Relief Approaches at National Geographic Magazine

An evaluation of current tools

Martin Gamache
National Geographic Magazine

8th Mountain Cartography Workshop
Tongariro National Park
Maps by relief style 2010-2012

- Plan: 4%
- Oblique: 22%
- Plannimetric: 74%
Canyoneers and Cascades

Dropping more than 2,000 feet in 1.5 miles, Deseret Creek Canyon requires canyoneers to make nine or more rope descents—nine down an 89-foot waterfall—and to swim through deep pools. Myles Duxbury, a naturalist who helped create the Great Rift Valley National Park (map opposite) found the canyon in the 1950s. Today it's the standard against which canyoneers measure their skills.

Hidden under a thick blanket of ice and forest, the canyons in this region contain remnant ice that has been isolated from the ice sheets of the continental glaciers. The canyons were Recently carved out of the rock by streams and glaciers, which eroded the rock layers, creating the canyons. The canyons are home to unique plant and animal species, including the endangered North American river otter and the Arctic grayling.

In the Threat Zone, volcanoes and earthquakes pose significant threats. The area is prone to landslides and rockfalls, which can be triggered by heavy rainfall or seismic activity. In addition, the area is subject to occasional volcanic eruptions, which can deposit ash and debris across the region. These hazards require careful preparation and monitoring by local authorities and emergency responders.
The distance between El Capitan and Half Dome summits is 5.8 miles (9.3 kilometers).
DEFINING AN EMPIRE

As the empire began to expand, the Roman Empire was divided into various provinces. The provinces were governed by Roman officials, and each province was responsible for the administration of local affairs. The provinces were divided into regions, and each region was further divided into smaller units. The provinces were also subjected to regular inspections by Roman officials to ensure that the laws were being enforced. The provinces were also responsible for providing soldiers for the Roman army, and the provinces were also responsible for providing taxes to support the army. The provinces were also responsible for providing food for the army, and the provinces were also responsible for providing raw materials to support the army. The provinces were also responsible for providing infrastructure, such as roads and bridges, to support the army.
Located at the intersection of three geologic plates, the Afar depression is caught in a tectonic tug-of-war that's splitting off part of the continent.
Making History
Portuguese explorers arrived at this harbor on the Atlantic in 1502. Having served as Brazil's capital until 1808, Rio is now a cultural center with a population of 6.3 million—almost a quarter in favelas. In 2016 it will bring the Olympics to South America for the first time.

The Imperial Heartland
Archaeologists have discovered royal estates around Cusco, the Inca capital. Spanish records indicate the locations of royal mummies, but the mummies have since been lost.

- Royal estate
- Mummy site
- Both
- Inca ruler (below)
Ansel Adams Wilderness
October 2011
A portfolio by Peter Essick pays tribute to Ansel Adams and the craggy California wilderness named in his honor.

THE MOUNTAINS THAT MADE THE MAN
HEART OF THE SIERRA

Shortly after Ansel Adams’s death in 1984, the California Wilderness Act more than doubled the Minaret Wilderness to some 230,000 acres and renamed it in his honor. The wilderness spans two national forests and links Yosemite National Park to the John Muir Wilderness to the south.

1. Donohue Pass 11,000 ft
2. Jack Lake 7,382 ft
3. Mount Ritter 13,143 ft
4. Banner Peak 12,306 ft
5. Thousand Island Lake 9,332 ft
6. Clark Lakes
7. Garnet Lake 9,478 ft
8. Shadow Creek
9. Minaret 12,344 ft
Uniform Sky Illumination Relief
Kennelly & Stewart, 2006

This methodology illuminates terrain with light sources from numerous directions and with varying intensity to approximate illumination diffusely distributed across a virtual sky. This technique is useful for steep terrain in which shadows would otherwise obscure or mask important portions of the map. Such areas in the umbrage of steep terrain will be softly shadowed so that underlying terrain detail remains apparent (Kennelly 2010).

Figure 7: The Schell Creek Range with diffuse and point source illumination (From Kennelly & Stewart, 2006).
HEART OF THE SIERRA

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1. Donoho Pass 11,000 ft
2. Jack Lake 7,726 ft
3. Mount Ritter 13,110 ft
4. Banner Peak 13,036 ft
5. Thousand Islands Lake 9,030 ft
6. Clark Lakes
7. Garnet Lake 9,736 ft
8. Shadow Creek
9. Minaret 12,244 ft
Against the soaring backdrop of Arizona’s Vermilion Cliffs, the 1929 Navajo Bridge, now used for foot traffic, crosses the Colorado River beside its 1995 counterpart.

Rock of Ages

Millions of years in the making, Vermilion Cliffs National Monument remains a little-known wonder.
An age-old story, written in stone

Towering nearly 3,000 feet above the benchland below, the Vermilion Cliffs—named for their vivid red hue—reveal the layered history of an ancient landscape. Over millions of years, geologic processes turned waterborne sediments and windblown sand into five distinct rock formations, together spanning a vast slice of Earth’s past. The Chinde layer is softer and more susceptible to erosion, undercutting the harder top layers. As they break off, the cliffs slowly retreat.
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A nomadic people in Papua New Guinea were rumored to be living in remote caves in the forest. When we found them, they sent a surprising message to the modern world.

By Mark Jenkins
Photographs by Amy Toensing
PEOPLE OF THE HILLS
The Meakambut are among the most reclusive of the Sepik region's peoples, clinging to the solitude of highland caves while other groups have settled in lowland villages. The territory of the Meakambut is hard to define, since they are seminomadic.
PEOPLE OF THE MOUNTAINS

The Meakambut are the most mysterious of the Sepik region’s ethnic groups, clinging to the solitude of highland caves while other tribes settled in lowland villages. The territory of the nomadic Meakambut is hard to define. Even their name is unclear. Some
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Antarctica Undercut

Pine Island Glacier in West Antarctica is hemorrhaging ice at an alarming rate. But its happening far beyond the reach of human eyes—1,000 feet below the ocean's surface, beneath a shelf of floating ice as thick as two Empire State Buildings would be tall.

Autonomous robot submarines visited this remote spot in 2006. It explored 30 miles under Pine Island’s ice shelf, using sonar to map the seafloor below and the ice ceiling above. While the sub worked, the research vessel Nathaniel B. Palmer measured a worrying process. Strengthening ocean currents are bringing more deep, warm water into contact with thinning ice, melting 19 cubic miles of the ice shelf’s underside in 2008 alone and causing the glacier to flow faster into the ocean. Since 1974, Pine Island has thinned by 230 feet and accelerated by more than 70 percent.

Hundreds of miles of Antarctica’s coastline are now subject to the same forces, which are expected to drive the increase in ice loss for decades to come. It’s difficult but vital to monitor what’s happening to the ice shelf’s weak underbelly, says Stanley Jacobs of the Lamont-Doherty Earth Observatory, who led the international expedition along with Adrian Jenkins of the British Antarctic Survey. The information gathered from beneath the world’s ice is essential to making accurate predictions about sea level rise. —Douglas Fox
VULNERABLE CORE
WHY WEST ANTARCTICA IS MELTING

How West Antarctica contributes to SLR

An icy core

Sea Ice
Continental Shelf

Pine Island Glacier Basin

Rate of ice loss in West Antarctica
2006 - 112 Gt/yr
1996 - 61 Gt/yr

Cross Section Below

Ronne Ice Shelf
Ross Ice Shelf

East Antarctic Plateau

Vulnerable Core

Why West Antarctica is Melting


Surface
Bedrock
Continental Shelf

Vulnerable Core

Why West Antarctica is Melting

Antarctica Undercut

Pine Island Glacier in west Antarctica is hemorrhaging ice at an alarming rate. But it’s happening 4,000 feet below the ocean’s surface, beneath a shelf of floating ice nearly two Empire State Buildings thick.

Autosub3, a robotic submarine, visited this hot spot in 2006. It spent a day and a night exploring 35 miles under Pine Island’s ice shelf. Using sonar to map the seafloor below and the fractured, undulating ice ceiling above, it measured an insidious process: Accelerating ocean currents are pushing deep, warm water against the Antarctic coast, melting 19 cubic miles of Pine Island’s underside each year and causing the glacier to flow faster into the ocean. Since 1996, when regular measurements began, Pine Island has thinned by 230 feet and accelerated by 60 percent.

Hundreds of miles of Antarctic coastline are subject to the same forces, which are likely to drive the increase in ice loss for decades to come. It’s difficult but critically important to monitor what’s happening to Antarctica’s “weak underbelly,” says Stanley Jacobs of the Lamont-Doherty Earth Observatory, who led the Autosub3 expedition. The information we gather from beneath the world’s bottom is essential to making accurate predictions about sea-level rise. —Douglas Fox
Antarctica Undercut

Pine Island Glacier in West Antarctica is hemorrhaging ice at an alarming rate. But it's happening far beyond the reach of human eyes—3,000 feet below the ocean's surface, beneath a shelf of floating ice as thick as two Empire State Buildings would be tall.

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Antarctica Undercut

Pine Island Glacier in West Antarctica is hemorrhaging ice at an alarming rate. But it’s happening far beyond the reach of human eyes—10,000 feet below the ocean’s surface, beneath a shelf of floating ice as thick as two Empire State Buildings would be tall.

Autosub60, a robotic submarine, visited this remote spot in 2006. It explored 30 miles under Pine Island’s ice shelf, using sonar to map the seafloor below and the ice ceiling above. While the sub worked, the research vessel Nathaniel B. Palmer measured a worrying process: Strengthening ocean currents are bringing more deep, warm water into contact with thinning ice, melting 19 cubic miles of the ice shelf’s underside in 2009 alone and causing the glacier to flow faster into the ocean. Since 1974 Pine Island has thinned by 230 feet and accelerated by more than 70 percent.

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Douglas Fox

*This information was originally reprinted in *Science* 316 (2007): 1845-1850.*
Mount Erebus
July 2012
We’ve come to one of the coldest spots on Earth to search for beings that thrive in blistering heat. In a place with full daylight for four months, we’re seeking life that dwells in utter darkness. Welcome to the topsy-turvy world of Antarctica’s Mt. Erebus.

Sunlight filters through the dome of an ice cave on Erebus, the most southerly active volcano in the world.
Erebus Crater

Ice caves and fumaroles
Icy Inferno
Just a short helicopter ride from New Zealand’s Scott Base and the U.S.’s McMurdo Station, the 12,446-foot Mount Erebus volcano dominates the skyline of Ross Island, Antarctica. The upper slopes, where temperatures can drop to minus 40°F in summer, are adorned with more than a hundred ice caves and towers.

Sculpted towers, melted cavens
The ice towers form over fumaroles, or vents, where hot, moist gases leak from within the volcano, instantly freezing in the cold air. Sculpted into strange shapes by wind, towers can reach more than 50 feet. Below the surface, frosty cavens are melted out of the ice by vent gases and the raw heat of the volcano.
Fractional Laplacian Operator Technique
Leland Brown, NACIS 2010-2011

www.box.com/textureshading
What texture shading does, in essence, is show the *relative* height of each point, relative to terrain nearby - where "nearby" is defined as a weighted average over all distances, giving the most weight to closer terrain but also considering data out to very large distances, to a lesser and lesser extent (following a power law).

Thus, light shading primarily indicates points high relative to things around - i.e., ridges - but also includes some indication of absolute elevation. Likewise, the darkest points generally indicate the deepest canyons. Minor ridges and canyons show up as more subtle variations on the local shading, in a manner reminiscent of the resolution bumping technique developed by Tom Patterson of the U.S. National Park Service.
Icy Inferno
Just a short helicopter ride from New Zealand's Scott Base and the U.S.'s McMurdo Station, the 12,448-foot Mount Erebus volcano dominates the skyline of Ross Island, Antarctica. The upper slopes, where temperatures can drop to minus 40°F in summer, are adorned with more than a hundred ice caves and towers.

Sculpted towers, melted caverns
The ice towers form over fumaroles, or vents, where hot, moist gases leak from within the volcano, instantly freezing in the cold air. Sculpted into strange shapes by wind, towers can reach more than 55 feet. Below the surface, frosty caverns are melted out of the ice by vent gases and the heat of the volcano.
ADIRONDACK PARK

FOREVER WILD

New York State’s sprawling preserve strikes an extraordinary balance between modern interests and the forest primeval.
AN ADIRONDACK MOSAIC

Since its original boundary was drawn 118 years ago, the park has grown to nearly six million acres, less than half of which are state owned. In recent years more and more private land (graph, above right) has been placed under conservation easements—legal agreements that restrict development while allowing for recreation, farming, timber management, and other traditional uses.
Land in conservation easements within Adirondack Park (acres)

Ownership categories

State land
- Forest preserve (least developed)
- Unprotected (more developed)

Private land
- In conservation easements (development restricted)
- Other private land (most developed)

21,095 (1979)
686,263 (2009)
AN ADIRONDACK MOSAIC

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SMITH, CUMMINGS, NUGENT, STAFF
SOURCE: ADIRONDACK PARK CONSERVANCY AND NATIONAL CONFERENCE ADIRONDACK PARK CHAPLAIN, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION