Geo Factsheet

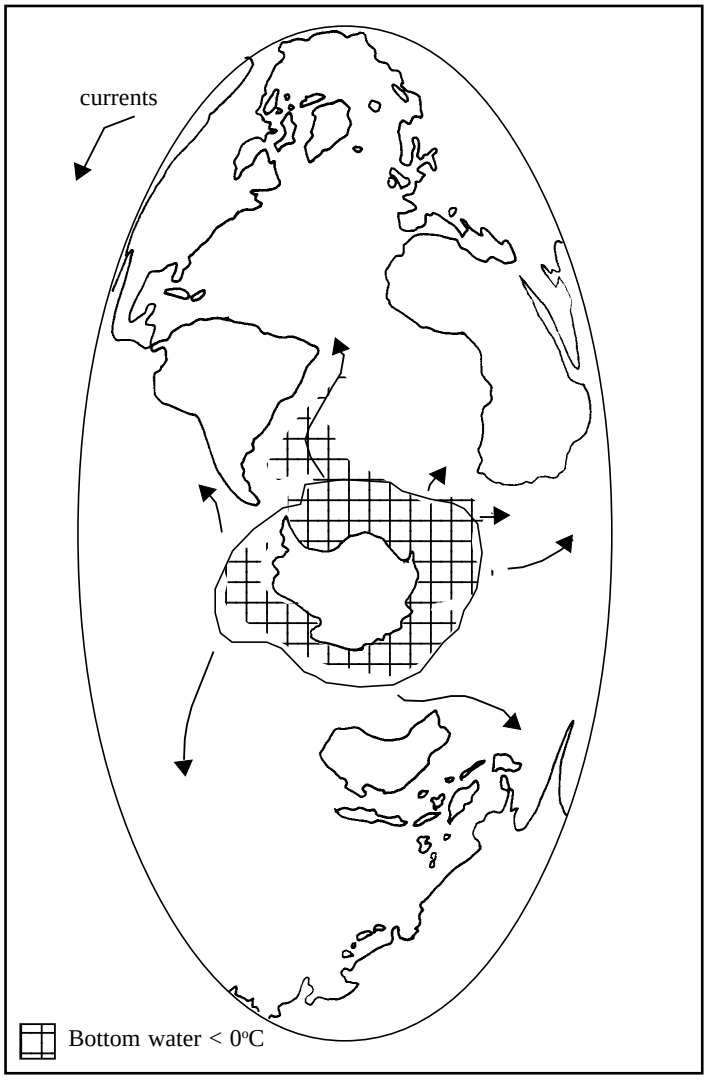
Number 80

Antarctica

Antarctica covers 14m km^2 (about 1.5 times the size of the U.S.) and is composed of 98% ice and 2% rock. The average elevation is between 2000 and 4000 m and mountain ranges extend up to 5000m. It is extremely cold with temperatures ranging from - 15^{0}C to -50^{0}C on the plateaus. Antarctica's ice holds $^2/_3$ of the world's fresh water, yet most of Antarctica receives less than 30 mm rain per year which makes it the driest continent. Blizzards are frequent and cyclonic storms regularly move clockwise along the coast. Thus, it is a continent of extremes. However, Antarctica also contains valuable natural resources - iron ore, chromium, copper, gold, nickel, platinum as well as valuable biotic resources and represents a huge, relatively undisturbed **continental laboratory.** As a consequence, many countries have established research stations on the continent and resource exploitation is therefore an ongoing threat.

Antarctica is also a major **heat sink** and **nutrient conveyor**. The ice masses that break off Antarctica feed into the cold Antarctic ocean. The currents in these waters radiate outwards and provide a source of nutrients for the world's oceans (Fig 1).

Fig 1. Antarctic currents



Antarctica's Conservation value

- Southern Ocean surrounding Antarctica is a very rich ecosystem
- 160m years of the planet's history is preserved in the ice and bedrock
- Continental laboratory
- The world's heat sink, reflecting solar radiation and insulating the oceans

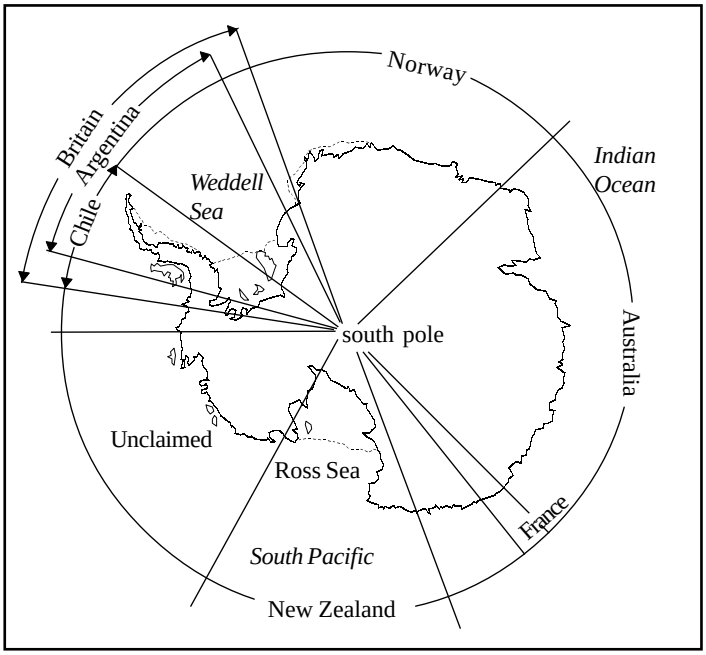
The sea ice region produces cold and dense **Antarctic Bottom Water** which is transported north and this, along with cold surface currents, serves to cool the oceans it reaches. These waters are replaced by water flowing south and thus Antarctica serves as a huge heat sink generating currents which exchange heat and nutrients. The high **albedo** (reflectivity) of sea ice also influences temperature and precipitation patterns in the lower latitudes but the precise mechanisms are poorly understood.

What is certain is that the cold Antarctic water can absorb much more atmospheric carbon dioxide than warmer water, thus the Antarctic ocean also acts as a **carbon sink.** Phytoplankton fix (absorb) this carbon dioxide and form the basis of complex food webs - this is why Antarctica is highly **biologically productive**.

Managing Antarctica

Forty three countries have signed the **1959 Antarctica Treaty** which sets out the legal framework for the management of the continent. Seven countries - Argentina, Australia, Chile, France, New Zealand, Norway and United Kingdom - have made territorial claims (Fig 2).

Fig 2. International claims in Antarctica



Britain, Argentina and Chile's territories overlap. It has been agreed that whilst the treaty is in force, nothing will be done to enhance or diminish territorial claims. However, although such territorial claims are not accepted

or recognised by countries such as the United States. The 1959 Antarctica Treaty actually **preserved** the positions of the seven nations claiming territory in Antarctica and the nations that do not recognise territory claims. In practice this means that every decision or agreement which is put forward is extremely carefully negotiated so that it does not prejudice either group's legal position.

Antarctica is administered through annual consultative meetings of the signatories to the Treaty. A range of **articles** and **agreements** have been made (Fig 3).

Fig 3. Major Treaties and Articles

1959 Antarctica Treaty - 12 countries took part in the 1957/58 International Geophysical Year. These are the original 12 signatories.
1972 Convention for the Conservation of Antarctic Seals
1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)
1988 Convention on the Regulation of Antarctic Mining Resource Activities (CRAMRA)

Major Articles

1. Area to be used for peaceful purposes only, military activity is prohibited
2. Free development of scientific investigation and co -operation
3. Free exchange of information and personnel between the UN and other investigative agencies
4. Territory claims will not be established, recognised or disputed
5. Prohibition of nuclear experiments or disposal of radioactive wastes
6. The treaty includes all land and ice shelves south of 60^0 00' south
7. Treaty signatories have free access to each other's stations
8. Treaty signatories will discourage actions by any country in Antarctica that are contrary to the treaty
9. Disputes to be settled peacefully

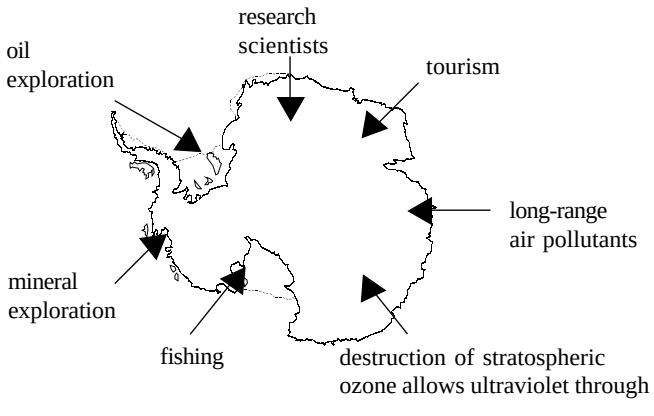
A number of conventions, acts and protocols also serve to protect various aspects of the continent's wildlife.

The Protocol on Environmental Protection to the Antarctic Treaty came into force in January 1998 and protects the Antarctic environment against marine pollution and any threats to flora and fauna. It also prohibits all actions related to mining except scientific research.

Conflicts in Antarctica

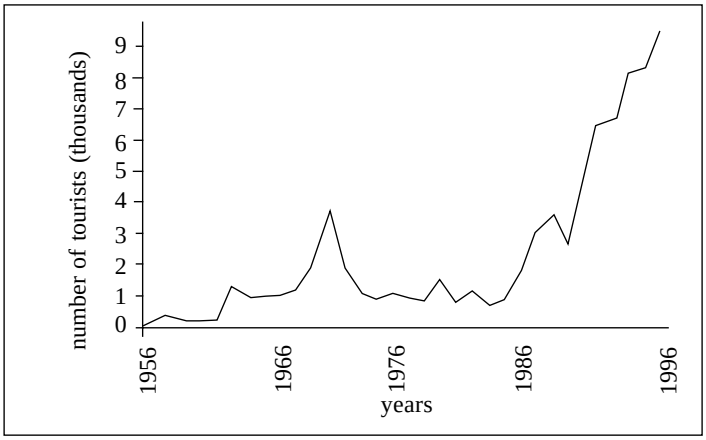
Antarctica faces a number of threats (Fig 4).

Fig 4. Conflicts in Antarctica



1. **Tourism** Antarctica receives 12000 visitors annually. Tourism is now the second largest commercial activity after fishing (Fig 5).

Fig 5. Estimated annual number of tourist visitors to Antarctica (1956-1996)



Most activity is concentrated in two areas:
1. Antarctica peninsula
2. South Georgia

Access to both areas is largely determined by the pack ice and the major attractions are the wildlife to be seen.

Impact:

- disturbance to wildlife e.g. through breeding season
- introduction of bird and mammal diseases
- destruction of historical sites
- disposal of waste from cruise ships.

Attempts are being made to try to persuade tourists to visit with tour operators who are members of **The International Association of Antarctic Tour Operators**, one of whose duties is to promote safe and environmentally responsible travel to the area.

Stratospheric ozone

The stratospheric ozone hole was first discovered in Antarctica. In 1999 the area of thinning of the ozone layer over Antarctica (the ozone hole) was the largest ever - 29 million km^2. The extent of the thinning is largely determined by the concentration of chlorine in the atmosphere which has been formed from CFCs (Fig 6). Increased ultraviolet radiation has damaged the DNA of ice fish and phytoplakton - the latter are the basis of all food chains in the region. The discovery of Antarctica's ozone hole led to the **Montreal Protocol** which has dramatically decreased CFC production and use.

Fig 6. Stratospheric ozone and chlorine concentration

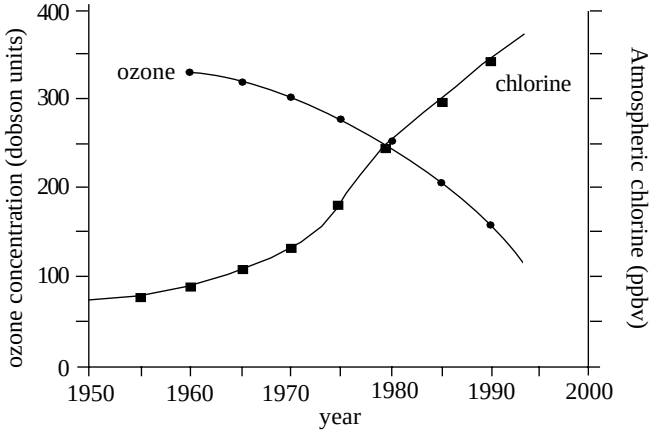


Table 1. Known and potential Antarctic resources

Resource	Potential yield	When Exploitable
Whales	Potential high, but stocks low and apparently not increasing	?
Krill	110 - 150 million tonnes per annum	Now
Seals	Considerable	Now, but no interest at present
Fish	Substantial, 1997 fin-fish catch 279,000 tonnes	Now
Oil	Tens of billions of barrels	?
Iron	Substantial, but low grade	?
Coal	Largest field in the world with approximately 11% of global reserves	?
Other minerals	Not known	?

2. Resource management

The potential and known Antarctic resources are summarised in Table 1. The exploitation of **open access marine resources** (seals, whales and finfish) has been unsustainable - following a pattern of discovery, exploitation, overfishing, collapse. Regulations are now tighter than they have ever been and **sustainable** management is a recognised concept.

Seal hunting was the first commercial exploitation of Antarctica's marine resources and harvesting quickly reached unsustainable levels. This resulted in collapse of the industry. **The Convention for the Conservation of Antarctic Seals (1972)** has allowed populations to increase and recover. A similar pattern occurred in the hunting of whale and finfish, both of which were harvested in huge and unsustainable quantities before they were regulated.

The 1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) rules that before any conservation measures can be implemented all 28 signatories must agree to them. The problem is that it has proved extremely difficult to get such agreement.

One problem has been the lack of scientific data on the size of the resources e.g. historical fish catches and the distribution and productivity of many species are still poorly understood. The CCAMLR was unique in that it set out to protect fisheries at an **ecosystem** rather than a species level. CCAMLR stipulates that marine life can only be hunted if ecological relationships between the species in the area remain unaltered and changes to the marine ecosystem that are not potentially reversible within 20 -30 years are prohibited. In other words, targeted species can only be hunted if their predators and prey are not harmed in the process. Such conservation measures, which take into account **ecological interactions**, are difficult to implement and monitor and effectively make the concept of maximum sustainable yield (MSY) irrelevant.

Protected Areas

The Agreed Measures for the conservation of Antarctic flora and fauna (1964) protect native mammals and birds. The most important methods are through the designation of Specially Protected Areas (SPAs), the protection of seals and the designation of Sites of Special Scientific Interest (SSSIs).

Problems

1. A disproportionate number of SPAs are terrestrial coastal ecosystems - thus the designation is spatially biased and unrepresentative.
2. A small percentage area (0.007%) is covered (Table 2)
3. SPAs lack buffer zones
4. SPAs only cover areas of scientific concern and neglect landscape, scenic and aesthetic sites
5. Scientific Research Stations have been built too close to SPAs

Two new categories of protected area have been suggested:

1. **Specially Reserved Areas**: designated on the basis of geological, glaciological, geomorphological, aesthetic, scenic or wilderness qualities.
2. **Multiple Use Planning Areas**: sites susceptible to cumulative impact.

Table 2. Categories of protected areas with existing site designations in Antarctica

Category	Date introduced	Number and objectives
Specially Protected Area (SPA)	1966	20 to protect areas of outstanding scientific interest
Site of Special Scientific Interest (SSSI)	1972	35 to prevent interference with scientific investigations and to protect sites of exceptional scientific interest from human interference
Historic Site and Monument	1972	72 to preserve and protect historic monuments
Seal Reserve	1972	3 to protect seal breeding areas
Tomb	1980	1 to ensure that the site of 1979 air crash on Mount Erebus is left undisturbed
CEMP Site	1992	2 to safeguard sites contributing to the CCAMLR Ecosystem Monitoring Programme (CEMP)
Specially Reserved Area (SRA)	1989	1 (480 proposed) to protect areas of outstanding proposed geological, glaciological, geomorphological, aesthetic, scenic or wilderness value
Multiple-Use Planning Area (MPA)	1989	1 (1535 proposed) to assist in coordinating human activities
Area of Special Tourist Interest	1975	0 areas designated for tourist visits

There is an on-going debate about the management of Antarctica. Some believe the Antarctica Treaty is working, others believe Antarctica would be better protected if it were made a World Park (Table 3).

Table 3. How should Antarctica be managed?

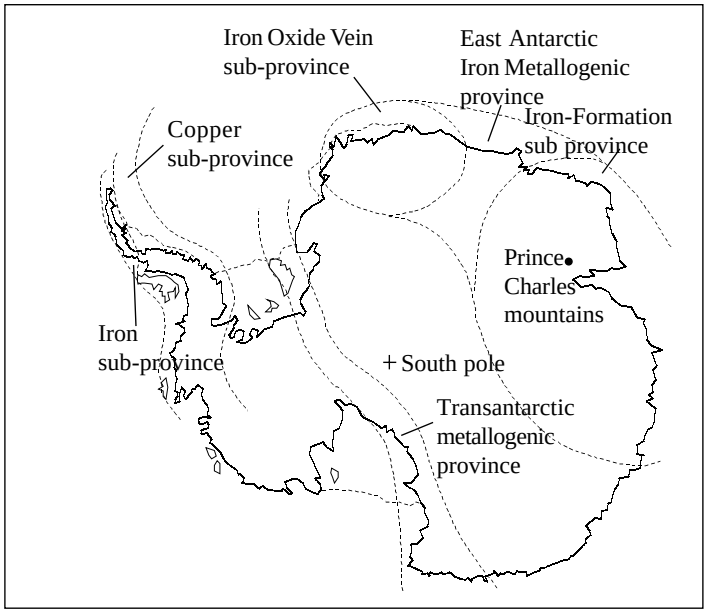
Options	Managing Antarctica	
	For	**Against**
Maintaining the treaty	The treaty has worked - there has been no attempt to exploit mineral resources and no military development has occurred. CCAMLR provides legal protection for marine life. CRAMRA will protect the Antarctic environment against damaging mineral exploration.	Very difficult to show that 'scientific research' is not exploration for minerals. Although parties are meant to share information, very little real information sharing may occur. Protection depends upon every party agreeing rather than a majority basis - CCAMLR has not prevented any exploration of seals, whales and finfish. Any form of mineral exploration will damage Antarctica - CRAMRA merely provides a framework to allow mining rather than prohibit it.
World Park	A WP Treaty would be based upon the **precautionary principle** whereby those wishing to conduct any activity would be required to prove that there would be no harmful environmental effects. Mining and exploration would be banned permanently. The overriding principles would be peace, co-operation and preservation of wilderness.	Would be very difficult to get agreement between present signatories. A complete ban leaves no room for discussion or compromise and would, therefore, be bound to fail. Without any possibility of future resource exploration, funding of scientific research would decline.

3. Minerals

Antarctica has huge potential or speculative resources.
Three main 'metallogenic' areas have been identified (Fig 6).

1. East Antarctica
2. Transarctic Mountains
3. Andean Province

Fig 6. Main metallogenic areas of Antarctica



Most interest has focused on the potential resources of **coal**, **hydrocarbons** and **manganese** nodules. **Coal** occurs in Permian and Triassic strata and the largest quantities occur in the Permian sandstones in the Transantarctic Mountains. However, at this time the problems of exploiting this resource seem to prevent economic development.

The most likely sites of **hydrocarbons** are along the coast of West Antarctica. The Ross Sea Basin includes three deep troughs filled with sediment and therefore, probably oil. A major problem in exploiting such resources will be their depth - the continental shelf has an average cross sectional depth of 500m whilst the average elsewhere in the world is 200m. In addition, extensive areas of the sea floor are prone to mass movement, gas release and volcanism - all serious potential hazards.

The 1988 Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) prohibits mineral exploration unless all the signatories agree that it could be carried out without environmental damage. CRAMRA was introduced before there was any clear evidence that the Antarctic contained valuable minerals. Its supporters say that such an approach was necessary given the huge potential damage of any exploration. Its opponents argue that the Convention merely raised awareness of the potential for exploitation and made it more difficult for Antarctica to be granted **World Park** status.

The Madrid Protocol adopted in 1991 prohibits mining but the prohibition can be lifted if all parties agree. The Protocol also designated Antarctica as a **natural reserve**, established environmental principles for the conduct of all activities and established the need for environmental impact assessment (EIA) for any actions.

The 1989 sinking of the Bahio Paraiso near Anvers Island and the Exxon Valdez oil spill in Alaska have increased public concern about possible harmful effects of minerals activity in Antarctica. However, the ultimate constraints on resource exploitation in Antarctica are likely to be political and economic rather than environmental.

Acknowledgements; *This Factsheet was researched and written by Kevin Byrne. Geopress Factsheets may be copied free of charge by teaching staff or students, provided that their school is a registered subscriber. No part of these Factsheets may be reproduced, stored in a retrieval system, or transmitted, in any other form or by any other means, without the prior permission of the publisher.* ***ISSN 1351-5136***