

COUNTRY NOTES

With the exception of Canada, the Country Notes on Natural Bitumen and Extra-Heavy Oil have been compiled by the authors of the Commentary. Names of sedimentary basins and reference locations are from *Sedimentary Provinces of the World* by St. John, Bally and Klemme (1984). In the case of Canada, the information has been supplied by the WEC Member Committee.

Albania

Two of Albania's oil fields contain extra-heavy oil accumulations, both located in the Durres Basin.

Angola

Two natural bitumen deposits are located in the Cuanza Basin in Bengo province. They contain about 4.5 billion barrels of oil in place, but have not been worked as an energy source. Their development could be an option after most of Angola's conventional oil resources have been produced.

Azerbaijan

The natural bitumen resources are small and will probably not be used as a source of energy in the near future. The deposits are located within the South Caspian Basin, and the best known is Cheildag (Waters, 1974). The large extra-heavy oil accumulation was discovered in 1904.

Canada

Canada has three major oil sands deposits in Alberta, the Athabasca deposit, centered on the

city of Fort McMurray, the Cold Lake deposit, north of Lloydminster, and the Peace River deposit, in northwest Alberta.

In the Athabasca area, where 80% of oil sands exist, the mineable portion of the Wabiskaw-McMurray formation (Cretaceous age) is estimated to contain 16 billion cubic metres in-place. A further 253 bcm of in-place bitumen resource is associated with the in-situ projects.

The Canadian Association of Petroleum Producers (CAPP) estimates of established reserves at year-end 2004 were 28 bcm, which is consistent with Alberta Energy and Utilities Board (EUB). Cumulative production is about 0.7 bcm. About 20% of established reserves are mineable and 80% require in-situ recovery. The ultimate potential (with improved economics and technology) of bitumen reserves is 55 bcm, including 8 bcm from surface mineable recovery methods.

Mineable Reserves. The surface-mineable oil sands area is defined by the amount of overburden that has to be removed to reach bitumen ore. Overburden of 75 m or less is considered to be surface-mineable. The EUB has designated over 850 000 acres where the overburden is less than 75 m. All other oil sands deposits that are below 75 m of depth are classified as in-situ. Due to low gravity and high viscosity, these oil sands require enhanced recovery schemes, such as thermal stimulation, in order for the bitumen to become mobile and produceable by pumping.

The quantity of volume in-place that is economic to produce is based on economic strip ratio

Oil Sands Mining Projects

Operator	Project	Capacity 000 m ³ /d		Expansion
		Current	Projected	
Syncrude	Syncrude	56	80	2012-15
Suncor	Millennium/Voyageur	41	80	2008-12
Shell	Athabasca	25	96	2010-15
CNRL	Horizon		37	2009-11
True North/UTS	Fort Hills		32	2011-14
Imperial	Kearl Lake		48	2011-15
Synenco	Northern Lights		16	2011-13
Total	Joslyn		32	2011-14
Fort MacKay First Nation			8	

criteria, a minimum bitumen saturation of 7 mass per cent bitumen, and a minimum saturated zone thickness of 3.0 m. The EUB also applies factors that sterilise volumes from being mineable, such as corridors along rivers, surface facilities, tailings ponds, and waste dumps. Mining and extraction operations result in an average loss of 18% of bitumen in-place volume.

Active projects shown in the table above have produced 0.5 bcm at end-2004. The Suncor mining project began operation in 1967, produced less than 8 000 m³/d for most of the period through the end of the 1980s, and then grew to production of 35 000 m³/d in 2004. The Syncrude project began operation in 1977 and has produced over 32 000 m³/d since 1995. The Albion project, led by Shell Canada, began operation in January 2004 and reached its design capacity of 25 000 m³/d in mid-2005.

In-Situ Reserves. Established reserves are based on economic cutoff limits and recovery factors. Commercial projects, given production history, were assigned thermal recovery factors from 25-40%, depending on the producing formation. A relatively small quantity, 0.2 bcm, has been produced by in-situ projects.

Prior to the extraordinary increase in world crude oil prices since 2002, thermal production of bitumen from oil sands was stagnant, at approximately 48 000 m³/d. Supply was dominated by cyclic steam projects of Imperial Oil at Cold Lake, and Canadian Natural Resources at Primrose, both projects initiated before the 1986 collapse in world oil prices. The

1996 agreement between Alberta and Ottawa on a generic oil sands regime, and the recovery of world prices which began in early 1999 encouraged the owners of oil sands to begin cautiously advancing in-situ projects. Since 2002, project proposals have grown dramatically.

The following table summarises the largest commercial and proposed projects.

Oil sands production will become an increasing part of Canada's crude oil supply, despite some challenges such as: capital cost escalation, operating costs, labour and infrastructure availability.

Record high oil prices have raised international awareness of Alberta's oil sands resources. Proposed projects for surface mining and in-situ reserves have mushroomed in the heated market for crude supply. Recent projections suggest that oil sands output could increase to between 240 000 m³/d and 480 000 m³/d by 2015, depending on the economic conditions.

China

Four natural bitumen accumulations have been identified in the Junggar Basin with resources of about 1.6 billion barrels of bitumen. Ten of the 12 extra-heavy oil accumulations are located in the Bohai Gulf Basin with the other two located in the Huabei and the Tarim Basins.

Columbia

The two extra-heavy oil accumulations are part of a single field in Colombia in the Barinas-

Oil Sands In-Situ Projects

Operator	Project	Capacity 000 m ³ /d		Expansion
		Current	Projected	
Imperial	Cold Lake	24	29	
EnCana	Foster Creek	6	80	2006-15
Suncor	Firebag	5	19	2006-12
Petro-Canada	MacKay River	5	11	
Blackrock		2	4	2012
Shell	Cadotte Lake	2	16	2010-15
CNRL	Birch Mountain		43	2012-18
Husky	Sunrise		32	2008-15
Nexen/Opti	Long Lake		23	2007-10
Conoco-Phillips/Total	Surmont		16	2006-12
Others		19	45	2006-10

Apure Basin. There are numerous oil seepages and small bitumen deposits, especially in the Middle and Upper Magdalena Basins. None of these deposits appears to be sufficiently large to be an important commercial source of synthetic oil.

Congo (Brazzaville)

Heavy oil is found in reservoirs offshore Congo but no extra-heavy oil is known. The natural bitumen deposit at Lake Kitina in the Cabinda Basin has been exploited for road material.

Congo (Democratic Republic)

A natural bitumen deposit occurs in the Democratic Republic of Congo in the Cabinda Basin near the border with Cabinda. It has served as a source of road material, with nearly 4 000 tonnes (24 000 barrels) having been produced in 1958. This deposit is not likely to become a source of synthetic oil.

Cuba

Most of the oil produced from Cuba is heavy. Cuba contains numerous oil seepages but no significant natural bitumen accumulations. The extra-heavy oil accumulation is located partially offshore in the Florida-Bahamas Basin (also called the Greater Antilles Deformed Belt).

Ecuador

Ecuador is endowed with large amounts of heavy oil but only a small amount, all in the

Putamayo Basin, is extra-heavy. Natural bitumen is restricted to scattered oil seepages.

Egypt (Arab Republic)

Many fields containing heavy oil are found in Egypt, but very little of this is extra-heavy. The single extra-heavy oil accumulation is undeveloped.

Georgia

The only significant natural bitumen deposit in Georgia is in the South Caspian Basin, at Natanebi. Neither heavy nor extra-heavy oil are known in Georgia, although conventional oil has been produced there for more than a century.

Germany

Heavy oil is produced from many fields in Germany, but extra-heavy oil has not been reported. Highly viscous natural bitumen is present in the Nordhorn deposit, in the Northwest German Basin.

Indonesia

In Indonesia, although many fields produce heavy oil, there does not appear to be a large extra-heavy oil resource. Natural bitumen occurs in the well-known Buton Island deposit. This has long been utilised as a source of road asphalt.

Iran (Islamic Republic)

The principal extra-heavy oil accumulation is part of an offshore discovery. A number of Iranian fields produce heavy oil.

Iraq

Oil seepages have been known and utilised in Iraq throughout historical time but are insufficient for serving as sources of synthetic oil. Although heavy oil fields are productive in the country, very little extra-heavy oil has been identified.

Israel

The extra-heavy oil that is known in Israel is located in the Dead Sea province. Natural bitumen occurs only as Dead Sea asphalt blocks, which occasionally rise to the surface.

Italy

Italy has 14 natural bitumen deposits and 31 extra-heavy oil deposits. The 269 million barrels of original reserves of extra-heavy oil in Italy are found in six separate basins, similar geologically to the Durres Basin of Albania. The most important of these is the Caltanissetta Basin, mostly offshore and including the Gela field. These fields are all found in the foredeep portion of the basins, where the sediments are thickest and most structurally disturbed. The viscous nature of the oil, the offshore environment, and the limited resources create challenges to economic development of these accumulations.

Kazakhstan

Although Kazakhstan possesses large resources of conventional and heavy oil, it contains little if any extra-heavy oil. It does have significant resources of natural bitumen in the North Caspian Basin. As with nearly all the large

natural bitumen deposits, the geological setting, like that of the Western Canada Sedimentary Basin, is conducive to the development of natural bitumen. In the light of the very large resources of conventional oil and natural gas in this country, development of the bitumen as a source of synthetic oil is unlikely in the foreseeable future.

Kyrgyzstan

Little is known about these deposits except their location in the Fergana Basin and that they have yet to be evaluated.

Madagascar

Bemolanga is the only natural bitumen deposit in Madagascar. It is large and attempts at producing synthetic oil have thus far failed. A large heavy-oil deposit, Tsimiroro, has similarly been the subject of a number of unsuccessful production tests but no extra-heavy oil has been identified in the country.

Mexico

Mexico, with numerous heavy oil fields, contains very few extra-heavy oil reservoirs. The latter are small in resources and production. Oil seepages are common in the country, but no large natural bitumen deposits have been found.

Nigeria

Natural bitumen in place, possibly totaling as much as 38 billion barrels, is located in southwestern Nigeria, in the Ghana Basin. This extensive deposit has not yet been evaluated as

a source of synthetic oil and its production will no doubt be delayed as long as Nigeria is a leading producer of conventional oil.

Peru

Peru contains numerous heavy oil deposits, mostly in the Oriente Basin. However, the recoverable oil from the two known extra-heavy oil accumulations of that country is relatively small.

Poland

With current technology, the two extra-heavy oil reservoirs of Poland are marginally economic.

Russian Federation

Extra-heavy oil has been identified in the Russian Federation in small amounts in the Volga-Urals and North Caucasus-Mangyshlak Basins (S.I. Goldberg, written communication). As is the case with many countries, accurate and timely data are insufficient for making estimates.

Information relating to natural bitumen deposits indicates that very large resources are present in the east Siberia platform in the Tunguska Basin (Meyer and Freeman, 2006). This is harsh terrain and only the Olenek deposit has been studied in sufficient detail to permit the estimation of discovered bitumen in place. The Siligir deposit has been frequently cited in reports of world bitumen deposits, but the primary source for these citations has not been located. It may be assumed that the estimate of

more than 51 billion barrels for the basin is conservative. This area is so remote, and Russia's conventional oil and gas resources so great, that it is not likely that attempts will be made in the near future to exploit this natural bitumen. Most of the other Russian bitumen deposits are located in the Timan-Pechora and Volga-Urals Basins, which are analogous geologically to the Western Canada Sedimentary Basin. However, these deposits are scattered and the recoverable portions are not quantitatively large. The deposits in the Tatar Republic have been studied extensively and efforts to exploit them may be conducted in the future.

Switzerland

The Val de Travers natural bitumen deposit in Switzerland is small, but representative of many such occurrences in Western European countries. Most of these have been known for centuries and a few have been mined, mainly for road material.

Syria (Arab Republic)

The Babenna natural bitumen deposit was mined for many years for asphalt. It is one of numerous such deposits throughout the Middle East, those in Syria and Iraq being especially prominent since antiquity. They are not regarded as potential commercial sources of synthetic oil.

Tajikistan

Little is known about the four bitumen accumulations except that three are located in

the Amu-Darya Basin and the fourth is located in the Fergana Basin.

Tonga

The Tonga natural bitumen accumulation was found as a seep but has yet to be evaluated.

Trinidad and Tobago

Trinidad and Tobago is rich in heavy oil, but only 300 million barrels of oil in place is extra-heavy. The country has more than 600 million barrels of oil in place in natural bitumen deposits, including Asphalt (Pitch) Lake. All these deposits are located in the Southern Basin, which is small, highly faulted, but highly productive.

Asphalt (Pitch) Lake, at La Brea, contains a semi-solid emulsion of soluble bitumen, mineral matter, and other minor constituents (mainly water). It has been mined since at least 1815 but mostly for use as road surfacing material. The lake contains 60 million barrels of bitumen, a sufficient supply for the foreseeable future. Production is between 10 000 and 15 000 tonnes per year (equivalent to 60 000 to 92 000 barrels per year), most of which is exported. In combination with asphalt from refined crude oil, the product is used for road construction. In addition, it can be used in a range of paints and coatings and for making cationic bitumen emulsions. Production of these emulsions of bitumen, water, and soap began in late 1996 and the emulsions are now used widely throughout the industrialised world in place of solvent-based bitumen emulsions.

United Kingdom

Offshore the United Kingdom has two extra-heavy oil deposits. One is a discovery in the West of Shetlands Basin, for which few data are available. The other is the producing Piper field in the North Sea Graben, which contains oil between 8.7° and 37° API gravity.

United States of America

The United States was endowed with very large petroleum resources, which are to be found in nearly all the various types of geologic basins. The resources of extra-heavy oil and natural bitumen likewise are distributed in numerous geological settings. Geologically, about 80% of the discovered US natural bitumen is deposited in basins similar to the Western Canada Sedimentary Basin. Such basins possess ideal conditions for occurrences of degraded oil. However, the bitumen deposits of the United States are much smaller, much less numerous, but more scattered. About 98% of the reported extra-heavy oil is found in basins which evolved along the rift-faulted, convergent continental margin of California where the island arcs which originally trapped the sediments against the land mass to the east have been destroyed. Distillation of oil from Casmalia tar sands in California was attempted in 1923. Many tar sands deposits in the United States have served as sources of road asphalt, but this industry disappeared with the advent of manufactured asphalt tailor-made from refinery stills. The largest deposits in the lower conterminous 48 states are in Utah. During the 1980s US energy

analysts studied criteria, both technical and economic, for supply of synthetic crude oil from tar sands and several tar sands pilot projects were started. With the decline in and stagnation of crude oil prices from the later 1980s to about 2000, there was little interest in pursuing these projects. The recent sustained increases in oil prices have revived this interest.

The extra-heavy oil accumulations in California account for about 97% of the extra-heavy oil produced to date. These are typically reservoirs found in large fields, multiple reservoir fields, and fields that may have already installed a thermal recovery operation for production of heavy oil in underlying reservoirs or overlying reservoirs.

Uzbekistan

Little is known about the eight natural bitumen occurrences in Uzbekistan except that six occur in the Fergana Basin and two are located in the Amu-Darya Basin. The single occurrence of extra-heavy oil is reported as part of the Khaudag deposit in the Amu-Darya Basin (S.I. Goldberg, written communication). Its size is unknown.

Venezuela

A small amount of the Venezuelan extra-heavy oil resource is found in the Maracaibo Basin, but the resources of worldwide significance lie in the Orinoco Oil Belt along the southern, up-dip edge of the Eastern Venezuela Basin. One natural bitumen deposit, Guanoco Lake, is found near

the Caribbean coast on the north side of the Eastern Venezuela Basin. The deposit has been estimated to contain 62 million barrels of oil in place (Walters, 1974).

Four joint ventures for the exploitation of extra-heavy crude have been operating since 2001, and as of 2006 have an extra-heavy oil production capacity of 640 000 b/d. All the projects, in one way or another, involve production, transportation, and upgrading facilities. In 2001, Venezuela passed the new Hydrocarbons Law that increased royalties and required all new projects with foreign oil firm participation to be formed as joint ventures with PDVSA (Petróleos de Venezuela) as majority owner.

Venezuela, through PDVSA, started a reserves certification programme to increase the proved reserves in the Orinoco Oil Belt. The companies that participate in the certification programme will be considered first for upstream development. Participation in the programme has been by foreign national oil companies: Petrobras (Brazil), Petropars (Iran), CNPC (China) and ONGC (India). Petrobras and PDVSA have already established a joint venture to develop the Carabobo 1 block. The project is supposed to produce 200 000 b/d of extra-heavy oil at its peak. An offsite upgrade facility is included. Project investment costs are expected to be \$4 billion. Some of the partnerships of currently-operating extra-heavy oil projects are seeking to increase reserves and production at their projects. However, the Venezuelan

government has announced its intention to nationalise the Orinoco projects.

In the early 1980s Intevep, the research affiliate of the state oil company PDVSA, developed a method of utilising some of the hitherto untouched potential of Venezuela's extra-heavy oil resource. The extra-heavy oil (7.5-8.5° gravity API) was extracted from the reservoir and emulsified with water (70% natural bitumen, 30% water, <1% surfactants). The resulting product was called Orimulsion®. Initial tests were conducted in Japan, Canada and the United Kingdom, and exports began in 1988. Bitúmenes del Orinoco S.A. (Bitor), a PDVSA subsidiary, operated a plant at Morichal in Cerro Negro with a capacity of 5.2 million tonnes per year. In 2005 PDVSA announced it would cease Orimulsion® production because it was more profitable to sell the extracted oil as feedstock to extra-heavy oil upgraders. In 2006, PDVSA and CNPC (Chinese National Oil Company) initiated the Sinovensa project, to supply two power plants in China and to meet some of PDVSA's commitments to supply Orimulsion®. However, in September 2006 the Minister of Energy and Petroleum announced that the Sinovensa operation would cease production at the end of the year.