# PART I

## Choosing a volcano to visit

# 1 Volcanoes of the world

## Why go to a volcano?

Active volcanoes are the ultimate adventure destination. Those who have been lucky enough to witness a fire-fountain spouting red lava high into the sky or billowing clouds of steam rising as lava pours into the ocean will testify that volcanoes provide one of nature's most awesome spectacles. Volcanoes are impressive, spectacular, and have a profound effect on life on Earth. Active volcanoes allow us to experience the thrill of hearing a loud explosion which can make the ground shake at our feet, to gaze at the cracking and shifting of a lava lake's surface, and to smell the strangely appealing sulfur odor. Even when they are dormant, volcanoes offer a wide variety of beautiful and strange sights, ranging from the majesty of snow-capped cones to the barren lava wastelands that have often been compared to Hell.

Volcanoes are definitely a destination for those of us who are adventurous travelers. We are no longer a peculiar group made up of daring eccentrics, but a growing number of intelligent people who are not content with spending our vacations in quaint seaside towns. Exotic and unusual destinations are increasingly within our reach. In recent years, the traveling public's growing interest in adventure as well as in ecology has led to a wave of "nature tours" ranging from safaris and whale-watching to shark diving and trekking in the Amazon forest. This trend should eventually make volcanoes one of the most popular destinations on Earth. A trip to a volcano has the potential to be a memorable adventure as well as a first-class lesson in how our planet works and even, in many cases, how history was made.

A trip to a volcano is a challenge to the mind because it gives us the opportunity to see a major geologic process at work. Out of the four fundamental geologic processes that shape the Earth's surface – volcanism, erosion, tectonism, and meteorite impacts – volcanism is the only one we can easily witness making rapid changes in the landscape. Volcanoes can be very cooperative: they can erupt gently for long periods of time, making it possible for us to plan a trip specifically to see the action. For example, the Italian volcano Strómboli has been nearly continuously active for centuries, while Kilauea in Hawaii is currently on its third decade of delighting visitors with an exceptionally "watchable" eruption.

Volcanoes shape not only the Earth's surface but also the course of human history. Eruptions have contributed to the downfall of civilizations, changed the course of wars, and, more frequently, destroyed whole cities killing thousands of inhabitants. On the positive side, volcanoes make fertile lands that are the source of livelihood for numerous people all around the globe. One of the most interesting aspects of visiting a volcano is learning how its eruptions have affected the local people and their culture. Equally fascinating is to find out how the current population views the volcano: feelings run from pride to terror, depending largely on the frequency and character of the predominant eruptions.

Even those who live far away from active volcanoes are vulnerable to their effects. Large eruptions, such as that of the Philippines' Mt. Pinatubo in 1991, can lower temperatures around the world. These eruptions inject large amounts of sulfur gases into the stratosphere, where they combine with moisture to produce a thin aerosol cloud. The cloud causes some sunlight to be deflected, causing slight decreases in average surface temperatures around the world. Although such changes are small (very rarely as much as 1 °C) and do not lead to major climatic effects, it is possible that large eruptions may have more profound effects on the Earth. There are indications that the amount of chlorine injected into the stratosphere by these eruptions may contribute to the depletion of the Earth's ozone

**Fig. 1.1.** Volcanic eruptions are some of nature's most awe-inspiring events and some, like this one from Kilauea volcano in Hawaii's Big Island, can be watched and photographed safely. (Photograph by the author.)

layer. This problem is still being studied and raises some serious concerns, because we cannot stop eruptions happening.

Given the major importance of volcanoes on the past, present, and future history of our planet it is not surprising that so many people become interested in them, often from a young age. Many children are as interested in volcanoes as they are in dinosaurs and space. Volcanoes have the distinct advantage of being neither extinct nor unattainable to most people. They are all over the Earth to be visited and explored. For those still wondering whether volcanoes are worthwhile traveling destinations I offer the following reasons: volcanoes deepen our understanding of how the Earth evolves and how humans interact with nature's forces. Volcanoes are magnificent in repose and thrilling in action, when they allow us to experience the sounds and sights of nature at work. Volcanoes appeal to our intellect, our sense of adventure, our appreciation of natural wonders, and our fascination with danger (Fig. 1.1). As many youngsters would agree, a visit to an active volcano would rank second in excitement only to a trip into space – or maybe one to Jurassic Park.

## Volcanic tours

What are the world's most interesting active volcanoes and where are they located? Our planet has many volcanoes that are considered active – about 600 on land and many more under the sea. On average, about 50 volcanoes erupt each year and about a dozen or more may be active in any particular month. Most people don't hear about these eruptions, either because they are small or because they occur in isolated places and do not have a significant local or global impact. The eruptions that grab the headlines are those which cause loss of life or major economic disasters. If you are determined to see an erupting volcano, you will need to choose either a persistently active volcano (such as Strómboli in Italy) or one that has just begun erupting, and hope that the activity will last until you arrive. Chapter 5 discusses how you can find out about current activity and how to choose a volcano to go to. For now, I'll borrow an idea from my late friend Peter Francis and take us on an imaginary journey to the Earth's most volcanic regions. We will follow the plate tectonic boundaries (discussed in Chapter 2) and break the journey into four volcano world tours: the Ring of Fire, the mid-Atlantic, Africa, and the Mediterranean. Time and money are no object; we will imagine ourselves to be wealthy volcanologists on sabbatical leave.

### The Ring of Fire and the Pacific Ocean

Volcanically speaking, this is the Earth's busiest side. The volcanoes that mark the Ring of Fire – over 1,000 of them – are located in no fewer than four continents and span a wide variety of scenarios, climates, and cultures (Fig. 1.2). A good starting point for our journey is the scenic North Island of New Zealand, one of the world's prime volcanic areas. This is where the most violent eruption in historical times took place: the Taupo eruption of AD 186. What we know about this cataclysmic event has been pieced together from geologic studies of the immense ash flow deposits, as no historical records exist. If people lived in the island at


**Fig. 1.2.** The distribution of volcanoes round the Pacific Ring of Fire. These include some of the deadliest volcanoes known, such as Pinatubo, Krakatau, and Mt. St. Helens. (Modified from Francis, 1993.)

the time, they didn't survive to tell their story. These days the Taupo–Wairakei area offers thermal baths and geothermal power stations, and Lake Taupo Caldera as reminder of the eruption. Aside from the record-setting Taupo, North Island has other volcanic areas that have been active more recently, if rather more sedately. These include Ngauruhoe, a frequently restless and nearly perfectly shaped volcano and Ruapehu, whose latest activity was a small mudpool eruption in 2001. Ruapehu has hiccups every few years, sometimes sending mudflows (also known as lahars, an Indonesian word) down the slopes, but this has not stopped New Zealanders from building ski runs on the side of the volcano. Both Ngauruhoe and Ruapehu are located inside the Tongariro National Park which has good facilities for visitors. The Rotorua–Tarawera area offers a variety of volcanic landscapes, The Tarawera complex of rhyolite domes erupted spectacularly in 1886, burying three villages. This, however, was a minor event compared with what could happen again in the island. The Waiotapu thermal area is a well-known tourist attraction, and the town of Rotorua is within a large geothermal area. For the more adventurous, a visit to White Island is recommended. You can get there by boat or helicopter, but get some local information first and a guide. White Island is very active, there are mudpools and fumaroles, and new craters form often (there is one crater named Donald Duck). A strong and unexpected explosion in July 2000 covered half the island with a thick layer of ash and pumice fragments, but luckily nobody was visiting the island at the time. With so many interesting choices, New Zealand is a great country for volcano tours.

North of New Zealand the Ring of Fire starts curving around towards Asia, along the Tonga–Kermadec island chain, Samoa, and the New Hebrides. These are the South Seas volcanoes whose fantasy versions show up now and then in Hollywood movies such as *South Pacific*, *Bird of Paradise*, and, more recently, *Joe versus the Volcano*. The reality is somewhat different: the inhabitants of these islands are quite friendly and don't throw themselves or visiting volunteers into fuming craters. In fact, many of these volcanoes are nowadays on the quiet side and in no need of appeasing. Travelers who want to see some action should head to Yasur volcano in Tanna Island, part of the nation of Vanuatu. Yasur has been in almost constant but fairly mild activity since its discovery in 1774 and you can – with caution – climb right up to the top and

look down at the erupting crater, and up to see the volcanic fireworks. Just don't try to take home rocks as souvenirs: native folks believe that every rock from their active volcano has spiritual significance and have confronted visitors who tried to take them away. Vanuatu has other interesting volcanoes, such as Ambryn, and it is a great destination for the adventurous, as the islands are well off the beaten tourist path. While in this part of the world, visitors may hear about the fascinating Falcon volcano in the Tonga Islands. This undersea volcano is famous for its "disappearing" islands, which are small ash cones formed during eruptions that are quickly washed away after the end of the activity. Volcanoes that come and go are not so uncommon in this part of the world. In May 2000, a lucky group of scientists came to the dormant underwater volcano of Kavachi and much to their delight found it spewing ash, forming a new, temporary beach that is truly far away from it all.

Continuing along the Ring we come to exotic Papua New Guinea, which boasts one of the world's great calderas, Rabaul. This is actually a group of small volcanoes clustered around the rim of a caldera bay. Rabaul had a large eruption in 1937 which generated disastrous tsunamis, killing 500 people. In 1994, Rabaul woke up again with a spectacular eruption from Vulcan and Tavurvur volcanoes. The town of Rabaul was greatly damaged and over 52,000 people had to be evacuated. Luckily only a few deaths occurred. Much more tragic circumstances resulted from the 1951 eruption of New Guinea's other notable volcano, Mt. Lamington, when glowing avalanches (*nuées ardentes*, French for "glowing clouds") devastated 230 $km^2$ (90 square miles) of land and killed about 3,000 people.

Further west from New Guinea we come to the volcanic wonderland of Indonesia, a country made up of over 13,000 islands and home to 76 historically active volcanoes. Some of the world's most notorious volcanoes are here: Krakatau, Tambora, Merapi (Fig. 1.3), Agung, Semeru, and Galunggung. These are big killers – past eruptions have claimed many thousands of lives. The Krakatau eruption of 1883 is thought by many to be the largest recent historical eruption but, in fact, the blast from Tambora in 1815 holds the record: it produced some 40 $km^3$ (10 cubic miles) of ash and magma fragments. These fell over thousands of square kilometers, killing crops and causing widespread famine. Krakatau, however, remains in the public's mind as one of the world's most infamous volcanoes and, for this reason, many visitors like to make their way there. Although the original island of Krakatau was destroyed by the 1883 eruption, a much smaller eruption in 1927 generated a new island – Anak Krakatau, meaning the "child of Krakatau" – which one hopes will not live up to its parent's reputation. It is not easy to travel in Indonesia at present because of the often volatile political situation and potential terrorist attacks, but this does not deter every traveler.

The safest place to go to is probably Bali, despite an isolated, recent terrorist attack. Bali is an idyllic island with interesting volcanoes such as Gunung Agung and Gunung Batur. Lombok is another popular tourist destination and it has Gunung Rinjani. Anak Krakatau is potentially dangerous, both because of its location and its mild-to-moderate activity in recent years. It is possible to get there by boat from beach resorts on the west coast of Java, but access has been limited in the last few years since the death of a tourist in 1996. The highest volcano in Java is Semeru, which rises to 3,676 m (12,060 feet) elevation. It is a very active and dangerous volcano; in August 2000 it killed two volcanologists from the Volcanological Survey of Indonesia and injured six others who were on a tour for professional scientists. This is not a place to go without a local guide and, even then, the risk is high. The same could be said about other majestic Indonesian volcanoes such as Merapi, one of the country's most active, which stands over the densely populated city of Yogyakarta. Among the dangers posed by Indonesian volcanoes are lahars. The explosive nature of the volcanoes creates steep flanks and deposits of fine ash; heavy rainfall can lead to devastating and deadly lahars.

The next notable volcano country along the Ring of Fire is the Philippines, site of several extremely dangerous types such as Taal, Mayon, and Pinatubo. The 1991 eruption of Mt. Pinatubo was the world's third largest eruption in the twentieth century and made many international headlines. Mayon is the country's most active volcano. It is known for its symmetrical shape, but the placid beauty hides a rather restless interior. Explosive activity and the growth of a lava dome led to evacuation of people from areas adjacent to the volcano in 2000 and 2001. Taal is a volcanic caldera filled with a lake, with the small but very active Volcano Island in the center. The eruptions have caused disastrous lake tsunamis. Taal is easily accessible from Manila and resorts on the crater rim provide good tourist facilities. Although not the best country from a tourism point of view, the Philippines are worth a stop because of these and other notorious volcanoes.

**Fig. 1.3.** Merapi in Java is one of Indonesia's most active and dangerous volcanoes. The steep-sided stratovolcano dominates the landscape of one of Java's major cities, Yogyakarta. Merapi's eruptions have caused many fatalities and devastated agricultural land. This type of volcano, part of the Earth's Ring of Fire, is best visited while in repose. (Photograph courtesy of Vincent Realmuto.)

Next comes Japan, another country where the volcanoes are numerous and restless, with Unzen and Sakurajima being the most frequently active these days. Unzen claimed the lives of famous volcano chasers Maurice and Katia Kraff in 1991 (see Chapter 4). A less dangerous highlight for a volcano tour is Mt. Fuji, undoubtedly the most scenic Japanese volcano and famous throughout the world for its postcard-perfect beauty. Fuji seems to be resting since its last eruption in 1707, but it has a history of being restless – it is known to have erupted at least 13 times in the last thousand years. It is considered by the Japanese to be a sacred mountain and each year many pilgrims make their way to the summit. Go in the summer if you want to join them, in the spring if you would like to take your own postcard-style photograph of the volcano with cherry blossoms in the foreground. Asama volcano, in central Japan, tends to have small eruptions, but in 1783 it sent out deadly *nuées ardentes*. Visitors should beware of Aso volcano, where small explosive eruptions have occasionally killed tourists standing on the rim at the wrong time. Go to

Sakurajima for a chance to see some action; the volcano often has small eruptions that can be seen from the base of the mountain. For hot springs, Hakone volcano is the place to visit. It has a beautiful crater lake, varied volcanic features, and plenty of tourist facilities.

The Ring of Fire then stretches along the Kurile Islands and the Kamchatka Peninsula in Russia. These places are not renowned for their tourist facilities, but Kamchatka is rapidly changing. This volcanic peninsula was closed to Westerners until the fall of the Soviet regime but since then it has started to become a popular destination for adventure tours. The major volcanoes in the peninsula are Bezimianny, Karymsky, Kliuchevskoi (Fig. 1.4), and Tolbachik. All are quite active, erupting on average more than once a decade. Bezimianny (in Russian "the nameless one") was considered rather insignificant until 1955, when it woke up with one of the most violent eruptions of the century, sending clouds of ash 45 km (28 miles) above the ground and giant *nuées ardentes* which devastated more than 60 $km^2$ (23 square miles).

The Ring of Fire continues along the Aleutian Islands, where there are active volcanoes such as Kanaga, but these islands are not easy to get to, and the tourist facilities are limited to say the least. The next group of volcanoes that are reasonably easy to reach are those in Alaska. Highlights are Mt. Spurr, Redoubt, Augustine, Pavlof, Veniaminof, and Novarupta. These tall volcanoes can have very violent eruptions that, because of the sparse population, do not usually cause fatalities. Novarupta caldera had a very powerful eruption in 1912. The eruption, the largest of the twentieth century, was known for the huge pyroclastic flows that formed the Valley of the Ten Thousand Smokes. Although almost all of those steam vents (the "smokes") are now gone, the site has not lost its appeal – a classic lava dome can be seen inside the caldera.

Canada represents a gap in the rich eastern side of the Ring of Fire, as its volcanoes have not been historically active. However, the West Coast of the United States more than makes up for the short gap. The majestic Cascade volcanoes attract millions of visitors

**Fig. 1.4.** Kliuchevskoi is the highest and most active volcano in Russia's Kamchatka peninsula. The 4,835 m (15,863 feet), beautifully symmetrical volcano has produced frequent eruptions, which range from stream and ash explosions to outpourings of lavas. This area photograph shows the 1993 lava flow in the foreground, dark against the snow. Volcanoes in the Kamchatka peninsula are spectacular, but the area was closed to foreign tourists during the Soviet era and is still seldom visited. (Photograph courtesy of Vincent Realmuto.)

to their beautiful, well-run national parks. All of them are worthy of a visit, from Mt. Baker near the Canadian border to Lassen Peak and Mt. Shasta in California. Highlights include the menacing Mt. Rainier, the still notorious Mt. St. Helens, and the breathtaking Crater Lake. The latter is no longer active, but it is the archetypal volcanic caldera and a must for the volcano aficionado. While in California no one should miss a visit to Long Valley Caldera, which is considered a possible site for a catastrophic eruption in the future.

At this point, two detours from the Ring of Fire are called for: one to the Yellowstone geothermal area, where thousands of visitors every year marvel at Old Faithful and other spouting geysers, and another to Hawaii, the world's prime example of "hot spot" volcanism (discussed in Chapter 2). Hawaii is also the prime example of volcano tourism, thanks largely to Kilauea's Pu'u O'o eruption that started in 1983 and is still delighting visitors, even though it has killed a few of the many thousands of tourists who have flocked there since the eruption started. Kilauea is one of the most accessible active volcanoes and the highlight of the Hawaii Volcanoes National Park. Other Hawaiian volcanoes worth a visit are the gigantic Mauna Loa, the slumbering Hualalai, and the magically beautiful Haleakala. All these volcanoes are easily accessible with excellent facilities for visitors.

South of the US mainland the Ring of Fire continues along Mexico, another country that does not lack volcanic activity. Mexico's most threatening volcano is Colima (Fig. 1.5), but Parícutin is far better known because of the circumstances of its birth – it literally sprang up from a cornfield in 1943. Most visitors climb little Parícutin, but only serious climbers tackle Fuego de Colima, Mexico's most restless volcano, or its resting neighbor Nevado de Colima. Tough climbers will want to go to El Pico de Orizaba, Mexico's highest mountain, rising up to 5,700 m (18,700 feet). Other Mexican highlights are Popocatépetl and El Chichón. Popo, as the volcano is known by those who are not comfortable speaking Aztec, is the snow-capped, majestic volcano which dominates the skyline south of Mexico City. Popo woke up from a five-decade slumber in 1994 and has caused a lot of concern. Most of its explosions have been on the small side but a repeat performance of the powerful historic eruption of 1720 is possible. El Chichón was an obscure volcano until 1982, when it woke up briefly but extremely violently, causing 2,500 deaths and significant effects on the world's climate.

The Ring of Fire's surface expressions continue to be plentiful and notorious south of Mexico. One of them

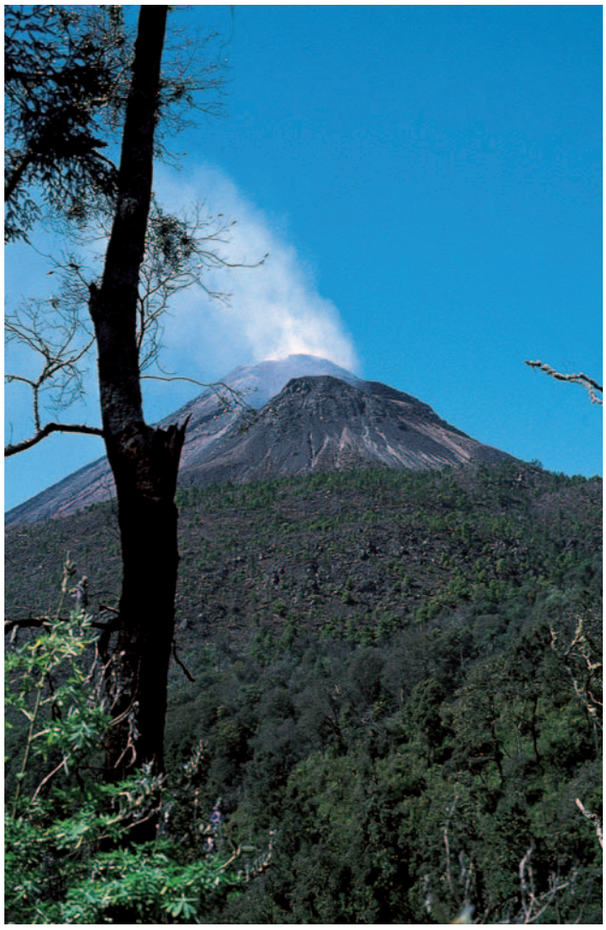

**Fig. 1.5.** Colima volcano in Mexico, also known as Volcán Fuego or Fuego de Colima, is one of Central America's most active volcanoes. It rises to 3,850 m (12,631 feet) and can be climbed during times of repose, though it is safer to view it by climbing its older, snow-capped neighbor, Nevado de Colima. Fuego can be extremely dangerous. Its historic activity has included violent explosive eruptions, pyroclastic flows, and debris avalanches which have threatened the nearby city of Colima. The city and the surrounding region are rich in history and archeological remains. (Photograph by the author.)

is Guatemala's Santiaguito dome, which has been growing on the flanks of the extremely dangerous Santa María volcano since 1922 (Fig. 1.6). Santiaguito sends out thick, pasty lava flows that move slowly and occasionally some explosions and pyroclastic flows. The volcano is, unfortunately, not an easy or safe place to visit. Pacaya and Fuego, also in Guatemala, are two very active volcanoes that have mildly explosive (Strombolian) eruptions and are better choices for a visit. Eruptions from Pacaya can often be seen from Guatemala City, the country's capital. El Salvador has Izalco, which was known as the Lighthouse of the Pacific until the nearly continuous activity stopped in

**Fig. 1.6.** Santa María volcano in Guatemala (right) erupted violently in 1902, devastating a large area of the country. Since 1922, the Santiaguito lava dome (left) has been growing at the base of the 1902 eruption crater. The growth of the dome is marked by almost continuous minor explosions and often by lava extrusions and more violent events. Santiaguito is considered very dangerous, but depending on conditions at the time, the volcano can be viewed safely from a distance. In 1929, a large pyroclastic flow from Santiaguito killed at least several hundred people; some report as many as 5,000. Guatemala is home to several other active volcanoes. (Photograph courtesy of Vincent Realmuto.)

1966 – just as a volcano hotel was being built. Nicaragua is home to Cerro Negro and Masaya, two very active volcanoes that would be very attractive destinations if the country became more politically stable. Although maidens are no longer thrown into the lava lake at Masaya, visitors should remember that some Central American countries can be as volatile as their volcanoes.

An exception to the above caution about Central America is the tiny, ecologically-conscious nation of Costa Rica. This is an easy country to travel in, as its politics are peaceful and its tourism well developed. Costa Rica was one of the countries that pioneered the concept of "eco-tours" and has become a popular vacation spot destination for environmentalists. The country's most active volcanoes are the very active (and dangerous) Arenal, the spectacular Poás, the easily accessible Irazú, and the little-known Turrialba, located in an exceptionally scenic region.

At this point a Caribbean detour is called for. Many volcanoes rise along the Lesser Antilles arc, a result of subduction of the North Atlantic ocean floor beneath the Caribbean plate. Many people have heard of the infamous Mt. Pelée in Martinique and its tragic 1902 eruption, but there are several less well-known but equally interesting volcanoes in the region. Among them are three that share the name La Soufrière ("the sulfur producer"). The homes of the three Soufrières are the charming islands of St. Vincent, St. Lucia, and Guadeloupe, while Dominica has the Grand Soufrière. The volcanoes are easily accessible and the islands receive many visitors, but most of them do not venture up the volcanic slopes. The volcano that made the news during the last years of the twentieth century and continues to do so in the new millenium is another "sulfur producer": Soufriere Hills in Montserrat. Once a haven for visitors wanting to see an unspoiled Caribbean island, Montserrat has been devastated by

the continuing eruption. It is hard to tell when tourism will return to the island, but while the volcano is still active it is an interesting choice for adventurous types who can forgo the usual tourist facilities. It may come as a surprise that the most active volcano of the Caribbean is a submarine one which bears the unusual name Kick-'em-Jenny. This volcano, near the island of Granada, was first spotted in 1939, when a black column of ash and steam rose almost 300 m (1,000 feet) out of a boiling sea. It has been growing and should form a new island in the near future. Keep watching the news and, when the volcano emerges, it's time to plan a visit.

The Ring of Fire continues down South America and we come next to Colombia, another volcanically interesting but politically problematic country. Two Colombian volcanoes grabbed the world's attention in recent years by having unexpected and deadly eruptions. Nevado del Ruíz caused one of the major volcanic catastrophes of the twentieth century, while Galeras volcano had a small but ill-timed explosion in 1993 which killed nine volcanologists. Just south of Galeras volcano is Ecuador, a country that owns not only two of the world's most majestic volcanoes – the much-climbed Cotopaxi and the often active Reventador – but also the Galápagos Islands. The Galápagos are all volcanic islands and some of the volcanoes are still very active. One of these is Fernandina, a shallow-sided volcano with a distinctively large summit caldera. Fernandina's last eruption was in early 1995 and another could start any time, as this is a volcano characterized by frequent Hawaiian-style activity. A popular choice for visitors is Isabella Island, home to Sierra Negra (whose summit can be reached on horseback) and Cerro Azul, the latter being one of the most active volcanoes in the Galápagos, but currently off-limits to visitors. Its eruption in 1998 created a serious threat to the island's rare tortoises and some had to be evacuated by helicopter, while others (weighing up to 225 kg, nearly 500 pounds) had to be carried by human rescuers across rugged terrain. Charles Darwin, who made the tortoises famous enough to be worth rescuing, also made important observations about volcanoes and ended up having an active one named after him: Volcan Darwin, also in Isabella Island. The Galápagos are an ideal destination for adventurous types who really want to learn about natural history, but visiting these islands requires some planning. The government of Ecuador has strict measures in force to protect this ecological paradise and the best way to go is to take one of the many organized tours. Only a few places in the islands are open to independent travelers; otherwise you must be in a tour or in the company of a Galápagos naturalist guide.

Continuing down the Andean chain we come to Chile and its imposing volcanoes exemplified by Villarrica and Calbuco, two of the most frequently active. Chile has beautiful national parks and facilities for visitors are very good, though climbing the volcanoes is not easy, as they rise to great heights. The 6,739 m (22,109 feet) high Llullaillaco has the honor of being the world's tallest historically active volcano. Travelers who are particularly adventurous may wish to go down to Cerro Hudson in Patagonia, a volcano that erupted violently in 1991, scattering ash as far away as Australia. The southernmost Andean volcano is Monte Burney, located at the tip of Patagonia, Chile. It is not an easy place to reach but visitors are rewarded with the knowledge that not many make it that far. The Ring of Fire goes on further south to the far-flung South Sandwich Islands, but most travelers would not venture that far. The Ring finally reaches Antarctica at the isolated and grim Deception Island, whose eruption of 1969 destroyed a research base and caused much alarm among the local penguin population.

## Volcanoes of the Atlantic

The volcanoes here result from the mid-Atlantic ridge's intense sea-floor spreading activity (Fig. 1.7), a rather different tectonic setting from that of the Ring of Fire. The southernmost active volcano in the mid-Atlantic chain is Norway's Bouvet Island, an uninhabited and almost inaccessible place, probably the most remote volcano in the world that is still considered active. The island, discovered in 1739, had a major eruption about 2,000 years ago, or so magnetic dating tells us. Further north is the isolated island of Tristan da Cunha. It may not get many visitors, but it is known to be a rather interesting place. Its eruption of 1961 forced the evacuation of the small population (a few hundred people) but since then the people have returned, the volcano has remained quiet, and the island has started to appear on one or two cruise brochures. Tristan has a nearby neighboring volcanic island that bears the rather appropriate name of Inaccessible and is, as expected, uninhabited.

Going north, the next volcanic point of civilization is the island of St. Helena, last home of Napoleon and considered a maritime pit stop since it was discovered in 1502. The volcano is no longer active and the island does not offer much to visitors, who must get there by sea, as St. Helena has yet to catch up with the age of air