

## The Geography of Antarctica

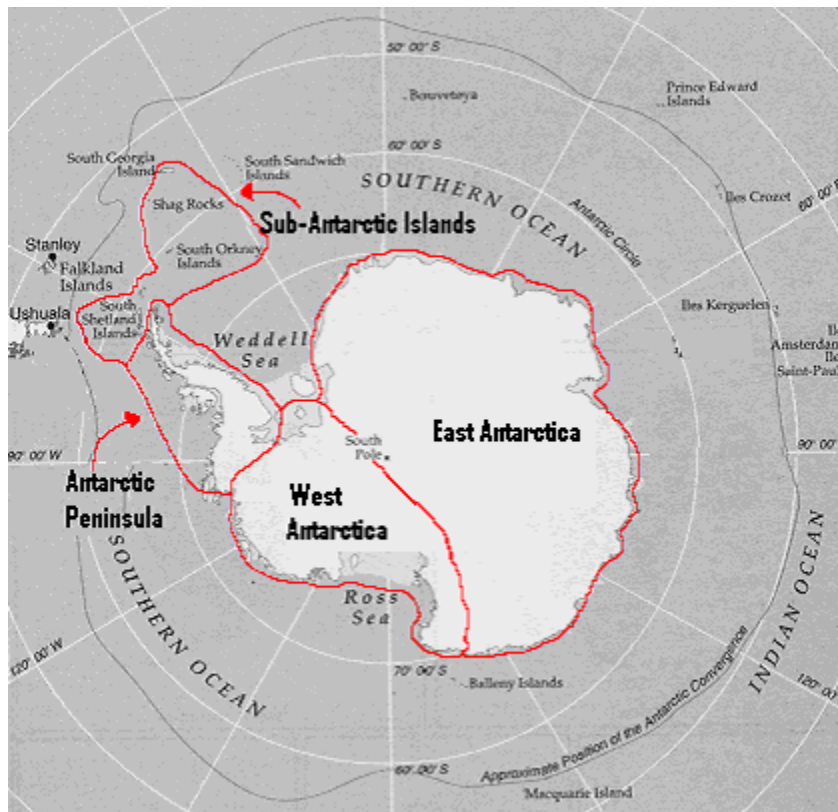
### *The Formation of the Continent*

The Antarctic continent was joined with Australia, Africa, South America, and India in a supercontinent known as Gondwanaland. This supercontinent was centered in the southern oceans of the Mesozoic era 200 million years ago. By the Cretaceous period approximately 70 million years ago these continents had begun to separate through continental drift. Africa, South America, and India drifted north to their current positions. Australia separated from Antarctica 40 million years ago during the Tertiary period. Antarctica remained in its southern position over the South Pole. Among the fossil evidence, which supports this theory, is plant fossils found on New Zealand, Tasmania, Iles Kerguelen, and the Falkland Islands, by British botanist Joseph Hooker. Other evidence is a deciduous conifer (*Glossopteris*), a fern (*Dicroidium*), and a terrestrial reptile (*Lystrosaurus*). These fossilized remains have also been found in rocks in the other Gondwanaland landmasses. Because *Glossopteris*' seeds and *Dicroidium*'s spores could not have been wind blown, and *Lystrosaurus* could not have swum across oceans separating the continents, their fossilized remains offer certain proof that the continents were once joined.

### *Geography*

The Antarctic is the fifth largest continent on Earth, 14.2 million square miles. Its shape is generally circular with a large curving peninsula in the northwest. The continent is divided by a 2900-kilometer long mountain chain known as the Transantarctic Mountains. This mountain chain divides East Antarctic (Lesser Antarctica) from West Antarctica (Greater Antarctica). The highest point of land on the continent is Vinson

Massif at 4897m, the lowest point is the Bentley Subglacial Trench at 8,327 feet below sea level. Antarctica is 99.6% covered in ice, with the exception of dry valleys, some coastal areas, and the peaks of the highest Transantarctic Mountains. This massive cover of ice contains 70% of the world's fresh water, and at points is 4775 meters thick, its enormous weight has depressed the underlying landmass 1600 meters in some places. In September, Antarctica's late winter, the size of the continent doubles in size, with the freezing of the surrounding southern ocean, which can extend more than 1000 kilometers from the coast. Antarctica has four major geographic regions; the Antarctic Peninsula, East Antarctica, West Antarctica, and the Sub-Antarctic Islands. Each of these regions is distinctly different and formed in varying ways.



### *The Antarctic Peninsula.*

The Antarctic Peninsula is 1500 miles long and very narrow promontory, which extends into the Southern Ocean towards South America. The entire length of the peninsula is mountainous, formed of rocks 65-225 million years old overlain by more recent rocks and glacial deposits. It is connected to the Andes in South America by a submarine ridge. The coast of the peninsula is dotted with thousands of islands, which are one of Antarctica's richest breeding grounds for seabirds, seals, and penguins. The islands are also the main location for ship based tourism operations because of their accessibility. The majority of these tourism operations visit the northern half of the peninsula known as Graham Land, and the focus of this section will be on the major geographical features of this region.

At the very northern tip of the peninsula lie is Antarctic Sound, which separates the peninsula from Dundee Island, Joinville Island, and Paulet Island. Dundee Island was found in 1893 by a British whaler captain who named the island after his home port in Scotland. Dundee Island is also the famous site in which American Lincoln Ellsworth took off on the first trans-Antarctic flight on November 22, 1935. Ellsworth later had a section of the southern peninsula named after him. Joinville Island was discovered in 1838 and named for a French nobleman and is the largest of the three islands at the tip of the peninsula. Paulet Island is a small volcanic island and is one of Antarctica's most visited sites.

The next area is the Erebus and Terror Gulf, which is on the east side of the Peninsula just south of the Antarctic Sound. Major features of this area are James Ross Island, and Seymour Island. James Ross Island is the site of Mount Haddington at

1,630m. Seymour Island is the site of Vicecomodoro Marambio, an Argentine research station.

Further south from here lies the Larsen Ice Shelf, which has been greatly decreased in recent years and is the source of the tabular icebergs seen by tourists. Yet further south is the Ronne Ice Shelf, which along with the Filchner Ice Shelf form the southern coast of the Weddel Sea.

As you travel south from the tip of the peninsula down the western coast you will reach the Palmer Archipelago. Major features of this region are the Gerlache Strait, Anvers Island, Neko Harbor, the Lemaire Channel, Port Lockroy, and Paradise Harbor. The Gerlache Strait, which forms the northern opening to the archipelago. The largest island in the archipelago is Anvers Island, which also has the highest point along the northern part of the peninsula, Mount Francis is 2,760m high. On the mainland across from Anvers Island is Andvord Bay, which leads inland to Neko Harbor, which extends inland 14km and is only 40kms from the Weddel Sea on the other side of the Peninsula. The harbor is fed by five glaciers flowing down from the 1,600m mountains at the head of the bay. The name comes from *Neko*, a whaling factory ship in the region from 1911-1924. The Lemaire Channel is a highlight of a voyage along the peninsula. The channel separates Booth Island from the peninsula, this spectacular 7km stretch of water is where the sheer rock and ice walls of Booth Island tower above. The channel at the midway point is less than 800m wide. Port Lockroy is an 800m-long harbor that lies on Wiencke Island and is home to a former British research station. Paradise Bay is correctly known as Paradise Harbor, which contains the Argentine research base Almirante Brown, this site offers tourists a chance to set foot on the Antarctic Continent.

The southern half of the Peninsula is known as Palmer land, this region lies south of the Antarctic Circle and is less visited by tourist operations. Palmer Land is much wider and has higher mountains than those in Graham Land. The highest point in the region is Mount Coman, 3,655m.

### *East Antarctica*

East Antarctica is also known as Greater Antarctica because the majority of the landmass lies on this side of the continent. East Antarctica is divided from West Antarctica by the Transantarctic Mountains. This area of the continent is roughly the size of Australia and is characterized by a stable Precambrian rock shield covered by a massive ice sheet. East Antarctica is divided into 11 major lands Dronning Maud, Enderby, Kemp, Mac. Robertson, Princess Elizabeth, Wilhelm II, Queen Mary, Wilkes, Terre Adelie George V, Oates, and Victoria. These names are derived from the nationality of the early expeditions.

East Antarctica is a barren desolate land, but it contains some distinct features. One of these is Lake Vostok. This site is located in the middle of East Antarctica and has the distinction of the world's lowest recorded temperature,  $-89.2^{\circ}\text{C}$  on July 21 1983. Here there is a Russian research station, the station is located 3,488m above sea level, and 1,399km from the moderating effects of the ocean. 4,000m below the station beneath the ice lies Lake Vostok, Antarctica's largest lake. The lake has been measured at 60km by 280km, and hundreds of meters deep. The lake remains unfrozen below the ice due to geothermal heating, and has been closed off by the ice for many thousands of years. This lake and other similar lakes beneath the Antarctic ice may harbor life forms long extinct elsewhere.

A cross-sectional look at East Antarctica will reveal that the icecap lies on bedrock near or well above sea level. The highest point of ice does not cover the South Pole but lies south of the Amery Ice Shelf near the center of East Antarctica. At this location the ice thickness is 4,000m. Other regional ice “domes” occurs at various other places. From these domes the ice flows outward more or less radially by flow under gravity. In places, ice movement is channeled into rapidly flowing ice streams. The ice sheet in East Antarctica also flows towards the Transantarctic Mountains where it is dammed. In some areas the dam is breached and the ice flows to feed the Ross Sea. In Mac. Robertson Land the world’s largest glacier by volume, the Lambert Glacier, feeds the Amery Ice Shelf. The Lambert Glacier is up to 65km wide and 400km long, and drains about 8% of Antarctica’s ice sheet. The fastest flowing glacier in Antarctica is Shirase in Queen Maud Land flowing at 2km per year.

### *West Antarctica*

West Antarctica is also known as Lesser Antarctica. It is a smaller landmass than that of East Antarctica and lies on the western side of the Transantarctic Mountains. The ice, which covers West Antarctica, is not as thick as that in East Antarctica, and it lies on rock below sea level. If this ice were to melt the result would be a series of small islands with one larger one with a long narrow spine that is the Transantarctic Mountains. There are two areas, which form West Antarctica, Marie Byrd Land, and Ellsworth Land. Other major features of West Antarctica include the Ross Ice Shelf, Ross Island, the Beardmore Glacier, the Transantarctic Mountains, Vinson Massif, and the dry valleys.

The Ross Sea area is rightfully known as the most significantly historical area of the Antarctic Continent. At the head of the Ross Sea is the Ross Ice Shelf. This shelf

covers 520,000sq. km, roughly the size of France. The mean thickness of the ice is 335m to 700m, but where glaciers flow into the shelf it is upwards of 1000m. The ice flows at a rate as high as 1100m per year and calves an estimated 150 cubic km of icebergs annually. In March 2000 an iceberg named B-15 measuring 298km by 37km calved off the ice shelf and is the largest ever recorded.

At the seaward edge of the Ross Ice Shelf is Ross Island. This entirely volcanic island is roughly the shape of a four-point star 70km wide. This island is the site of a historical expedition hut used by Robert Scott, New Zealand Research Base Scott, United States Research Base McMurdo, and Shackleton's hut at Cape Royds. The major features of this island are the two volcanoes, Mount Terror and Mount Erebus. Mount Terror 3230m in height is now an extinct volcano. Mount Erebus however, is still active, and is the youngest and largest volcano in Antarctica, 3795m in height. It is also the world's most southerly active volcano. Erebus has many notable features including a permanent convecting lake of molten magma at 1000°C. Another feature unique to Erebus is the occurrence of large crystals in the magma; these crystals are feldspar and belong to the anorthoclase variety. Since the mid-1980's 6-10 small daily eruptions are common, these eruptions are of the Strombolian variety. In 1984 there was a four-month period of intensified volcanic activity.

The Beardmore Glacier flows off the continental ice sheet onto the Ross Ice Shelf, this glacier extends further towards the South Pole than any other glacier feeding the Ross Ice Shelf. It is for this reason that it was historically chosen as a prominent route to the South Pole by explorers such as Ernest Shackleton in 1907-09 and Robert Scott in 1911-12.

The Transantarctic Mountains are a 3,500km mountain chain dividing the younger and lower rock of East Antarctica from the ancient and highly elevated rock of West Antarctica. These mountains were formed through continent-continent collision. The mountain belt extends northwest through the continent and is thought to mark a region that has been subjected to repeated compression and extension events over very long periods. The mountains continue offshore to form the South Sandwich volcanic arc and the southwestern edge of the Pacific Ring of Fire.

The Ellsworth Mountains form the border between West Antarctica and the Antarctic Peninsula. This mountain chain hosts Antarctica's highest point, Vinson Massif at 4897m. The mountain is 20km long by 13km wide, and was first discovered by US Navy aircraft in 1958. On December 18, 1966, four members of a private American expedition led by Nicholas Clinch made the first ever ascent of Vinson.

Antarctica's dry valleys are on the western side of McMurdo Sound. These are large ice-free areas covering 4,000 sq. km. The dry valleys exist because the Transantarctic Mountains act as a dam wall containing the polar ice cap. The valleys are close to the coast, and are now bare because the glaciers that formed them have retreated. Three main valleys exist parallel to one another on an east-west axis, Taylor, Wright, and Victoria. The dry valleys are a microclimate, which is dominated by dry winds, and so evaporation far exceeds precipitation. The valleys are not lifeless however, minute bacteria, algae, and fungi have been found living in cracks in rocks. The Wright Valley is the site of Antarctica's longest river, the Onyx River flows 30km from the Wright Lower Glacier to Lake Vanda. Lake Vanda is ice covered year round but the bottom of the lake is remarkably warm, 25°C. The surface water in the lake is fresh, however, the water at

the bottom of the lake is three times as salty as seawater. This valley also contains a lake so salty that it never freezes; this is Don Juan Pond, at a maximum of 75cm deep.

### *Sub-Antarctic Islands*

The Sub-Antarctic Islands lie within the Antarctic Convergence. This is a temperature and salinity boundary of the Southern Ocean. North of this seasonal and longitudinally varying line, the summer surface temperature is about 7.8°C, while south of the convergence the temperature drops to 3.8°C. The Convergence is of great biological importance, for the meeting of the cooler southern seas with the warmer northern waters acts as a great mixing agent, bringing an upwelling of nutrients to the surface. The main Sub-Antarctic Islands are the South Shetland Islands, the South Orkney Island, South Georgia Island, Elephant Island, Iles Kerguelen, Macquarie Island, and Iles Crozet. The geography of the South Shetland Islands, and South Georgia is discussed in the first section along with the Falkland Islands.

The South Orkney Islands lie 600km northeast of the tip of the Antarctic Peninsula and cover a land area of 622km, almost 90% of the islands are glaciated. The largest island is the group is Coronation Island which gives rise to the highest point Mount Nivea 1,265m. Signy Island lies to the south, Powell and Laurie Islands lie to the east. Laurie Island is home to the longest continually-operated Antarctic station, Orcadas station is operated by Argentina and was opened in February 1904 as a meteorological station. Both Argentina and Britain stake claim to the islands and these are held in abeyance by the Antarctic Treaty System.

Elephant Island is located off the northeastern tip of the South Shetland Islands, it is only 12km by 20km in size. The island is rarely visited by tourism operations as ice in

the bay and treacherous currents make landing tricky, and becomes even more challenging when seals and penguins crowd the beach. This island is the site in which Ernest Shackleton left 22 men in 1915 as he began his open-boat voyage for rescue at South Georgia Island. The group spent 135 days at Point Wild where they lived beneath two upturned boats. The island is also home to several chinstrap penguin rookeries and moss colonies dated at more than 2000 years old, with peat nearly 3 feet deep.

Iles Kerguelen is not a true sub-Antarctic island because it lies north of the Antarctic Convergence. It is however, a frequent stop for tourism operations and an important wildlife site. The land was first discovered in 1772 and named South France. The desolate volcanic islands are now part of the French Southern and Antarctic Lands, they consist of the main island, measuring 120km by 110km, and some 300 smaller islets and reefs. The main island is heavily glaciated in the interior and deep fjords line the coast. The highest point is Mount Ross at 1,850m. In 1949 Port-aux-Francais was built and now is a fully operational year-round base.

Macquarie Island lies 1,500km south of Tasmania and just north of the Antarctic Convergence, halfway to Antarctica. The island is long and narrow, 34km by 5.5km. The ocean around the island is an Australian Marine Park. Its World Heritage listing is largely due to its geological features. It is the only island that solely consists of rocks from deep within the Earth's mantle and crust. Australia's Macquarie Island station was built in 1948 and has operated continually since.

The Iles Crozet are the peaks of an underwater volcanic plateau. The highest point on these islands, which are located 2000km north of Antarctica south of India, is Pic Marion-Dufresne at 1,090m. The chain of islands consists of two groups. The eastern

group consists of Ile de la Possession and le de l'Est. The western group consists of Ile aux Cochons, Iles des Pingouins, and Iles des Apotres. Ile de la Possession is home to the islands only research station, Alfred-Faure, which is occupied year-round. The entire island group is also home to the largest group of King penguins in the world, with perhaps a third of the world's population breeding there.