surprising decline of arctic sea ice in just 3 years

Prior to its 2018 launch into orbit, Polar Science Center researchers led science definition teams for NASA's second generation Ice, Cloud, and land Elevation Satellite. And since, they have collaborated with the large community of scientists interpreting ICESat-2's precise measurements of elevation spanning the Earth's surface from pole to pole.

Surprising decreases in snow depth and sea ice thickness have been observed in just the first three years of the ICESat-2 mission. Senior Principal Scientist **RON KWOK** and co-author Sahra Kacimi at the Jet Propulsion Laboratory reported earlier this year that springtime (annual maxima) snow depth and sea ice thickness decreased by over 2 cm and nearly 30 cm, respectively, since 2018.

Obtaining measurements of snow-covered floating sea ice from Earth orbiting satellites is a challenge. The new, unexpected findings of recent, rapid snow and sea ice thinning are made possible by combining independent altimeter measurements from the ICESat-2 lidar and CryoSat-2 (European Space Agency) radar. The lidar measures the air–snow interface while the radar measures the snow–ice interface above the sea surface. Differencing the concurrent products provides a new, accurate assessment of snow depth and sea ice thickness trends across the Arctic.

Kacimi and Kwok placed the past three years in a broader context by comparing derived sea ice volumes from the ICESat-2 observations with those from satellite missions extending back to 2003. Since then, an astounding one-third of the maximum winter sea ice volume has disappeared from the Arctic.

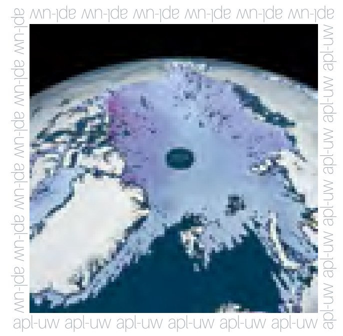
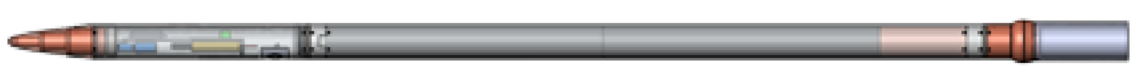


image: NASA Scientific Visualization Studio

on(down)ward to find the oldest ice on earth

The Ice Diver team at APL-UW has a successful record of developing melt probes that descend through glacial ice using modest amounts of electrical power. Logistically, they are very light, allowing researchers to reach deep into ice sheets to make novel observations at low cost.

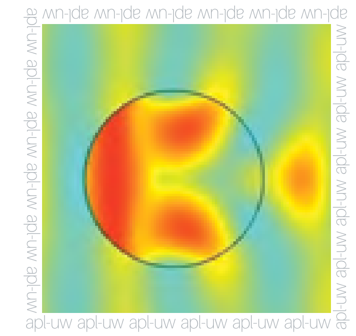
The team's current mission is part of a multi-institutional effort, the Center for Oldest Ice Exploration (COLDEX) Science and Technology Center, funded by NSF. They are designing and fabricating probes to explore ancient ice beds several kilometers deep in East Antarctica. "Our aim is to find and sample some very old and deep ice that preserves climate records from a poorly understood shift in Earth's climate about one million years ago," explains Senior Principal Physicist **DALE WINEBRENNER**.



In 2014 the team sent expendable probes to a record depth of 400 m on the Greenland Ice Sheet. Based on this classic melt probe design, which maintains connection to the surface and electrical heating supply through wires spooled inside the vehicle that unwind during descent, the COLDEX Ice Diver probes are designed to reach 3000 m. On board are optical sensors, developed by collaborator Ryan Bay at the University of California Berkley, to log dust particles. Because the atmosphere was dustier during past, colder epochs in Earth's history, scientists can infer ice age versus depth. Winebrenner adds, "We will also deploy optical fiber from the Ice Diver as it descends and use new commercially available technology to measure the depth profile of temperature in the ice sheet, and from that infer geothermal fluxes that are presently poorly understood."

Work continues to fabricate six nonrecoverable probes that will be deployed in reconnaissance missions in upcoming field seasons to identify promising sites in East Antarctica to later core drill for the most ancient ice on Earth.

editorial praise for ultrasonic kidney stone treatment studies



Both the *Journal of the Acoustical Society of America* and the *Journal of Urology* gave special notice this year to reports by investigators at the Center for Industrial + Medical Ultrasound and their multi-institutional collaborators. Burst wave lithotripsy treatment of kidney stones continues to generate broad interest from the medical, science, and engineering communities.

The transcutaneous application of sinusoidal ultrasonic tone bursts has been shown in clinical trials to be easily performed by urologists, and to be minimally invasive and have few side effects for patients. In a recent clinical trial the team reports that patients who were about to undergo surgical intervention for their stones were first treated with burst wave lithotripsy. Treatments limited to only 10 minutes' duration disintegrated 90% of total stone volume to less than 2-mm fragments.

The researchers noted that the trial was limited to a single transducer operating at one frequency. In subsequent numerical modeling and laboratory experiments they explored techniques to maximize the mechanical stress in stones by matching ultrasound frequency to stone size. As reported in ***JASA***, when the stone diameter is about one-half the acoustic wavelength, stresses greater than six times the incident pressure are achieved inside the stone. They conclude that an optimal treatment strategy may use a low frequency to initially create high stresses inside a large stone to break it into pieces, then switch to a higher burst wave frequency to erode the multiple fragments to dust.

The team's theoretical, experimental, and clinical advances may benefit early intervention, surgical treatment, and emergency relief for kidney stone patients.

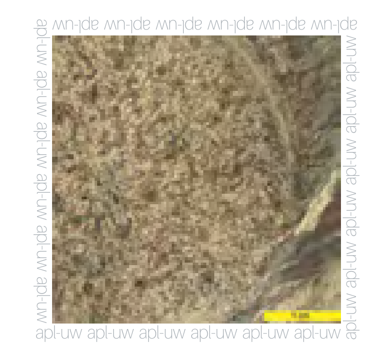
new discoveries in jezero crater, mars

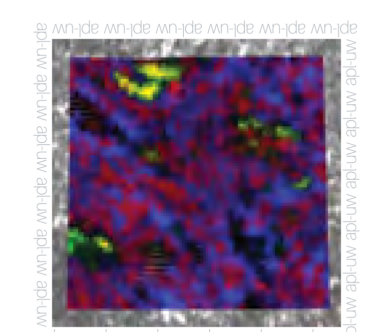
The NASA rover ***Perseverance*** landed on Mars in early 2021 and began its science mission to study the small-scale structure of rocks in the search for signs of ancient microbial life. One of the instruments on the rover's robotic arm is PIXL (the Planetary Instrument for X-ray Lithochemistry). This summer, the PIXL science team published its first paper in ***Science***. Based on the X-ray spectroscopy and other data, they report that a rock in Jezero Crater likely formed from a slowly cooling, thick magma body deep underground that, due to erosion, is now exposed on the surface. Over its history, this igneous rock was altered by the presence of water that once filled the crater.

Senior Principal Physicist **TIM ELAM**, self-identified 'chief spectroscopist' of the Mars rover mission, joined the PIXL team in the early days of mission planning. "PIXL measures the energy of X-rays emitted from the material. And the intensity of each of those X-rays tells us how much of that element is there," explains Elam. "So my job all along has been to model and help design, build, and test the X-ray spectroscopy part of PIXL."

Elam wrote software to process the data beamed back from Mars and provides two interpretive components to the Mars rover science team: converting the PIXL emission spectra to elemental compositions and abundances, and producing a map of the elements distributed on the rock's surface.

"The story of a rock's formation is contained in the set of minerals present because they all form at different temperatures and pressures and under different conditions," says Elam. "Handing off the chemistry and elemental distribution analysis allows geologists to interpret a lot about the history of the rock."





images: NASA/JPL-CalTech