



# Erebus The Ice Dragon

A PORTRAIT OF AN ANTARCTIC VOLCANO

COLIN MONTEATH







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In memory of Ray Dibble, Werner Giggenbach,  
Tony Taylor and Garth Varcoe

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# Foreword

When first sighted in 1841 by Captain James Clark Ross and his crew, Erebus was in fiery eruption. It is the only active volcano on the Antarctic continent and has attracted explorers and puzzled scientists ever since.

Colin Monteath was destined to be drawn to this mountain, too. His love of adventure and mountains began well before he applied successfully to be a field guide with the New Zealand Antarctic Programme for the summer of 1973/74. In that first season at Scott Base, he met Haroun Tazieff, the legendary French volcanologist, who was on his first visit to Antarctica to explore the crater of Erebus at the invitation of New Zealand geologist Phil Kyle.

Monteath's alpine skills and experience led to a full-time position the following year with New Zealand's Antarctic Division, at the Department of Scientific and Industrial Research. His role as field operations officer included responsibilities for ensuring field parties were properly equipped and capable of taking on the work they had planned, as well as dog-team management. It also allowed him to apply his high-altitude skills to Phil Kyle's Mount Erebus project. This had by then become a multi-year, multifaceted scientific monitoring and sampling programme as sophisticated as any in the world, but with the extra challenge of being polar. In 1978 Monteath made the first descent into the Inner Crater, a key step for sampling volcanic gasses.

Monteath left the Antarctic Division a few years later to broaden his polar and alpine experience and increase public awareness of these special parts of our planet. For three decades he worked as an expedition guide and lecturer for many polar cruise and adventure companies in the Arctic and Antarctic, and founded Hedgehog House New Zealand to build photo galleries of exceptional quality, and to support his work through feature stories for national and international magazines.

He has been deeply involved in a number of books, beginning with *Great Stories from the Frozen Continent* (1985), for which he was principal photographer, working with editor Edward Barnard. As with that book, *Erebus The Ice Dragon* appeals with engaging text and remarkable images, but it focuses on a variety of human interactions with just a single mountain.

The introduction provides a glimpse of the following grand sweep in 13 chapters, along with a mention of the title from a poem he scribbled in a notebook during his first camp on the mountain in 1976. The first two chapters offer a superb, up-to-date lay description of Antarctic geological history, as well as that of Erebus itself. Human

history follows in Chapter 3 with the 1841 sighting from HMS *Erebus* of the volcano erupting on a grander scale than at any time since. Chapters 4 to 6 record the first three ascents of the mountain in 1908, 1912 and 1959, each a small miracle in different ways and retold by someone who can identify with the experiences of the climbers.

For me, the heart of the book is Chapter 7, aptly titled 'The heartbeat of Erebus'. It describes how, between 1972 and 1978, the team led by Phil Kyle worked to understand just how this active volcano came to be the feature we see today; the technology they drew on and developed; and the considered risks they had to take. They paved the way for the exciting scientific work that followed two decades later.

For some readers it may be the excitement, hardships and danger of early exploration and ascents in this dramatic landscape, while others may seek out information on the latest science being undertaken on Erebus. Whatever your particular interest, the book shifts easily between observations, supporting images and storytelling, weaving together the many histories of Erebus and the attraction it has held for so many people. It concludes with researcher, curator and artist Adele Jackson's review of the many imaginative ways in which this active polar volcano has been depicted in visual arts and music, and even its role in geopolitics.

No book on Erebus would be complete without a chapter acknowledging New Zealand's greatest peace-time tragedy — the 1979 crash of TE901 on Ross Island with the loss of 257 lives. Monteath provides a clear statement of the circumstances leading up to the crash. The reflections that follow from four of the recovery team (including the author himself) provide a depth of understanding of both the situation and the consequences not found elsewhere.

Colin Monteath describes himself as 'a polar and mountain photographer and writer who is passionate about wild places and expedition travel'. In *Erebus The Ice Dragon* he shows that he is indeed this, and much more. He also has a keen sense of history and the human psyche. In this book of stories from a remarkable volcano, he introduces us to those with the ability and drive to explore new lands, new knowledge and the human imagination. It is beautifully illustrated and seductively readable.

*Peter Barrett, NZAM, FRSNZ, FGS (Hon)*  
*Emeritus Professor of Geology and Founding Director,*  
*Antarctic Research Centre, Te Herenga Waka Victoria University of Wellington*





# Erebus

Son of Chaos

**T**he name Erebus (Έρεβος, Ερεβος) originates from the fantastic world of Greek mythology. The direct offspring of Chaos, from which all things arose, were Nyx, the goddess of the night, and her brother, Erebus, the god of darkness and shadow. Erebus, who had no shape or form, was thought to be responsible for the corruption and evilness of Hades, the underworld, spreading miasmas upon the heavens and turning dreams into nightmares.

This sunless, dismal place of death, where roaming ghosts were trapped in the subterranean cavities of the Earth, appears in Homer's *Iliad* and *Odyssey*. Later, the Roman Christians associated Hades with the fires of hell. In his *Divine Comedy*, written in 1320, Italian poet Dante Alighieri imagined an afterlife divided into three parts: Inferno, Purgatorio and Paradiso. The first tells how Dante, riding a serpent-like monster called Geryon, is guided by the poet Virgil past the gloomy gateway of Erebus.

The active volcano in Antarctica called Erebus was first seen by James Clark Ross in 1841 and named after the former warship in which he sailed. The name of his expedition's second vessel, HMS *Terror*, was bestowed on the nearby dormant volcano also on Ross Island. As Alan Gurney writes in *The Race to the White Continent*, 'Paintings of these vessels in action, spewing forth flame and smoke like volcanoes, set the Admiralty namesmiths, like advertising men, to dream up names that reflected their

**Previous pages** A lava bubble bursts inside Mount Erebus's Inner Crater, sending molten lava flying 200 metres upwards. HARRY KEYS

**Below** The Mount Erebus lava lake reflects on the underside of the summit plume. Winter lights shine from McMurdo Station (left) and Scott Base (right) in this view from the road to Williams Field runway. ANTHONY POWELL



classical education and the product's attributes . . . in this case . . . fire, destruction and death. Erebus, Terror, Beelzebub . . . , Infernal, Fury, Meteor, Sulphur, Thunder, Hecla, Vesuvius, Aetna . . .' The last three were named after volcanoes; *Erebus* and *Terror* were destined to have their names 'indelibly associated with very real mountains of fire'.

But for those who have lived and worked under the shadow of Erebus in more recent times, the mountain is often a familiar, constant and welcome presence, with its signature steam plume acting as a weathervane. This unique volcano is an opening into an inner burning world located between the polar extremes of bright summer and dark winter — a quixotic frigid landscape where the water is solid yet the rock is molten. In 1975, when I first lived on its slopes, I saw Erebus as a fiery dragon cloaked in ice. Huddled in a polar tent near its summit, I scribbled this poem in a dog-eared notebook:

There are mountains here  
too many for the eye . . . and mind.  
I live on one — Erebus the ice dragon,  
an island 'tween heaven 'n Hades,  
fiery weaver of a stained-glass sea.



Dragons can be fearsome but they can also be auspicious, representing power and strength. They are defenders of treasure, just as Erebus guards the wealth of knowledge that has been revealed and accumulated through almost two centuries of scientific and artistic endeavour.

Volcanologists themselves breathe life into volcanoes through their scientific writing descriptions, labelling them active (alive), dormant (asleep) or extinct (dead). Volcanoes have vents (boccas or mouths) and down their flanks flows lava with fingers and toes. It is a small step, perhaps, to Vulcan, the Roman god who lived on a volcano, to Pele, the Hawaiian goddess of volcanoes, and to Rūaumoko of Māori mythology, who is responsible for the violent stirrings beneath the Earth.

ROSS'S DISCOVERY ASTOUNDED THE GEOGRAPHICAL and scientific communities. Erebus was first climbed in 1908 and again in 1912. In an exciting blend of science and adventure, teams from the Shackleton and Scott expeditions reached the highest caldera of Erebus on climbing excursions from their huts on the Ross Island coast. The scientific information and rock samples they gathered stimulated an interest in Antarctic volcanism. More intensive studies of the volcano, however, did not take place for another 60 years.

From hesitant beginnings in the 1960s, expeditions to the summit increased in the early 1970s, with New Zealander Philip Kyle the main driving force. Largely at Kyle's direction, during his 44 summer seasons on Erebus, scientific studies on the volcano have continued and diversified. Expeditions to work near the summit have been supported by national Antarctic programmes from the United States, New Zealand, France and Japan. Scientific research on Erebus has evolved and is continually being refined, guaranteeing it an exciting future.

Since its discovery, Erebus has attracted explorers, adventurers, artists, sightseers and scientists, each drawn to the mountain by their own particular vision or curiosity. Scientists especially have applied themselves over many decades, increasingly refining their questions, seeking answers to intricate puzzles. *Erebus The Ice Dragon* documents the exploration and early climbs on the volcano, forerunners to a number of private expeditions in more recent years by self-funded climbers and scientists who have reached Ross Island in vessels ranging from cruise ships to ice-strengthened yachts. Also covered in the book, with contributions from leading scientists, are the extraordinary and unique microbial world of the mountain and the scientific mysteries that have continued to challenge volcanologists.

Inescapably, of course, the name Erebus is also synonymous with tragedy. On 28 November 1979, Air New Zealand's DC-10 sightseeing flight TE901 crashed near the base of Ross Island at an altitude of 447 metres; all 257 aboard died instantly. The recovery mission launched from Scott Base and McMurdo, and the subsequent drawn-out legal saga in New Zealand, have etched Erebus indelibly into the darkest

pages of New Zealand's history. For many, Erebus will always be a place of destruction and despair, wrought by a single, momentous accident. Many decades on, this book offers reflections by four of those involved in the recovery operation.

Complementing the creativity of science is the response of artists to this amazing place. In the final chapter, 'Shaping a volcano: Erebus and the artistic imagination', Dr Adele Jackson, who has a number of Antarctic seasons behind her, contributes a fascinating discussion about the representations of the mountain over almost 200 years.

The name Erebus has its origin in Greek mythology, but the Erebus of Antarctica is a very real volcano where powerful forces are at play. Haunting and searingly beautiful, Erebus is the molten heart of a mountainous island located at the juncture of saltwater ice and a vast continent buried by the thickest freshwater ice on the planet. It is one of the world's most significant natural laboratories, where the lofty goal of studying a volcanic system from mantle to microbe is being realised. *Erebus The Ice Dragon* is the story of a volcano like no other.

*Colin Monteath*

*March 2023*



A full-page background image of an Antarctic landscape. In the foreground, there are jagged, sculpted ice formations. In the middle ground, a range of snow-covered mountains is visible. In the far background, a large, rounded mountain peak rises against a clear, deep blue sky. The overall color palette is dominated by blues and whites, with a hint of purple/pink in the sky near the horizon.

# I Antarctica

Carved by ice, forged in fire

A pioneer has an unspoken responsibility to bring back something of value from one's travels — a map, a unique discovery, or specialist knowledge that contribute to mankind's understanding of our planet — but therein lies a dilemma: if one finds paradise, should one reveal its secrets to one's fellow man? It is not an easy choice; when one discovers a place of beauty, one becomes responsible, in many ways, for its future.

Wally Herbert, *The Polar World*

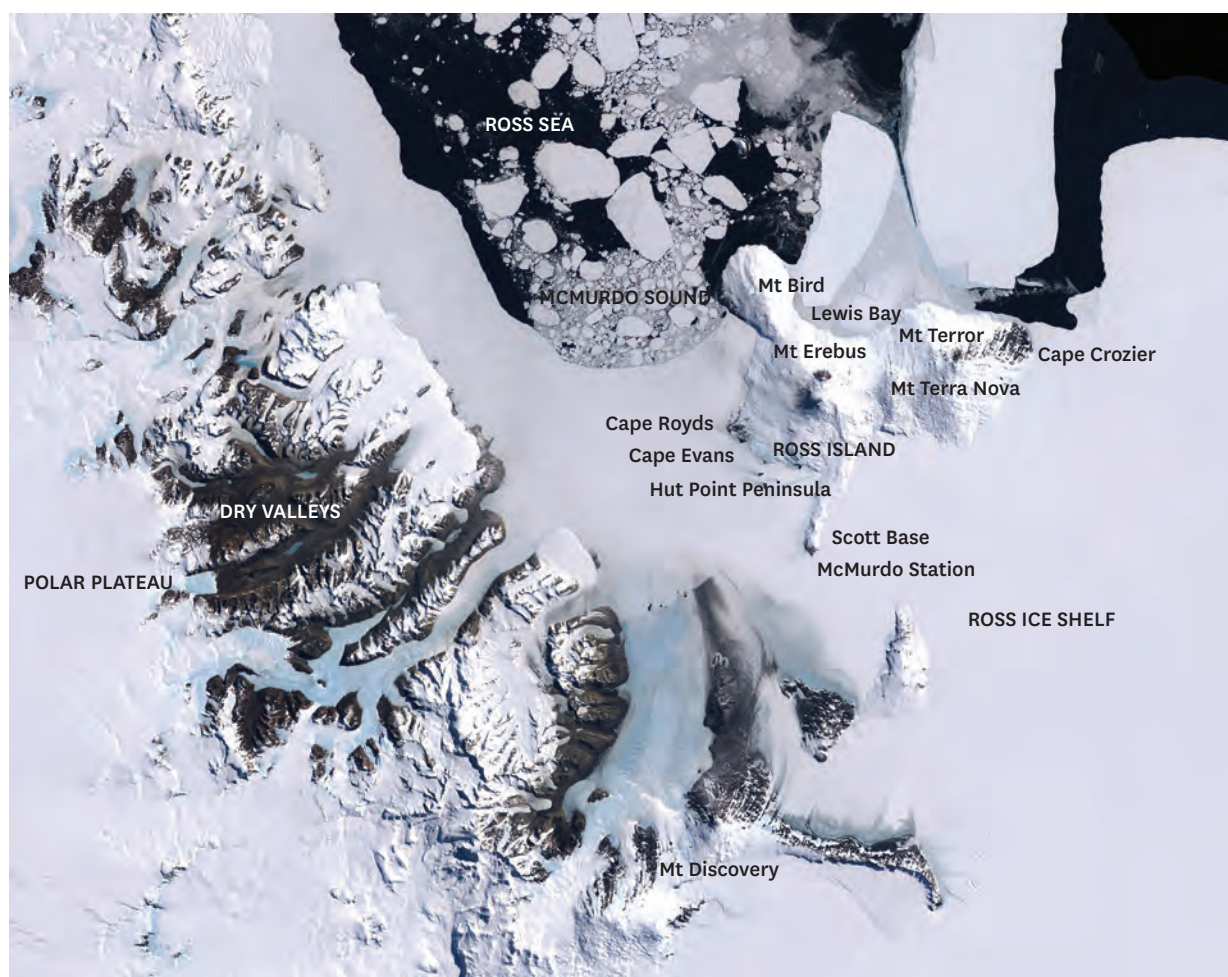
**Previous pages** The full moon sets over a rose-tinted Mount Erebus in the spring; a view from the sea-ice pressure ridges in front of Scott Base.  
COLIN MONTEATH

**Below** Taken in 2020, this Copernicus Sentinel satellite view shows Ross Island, Mount Erebus, McMurdo Sound and the Dry Valleys in the Transantarctic Mountains at a similar scale to the 1912 map opposite. IMAGE ENHANCED BY PIERRE MARKUSE

**T**he deep cold of Antarctica is to be expected. Not familiar, perhaps, is the presence of volcanoes. For this vast frozen continent is also a land with spectacular fiery hotspots; a land defined and carved by ice but also forged in fire. Active volcanoes are spread widely across Antarctica, though of the 138 volcanoes documented in a 2017 study most are extinct.

Mount Erebus, or Erebus volcano as it is better known, is unquestionably Antarctica's most famous volcano, and its second highest. At 3794 metres, it is the breathtaking centrepiece of Ross Island in the southern Ross Sea. And it is in a constant state of activity, with violent and unpredictable eruptions from its lava lake and surrounding vents.

Straddling the bottom of the globe, Antarctica, the seventh continent, is the epitome of wildness; a searingly beautiful, outlandish, chimerical place. Its sheer immensity — at 14 million square kilometres it is almost twice the size of Australia — is hard to grasp. This is the ultimate cold desert, predominantly a remote, windy,

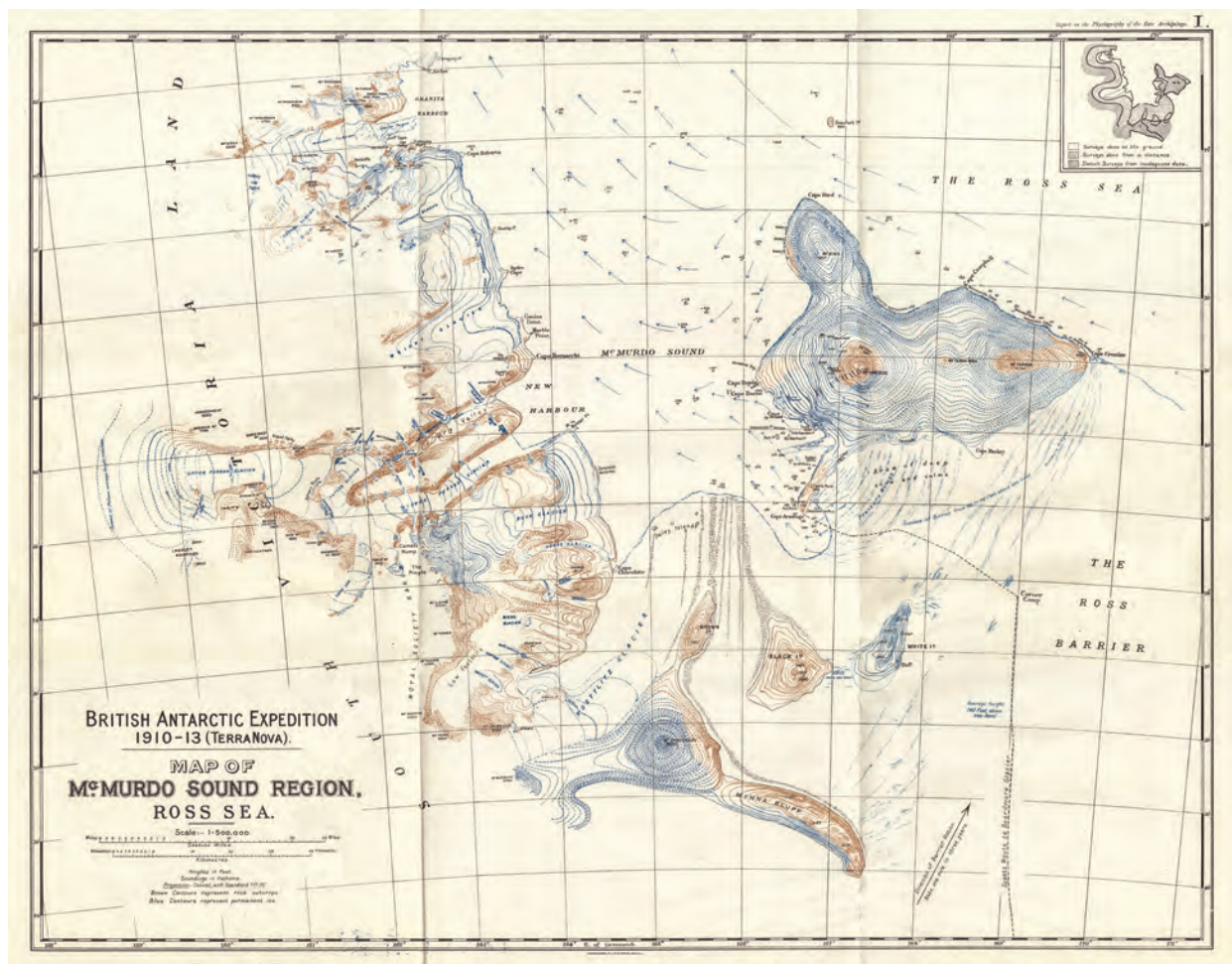


high plateau of ice that sustains almost no life. But especially in summer, Antarctica's coastal fringe and the vast surrounding Southern Ocean teem with life, much of it unique to these high latitudes.

The ancient Gondwana supercontinent, of which present-day Antarctica was a part, was ruptured 180 million years ago by subcrustal forces, around a central Antarctic Plate. These forces moved the other fragments, now called South America, Africa, Arabia, Madagascar, India and Australia, northwards, leaving deep ocean basins floored by dense basalt between them. For most of this period the Earth had an equable climate from high carbon dioxide levels (over 1000 parts per million); it was a little warmer in the tropics, but much warmer (subtropical) around the Antarctic margin. Antarctica was then a green continent, but snowy mountain peaks could be found around the rifted margins and on a still mysterious massif in the centre.

Global cooling began around 50 million years ago with accelerated trapping of atmospheric carbon dioxide by rock weathering, plants and algae. This was assisted

A contour map of the McMurdo Sound region with the Dry Valleys on the mainland, at left, and Ross Island and Mount Erebus, at right. It was drawn by Frank Debenham in 1912 after detailed plane table surveying, some of which was done during his involvement in the second ascent of Erebus. *THE PHYSIOGRAPHY OF THE ROSS ARCHIPELAGO*, FRANK DEBENHAM. COLIN MONTEATH ARCHIVE





Ross Island and Mount Erebus from the window of a US aircraft flying north up McMurdo Sound heading for New Zealand. Mount Erebus is centre right, Mount Terror behind and Mount Bird to the left. ANTHONY POWELL

around 34 million years ago by winds of the polar vortex (a large area of low-pressure cold air that blows counter-clockwise around Antarctica) over a growing Southern Ocean as Australia and South America finally separated from Antarctica, leading to snow covering the whole continent all year round, creating the first continental ice sheets.

As global cooling was beginning, Antarctica itself began to break up into a larger continental block, little changed today and now covered by the East Antarctic Ice Sheet. The smaller West Antarctic Ice Sheet covers an archipelago and rift system, the edge defined by the Transantarctic Mountain Front. The region also includes the Marie Byrd Land Volcanic Province, one of the world's largest and mostly developed since the West Antarctic Ice Sheet formed.

Scientists have used a range of aircraft and satellite remote-sensing techniques to map both surface and bedrock topography and crustal thickness. These show East Antarctica's geological crust is thick and continuous, but the stretching of the crust beneath West Antarctica is thinner. This has led to the West Antarctic Ice Sheet being grounded largely below sea level, making it more susceptible to warming and future collapse.

Although the interior of Antarctica is largely flat and featureless, there are major mountain ranges on the margins. The highest peak, 4892-metre Mount Vinson in the Ellsworth Mountains, is not high by world standards but the grandeur of peaks



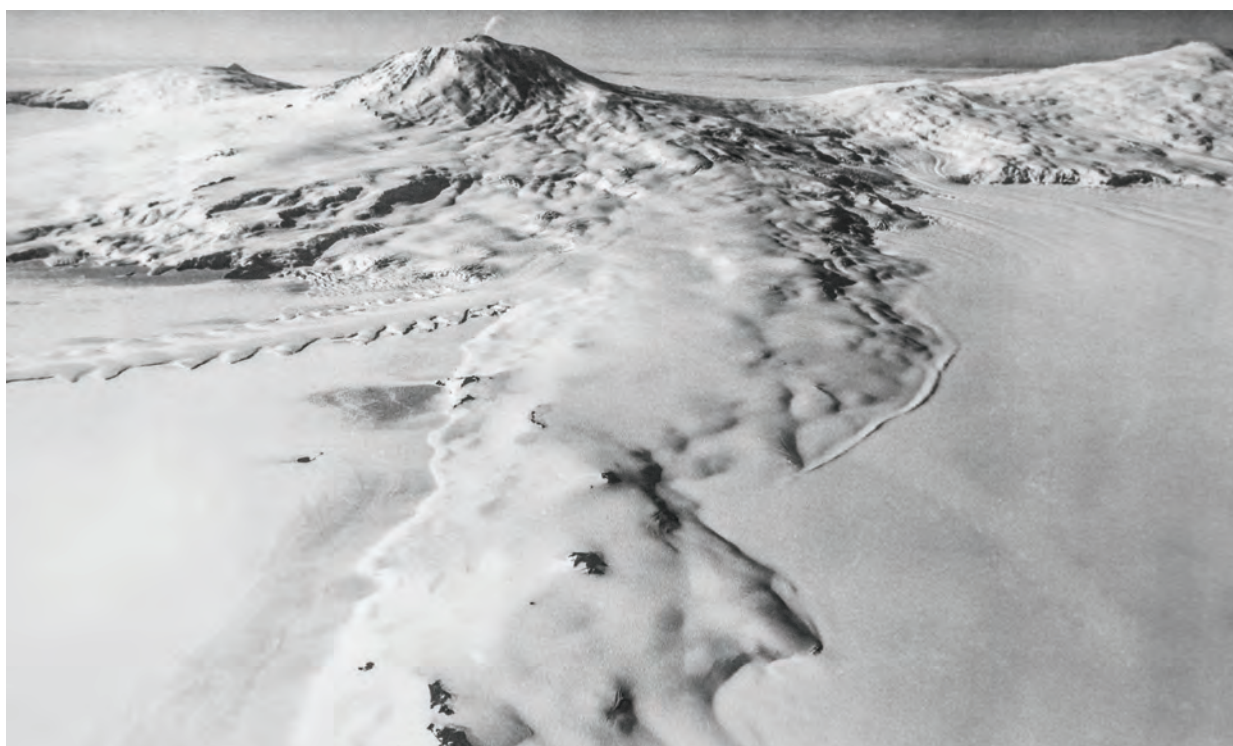
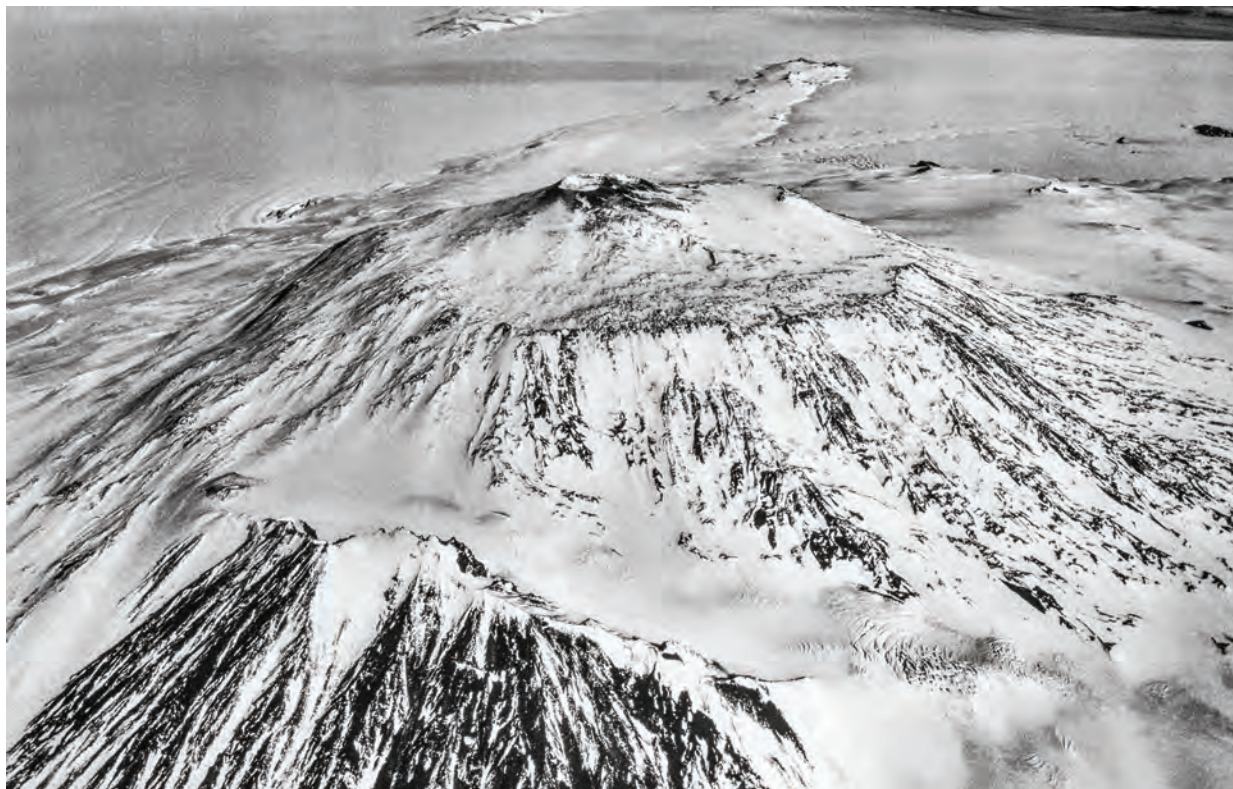
in the Ellsworths, in Dronning Maud Land, on the Antarctic Peninsula and throughout the 3500-kilometre-long Transantarctic Mountains, is impressive. Together, these mountains are as eye-catching as any on Earth.\*

Snowfall in Antarctica is surprisingly small but what falls does not melt, it simply blows about as fine dry powder, collects in snowdrifts and gradually compresses into ice. With such a consistently high plateau of inland ice that extends to the coastal edge in many places, Antarctica is the highest continent on the globe. Ice covers 99.7 per cent of its surface. It contains about 90 per cent of the world's ice and 70 per cent of its fresh water. If all the ice in Antarctica were to melt, global sea level would rise some 60 metres.

Under pressure, snow transforms into ice. So great is this pressure at depth that heat is generated, transforming ice into liquid water, which collects in hollows in the bedrock, often below sea level. The liquid water that flows beneath Antarctica's ice sheets fills sub-ice lakes, allows the overriding ice to slide, and eventually drains into

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\* The subglacial Gamburtsev Mountain Range has puzzled geologists for decades because it lies in the middle of the Antarctic Plate. Completely buried under Dome A, the highest part of the East Antarctic Ice Sheet (4093 metres above sea level), it is similar in size and appearance to the European Alps, with the highest summits just 700 metres beneath the snow surface. Geologists speculate that the mountains were formed by a plate collision a billion years ago as the Rodinian Supercontinent formed.



a warming ocean. There are 400 subglacial lakes under the Antarctic ice sheets. The largest, Lake Vostok, is 250 kilometres long by 50 kilometres wide and some 4000 metres beneath the surface of the East Antarctic Ice Sheet.

Despite the cold surface temperatures, water is possible thanks to heat from the Earth and from ice deformation, and also the insulation provided by the blanketing ice sheets. Volcanic heat during subglacial eruptions can also modulate ice-sheet behaviour and stability.

Though attached to the land, ice shelves float so that when they break up or calve large icebergs that gradually melt they do not raise global sea levels. But their demise does accelerate the movement of the big glaciers that feed them. The consequences of this rapid movement of glacial ice into the sea are profound. Together with the increasing rate of melting of the Greenland Ice Sheet glaciers in the temperate regions of Earth, and the loss of permafrost in Siberia, a significant rise in world ocean levels is certain. And the Antarctic Peninsula is also warming quickly — by 3°C between the 1950s and 2000. Entire Antarctic glacier and ice shelf systems, such as the northern part of the Larsen Ice Shelf, have collapsed in the past decade. These and similar break-ups in the Arctic are unprecedented events in recorded glaciological history.

Gravity also forces Antarctic ice to flow from the Polar Plateau through the mountains towards the ocean. Within the ice sheets there are fast-flowing glacier systems called ice streams that wind their way seaward to gradually discharge massive amounts of ice, which coalesce to form floating ice shelves. One of these is the Ross Ice Shelf, often equated with the size of France, which flexes up and down with the tidal cycle and is a giant factory for tabular icebergs that calve into the Ross Sea. These flat-topped icebergs can measure over 100 kilometres in length with 90 per cent of their mass lying under the water's surface. Iceberg ice, formed from fresh water, is hard, rigid and brittle, often with a bluish tint. Sea ice, which forms each winter and spring on the ocean surface, is, initially, a thin skin of frozen salt water. Multi-year sea ice floes grow up to 3–5 metres thick, and the ice is relatively soft and flexible, especially in summer. Sea ice floes commonly have yellow–green to brown stains due to layers of phytoplankton.

Antarctica has some unique environments. The Dry Valleys in South Victoria Land, originally carved by giant glaciers draining when the ice sheet was at its highest, constitute the largest area of ice-free land on the continent. As the sheet thinned, the ice retreated in some of the valleys until they became largely ice-free. Polar winds modified the valley surface, which became mantled by the weirdly shaped rocks known as ventifacts that now litter this alien desert landscape. Dry Valley soils are poorly structured, though they do support some vegetation.

The Southern Ocean is defined by the Antarctic Convergence. This constantly shifting biological boundary is where cold northward-flowing Antarctic waters dive beneath warmer subantarctic waters to cause an upwelling of nutrients that sustain an enormous biomass of plankton. This, in turn, supports massive krill swarms that



**Opposite above** An aerial view of Mount Erebus looking down on the old caldera remnant, Fang Ridge and Glacier, with the summit caldera above. Hut Point Peninsula, where Scott Base and McMurdo Station are located, stretches away in the background. US NAVY

**Opposite below** An aerial view over Hut Point Peninsula helps to give the scale of Ross Island, with Mount Erebus to the left and Mount Terror to the right. The low dome in the centre between the two main volcanoes is Mount Terra Nova. US NAVY

**Above** The continent of Antarctica with its floating ring of sea ice stretching out into the Southern Ocean — a view that indicates how the continent dominates the 'bottom' of the planet, with Africa shown for perspective.



A midwinter view from near Scott Base shows a spectacular canopy of stars and aurora australis over Mount Erebus, with a faint hint of red glow from under the summit plume. JOHNNY HARRISON

nourish wildlife, much of which is found nowhere else on Earth. Compared with the Arctic, there are only a few individual species in Antarctica and no land predators, though the species that do exist — flying seabirds, seals and the penguins for which the continent is renowned — are often there in great profusion. Filter-feeding baleen whales also depend on krill. Now that the slaughtering of Antarctic whales is mostly over, increasing numbers of cetaceans have been observed feeding in Southern Ocean waters.

In winter, the Southern Ocean freezes into a grinding, iron-hard mosaic of sea ice, effectively doubling the size of the continent. The albedo (reflective effect) of solar energy on this extent of white ice is considerable. The combined influence of Antarctica and the Southern Ocean has far-reaching consequences for global weather systems and ocean circulation patterns, even in the northern hemisphere.

The subantarctic and periantarctic islands are Antarctica's crown jewels. Remote and windswept, they encircle the Southern Ocean, both north (subantarctic) and south (periantarctic) of the Antarctic Convergence. Macquarie, Campbell and Auckland Islands are subantarctic; South Georgia, the South Sandwich group and Heard Island, to name a few, are periantarctic. All are unique southern hemisphere ecosystems, precious sanctuaries that must be protected at any cost. These islands support complex plant communities and host the nesting sites of seabirds such as petrels, albatrosses and penguins.

THE EXISTENCE OF A SOUTHERN land made sense to the Greek philosopher Aristotle and, later, to the first-century Greek astronomer and mapmaker Ptolemy. The Greeks, who believed there must be land in the south to counterbalance known Arctic lands, coined the word *Antarktikos* — ‘opposite the Bear’, referring to the constellation *Ursa Major*, The Great Bear, which hung in the northern sky. Over the centuries, navigators plotted the discoveries of subantarctic islands. Fifteenth-century mapmakers created projections that simply connected these frigid mist-shrouded specks of land. The concept of a huge landmass, *Terra Australis Incognita*, gained credence.

It is possible that early Polynesian navigators may have approached the Southern Ocean and it is likely they saw ‘floating rocks and smoking islands’ (possibly referring to icebergs with snow blowing off the top) in the latitudes of New Zealand’s subantarctic islands or beyond. Rarotongan legend relates how the explorer *Ui-te-Rangiora* and his crew sailed as far south as the frozen ocean (described as *Te Tai-uka-a-pia*) about 650 CE. There is no evidence that they penetrated the pack ice or sighted Antarctica, but there is clear evidence of them spending time on Enderby Island at 50°S in the Auckland Island group.

In the seventeenth and eighteenth centuries the lure of this unknown southern land enticed northern hemisphere navigators — Willem Schouten, Abel Tasman, Edmond Halley — southward on long dangerous voyages, each of which gradually whittled down the size of this mythical supercontinent. Although Captain James Cook crossed the Antarctic Circle, 66°33’S, three times in 1773–74, and landed on and named the island of South Georgia before sailing south to the South Sandwich Islands, he did not sight the Antarctic continent. Despite his progress being blocked by icebergs and menacing ice floes, Cook reasoned that land lay just beyond the horizon.

In 1819, British captain William Smith saw land south of 60°S, and a number of sightings of land in the South Shetland Islands and along the western spine of the Antarctic Peninsula led to an era of exploitation: the plunder of fur seals for their valuable skins and elephant seals and whales for their oil-rich blubber. British sealer James Weddell reached 74°S in 1823, penetrating far into the sea that bears his name, a frightening body of water jammed with grinding ice floes. These voyages in lumbering sailing vessels were fraught with danger. Seafarers such as Smith, Weddell, the Russian Fabian von Bellingshausen, the British mariner Edward Bransfield and the United States sealer Nathaniel Palmer are forever etched in polar history.

In 1840, Captain James Clark Ross embarked on a quest for the south magnetic pole (see Chapter 3), sailing from Hobart into the heart of what is now the Ross Sea. He found the mountainous coast of Victoria Land, the Great Ice Barrier (the Ross Ice Shelf) and the volcano he called Erebus. His voyage made possible an era of inland exploration utilising shore-based huts; notably expeditions led by Carsten Borchgrevink, Robert Scott, Ernest Shackleton and Roald Amundsen. These early explorers gradually revealed the scale and nature of this ice-clad continent. Their reports astounded the world.



A twin-engine Bell 212 helicopter chartered by the National Science Foundation flying from McMurdo Station to the summit of Mount Terror. Some 40 kilometres away lies Erebus volcano, with Mount Bird to the right. Beaufort Island can be seen at far right, at the entrance to Lewis Bay. ANTHONY POWELL

NO ONE OWNS ANTARCTICA AND there are no national parks in the conventional sense. Due to the far-sighted vision of the 1959 Antarctic Treaty, everything beyond 60°S will remain protected. By 2021, 54 nation states were signatories to the treaty; 44 of these were also members of the Scientific Committee on Antarctic Research. The treaty's tenets include sensible conservation measures and the prohibition of the dumping of nuclear waste. Overt armed military activity is expressly excluded, though military personnel can be deployed to support science. Although the original treaty did not deal with the potential for the exploitation of hydrocarbons or other minerals it is remarkable, in a resource-hungry world, that an entire continent has been set aside strictly for peaceful purposes — as a place for high-quality scientific research, for the preservation of wildlife and ecosystems and for low-impact recreation.

Antarctic stations still rely on the delivery of diesel fuel and bulk foodstuffs by slow, vulnerable ships with, at best, limited icebreaker support. Much of the fuel goes into ski-equipped aircraft or onto tractor trains to help run inland stations. It can be argued that humans have overstretched their ability to support the level of sophistication expected in a modern polar station. However, though still in their



infancy, wind and solar power generation are both gaining momentum in Antarctica.

Paradoxically, a human presence is still needed in Antarctica for urgent and continued glaciological, meteorological and other scientific research. Sensitive indicators of climate change, both Antarctica and the Arctic have acquired a new significance. In a world that is over-populated and where plant and animal species, indeed entire ecosystems, are under threat of extinction, Antarctica remains a talisman, perhaps, that humans can look after an entire continent.

Everything about Antarctica is raw and extreme, but it also has a softer side. There are frequent periods of calm — a welcome respite from the bite of the wind — when even the low-angled sun can feel warm. Then it is a joy to experience open fjords lined with mountains, glacial fronts and icebergs reflected in a glittering mirror image. The polar regions are especially spectacular during a long, lingering dawn or dusk, when the entire icescape is bathed in delicate pastels that illuminate the intricate textures in the snow and there is hardly a sound except the occasional tinkle of ice crystals. In a noisy, cluttered world, perhaps Antarctica's greatest blessing and solace is silence. It is a place of wonder that spiritually nourishes us all.





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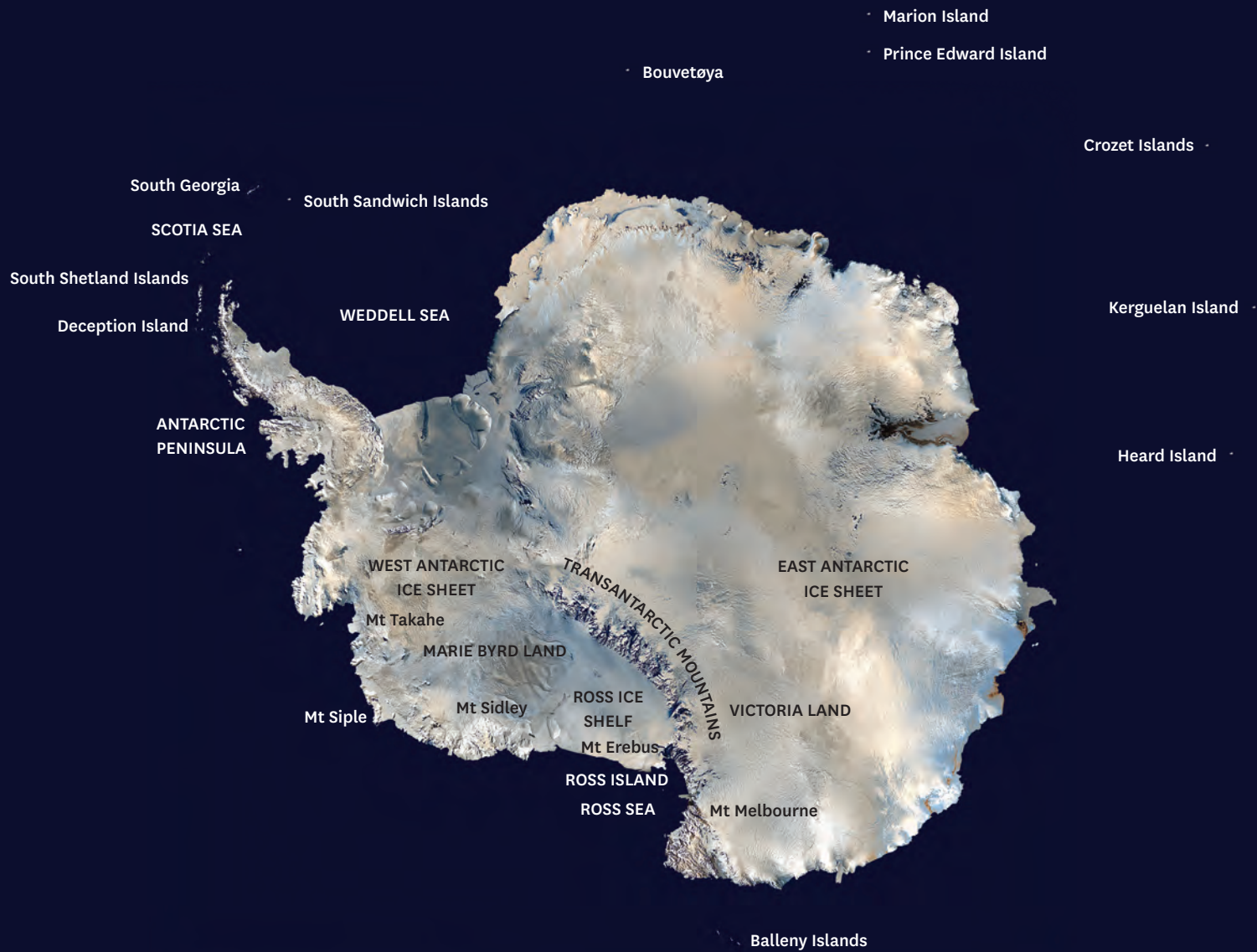
# ‘Mountains of Madness’

A continent ringed by fiery islands

While on shore we picked up several lava stones, which we supposed had been thrown out of a high and terrific volcano . . . This volcano might, with the strictest propriety, be denominated one of the wonders of the world . . . Another peculiarity which this volcano possesses is that it is one of nature’s lighthouses, planted in the midst of a distant ocean by that unseen hand, to serve as a beacon for the fearless mariner . . . when the dark curtains of night are spread over the venerable head of this majestic mount, it throws forth from its crater scarlet flames mingled with huge, red-hot, melted lava stones which roll down its sides to the sea.

Tom Smith, sealer, South Sandwich Islands, 1818

# Volcanoes of Antarctica and the surrounding islands



To suggest that there are active volcanoes in Antarctica sounds incongruous — in fact, preposterous. And yet, that is exactly what exists, both in the heart of Antarctica and around its periphery: on the Ross Sea coast, emerging from the West Antarctic Ice Sheet, on islands close to the Antarctic Peninsula and even on remote periantarctic islands dotted around the Southern Ocean. Many of these polar hotspots can blow up violently, with eruptions changing the shapes of beaches, destroying science bases, throwing volcanic bombs hundreds of metres into the air and, as recently as 2005, pouring molten lava into the Southern Ocean to form new land.

The volcanoes of the outer Antarctic islands played a significant role during the sealing era in the eighteenth century and a pivotal role on Ross Island during the so-called Heroic Era of Antarctic exploration (see Chapters 3, 4 and 5). They even captured the imagination of science fiction writer H. P. Lovecraft in his famous novella *At the Mountains of Madness*, originally serialised in the magazine *Astounding Stories* in 1936: '[We] stood off the coast in the lee of smoking Mt Erebus. The scoriac peak towered up some 12,700 feet against the eastern sky, like a Japanese print of the sacred Fujiyama; while beyond it rose the white ghost-like height of Mt Terror.'

Antarctic volcanoes have an allure all their own — many of these steaming, ice-clad mountains are surrounded by a stained-glass mosaic of sea ice, complete with a scattering of penguins and seals. But volcanoes of the south polar regions are not only beautiful: given their latitude and isolation, they are mountains of significant scientific interest.\* The international science community has long been interested in their geographic location, their eruptive patterns and the chemical composition of their gases. Yet, Antarctica, perhaps because of its huge overburden of ice and the fact that it is formed as part of a single tectonic plate, is seismically quiet, with earthquakes being exceedingly rare. (Small earthquakes have been recorded triggered by the movement of ice and active volcanoes.)

The Ross Sea coast features a number of volcanoes and their remnants. The 160-kilometre-long chain of the Balleny Islands, principally Young, Buckle and Sturge islands, were once stratovolcanoes with remaining ridges up to 1700 metres high. The Balleny group is situated between 66° and 67°S, off the tip of northern Victoria Land. Early visitors to these rugged, isolated islands thought they could see steaming ground. (A volcanic plume was observed on Buckle Island in 1839 and studies of ice cores suggest that Sturge Island erupted in 2001.) There are also a number of sub-surface volcanoes stretching from the Ballenys southward into the Ross Sea.

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\* The Arctic also has volcanoes, though they are located on tectonic plate boundaries while their southern counterparts lie largely within the Antarctic Plate. There is active volcanism in Alaska and the Aleutian Islands and, in far eastern Siberia, an extremely active volcanic chain on Kamchatka Peninsula. The most volatile of all Arctic volcanoes are in the thermal and geyser regions of Iceland and Jan Mayen, 600 kilometres north-east of Iceland.

**Previous pages** Big Ben volcano, on Heard Island, has active fumaroles around its summit caldera and may well have a lava lake. This dramatic view was taken from the yacht *Patanela* during the 1964 Australian–New Zealand South Indian Ocean Expedition that made the first ascent of its highest point, Mawson Peak. PHILIP TEMPLE

**Opposite** A composite satellite image of the Antarctic continent featuring the volcanoes of Victoria Land, Ross Island, Marie Byrd Land and the islands surrounding it, including the South Shetland Islands, South Sandwich Islands and those of the Southern Indian Ocean.