# Large ice-shoved ramparts tell of wetter, stormier times

*by Ed Berg*

*Geologist Dick Reger inspects ice-shoved ramparts at Cow Lake. The lake is to the left. The ramparts are located 250 feet from the lakeshore at a height of 24 feet above the present lake water level. Photo Credit: Ed Berg/USFWS*

"Where are the soldiers?" I asked myself when I first saw the big berms west of Cow Lake. The two parallel earth berms running through the woods looked very much like Civil War fortifications, and you could easily imagine riflemen positioned behind them firing at an attacking enemy.

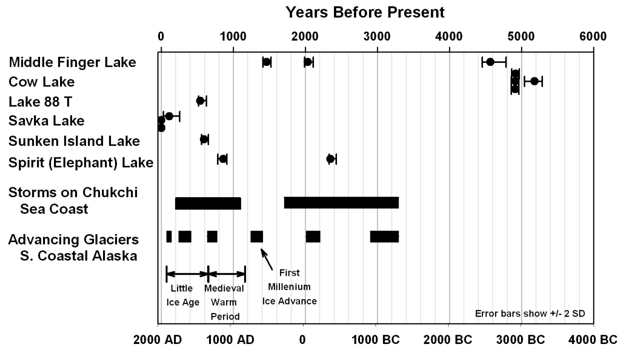
I had seen such berms before, but always on the shores of lakes. At Cow Lake the berms were 250 feet back in the woods and were about 24 feet above the present lake level. My colleague and fellow hiker on that day in September 2007 was geologist Dick Reger who immediately identified these berms as "ice-shoved ramparts," similar to ones that he had seen northwest of Tok on the shore of Moosehead Lake. Dick retired a few years ago from the Alaska Division of Geological and Geophysical Surveys and has written extensively on the glacial history of Alaska. He was sure that these berms were not glacial features, such as moraines or eskers.

Ice-shoved ramparts are formed in the spring when lake ice breaks up into large pans. Strong winds, typically from the northeast, drive these pans onto the shore and they bulldoze up lake sediments and soil into berms.

I remember camping in 2001 on a 10-foot high rampart on Barabara Lake near Point Possession while doing forest surveys. I drew a small sketch in my field notes. This rampart was about two feet above the lake level, and I wrote in my notes, "Could ice push have created this berm at a time of higher water level? I have never seen ice push create more than a 12-18 inch berm. Very Strange!" My sketch also shows a smaller 1-foot berm on the lake side of the large rampart.

Similarly, in 2005 my field party camped behind a 4-foot rampart on the shore of Lachbuna Lake in Lake Clark National Park across Cook Inlet. My field notes also mention a larger 10-foot "moraine" back in the woods, which I would now interpret as a second ice-shoved rampart, formed at an earlier time.

*A large ice-shoved rampart on the west shore of Spirit (Elephant) Lake. The lake is to the right and downhill from Kenai Refuge biological technician Toby Burke. Photo Credit: Ed Berg/USFWS*




*Radiocarbon dates of ice-shoved ramparts (berms) on lakes in the central Kenai Peninsula. These large berms are created by the bull-dozing action of wind-driven ice pans during spring break-up. They may have formed during periods of extreme precipitation and strong springtime winds accompanying changes in North Pacific weather patterns. Graphic Credit: Ed Berg*

It was however at Cow Lake that I began to appreciate the climatic significance of these ramparts. The large ramparts at Barabara and Lachbuna Lakes certainly reflected very strong wind conditions. Ask yourself what kind of wind would it take to make an ice pan bulldoze up a 10-foot high berm? Next ask yourself, what kind of climate would it take to make lake levels 24 feet higher than modern lake levels, as at Cow Lake?

Cow Lake is a closed-basin lake with no outlet, unlike Barabara and Lachbuna Lakes. Closed-basin lakes are good recorders of precipitation or more precisely, of "available water" after precipitation has been reduced by evapotranspiration. Add 24 feet of water to any lake and you have a much wetter climate. Add 10-foot high berms and you have a much stormier climate, or at least extremely strong winds in the spring.

Since our Cow Lake discovery, Dick Reger and I have found ice-shoved ramparts on seven more central Kenai lakes. The ramparts are typically on the southwest ends of lakes, as you would expect from strong northeast winds. They are best formed in sandy soils which slope gently down to a shallow lake margin which faces several hundred yards of fetch across the lake. This configuration allows the wind to pick up speed and effectively bulldoze ice pans through soft lake sediments and sandy soil, depositing the berms well back from the lake edge.

We have seen as many as five ramparts, lying like topographic ripples along a lake margin, e.g., Pollard Lake. Presumably these ripples progress from younger to older as you move away from the shore, because an older rampart would be destroyed by more recent ice shoving. We can see distorted layering in ramparts that we have excavated, and can sometimes identify two or more distinct shoving events.

To date a rampart we dig a soil pit on the landward face, trying to excavate down into the original soil layer over which the rampart was deposited. If we find an intact soil profile, we look for organic matter that might have been the original forest floor or perhaps charcoal from an old fire. We send these samples to a lab in California for radiocarbon dating.

We have so far dated ramparts at six lakes. To our surprise, these ramparts all dated to within the last 5200 years. The land in this area has been free of ice from the last glacial period for about 19,000 years. We know from lake sediment studies that the Kenai climate has generally cooled and become wetter over the last 9000 years, but we have had hitherto no record of really extreme wetness suggested by the high lake levels at closed-basin lakes like Cow Lake (24 feet), Sunken Island Lake (15-20 feet), and Middle Finger Lake (8.5 feet).

The dates are strung out from as young as mid-20th century (Savka Lake) to as old as 5200 years (Cow Lake), with a concentration within the last 900 years. We interpret this distribution cautiously, however, because as I said, younger events tend to destroy evidence of older events, just like glaciers do, so we would expect to detect more younger events than older ones.

We suspect that the ice-shoved ramparts are part of a large regional climate trend, perhaps a series of stormy, high precipitation anomalies that have occurred over the last 5200 years, reflecting major changes in the North Pacific weather system. If this is true, our story will be useful for global climate models that forecast the effects of global warming. These models must be calibrated with data about past climate history if they are to accurately forecast the future climate. Properly calibrated climate models should be able to run backward in time and accurately "backcast" the past, which obviously requires that the model makers know what happened in the past.

We are busy trying to collect evidence of other extreme weather events in the last 5200 years and have some suggestive leads. For example, periods of intense storm activity along the coast of Cape Krusenstern and Cape Espenberg in northwestern Alaska beveled off beach ridges and barrier islands in two periods (200-

1100 and 1700-3300 years ago), according to studies by Owen Mason and James Jordan on the Chukchi Sea coast.

We also have an increasingly good record of glacial advances and retreats in southern Alaska, due to the work of David Barclay, Greg Wiles and colleagues. On the Kenai glaciers advance during cooler summers and retreat during warmer ones. While cooler summers tell us nothing about storm activity, they could be wetter times due to less evaporation and more winter precipitation.

To firmly connect the ice-shoved ramparts story to the climate history record, we need to examine and date many more ramparts around the Kenai, across Cook Inlet and in southern Alaska generally. We appeal to readers who have seen these features to contact us with information about them. Stay tuned: this is definitely a work in progress!

*Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. Previous Refuge Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.*