● ECONOMICS ○ HISTORY GEOGRAPHY ● LANGUAGES ● PHYSICS CHEMISTRY ● BIOLOGY LIFE&EARTH SCIENCES ○ TECHNOLOGY

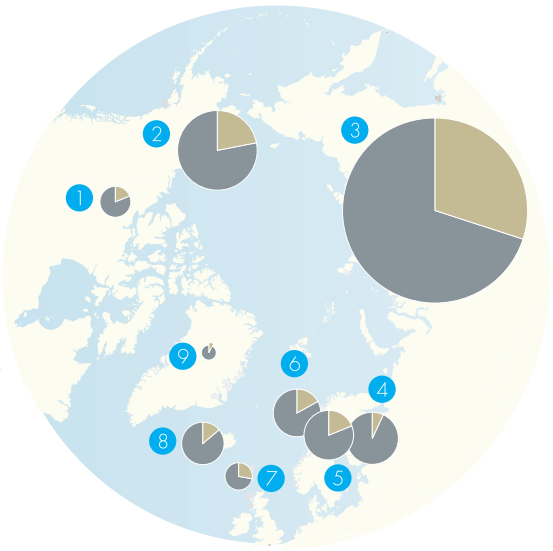
SHEET N°18

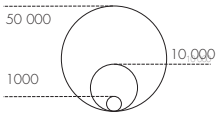
EXPLOITATION OF MINERAL RESOURCES IN THE POLAR REGIONS :

Current climate change and the melting ice in polar regions is opening up new opportunities to exploit mineral and oil resources, particularly in the Arctic. Increased interest and territorial claims are being lodged by States bordering on the Arctic as the prospect of extracting the many riches hidden beneath the ice becomes a reality. Every country wants its slice of the energy pie, especially as fossil fuel resources are limited and are seen as key to the future of our world economy. The extraction and exploitation of mineral resources in the polar regions could well become the major economic and political issue of future decades.

Figure 1

Share of the primary sector in the Arctic economy (shown in light brown). This sector represents the extraction industries (coal and mineral mines), exploration for oil and gas deposits, as well as timber, fishing and farming.
The size of the circles represents gross product in US dollars US, 2002





1
Northern Territories(Canada)

2
Alaska (USA)

3
Northern Territories of the Russian Federation

4
Northern Territories of Finland

5
Northern Territories of Sweden

6
Northern Territories of Norway

7
Faroe Islands (Denmark)

8
Iceland

9
Greenland (Denmark)

1) THE ARCTIC: TOWARDS INCREASING EXPLOITATION OF ITS OIL AND MINERAL RESOURCES

As soon as the question of oil "black gold" raises its head, passions become enflamed and financial fever takes over. Today's modern society has become highly dependent on this precious fossil resource because we obtain a large proportion of our energy by burning it.

With the worldwide consumption of fossil fuels constantly on the increase, we should reach peak production of crude oil - all quality categories combined - within the next few years. Gas will not be far behind. The regions around the Arctic basin are gradually becoming a focal point for countries bordering the area because of the huge potential oil and gas resources – as well as coal, minerals and diamonds. According to some estimates, the Arctic could contain about 13% of the world's undiscovered oil reserves and 30% of its natural gas reserves. These reserves correspond to approximately three years of the planet's current consumption of oil (around ten years for gas). These deposits, which have been preserved beneath the ice until now, are the object of much speculation among the neighbouring countries who are busy claiming their slice of the energy pie. Norway, Denmark (in Greenland), Russia and the United States (in Alaska) are already manoeuvring to exploit these precious energy reserves.

But what, in fact, is oil? Oil is part of a group of substances composed mainly of carbon and hydrogen. These hydrocarbons are formed from organic matter and take on different appearances and forms according to their density. This ranges from combustible natural gas, such as methane (marsh gas), to oil shale and oil of greater or lesser viscosity. Gas and oil have the same origins and are often found together in deposits made up of porous rock (see figure 2). Gas is usually at the top of a deposit because it is less dense than oil. Oil usually floats on a watery solution that is denser and possibly briny, at the base of the deposit.

How is oil formed? The process takes place over millions of years. Imagine a sedimentary basin by the coast, where plankton residue and mud with clay build up on the seabed. These layers of sediment gradually become anaerobic, i.e. deprived of oxygen, and bacteria slowly convert the organic substances trapped there. Initially, the micro-droplets of oil diffused in the clay on the seabed produce kerogen, which through a gradual sinking mechanism undergoes an increase in pressure and temperature. In general, the kerogen is converted into oil at a depth of between 2000 and 3000 metres at temperatures between 60 and 120 degrees Celsius. Natural gas is usually formed at even higher temperatures.

The oil is then able to leave the source rock where it was created and migrate upwards through the porous layers above it. For an oilfield to be able to form, the oil has to encounter an impermeable layer that prevents it from rising any further. Trapped in the honeycomb formation of the reservoir rock, it will arouse the interest of thousands of geologists and oil prospectors all over the world. However, it is very rare for oil and gas to be trapped underground. They will often rise to the surface and become commercially unusable.

Where are these hydrocarbons found in the Arctic? As is the case for many sedimentary rocks, these hydrocarbons are often located just offshore in the depths of the continental shelf, close to ancient sedimentary basins.

Are there any other reserves? Hydrocarbons are not the only resources hidden beneath the Arctic. The region also appears to harbour abundant deposits of diamond, gold, silver, copper, lead and zinc.

Until now, the waters of the Arctic have not been navigable to merchant ships due to the presence of ice for much of the year. Only powerful icebreakers are able to cut a path through the sea ice, consuming huge amounts of energy as they go. However, with the accelerated speed at which the ice has melted in the Arctic in recent years, two new maritime routes should soon be open during the summer months: the Northwest Passage through the immense archipelago of northern Canada, and the Northeast Passage along the Siberian coast. Naturally, any plans to open up these winding new maritime routes, dotted as they are with icebergs and drifting ice floes, is a job for the majors (the big multinational oil companies) and large shipping companies.However, to open up these routes presents a significant danger for the

Figure 2

Cross-section of a deeply buried oil deposit

1

Impermeable rock (blocking the oil in its natural migration to the surface).

By ascending order of density in the deposit, from top to bottom:

2a

Pocket of natural gas.

2b

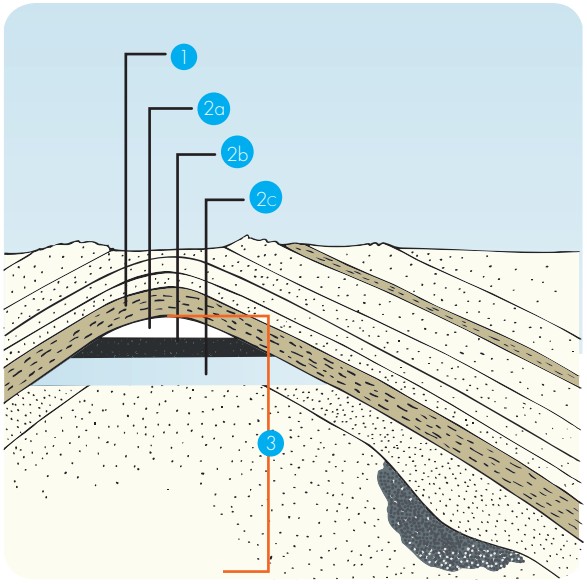
Layer of oil

2c

Layer of watery solution, partially enriched with hydrocarbons.

3

Reservoir rock containing oil deposits.



fragile environment in these high latitudes.

The potential opening of these sea routes recalls the sad story of the massive oil spill and slick left by the Exxon Valdez, an oil tanker that ran aground and released 42 million litres of oil to wash up on the Alaskan coastline in March 1989. Up until that time, this region of the world had remained pristine and totally unspoilt. This unprecedented environmental disaster will remain in people's minds forever and has made the international community acutely aware of environmental issues.

2) A PRINCIPLE OF PRECAUTION APPLIED IN ANTARCTICA

The question of exploiting Antarctica's mineral resources goes back to the 1980s, when it was clearly asked for the first time. This came about as the result of improved modelling of continental drift, linked to various prospecting operations dotted about the vast white continent, and scientists came to the conclusion that there were significant mineral reserves in Antarctica. Given the tight links that existed between the continental blocs of South America, Africa, Australia and the Antarctic when they still formed a single super-continent, Gondwanaland, it was a good bet that the frozen continent would be hiding huge riches below the surface.

To accommodate the idea of controlled prospecting and exploitation of Antarctica's mineral resources, the Wellington Convention was signed in June 1988. The aim of the agreement was to create a strict framework regulating mineral resource activities. However, Captain Jacques-Yves Cousteau firmly opposed the convention and conducted an awareness campaign in conjunction with the Antarctic and Southern Ocean Coalition (ASOC). The environmental risks involved were far too real, he said, and the French President at the time, François Mitterrand, boycotted the signing of the Wellington Convention, stating that he was in favour of an Antarctica having the status of a nature reserve, free of any mining activity.

Other countries jumped on the bandwagon, including Australia, Belgium and Italy. In 1991, the Madrid Protocol was signed, effectively freezing the prospect of any exploitation in Antarctica for fifty years. This ban may only be lifted if all of the parties involved agree unanimously.

A frequently quoted example of an international dispute over Antarctica relates to the continent's sub-glacial Lake Vostok, where Russia drilled into the ice down to a depth over 3200 metres in 1998. There are only a few tens of metres separating the base of the drilling from the sub-glacial lake under the ice sheet. The Russians have argued in favour of drilling through this final layer of ice to access the lake and take various samples from it, but this has irritated the remainder of the international community, which believes there is a risk of contamination. Lake Vostok is about the same size of Corsica and is the largest sub-glacial lake discovered so far in the Antarctic. It has remained totally isolated for tens of thousands of years and many researchers believe that it should be totally preserved by maintaining its natural isolation. According to many scientists, "taking these samples of frozen water would no doubt contribute little in the way of significant scientific elements, given the risk of contamination". Any such contamination would be even more serious because it is thought that several sub-glacial lakes may be linked by a network of various channels.

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GLOSSARY:

Continental shelf: n. Tectonics. – Part of a continent that extends in a gentle slope under an ocean or sea (syn. continental platform).

Hydrocarbons: n. Petrology. – Long chains of carbon and hydrogen atoms whose generation requires a slow accumulation of organic, mainly planktonic matter under reducing conditions (no oxygen). This sediment must then be raised to the appropriate temperature and pressure for hydrocarbons to form.

Oil shale: n. Petrology. – General term designating clay-like limestone rock rich in kerabitumen (a thick mixture of hydrocarbons and organic mud). Treated at high temperatures (+500°C), they are a potential source of combustible oil.

Oil spill/slick: n. Ecology. – Deposits of crude oil that have escaped from the hold of an oil tanker or other large marine carrier and are carried to land on the tide. The terms also relates to the pollution caused on shorelines as a result of hydrocarbons being spilled.

Deposits: n. Geology. – Location where large concentrations of a particular material (minerals, metals, oil, gas, etc.) are found.

Natural gas: n. Petrology. – Hydrocarbon with the chemical formula C_nH_{2n+2}. When n varies from 1 to 4, the gas is methane, ethane, propane and butane respectively. Natural gas is usually composed mainly of methane.

Peak production of crude oil (on a worldwide level): Geopolitics. – Maximum global production of oil. This critical point is due to be reached soon and will result in rocketing oil prices as reserves gradually run out.

Reservoir rock: n. Petrology. – Porous and permeable rock containing fluids (water, oil, gas, etc.). Of obvious economic interest if it is sufficiently large and is covered by an impermeable layer that prevents the fluids from migrating and escaping. Usually consists of limestone, dolomite or sandstone.

Sedimentary basin: n. Geology. – Huge geographic depression, usually with a flat base, bordering a continent.

Wellington Convention: Signed on 2nd June 1988, this convention was designed to regulate the exploitation of mineral resources in Antarctica by instituting a system of freedom to prospect. However, the convention never came into effect on account of the total ban on exploiting the mineral resources of the Antarctic.

WEB:

See the teaching dossier on "**Fossil and renewable energy**", as well as the animations on "**Where does energy come from?**", "**Resources and reserves: how much energy is left underground?**", "**Current and future energy sources**" and "**Oil: looking for black gold**"at **EDUCAPOLES**, the educational website of the International Polar Foundation (IPF).

http://www.educapoles.org

Pour en savoir davantage sur les ressources fossiles des régions polaires :

http://energy.usgs.gov/arctic/

http://maps.grida.no/index.cfm?event=searchFree&q=arctic+resources

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