CHAPTER - 2

THE RESOURCES IN THE ANTARCTIC REGION

The importance of the Antarctic Region as a source of natural resources is attaining great importance. The prospects of resources have been a major cause of interest in this region, right from the beginning. The advancement in the exploration, increasing population and the growing perception that access to increasingly scarce products like hydrocarbons will be a significant determinant of power relations in the future has kept this interest alive.

The most interesting aspect of all these developments is that there have not yet been sufficient investigations to determine whether the region is in fact endowed with abundant and exploitable natural resources. This lack of information has been further compounded by other problems that are posed by climate, distance and inaccessibility due to floating ice, technological requirements and the need for environmental protection. Further, there are resources available elsewhere which can be exploited at lesser cost as compared to the Antarctic Region. Thus, the interest shown by the countries is based on speculation and perception of long term benefits.

Natural Resources of the Antarctic Region can be broadly divided into the living resources and the non-living mineral resources. Though the potential of mineral resources in the region has not yet been scientifically confirmed but the living resources of the region have been
well researched. In fact, some of these resources, like krill and fishes, are already being used by the mankind.

THE ANTARCTIC LIVING RESOURCES

"The Antarctic living resources, in its totality, is a paradox. While the icy continent, both qualitatively and quantitatively, presents the most impoverished manifestation of life, the encircling Southern Ocean, is probably the biologically most luxuriant province on the surface earth."1

The Antarctic Ocean, surrounding the Antarctic continent, has a strong developed system of currents and associated with it is the upwelling of nutrient-rich bottom waters. During the summer period, the abundant nutrient coupled with long period of sunlight, turns the icy cold ocean into a lush green pasture of phytoplankton. The rate and magnitude of phytoplankton production is as much as nine to ten times the average of the world oceans, during the corresponding time scale. This large crop of phytoplankton supports a large mass of zooplankton, about half of which is krill, the primary food of fishes, squids, penguins and other seabirds, seals and whales.

The major living resources in the region can be considered under the broad headings of krill, whales, seals, fishes, birds and squids. These resources play a vital role in the Antarctic ecosystem. So, their

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1 Arun Parulekar, "Living Resources of Antarctic-India's Contribution to Exploration and Future Plans For Exploitation", in S.N. Dwivedi et al., ed., Proceedings of the Workshops on Antarctic Studies (New Delhi; 1988), p. 159
Figure 8
Distribution and major harvest areas of Krill

exploitation has been marked by the environmental conservation protests against resultant threat to the fragile Antarctic ecosystem.

Therefore, it is important to understand that these marine organisms play a vital role not only as a resource potential but also as a component of the fragile ecosystem.

Krill

Krill is a tiny shrimp like crustacean found in abundance in the Antarctic Ocean. The Norwegian whalers gave the name ‘Krill’, which means "tiny fish". These are zooplanktons, which form the basic food for all higher forms of life in the Antarctic ecosystem. "The two important species of Krill in the Antarctic Ocean are Euphausia Superba and Euphausia Frigida".2

Krill tends to have a circumpolar distribution but there are areas of concentration, like around Weddell Sea and Ross Sea. Relatively Euphansia Superba has a wider distributional range, extending upto the Antarctic convergence. The other species are found closer to the Antarctic continent in dense pack (figure-8). "In theory, the occurrence of dense concentrations near the surface facilitates catching, especially as some super swarms have been estimated to comprise circa five to ten million tons of Krill, but in practice the variable distribution of Krill, in conjunction with a basic lack of information on many aspects, has

hampered both stock assessment and commercial exploitation.\(^3\) This is further complicated by the swarming behaviour of Krill.

The swarms of the Krill "vary in area, depth (from a few metres upto 600 metres plus), range, sex ratios and age classes. Sometimes, the swarms may be composed of individuals of the same age class. From the recent research it is clear that there are several types of swarms and the following contrasts have been noted:

(1) Swarms apparently associated with island or continental shelves such as those of the Scotia Arc versus those in the ocean over deep water such as in the Indian Ocean Sector;

(2) Swarms of sexually mature Krill (sometimes strongly biased towards one sex) versus swarms or aggregations of larval or juvenile individuals;

(3) Swarms concentrated at the surface, versus subsurface swarms; and

(4) Swarms that have lifetimes of many days versus ephemeral swarms.\(^4\)

Generally the densest concentration of the Krill is within the top 100 metres. The usual situation is a dispersed distribution over a wide area with local concentrations forming what are called patches (or shoals) with horizontal distribution of several kilometres.


Krills spawn once or twice in a year for up to two years. They lay between 2,000 and 3,000 eggs per spawning. The longevity of Krill is believed to be around four years. Kirlls mostly feed on phytoplankton. Researches have shown that Krill can feed on detritus, allowing them to feed throughout the year.

Several countries have been involved in catching Krill in this region. Erstwhile Soviet Union was the first country to send Krill fishing ship to Antarctica in 1964. Other countries including Bulgaria, Chile, Germany, Poland, Japan, China and South Korea joined subsequently. They were engaged in Krill fishing either experimentally or commercially. The interest shown by these countries are mainly because Krill is a rich source of protein. The total Krill catch is around a million-ton "which has been derived mainly from the Atlantic and Indian Ocean sectors of the Southern Ocean."\(^5\)

India is also examining the prospect of Krill fishing in the Antarctic Ocean. It has sent its research vessel and is developing a reprocessing technology to start commercial production.

A major issue of debate surrounding Krill fishing is the potential total Krill catch. "In absence of an acceptable method to calculate the total amount of Krill a wide range of sustainable catch figures have been suggested."\(^6\) Some of these estimates have been encouraged by the alleged surplus of Krill consequent upon the decline of the Whale

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\(^5\) Beck n. 3, p. 214

stock due to excessive whaling. It has been further compounded by the fact that Krill performs a crucial role in the Antarctic ecosystem and its diminution would exert serious effects upon all parts of the food chain.

Another aspect of Krill fishing is the constraints faced by it. These constraints include lack of market possibilities, as Krill is not commonly used for human and animal consumption. Further, constraints derive from the absence of proper processing technology, capital and fuel cost requirements and relatively short catching season of some three to seven months.

However, with the advancement of technological research the Krill fishing is excepted to experience a boost. But the political and economic interests of the countries and the environmental concerns in the regions may emerge as hindrance.

Fish

Commercial fishing in the Antarctic Region is relatively recent and experiments are still being conducted to get the detailed information about the fish stocks and their ecology. However, it is understood that unlike other oceans the Antarctic Ocean does not contain a dense stock of fish. Even the number of species found in this region is few. Out of the 20,000 species of modern fishes, only 120, representing 29 families are found here. Of them only three species are found in abundance:

i. The *Nototheniidae*, a cod like species
ii. The *chaenichthyidae*, a so called 'ice fish', and
iii. The *Myotopidae* or Lanterna fish.

The most dominant group among them is the 'Nototheniidae' also known as the Antarctic cod or toothfish, which constitutes three quarters of all coastal fish species. Their concentration is maximum in the water above the continental shelf of the Continent and the continental shelf areas surrounding Island groups.

"The great majority of the species of economic importance are demersal (bottom dwelling species)". But they are mostly indigenous to sub-Antarctic waters and they migrate to the Antarctic convergence to feed on zooplankton, principally krill. For example, southern blue whiting and Patagonean hake have frequently been located around the south Shetland and south Orkney Islands during the summer season. In addition to the above mentioned varieties, epipelagic schooling species such as pleurogramma are found in abundance in the pack-ice areas.

Main target species are the Patagonian toothfish and Antarctic toothfish, which are traded under the names Antarctic cod, Chilean sea bass and Mero. "The fishery is still in its exploratory stage and needs more research, but it is a potentially lucrative industry."

Antarctic fishes are mostly small in size and number. A majority of them are found swimming around the Island shelves. Though their

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7 Knox, n.4, p. 35
contribution to the overall dynamics of the Antarctic ecosystem is not fully understood, the role of fish in the food chain of Antarctic mammals has been conclusively demonstrated. In addition, their slow growth and longevity rates make Antarctic fish stock highly susceptible to over-exploitation.

Squids
Squids or Antarctic cephalopods are another conspicuous marine life in the Antarctic Region. They feed on Krill and are important ingredient in the diet of the sperm whales, seals, penguins and certain pelagic fishes. Thus, they are an important element in the Antarctic ecosystem. Seventy two species of squids are found in the Antarctic Ocean. Still, there is little information about their distribution, biomass and reproduction. Currently, there is no fishing of squids in the Antarctic Region. However, it has attracted the interest of countries like Spain and there is a high potential of squid fishing developing as an offshoot of Krill or fish oriented fishery.

Birds
Antarctic Birds are not a direct resource but their role in the Antarctic marine ecosystem cannot be overlooked. "Further bird’s guano specially of the penguins can be a rich source of protein"\textsuperscript{9}. Approximately fifty species of birds have been found in the Antarctic

Region. Of these "thirty eight species have breeding and/or feeding ranges extending south of the Antarctic convergence and many of these have a circumpolar zonal distribution pattern". The breeding sites for these birds are very limited, so large proportion of these birds are seen concentrated in small areas.

The groups of birds include seven species of Penguins - Emperor, King, Adelie, Gentoo, Chinstrap, Rockopper and Macaroni. "They comprise 31 percent of the stocks of birds (or 91 percent of the biomass) in the Southern ocean." The remaining 69 per cent of stocks include six species of Albatross, eighteen species of petrels, skuas, gulls, shags and terns.

"The primary significance of sea birds in the Southern Ocean's ecosystem lies in their role as predators. Antarctic seabirds may consume as much as 115 million metric tons of Krill annually - with some 85% of that attributed to Penguins - as well as substantial amounts of Squid and fish."  

Seals

Six species of seals are found in the Antarctica Region. Of these, only four are considered to be true Antarctic seal species. These seals have life-cycles associated with ice-zones. These are:-

i. The Crabeater seal (*Lobodon carcinophagus*),

ii. The Lepoard seal (*Hydrurga Leptomyx*),

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11 Knox, N.4, p. 37

12 Joyner, n.9, p. 27
Figure 9
Distribution of Seals

Source: Bonner (1982) p.22
iii. The Ross seal (*Ommatophoca rossii*), and
iv. The Weddell seal (*Leptonychotes Weddelli*)

The other two species are land breeders, and are rarely found in the areas of pack ice. They inhabit the pelagic region in the lower latitudes, they are: -

v. The Antarctic fur seal (*Arctocephalus gazella*), and
vi. The Southern elephant seal (*Mirounga Leonina*)

Of the six species, Crabeater seals are ecologically most significant due to their abundant population and pervasive role as predators of Krill (Figure-9). Sealing was an important Antarctic activity during eighteenth and nineteenth century for its fur and oil. Its dwindling population led to a halt on sealing in the early part of this century. The termination of commercial sealing in association with other factors like the Krill surplus has contributed to a remarkable increase in the seal population. Inspite of the recovery of the real stock, commercial sealing seems to be a remote possibility. It is "partly because of public opposition and partly because of lack of demand for sealing products".\(^\text{13}\) Further, exploitation of seals is now being monitored by the sealing convention.

**Whales**

Antarctic Ocean supports a more extensive stock of whales then any part of the world ocean. Most baleen or filter feeding whales migrate between tropical breeding ground and polar feeding regions as do adult sperm whales. They spend the summer in Antarctic Ocean

\(^{13}\) Beck, n.3, p. 217
feeding on the rich plankton in the circumpolar water. Among Planktons, Krill seems to be the main food. "About 80 per cent of the Blue, Fin and Humpback whale diet is krill."\(^{14}\) In winter they move north to warmer seas near the equator. Here they breed in tropical water until late spring when the migratory cycle begins.

There are six species of baleen whales, which are commonly found in the Antarctic Ocean. They are:

i) The Blue whale (*Balaenoptera Musculus*),

ii) The Fin whale (*Balaenoptera Physalus*),

iii) The Sei whale (*Balaenopetra borealis*),

iv) The Minke whale (*Balaenoptera acuterstrata*),

v) The Humpback whale (*Megaptra novaangeliae*), and

vi) Southern Right whale (Balaena glacialis)

In addition, one species of a large toothed whale, the Sperm whale (*phuseter catodom*) and eleven species of smaller Cetaceans including Beaked whale (*Mesoploodon*), the Pygmy Right whale (*capaere margineta*) and the Killer whale (*orcinus orea*) are also found.

Due to intensive whaling the abundant stocks of whales were decimated leaving several species in endangered condition. Earlier the larger species like Blue whales were targeted. When the catches of these species declined, "the industry turned in succession to the smaller species like Fin, Sei and Minke".\(^{15}\) It is understood that due to


\(^{15}\) Knox, n.4, p. 42
Figure 10
Major changes in the Antarctic Biomass connected with whaling

Source: Chittleborough (1984), p.116
intensive whaling, the structure of the Antarctic Ocean ecosystem was severely altered. Excessive whaling by Norway and Great Britain prior to World War II and by erstwhile Soviet Union and Japan since, led to progressive depletion of Blue, Fin and Sei whales in Antarctica (Figure-10). In reaction to this alarming situation the International Whaling Commission (IWC) was created in 1946 to protect endangered species and to set country-wise quota. However, throughout the 1950s, 1960s and 1970s, scientific uncertainty over the status of various whale population, aggravated by the inability to secure member states compliance with its decisions, severely impeded any resolute conservation action by IWC.

In 1975, a moratorium amendment was proposed by Australia to the IWC. A year later it entered into force, known as the 'New Management Procedure'. This action plan called for an indefinite ban on commercial hunting of those whale populations considered to be below the threshold level necessary for 'minimum sustainable yields'. It meant to maintain approximately 60% of their original number. Then at 1979 IWC meeting a 'factory ship moratorium' applicable to all whale species except the Minke whale was passed. In 1982, the IWC voted overwhelmingly to ban all commercial whaling after 1986, a moratorium that has since remained in force. The effects of the moratorium on the whale stocks are periodically reviewed and assessed ostensibly to determine if whale population have sufficiently revived to
permit hunting again. Significantly, Japan, Norway and erstwhile Soviet Union filed formal objection to the moratorium policy, which under the IWC's procedure exempt them from their obligation to be bound by the decision. The erstwhile Soviet Union and Norway subsequently stopped whaling.

However, a controversy has arisen in Antarctic whaling regarding what is popularly known as the 'Scientific whaling'. It has been proposed and practiced mainly by Japan. This obvious loopholes in the moratorium argues that the taking of whales for the scientific research purpose should be permitted. Although the practice has been widely criticized by the environmental groups and the scientific committee of the IWC because of the infallibility of research efforts undertaken, Japan persists in taking some 400 Minke whales each year under the guise of 'scientific research'. Norway also legally hunts whales as part of its scientific research.16

The impact of excessive whaling has been profound on the Antarctic ecosystem. Whales are great consumers of krill which account for about half of the herbivorous zooplankton, by weight, in Antarctic waters.17 The removal of the whales has led to an increase in other krill-eating species. One consequence of the reduction on whales may

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16 “Saving the Whales”, Antarctic; The journal of the New Zealand Antarctic Society, Vol.21, No.3&4 (2003), p.48
be that the Antarctic crabeater seal is now the world's most abundant seal; its total population of around 20 million accounts for some 75 per cent of the world's seal biomass.\(^{18}\) Certain penguins, notably the chinstrap, also have increased their abundance and range. It has also resulted in the increase of small Minke whale. "Indeed, the abundance of these and smaller species now may be hampering the recovery of the great whales, whose numbers were so gravely depleted. Moreover, human fishing for krill, which has been increasing slowly over the past 15 years, poses a further threat to the food supply and recovery of the great whales."\(^{19}\)

INTEREST IN ANTARCTICA'S LIVING RESOURCES: HISTORY AND EXPERIENCES

Antarctica attracted the world's attention mainly due to economic interests especially the potential of its living Resources. Historically, three waves of economic interest can be outlined in this region.\(^{20}\)

The first wave of economic interest was just after the discovery of the continent of the early nineteenth century. The region became the most important area of seal hunting. Fur seal, which was valued for its

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\(^{19}\) Martin W. Holdgate, "Antarctica: Ice Under Pressure" Environment Vol. 32, No. 8 (1990), p. 7

fur and the elephant seal, which was known for its oil were plundered in large scale around the seal colonies of South Georgia, the Malvinas (Falkland Island) and the South Shetland Islands.

In the second wave, which began in early 1900, whaling became the focus of intensive economic activity. Whales were numerous in number in this region and their size made them more profitable source of oil than the Elephant Seal. "With the invention of the harpoon gun in 1904, whaling was transformed from a craft into an industry. The development of factory ships made an equally significant expansion of the whaling industry possible during the period between the two world wars."

The third wave of economic interest in Antarctica's living resources started in the early 1970s. "The widespread adoption of economic and fishing zones by coastal states meant that some states with powerful high seas fleets were excluded from their traditional fishing grounds. The singular political and legal status of Antarctica (a freeze on claims to sovereignty or lack thereof) encouraged states to develop their fleets in these southernmost waters once more". However, the focus was primarily on krills as fish stocks had very low density. One of the major factor responsible for this wave was the technological advances. "The new system of ultra-low-temperature processing, which preserves this highly perishable product, led to the

21 Ibid. p. 139
22 Ibid, p. 140.
appearance of products for both human and animal consumption.\textsuperscript{23} However, intensive fishing in this region has adversely affected the Antarctic ecosystem. From the available data it is clear that there has already been a considerable reduction in the population specially around the islands, and that initial catches were very much in excess of the maximum sustainable yield.\textsuperscript{24} This underlined the urgent need for the conservation measures in the region which was fulfilled with the entry into force of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).

In this way, we find that the living resources in this seventh continent and its adjoining ocean has attracted the world attention. However, they are a 'biologist's paradox'. It is often claimed that the Antarctic Region has the largest single animal protein source on the earth. The variability in the magnitude of potential and sustainable marine living resources around this seventh continent in still not properly estimated and it has been a matter of lively debate amongst the Antarctica Researchers.

MINERAL RESOURCES OF ANTARCTIC REGION

Most of the mineral resources of the world are non-renewable. Their rampant use for human need has threatened depletion of some of

\textsuperscript{23} Ibid, p. 140.
\textsuperscript{24} Knox, n.4. p. 50
Figure 11

Mineral deposits in Antarctic Region

the important mineral resources. This threat has led to increased efforts by different nations of the world to look for new reserves. It is in this background that the Antarctic region is attaining great importance. The minerals found in the Antarctic region can be broadly divided into two categories- metallic mineral resources and the non-metallic mineral resources (Figure-11).

Metallic Mineral Resources

"The probability of the existence of the metallic mineral resources in Antarctica, at present, is exclusively in the speculative category and wavers between the theoretical conceptions on one side to the realistic geoscientific data base on the other".25 Some of the factors which point towards the existence of metallic mineral resources in the region are as follows:

1. "Landmass of Antarctica which covers an area of about $14 \times 10^6$ Km$^2$ has a creatonic nucleus of about 3.2 to 3.6 billion years old, covered by rocks of relatively younger age of sedimentary, plutonic and volcanic origin. We know today that the shield areas of the other continents of the world have likewise a nucleus of ancient rocks - mostly gneisses and granites with belts of greenstones, older meta-sedimentaries and meta-volcanic and these have revealed the presence of large and such deposits of Cu (Copper), Ni (Nickel) and smaller deposits of Li (lithium), Beryllium, columbium, tantallum, tin,

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tungsten, chromites, etc. Most of these deposits have been discovered within the pre-Cambrian (2000 million years and younger) of these continents."\(^{26}\)

ii) "The reconstruction of Gondwanaland made on the basis of the results of the marine geophysical surveys and of geological studies in Antarctica makes it most probable that some of the known ore belts of the other fragments of Gondwanaland continue into Antarctica".\(^{27}\)

Metallogenic Provinces of Antarctica

Geologically, Antarctica can be divided into three metallogenic provinces. They are:-

i) East Antarctica Iron Metallogenic Province
ii) Transantarctic Metallogenic Province
iii) Andean Metallogenic province

*The East Antarctica Iron Metallogenic Province*

This province is characterised by the outcrops of the compounds of iron minerals scattered over most exposed parts. "The province was formed during several metallogenic epoch in Archean, Proterozoic and perhaps Phanerozoic time. It seems to consist of two sub-provinces,

\(^{26}\) Ibid, p. 454
here termed as the 'iron-formation sub-province and the iron-oxide vein sub-province'.

"The iron-formation sub-province extends from western Wilkes Land to western Enderby Land and contains scattered exposures and glacial erratics and banded iron-formation (Jaspilite)." In this sub-province, the thickest exposed iron-deposits occur in the Prince Charles Mountains.

"The iron oxide vein sub-province occurs in western and central Queen Maud Land, where abundant iron and other metals have been reported." This sub-province, is of great interest to the Indian geologists, as it is in the vicinity of the Indian stations of Dakshin Gangotri and Maitri. However, there is lack of information regarding the presence of metals in the interior parts of both the sub-provinces because of the lack of bedrock exposure.

Traces of other minerals like copper, molybdenum, tin, manganese, titanium and uranium has also been found in this province.

Transantarctic Metallogenic Province

This province got its name form the Transantarctic

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29 Ibid.
30 Ibid. p. 416
mountains. This province can be divided into two overlapping sub-provinces, the Ross sub-province and the Ferrar sub-province. The deposits in the Ross sub-province "are comparable to those of the eastern (Adelaide) part of the Tasman fold belt. Minor Precambrian deposits containing molybdenite, pyrite, sphalerite, and arsenopyrite, and local traces of gold and silver has been noted".\(^{32}\)

The rock found in the Ferrar sub-province are similar to the middle Jurassic Karoo Dolerite of Southern Africa. It contains sparse non commercial Fe (Ferrous), Ni (Nickle) and Cu (Copper). Pensacola mountains in this sub-province is the largest and best known of the Ferrar bodies.

**Andean Metallogenic Province**

"The Andean Metallogenic province, of Mesozoic and Cenozoic age, primarily contains copper, but Fe (Ferrous) Mo (Molybdenum), Pb (lead), Zn (Zinc), Ag (Argon), and related metals also are present". It is the southward extension of the province of the same name in Western South America and partly corresponds in dimensions to the Andean magmatic and deformational belt."\(^{33}\) Traces of Gold and Silver have also been found in this province "Two sub-province; Copper sub-province, and Iron sub-province have been identified in this

\(^{32}\) Rowly, n.28, p. 417

\(^{33}\) Ibid, p. 417
province. Mineralisation here is related to calc-alkaline Plutonism and some of the best reported prophyrr copper deposits of Antarctica occur in a few islands of the Peninsula area within this province."

However, the information about the availability of individual metallic minerals is very limited. The available information can only be used to demarcate for future prospecting. "Exploration and investigation have so far been in preliminary reconnaissance stage and more detailed geological mapping, geophysical and geo-chemical survey and exploratory drilling will have to be undertaken before assessment of the resources potential can begin." Further, considering the fragile environment of the region, it should be planned with environmental concerns in mind.

Non-Metallic Deposits

Among the non-metallic deposits in the region, coal and oil are most important.

Coal

"Coal was one of the first minerals to be discovered in the region. It was burned as a fuel as early as 1907-09". It is believed that Antarctica has as high as 11% of the total world reserves. "Coal seams varying in thickness from 1.5 m to 2.5 m and in some section, upto

Raina, n.25, p. 456
eight in number, have been reported from the Trans-Antarctic ranges. United States Geological Survey (USGS) geologists postulate the existence of coal beds under most of the East Antarctica’s great central ice sheet.\textsuperscript{37}

However, "coal in Antarctica is not particularly significant as a resources because of the complicated logistics related to its exploitation, and also because coal reserves are relatively abundant in other parts of the world".\textsuperscript{38}

\textit{Oil and Natural Gas}

Oil is one of the important mineral which is attracting world attention in the Antarctica Region. There have been a series of geophysical and geological studies which have indicated towards the potential of mineral oil in the region. "United States Geological Survey (USGS) has estimated reserve of 45,000 million barrels of oil and 115 trillion cubic feet of gas may lie off the Antarctic coast."\textsuperscript{39}

However, most of these studies are speculative in nature "In case of figures (of the amount of oil present) published for Antarctica, they are based on a total abstraction without any information on source rocks and imperfect knowledge of the sedimentary succession. The only

\textsuperscript{35} Ibid, p. 457
\textsuperscript{36} Bergsager, n.31, p. 167
\textsuperscript{37} Raina, No. 25, p. 457
\textsuperscript{38} J.F. Spletsoesser, "Mineral Resources Potential in Antarctica-Review and Predictions", in Oliver, R. et. al ,ed., \textit{Antarctica Earth Science} (London, 1983) p. 413
\textsuperscript{39} Raina, n. 25, p. 457
direct evidence of hydrocarbons comprises puffs of gas from seabed coring during the 1974 Deep Sea Drilling Project".  

The studies have found basins in West Antarctica containing significant sedimentary thickness from the Cretaceous and Tertiary periods. "These basins are situated in the Weddell and Bellinghausen areas and in the Ross Sea where sedimentary deposits, which correlate with other areas such as south western Australia, western New Zealand and the southern tip of South America, are projected to be highly promising areas for oil exploration."  

No major oil or Natural Gas deposits have been found in the East Antarctica or its margin, "but taking into account the extent to which they have been explored, geologists have always believed it to be very likely that oil is present in these areas".  

The geological explorations that have been taking place are to locate sedimentary zones and those area in which any possibility of the presence of the oil has been speculated. However, these explorations may not lead to its exploitation, considering certain hurdles, at the given level of technological know-how.

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"The Antarctic glacial ice cap is from 2 to 4 kilometres thick and is in constant movement. Given these conditions, there is no technology yet available which would allow commercial exploration or exploitation of the rocks capped by this ice-sheet."\(^{43}\) Even the offshore drilling poses certain technological challenges. The Antarctic continental margin is deeper than that of the other continents. Further the installations will have to be protected from the icebergs.

It is therefore evident that in the Antarctic Region, we can only speak in terms of speculative mineral resource. Even if the deposits exists, there is no guarantee of exploitation. Apart from the technological limitations, economic factors like distance from market, lack of infrastructure, high energy, transport and personnel costs, and environmental factors like the freezing temperature and fragile ecosystem also pose challenge for mankind. In addition to it, the exploitation of mineral in the region may lead to political strain between the claimant and the non-claimant states. Similarly, it may also lead to differences between the consultative parties and non-consultative parties. Thus, threatening the Antarctic Treaty system, which has been a success. However, this problem has been deferred with the signing of the Madrid Protocol. The Protocol bans mineral exploitation in the Antarctic region for the next 50 years.

\(^{43}\) Ibid, p. 188.
ICE AS A RESOURCE

The icebergs in the Antarctic Region are a valuable renewable resources considering the fact that they actually exist there and are available in such large quantities as cannot be rivalled by any other part of the world.

Ice in the Antarctic Region can be a source of fresh water. "It has been stated that the vast amount of ice existing in the Antarctic constitutes a very large proportion of the world's reserves of fresh water, often established by scientific studies as 70% of the usable fresh water existing on earth." The icebergs can be towed to the areas of water shortage as in Middle East, Australia or South America.

"The possibility of transporting them (icebergs) to arid locations on both the southern and northern hemisphere has been considered and the technological, economic and environmental feasibility of their transportation has been illustrated in various scientific studies."45

The potential use of ice has also been raised at the Meetings of the Consultative Parties to the Antarctica Treaty. Despite the objections and immense difficulties of making practical use of ice, the Consultative Parties to the Antarctic Treaty have had this topic in their agenda since one of the early sessions of the Fourth Special

45 Ibid., p. 226
Consultative Meeting (1983). In this meeting it was decided that the Antarctic ice should not be treated as a 'mineral' for the purpose of the negotiation of an Antarctic Mineral regime which was taking place at that time. This was agreed mainly because it was felt that more technological and environmental feasibility studies were needed for iceberg exploitation.

"The Fifteenth Consultative Meeting, held in Paris in 1989, discussed the uses of Antarctica ice, taking into account past consideration of the issue, the possible impact of harvesting on the environment and the desirability that commercial exploitation of ice does not occur prior to examination of the issues involved." The meeting also considered that technological developments can make possible the utilisation of icebergs without adversely affecting the environment.

However, it is interesting to note that none of the treaties under the Antarctic Treaty System contain any reference to 'icebergs'. Even the Protocol on Environmental Protection to the Antarctic Treaty itself neither mentions icebergs nor states whether their potential harvesting may create harmful environmental effects in Antarctica.

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47 Trombetta – Panigadi, n.44, p. 229
ANTARCTIC REGION AND TOURISM

The vast mass of ice in the Antarctic Region holds immense tourist potential. The unique life forms and the eagerness to see the "Terra Incognita" has attracted the tourists. Further, the challenges of sailing to the southern most continent of the world has also attracted a large number of adventure loving tourists.

"Commercial travel to Antarctica was proposed as early as 1910 but was not to become a continuing feature of Antarctic affairs until and from 1956."48 "The first cruises to the Antarctic Peninsula took palce between 1959 and 1962."49 Since then the number of tourist cruises to the region has increased and there have been regular sight seeing flights over the land. From the last decade of the 20th Century, it has been found that the number of tourists far exceed the number of scientists working in the Antarctica.50 However, such figures may be misleading as tourists stay in the Antarctica for a couple of days or weeks, while the scientists are often there year round. Still tourism has become significant in the region considering the fact that, "in dollar terms the value of tourism industry makes it second only to fisheries as the most lucrative commercial use of Antarctica resources".51

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49 M.W. Holdgate, n.19, p.9
Uniqueness of the Antarctica Tourism

The tourism in Antarctica is unique in itself. There are several peculiarities of Antarctic tourism which make it different from tourism in other parts of the globe. Some of these peculiarities or special features are discussed below.\(^{52}\)

1. **Tourism without a clear recipient state.**

   Since the claims of sovereignty in the continent has been frozen under the Antarctic Treaty there is no receipt or host state. Further, a chunk of the continent is unclaimed. Only the notion of a recipient base could be applicable in Antarctica.

2. **Tourism restricted to certain short periods of the year.**

   Antarctic tourism peaks during the polar summer which is very brief as it consists of only two months January and February. However, there is the danger of disturbing the Antarctic wildlife whose breeding season is in the summer. According to the United Nations Environment Programme (UNEP) Report, at the Cape Royds Adelie Penguins rookery, a 50 per cent reduction in the birds breeding population over a six years period was attributable to stress from repeated visits by

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tourists. Further, the tourist visits tend to concentrate heavily in selective areas like the Antarctic Peninsula. These areas have started experiencing ecological strain.

3. Predominantly Seaborne Tourism

Antarctic tourism are either sea-borne or air-borne. However, most of the tourists visit Antarctica through commercial cruise lines. "One of the trickiest issue here is how to ensure that tour-company ships registered in countries not parties to the Antarctic Treaty meet safety and pollution standards. The so-called PAN-HO-LIB (Panama, Honduras, Liberia) registration is well known in Antarctic waters as well". Further there have been instance of non-ice-strengthened ships visiting Antarctic, which pose significant risk of accidents.

4. Tourism in Antarctica as an inherently hazardous activity

Due to the unpredictable and harsh environment accidents may easily happen in Antarctica. The vast area makes emergency preparedness a tough tasks in the region. It was well exposed when an Air New Zealand aircraft crashed on Mount Erebus in November 1979.

Thus, the increasing number of tourists draw attention to negative impacts on the region, despite the commercial allure. It has been alleged that increased tourist activity has disrupted the scientific

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54 Vidas, n. 52, p. 292
programmes. It has often disturbed local breeding sites and trampled on vegetation. It is also feared that increase in the number of tourists may cause irreparable damage to the fragile site of the region.