltwater didn't all sink in or run off. Some of it froze in place. I think that, along with the rain that fell in September, that re-frozen meltwater contributed to a saturated, frozen top slab that slid as a unit over the underlying sediments until it folded, at times away from the lake.

**A note: While ice does contract as it cools, there is expansion right as it freezes. This has to do with formation of the crystalline lattice, and explains the bulge in a milk jug of water that is frozen.**

*Summary by Mike Doxey*