

GREENLAND

By The Bureau of Minerals and Petroleum (BMP)

It is interesting to note that the amount of money put into exploration has not, despite financial stagnation, been halved in Greenland as it has in the rest of the world. Still, a number of companies have had to relinquish their licences, and in 2001 the number of exploration licences was at its lowest since 1992. At the end of 2001, 17 licences were in force covering a total area of 8,049 km². In 1997 (see Table 1), investments amounted to DK104.7 million whereas by comparison DK97.2 million were invested in 2000. In 2001, six new licences were granted, involving 5,215 km² and there were two applications for extension. It can, therefore, be hoped that, in spite of financial stagnation, Greenland is considered to be an attractive country in which to invest.

Greenland is experiencing renewed interest as a target for diamond exploration. After a few years of modest activity, diamond exploration was resumed in 2001 and several areas in west Greenland with known kimberlite occurrences were reinvestigated.

In September 2001, Citation Resources Inc., operating on behalf on its joint-venture with DiaMet Minerals Ltd and Cantex Mine Development Corp., completed a seven-hole diamond drilling programme totalling approximately 1,000 m of drill core. Two drill-holes situated 2,651 m apart intersected a large north-trending kimberlitic dyke, with a true width of approximately 20 m at both intersections. Magnetic airborne geophysics suggests that the near-vertical dyke is open to the south by approximately 500 m and to the north by more than 1,850 m, resulting in a total length of at least 5,000 m. A 175 kg drill-core sample from the dyke has been tested for microdiamonds in order to assess the economic potential of the discovery. The results proved to be negative, but the fact remains that indicator minerals of outstanding

composition have been retrieved from several till samples from the same area.

At Kirkespirdalen in south Greenland it seems that Greenland's first gold mine is closer than ever to becoming a reality. The gold project Nalunaq A/S is a joint venture between the Greenlandic company, NunaMinerals A/S (18%) and the Canadian company, Crew Development Corp. (82%). This year the project has seen extensive exploration and the results seem promising. In Kirkespirdalen, in the year 2001 alone, there has been 3,100 m of diamond drilling and 1,900 m of adit and raise work. Since 1998 there have been 15,000 m diamond drilling and 3,750 m of underground investigations, of which 2,750 m are in the mineralised structure. There are four adits to date. They are at levels 300, 350, 400 and 450 m above sea level. The adit at 350 m above sea level is the longest, with a length of 600 m.

The gold is in a 2 m - thick quartz vein, which can be followed over a distance of 1,700 m along the mountainside. Based on this year's extensive collecting of samples, the average gold content in the ore has been calculated to be 25 g/t. This estimate is based on a mining width of 1.2 m. There have, however, been high-grade samples of up to 5,000 g/t. The measured and indicated gold resource is 483,900 oz with an inferred gold resource of 281,300 oz.

The environmental consequences of the gold mine have also been examined. For several years the natural content of metals in the streams flowing through Kirkespirdalen has been monitored to give a measurement of the background level of heavy metal in the area. Based on these measurements it is possible to judge how a future gold mine will affect the environment of the region. In Saqqa fjord, which lies off Kirkespirdalen, there have been

continuous investigations of the marine, animal and plant-life as well as fjord bed and current conditions. This information will, along with other environmental and technical investigations, form the basis for deciding how tailings from the gold extraction process can be deposited.

In mid-2002, Nalunaq A/S plans to carry out a programme with the intention of expanding the resource base in preparation for production. The bankable feasibility study is expected to be completed in the near future, with the Environmental Impact Assessment to be finalised shortly thereafter.

The ongoing demand for niobium and tantalum on the world market is reflected in the exploration activity in Greenland. The Australian company, New Millennium Resources, has, since 2000, had an exploration licence at the Sarfartoq carbonatite complex, 65 km south of Kangerlussuaq.

The results of the analyses from a diamond drilling programme on the deposit in 1998 show an estimated resource of 35,000 t with 11.3% niobium pentoxide (Nb₂O₅). Moreover, the mineralisation has been estimated to comprise an indicated resource of 100,000 t with a grade of 4.6% Nb₂O₅. The estimated resource of 35,000 t has a conservative in situ value of approximately £39 million (~DK470 million). These results open up the possibility that by drilling deeper the estimated resource will be increased to 300,000 t.

New Millennium Resources has developed a new method of extracting niobium from the pyrochlore ore. The method aims to produce a cost-effective, very pure niobium oxide product by using a special catalyst and inexpensive chemicals. By using this new method it is possible to extract more than 90% of the niobium content of the pyrochlore ore. The company plans to mine, crush and grind the ore at the site, then to transport it via pipeline to the fjord. From there it will be shipped out to the old cryolite mine at Ivittuut in southwest Greenland.

Since the beginning of 2001, New Millennium Resources has had an exploration licence, which included the old mining area at Ivittuut. The old infrastructure of the mine can be successfully used in the final processing phase, when the niobium is extracted from the pyrochlore. New Millennium aims at drawing up a feasibility study before the end of 2002, and at starting a production in the latter half of 2003.

The UK company Angus & Ross plc which, since 2000, has had an exploration licence covering the alkaline Motzfeldt complex in south Greenland, has this year conducted an extensive diamond drilling programme in order to map the extent of the tantalum occurrences in the complex.

Mineral exploration in Greenland (at year-end)

	1997	1998	1999	2000	2001
No. of prospecting licences	24	13	14	15	6
No. of exploration licences	57	41	23	24	17
No. '000 km ² under exploration licences	53.6	23.8	11.4	11.3	8.0
Exploration commitments (DK million)	105.6	75.1	30.7	27.6	40.5
Exploration expenses (DK million)	104.7	109.0	46.8	97.2	0

The positioning of the drill-holes was based on the geophysical survey and the discovery of boulders with high-grade values of tantalum pentoxide (Ta₂O₅) of between 0.10-0.73%. The geophysical surveys showed a number of north-south trending anomalies that could be seen at the top of the complex and along a steep cliff side. Nine holes were drilled with a total length of 1,622 m. The analyses of the first drilling programme have so far shown very promising results. The best result was obtained from an 18 m - wide zone with

grades of 0.063% Ta₂O₅. Previous surveys undertaken by the Geological Survey of Denmark and Greenland (GEUS) have estimated that in the Motzfeldt complex there is a resource of 50 Mt of ore with a grade of 0.03-0.1% Ta₂O₅.

Oil and Gas

Since the establishment of a new strategy for future hydrocarbon investigations was made in 1999, it has been the intention to work towards a licence round for west Greenland, where oil companies will be able, in competition with each other, to apply for licences within a licence area. The licence round opened on April 11, 2002 and is completed on July 16, 2002 and it will cover the offshore region of west Greenland between 63°N and 68°N.

One of the aims in this strategy was to create more attractive conditions for exploration in order to increase the interest and desire to invest. This would intensify exploration and, by means of new investigations, increase the possibility of making commercial hydrocarbon discoveries after the licensing round. Already extensive seismic data has been collected (see Table 2), especially in the coming licence round area. The relinquishment of the Sisimiut-West- and Fylla licences on December 31, 2001 released a lot of new data in the area and furthermore, a lot of information is available for the oil companies to evaluate from the six exploration wells, previously drilled offshore west Greenland.

According to the Act on Mineral Resources in Greenland, the Joint Committee makes recommendations regarding among other issues the terms of the licence round to the Greenland Government and the Danish Minister for Economic and Business affairs, which in turn make the final decision on the terms. Thus a considerable amount of work by the Bureau of minerals and Petroleum (BMP) in the area of hydrocarbons in 2001 has been focused on preparation of model licences and economic conditions for the licence round. The licence terms ensures that the interests of

society with regard to income and environmental issues are secured. Also international promotion towards oil companies has been undertaken in close co-operation with especially GEUS and Nunaoil.

In areas covered by the so-called open-door procedure, companies can at any time apply for exploration licences, unlike the procedure in the licence round. The only time when applications are not dealt with is in the summer months. In west Greenland the areas included in the open-door procedure are: the seas between 60°N to 63°N and 68°N to 71°N (apart from the areas covered by the Kanumas licence), and the Disko and Nuussuaq regions. In east Greenland, Jameson Land is also included in the open-door procedure. In these areas knowledge of the petroleum potential is fairly limited and there is usually poor seismic coverage. In order to increase interest in exploration in these areas, especially favourable conditions have been introduced. In 2001, TGS-NOPEC has conducted a seismic programme in the coming licence round and partially in the open-door area offshore west Greenland.

In the waters off west Greenland, more than 4,500 km of seismic data were acquired in mid-2001, carried out by the seismic survey vessels, Zephyr-1. The region covered was primarily the western and northern part of the coming licence round area. The seismic data (so-called speculative seismic data) are collected with a view to future sale, mainly to the oil companies that are considering exploration, and the marketing of data and the region's hydrocarbon potential have been extensive. Until now the area has been sparsely covered but the new seismic data have given important new knowledge.

In the area near the Greenlandic-Canadian border, 2,828 km of seismic data (GreenCan2001 project) have been acquired in a partnership between the BMP and TGS-NOPEC. Of this total, 1,267 km were acquired in Greenland waters and 1,561 km in Canadian waters. These new data will be the

basis for closer investigation of the previously unknown, deep sedimentary basins, which became known in connection with last year's seismic investigations. This type of basin gives the opportunity for new exploration targets, different from those otherwise known in west Greenland. The data have, therefore, been the source of great interest within the industry.

Other information in the region such as the latest offshore exploration well Qulleq-1, drilled in 2000 in the Fylla licence, has also added to a greater understanding of the petroleum-geology of the region, and also facilitated the pinpointing of previously unknown exploration targets, although it did not show hydrocarbons. The Statoil group acquired some 948 km of seismic data (FyllaW2001 project) as a part of its remaining exploration commitments in the Fylla licence. Further north, TGS-NOPEC acquired 900 km of seismic data (Green2001), mainly on the boundary to the northern open-door area. TGS-NOPEC owns, after last year's surveys, more than 10,000 km of high quality seismic data from offshore west Greenland and the company plans on continuing to acquire data in the year 2002. Otherwise it is primarily GEUS, Nunaoil and Fugro-Geoteam which own the data from the pending licence round area.

During 2001, BMP also supported a number of petroleum-related research activities. This includes studies of hydrocarbon-forming rocks

and correlation of rocks and microfossil in the region between Greenland and Canada, performed by GEUS. Also, a study of ice occurrences, performed by ASIAQ and the Danish Meteorological Institute has been supported by BMP to clarify the operational conditions in the licence round area.

Ice and Water

In July 2001, the Act on the exploitation of ice and water for exportation (the Ice and Water Exportation Act) came into force. Just like the Act on Mineral Resources in Greenland, the law is a framework law.

Substantial developments within the field of ice and water are expected in the next few years, both technically and commercially. Also substantial social and economic development is expected. Within a framework law it is possible to make the necessary adjustments for the interaction between activities in the field of ice and water and the Greenlandic society.

The Act is seen from a political and organisational aspect, different from the Act on Mineral Resources in Greenland. The political responsibility for mineral resources and petroleum is shared between Denmark and Greenland, whereas the export of ice and water is a completely Greenlandic affair. It is, therefore, not a matter that is included in the Greenlandic/Danish joint decision making.

Acquired seismic data offshore (Line km) West Greenland since 1990

	1990-92	1993-95	1996-98	1999-2001
GEUS	6,633	3,770	-	2,743
Western Geophysical	1,915	-	-	-
Nunaoil	-	1,706	3,919	-
Fugro-Goeteam	-	-	3,126	-
Phillips				2,716
Statoil				334
TGS-NOPEC				10,855*
The Bureau of Minerals and Petroleum	-	-	-	2,648

*Includes 1,267 km of the BMP figure listed below (GreenCan2001, Joint Venture Survey).

The BMP is the co-ordinating authority within the Government of Greenland. The law is administered according to a 'one-door principle'. This implies that the applicants can direct applications to one authority; the BMP obtains the necessary licences from other authorities. These authorities include: the Ministry of Environment and Nature, the Ministry of Housing and Infrastructure, the Municipal Departments and Citizens Councils.

The Government of Greenland then grants the exploitation licences.

In connection with the new law, interest in this area has arisen from Greenland, Canada and Denmark. At this moment, the Government of Greenland has granted one exploitation licence to a Greenlandic company. This company has previously exported ice from Greenland.