Glaciers Have Important Role in Building Mountains

The seesaw competition between glacial erosion and plate tectonics in shaping mountains is—at least in some cases—being won by the glaciers, according to a new study published in the *Proceedings of the National Academy of Sciences.* The research, undertaken at the St. Elias Mountains on Alaska's southeastern coast, highlights how changes in climate that lead to glacial activity can influence the shape of Earth's mountains.

Scientists studied sediment cores taken from an underwater sediment fan in the Gulf of Alaska that comprised material eroded from the adjacent St. Elias range. They also looked at drill cores taken from the Gulf's floor and from the Alaskan continental shelf, which contained millions of years of geologic history in the area. They discovered that "the composition of the sediment gave clear evidence of when the glaciation started and then expanded, in sync with global climate trends," explains study coauthor Alan Mix of Oregon State University, which allowed the researchers to accurately determine ages of the sediment sequences.

Their findings showed that "most sediments were younger than we anticipated, implying that erosion was higher than we expected," explains the study's lead author, Sean Gulick of the University of Texas. The mountain erosion increased approximately one million years ago, when 40,000-year climate oscillations turned into 100,000-year glacial periods and "erosion of the mountains accelerated under attack from the ice," says Gulick. "In fact, more rock was eroded than tectonics has replaced." That trend has continued since the mid-Pleistocene, with erosion outpacing tectonic activity by rates of 50%–80% in the studied region.

"People often see mountain ranges as permanent, but they aren't really," notes coauthor John Jaeger of the University of Florida. "If more rock is pushed in, they grow, and if more rock is eroded away, they shrink." [Source: Oregon State University]

Study Links Volcanic Eruptions, Weather Patterns, and Polar Melting

A growing body of research has demonstrated that large volcanic eruptions lead to cooling across the world for several years due to the reflection of solar radiation by sulphate aerosols created from volcanic particles blasted into the atmosphere. But new research published in *Scientific Reports* "suggest[s] an extra layer of complexity" in the climatic impacts of eruptions, according to the lead author of the study, James Baldini of Durham University. The research reveals that very large eruptions could cause localized warming that has significant effects on ice sheets and sea levels.

Baldini and colleagues examined ice core, volcanological, and speleothem-based data from earlier

ECHOES

"I want to walk in the woods. I'd like to be able to cut a Christmas tree when there's snow on the ground, but I can't do it this year."

—Virginia Kuebler of the Buffalo, New York, suburb of East Aurora on the record-breaking lack of snow as of December 3. It had been a long time since the city had been without snow by that time of year—116 years to be exact, with the previous record for latest first measurable snowfall being December 3, 1899. The dry ground was quite a change from 2014, when Buffalo got hit in November with a historic storm that dropped up to seven feet of snow in some areas. The average temperature for this past November was 5.5°F above normal, making it Buffalo's seventh warmest November on record. Temperatures were 4°–8°F above normal in almost all of the lake-effect snowbelt from Michigan to upstate New York, and the warm trend continued through most of December. The city finally received its first snowfall—albeit just a dusting—on December 18. In an average year, Buffalo would have had more than 20 inches of the white stuff by that date. [Source: wivb.com]

studies that tracked temperature and rainfall changes over long time periods. The data suggested connections between eruptions and the location of each hemisphere's polar front that had far-ranging climatic consequences. For example, their findings indicated that all eight known volcanic eruptions in the Northern Hemisphere between 30,000 and 80,000 years ago that were as large or larger than the 1815 eruption of Mount Tambora—the largest volcanic eruption in recorded history—led to warm periods in the Antarctic region, as the cooling of the Northern Hemisphere due to the reflection of solar radiation by volcanic particles pushed the Southern Hemisphere polar front south. Similarly, the researchers found evidence of eruptions in the Southern Hemisphere during the last ice age that forced the Northern Hemisphere polar front to retreat, producing warming in Greenland.

Although the overall global effect would still lead to lower average temperatures, it would occur "with warming in the polar regions in the hemisphere opposite the eruption, as well as a major disruption of low-latitude rainfall patterns," explains Baldini. When applied to today's world, these localized polar impacts could cause destabilization of some of the world's largest ice sheets, with potentially significant implications for global sea levels. While Baldini points out that "there are no large Northern Hemisphere ice sheets to amplify the effects of the original eruption," emissions of greenhouse gases and sulfates into the atmosphere since the Industrial Revolution "have already had an effect on weather patterns," and a large volcanic eruption "could add to this problem in an unexpected way." He noted that a significant eruption in the Northern Hemisphere that produced moderate warming in the Antarctic would exacerbate the instability of the West Antarctic Ice Sheet and "could have very serious consequences." [Source: Durham University]

Warming Waters Trigger More Dead Zones

Oxygen Minimum Zones, also known as hypoxic zones or dead zones, can be devastating for marine life, either killing off species or forcing them to other locations. A study in 2008 found more than 400 dead zones throughout the world's oceans and large lakes, highlighting the importance of understanding what causes the in-

creasingly common phenomenon. By looking back to the end of the last ice age, new research published in *Nature* has discovered a link between warming waters and the genesis of dead zones.

Researchers looked at marine sediment cores and plankton biomarkers collected from the North Pacific to put together a high-resolution record of climate there. The data indicated that about 14,700 years ago, and again about 11,500 years ago, rapidly occurring warming of about 4–5°C in the Gulf of Alaska spurred an increase in marine plankton known as diatoms settling to the ocean's floor, which led to sudden oxygen loss in those locations. According to the study's lead author, Summer Praetorius of the Carnegie Institution for Science, during both events, "the transition to hypoxia occurred abruptly and persisted for about 1,000 years, suggesting a feedback that sustained or amplified hypoxia."

The researchers found that the feedback is connected to the lack of iron in the high latitudes of the North Pacific. When oxygen levels begin to decrease, a chemical reaction occurs, releasing iron that had been locked up in continental marine sediments. According to study coauthor Alan Mix of Oregon State University, "that iron then fuels diatoms, which bloom, die, and sink to the seafloor, consuming oxygen along the way."

Praetorius noted that recent climate conditions, such as atypical warming of waters in the northeastern Pacific and the Bering Sea, "seem eerily reminiscent of past conditions that gave way to extended periods of hypoxia." The new research indicates "that the ecological consequences of climate change can be massive and can occur pretty fast with little warning," says Mix. [Source: National Science Foundation]

ECHOES

"It's a bad smog day, so people aren't coming out."

—Bill Isler, who owns a bar in Beijing, China, commenting on the effects the city's extreme air pollution has on many businesses. After sales dropped by about one-third during a smoggy week, another Beijing bar introduced a beer called "Airpocalypse" that is priced on a sliding scale that depends on the air quality—when the air improves, the price goes down. In early December, the city announced its first-ever "red alert," the country's highest air pollution warning, which puts restrictions on automobile use, advises school closures, and shuts down outdoor construction sites and some industrial plants. Just two weeks later, a second red alert was issued. The pollution has hindered many businesses around the country, especially those related to tourism. However, some companies benefitted from the conditions, such as delivery services, which often see an uptick because residents tend to avoid going outside when the smog is severe. [Source: Greenwire]

Smog seen from a hotel in Tianjin, China, about 75 miles southeast of Beijing. [Photo Credit: Mike Friedman, AMS]

New Discovery on How Earth's Slant Affects Equatorial Climate

Gravitational dynamics cause periodic variations in Earth's movement on its axis and its orbit around the sun, and the well-known Milankovitch cycles describe the climatic effects caused by these changes. A recent study in *Nature Communications* has made a surprising new breakthrough in this area by connecting a particular periodic tilt of the Earth to changes in the world's heaviest rain belt and largest source of heat and moisture—the Intertropical Convergence Zone (ITCZ).

By comparing sediment cores dating back 282,000 years taken from the coast of Papua New

Guinea and stalagmite samples from ancient caves in China, researchers found a previously unknown effect in the western Pacific Ocean from obliquity, which is the angle between the plane of the equator and the plane of Earth's orbit around the Sun, As Milankovitch learned, Earth's obliquity fluctuates every 41,000 years between 22.1° and 24.5° due to the gravitational pull of the moon and planets.

The new study's coauthor, Kristine DeLong of Louisiana State University, "took the data and put it through a mathematical prism so I could look at the patterns, and that's where we see the obliquity cycle, that 41,000-year cycle." The analysis showed the obliquity in both the paleontological record and in computer model data, but the surprise was that in the computer spectral analysis ("prism"), the 41,000-year tilt appeared in the Tropics, and "that's not supposed to be there," explains DeLong. "That's not what the textbooks tell us."

The research indicates a much more significant impact of obliquity on ITCZ migration than had previously been known, which subsequently indicates an influence on global hydroclimate cycles, as the ITCZ can have a major impact on rainfall in many equatorial areas, and over longer time periods can lead to intense droughts or flooding. [Source: Louisiana State University]

TECHNOLOGY

Mini-Satellites to Monitor Wildfires

NASA is currently developing a network of small sensors that can piggyback on satellites and monitor wildfires throughout the world. Researchers hope the FireSat program will help fire managers get potentially life-saving information more quickly.

The project would place approximately 200 thermal infrared imaging sensors—each about half the size of a shoebox—onto private-sector communication satellites. The sensors will be able to recognize fires as small as 35 feet wide as rapidly as 15 minutes after they first ignite and send communications to emergency responders within 3 minutes of detection. They will then continuously supply fire activity updates in near-real time.

"While many wildfires are reported by 911 calls soon after ignition, some are not, and delays in detection can lead to rapid escalation of a fire and dramatic growth of the cost of suppression," notes the lead designer of FireSat, Robert Staehle of NASA's Jet Propulsion Laboratory. "The system we envision will work day and night for fires anywhere in the world."

Currently, satellite-based wildfire sensors can only identify blazes about two times per day and send out large images, but FireSat will be able to transmit low-resolution images every minute, and also identify the longitude and latitude of the fire, allowing for nearly constant communication to those on the ground. The system will also be useful for monitoring oil spills, explosions, and other high-heat events.

The first array of FireSat sensors is scheduled to launch in late 2017, with full implementation to be completed in 2018. [Source: Jet Propulsion Laboratory]