

**GENERAL CERTIFICATE OF SECONDARY EDUCATION  
GEOGRAPHY SPECIFICATION C (1988)**

**2401/RB**

RESOURCE BOOKLET FOR DECISION MAKING EXERCISE

**MONDAY 11 JUNE 2007**

Afternoon

This Resource Booklet should be available to candidates for up to three working weeks prior to this date



\* C U P / T 3 7 6 0 7 \*

**THE ISSUE  
ANTARCTICA – THE LAST WILDERNESS?**

**INSTRUCTIONS TO CANDIDATES**

This Resource Booklet must be handed in to your teacher at the end of each lesson. **You must not write on the booklet.**

**INFORMATION FOR CANDIDATES**

The following abbreviations may be used:

MEDC – More Economically Developed Country

LEDC – Less Economically Developed Country

EU – European Union which includes the United Kingdom

**CONTENTS OF THE RESOURCE BOOKLET**

- Resource 1 – Introduction to Antarctica
- Resource 2 – A map of the continent of Antarctica
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- Resource 7 – The Antarctic Treaty System
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- Resource 12 – The future development of Antarctica
- Resource 13 – Two views on the future of Antarctica

This document consists of **16** printed pages.

## RESOURCE 1

### Introduction to Antarctica

Antarctica, the great white continent, is one of the most remote and inhospitable places on Earth. It is the world's last great wilderness, being almost entirely buried by snow and ice, and has no permanent inhabitants. It is the fifth largest continent. It has a coastline of 18000 kilometres. It is the highest continent, with an average height of 2300 metres and a highest point of 4897 metres. It is over 1000 kilometres from the nearest continent – South America. Travel away from the South Pole is always northwards.

Antarctica is entirely surrounded by the Southern Ocean, which accounts for about 10% of the world's seas. The water is extremely cold and surface temperatures can fall to  $-1.8^{\circ}\text{C}$  near the continent. The Southern Ocean is dominated by prevailing westerly winds, which produce circumpolar currents. Eventually this cold, dense water meets warmer, less dense water from the tropics and creates a zone some 40 km wide where sea surface temperatures rise by  $2-3^{\circ}\text{C}$ . This zone is known as the Antarctic Polar Front and marks the northern boundary of the Southern Ocean.

Sea ice is formed by the freezing of the surface sea water around Antarctica in autumn and winter. The sea ice reaches its maximum extent in September when it covers 20 million square kilometres of the Southern Ocean. It melts back in summer, dropping to a minimum 5 million square kilometres in February. This immense ice sheet on land and sea has a big effect on the Earth's weather, reflecting great amounts of heat from the sun back into the atmosphere, tying up large amounts of the Earth's freshwater and acting as a freezer at the end of the Earth.

### Fact file

- Antarctica covers an area of 14 million  $\text{km}^2$ , which is 58 times the size of the United Kingdom
- The ice on the continent contains 70% of the world's fresh water and 90% of the world's ice
- In places the ice sheet is over 4 km thick
- If all the ice in the Antarctic ice sheet melted, sea levels would rise by around 70 metres
- Only 0.6% of Antarctica is free of ice
- If you measure Antarctica's precipitation (which falls as snow) it is as dry as the Sahara Desert
- The world's record lowest temperature of  $-89.2^{\circ}\text{C}$  was recorded in Antarctica

© Philip Allan Updates

### second opinion

**CAPTAIN SCOTT, 1912**

"Great God! This is an awful place."

**SARAH WHEELER, 1996**

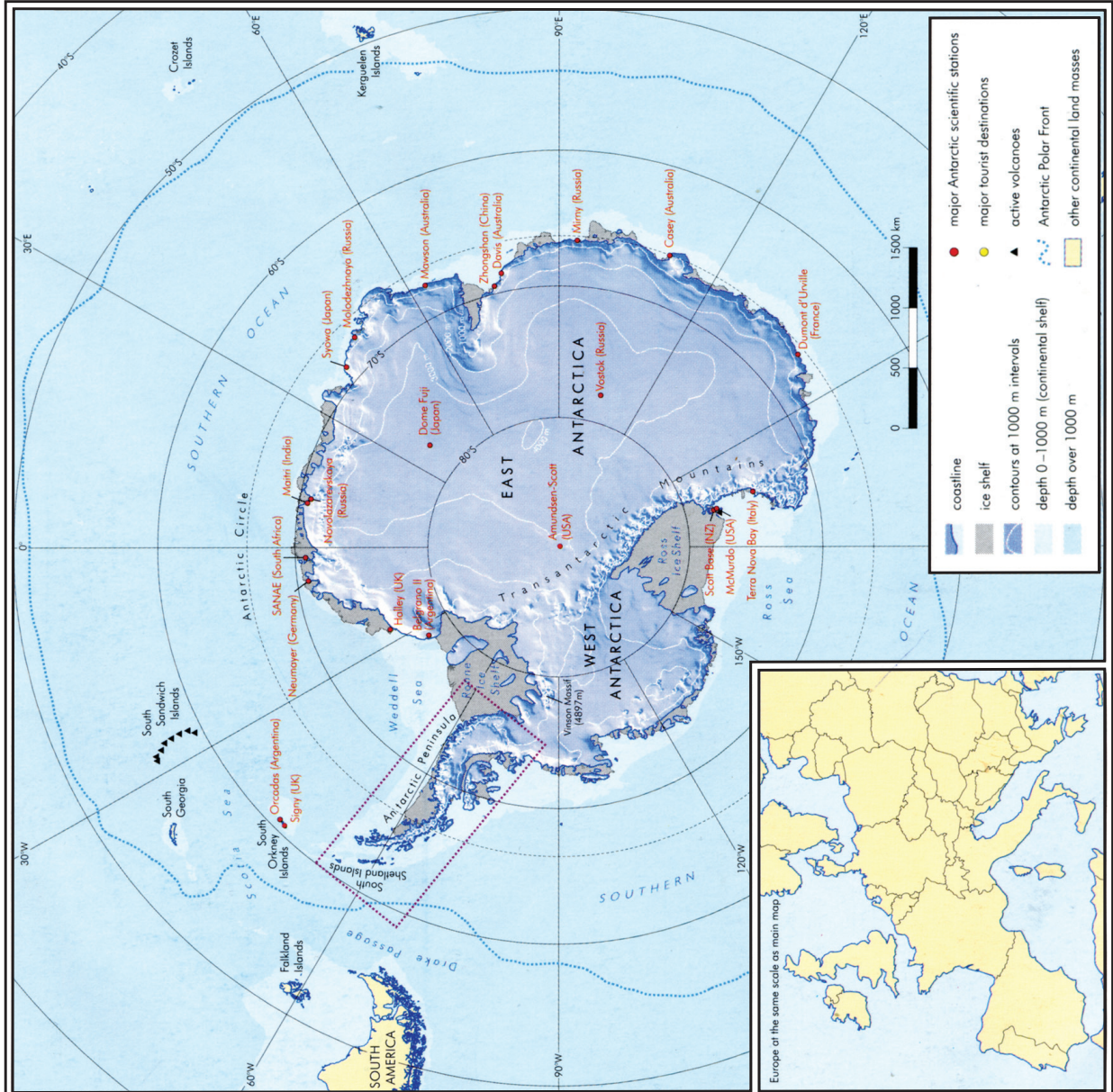
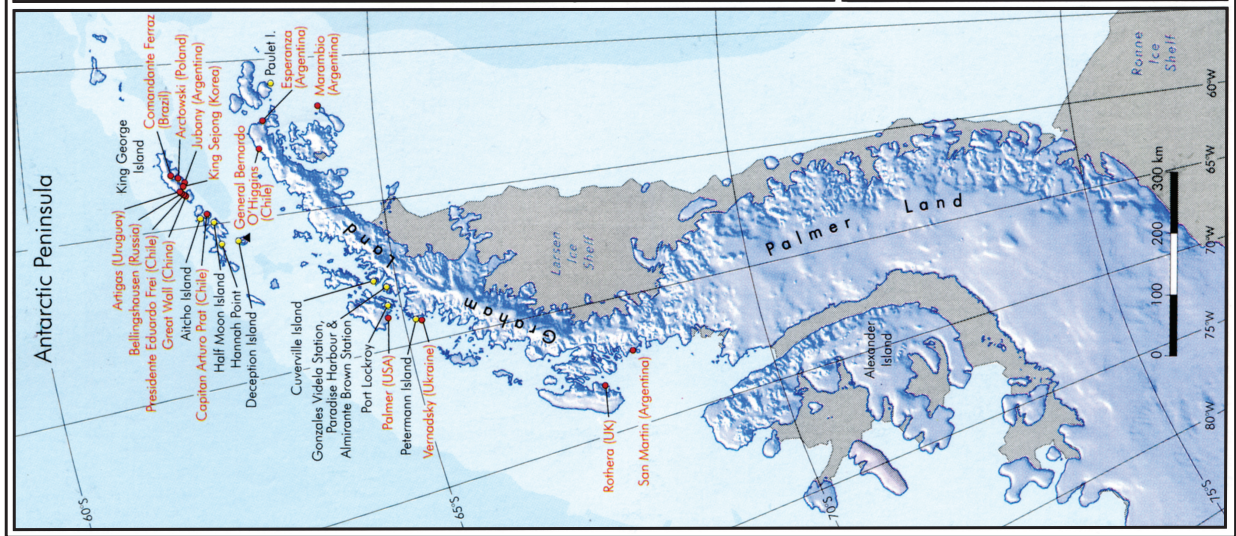
"Standing on the edge of the ice field in a wind strong enough to lean on, squinting into the buttery light, it was as if I were seeing the earth for the very first time. I knew immediately that I had to return."

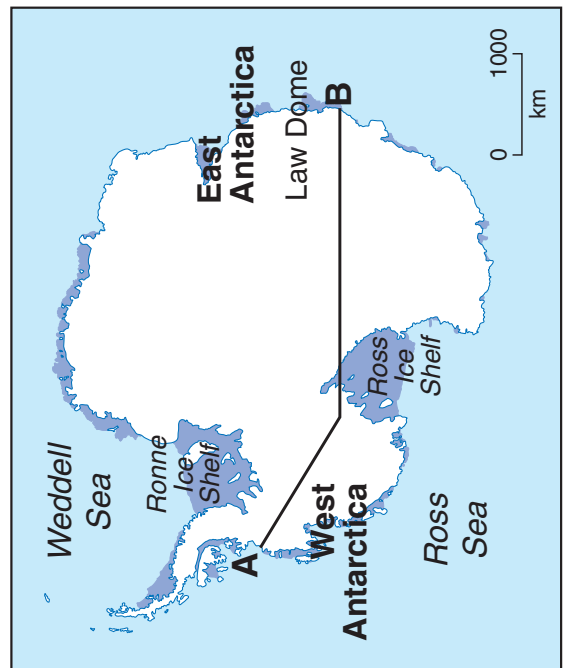
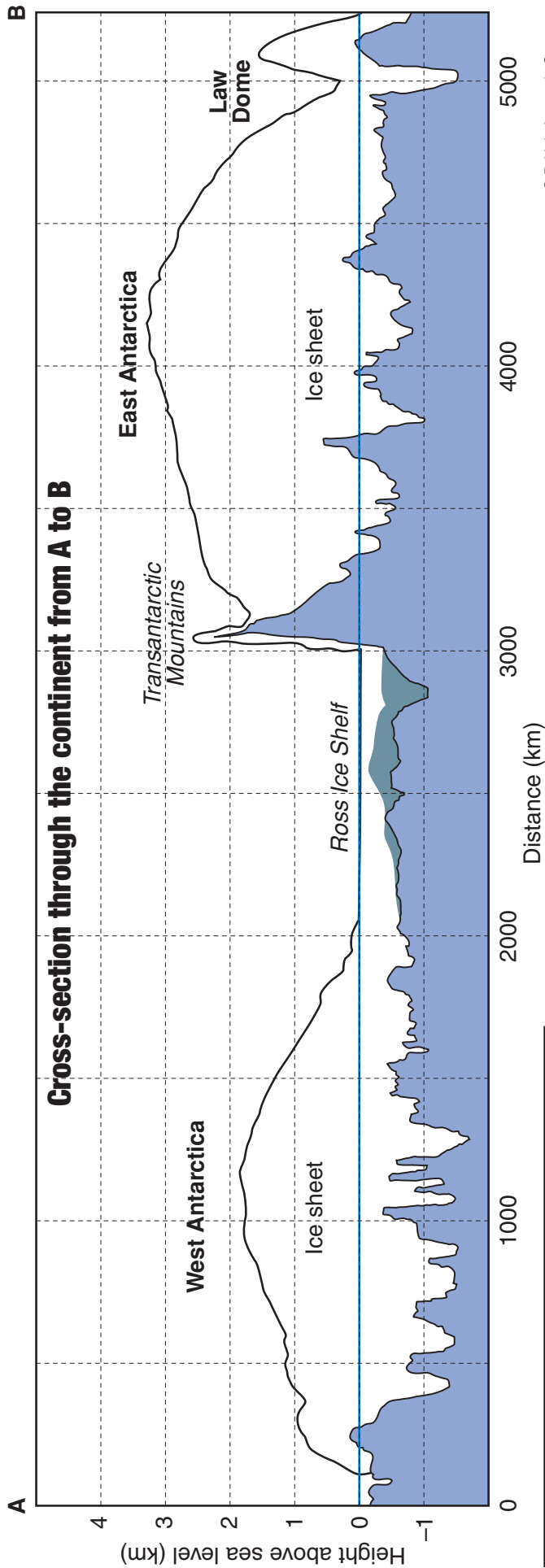
**APSLEY CHERRY – GARRARD, 1922**

"Polar exploration is the cleanest and most isolated way of having a bad time which has been devised."

# RESOURCE 2

## A map of the continent of Antarctica





Cross-section through the Antarctic ice sheet from the Ronne Entrance, Bellingshausen Sea, West Antarctica to Colvocoresses Bay, East Antarctica.

© British Antarctic Survey

## RESOURCE 4

### The Antarctic climate

Antarctica is a continent of extremes; it is the coldest, windiest and driest. Temperatures of  $-25^{\circ}\text{C}$  are considered warm sunny days; mean winter temperatures range from  $-40^{\circ}$  to  $-80^{\circ}\text{C}$  and winds of 300 km per hour are not uncommon.

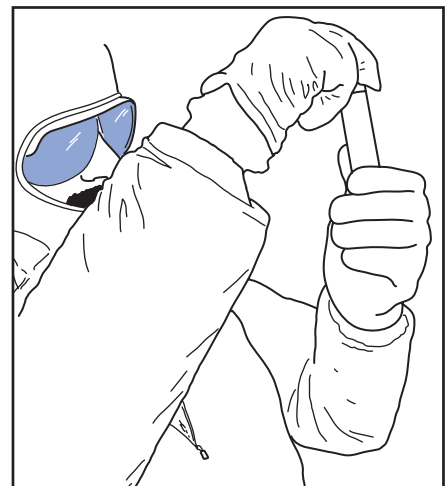
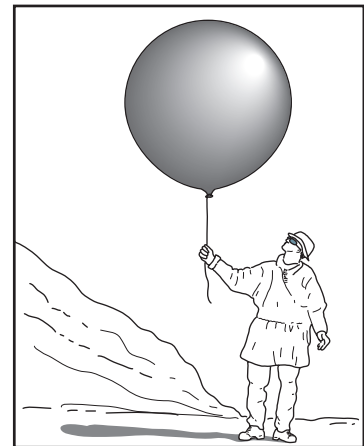
The world's lowest air temperature of  $-89.2^{\circ}\text{C}$  was recorded at the Russian **Vostok** station on 21 July 1983. The location of Antarctica at the South Pole, its massive ice sheet and its high altitude ensure that temperatures on the continent are 10 to  $30^{\circ}\text{C}$  colder than at comparable northern latitudes.

The Antarctic continent and surrounding Southern Ocean play critical roles in the Earth's atmospheric and oceanic systems. The massive ice cap reflects 50–90% of the sun's energy and is a reason why the region is so cold. While this cold air is transferred north by the atmosphere and oceans, the ice cap acts as a huge heat sink, causing summer northern air to move down towards it. Any significant melting of the ice cap from global warming or pollution from mining activities could cause changes in global weather and wind patterns.

The climate is not the same over the whole of Antarctica. The climate and weather are influenced by a number of factors including latitude, altitude, the continental ice sheet, the Southern Ocean, and seasonal variations in sea ice cover. There are therefore major climatic differences between the interior and the coasts.

<b>Amundsen-Scott (South Pole)</b>	
Latitude	$90^{\circ}\text{S}$
Longitude	$0^{\circ}$
Altitude (metres)	2800
Annual mean temperature ( $^{\circ}\text{C}$ )	$-49.4$
Annual mean wind speed (km per hour)	20.9
<b>Vostok</b>	
Latitude	$78.5^{\circ}\text{S}$
Longitude	$106.9^{\circ}\text{E}$
Altitude (metres)	3488
Annual mean temperature ( $^{\circ}\text{C}$ )	$-55.3$
Annual mean windspeed (km per hour)	18.4
<b>Mawson</b>	
Latitude	$67.6^{\circ}\text{S}$
Longitude	$62.9^{\circ}\text{E}$
Altitude (metres)	16
Annual mean temperature ( $^{\circ}\text{C}$ )	$-11.2$
Annual mean windspeed (km per hour)	39.8
<b>Rothera</b>	
Latitude	$67.5^{\circ}\text{S}$
Longitude	$68.1^{\circ}\text{W}$
Altitude (metres)	16
Annual mean temperature ( $^{\circ}\text{C}$ )	$-5.2$
Annual mean windspeed (km per hour)	21.3

### Collecting weather data



## RESOURCE 5

### Climate change in Antarctica

#### The ozone hole

The hole in the ozone layer has attracted much publicity in recent years following its discovery by the British Antarctic Survey in the early 1980s. The BAS scientists found that, during October each year, ozone was almost completely destroyed over Antarctica. They suspected that CFCs might be responsible for ozone depletion. CFCs can remain in the atmosphere for over a century. Ozone protects us from the harmful effects of radiation. Following international agreements to ban the use of CFCs, more recent measurements suggest that the hole is getting smaller and shallower.



**The Ross Ice Shelf**

© NOAA

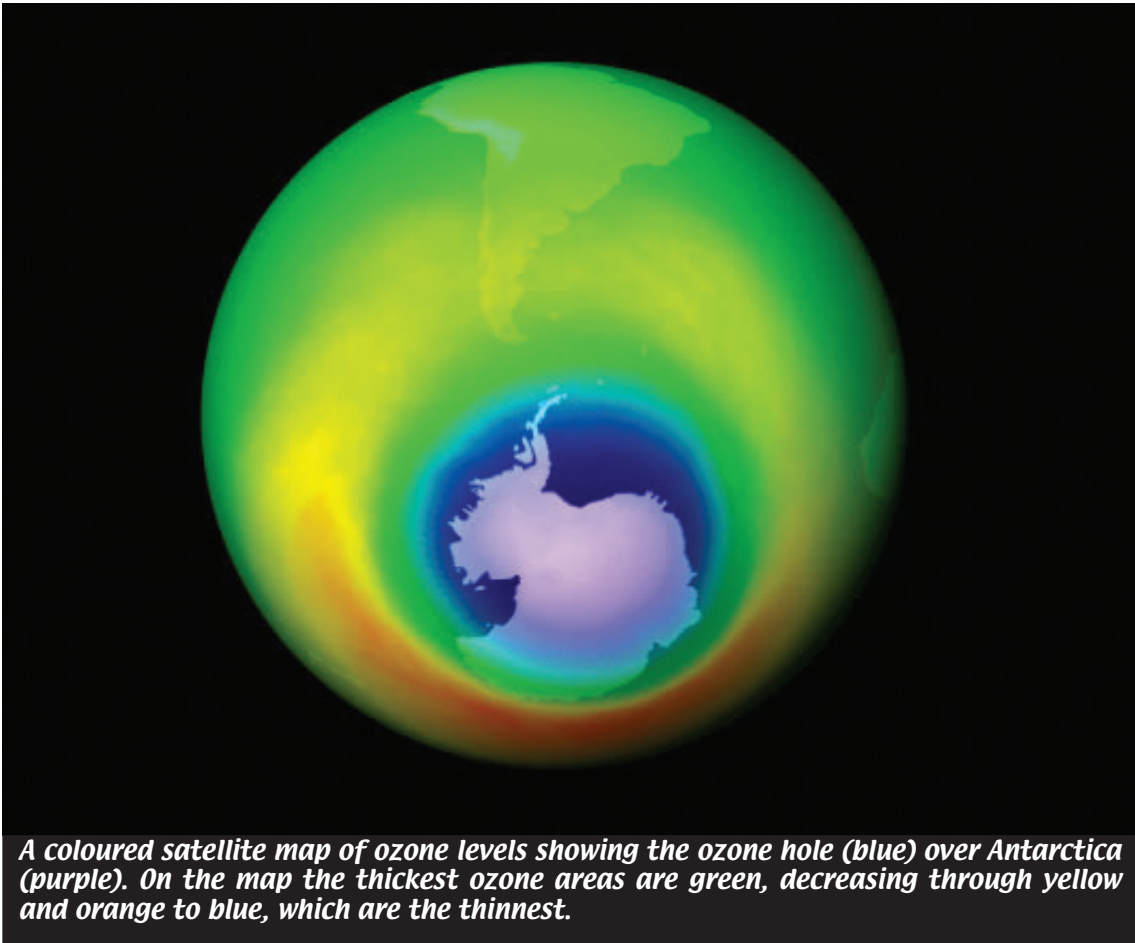
#### Global warming

On the Antarctic Peninsula, temperatures have risen by around 2.5°C since the 1940s. Most scientists suspect that this is due to global warming, but a few suggest natural climate fluctuations as the cause. The increase in temperature has caused the melting of several smaller ice shelves. Ice shelves are the floating extension of the ice sheet and surround much of Antarctica. If larger ice sheets were to break up, global sea levels could rise by 5–7 metres.



© Simon Fraser/Science Photo Library

*Researchers taking an ice core sample. The ice has been laid down over thousands of years and gives information about the changing global climate and levels of pollution.*



*A coloured satellite map of ozone levels showing the ozone hole (blue) over Antarctica (purple). On the map the thickest ozone areas are green, decreasing through yellow and orange to blue, which are the thinnest.*

© NASA

## RESOURCE 6

## Wildlife in Antarctica

Antarctica is the world's largest wildlife sanctuary, home to over 100 million birds, including seven species of penguins and six species of seals. It is the summer feeding ground for fifteen species of whales. The waters of the Southern Ocean are among the most biologically productive in the world; they support a unique, highly-adapted and specialized ecosystem.



These animals have successfully adapted to the sub-freezing waters due to the rich nutrients in the sea and the stability of the marine ecosystem. Any minor change brought about by mineral extraction or increased tourism can have major, perhaps fatal, consequences on Antarctica's fragile ecosystem.



In the past, tourist visits have caused damage to moss beds, disturbed penguins and taken historic items or geological souvenirs. Rubbish and waste from ships have been a problem, as have uninvited visits to scientific bases.



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## RESOURCE 7

### The Antarctic Treaty System

The system of international governance that has evolved in Antarctica is unique. Activities south of latitude 60°S are governed by the Antarctic Treaty (updated 1991). This Treaty established Antarctica as a region of peace and science, and sets territorial claims to one side. 44 countries have now signed the Treaty, representing over 80% of the world's population. These rules and regulations, together with the Treaty itself, are known as the Antarctic Treaty System.

Below is a summary of its major points:

1. Military activities are not allowed.	7. Treaty nations will meet regularly to consider ways of furthering the principles and objectives of the Treaty.
2. Freedom of scientific investigation and cooperation shall continue.	8. Treaty nations will try to ensure that no one engages in any activity contrary to the principles of the Treaty.
3. Territorial claims are not recognised and no new territorial claims can be made.	9. Any dispute shall be settled by the International Court of Justice.
4. Nuclear explosions and radioactive waste disposal are banned.	10. The Treaty may be modified at any time by unanimous agreement.
5. The Treaty applies to all land, but not to the seas within the area.	11. The Treaty must be accepted by any nation wishing to join.
6. All research stations, ships and aircraft operating in Antarctica have to be open to inspection.	12. The original Treaty was signed on 1 December 1959.

© British Antarctic Survey

Comments on the Antarctic Treaty System (ATS)

**A.** The ATS is one of the few international agreements to have succeeded.

**E.** The ATS has brought together many different nations, some of whom have been in conflict elsewhere in the world e.g. the UK and Argentina during the Falklands War.

**H.** There has been no armed conflict within Antarctica since the Antarctic Treaty was signed.

**K.** Government by consensus is a recipe for achieving the lowest common denominator at the slowest possible rate of progress.

**B.** The ATS has maintained the spirit of peaceful international cooperation in Antarctica.

**I.** The ATS has focused only on the issues that are easily resolved, e.g. scientific cooperation.

**F.** The ATS is a 'rich man's club' run by a select group of MEDCs for their own benefit.

**L.** The ATS has only succeeded because the principal Treaty nations feared what might happen if it failed.

**C.** The ATS has limited environmental damage within Antarctica.

**J.** Antarctica is a 'common heritage for mankind' and should be governed as a 'World Park' by the United Nations.

**G.** Much of the science conducted in Antarctica is poor and is done to disguise territorial claims or potential rights to mineral exploitation.

**D.** The ATS has permitted Antarctic science to flourish and many issues of global concern such as the ozone hole have been researched there.

**M.** The ATS does not provide any benefits to countries unable to pay for expensive scientific programmes within Antarctica.

## RESOURCE 9

### Minerals in Antarctica

Since the earliest days of exploration in Antarctica there has been speculation on the mineral wealth of the continent. Small deposits of iron ore and coal already found are not economically viable. The Antarctic Treaty bans commercial mining at present. However, the world is running out of resources that are needed to improve standards of living and Antarctica may have a large store of mineral resources.

Reasons to exploit minerals in Antarctica	Reasons not to exploit minerals in Antarctic
1. The world's thirst for oil, gas and other minerals could be the continent's future	1. The unpredictable weather would make mineral extraction dangerous
2. The rising cost of oil may make offshore tapping of crude oil worthwhile in the future	2. More human activity required to support mineral activities would destroy habitats
3. The melting of ice sheets would cut exploitation costs considerably	3. It would increase pollution and damage the fragile ecosystem



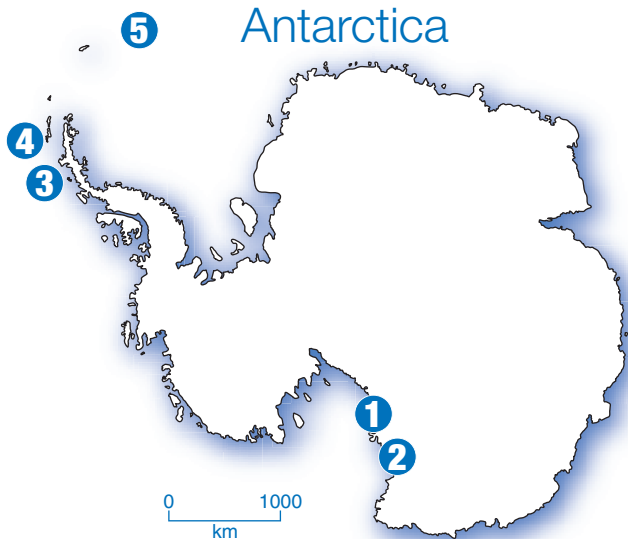
© British Antarctic Survey

Sedimentary rocks on the Transantarctic Mountains. The black layer in the centre is coal.

## RESOURCE 10

### Tourism in Antarctica

Commercial tourism became a significant activity in 1969. Now you can cruise to the continent and fly to a black-ice airfield. Most people come to see the scenery and wildlife but you can now climb mountains, ski and undertake scuba-diving holidays. November to February is the time to visit. In December and January, penguins hatch and feed chicks and there is daylight for up to 20 hours a day. Most visitors travel by ship but Antarctic Airways run flights to the interior.



### top sights

- 1 **Ross Sea** Peer inside the actual huts where Captain Scott and his contemporaries based their expeditions in the heroic era of exploration.
- 2 **The Dry Valleys** Visit desolate expanses of barren, ice-free rock 'oases', where the air is so dry that no rain has fallen in millions of years.
- 3 **Paradise Harbour** Drift among awesome icebergs in an inflatable dinghy.
- 4 **Deception Island** Thaw out with a sea bath in the volcanically-heated waters of Pendulum Cove.
- 5 **South Sandwich Islands** Witness the stunning rookery at Zavodovski Island, where as many as a million chinstrap penguins congregate in the breeding season to lay and hatch their eggs.

### Tourists approaching Antarctica



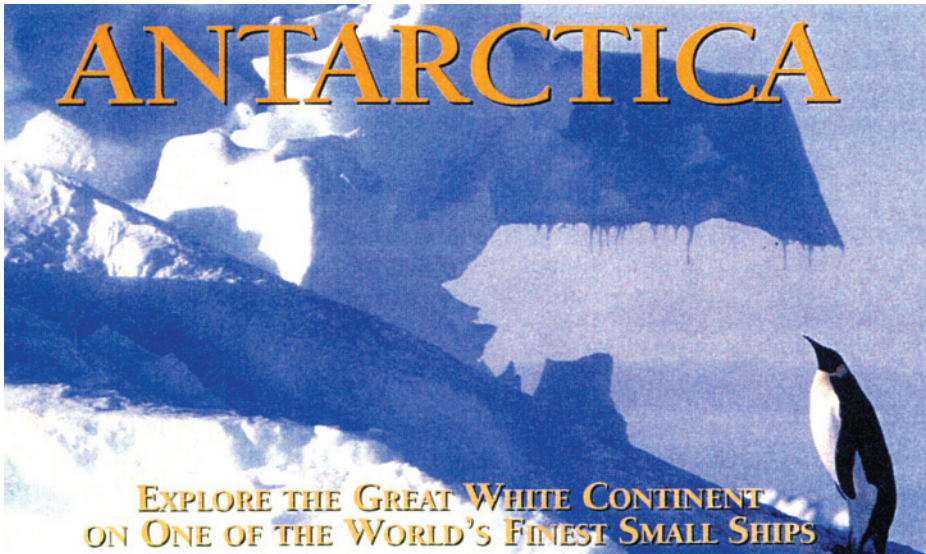
© Robert Harding Picture Library Ltd/Alamy

## RESOURCE 11

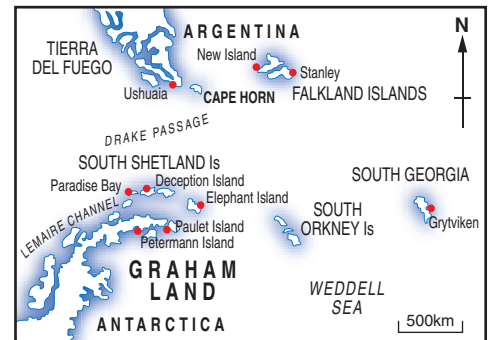
### Tourism in Antarctica (continued)

#### A typical cruise to Antarctica

If you have always had the urge to visit Antarctica, this could be the time. The Explorer 2 will undertake a cruise to the Antarctic Peninsula at a lower price than normal. The cruise will begin in Argentina and sail across Drake Passage to the Antarctic Peninsula where you will enjoy days of exploration amongst the incomparable beauty of its bays and inlets, islands and waterways. The sights, sounds and emotions will stay with you forever – icebergs, penguins and whales. You will travel with polar expedition experts who are committed to making your trip a learning, enjoyable and memorable experience!



**EXPLORER II**



#### The Itinerary

**Day 1** – fly to Buenos Aires

**Days 2-3** – explore Buenos Aires

**Day 4** – fly to Ushuaia in Tierra Del Fuego

**Days 5-6** – at sea

**Days 7-11** – Antarctic Peninsula (South Shetland Islands, Deception Island, Paradise Bay, Elephant Island)

**Days 12-13** – at sea

**Day 14** – Ushuaia to Buenos Aires

**Day 15** – Buenos Aires to London

**Day 16** – arrive home

#### Some concerns over tourism in Antarctica

- Tourism will damage the Antarctic environment.
- Tourism places large numbers of people close to wildlife during the breeding season.
- Larger tourist ships are equipped with helicopters that allow access to many previously out of the way spots.
- The Antarctic Treaty countries have adopted a 'wait and see' policy whereby the negative impacts of tourism have to be blatant before any response is made.
- Visits are concentrated into a small number of landing sites which can destroy parts of a unique environment and jeopardise scientific research.
- Some tourist groups have needed assistance from staff at scientific bases.
- Accidents can occur with major environmental consequences, e.g. an oil spill from a tourist supply ship on the Antarctic Peninsula in the early 1990s.

## RESOURCE 12

### The future development of Antarctica

A lot has been written about Antarctica's future. However, due to the Antarctic Treaty, it has remained free of all commercial development and only scientific research is allowed to be carried out there. This could change over time.

#### Arguments for Development

As the world's population increases, people will require more resources to support them.

Developers now have a large amount of experience in protecting unique environments.

Strict controls can be imposed on developers to minimise environmental change.

By allowing small amounts of development, we can find out the effects on environments.

#### Arguments against Development

Antarctica is the last great wilderness and should remain so. Once it is developed, it will be lost forever.

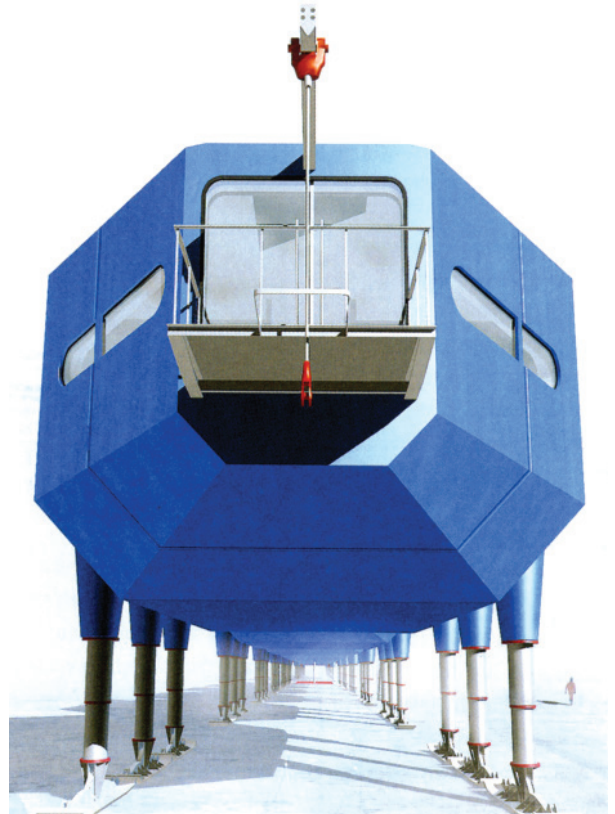
For research programmes to be of real benefit, the environment needs to remain as natural as possible.

Not enough is known about how the environment might be affected by development. In such a cold climate, it takes the environment a long time to recover from any damage.

If any resources were found, they would only last a few decades. It would be better to invest money finding ways to reduce our current use of resources.

### Futuristic design for Antarctic research station

There is a futuristic design for the new British Antarctic Survey Halley Research Station. The new modular station, elevated on ski-based jackable legs to avoid burial by snow, can be towed across the ice and located inland as the ice shelf flows towards the sea. It features renewable energy sources and environmental plans for fuel, waste and material handling, reducing its environmental impact by an estimated 25% compared to the current station. The new station will allow long-running research on global change to continue at the site where the ozone hole was discovered.



© Hugh Broughton Architects

## RESOURCE 13

### Two views on the future of Antarctica

#### A) The Greenpeace view of Antarctica as a 'World Park'



© Greenpeace/Morgan

Greenpeace's vision of a World Park is guided by four principles:

- The recognition of the value of the continent as the world's last great near pristine wilderness.
- The protection of all wildlife.
- The use of the continent only for high quality scientific activity.
- Maintaining the continent as a zone of peace.

Protection of the Antarctic environment would be the main consideration in a World Park. Activities considered damaging to the environment would be prohibited. These include:

- Mineral and oil exploitation.
- Military and nuclear activities.
- Disposal of radioactive and toxic waste.
- Killing or harming marine mammals, birds and plant life

#### B) The view of the United Nations

- The long-term environmental impacts of tourism in Antarctica remain largely unknown due to the short time over which data has been collected.
- Current fishing levels are below total allowable catch quotas, but it is important to have accurate knowledge of the marine ecosystem to allow decisions to be made to produce a sustainable fishery.
- Pollutants from the industrial and populated areas of the world are transported to Antarctica by atmospheric and oceanic circulation. Levels in Antarctica itself are still very low.
- The Antarctic ozone hole can be expected to disappear due to recent global agreements. Sea ice is expected to be reduced by global warming and sea level rise in the future. Changes on the Antarctic Peninsula over the next 50 years will be a sensitive indicator of climate change.
- Overall, the future of Antarctica seems to be one of little change.

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