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Compilation

This chapter summarizes the methodology followed in creating the oil and gas field outlines shown in each relevant Atlas chapter. Also included is a summary of oil and gas reserves and production distribution, again in accordance with Atlas stratigraphic intervals.

The original assignment for this project was to provide up-to-date and reliable oil and gas field outlines, reserves and production summaries for the 13 producing stratigraphic intervals embraced by this Atlas. This target was achieved using Digitech's Production Data System and the Geological Survey of Canada's PETRIMES reserves database.

Sources of Data

The producing oil and gas wells were identified and located using PDS (Production Data System), marketed by Digitech Information Services Limited of Calgary. Retrieval of these data for producing wells was obtained using Alberta data that had been updated to January 31, 1991, British Columbia data updated to October 31, 1990, and Saskatchewan data updated to August 31, 1990. Further clarification of producing zone and production figures for specific horizons in each province was obtained from provincial reports listed in the references at the end of this chapter.

Reserves, cumulative production and size distribution data were provided by P. J. Lee of the Institute of Sedimentary and Petroleum Geology in Calgary, using the PETRIMES reserves database (Lee and Tzeng, 1988), updated to 1991.

Methodology

The first step in identification of producing wells was to request a printout from Digitech listing all producing oil or gas wells for each of 17 major stratigraphic zones. The wells were listed in order of location (i.e., U.W.I.) and current status; field, zone and pool were given. The 17 major stratigraphic zones included several, such as Elkton, Shunda and Banff, that were later lumped together to provide the production data for the 13 producing zones discussed in this Atlas. Included in the retrieval were all abandoned and suspended oil and gas wells, which were identified as such under the current status column. Digitech also provided maps, at a scale of 1: 500 000, showing the location of all producing oil or gas wells for each horizon.

The second step was to outline and name all the pools and fields on these maps, using the printouts as a reference. All wells in the same pool were outlined in red by tracing a smooth line around the perimeter wells at a distance of approximately one legal subdivision. This has been described as the "rubber band" method, although indentations were carefully included. All of the pool outlines belonging to the same field were then outlined in blue, following the same "rubber band" method.

In addition to outlining all field boundaries and assigning the proper field names, major fields were identified by a special symbol, so that only the names of these major fields would be printed on the final maps provided for the Atlas. There are many small oil or gas fields that need not be identified by name on the Atlas maps, and this method thus allowed deletion of the names of these smaller fields. Major fields were arbitrarily selected on the basis of large size and number of wells, as likely being among the top 20 fields for that particular horizon. Careful review of reserves data commonly resulted in change of apparently minor fields to the major field designation.

The third step was to return these maps with red pool outlines and blue field outlines to Digitech for digitization, so that these outlines could be retrieved on any scale. Thorough verification of these digitized oil and gas pool and field outlines was carried out before the final 1: 2 500 000 scale maps for each of the Atlas' major 13 stratigraphic intervals were ordered.

The fourth step was to request these digitized pool and field outlines from Digitech, in maps at a scale of 1: 2 500 000, showing all field outlines for each stratigraphic interval, but names of only the major fields. The individual producing wells and pool outlines were deleted to reduce overprinting. This step completed the retrieval of producing well locations and digitized pool and field outlines and names from Digitech.

The fifth step was the retrieval of reserves and production data for every oil and gas field within each of the 17 stratigraphic horizons. These data were obtained from the Institute of Sedimentary and Petroleum Geology, using the PETRIMES package. Retrievals were made of all producing pools and of all producing fields within each interval. Close correlation was found between the wells, pools and fields on Digitech's PDS system and on PETRIMES.

The sixth step involved compilation from PETRIMES of the reserves and production statistics for the top ten fields in each interval. Some zones, such as the Permian and Dunvegan, showed small individual field reserves, so that a lower limit of 1000 x 10^6m^3 (i.e., 35 BCF) initial established marketable gas reserves or 1 x 10^6m^3 (i.e., 6 MMBbls) initial established recoverable oil reserves was set. The size distribution of individual pools within each horizon was also retrieved through PETRIMES and is included in the statistical summaries.

Retrieval Specifications

Stratigraphy

Minor problems were encountered in assigning production from some stratigraphic intervals because of the broad stratigraphic range of the producing formation. For example, production from the Mississippian Rundle Group is assigned to the Debolt-Elkton interval, even though the Rundle extends down into the Shunda-Pekisko interval. This arbitrary designation of Rundle to the Debolt-Elkton has proven satisfactory; however, the occurrence of a few Rundle fields beyond the Debolt-Elkton wedge edge indicates that in these cases Rundle production is derived from the Shunda-Pekisko.

The Nikanassin is generally regarded as Late Jurassic to earliest Cretaceous in age, and another arbitrary decision was made to assign all Nikanassin production to the Jurassic stratigraphic interval.

Similarly, the Granite Wash is arbitrarily assigned to the Elk Point, and not extended down into the Cambrian. The Wapella is assigned to the Lower Mannville rather than the Jurassic, Cantuar to Lower rather than Upper Mannville and Unity to Lower Mannville rather than Viking.

Production from the Camrose member in the Wainwright field is assigned to the Woodbend rather than the Winterburn.

In southern Alberta, five major oil fields are listed as producing from the Blairmore, without clarification as to Upper or Lower Blairmore (i.e., Mannville). In such cases, computer retrievals assigned such production to the uppermost zone. However, these five fields, namely Bellshill Lake, Bantry, Cessford, Taber and Taber South, produce primarily from the Lower Mannville.

Solution Gas

In a few major gas fields, production is primarily derived from solution gas associated with major oil production. For example, Beaverhill Lake gas production from the Swan Hills and Judy Creek fields is reflected in only two gas wells, even though these two fields are among the largest Beaverhill Lake gas fields. Because oil and gas fields are shown together for each interval, this anomaly is not apparent on the maps.

Summary of Reserves and Production Data

Cumulative production totals for oil and gas, by stratigraphic interval, are shown as tables accompanying the field outline maps in each of the 13 relevant Atlas chapters. These data are reproduced below (Tables 32.1 and 32.2) to allow comparison of reserves and production capability for each interval. Also represented are the reserves and production percentages of each interval compared to total reserves and production. Note that the tabulated data refer to established reserves and cumulative production to date, and do not include potential or unproven reserves.

The Devonian (last four intervals) contains 50.7 percent of Western Canada's initial established recoverable oil reserves, and accounts for 53.8 percent of Western Canada's cumulative production oil to date. The five Cretaceous intervals contain 26.6 percent of recoverable oil reserves and have produced 23.7 percent of Western Canada's oil to date. The Carboniferous contains 13.0 percent of the reserves and has produced 13.1 percent of the oil. The remaining 9.8 percent of reserves and 9.3 percent of production is divided between Jurassic and Triassic, with the minor remainder assigned to the Permian.

Table 32.1 Summary of oil reserves and production data. (units of 10^6m^3)

Stratigraphic interval	Initial established recoverable reserves	Percentage of total basin reserves	Cumulative production	Percentage of total basin production
Belly River	39.3	1.4	19.9	0.9
Cardium	305.0	10.8	220.9	10.1
Dunvegan	9.9	0.4	3.1	0.1
Viking	88.7	3.2	66.8	3.1
Mannville	304.8	10.8	206.8	9.5
Jurassic	136.1	4.8	102.1	4.7
Triassic	127.4	4.5	89.1	4.1
Permian	14.7	0.5	10.4	0.5
Carboniferous	364.8	13.0	285.4	13.1
Wabamun	7.2	0.3	3.2	0.1
Woodbend -Winterburn	669.1	23.8	607.9	27.9
Beaverhill Lake	409.1	14.5	322.5	14.8
Elk Point	339.3	12.1	240.5	11.0
TOTALS	2815.4 x 10^6m^3		2178.6 x 10^6m^3	

Table 32.2. Summary of gas reserves and production data (units of 10^9m^3)

Stratigraphic interval	Initial established marketable reserves	Percentage of total basin reserves	Cumulative production	Percentage of total production
Upper Colorado	419.3	11.4	36.8	2.7
Cardium	88.3	2.4	30.8	2.3
Dunvegan	18.7	0.5	4.5	0.3
Viking	277.9	7.6	103.4	7.7
Mannville	961.6	26.2	270.4	20.2
Jurassic	127.5	3.5	58.7	4.4
Triassic	278.7	7.6	94.4	7.0
Permian	73.0	2.0	20.2	1.5
Carboniferous	579.9	15.8	266.2	19.8
Wabamun	102.8	2.8	53.5	4.0
Woodbend -Winterburn	332.0	9.1	212.0	15.8
Beaverhill Lake	262.4	7.2	111.2	8.3
Elk Point	142.7	3.9	79.5	5.9
TOTALS	3664.8 x 10^9m^3		1341.6 x 10^9m^3	

Reserves and production percentages generally mirror each other, but a slight trend is apparent for higher percentage of oil production relative to reserves for the Woodbend-Winterburn and Beaverhill Lake. The shallower intervals have greater percentages of reserves compared to production, because of their more recent development.

The four Devonian intervals contain only 23.0 percent of Western Canada's initial established marketable gas reserves (vs. 50.7 percent for oil) and have produced 34.0 percent of Western Canada's cumulative gas to date. The five Cretaceous intervals contain 48.1 percent of marketable gas reserves (vs. 26.6 percent for oil) and have produced 33.2 percent of Western Canada's gas to date. The Carboniferous contains 15.8 percent of the total gas reserves and has produced 19.8 percent of the total gas to date. Over half the remaining 13.1 percent gas reserves are contained in the Triassic, with the rest split between the Jurassic and Permian.

Note that in Table 32.2 the percentages of production compared to total reserves are significantly higher for the Carboniferous and Devonian intervals. This implies that a greater percentage of the gas reserves is yet to be produced from the Cretaceous horizons relative to the Paleozoic horizons, especially from the Upper Colorado Group.

Tables 32.3 and 32.4 summarize the distribution of oil and gas reserves in each interval according to pool size, as measured by the initial in-place volume. Also shown is the average pool size. Note that individual pools rather than fields are considered in these tables .

Table 32.3 Size distribution of oil pools (units of $10^6 m^3$)

Stratigraphic interval	Average pool size	Number of pools Pool size class (units of $10^6 m^3$) for in-place vol. Less than 0.1	0.1-1	1-10	10-100	Over 100
Belly River	0.16	28	183	30	6	
Cardium	1.03	76	174	37	8	2
Dunvegan	0.20	5	32	11	1	
Viking	0.31	116	135	26	11	1
Mannville	0.13	635	1349	309	62	
Jurassic	0.50	48	146	70	11	
Triassic	0.38	84	195	50	8	
Permian	0.67	8	9	3	2	
Carboniferous	0.82	76	237	132	31	4
Wabamun	0.06	27	87	6		
Woodbend-Winterburn	1.71	46	236	89	17	2
Beaverhill Lake	2.48	29	101	23	9	3
Elk Point	0.28	182	952	87	6	2

Table 32.4 Size distribution of gas pools (units of $10^9 m^3$)

Stratigraphic interval	Average pool size	Number of pools Pool size class (units of $10^9 m^3$) for in-place vol. 1-10	10-100	100-1000	1000-10,000	Over 10,000
Belly River	0.25	244	1113	258	56	13
Cardium	0.31	8	134	124	18	5
Dunvegan	0.14	10	89	34	6	
Viking	0.08	705	2051	460	62	2
Mannville	0.07	2439	8569	2395	168	7
Jurassic	0.29	19	199	189	27	4
Triassic	0.41	13	310	302	41	8
Permian	0.33	4	67	136	10	1
Carboniferous	0.63	54	407	361	75	20
Wabamun	0.30	28	162	122	21	5
Woodbend-Winterburn	0.55	60	231	242	64	12
Beaverhill Lake	0.80	78	136	73	31	12
Elk Point	0.16	122	631	114	26	3

Table 32.3 shows that the average pool size generally increases with the increasing age of the interval, with the Beaverhill Lake oil pools averaging ten times larger than Upper Cretaceous oil pools. There are, however, some exceptions. For example, the Wabamun is characterized by very small average oil pool sizes (0.06 x $10^6 m^3$) as well as a small number of pools. This low relative productivity of the Wabamun may be related to the disappearance of stromatoporoids at the beginning of Wabamun deposition, thus curtailing the development of reefs that could act as reservoirs. The Elk Point also has an anomalously low average oil pool size, but a large number of pools, both characteristics related to numerous small pinnacle reef reservoirs in the Rainbow and Zama fields.

Lower average oil pool sizes in the Cretaceous relative to the Devonian is to be expected because Cretaceous oil reservoirs occur mainly in porous sands, which are much smaller and more discontinuous than Devonian reefal oil reservoirs. An exception, however, occurs in the Cardium, where the extensive sheet sands in the Pembina field account for increased average oil pool size, to over 1 x $10^6 m^3$ in-pool volume.

Table 32.3 provides an indication of the oil pool sizes to be expected in new discoveries from specific horizons. Note that in every horizon, the pool size class of 0.1 to 1x$10^6 m^3$ contains the largest number of pools. However, it is also instructive to note that 11 of the 14 largest pools occur in the Paleozoic.

In Table 32.4, a similar trend is apparent for average gas pool size as for oil; namely, that the average pool size increases with increasing age of the interval, with the Beaverhill Lake gas pool sizes averaging ten times larger than those of the Lower Cretaceous gas pools.

The very low average gas pool sizes for the Viking and Mannville are the result of the extremely large numbers of gas pools in these two horizons, more than twice as many as all other 11 intervals combined. The average gas pool size would be expected to increase if the total number of pools in these two intervals dropped.

Table 32.4 indicates the average gas pool size to be expected in new discoveries from specific horizons. Note also that 52 of the 92 largest gas pools occur in the Carboniferous and Devonian, a more equitable distribution of largest pools than is evident for largest oil pools.

There are three major oil sands areas, all in Alberta, with reserves that dwarf those of the conventional oil fields. These three areas, namely the Athabasca, Cold Lake and Peace River oil sands areas, contain initial oil-in-place reserves of 266 392 x $10^6 m^3$, compared to the 11 544 x $10^6 m^3$ initial established in-place volumes in conventional oil fields. The oil sands reserves occur primarily in the Upper and Lower Mannville (73%), with lesser amounts in the Devonian Grosmont (19%) and Nisku (4%), the Carboniferous Debolt (3%) and Shunda (1%), and the Belloy (trace). The major oil sands areas are outlined on the maps in the relevant Atlas chapters.

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