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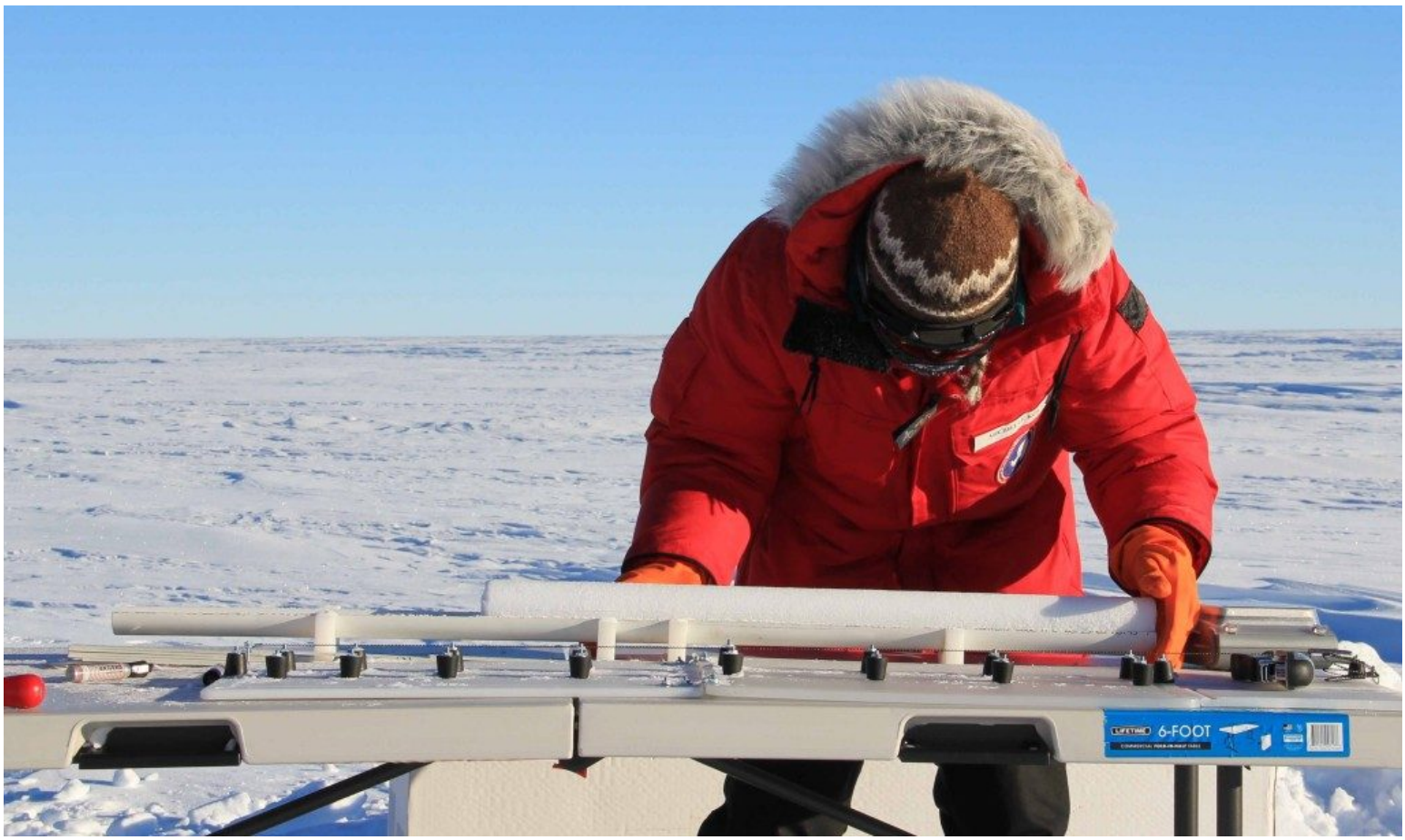
Lasers Help Probe Past Climates In Ice Cores

Researchers from RIKEN have developed a laser melting sampler to study ancient glacial ice cores.



Asian Scientist Magazine (Oct. 30, 2023) —Around the poles, ice accumulated over millions of years can get as deep as several kilometers. Undisturbed, deep ice preserves information about the past. Pockets of air and particles trapped inside ice tell scientists what the past atmosphere looked like. This makes glacial ice cores of immense interest to paleoclimatologists — scientists who study ancient climates.

By sampling ice cores at regular intervals across the depth of an ice core, they can reconstruct the past climate and its evolution over time. Like many other elements, hydrogen and oxygen have rarer, heavier variants or isotopes. Since lighter variants evaporate more readily, the ratios of heavy and light isotopes of hydrogen and oxygen isotopes in ice cores serve as a proxy of the temperature when the ice formed.

However, as researchers dig deeper, they reach older ice that's barely a few millimeters thin each year. This ice is hard to study with existing methods that provide centimetre-scale resolution. For instance, laser ablation-based methods violently shake up the surface of the ice cores. This, much like evaporation, disturbs the ratio of isotopes, limiting the resolution of laser ablation.

In a study published in the *Journal of Glaciology*, researchers from the RIKEN Nishina Center in Japan reported a laser melting method to investigate finer slices of ice cores. "It can analyze the stable water isotopes in ice cores as thin as three millimeters," said Yuko Motizuki, the study's corresponding author.

Motizuki and team developed a laser melting sampler that shoots lasers through an optical fiber. When the laser hits a particular spot on the ice cores, it melts the ice into water. A nozzle attached to the end of the optical fiber extracts meltwater into stainless steel vials. But then the researchers hit another challenge—the laser heating up samples and altering isotope levels.

To avoid this, the research team carefully optimized the power of the laser, the speed of the nozzle as it cut through the ice, and the rate at which to vacuum out the melted sample. With a delicate balance between speed and heat, the system quickly melts ice below boiling point without disturbing the isotopes, resulting in more accurate measurements.

Next, they validated the utility of the laser melting method by putting it to test on ice cores from Dome Fuji, a Japanese research station in Antarctica. At a depth of over 90 meters, they recorded 51 observations at regular 3-millimeter intervals. While this depth was chosen for ease of validation with other methods, with its greater resolution, the new method will allow paleoclimatologists to study past climate from far deeper and older ice cores.

Imagine a dramatic, one-time event that rapidly changed the temperature in the past. Even though such an event would be of huge interest, it would be hard to pin down exactly when it happened in the absence of annually resolved past temperatures. The new method pushes back the time range until researchers can spot such events and if the event occurred in the more recent past, figure out when with more precision.

Beyond sudden events, the method will enhance the understanding of natural solar variations. The heat radiated from the sun changes periodically, impacting temperatures on Earth. By identifying annual temperatures in the distant past, scientists could be able to better distinguish temperature changes due to solar activity from those due to anthropogenic global warming.

Studying past climate also provides clues into the future. "If we understand the natural variation of the past, we can predict more precisely about the future of global warming," said Motizuki.

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Source: RIKEN ; Image: Flickr

The paper can be found at: A novel laser melting sampler for discrete, sub-centimeter depth-resolved analyses of stable water isotopes in ice cores

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