Technical Report

National Energy Board

Office national de l'énergie

Northeast British Columbia Natural Gas Resource Assessment 1992–1997

October 2000

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Figures

Tables

Abbreviations

10^6m^3	Million cubic metres
Bcf	Billion cubic feet
Board	National Energy Board
BCMEM	British Columbia Ministry of Energy and Mines
BCOGC	British Columbia Oil and Gas Commission
Tcf	Trillion cubic feet

FOREWORD

The National Energy Board (the Board) continually monitors the overall energy situation in Canada by identifying long and short-term developments in supply and demand.

The Board has established a methodology to determine and evaluate remaining undiscovered potential for natural gas and oil resources. A review of current practices and approaches by industry and other government departments involved in resource assessments show that the resource assessments are typically regional in nature and, as such, are difficult to apply to more localized evaluations. The methodology is described in the Board's reports - *Natural Gas Resource Assessment - Northeast British Columbia (1994)* and *Non-Associated Natural Gas Resource Assessment Study - Saskatchewan (1999)* and is used in this report.

This technical report, entitled *Northeast British Columbia Natural Gas Resource Assessment - 1992 to 1997*, has been prepared by the Board to provide a review of the impact of industry activity upon gas supply in Northeast British Columbia from 1992 to 1997. The main objective of this report is to assess the effectiveness of drilling activity in developing new sources of gas supply within the region.

This document is based on the Board's working document *Natural Gas Resource Assessment - Northeast British Columbia*, first published in 1994 and re-edited in 1999, that determined natural gas resources in regional settings as well as geological plays. British Columbia's Oil and Gas Commission and Ministry of Energy and Mines provided assistance and comments in the preparation of this report. However, the conclusions and interpretations presented are those of the Board.

The Board welcomes any comments on the design or use of the selected methodology, or on the results of this study. Written comments should be directed to the Secretary of the Board located at 444 - Seventh Avenue S.W., Calgary, Alberta, Canada T2P 0X8.

NORTHEAST BRITISH COLUMBIA

Natural Gas Resource Assessment

- 1992 to 1997 -

Summary

Drilling activity in northeast British Columbia discovered 70 158 10^6m^3 (2.5 Tcf) of initial established (marketable) gas reserves from 1992 to 1997. During this time, adjustments from drilling and reservoir performance reviews increased pre-existing pool initial established gas reserve estimates by a net volume of 1 870 10^6m^3 (66 Bcf). The remaining undiscovered gas resource estimate for northeast British Columbia has decreased from approximately 940 500 10^6m^3 (33.2 Tcf) to 873 421 10^6m^3 (30.8 Tcf) over the past five years.

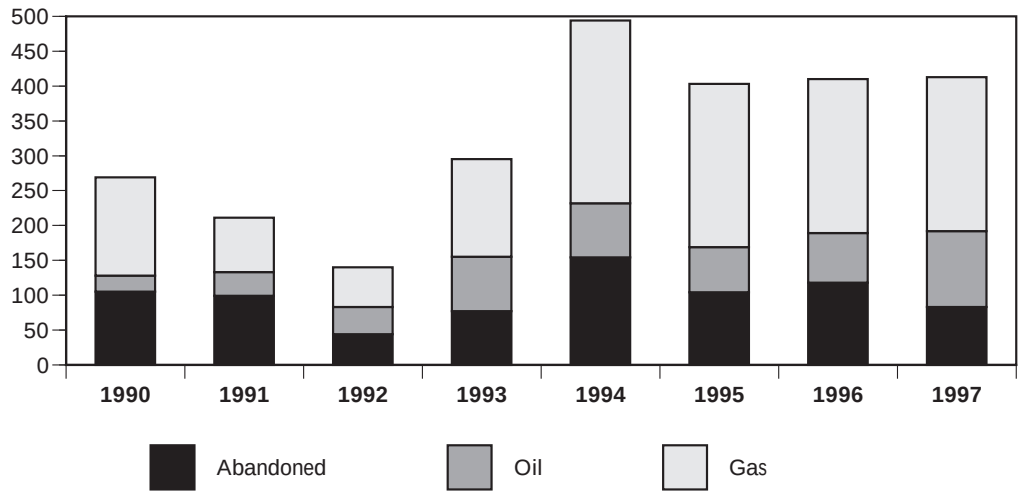
Introduction

The purpose of this report is to provide a five year update of the National Energy Board's 1994 report entitled *Natural Gas Resource Assessment - Northeast British Columbia*. That report relied on year-end 1992 data. This report reviews 1993 to 1997 industry activity in northeast British Columbia in an attempt to gauge the effectiveness of drilling operations to add marketable gas reserve volumes to the overall conventional gas supply for Western Canada.

FIGURE 1

Annual Drilling Activity

Well Count



Industry Activity

Northeast British Columbia underwent a period of drilling that has rebounded from a low of 158 drilled wells in 1992 to just over 400 wells per year in the past three years (Figure 1).

Over the five year period, drilling activity resulted in 1,070 gaswells (BCMEM, 1998). There were also 536 dry and abandoned wells and 401 oilwells drilled over the same time frame. The past three years of activity resulted in gas well drilling of about 220 wells annually.

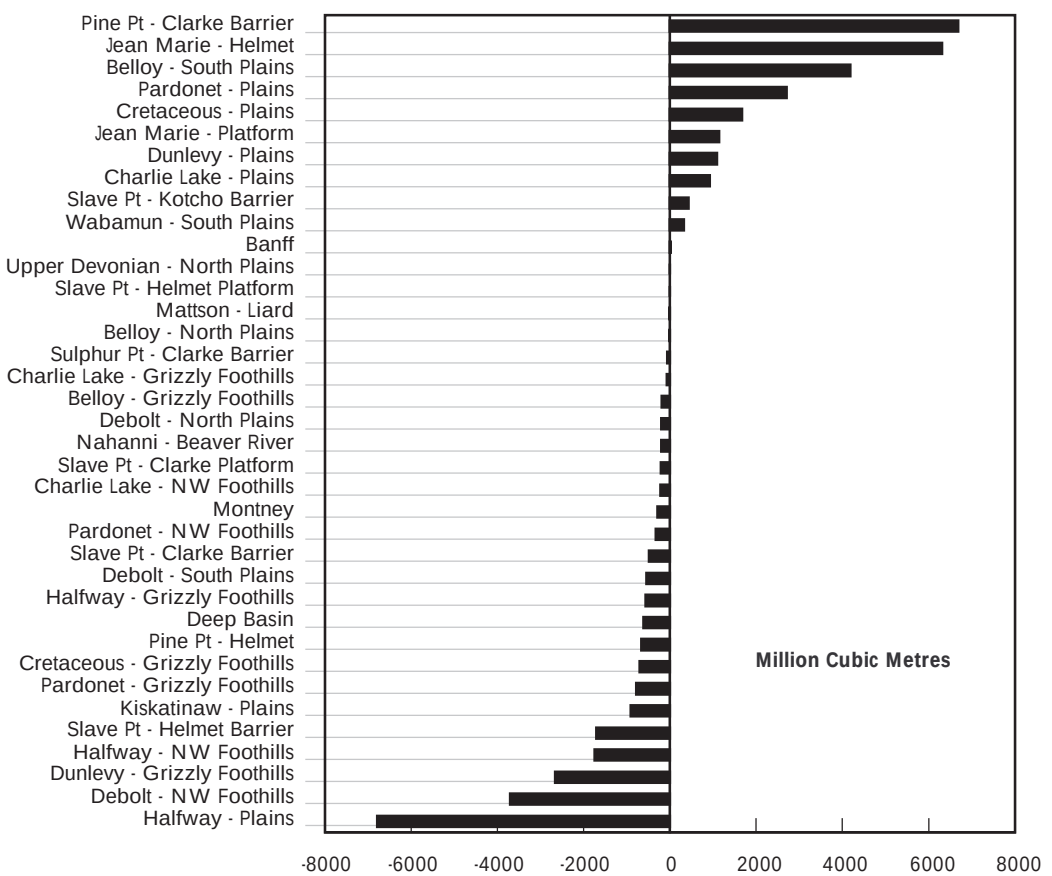
Northeast British Columbia annual gas production increased from a 1992 total of 14 272 to 18 796 10^6m^3 in 1997 for a total of 85 051 10^6m^3 (3.0 Tcf) during these five years. The number of producing gas wells has also increased from 886 to 1425 wells.

Existing Pool Reserves Appreciation and Depreciation

This study compared 1992 and 1997 initial established (marketable) gas reserve estimates of existing pools (Table 1) (BCMEM, 1992, 1997). Although gross reserve additions amounted to 25 493 10^6m^3 (900 Bcf) in 11 plays, the full effect of this change was offset by reserves depreciation of 23 623 10^6m^3 (834 Bcf) in the other 27 plays (Figure 2). The depreciation includes revised gas reserve estimates from the Board's 1997 unconnected gas study for northeast British Columbia. As a result, there was a net increase of 1 870 10^6m^3 (66 Bcf) to initial established gas reserve estimates of existing pools over the five year period.

FIGURE 2

Volume Changes to Existing Established Reserves Estimates



In terms of reserve appreciation, the Pine Point - Clarke Barrier play had its existing gas reserves base increase by a net amount of 6 682 10^6m^3 (236 Bcf) primarily through improved recovery efficiency in the Sierra Pine Point A and D pools (Figure 2). The Jean Marie - Helmet play followed with 6 313 10^6m^3 (223 Bcf) of gas reserves added by development drilling. The Belloy - South Plains play's existing gas reserve base increased by 4 185 10^6m^3 (146 Bcf) as several pools were reassessed with material balance estimates that replaced the volumetric estimates.

There were significant depreciation revisions in three of the existing plays to initial reserve estimates between 1992 and 1997 (Figure 2). In the Halfway - Plains Play, the Monias Halfway Pool had the recovery factor lowered, due to an engineering review, from 90 to 60 percent resulting in a 5 887 10^6m^3 (208 Bcf) loss in initial established reserves. This loss, 62 percent of the play's total decrease, combined with a large number of pools having small adjustments to various reservoir parameters made up the largest play loss in northeast British Columbia. The Debolt - northwest Foothills play had five existing pools' recovery factors reduced from about 90 percent to 60 percent or lower due to water influx. This accounted for 68 percent of the play's loss. The Dunlevy - Grizzly Foothills play had one pool reclassified from having established reserves to dry and abandoned and another pool decrease the assigned area and net gas pay estimates. These two pools accounted for 84 percent of the play's decrease of established gas reserves.

Conversion of Undiscovered Resources to Established Reserves

There were 408 exploratory gas wells drilled over the five year period that resulted in 379 new pools being discovered. Out of 38 identified geological plays, 27 of the plays were assigned new pool established gas reserves (Table 2). These new pools added 70 158 10^6m^3 (2.48 Tcf) to the established marketable gas reserve estimates. The overall average for reserve additions was 184 10^6m^3 (6.5 Bcf) per pool. The average pool size addition by geological play for the new pools is shown in Figure 3.

The Pardonet/Baldonnel - Grizzly Foothills play lead all other plays with new reserve additions of 19 050 10^6m^3 (672 Bcf) (Table 2). This play had 25 pools added, while the Halfway - Plains play followed with 9 622 10^6m^3 (340 Bcf) added in 87 pools. The Cretaceous - Plains play had 6 701 10^6m^3 (236 Bcf) added from 64 new pools.

Drilling in the Foothills areas accounted for 51 pools being discovered with an average of 580 10^6m^3 (20.5 Bcf) per pool. The Plains area had 278 new pools found with an average of 97 10^6m^3 (3.4 Bcf). In the northern part of the region, Devonian plays averaged 290 10^6m^3 (10.2 Bcf) in 33 new pools.

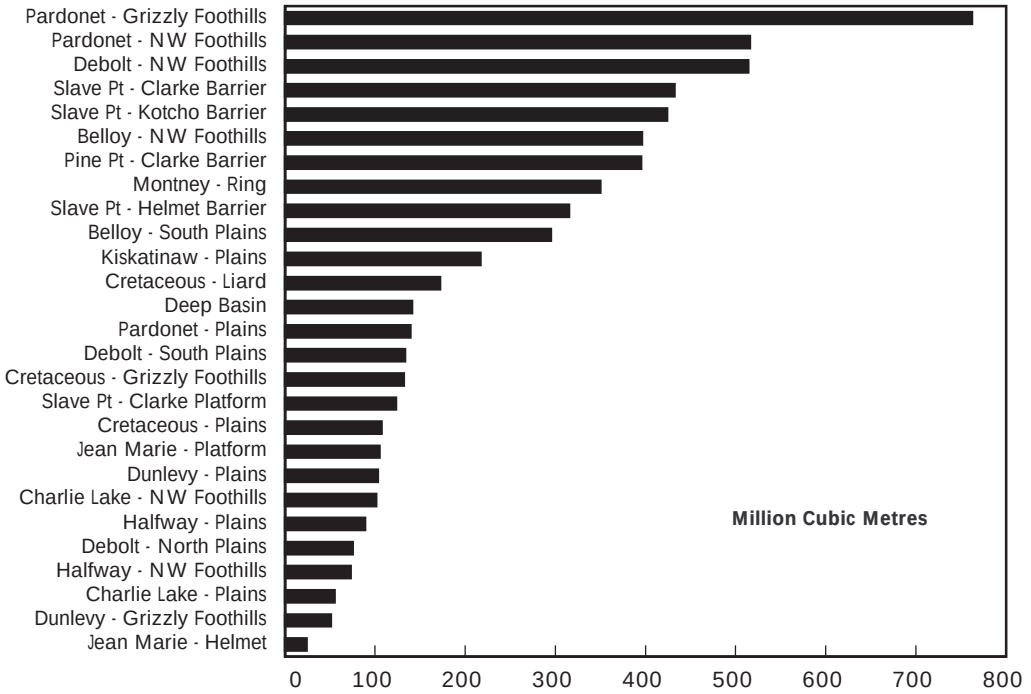
There were 38 conventional gas plays identified in the previous report. One new play, Cretaceous - Grizzly Foothills, has been added to this report to allocate established gas reserves. Distribution of production, discovered reserves and undiscovered resources of each play's ultimate gas resources is shown in Figure 4.

The original gas resource estimate for the Jean Marie - Helmet play was exceeded and drilling activity continues to increase the established reserves estimates for pools in this play. An updated resource assessment for this play has been included (Table 3).

Revisions to the remaining undiscovered gas resource estimates for each play are shown in Table 4. These gas resources are combined with cumulative gas production and remaining established gas reserves (Figure 4) to provide a comparison of ultimate gas resources for each geological play.

FIGURE 3

Average Reserve Addition Size for New Pools by Geological Play



Conclusions

1. Reserves replacement of production volumes is approximately 87 percent over the past five years.

2. Annual conversion rate of undiscovered gas resources to proven reserves is about 1.4 percent or seven percent in total over the five years.

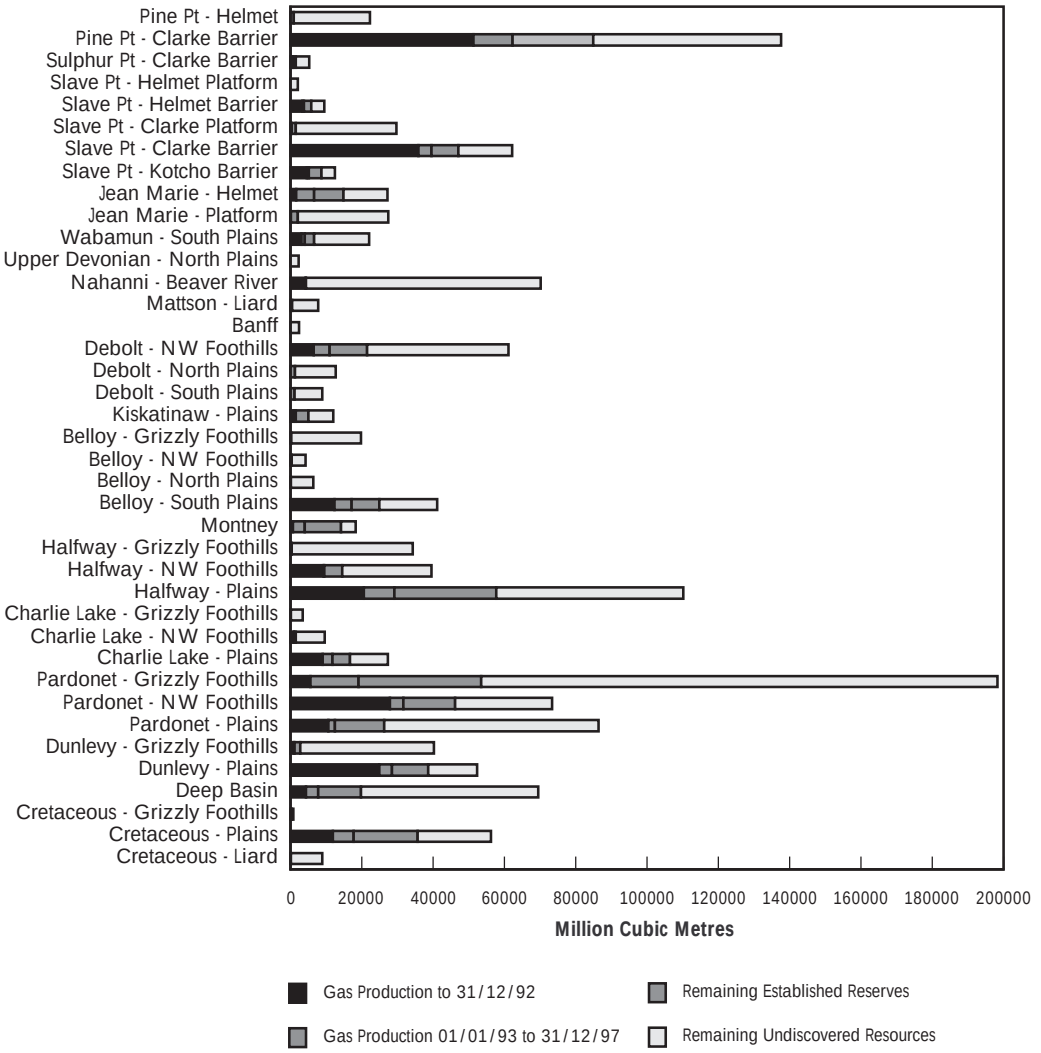
3. Discoveries in the Foothills plays are expected to exceed the average northeast British Columbia pool size of 184 10^6m^3 (6.5 Bcf). Devonian plays in the northern part of the region should also have discoveries greater than the average pool size.

4. Exploration will need to shift to the Foothills areas to add the volume of reserves required to meet or exceed production forecasts.

5. The Plains area will continue to be attractive for drilling due to the accessibility to existing infrastructure and likelihood of finding new pools.

F I G U R E 4

Ultimate Gas Resources by Geological Play



References

BCMEMPR, 1993, British Columbia Ministry of Energy, Mines and Petroleum Resources, *Hydrocarbon and By-Product Reserves in British Columbia - 1992*.

BCMEM, 1998, British Columbia Ministry of Energy and Mines, *Hydrocarbon and By-Product Reserves in British Columbia - 1997*.

BCMEM, 1998, British Columbia Ministry of Energy and Mines, *Oil and Gas in British Columbia, Statistics 1987-1997*.

National Energy Board, 1994 (revised 1999), *Natural Gas Resource Assessment - Northeast British Columbia*.

TABLE 1

Volume Changes to Initial Established Reserves of Pre-existing Pools

Geological Play	Initial Established Gas Reserves ($10^6 m^3$)		
	1992	**1997**	**Difference**
Pine Point - Clarke Barrier	73 925	80 607	6 682
Jean Marie - Helmet	8 503	14 816	6 313
Belloy - South Plains	20 211	24 396	4 185
Pardonet/Baldonnel - Plains	19 475	22 182	2 707
Cretaceous - Plains	27 191	28 860	1 669
Jean Marie - Platform	476	1 619	1 143
Dunlevy - Plains	35 351	36 441	1 090
Charlie Lake - Plains	13 400	14 328	928
Slave Point - Kotcho Barrier	7 479	7 912	433
Wabamun - South Plains	6 337	6 659	322
Banff	63	84	21
Upper Devonian - North Plains	35	34	-1
Slave Point - Helmet Platform	81	80	-1
Mattson - Liard	527	518	-9
Belloy - North Plains	187	171	-16
Sulphur Point - Clarke Barrier	1 549	1 486	-63
Charlie Lake - Grizzly Foothills	161	91	-70
Belloy - Grizzly Foothills	454	266	-188
Debolt - North Plains	1 216	1 018	-198
Nahanni - Beaver River	4 382	4 181	-201
Slave Point - Clarke Platform	1 593	1 381	-212
Charlie Lake - Northwest Foothills	1 590	1 372	-218
Montney - Ring	12 978	12 694	-284
Pardonet - Northwest Foothills	42 907	42 578	-329
Slave Point - Clarke Barrier	45 026	44 542	-484
Debolt - South Plains	1 278	735	-543
Halfway - Grizzly Foothills	929	364	-565
Deep Basin	18 723	18 116	-607
Pine Point - Helmet	1 659	1 002	-657
Cretaceous - Grizzly Foothills	1 043	347	-696
Pardonet - Grizzly Foothills	35 252	34 473	-779
Kiskatinaw - Plains	4 447	3 542	-905
Slave Point - Helmet Barrier	6 885	5 178	-1 707
Halfway - Northwest Foothills	16 207	14 466	-1 741
Dunlevy - Grizzly Foothills	5 338	2 676	-2 662
Debolt - Northwest Foothills	19 050	15 346	-3 704
Halfway - Plains	54 897	48 114	-6 782
TOTAL	**490 805**	**492 675**	**1 870**

TABLE 2

Geological Plays Ranked by New Reserve Addition Volumes

Geological Play	1992 Initial Established Gas Reserves (10^6m^3)	Existing Reserves Adjustment (10^6m^3)	New Reserves Additions (10^6m^3)	1997 Initial Established Gas Reserves (10^6m^3)	New Pool Count
Pardonet/Baldonnel - Grizzly Foothills	35 252	-779	19 050	53 523	25
Halfway - Plains	54 897	-6 782	9 662	57 736	87
Cretaceous - Plains	27 191	1 669	6 701	35 561	64
Debolt - Northwest Foothills	19 050	- 3 704	6 163	21509	12
Pine Point - Clarke Barrier	73 925	6 682	4 354	84 961	12
Pardonet/Baldonnel - Plains	19 475	2 707	4 021	26 203	29
Pardonet/Baldonnel - Northwest Foothills	42 907	-329	3 612	46 190	7
Slave Point - Clarke Barrier	45 026	-484	2 589	47 131	6
Charlie Lake - Plains	13 400	928	2 437	16 765	60
Dunlevy - Plains	35 351	1 090	2 151	38 592	22
Deep Basin	18 723	-607	1 690	19 806	12
Kiskatinaw - Plains	4 447	-905	1 516	5 058	7
Montney - Ring	12 978	-284	1 398	14 092	4
Slave Point - Kotcho Barrier	7 479	433	848	8 760	2
Slave Point - Helmet Barrier	6 885	- 1 707	630	5 808	2
Belloy - South Plains (PRA)	20 211	4 185	589	24 985	2
Cretaceous - Grizzly Foothills	1 043	-696	528	875	4
Jean Marie - Platform	476	1 143	523	2 142	5
Debolt - South Plains	1 278	-543	399	1 134	3
Debolt - North Plains	1 216	-198	299	1 317	4
Cretaceous - Liard	0	0	172	172	1
Jean Marie - Helmet	8 503	6 313	122	14 938	5
Slave Point - Clarke Platform	1 593	-212	123	1 504	1
Charlie Lake - Northwest Foothills	1 590	-218	101	1 473	1
Halfway - Northwest Foothills	16 207	- 1 741	73	14 539	1
Dunlevy - Grizzly Foothills	5 338	- 2 662	51	2 727	1
Pine Point - Helmet	1 659	-657	0	1 002	0
Sulphur Point - Clarke Barrier	1 549	-63	0	1 486	0
Slave Point - Helmet Platform	81	-1	0	80	0
Wabamun - South Plains	6 337	322	0	6 659	0
Upper Devonian - North Plains	35	-1	0	34	0
Nahanni - Beaver River	4 382	-201	0	4 181	0
Mattson - Liard	527	-9	0	518	0
Belloy - Grizzly Foothills	454	-188	0	266	0
Belloy - North Plains	187	-16	0	171	0
Banff	63	21	0	84	0
Halfway - Grizzly Foothills	929	-565	0	364	0
Charlie Lake - Grizzly Foothills	161	-70	0	91	0
TOTAL [1]	**490 805**	**1 870**	**70 158**	**562 833**	**379**

[1] totals will not match BCMEM total due to rounding

TABLE 3

Remaining Undiscovered Gas Resource Volumes Ranked by Geological Age

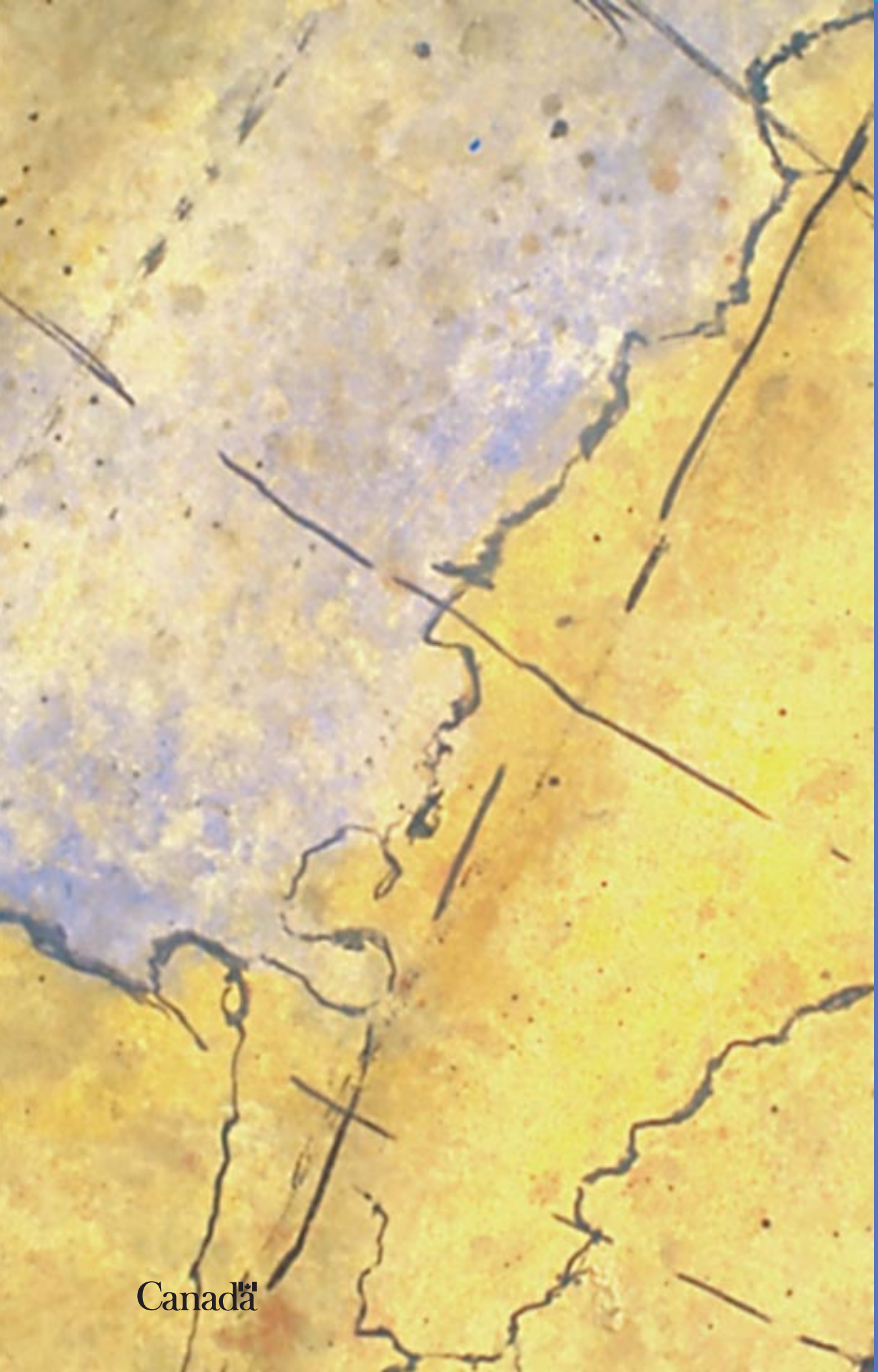
Geological Play	1992 Remaining Undiscovered Resources (10^6m^3)	1997 Initial Established Reserves (10^6m^3)	1997 Remaining Undiscovered Resources (10^6m^3)	Ultimate Resource Total (10^6m^3)
Pine Point - Helmet	20 655	1 002	21 312	22 314
Pine Point - Clarke Barrier	63 742	84 961	52 706	137 667
Sulphur Point - Clarke Barrier	3 691	1 486	3 754	5 240
Slave Point - Helmet Platform	1 961	80	1 962	2 042
Slave Point - Helmet Barrier	2 677	5 808	3 754	9 562
Slave Point - Clarke Platform	28 154	1 504	28 243	29 747
Slave Point - Clarke Barrier	17 320	47 131	15 104	62 235
Slave Point - Kotcho Barrier	5 067	8 760	3 786	12 546
Jean Marie - Helmet [1]	5 784	14 938	12 280	27 418
Jean Marie - Platform	27 014	2 142	25 348	27 490
Wabamun - South Plains	15 707	6 659	15 385	22 044
Upper Devonian - North Plains	2 312	34	2 313	2 347
Nahanni - Beaver River	65 671	4 181	65 872	70 053
Mattson - Liard Basin	7 241	518	7 250	7 768
Banff	2 380	84	2 359	2 443
Debolt - South Plains	7 704	1 134	7 848	8 982
Debolt - North Plains	11 451	1 317	11 350	12 667
Debolt - Northwest Foothills	41 947	21 509	39 723	61 232
Kiskatinaw - Plains	7 550	5 058	6 939	11 997
Belloy - Grizzly Foothills	19 333	266	19 521	19 787
Belloy - Northwest Foothills	4 229	396	3 833	4 229
Belloy - North Plains	6 220	171	6 236	6 407
Belloy - South Plains (PRA)	21 000	24 985	16 226	41 211
Montney - Ring	5 273	14 092	4 159	18 251
Halfway - Grizzly Foothills	33 334	364	33 899	34 263
Halfway - Northwest Foothills	23 378	14 539	25 046	39 585
Halfway - Plains	55 255	57 736	52 415	110 151
Charlie Lake - Grizzly Foothills	3 352	91	3 422	3 513
Charlie Lake - Northwest Foothills	7 998	1 473	8 115	9 588
Charlie Lake - Plains	13 952	16 765	10 587	27 352
Pardonet/Baldonnel - Grizzly Foothills	163 122	53 523	144 851	198 374
Pardonet/Baldonnel - NW Foothills	30 457	46 190	27 174	73 364
Pardonet/Baldonnel - Plains	66 972	26 203	60 262	86 465
Dunlevy - Grizzly Foothills	34 921	2 727	37 532	40 259
Dunlevy - Plains	17 031	38 592	13 790	52 382
Cadotte/Gething - Deep Basin	50 705	19 806	49 622	69 428
Cretaceous - Grizzly Foothills	N.A.	875	N.A.	N.A.
Cretaceous - Plains	29 068	35 561	20 698	56 259
Cretaceous - Liard Basin	8 917	172	8 745	8 917
TOTAL	**932 545**	**562 833**	**873 421**	**1 436 254**

[1] original 1994 ultimate resource estimate revised. New estimate listed.

TABLE 4

Geological Plays Ranked by Remaining Undiscovered Gas Resource Volumes

Rank	Geological Play	$10^6 m^3$	Bcf
1	Pardonet/Baldonnel - Grizzly Foothills	144 851	5113
2	Nahanni - Beaver River	65 872	2325
3	Pardonet/Baldonnel - Plains	60 262	2127
4	Pine Point - Clarke Barrier	52 706	1861
5	Halfway - Plains	52 415	1850
6	Cadotte/Gething - Deep Basin	49 622	1752
7	Debolt - Northwest Foothills	39 723	1402
8	Dunlevy - Grizzly Foothills	37 532	1325
9	Halfway - Grizzly Foothills	33 899	1197
10	Slave Point - Clarke Platform	28 243	997
11	Pardonet/Baldonnel - Northwest Foothills	27 174	959
12	Jean Marie - Platform	25 348	895
13	Halfway - Northwest Foothills	25 046	884
14	Pine Point - Helmet	21 312	752
15	Cretaceous - Plains	20 698	731
16	Belloy - Grizzly Foothills	19 521	689
17	Belloy - South Plains (PRA)	16 226	573
18	Wabamun - South Plains	15 385	543
19	Slave Point - Clarke Barrier	15 104	535
20	Dunlevy - Plains	13 790	487
21	Jean Marie - Helmet	12 280	433
22	Debolt - North Plains	11 350	401
23	Charlie Lake - Plains	10 587	374
24	Cretaceous - Liard Basin	8 745	309
25	Charlie Lake - Northwest Foothills	8 115	286
26	Debolt - South Plains	7 848	277
27	Mattson - Liard Basin	7 250	256
28	Kiskatinaw - Plains	6 939	245
29	Belloy - North Plains	6 236	220
30	Montney - Ring	4 159	147
31	Belloy - Northwest Foothills	3 833	135
32	Slave Point - Kotcho Barrier	3 786	134
33	Sulphur Point - Clarke Barrier	3 754	132
34	Slave Point - Helmet Barrier	3 754	132
35	Charlie Lake - Grizzly Foothills	3 422	121
36	Banff	2 359	83
37	Upper Devonian - North Plains	2 313	82
38	Slave Point - Helmet Platform	1 962	69
39	Cretaceous - Grizzly Foothills	N.A.	N.A.
	TOTAL	**873 421**	**30833**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