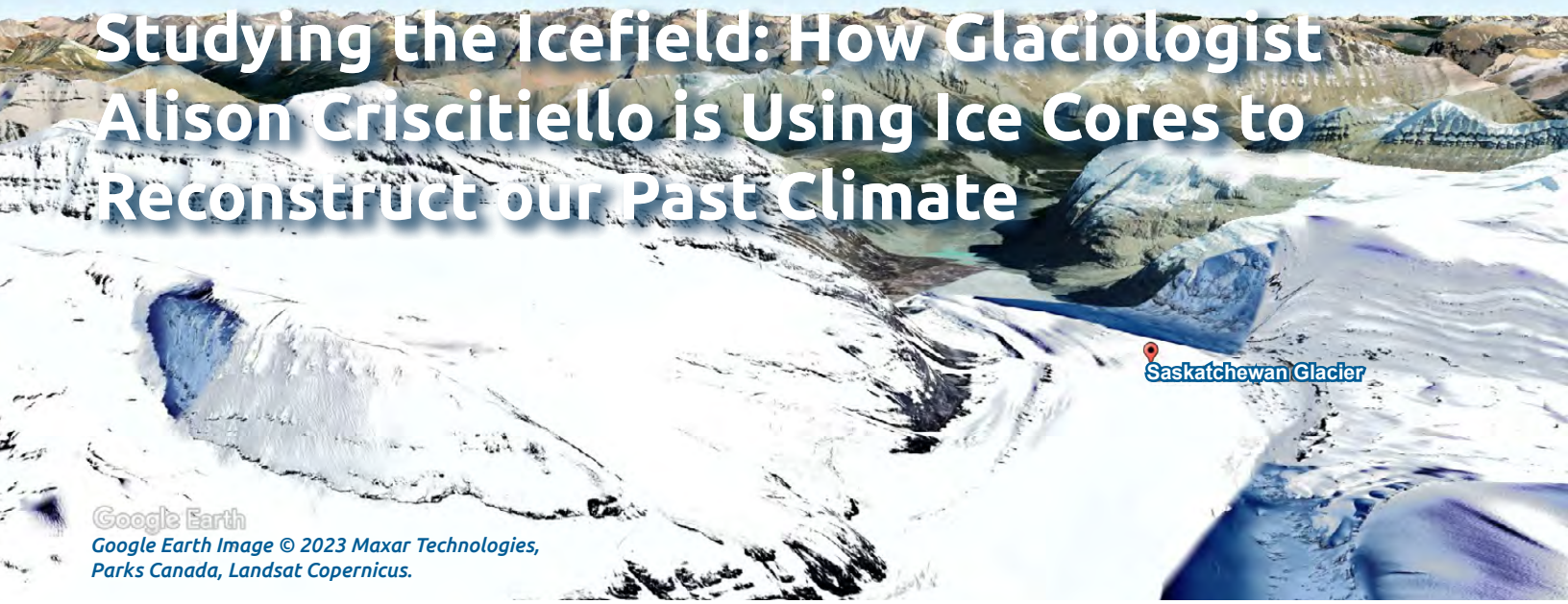
Studying the Icefield: How Glaciologist Alison Criscitiello is Using Ice Cores to Reconstruct our Past Climate



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The Saskatchewan Glacier has the largest outflow of any glacier in the Columbia Icefield and is the source of our headwaters. Receding glaciers are a recognizable symbol of our changing climate, so we spoke with glaciologist Dr. Alison Criscitiello to find out what they're learning through recent research on the Columbia Icefield.

Alison Criscitiello's passion for glaciers began while she was working as a US Climbing Ranger in the Olympic and North Cascades National Parks. These frozen and often severe landscapes appealed to Criscitiello because of "the incredible potential for both scientific and physical exploration and breakthrough." After finishing her Ph.D. at MIT in 2014, Criscitiello moved to Alberta, where she is now a professor at the University of Alberta. In 2017, she also took on the Executive and Academic Director positions at the University of Alberta's Canadian Ice Core Lab (CICL) in Edmonton.

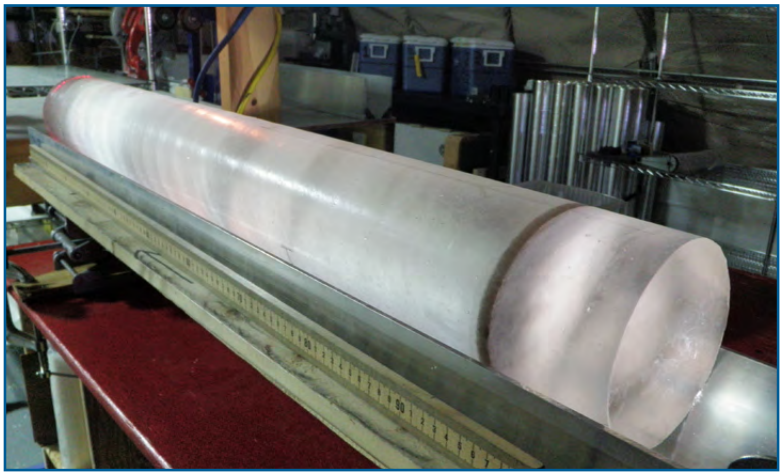
Having primarily conducted research in polar regions, Criscitiello has more recently collaborated on a multidisciplinary project here in Alberta's Columbia Icefield. Criscitiello's work on the Columbia Icefield is funded equally through three partners: EPCOR, Natural Sciences and Engineering Research Council of Canada (NSERC), and National Geographic's Alpine Climate Change Initiative. The fieldwork took place in 2020 and 2021 and the data will shed light on how humans have impacted the Icefield over the past two decades, through use of chemicals and other pollutants that have made their way to this region.

ICE CORING THE ICEFIELD

The primary means of piecing together these past climate stories is through ice coring. Ice cores are tube-shaped cylinders of ice retrieved from a glacier for scientific study. Criscitiello explains, "Nearly anything you may wonder about past climate, we can reconstruct using ice cores." This includes past air temperature, forest fire frequency, environmental contaminant histories, and atmospheric gases such as CO2.

Because the Icefield glacier projects are focused on recent history, the glaciologists used shallow coring methods, only drilling to depths of about 20 metres deep. While Criscitiello says that this project was focused on "more recent

Alison Criscitiello holds up a melt layer in an ice core section on Snow Dome, Columbia Icefield. Photo by Rebecca Haspel.



Ice core showing a layer of volcanic ash from the Western Antarctic Ice Sheet Divide project. Photo credit: National Science Foundation Ice Core Facility.

environmental contaminant histories in the upper snowpack," she points out that glaciers not only record chemistry, but also gases – something that could be analyzed in a hopeful future deep ice core from this site on Snow Dome. Criscitiello explains that these ice cores will allow glaciologists to understand the "kind of burden of chemicals sitting in the snowpack up there," meaning what type and amount of chemicals are being stored there that may be released over time as the glaciers melt. She continues, "We know that these contaminants have cold-condensed into the snowpack, mostly from a few studies done decades ago on Bow Lake and other downstream lakes. They showed the accumulation of many different contaminants like DDT in the lakes." DDT was an agricultural pesticide that was once commonly used, but was banned in Canada in 1985 due to its harmful effects on humans and wildlife. But, if it was trapped in ice while in use, it can still impact water many decades later (known as a legacy pollutant). One of the goals of this project is to give solid information to scientists, water officials and decision makers so they can "be proactive about it and know what's coming down the pipeline."

After the coring was done, Criscitiello says the team returned in the spring of 2022. They worked "from the toe of both the Athabasca and Saskatchewan Glaciers all the way up to the summit of Snow Dome," sampling for all the same contaminants they were sampling for in the ice cores, with about 8 different points on each glacier. Criscitiello says this information is new and hasn't really been fully unpacked, but does say, "The results look very interesting, because there's an elevation-dependent component to the deposition of contaminants." This means that some contaminants are more likely to be seen at lower elevations, while others might only be seen at higher elevations.

Criscitiello says she's hopeful that a deeper ice core will be drilled on Snow Dome to retrieve much longer-term environmental data for the region. She says of this area, "This is the harshest part of the Icefield, yet we can see that the core chemistry is basically destroyed in the upper part of these shallow cores as a results of summer melt. If you look at what should have a seasonal cycle, the glaciochemistry has been washed out by melt. This is one of those places where if we want a long-term climate record, we need to drill it now." Criscitiello emphasizes the need to do this soon, adding, "The longer we wait, the deeper that process happens, and the more information we lose."

As for how this all bodes for our future water supply or aquatic health, Criscitiello answers thoughtfully, "In terms of what does that mean for a wastewater treatment plant in Edmonton? I really don't know. But hopefully this work will help to inform that."

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EMPOWERING THE NEXT GENERATION

Despite her busy schedule, Criscitiello enjoys sharing her passion for glaciers and experiential learning with a younger generation. In 2018, Criscitiello, along with co-founders Jocelyn Hirose and Ellie Bash, were able to get the funding to launch their first expedition for the Girls on Ice Canada program. The website describes the program's approach as "tuition-free, multi-day expeditions for high school girls that interweave science, art, and backcountry travel." Criscitiello says, "Working with the program is pretty incredible." She explains that the underlying intent isn't necessarily just about getting more females into science; it's about empowering girls, particularly from remote communities, by providing new experiences and opportunities they may not normally have. "Whether they decide to go into STEM or become an artist, it doesn't really matter. It's more about knowing that the world is your oyster."