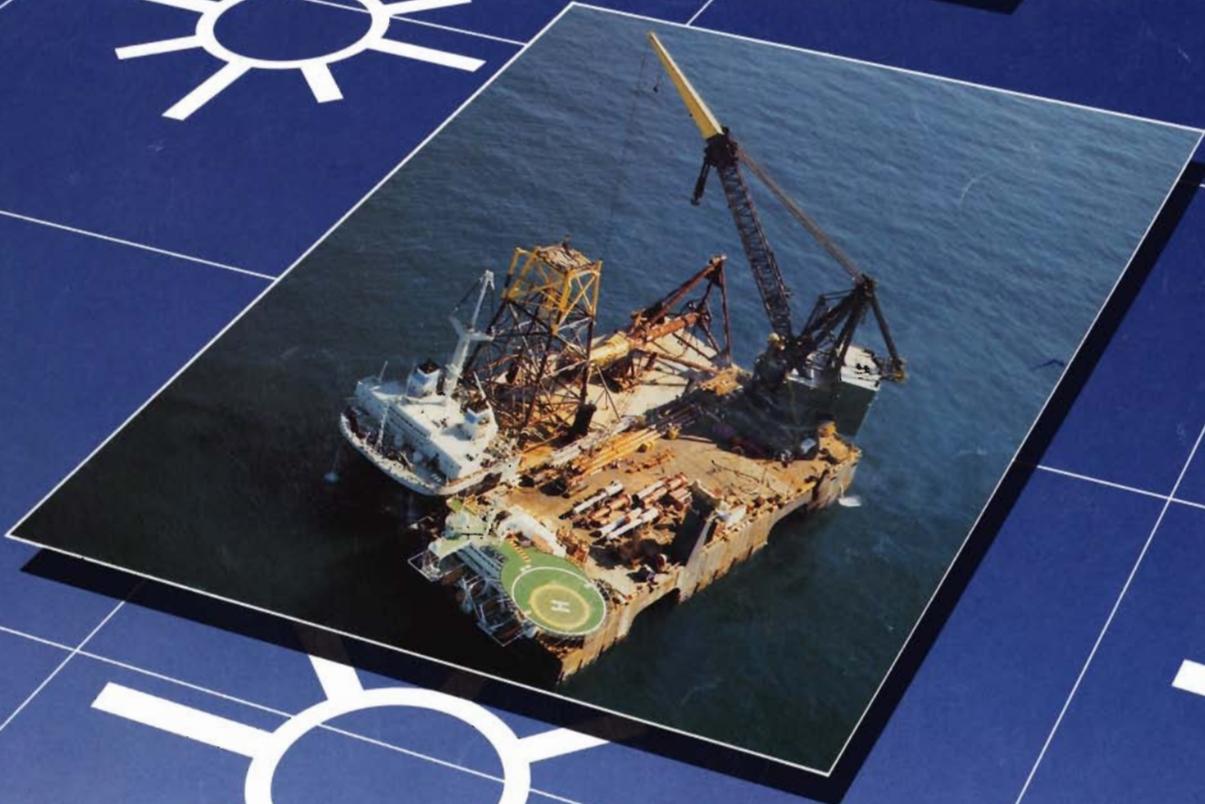
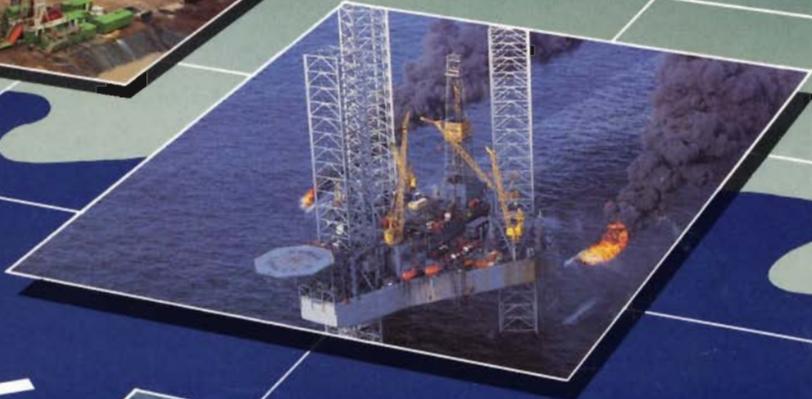


Petroleum  
Resources  
**Offshore**  
**and**  
**Onshore**  
Nova Scotia  
Canada

IC 23

OUT OF PRINT



This is an exciting time for Nova Scotia's oil and gas industry. Nova Scotia is about to become Canada's newest oil-producing province (Figure 1). Development activities are well under way to produce light, sweet oil from the Cohasset and Panuke fields in Canada's first offshore project. In addition, a new cycle of exploration has begun offshore with another oil discovery. Onshore, new explorers are planning exploration programs for areas near a previous gas show.

Nova Scotia is located on Canada's east coast, close to the major energy markets of the northeastern United States. For regulatory purposes, oil and gas activity in Nova Scotia is divided into offshore and onshore jurisdictions (Figure 2). The offshore region is administered jointly by the governments of Nova Scotia and Canada under the provisions of the

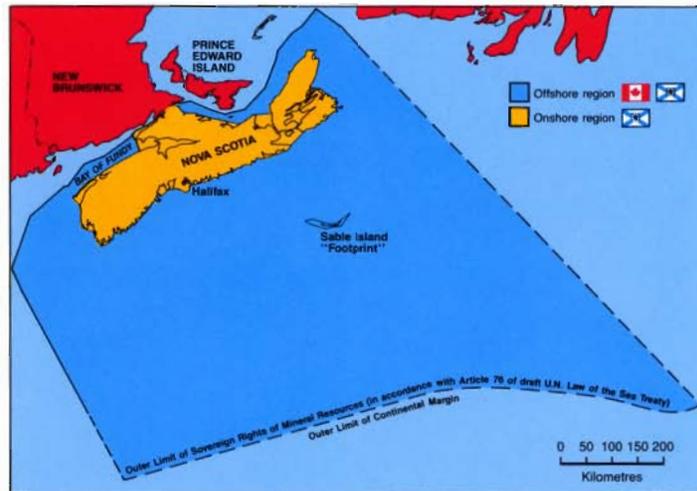


Figure 2: Nova Scotia Offshore and Onshore Regions.

Canada–Nova Scotia Offshore Petroleum Resources Accord. The onshore region is administered solely by the provincial government.

The offshore region covers approximately 400 000 km<sup>2</sup>. The operational environment is favourable, being ice-free and similar to that of the North Sea. More than 127 wells have been

drilled offshore and over 300 000 km of seismic data have been acquired. To date approximately 165 billion (10<sup>9</sup>) m<sup>3</sup> (5.8 trillion cubic feet) of gas and 23.7 million m<sup>3</sup> (149 million barrels) of oil and condensate have been discovered. It has been estimated that this amounts to only 32 per cent of the total gas and 13 per cent of the total oil and condensate predicted to exist offshore Nova Scotia. Therefore, the Scotian Shelf Basin is still relatively unexplored and many other undrilled prospects exist.

The onshore region comprises the land mass of the province together with certain submarine areas not subject to the Canada–Nova Scotia Offshore Petroleum Resources Accord (see Figure 2). This amounts to approximately 5.9 million hectares; one third of this area has the geological potential to contain hydrocarbons. Most

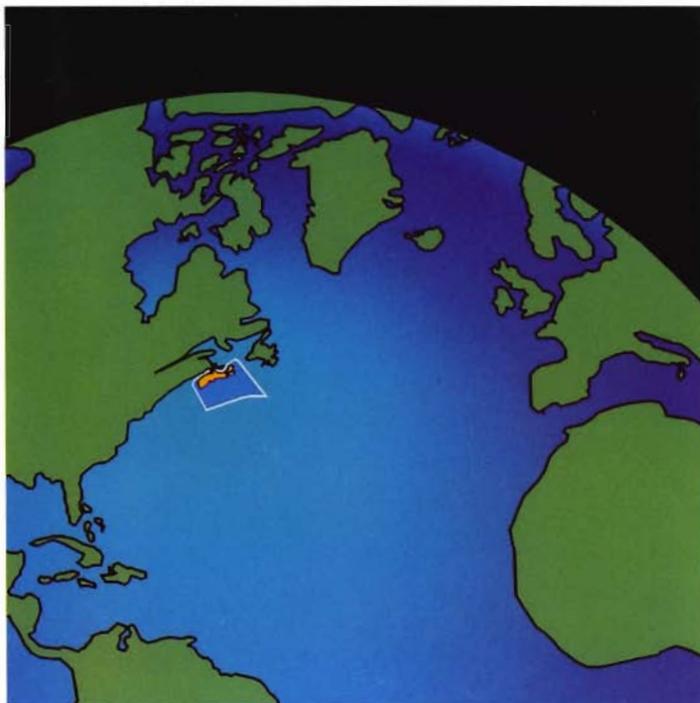


Figure 1: Nova Scotia in relation to North America, Great Britain and Europe.

Cover Photographs.

1. McDermott Derrick Barge DB-101 and the Mighty Servant I with the Panuke and Cohasset jackets onboard at the Panuke site. Photo by Reg Morrison.
2. Rowan Gorilla I testing the Cohasset A-52 well, March 1986. Photo courtesy of Petro Canada.
3. Simmons Rig #6 on location, drilling Irving Chevron Mull River #1, in the rolling hills of Western Cape Breton. Photo by Reg Morrison.

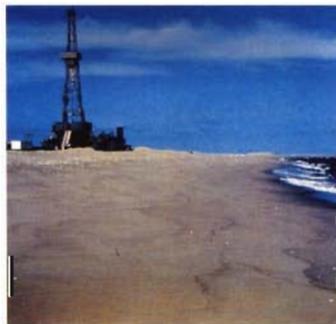
onshore exploration has concentrated on rocks of Carboniferous age which extend throughout much of the province and into New Brunswick's Stoney Creek field, an oil and gas producer since 1912.

The following is a basic overview of the oil and gas exploration and development opportunities for the offshore and onshore areas of the Province of Nova Scotia. Additional information may be obtained by contacting the Petroleum Resources Section of the Nova Scotia Department of Natural Resources. ◊

# OFFSHORE

**P**etroleum exploration offshore Nova Scotia began in 1959 when Mobil Oil Canada Ltd was issued the first provincial exploration licences covering Sable Island (see Figure 2) and the surrounding offshore area. Mobil undertook an aeromagnetic survey over lands around Sable Island that confirmed the presence of thick sediments. The potential was confirmed in 1967 when Mobil and its partners drilled the first offshore well which encountered a thick sedimentary section, 11 gas shows, and evidence of light oil in the area. This initiated the first exploration cycle, which lasted the remainder of the 1960s and 1970s, declining at the end of 1978. Unfortunately, the goal of discovering commercial quantities of oil and gas during this cycle was not achieved.

It was not until 1979 that significant quantities of gas and condensate were encountered at a discovery well drilled on the Venture structure (Fig. 4). This fuelled a second exploration cycle which peaked during the mid 1980s and ended in 1989. In early 1990, a renewal of activity offshore Nova Scotia occurred due to the efforts of



A Bawden land rig drilling for Mobil and partners on Sable Island in the late 1960's. Photo courtesy of Mobil

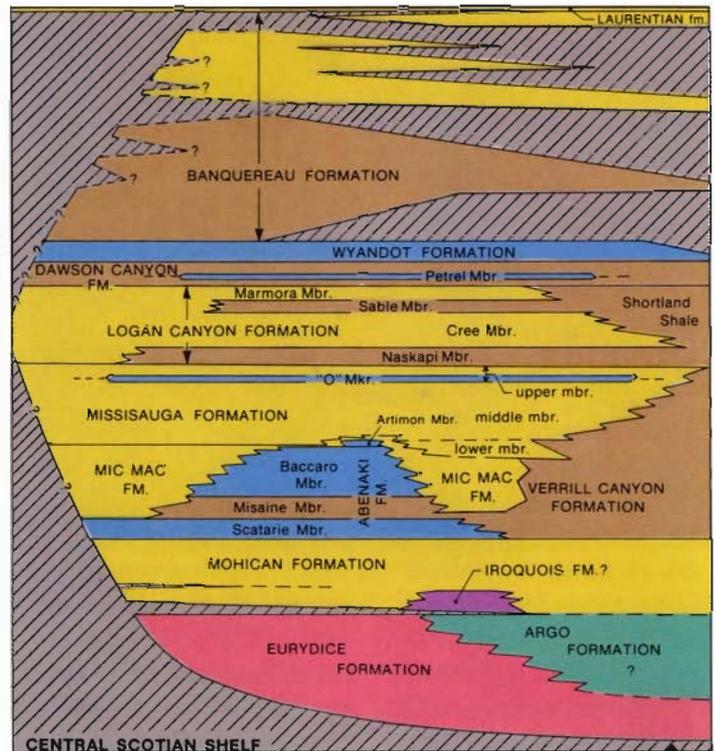


Figure 3. Table of formations.

a new operator, LASMO Nova Scotia Limited and its partner, Nova Scotia Resources (Ventures) Limited, who began actively developing the Cohasset and Panuke oil fields. They are also exploring for other look-alike oil fields on trend with Cohasset and Panuke, and recently announced that they had tested oil at the nearby Balmoral structure.

## Geology

The Scotian Shelf is one of Canada's largest sedimentary basins. The thickest accumulation of sedimentary rock capable of producing hydrocarbons is found in the Sable Sub-basin and most oil and gas discoveries have been made there.

Formations deposited from the Early Jurassic to Late Cretaceous periods (Figure 3) are critical to the

hydrocarbon potential of the Scotian Shelf and the Sable Island area in particular. The Baccaro bank, a thick, regionally extensive carbonate unit, is largely unexplored and contains a number of potential plays. While no discoveries have been made within this carbonate unit, sands that occur at shallow depths (2150–2400 m) and drape over the bank contain oil accumulations discovered at such fields as Cohasset, Panuke and Balmoral.

Extending through the Sable Sub-basin are coarse clastic units, known as the Missisauga and Mic Mac formations which are interbedded with shale. They have been encountered in structures that are

related to down-to-basin structural faults. Exploration of the Missisauga and Mic Mac formations has yielded several gas discoveries. The reservoirs are often overpressured and typically have high flow rates. However, drilling has also indicated reservoirs of normal pressure, which are shallower and less costly to drill.

Other plays related to shallow and intermediate salt piercement structures, stratigraphic traps such as turbidite fans, deep-seated structures and basement-related structures occur offshore Nova Scotia and several have produced oil and gas shows. High quality reflection seismic data are available over the continental shelf and slope. Most of these data coincide with the areas of oil and gas discoveries in the Sable Sub-basin. Numerous geophysical, geological and well history reports are also available to industry through the Petroleum Resources Section of the Department of Natural Resources.

## Discovered Resources and Hydrocarbon Potential

To date, 22 significant discoveries have been made in the Nova Scotia offshore area, in the Sable Sub-basin (Figure 4). Most of these discoveries are gas and condensate. However, several have produced oil.

It is estimated that 512 billion m<sup>3</sup> (18.1 trillion cubic feet) of gas may exist on the Scotian Shelf and Slope, of which 165 billion m<sup>3</sup> (5.8 trillion cubic feet) have been



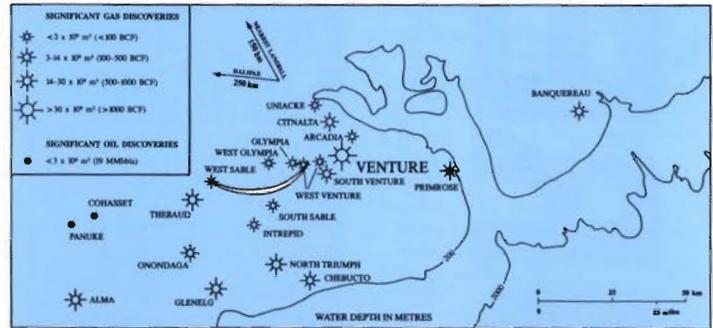
Rowan Gorilla III testing the Balmoral M-32 discovery well, spring 1991 Photo courtesy LASMO N.S. Ltd

discovered. Most of this discovered resource is located in gas pools ranging from 7 to 39 billion m<sup>3</sup> (0.25 to 1.38 trillion cubic feet), with the major discoveries situated within a 40 km radius of Sable Island. The total oil and condensate estimate is 171 million m<sup>3</sup> (1.1 billion barrels), of which only 23.7 million m<sup>3</sup> (149 million barrels) have been found so far.

It is estimated that over 200 undrilled prospects have been seismically mapped by industry. It is expected that these may yield additional significant discoveries, particularly for gas pools with reserves in the range of 6 to 30 billion m<sup>3</sup> (200 Bcf to 1 Tcf). The 171 million m<sup>3</sup> (1.1 billion barrels) estimate for oil and condensate is also encouraging, even though individual pool sizes are predicted to be small.

## Development Opportunities and Markets

Prospects for the future development of Scotian Shelf gas remain promising. Significant reserves have been established and there is a growing market in the neighbouring New England States and eastern



Top Figure 4 showing the Sable Sub-Basin significant discoveries

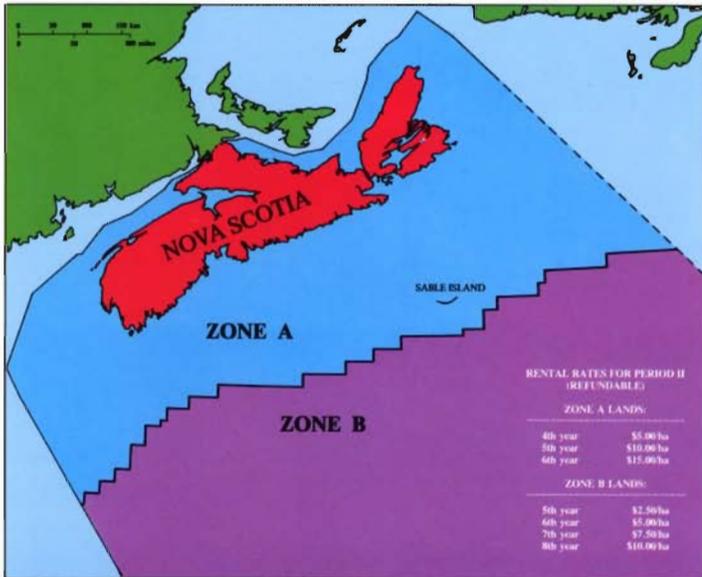
Above Panuke J-99 deck awaiting departure from M&M Manufacturing Ltd., Dartmouth, Nova Scotia Photo by Reg Morrison

Canada. Scotian Shelf gas could provide a dedicated source of gas for these regions. In addition, growing environmental concerns are expected to increase the demand for clean-burning natural gas, for example in co-generation of electricity.

The Cohasset/Panuke project will establish that the small offshore oil fields are commercially viable. Panuke and Cohasset are small by world offshore standards (5.6 million m<sup>3</sup> or 35 million barrels total recoverable oil reserves). However, they can be developed profitably

because of the high productivity, shallow water and the moderate climate offshore Nova Scotia.

In September 1990, the Canada-Nova Scotia Offshore Petroleum Board approved a development plan for the Cohasset and Panuke fields submitted by LASMO Nova Scotia Limited and its partner, Nova Scotia Resources (Ventures) Limited. Production facilities consist of a converted jack-up rig operating as a production platform together with a manned wellhead platform at



Above Rowan Gorilla III drilling the first production well at the Panuke field  
Photo by Reg Morrison



Top Figure 5 showing offshore zones for rights management

Above Single point mooring system with Cohasset jacket in background. Photo by Reg Morrison

Cohasset, an unmanned wellhead platform at Panuke, and subsea flow and control lines connecting the two. Oil will be produced into a storage tanker moored near the Cohasset platform. The oil is to be transported to shore using a smaller shuttle tanker. Production from these two fields will begin during the summer of 1992.

## Resource Management

The federal and Nova Scotia governments share jurisdiction over the offshore area in accordance with the provisions of the *Canada-Nova*

*Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord (Nova Scotia) Act*. A key feature of this legislation was the creation of the Canada-Nova Scotia Offshore Petroleum Board which oversees the day-to-day management of petroleum operations in the offshore area on behalf of both governments. However, certain Board decisions which are considered "fundamental decisions" are subject to directives and vetoes by the governments.

The Accord gives the provincial,

government responsibility for, and revenues from, royalties as if the resource were located on the land portion of Nova Scotia. The province has adopted a royalty regime based on a low fixed rate royalty before project payout and a net profits royalty subsequent to payout.

The rights management legislation that applies in the Nova Scotia offshore area is substantially similar to the rights management legislation that applies in other Canadian frontier jurisdictions. Interests are issued following a competitive bidding process based upon a single defined criterion, usually work expenditures.

The type of interest most commonly issued after a Call for Bids is an exploration licence (EL). The term, rental rates and drilling requirements of ELs vary depending upon whether they are located in

Zone A or Zone B as shown in Figure 5. ELs are issued for a six-year term in Zone A with the term divided into two three-year periods. In Zone B, ELs have an eight-year term divided into two periods of four years each. It is a condition of every EL that a well be commenced before the end of period one. If the interest owner fails to comply with this drilling requirement the EL terminates and the lands revert to the Crown. All rentals are refundable against allowable expenditures incurred in respect of the lands. ◊

# ONSHORE

The discovery of the Stoney Creek field in eastern New Brunswick at the turn of the century sparked interest in similar Carboniferous rocks found in Nova Scotia. In the following years, several wells were drilled in Nova Scotia near Lake Ainslie and in Cumberland County. Further drilling took place in later years yielding several oil shows but no commercial discovery. Chevron Standard Limited encountered an oil show at Malagawatch on Cape Breton Island in 1979. Three operators remained active during the 1980s, drilling a total of six wells. Four exploration agreements are currently held in the Minas Basin area. Each exploration agreement requires the operator to undertake a work program which includes the drilling of a well.



Above: Oil stained sandstone at Lake Ainslie, Nova Scotia. Photo by Pat McMahon.

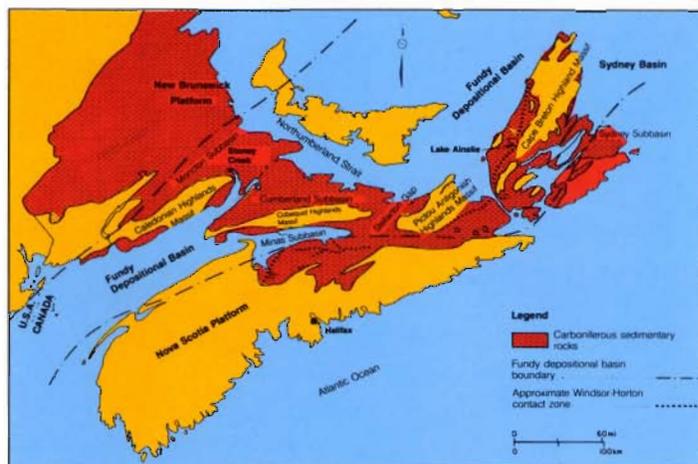


Figure 6: Carboniferous Age Sediments Onshore Nova Scotia.

In all, 99 wells have been drilled onshore for oil and gas by 22 operators. Information derived from these wells has indicated the presence of petroleum in about one third of them and another 70 drillholes, drilled for other minerals, have encountered petroleum shows.

## Geology

Most onshore petroleum exploration has concentrated on rocks of Carboniferous age (Figure 6). The Carboniferous clastic rocks were formed from sediments first deposited in narrow, elongate basins bordered to the northwest by uplands in New Brunswick and to the south by an uplifted region of pre-Carboniferous rocks in Nova Scotia. The first sediments were deposited in the Fundy depositional basin and consist of the Horton Group red and grey sandstone, conglomerate, siltstone and thick shale (Figure 7). The Stoney Creek field produces from

this stratigraphic interval, having yielded some 809 million m<sup>3</sup> (28.6 billion cubic feet) of natural gas and 127 000 million m<sup>3</sup> (800,000 barrels) of oil.

Overlying the Horton Group are rocks of the Windsor Group which contain important deposits of gypsum, anhydrite and shale, as well as thin tabular sequences of limestone and dolomite. Thick salt deposits occur at a number of localities and often have a noticeable effect on deformation. Halokinesis (salt flowage) accounts for diapirs, domes and ridges.

The Mabou Group lies above the Windsor Group and contains mainly thin, laminated red and grey shale, sandstone and minor limestone. The upper portion comprises thick, coarse red and grey clastics with siltstone, shale and minor coal.

Significant quantities of mineable coal, along with non-marine red and grey conglomerate, sandstone and shale, are found in the Cumberland Group of Late Carboniferous age. During deposition of the upper part of the Cumberland Group, non-marine

Era	Period/Epoch	Group	
Paleozoic	245 Ma	Permian	
	266 Ma		
	Carboniferous	Late	Pictou (and Stellarton)
		Early	Cumberland
			Mabou
			Windsor ?
	360 Ma	Devonian	
	Late		Horton
	Middle		Basement Complex
	408 Ma		

Figure 7 Table of Formations



Above: Nova Scotia coal.

## Source Rocks

Petroleum potential onshore is still uncertain but new evidence suggests that there is considerable potential in Windsor Group rocks. Previous exploration has focused on the clastic intervals of the Horton Group for both source and reservoir. A source rock study recently conducted by the department has revealed that there is untested potential in the Windsor Group carbonates and evaporites.

## Coal Gas

For many years methane gas associated with coal seams was regarded as a dangerous byproduct resulting from coal mining. Over the last ten years or so there has been an aggressive effort in the United States to develop coal gas as a resource. Other coal-bearing areas, such as western Canada, are also investigating the resource potential of this commodity. The department is currently assessing the coal gas potential of each of the province's coal basins. One recent estimate put

the methane potential at some 38 billion m<sup>3</sup> (1.34 trillion cubic feet) for the Atlantic region. Nova Scotia has the greatest share of the region's coal resources and, therefore, the associated methane

## Petroleum Resources Act

Exploration and production rights onshore are governed by the *Petroleum Resources Act* and the *Petroleum Resources Regulations*. The Act provides for the following types of agreements in connection with exploration and production of oil and gas:

### EXPLORATION LICENSE

Grants a non-exclusive right to explore for petroleum. An exploration license has a term of one year and is intended to allow preliminary exploration to delineate areas of potential. The licensee may not drill a well deeper than 90 m and does not have the right to produce petroleum.

### EXPLORATION AGREEMENT

Confers the exclusive right to explore for petroleum and the exclusive right to apply for a production lease for specified lands. An exploration agreement is usually issued after a Call for Proposals has been held, and has a three-year term renewable for a further three years. It permits the agreement holder to drill deep test wells and to produce oil and gas for test purposes. Annual rentals are \$0.12 per hectare.

### PRODUCTION LEASE

If a commercial discovery is made and the explorer submits a development program acceptable to the Minister, a production lease will be issued for an initial term of 10 years. A production lease grants the lessee the right to produce oil and gas from the leased area and to market it in accordance with the regulations. All oil and gas marketed is subject to a 10 per cent royalty payable to the province. However, as an incentive to encourage development, the first lease granted from any exploration agreement is exempt from this royalty for the first two years.

### COAL GAS

The *Petroleum Resources Act* defines petroleum so as to include "coal gas" and vests title to it in the Crown. Rights to explore or produce coal gas for commercial purposes are granted by Coal Gas Exploration Agreements and Coal Gas Production Agreements, respectively. Regulations setting out the procedure for applying for coal gas rights, work program requirements, rentals and other terms and conditions were promulgated in 1987. ◇

In every respect Nova Scotia is an attractive area for future offshore and onshore exploration and development activities. Nova Scotia contains some of the major frontier oil and gas plays yet to be explored in North America today. The offshore development of the Cohasset and Panuke oil fields, which will be Canada's first, bodes well for the future exploitation of very much larger oil and gas reserves in the Sable Sub-basin. Although no commercial discoveries have been encountered onshore, the existing database on petroleum and coal gas potential will provide an incentive to any interested explorer. ◊



Bluenose II entering Halifax Harbour, Nova Scotia. The port of Halifax is the closest major North American port to Europe. Service and manufacturing facilities for offshore exploration and production activities are located nearby. The shipyard has drydocks capable of handling Panamax-size vessels. It is the site of Bedford Institute of Oceanography — world's second largest oceanographic research centre. Photo courtesy of Nova Scotia Department of Tourism and Culture.

For more information on oil and gas exploration and development in Nova Scotia, contact:

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