Geophysical Research Abstracts,
Vol. 11, EGU2009-13221, 2009
EGU General Assembly 2009

Dendrochronology to the Beat of a Different Drummer: Lakes Dammed by a Tidewater Glacier Out of Phase with Climate

D. Capps (1), G. Wiles (2), and J. Clague (1)

(1) Centre for Natural Hazard Research, Simon Fraser University, Vancouver, Canada (dcapps@sfu.ca), (2) Department of Geology, The College of Wooster, Wooster, Ohio USA (gwiles@wooster.edu)

Glacier-dammed lakes typically form during glacier advance or retreat that is in phase with climate change. Most glacier-dammed lakes that have formed in the past century are located in closed basins created by glacier retreat and downwasting. However, tidewater glaciers can be relatively insensitive to climate and can advance when adjacent land-based glaciers are in retreat. The regimen of tidewater glaciers is strongly controlled by the nature of the terminus. When a morainal shoal or fjord constriction limits mass loss due to calving, the glacier may remain stable or advance even in a warming climate. However, a small perturbation in climate can cause the terminus to retreat off a shoal or beyond a constriction into deeper, open water. Once this happens, more mass is lost through calving than is replenished and the glacier may catastrophically retreat. Because many tidewater glaciers are large, this cycle can be several hundred years in length, thereby lagging climatic perturbations that affect other glaciers.

Many tidewater glaciers have dammed lakes as they advanced over the past century. Brady Glacier, at the head of Taylor Bay in southeast Alaska, advanced through most of the 20th century. When George Vancouver's party mapped Taylor Bay in 1794, the glacier terminus was a steep calving front. In 1880 John Muir visited the glacier and commented that it was advancing onto an outwash plain that it had built. It continued to advance until the 1960s and has remained at almost the same position since then, despite thinning many tens of meters.

As Brady Glacier advanced, it buried trees along the walls of the fjord and impounded large lakes in tributary valleys. At least two of these lakes formed on opposite sides of the glacier in areas occupied by mature forest. We collected incremental cores and discs of trees killed by overriding ice and rising lake waters in order to establish a dendrochronological history of the last glacier advance and the filling of the lakes. The samples are from rooted subfossil trees located at different elevations within the lake basins and below the previous limit of the glacier. The elevation and location of each tree base were determined with a differential GPS.

The results show that the Brady was advancing through the area in the early 1800s and that it killed trees along the valley margins at progressively higher levels through time. The oldest and lowest trees that were sampled in the Spur Lake basin on the east side of the glacier were killed in the early 1800s. The lake rose tens of meters over a few decades. The oldest and lowest trees sampled in the North Trick Lake basin on the west side of the glacier were killed in the early 1830s. Like Spur Lake, North Trick Lake increased in depth over a few decades. Many of these trees in both Spur and North Trick lakes were over 300 years old, which indicates that the glacier had been less extensive than today for at least that long. Just to the east, the tidewater glacier in Glacier Bay had advanced about a century earlier than Brady Glacier, underscoring non-climatic controls on glacier activity in the area. As Glacier Bay ice retreated and presumably ice-dammed lakes drained in Glacier Bay, Brady Glacier advanced, damming lakes at its margins.

The lakes impounded by Brady Glacier and frequent jökulhlaups derived from them affect glacier motion, mass balance, and glacier stability. The lakes extend beneath portions of the glacier, and significant ice mass is lost to the lakes by calving. Jökulhlaups carve channels into the base of Brady Glacier and could erode the outwash plain at the glacier terminus. Both processes could initiate catastrophic retreat of the glacier.