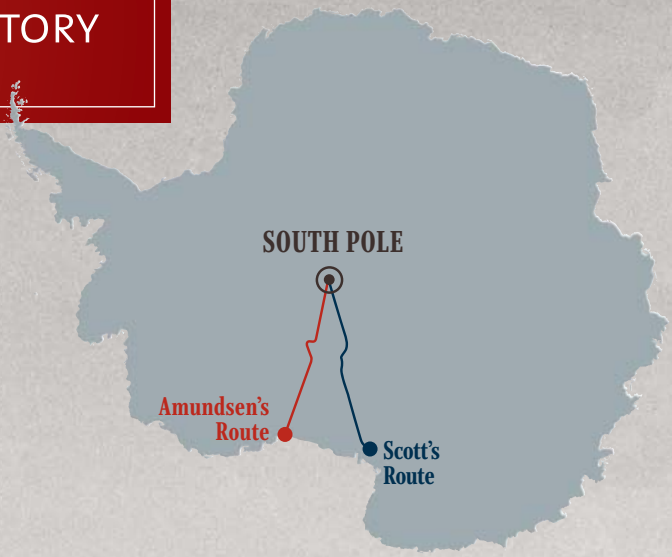
American Museum of Natural History



RACE

to the End

OF THE EARTH

Roald Amundsen

Robert Falcon Scott

EDUCATOR'S GUIDE

amnh.org/education/race

INSIDE:

- Suggestions to Help You **Come Prepared**
- **Essential Questions** for Student Inquiry
- Strategies for **Teaching in the Exhibition**
- **Map** of the Exhibition
- **Online Resources** for the Classroom
- Correlation to **Standards**
- **Glossary**

ESSENTIAL QUESTIONS

Who would be first to set foot at the South Pole, Norwegian explorer Roald Amundsen or British Naval officer Robert Falcon Scott? Tracing their heroic journeys, this exhibition portrays the harsh environment and scientific importance of the last continent to be explored. Use the Essential Questions below to connect the exhibition's themes to your curriculum.

What is Antarctica?

Antarctica is Earth's southernmost continent. About the size of the United States and Mexico combined, it's almost entirely covered by a thick **ice sheet** that gives it the highest average elevation of any continent. This ice sheet contains 90% of the world's land ice, which represents 70% of its fresh water. Antarctica is the coldest place on Earth, and an encircling polar ocean current keeps it that way. Winds blowing out of the continent's core can reach over 320 kilometers per hour (200 mph), making it the windiest. Since most of Antarctica receives no precipitation at all, it's also the driest place on Earth. Its landforms include high plateaus and active volcanoes. The **austral** winters and summers resemble one long night and one long day between weeks of sunrise and sunset. Although most life is concentrated on the shoreline and surrounding waters, microbes thrive in unexpected places like dry valleys and ice-capped brine lakes.

How has Antarctica changed over time?

Fossils, rocks, and **ice cores** reveal that Antarctica was once very different. Until around 30 million years ago, **temperate** conditions would have permitted plants and animals (including mammals and birds) to survive, although they would have had to adapt to a very brief summer. Today, besides a variety of **microbial** life, few species (which include penguins, seals, seabirds, and **tundra**-like vegetation) have characteristics that enable them to live there. These traits include fur and physiological **adaptations** such as the "antifreeze" molecules in the blood of certain fish.

Why explore Antarctica?

Early sightings of the continent were made by maritime explorers, whalers, and seal hunters. By the mid-1800s, drawn by trade, imperialism, or curiosity, a number of expeditions had braved the icy continent's brutal conditions. Exploration was a symbol of national pride, and in 1910 two very different men staked their fortunes on a race to the South Pole. One was Norwegian Roald Amundsen, an experienced polar explorer who sought the recognition in order to garner support for further voyages. The other, British Naval officer Robert Falcon Scott, hoped to advance both his career and scientific understanding of this strange territory. Scientists who accompanied Scott laid the groundwork for discoveries in fields ranging from magnetism to ornithology.

What do explorers need to survive during polar expeditions?

Roald Amundsen in loose fur clothing adopted from his time in the Canadian Arctic. "I find it excellent," he reported. "Am always warm, without sweating."

Exploring Antarctica involved great danger and unimaginable physical hardship. Hazards included snow blindness, malnutrition, frostbite, **crevasses**, and howling **blizzards**. With ground and sky often merging into a featureless plain, navigation was difficult. To deal with these challenges, Scott and Amundsen adopted very different strategies. Scott brought ponies, dogs, and motorized vehicles, and once on the polar plateau relied on men in harnesses to pull long, heavy sleds. Adopting technologies learned from the Inuit in the Arctic, Amundsen and his men skied alongside custom-designed dog sleds. Today's travelers arrive in airplanes instead of wooden ships, navigate by GPS instead of sextant, wear moisture-resistant and windproof clothing instead of wool and reindeer fur, and communicate via satellite.

Why is Antarctica important today?

Known as "the continent of science," this vast natural laboratory is protected from military and commercial use by the **Antarctic Treaty**. Ice cores contain a record of how the ice sheets formed and moved, and how climate changed in the past. The unpolluted atmosphere at the bottom of the world is superb for astronomy. Fossil finds help paleontologists chart the **biogeography** of the southern hemisphere, and support the theory of continental drift. Biologists are finding organisms that illuminate the history of life. It is Antarctica's unique conditions that make these explorations possible.

GLOSSARY

adaptation: a trait — physical, chemical, or behavioral — that has evolved by natural selection and enhances an organism's survival and reproduction

Antarctic Treaty: In 1961, 12 countries signed a treaty establishing that the continent belonged to all and would be used for peaceful purposes only — in particular scientific investigation and collaboration. 48 nations are now parties to this treaty.

austral: relating to the southern hemisphere. Earth rotates around the Sun on a tilted axis that creates the seasons, which are opposite at the two poles. In Antarctica the brief austral summer runs between mid-December and mid-March.

crevasse: a deep crack in the ice sheet, sometimes concealed by snow

biogeography: the distribution of plants and animals across the planet

blizzard: a violent snowstorm with high winds. In Antarctica, the snow is blown up from the ground.

fossil: remains or traces of ancient life typically preserved in sedimentary rocks

ice core: drilled through thick ice sheets, these cylindrical samples contain a climate time capsule. The record in Antarctica presently stretches back 800,000 years.

ice sheet: a thick blanket of ice formed by the accumulation and compression of thousands or millions of years of snowfall. Ice sheets that float out over water are called ice shelves.

microbial: involving microbes, single-celled life forms usually invisible to the naked eye

overwinter: to wait out the winter, as early Antarctic explorers had to do. Teams would spend a summer planning and provisioning, wait out the winter in base camp, and travel to the interior the following summer.

temperate: having a moderate climate, without extremes of hot or cold

tundra: the treeless plain of the northern hemisphere's Arctic regions, where vegetation such as lichens and mosses grows

COME PREPARED

Plan your visit. For information about reservations, transportation, and lunchrooms, visit **amnh.org/education/plan**.

Read the Essential Questions in this guide to see how themes in *Race to the End of the Earth* connect to your curriculum. Identify the key points that you'd like your students to learn from the exhibition.

Review the Teaching in the Exhibition section of this guide for an advance look at the artifacts, models, and interactives that you and your class will be encountering.

Review the activities and student worksheets in this guide. Designed for use before, during, and after your visit, these activities focus on themes that correlate to the NYS Science and Social Studies Core Curriculum:

- Environments & Adaptations (grades K–2)
- Problem Solving (grades 3–5)
- Geography (grades 6–8)
- Exploration (grades 9–12)

Decide how your students will explore *Race to the End of the Earth*. Suggestions include:

- You and your chaperones can facilitate the visit using the **Teaching in the Exhibition** section of this guide.
- Your students can use the **student worksheets** to explore the exhibition on their own or in small groups.
- Students, individually or in groups, can use copies of the **map** to choose their own paths.

CORRELATIONS TO NATIONAL STANDARDS

Your visit to the *Race to the End of the Earth* exhibition can be correlated to the national standards below. See the end of this guide for a full listing of New York State standards.

Science Education Standards

All Grades · A1: Abilities necessary to do scientific inquiry · E1: Abilities of technological design · E2: Understandings about science and technology
K–4 · B1: Properties of objects and materials · C1: Characteristics of organisms · D1: Properties of Earth materials · D2: Changes in Earth and sky · G1: Science as a human endeavor
5–8 · C2: Reproduction and heredity · C3: Regulation and behavior · C4: Populations and ecosystems · C5: Diversity and adaptations of organisms · D1: Structure of the Earth system · F1: Personal health · F4: Risks and benefits · G3: History of science
9–12 · B2: Structure and properties of matter · B4: Motions and forces · C3: Biological evolution · C6: Behavior of organisms · D1: Energy in the Earth system · D3: Origin and evolution of the Earth System · F5: Natural and human-induced hazards

Social Studies Standards

Thematic Strands · III. People, Places, and Environment · VIII. Science, Technology, and Society

TEACHING IN THE EXHIBITION

The *Race to the End of the Earth* exhibition uses artifacts, models, maps, interactives, videos, and more to help students learn about early polar exploration and the challenges of survival in Antarctica. This guide divides the exhibition into seven numbered areas, which correspond to the map and to the text below.

1. Introduction

OVERVIEW

The mean annual temperature at the South Pole is –49°C (–56°F), an environment so harsh that a small misstep can spell disaster. A century ago the margin of safety was even smaller.

GUIDED EXPLORATION

Theater: Invite students to watch the video, which sets the stage for the race to the Pole.

> **Just beyond the theater, students can "Meet the Men."** As students go through the exhibition, encourage them to pay close attention to the decisions the British and Norwegian teams made about clothing, transportation, and timing, and to the consequences of those choices.

2. First Glimpses

OVERVIEW

From the time of the early Greeks, people proposed the existence of a southern continent, perhaps habitable, perhaps a howling wasteland. Two hundred and fifty years ago men began braving the world's roughest waters to see for themselves.

GUIDED EXPLORATION

Interactive table map, historical maps and paintings, and ship's log: Invite students to see how early maps and globes depicted the mysterious continent, and to track the first journeys southward. Ask students to imagine what it was like to be an explorer in the 18th or 19th century. What's surprising about what these early voyagers knew (and didn't know) about geography?

Answers may include: Antarctica was long thought to be as large and livable as Asia. It wasn't until the mid-1800s that ships got close enough to observe the ice-covered land.

3. The Race Begins

OVERVIEW

As the exploration of Antarctica captured the imagination of the British public, they clamored for Naval officer Robert Falcon Scott to claim the final frontier: the South Pole. At the same time, but in secret, veteran Arctic explorer Roald Amundsen set his sights on the prize for his native Norway.

GUIDED EXPLORATION

Cross-sections, models, and photos of the *Fram* and the *Terra Nova* and objects from the voyages: Have students examine and contrast the two vessels and their crews. How do the motivations of the two leaders compare?

Answers may include: A career naval officer, Scott knew that he would be well paid and that the hazardous journey might earn him a promotion. He was also keen to carry out scientific investigations. Amundsen's lifelong dream was to be a professional polar explorer and he trained steadily for it.

4. Two Teams, One Goal

OVERVIEW

In January, 1911, the two parties set up very different base camps on opposite edges of the Ross Ice Shelf. There they spent ten months — four in utter darkness — and planned their trips to the Pole.

GUIDED EXPLORATION

Antarctica's Seasons wall: Students can learn about Earth's axis and how it affects seasons in each hemisphere. Ask students why Antarctica's seasons resemble one long day and one long night.

Answer: The Earth has seasons because its axis is tilted and because it revolves around the Sun once every 365 days. During the austral summer, the Earth's tilt exposes most of the southern polar region to the Sun's rays all of the time — even though Earth is rotating daily on its axis. Six months later, during the austral winter, the South Pole is perpetually dark because it is now maximally tilted away from the Sun, while the North Pole soaks up twenty-four hours of sunlight a day. Consequently, weeks of sunrise precede the austral summer, and winter follows weeks of sunset.

How does this affect the planning of an expedition?

Answers may include: Expeditions had to be carried out during the brief summer's light and relative warmth, before the long, frigid winter set in.

Replica of Scott's hut: Have students consider what these objects reveal about overwintering in Antarctica, and how Scott and his team put this time to use.

Answers may include: In addition to planning and preparing for the journey to the Pole, they spent time listening to music on the gramophone, playing chess, writing and drawing, giving lectures and attending Sunday church services led

by Scott. Along with bunks, kitchen, and dining tables, the room contained scientific laboratories, a darkroom, and a player piano. The scientists on the British team researched weather, wildlife, and geology of this unexplored land's.

Captain Scott spent much of the Antarctic winter recording his impressions of the continent, writing letters, and working out a strategy for reaching the Pole.

Polar clothing: Have students compare the way the two teams were outfitted. Ask them what informed each team's decisions.
Answers may include: During the race to the South Pole, the British team relied mainly on woolen clothing. The Norwegians dressed in furs, based on Inuit designs that Amundsen had studied during his time in the Arctic.

Compass interactive: Invite students to manipulate the compass. What does it show about the response of the needle to the magnetic pole?
Answer: In Antarctica, because the magnetic pole is so close, a compass needle will dip down instead of pointing north.

Replica of Amundsen's carpentry workshop: Ask students to look at the way the Norwegians spent the dark winter months. How does this network of under-snow tunnels compare to Scott's winter quarters?
Answers may include: Both teams brought pre-fabricated wooden huts. Amundsen's smaller one, used for sleeping and eating, was connected by tunnels to what he described as "a whole underground village" that was insulated by the snow.

5. To the Pole!

OVERVIEW
The austral summer (December to March) with its long days and somewhat warmer temperatures, was the only window for the grueling round-trip journey of 2,900 kilometers (1,800 mi). The explorers knew that every hour would count.

GUIDED EXPLORATION
Scott vs. Amundsen wall panels and Race Timeline: Students can compare factors such as transportation, clothing, food, and shelter that each team relied upon. Ask students which proved the most effective for surviving, and succeeding, under the harsh conditions. What logistics helped the team that reached the Pole first?
Answers may include: Amundsen used dogs to pull the sleds, while his men skied alongside, or even rode. The British used experimental motorized vehicles and horses, neither of which performed well in the extreme cold. Once up on the polar plateau, the men pulled the sleds themselves, as planned.

"Man-hauling" required men strapped into harnesses to drag heavy sleds. Henry "Birdie" Bowers said, "I have never … so nearly crushed my inside into my backbone by the everlasting jerking with all my strength."

Hauling sleds interactive: Students can push a model sled across two different surfaces. Ask them how temperature affects the task.
Answer: As the temperature sinks below -20oC (-4oF), friction no longer heats the snow enough to create or maintain a liquid film. As a result, the ice surface feels rougher and the sled becomes harder to pull.

6. Back From the Pole

OVERVIEW

After reaching the Pole on December 14, 1911, one team hurried back to base camp. In contrast, the other team took a full month longer to reach their goal. Exhausted and starving, the men were still struggling back as the light began to dim and the weather to turn bitter cold.

GUIDED EXPLORATION

Race Timeline (cont'd.): What factors contributed to Amundsen's team's return to base camp 10 days ahead of schedule? What led to the death of Scott and his men?

Answers may include: Better provisioned and in better health, the Norwegian team traveled fast and escaped the onset of winter. Having set out on their return trip a month later, Scott and his men soon ran into stormy weather. They found themselves increasingly short of food and fuel, and slowed during the last leg of the journey as temperatures dropped rapidly.

Reaching the South Pole on January 17/18, 1912, the Scott party found the three-man tent the Norwegians had left behind.

7. Antarctica Today

OVERVIEW

Forty-eight nations are parties to the Antarctic Treaty agreeing to peaceful, scientific exploration of the continent. The continent's only long-term occupants — 4,000 in summer, 1,000 in winter — are researchers, students, and support staff.

Flags in front of the new Amundsen-Scott South Pole Station, the latest U.S. scientific station at the southernmost end of the Earth.

GUIDED EXPLORATION

Life in Antarctic Seas video: Ask students to describe the marine environment around Antarctica, the organisms that live there, and their adaptations.

Answers may include: The ocean around Antarctica teems with life. The top predators are marine mammals—seals and whales. There are many sea birds, and five species of penguin, which can dive 550 meters (1800 feet) deep to feed and hold their breath for over 20 minutes. The sea is home to fish found nowhere else in the world, and to vast quantities of the shrimp-like crustaceans called krill. Some polar invertebrates are much larger than their warm-water relatives, perhaps because there's more food and/or more oxygen in the water.

Fossil specimens (reptiles, birds, teeth of early mammals, wood): Have students observe these specimens and consider what they tell us about Antarctica's climate in the past.

Answers may include: These fossil specimens tell us that Antarctica was once warm enough for reptiles, mammals, birds, and trees to live there. They also tell us that the continent was once connected to what is now South America.

Modern clothing and equipment: Ask students to imagine what it's like to live and work in Antarctica. How have modern technologies changed the experience? What did present-day explorers learn from Scott and Amundsen?

Answers may include: Today, people who go to the Antarctic can make the trip by air, wear clothing that keeps them dry and warm, and stay in contact with the rest of the world.

Most ECW—Extreme Cold Weather—clothing is now made of synthetic materials that allow the body's moisture to escape but keep out wind and rain.

Science of Antarctica interactive map: Have students use the interactive map to explore the continent's weather, the land under the ice, and the impact of global warming.

Polar Personality Test: Have students take this quiz to see if they have what it takes to winter over at the bottom of the Earth.

ONLINE RESOURCES

Race to the End of the Earth Exhibition Website
amnh.org/race
Access featured content from the exhibition, including an interactive map and photo gallery.

Race to the End of the Earth for Educators
amnh.org/education/race
All exhibition-related resources are listed on this page, including tips on planning your visit and links to resources that include the complete Educator's Guide in PDF form.

Polar Mammals
beyondpenguins.nsdl.org/issue/index.php?date=January2009
Focused on polar regions, this issue of an online magazine for K–5 educators features a podcast of AMNH Curator Ross MacPhee talking about mammals.

As Antarctic Ice Melts, Wildlife Shifts
sciencebulletins.amnh.org/?sid=b.s.antarctic_web.20090323
The Antarctic Peninsula is warming far faster than anywhere else on Earth. This interactive explores the effect on the local food web.

Finding Life at the Frozen Poles: Antarctica
sciencebulletins.amnh.org/?sid=b.s.antarctica_life.20071210
Aimed at middle- and high-school students, this interactive describes recent ecological discoveries.

Global Ozone: 2004–2008
sciencebulletins.amnh.org/?sid=e.v.ozone08.20090101
This dynamic visualization of changes in Earth's ozone shield between 2004 and 2008 focuses on levels over Antarctica.

The Endurance: Shackleton's Legendary Antarctic Expedition
amnh.org/exhibitions/shackleton
Text, animations, and historic photographs tell one of history's greatest tales of survival: Sir Ernest Shackleton's 1914 voyage to the Antarctic.

Antarctica Curriculum
amnh.org/resources/antarctica
This award-winning curriculum connects students to the continent's biology and geology, and helps them master important science skills. Easily tailored to your time frame and grade level.

Expeditions OLogy
amnh.org/ology/expeditions
Kids ages 7 and up can meet Ross MacPhee, scientist and curator of *Race to the End of the Earth*, go on virtual expeditions, and make their own compasses and field journals.

ANTARCTIC FACTS

- Antarctica is on average the coldest, driest, windiest, and highest continent on Earth.
- A continent surrounded by ocean, Antarctica is the opposite of the Arctic, which is an expanse of ocean surrounded by continents.
- If melted, the ice sheets covering Antarctica would raise global sea level by almost 70 meters (230 feet).
- In the long, dark winter, temperatures at the South Pole may plunge to –58°C (–73°F). Even in the summer, temperatures of –26°C (–16°F) can lead to frostbite and hypothermia.
- Antarctica's harsh climate is similar in some respects to that of Mars. NASA tests equipment there to prepare for planetary expeditions.
- Once Scott and his men left, it was 44 years before another person set foot at the South Pole.

CREDITS

Race to the End of the Earth is organized by the American Museum of Natural History, New York (www.amnh.org), in collaboration with Musée des Confluences, Lyon, France, and Royal BC Museum, Victoria, British Columbia, Canada.

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British Consulate-General New York

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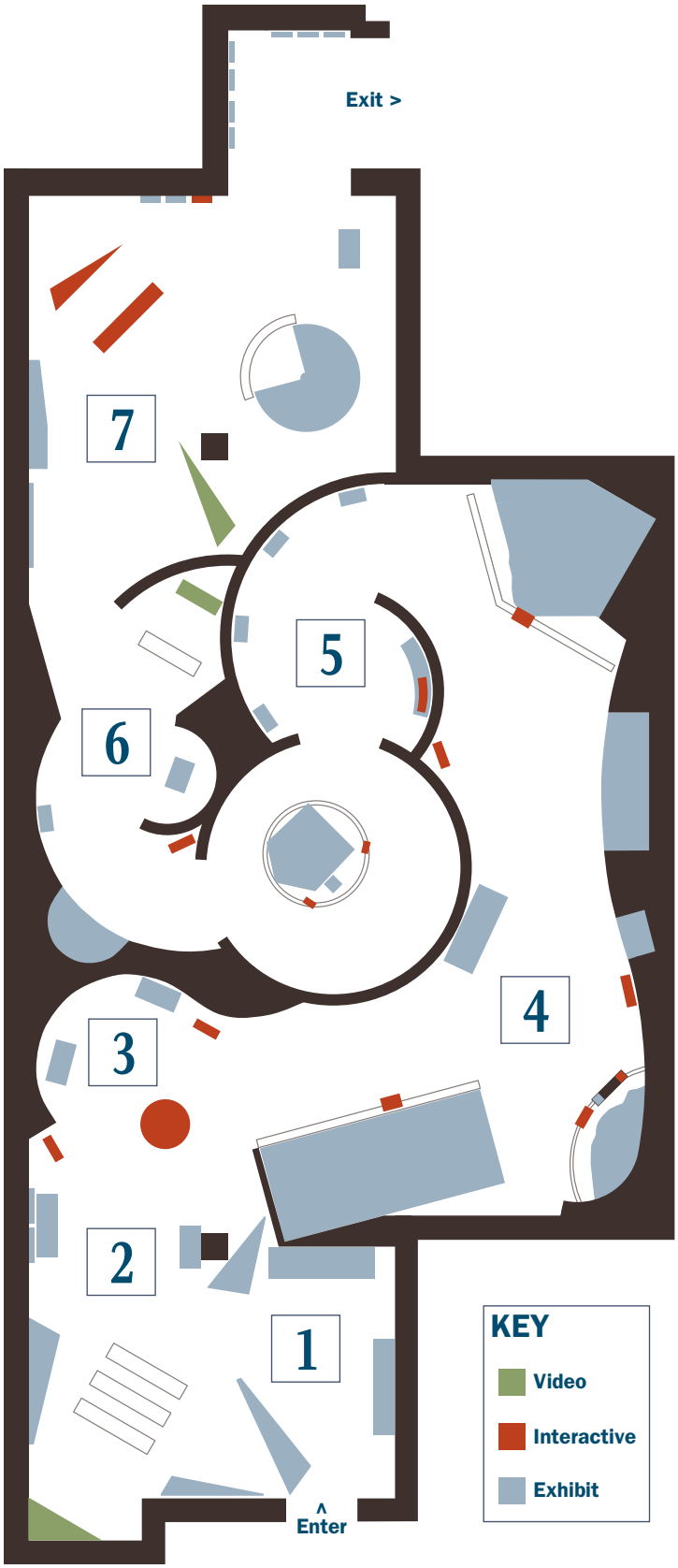

MAP OF THE EXHIBTION

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2. First Glimpses

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4. Two Teams, One Goal

In January, 1911, the two parties set up very different base camps on opposite edges of the Ross Ice Shelf. There they spent ten months — four in utter darkness — and planned their trips to the Pole.

5. To the Pole!

The austral summer (December to March) with its long days and somewhat warmer temperatures, was the only window for the grueling round-trip journey of 2,900 kilometers (1,800 mi). The explorers knew that every hour would count.

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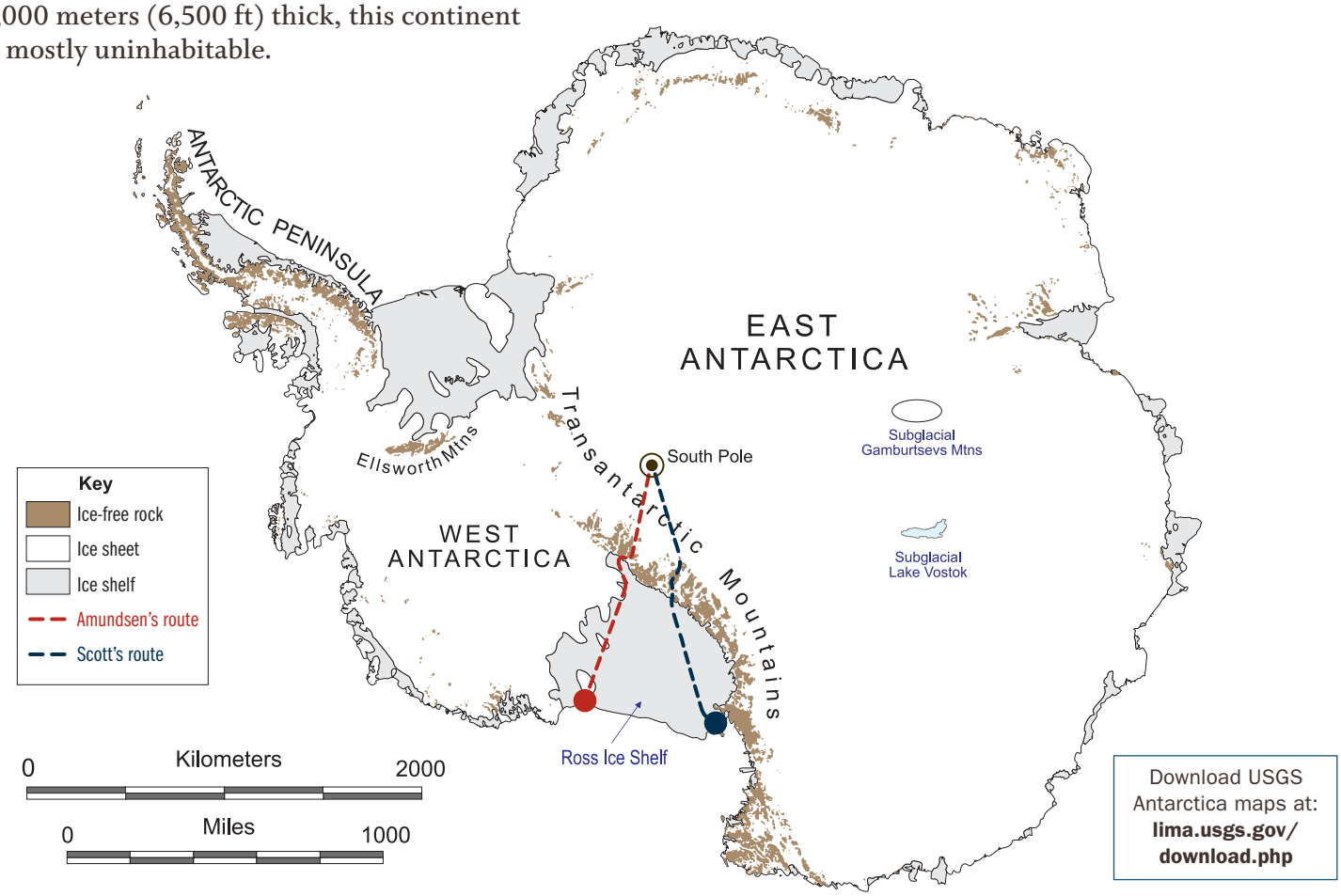
7. Antarctica Today

Forty-eight nations are parties to the Antarctic Treaty agreeing to peaceful, scientific exploration of the continent. The continent's only long-term occupants — 4,000 in summer, 1,000 in winter — are researchers, students, and support staff.

ANTARCTICA: A CONTINENT OF EXTREMES

Antarctica is on average the coldest, driest, windiest, and highest continent on Earth. Covered by ice 2,000 meters (6,500 ft) thick, this continent is mostly uninhabitable.



Two Landmasses

Antarctica is really two distinct landmasses. East Antarctica is a "shield"—a dome of very ancient rocks within a continent. Geologically younger West Antarctica was formed in part by the same mountain-building processes that created the Andes.

High Peaks & Deep Valleys

Fifty years ago, scientists were stunned to discover a mountain range, the Gamburtsevs, completely buried under the ice. Now, new imaging has also revealed deep valleys, in a landscape some compare to the European Alps.

Broad Plateau

Composed entirely of ice, the plateau sits 4,000 meters (13,000 ft) above sea level and covers all of East Antarctica.

Under-Ice Lakes

An interconnected network of lakes, large and small, is being discovered under the polar ice sheet. The largest of these lakes, Lake Vostok has been sealed for millions of years. Scientists want to sample this environment but worry about contamination.

Katabatic Winds

Ferocious katabatic winds occur when dense, frigid air builds up on the polar plateau. The air spills over, gathering speed like an "avalanche" as it tumbles toward the coast.

Sea Ice

Every fall and winter, the amount of sunlight falling on Antarctica decreases. As the surrounding ocean chills, it develops a coating of sea ice. In spring, as the Sun returns, the sea ice begins to retreat.

Powerful Current

The ocean current circling Antarctica is the most powerful current on the planet. Driven by strong winds from the west, this swirling moat of cold water stretches more than 20,000 kilometers (12,400 mi) around the continent and has isolated it for about 30 million years.

Ice Shelves

An ice shelf is a thick, floating mass of ice that forms as the ice sheet flows outward under its own weight. The shelves dam the flow of glaciers to the sea. As global temperatures rise, ice shelves on the Antarctic Peninsula seem to be collapsing more often, and more quickly, than in the past. Their loss may speed sea-level rise.