ER
22(21)
212tc
76-29
(c.2)

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

CANMET
Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

Doc 622(21)
c212tc

CANMET LIBRARY
JAN 1977
c2

MINING TECHNOLOGY IN 1974

R.J.R. WELWOOD

MINING RESEARCH LABORATORIES

SEPTEMBER 1976

MINERALS RESEARCH PROGRAM

MINING RESEARCH LABORATORIES

CANMET REPORT 76-29

© Minister of Supply and Services Canada 1976

Available by mail from

Printing and Publishing
Supply and Services Canada
Ottawa, Canada K1A 0S9

CANMET
Energy, Mines and Resources Canada,
555 Booth St.,
Ottawa, Canada K1A 0G1

or through your bookseller.

Catalogue No. M38–13/76-29 Price: Canada: $1.50
ISBN 0-660-00578-6 Other countries: $1.80

Price subject to change without notice.

© Ministre des Approvisionnements et Services Canada 1976

En vente par la poste:

Imprimerie et Édition
Approvisionnements et Services Canada,
Ottawa, Canada K1A 0S9

CANMET
Énergie, Mines et Ressources Canada,
555, rue Booth
Ottawa, Canada K1A 0G1

ou chez votre libraire.

Nº de catalogue M38–13/76-29 Prix: Canada: $1.50
ISBN 0-660-00578-6 Autres pays: $1.80

Prix sujet à changement sans avis préalable.

MINING TECHNOLOGY IN 1974

by
R.J.R.Welwood*

SUMMARY

The tonnage of metallic ore mined underground in Canada decreased slightly to 64.4 million tons in 1974 from 65.5 million tons in 1973, a decrease of 1.7%. An increase of less than 1% in surface-mined ore brought the total from surface operations to 239.7 million tons, i.e. approximately 79% of the total metallic ore mined in Canada.

In the non-metallic mines, there was a 10.6% increase from underground, largely owing to increased production of potash. A minor increase occurred in surface-mined non-metallic ores.

During 1974, approximately 40% of the metallic underground ore was mined by cut and fill methods or variations, followed by open stoping with about 36%. The tons mined by other underground methods were slightly reduced.

Sharp rises in underground mining costs are noted for 1974. This trend is expected to continue at a high rate in 1975. Surface mining costs in general showed only slight increases.

Key Words: Mining, Stoping, Mine Costs

*Mining Engineer, Mining Research Laboratories, CANMET, Department of Energy, Mines and Resources, Ottawa, Canada.

TECHNOLOGIE MINIERE EN 1974

par
R.J.R.Welwood*

RESUME

Le tonnage de minerai métallique exploité sous terre au Canada a été de 64.4 millions de tonnes en 1974 montrent une légère diminution de l'année 1973 qui était à 65.5 millions de tonnes, une baisse de 1.7%. Une augmentation de moins de 1% dans l'exploitation du minerai à ciel ouvert qui amena le total pour les opérations de surface à 239.7 millions de tonnes, i.e. 78% approximatif du total de minerai métallique exploité au Canada.

Pour ce qui est des mines non-métalliques, il y a eu une augmentation approximative de 10.6% de l'exploitation souterraine, dont une large part est attribuable à l'augmentation de la production de potasse. Une légère augmentation s'est produite concernant les minerais non-métalliques exploités à ciel ouvert.

Durant l'année 1974, approximativement 40% du minerai métallique sous terre a été extrait par méthodes d'abattage de déblais et remblais ou par des méthodes variées, suivit de l'abattage à chambre ouverte avec 36%. Les tonnes extraites par d'autres méthodes souterraines ont été à peine réduites. Des hausses importantes des coûts d'exploitation souterraine sont signalées en 1975. En general, les coûts d'exploitation à ciel ouvert ont augmentés légèrement.

Mots Clefs: exploitation, abatage en gradins, le coût des mines

*Ingénieur minier, Laboratoires de recherches minières, CANMET, Ministére de l'énergie, mines et des ressources, Ottawa, Canada.

CONTENTS

	page
Introduction	1
Production analysis	1
Tonnage of ore and waste mined	1
Underground and surface mining	4
Mining methods used in breaking of Canadian ores	6
Rock breaking analysis	13
Employment in producing mines	13
Operating costs	26
Acknowledgements	33

FIGURES

1. Value of Canadian mineral production by classes, 1955-1974 ---- 2

LIST OF TABLES

1. Tonnage of ore mined and rock quarried in Canada, selected years, 1950-1974 ---- 3
2. Ore distribution, surface and underground ---- 5
3. Methods used in mining of Canadian ores, 1969 ---- 7
4. Methods used in mining of Canadian ores, 1970 ---- 8
5. Methods used in mining of Canadian ores, 1971 ---- 9
6. Methods used in mining of Canadian ores, 1972 ---- 10
7. Methods used in mining of Canadian ores, 1973 ---- 11
8. Methods used in mining of Canadian ores, 1974 ---- 12
9. Rock breaking analysis, Canadian mines, 1968-69 ---- 14
10. Rock breaking analysis, Canadian mines, 1970 ---- 15
11. Rock breaking analysis, Canadian mines, 1971 ---- 16
12. Rock breaking analysis, Canadian mines, 1972 ---- 17
13. Rock breaking analysis, Canadian mines, 1973 ---- 18
14. Rock breaking analysis, Canadian mines, 1974 ---- 19
15. Summary of employment, Canadian producing mines, 1969 ---- 20

16. Summary of employment, Canadian producing mines, 1970---------- 21
17. Summary of employment, Canadian producing mines, 1971---------- 22
18. Summary of employment, Canadian producing mines, 1972---------- 23
19. Summary of employment, Canadian producing mines, 1973---------- 24
20. Summary of employment, Canadian producing mines, 1974---------- 25
21. Analysis of operating costs of selected mines, 1969---------- 27
22. Analysis of operating costs of selected mines, 1970---------- 28
23. Analysis of operating costs of selected mines, 1971---------- 29
24. Analysis of operating costs of selected mines, 1972---------- 30
25. Analysis of operating costs of selected mines, 1973---------- 31
26. Analysis of operating costs of selected mines, 1974---------- 32

INTRODUCTION

As well as pursuing research in matters of interest to the mineral industry, the Canada Centre for Mineral and Energy Technology (CANMET), formerly Mines Branch, of the Department of Energy, Mines and Resources, gathers information on trends in mining technology. The purpose of this activity is to assess the effect of new developments and to identify areas into which research efforts can profitably be directed.

CANMET works closely with Statistics Canada in the gathering of production and technical information. Information for the compilation of this report is obtained from Statistics Canada, technical literature and mining companies and associations.

A series of tables is presented which outlines the growth of mining and shows trends in technology. Complete production data are available for 1974; data for 1975 will not appear until early 1977.

PRODUCTION ANALYSIS

Tonnage of ore and waste mined

Table 1 shows the tonnage of ore mined and rock quarried in the Canadian mining industry for selected years between 1950 and 1974. Statistics Canada reports of ore mined exclude waste material for all minerals except asbestos, where waste broken in surface mines is included. To bring the tables for metals and non-metals in this report to the same standard, waste has been excluded for non-metal mines, commencing in 1968. Table 1 shows the changes in the scale of production of metal and non-metal ores. During 1974 there were minor increases in ore production of copper, gold, silver, cobalt and nickel. There was an increase in production of non-metallic ore, largely accounted for by increased potash and asbestos production. The production of coal showed an increase to 25.5 million tons in 1974 and the preliminary estimate for 1975 anticipates a similar additional increase.

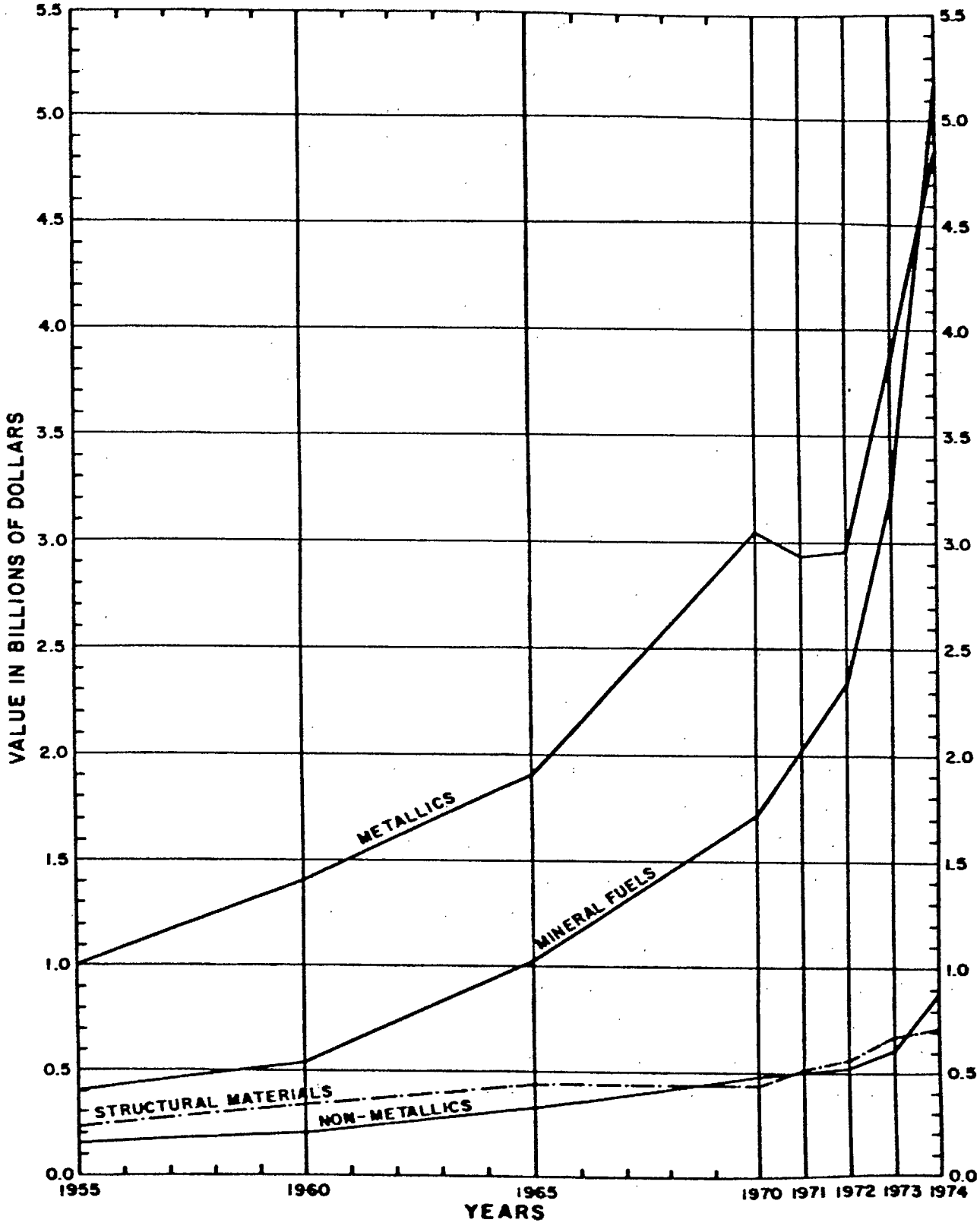

Figure 1. Value of Canadian Mineral Production by Classes, 1955-1974

TABLE 1

TONNAGE OF ORE MINED AND ROCK QUARRIED IN CANADA

Selected Years, 1950 to 1974

(millions of net tons)

Types of Mines	1950	1960	1965	1970	1971	1972	1973	1974
METAL MINES (excluding waste broken)								
Gold - Quartz	17.0	14.7	12.0	8.0	7.4	6.7	6.5	6.2
Uranium[1]	-	-	-	2.0	3.2	3.2	3.1	2.9
Iron Ore	4.4	33.0	89.2	103.0	100.8	93.6	119.9	118.0
Copper - Gold - Silver	8.8	14.0	20.0	42.3	48.8	72.1	116.7	120.4
Nickel - Copper	10.8	20.8	24.3	34.6	34.2	25.5	25.8	27.3
Silver - Cobalt	0.7	0.2	0.3	0.2	0.3	0.1	0.1	0.2
Silver - Lead - Zinc	4.8	5.8	10.1	14.0	14.4	12.3	16.8	15.5
Molybdenum[1]	-	-	-	18.1	12.3	7.1	10.3	9.2
Misc. Metal Mines	0.2	13.0	10.7	4.0[2]	4.1	3.6	3.9	4.5
Sub-total, Metal Mines[3]	46.7	101.5	166.6	226.4	225.5	224.2	303.2	304.2
NON-METAL MINES (excluding waste broken)								
Asbestos[4]	12.2	33.2	53.4	34.9	36.1	34.3	36.3	38.1
Gypsum	3.8	5.1	6.1	6.2	6.5	8.0	8.4	7.1
Talc and Soapstone	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Feldspar, Quartz, Neph Syen.	1.1	1.6	2.0	1.2	2.1	2.0	1.9	1.9
Rock Salt	-	1.3	3.4	4.4	4.6	4.6	4.0	3.8
Potash[5]	-	-	-	13.9	15.6	17.0	20.6	24.2
Other non-metals	0.5	0.7	5.7	0.3	1.1	0.5	0.5	0.7
Sub-total, Non-Metal Mines[3]	17.6	42.0	70.7	61.0	66.1	66.5	71.8	75.9
Stone, all kinds, quarried	18.1	45.4	76.8	70.7	73.5	80.2	85.5	102.3
COAL MINING (excluding waste broken)								
Coal	18.5	10.7	11.4	16.6	18.4	20.7	22.6	25.5
Grand Total, Ore and Rock[3]	100.9	199.6	305.5	374.7	383.5	391.6	483.1	507.9

(1) with miscellaneous metals prior to 1970
(2) excludes uranium and molybdenum as of 1970
(3) may not balance owing to individual rounding
(4) waste included, 1950-1965, inclusive
(5) included with "other non-metals", prior to 1970.

Source: Statistics Canada, Reports.

Underground and surface mining

Table 2 gives a comparison of ore produced from underground and surface mines from 1950 to 1974. During 1974 there was a decrease of about 1.7% in the metallic ore mined from underground and an increase of about 0.8% in surface ore. Surface mined ore represented 79% of the total ore in metal mines in 1974, an all time high.

Table 2 does not show the large amounts of waste mined in surface mines. In 1971 the waste to ore ratio for producing surface metal mines was 0.94:1; in 1972 the ratio was 0.89:1; in 1973, 0.82:1 and in 1974 remained at 0.82:1. This includes only the waste which was drilled and blasted. It is estimated that about 30 million tons of waste were excavated in producing surface metal mines without drilling and blasting. There was also an unknown tonnage of waste from mines in the pre-production period. Until a mine reaches production federal agencies do not gather data on waste mined.

In 1974, an estimated 3.9 million tons of waste were mined in underground metal mines to recover 64.4 million tons of ore. It is estimated that during 1974, 150 miles of lateral development and 50 miles of raises were driven in Canadian underground mines.

In surface mining of industrial minerals, the waste to ore ratio for 1974 is estimated at 2.30:1 against 1.24:1 in 1973. The ratio fluctuates depending on the opening of new mines and implementation of short-term major stripping programs in established mines. The smaller number of industrial mineral mines compared with metal mines tends to accentuate the effect of major stripping programs on the waste to ore ratio for the group. Close to 22 million tons of waste were mined in underground industrial mineral mines with asbestos accounting for the major portion.

During 1974, surface-mined coal accounted for 86% of the total coal. Tonnage in this report refers to clean coal. Not shown in Table 2 is the rock-waste drilled and blasted before coal can be removed in some western Canadian surface mines. For 1974, it is estimated that up to 60 million tons of waste rock were drilled and blasted.

TABLE 2

ORE DISTRIBUTION - SURFACE AND UNDERGROUND

(millions of net tons of ore broken)

	METAL MINES				NON-METAL MINES				COAL MINES			
Year	Underground	Surface	Total	Surface % of Total	Underground	Surface	Total	Surface % of Total	Underground	Surface	Total	Surface % of Total
1950	39.6	6.3	45.9	14	2.3	15.4	17.7	87	13.3	5.8	19.1	30
1960	74.8	26.8	101.6	26	3.5	38.5	42.0	92	6.7	4.3	11.0	39
1965	81.0	85.5	166.5	51	9.8	60.8	70.6	86	6.0	5.6	11.6	48
1966	67.5	94.8	162.3	58	11.1	67.4	78.5	86	6.0	5.4	11.4	47
1967	70.9	115.6	186.5	62	18.2	79.4	97.6	81	5.5	5.9	11.4	52
1968	70.0	135.0	205.0	66	17.9	38.2	56.1(1)	68	4.7	6.3	11.0	57
1969	62.7	127.8	190.5	67	20.2	38.3	58.5	65	4.3	6.4	10.7	60
1970	71.3	155.1	226.4	69	20.8	40.2	61.0	66	4.6	12.0	16.6	72
1971	75.5	149.9	225.4	66	23.0	42.9	65.9	65	4.6	13.8	18.4	75
1972	64.2	160.2	224.4	72	24.2	42.3	66.5	64	4.3	16.4	20.7	79
1973	65.5	237.7	303.2	78	27.7	44.2	71.9	62	3.7	18.9	22.6	84
1974	64.4	239.7	304.1	79	31.0	44.9	75.9	59	3.6	21.9	25.5	86

(1) waste not included for 1968 and later years.

Source: Statistic's Canada and author's estimates

If waste (tailings) rejected during processing is taken into account, it can readily be seen that the final saleable product from mines represents only a small part of the volume actually mined. For example, in all asbestos mining in 1974, about 38.1 million tons of ore were mined and 110.9 million tons of waste rock were broken for a total of 149.0 million tons. The fibre actually shipped amounted to 1.9 million tons or 1.3% of the ore and waste mined. In addition, the asbestos mining companies excavated several million tons of overburden without blasting, which is not included in the estimates. In base metal mining, a greater percentage of the product is shipped owing to the different degree to which the ore is concentrated; however, tonnage shipped may be only 10 to 15% of that mined.

Mining methods used in breaking Canadian ores

Tables 3 to 8 show the mining methods used in breaking Canadian ores from 1969 to 1974 inclusive. In compiling these tables, it was difficult to classify some underground mines owing to variations of recognized mining methods. However, the tonnage of such material mined was distributed as impartially as possible among the recognized methods.

An example of the difficulty of classifying mining methods is illustrated by open stoping whereby the ore may be drilled off with either long or short holes. The sublevel caving method sometimes does not rely on "caving" for breaking the ore, in which case it could be considered as open stoping. Again, a mining company may rely largely on caving, yet may induce caving by doing some drilling and blasting.

Since 1970, mining methods have been reclassified to exclude "blasthole stoping", a term which is inconsistent with the normal classification according to the method of support. Long holes may be used for shrinkage, open or other stoping. For purposes of this report, long holes are those which are longer than 25 feet.

Tables 3 to 8 show that cut-and-fill stoping or variations of it are most widely used in underground metal mining, followed by open stoping with long holes.

TABLE 3

METHODS USED IN MINING OF CANADIAN ORES - 1969

(millions of net tons of ore broken)

ORE MINED	Total No. of Mines	Tons Broken	UNDERGROUND MINES								SURFACE MINES	
			Stoping Methods									
			Shrinkage	Cut & Fill Sg. Set. Stulls	Longholes Open Stopes Sublevel	Shortholes Open Stopes Sills	Room & Pillar Panel	Caving -block -sublevel	Number of mines	Tons Ore Broken	Number of mines	Tons Ore Broken
METAL MINES												
Gold - Quartz	32	9.03	2.46	3.33	2.59	0.65	-	-	32	9.03	nil	-
Copper - Gold	54	33.14	2.06	4.40	5.86	1.71	1.19	1.10	43	16.32	11	16.82
Nickel - Copper	28	22.16	1.53	10.31	3.99	0.06	-	4.00	24	19.89	4	2.27
Silver - Cobalt	7	0.22	0.22	-	-	-	-	-	7	0.22	nil	-
Silver - Lead - Zinc	21	13.51	0.61	0.99	4.15	0.11	2.80	-	18	8.66	3	4.85
Uranium	4	3.06	-	0.44	-	-	2.60	-	3	3.04	n/a	n/a
Iron Ore	18	90.88	-	-	2.21	-	1.34	-	3	3.55	15	87.33
All Other Metals	13	18.43	0.38	0.12	1.28	-	0.17	-	6	1.95	7	16.48
Total Metals (1)	177	190.43	7.26	19.59	21.18	2.43	8.10	5.10	136	62.66	40	127.75
NON-METAL MINES												
Asbestos	13	32.54	-	-	-	-	-	n/a	2	n/a	11	30.63
Gypsum	12	6.56	-	-	-	-	0.71	-	3	0.71	9	5.85
Salt	3	3.21	-	-	-	-	3.21	-	3	3.21	nil	-
Barite	2	n/a	-	n/a	-	-	-	n/a	2	n/a	nil	-
Feldspar, Qtz, Neph-syen	12	1.73	-	-	-	-	-	-	nil	-	12	1.73
Potash	8	13.84	-	-	-	-	13.84	-	8	13.84	nil	-
Talc and Pyrophyllite	3	0.05	n/a	-	-	-	-	-	2	n/a	1	n/a
Fluorspar and Misc.	2	0.27	-	0.20	0.07	-	-	-	2	0.27	nil	-
Total Non-Metals (1)	55	58.45	n/a	0.26	0.07	-	17.76	2.06	22	20.17	33	38.28
FUELS												
Coal	43	10.67	-	-	mined by longwall and room and pillar methods				18	4.27	25	6.40
Total, all ores (1)	275	259.55	7.28	19.85	21.25	2.43	27.44	7.16	176	87.10	99	172.45

(1) Totals may not balance due to individual rounding and to absence of data (noted n/a) which could not be published under the Statistics Act.

Source: Statistics Canada and author's estimates.

TABLE 4

METHODS USED IN MINING OF CANADIAN ORES - 1970

(millions of net tons of ore broken)

ORE MINED	Total No. of Mines	Total Tons Broken	UNDERGROUND MINES									SURFACE MINES	
			Stoping Methods										
			Shrinkage	Cut & Fill Undercut & Fill	Open Stoping	Room and Pillar	Sublevel Caving	Caving, Other	Other Methods	No. of Mines	Tons Ore Broken	No. of Mines	Tons Ore Broken
METAL MINES													
Gold - Quartz	29	8.01	2.00	2.87	1.44	0.13	0.22	1.09	0.27	29	8.01	nil	-
Uranium	4	1.96		0.33		1.63				4	1.96	1	n/a
Iron Ore	15	102.96	-	-	-	-	-	-	-	2	n/a	14	99.52
Copper - Gold - Silver	50	42.43	2.78	3.61	7.96	0.43	1.98	0.52		36	17.28	14	25.16
Nickel - Copper	29	34.64	2.96	11.59	2.52	-	8.17	5.52	0.31	24	31.07	5	3.59
Silver - Cobalt	7	0.25	0.22	-	-	-	-	-	-	6	0.22	1	n/a
Silver - Lead - Zinc	26	13.96	0.47	0.55	5.51	.23	-	.03	0.20	22	6.98	4	6.98
Molybdenum	7	18.10	0.66	-	0.68	-	-	-	-	4	1.34	3	16.76
Other Metals	6	4.05	-	0.18	0.71	0.16	-	-	-	3	1.05	3	3.00
Total Metals[1]	173	226.36	9.09	19.13	18.82	2.58	10.37	7.16	0.78	130	67.93	45	155.01
NON-METAL MINES													
Asbestos	13	34.93	-	-	-	-	-	n/a	-	2	n/a	11	33.14
Gypsum	10	6.18	-	-	-	0.34	-	-	-	3	0.34	7	5.84
Talc-Soapstone-Pyrophyllite	4	0.03	n/a	-	n/a	-	-	n/a	-	2	n/a	2	n/a
Feldspar and Quartz	9	1.16	-	-	-	-	-	-	-	nil	-	9	1.16
Salt (mined only)	3	4.37	-	-	-	4.37	-	-	-	3	4.37	nil	-
Potash	9	13.93	-	-	-	13.93	-	-	-	9	13.93	nil	-
Other non-metals	4	0.33	-	0.20	.03	-	-	0.11	-	3	0.33	1	n/a
Total, Non-Metals[1]	52	60.93	-	0.20	0.03	18.64	-	0.11		22	18.97	30	39.14
FUELS													
Coal	29[2]	16.60	Underground coal mined by longwall and room and pillar, not included in totals below.							15	4.62	14	11.98
Total, all ores[1]	254	303.89	9.09	19.33	18.85	21.22	10.37	7.27	0.78	167	91.52	89	206.13

(1) Totals may not balance due to individual rounding and to absence of data (noted n/a) which cannot be published under the Statistics Act.

(2) Includes only mines producing 25,000 tons per year or more, but total tons produced is from all mines.

Source: Statistics Canada and author's estimates.

TABLE 5

METHODS USED IN MINING OF CANADIAN ORES, 1971

(millions of net tons of ore broken)

ORE MINED	Total No. of Mines	Total Tons Broken	UNDERGROUND MINES									SURFACE MINES	
			Stoping Methods										
			Shrinkage	Cut & Fill Undercut & Fill	Open Stoping	Room and Pillar	Sublevel Caving	Caving Other	Other Methods	No. of Mines	Tons Ore Broken	No. of Mines	Tons Ore Broken
METAL MINES													
Gold - Quartz	27	7.38	1.89	3.29	1.57	-	.12	-	.09	27	7.38	nil	-
Uranium	4	3.17	-	.21	-	2.95	-	-	-	3	3.16	1	.01
Iron Ore	17	100.75	-	-	1.09	.08	1.54	1.5	-	3	4.21	14	96.55
Copper - Gold - Silver	52	48.73	3.00	3.04	10.00	.30	5.0	-	.30	38	21.95	14	26.78
Nickel - Copper	10	34.23	4.04	16.53	2.22	.01	6.49	1.00	.53	8	30.81	2	3.42
Silver - Cobalt	7	.26	.21	-	.05	-	-	-	-	7	.26	nil	-
Silver - Lead - Zinc	19	14.40	.44	1.70	4.01	.03	-	.01	.17	15	6.36	4	8.04
Molybdenum	8	12.32	.09	-	.58	-	-	-	-	4	.67	4	11.65
Other Metals	6	4.11	-	.12	.35	.16	-	-	.07	3	.70	3	3.41
Total Metals[1]	150	225.35	9.67	24.89	19.87	3.53	13.15	2.51	1.16	108	75.50	42	149.86
NON-METAL MINES													
Asbestos	13	36.06	-	-	-	-	-	n/a	-	2	n/a	11	34.24
Gypsum	11	6.46	-	-	-	.81	-	-	-	3	.81	8	5.65
Talc - Soapstone - Pyrophyllite	4	.07	n/a	-	-	-	n/a	n/a	-	2	n/a	2	n/a
Feldspar & Quartz	12	2.08	-	-	-	-	-	-	-	nil	-	12	2.08
Salt	3	4.58	-	-	-	4.58	-	-	-	3	4.58	nil	-
Potash	8	15.60	-	-	-	15.60	-	-	-	8	15.60	nil	-
Other, Non-Metals	10	1.08	-	.13	.01	-	-	.04	-	2	.18	8	.90
Total Non-Metals[1]	61	65.93		.13	.01	20.99		.04		20	23.02	41	42.91
FUELS													
Coal	26[2]	18.43	Underground coal mined by longwall, room and pillar and hydraulicking, not included in totals below.							13	4.62	13	13.81
Total, All Ores[1]	237	309.71	9.68	25.02	19.88	24.52	13.16	4.38	1.16	141	103.14	96	206.58

(1) Totals may not balance owing to individual rounding and to absence of data (noted n/a) which cannot be published under The Statistics Act

(2) Includes only mines producing 25,000 tons per year or more, but total tons produced is from all mines.

Source: Statistics Canada and author's estimates.

TABLE 6

METHODS USED IN MINING OF CANADIAN ORES, 1972

(millions of net tons of ore broken)

ORE MINED	Total No. of Mines	Total Tons Broken	UNDERGROUND MINES									SURFACE MINES	
			Stoping Methods										
			Shrinkage	Cut & Fill Undercut & Fill	Open Stoping	Room and Pillar	Sublevel Caving	Caving Other	Other Methods	No. of Mines	Tons Ore Broken	No. of Mines	Tons Ore Broken
METAL MINES													
Gold - Quartz	21	6.74	1.47	2.65	1.28	-	.56	.29	.31	21	6.74	nil	-
Uranium	3	3.20	.10	.10	-	2.67	-	-	.33	3	3.20	nil	-
Iron Ore	17	93.60	-	-	4.17	.12	.11	-	-	3	4.39	14	89.20
Copper - Gold - Silver	53	72.12	.95	4.49	6.73	2.11	4.27	.95	.53	36	20.02	17	52.10
Nickel - Copper	13	25.46	.18	16.31	2.86	-	1.68	1.00	.95	9	22.97	4	2.49
Silver - Cobalt	4	0.13	.13	-	-	-	-	-	-	4	0.13	nil	-
Silver - Lead - Zinc	15	9.44	.46	.15	4.85	-	-	-	.08	12	5.41	3	4.02
Molybdenum	4	7.14	.18	.02	-	-	-	-	-	2	.21	2	6.93
Other Metals	8	3.62	.60	.12	.03	.36	-	-	-	5	1.12	3	2.50
Total Metals[1]	138	221.45	4.07	23.84	19.94	5.26	6.62	2.24	2.20	95	64.19	43	157.24
NON-METAL MINES													
Asbestos	13	34.26	-	-	-	-	-	1.29	-	2	n/a	11	32.97
Gypsum	10	8.04	-	-	-	.88	-	-	-	3	.88	7	7.16
Talc - Soapstone - Pyrophy	4	.09	n/a	-	-	-	n/a	n/a	-	2	n/a	2	n/a
Feldspar & Quartz	12	1.99	-	-	-	-	-	-	-	nil	-	12	1.99
Salt	3	4.62	-	-	-	4.62	-	-	-	3	4.62	nil	-
Potash	8	16.99	-	-	-	16.99	-	-	-	8	16.99	nil	-
Other, Non-Metals	8	.52	-	.24	.15	-	-	-	-	3	.40	5	.12
Total Non-Metals[1]	58	66.51	.01	.24	.15	22.49	.01	1.30	-	21	24.22	37	42.29
FUELS													
Coal	29[2]	20.70	Underground coal mined by longwall, room & pillar, & hydraulicing, not included in totals below									20	16.40
Total, All Ores[1]	225	308.66	4.08	24.08	20.09	27.75	6.64	3.54	2.20	116	88.41	100	215.93

(1) Totals may not balance owing to individual rounding and to absence of data (noted n/a) which cannot be published under The Statistics Act

(2) Includes only mines producing 25, 000 tons per year or more, but total tons produced is from all mines.

Source: Statistics Canada and author's estimates.

TABLE 7

METHODS USED IN MINING OF CANADIAN ORES, 1973

(millions of net tons of ore broken)

ORE MINED	Total No. of Mines	Total Tons Broken	UNDERGROUND MINES — Stoping Methods: Shrinkage	Cut & Fill Undercut & Fill	Open Stoping	Room and Pillar	Sublevel Caving	Caving Other	Other Methods	No. of Mines	Tons Ore Broken	SURFACE MINES: No. of Mines	Tons Ore Broken
METAL MINES													
Gold - Quartz	21	6.46	1.03	1.70	2.25	-	0.56	0.29	0.63	21	6.46	nil	-
Uranium	3	3.05	0.07	0.12	-	2.85	-	-	-	3	3.05	nil	-
Iron Ore	17	119.93	-	-	4.54	0.11	0.17	-	-	3	4.82	14	115.11
Copper - Gold - Silver	49	116.72	0.61	5.77	5.93	1.26	4.66	0.99	-	31	19.22	18	97.50
Nickel - Copper	34	25.49	0.08	17.13	2.76	-	1.68	-	0.49	28	22.14	6	3.35
Silver - Cobalt	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	n/a	nil	-
Silver - Lead - Zinc	23	10.91	0.55	1.93	3.24	-	0.19	-	2.45	17	8.37	6	8.46
Molybdenum	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1	n/a	1	n/a
Misc. Metals	7	3.94	-	0.09	0.69	0.15	-	-	-	5	0.93	2	3.01
Total Metals[1]	158	302.85	2.34	26.74	19.41	4.37	7.26	1.28	3.57	111	64.99	47	224.42
NON-METAL MINES													
Asbestos	13	36.32	-	-	-	-	-	1.64	-	2	n/a	11	34.68
Gypsum	10	8.40	-	-	-	0.93	-	-	-	3	0.93	7	7.47
Talc - Soapstone	4	0.09	n/a	-	n/a	-	-	n/a	-	2	n/a	2	n/a
Feldspar & Quartz	8	1.95	-	-	-	-	-	-	-	nil	-	8	1.95
Salt	3	3.99	-	-	-	3.99	-	-	-	3	3.99	nil	-
Potash	8	20.65	-	-	-	20.65	-	-	-	8	20.65	nil	-
Other Non-Metals	4	0.49	-	0.23	0.02	-	0.16	0.03	-	3	0.43	1	n/a
Total Non-Metals[1]	50	71.89	-	0.23	0.02	25.57	0.16	1.67	-	21	26.00	29	44.10
FUELS													
Coal	28[2]	22.55	Underground coal mined by longwall, room & pillar, & hydraulicing, not included in totals below							13	3.71	15	18.84
Total, All Ores[1]	236	397.29	2.34	26.95	19.43	29.94	7.42	2.95	3.57	145	94.90	91	287.36

(1) Totals may not balance owing to individual rounding and to absence of data (noted n/a) which cannot be published under The Statistics Act

(2) Includes only mines producing 25,000 tons per year or more, but total tons produced is from all mines

Source: Statistics Canada and author's estimates

TABLE 8

METHODS USED IN MINING OF CANADIAN ORES, 1974
(millions of net tons of ore broken)

ORE MINED	Total No. of Mines	Total Tons Broken	UNDERGROUND MINES									SURFACE MINES	
			Stoping Methods									SURFACE MINES	
			Shrinkage	Cut & Fill Undercut & Fill	Open Stoping	Room & Pillar	Sublevel Caving	Caving Other	Other Methods	No. of Mines	Tons Ore Broken	No. of Mines	Tons Ore Broken
	METAL MINES												
Gold - Quartz	21	6.17	0.92	1.54	2.99	-	-	0.43	0.29	21	6.17	nil	-
Uranium	3	2.90	0.02	0.14	1.45	0.99	-	-	0.30	3	2.90	nil	-
Iron Ore	17	117.97	-	-	4.34	0.06	-	-	-	3	4.40	14	113.57
Copper - Gold - Silver	45	120.40	0.68	3.84	6.22	1.53	4.76	-	0.22	28	17.25	17	103.25
Nickel - Copper	34	27.33	0.04	18.28	2.62	-	2.86	-	0.53	28	24.33	6	3.00
Silver - Cobalt	3	0.16	0.16	-	-	-	-	-	-	3	0.16	nil	-
Silver - Lead - Zinc	22	15.52	0.03	1.63	5.06	0.02	0.50	-	0.28	18	7.52	4	8.01
Molybdenum	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1	n/a	1	n/a
Misc. Metals	7	4.41	-	0.10	0.18	0.17	-	-	0.71	5	1.16	2	3.25
Total Metals (1)	154	294.86	1.85	25.53	22.86	2.77	8.12	0.43	2.33	110	63.89	44	230.98
	NON-METAL MINES												
Asbestos	13	38.06	-	-	-	-	-	n/a	-	2	n/a	11	36.18
Gypsum	9	7.01	-	-	-	0.65	-	-	-	3	0.65	6	6.36
Talc - Soapstone	4	n/a	n/a	-	n/a	-	-	n/a	-	2	n/a	2	n/a
Feldspar & Quartz	7	1.93	-	-	-	-	-	-	-	nil	-	7	1.93
Salt	3	3.82	-	-	-	3.82	-	-	-	3	3.82	nil	-
Potash	8	24.19	-	-	-	24.19	-	-	-	8	24.19	nil	-
Other Non-Metals	5	0.75	0.01	0.21	0.17	-	0.03	0.02	-	3	0.44	2	n/a
Total Non-Metals (1)	49	75.76	0.01	0.21	0.17	28.66	0.03	0.02	-	21	29.10	28	44.47
	FUELS												
Coal	23	25.47	Underground coal mined by longwall, room & pillar, & hydraulicing, not included in totals below							8	3.60	15	21.86
Total All Ores (1)	226	396.09	1.82	25.74	23.03	31.43	8.15	0.45	2.33	139	96.59	87	297.31

(1) Totals may not balance owing to individual rounding and to absence of data (noted n/a) which cannot be published under The Statistics Act
(2) Includes only mines producing 25,000 tons per year or more, but total tons produced is from all mines

Source: Statistics Canada and author's estimates

The room-and-pillar method dominates in underground mining of industrial minerals inasmuch as the method is ideally suited to Canadian deposits of potash, salt and gypsum.

Rock breaking analysis

Tables 9 to 14 give estimates of the amount of drilling required to break rock between 1968 and 1974. It is apparent from the tables that long hole drilling produces over five times as much broken rock per foot of hole as short hole drilling. There is also a correlation between the tons broken per foot drilling and stoping method. Where larger-scale stoping methods are in use, the yield per foot drilled is high, whereas the yield is low for small-scale stoping methods. This is illustrated in Table 13 by the higher yields shown in mining of iron ore, nickel, copper and lead-zinc compared with uranium and gold-quartz.

The large tonnage broken per foot of drilling in surface mining is to be expected owing to the large hole-diameter. During 1974, the yield in iron ore mining was 32.41 tons per foot drilled; the yield for asbestos mining was 19.08 tons per foot but the average for all surface industrial minerals (15.10 tons per foot) was less because of low yields for gypsum and quartz.

Employment in producing mines

Tables 15 to 20 show total employment, cost of labour and labour productivity in Canadian mines for 1969 to 1974. The final tabulation is affected by the different policies of mining companies in distributing operating costs. It might be assumed that iron ore companies are less productive but this is due to the inclusion of personnel in the extensive port materials-handling facilities.

From available data, it is concluded that productivity is highest in the surface mines of copper, molybdenum, lead-zinc and iron ore. Productivity in surface industrial mineral mines follows the pattern of previous years. The lowest productivity occurs in mines where small-scale underground operations were in effect (silver-cobalt) or where the mines

TABLE 9

ROCK BREAKING ANALYSIS, CANADIAN MINES

(average of years 1968 and 1969)

ORE MINED	UNDERGROUND MINES								SURFACE MINES			
	LONGHOLE DRILLING				SHORTHOLE DRILLING				LONGHOLE DRILLING			
	Tons ore & waste broken	Feet drilled	Most common bit diam.	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Most common bit diam.	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Most common bit diam.	Tons per foot drilled
	(millions)		(in.)		(millions)		(in.)		(millions)		(in.)	
METAL MINES												
Gold-Quartz	2.4	2.4	1 5/8	1.0	7.0	21.6	1 1/4	0.33	nil	-	-	-
Copper - Gold	7.1	6.0	1 3/4	1.2	10.2	24.9	1 1/4	0.41	49.0	2.3	9 7/8	21.2
Nickel - Copper	10.1	5.6	2 1/8	1.8	14.3	31.7	1 3/8	0.45	7.7	0.4	9 7/8	20.8
Silver - Cobalt	nil	-	-	-	0.3	1.4	1 1/4	0.20	nil	-	-	-
Lead - Zinc	4.4	4.2	2	1.1	4.8	11.3	1 1/4	0.43	8.4	0.4	9	20.5
Uranium	nil	-	-	-	3.4	9.2	1 3/8	0.36	nil	-	-	-
Iron Ore	3.9	1.7	2 1/8	2.2	nil	-	-	-	139.0	4.8	9 7/8 12 1/4	28.8
Other Metals	1.2	1.3	1 5/8	1.0	0.6	2.9	1 1/4	0.21	21.7	1.2	9	16.8
Total Metals[1]	29.1	21.2	-	1.4	40.6	103.0	-	0.40	225.8	9.1	-	24.7
NON-METAL MINES												
Asbestos	-	-	-	-	1.9	0.8	1 3/8	2.35	81.1	7.0	4 6 1/2	11.7
Gypsum	-	-	-	-	0.7	0.9	1 3/4	0.76	8.5	1.5	2 1/8	5.8
Salt	-	-	-	-	4.3	5.3	1 7/8	0.80	nil	-	-	-
Barite	-	-	-	-	0.2	0.3	2 1/8	0.71	nil	-	-	-
Feld. Qtz., N. Syen.	-	-	-	-	nil	-	-	-	1.7	0.3	3	5.4
Potash	Boring machines mostly used - little drilling and blasting								nil	-	-	-
Pyrophyllite and Talc	-	-	-	-	0.04	0.06	1 1/4	0.67	0.2	0.01	2 1/2	20.0
Fluorspar and Misc.	0.9	0.9	1 7/8	1.0	0.18	0.25	1 1/4	0.72	nil	-	-	-
Total Non-Metals[1]	0.9	0.9	-	1.0	7.3	7.6	-	0.96	91.5	8.8	-	10.4

(1) Totals may not balance owing to absence of data (shown n/a) which could not be published

n/a - not available

Source: Statistics Canada and author's estimates

TABLE 10

ROCK BREAKING ANALYSIS, CANADIAN MINES, 1970

ORE MINED	UNDERGROUND MINES								SURFACE MINES			
	LONGHOLE DRILLING				SHORTHOLE DRILLING				LONGHOLE DRILLING			
	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled
	(millions)		(inches)		(millions)		(inches)		(millions)		(inches)	
METAL MINES												
Gold - Quartz	1.2	0.9	1 5/8	1.35	7.2	18.0	1 1/4	0.40	nil	-	-	-
Uranium	n/a	n/a	n/a	n/a	2.2	10.0	1 3/8	0.22	n/a	n/a	n/a	n/a
Iron Ore	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	141.7	4.0	7 7/8 to 12 1/4	35.4
Copper - Gold - Silver	10.1	7.8	1 7/8	1.36	8.8	18.0	1 1/4	0.49	70.6	3.3	9	21.6
Nickel - Copper	11.3	5.7	2 1/8	1.99	21.5	30.7	1 3/8	0.70	10.4	0.3	9 7/8	33.9
Silver - Cobalt	-	-	-	-	0.2	1.0	1 1/4	0.20	n/a	n/a	n/a	n/a
Silver - Lead - Zinc	5.6	2.3	2 1/4	2.39	1.8	6.0	1 1/4	0.30	24.7	1.0	9	25.2
Molybdenum	0.7	0.6	-	1.28	0.7	2.5	1 1/4	0.28	21.8	1.0	9	21.6
Other Metal Mines	n/a	n/a	n/a	n/a	0.4	1.1	1 5/8	0.36	5.8	0.2	6 1/2	31.8
Total Metals[1]	28.9	17.3		1.67	42.8	87.3		0.49	275.0	9.8		28.1
NON-METAL MINES												
Asbestos	nil	-	-	-	n/a	n/a	1 3/8	1.92	88.7	6.2	2 to 9	14.3
Gypsum	nil	-	-	-	0.3	0.5	1 1/2	0.60	7.5	1.5	4	5.1
Talc - Soapstone - Pyrophyllite	nil	-	-	-	0.03	0.01	1 1/4	2.66	n/a	n/a	2 1/2	23.2
Feldspar and Quartz	nil	-	-	-	nil	-	-	-	1.3	0.2	3	5.6
Salt	nil	-	-	-	5.3	5.4	1 7/8	0.99	nil	-	-	-
Potash	Cutting machines used - little drilling and blasting								-	-	-	-
Other Non-Metals	-	-	-	-	0.3	0.7	1 3/8	0.42	n/a	n/a	n/a	n/a
Total, Non-Metals[1]					5.9	6.6		0.89	97.5	7.9		12.3

(1) Totals may not balance owing to absence of data (shown n/a) which could not be published.

n/a - not available

Source: Statistics Canada and author's estimates

TABLE 11

ROCK BREAKING ANALYSIS, CANADIAN MINES, 1971

ORE MINED	UNDERGROUND MINES								SURFACE MINES			
	LONGHOLE DRILLING				SHORTHOLE DRILLING				LONGHOLE DRILLING			
	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled
	(millions)		(inches)		(millions)		(inches)		(millions)		(inches)	
METAL MINES												
Gold - Quartz	0.4	0.4	2	1.00	7.2	14.0	1 ¼	0.51	nil	-	-	-
Uranium	n/a	n/a	n/a	n/a	3.42	8.0	1 3/8	0.43	n/a	n/a	n/a	n/a
Iron Ore	4.2	1.2	2 1/8	3.50	-	-	-	-	151.2	3.2	7 7/8 to 12¼	47.25
Copper - Gold - Silver	6.3	3.2	2	1.97	15.0	25.2	1 ¼	0.60	77.8	2.6	9 7/8	29.80
Nickel - Copper	8.7	3.5	2 ¼	2.49	25.4	43.7	1 ¼	0.58	9.7	n/a	n/a	-
Silver - Cobalt	-	-	-	-	0.3	0.4	1 ¼	0.75	n/a	n/a	n/a	-
Silver - Lead - Zinc	3.7	2.0	2	1.85	2.5	5.1	1 3/8	0.49	25.1	1.0	9	25.1
Molybdenum	n/a	n/a	n/a	n/a	0.6	0.6	1 ¼	1.00	20.7	1.0	2 ¾ & 9	20.7
Other Metal Mines	n/a	n/a	n/a	n/a	0.4	0.5	1 5/8	0.8	5.7	0.3	6 ½ & 3 ½	19.0
Total Metals(1)	23.0	10.7		2.15	54.82	97.5		0.56	290.2	8.1		36.0
NON-METAL MINES												
Asbestos	nil	-	-	-	n/a	n/a	1 3/8	n/a	82.4	5.1	2 ½ to 9	16.15
Gypsum	nil	-	-	-	0.8	1.8	n/a	0.44(3)	7.8	1.3	4	6.00(3)
Talc - Soapstone - Pyrophylite	nil	-	-	-	0.04	0.01	1 ¼	4.0	n/a	n/a	2 to 2 ½	-
Feldspar and Quartz	nil	-	-	-	nil	-	-	-	2.2	0.2	1 ½ to 4 ½	11.0
Salt	nil	-	-	-	5.3	5.6	1 7/8	0.95	nil	-	-	-
Other Non-Metals(2)	nil	-	-	-	0.2	0.2	1 3/8	1.0	1.2	n/a	n/a	-
Total Non-Metals(1)					8.14	7.11		1.01	93.6	5.8		16.14

(1) Totals may not balance owing to absence of data (shown n/a) which could not be published.
(2) Excluding potash.
(3) Revised.
Source: Statistics Canada and author's estimates

n/a - not available

TABLE 12

ROCK BREAKING ANALYSIS, CANADIAN MINES, 1972

ORE MINED	UNDERGROUND MINES								SURFACE MINES			
	LONGHOLE DRILLING				SHORTHOLE DRILLING				LONGHOLE DRILLING			
	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled	Tons ore & waste broken	Feet drilled	Common bit diameter	Tons per foot drilled
	(millions)		(inches)		(millions)		(inches)		(millions)		(inches)	
METAL MINES												
Gold Quartz	1.3	0.9	2	1.40	5.8	13.9	$1\frac{1}{4}$	0.42	-	-	-	-
Uranium	-	-	-	-	3.5	8.4	$1\frac{3}{8}$	0.42	-	-	-	-
Iron-Ore	4.5	1.8	$2\frac{1}{8}$	2.50	-	-	-	-	121.4	3.2	7 to $12\frac{1}{4}$	37.80
Copper - Gold - Silver	10.9	6.9	$2\frac{3}{8}$	1.60	10.2	14.4	$1\frac{1}{4}$	0.71	140.8	8.5	$2\frac{3}{4}$ to $12\frac{1}{4}$	16.50
Nickel - Copper	2.7	0.9	$2\frac{3}{4}$	3.00	22.1	42.6	$1\frac{1}{4}$	0.52	4.6	0.4	n/a	11.50
Silver - Cobalt	-	-	-	-	0.1	0.4	$1\frac{1}{4}$	0.25	-	-	-	-
Silver - Lead - Zinc	4.3	2.3	2	1.90	1.3	4.3	$1\frac{3}{8}$	0.30	20.3	0.9	9	22.60
Molybdenum	nil	n/a	n/a	n/a	0.2	n/a	n/a	n/a	11.7	0.5	9	23.30
Other Metal Mines	n/a	n/a	n/a	n/a	1.2	2.6	$1\frac{1}{4}$	0.46	4.1	0.3	$3\frac{1}{2}$ to $6\frac{1}{2}$	13.60
Total Metals[1]	23.7	12.8		1.85	44.4	86.6		0.51	282.9	13.8		20.50
NON-METAL MINES												
Asbestos	nil	-	-	-	n/a	n/a	$1\frac{3}{8}$	n/a	78.9	5.3	4 to 9	14.80
Gypsum	nil	-	-	-	0.9	1.9	$1\frac{1}{2}$	0.48	10.2	1.6	4	6.40
Talc - Soapstone - Pyroph	nil	-	-	-	0.04	.01	$1\frac{1}{4}$	4.00	n/a	n/a	2	n/a
Feldspar and Quartz	nil	-	-	-	nil	-	-	-	2.2	0.5	$1\frac{1}{2}$ to $4\frac{1}{2}$	4.40
Salt	-	-	-	-	5.6	4.6	$1\frac{7}{8}$	1.21	nil	-	-	-
Other Non-Metals[2]	0.2	0.1	$1\frac{7}{8}$	2.00	0.2	0.4	$1\frac{3}{8}$	0.50	0.1	n/a	n/a	n/a
Total Non-Metals[1]	0.2	0.1		2.00	8.4	7.0		1.20	91.4	7.4		12.20

(1) Totals may not balance owing to absence of data (shown n/a) which could not be published.

(2) Excluding potash.

n/a - not available

Source: Statistics Canada and author's estimates

TABLE 13

ROCK BREAKING ANALYSIS, CANADIAN MINES, 1973

ORE MINED	UNDERGROUND MINES								SURFACE MINES			
	LONGHOLE DRILLING				SHORTHOLE DRILLING				LONGHOLE DRILLING			
	Tons Ore & Waste Broken	Feet Drilled	Common Bit Diameter	Tons Per Foot Drilled	Tons Ore & Waste Broken	Feet Drilled	Common Bit Diameter	Tons Per Foot Drilled	Tons Ore & Waste Broken	Feet Drilled	Common Bit Diameter	Tons Per Foot Drilled
	(millions)		(inches)		(millions)		(inches)		(millions)		(inches)	
METAL MINES												
Gold - Quartz	2.5	1.1	$1\frac{5}{8}$	2.27	4.3	14.6	$1\frac{1}{4}$	0.29	-	-	-	-
Uranium	n/a	n/a	n/a	n/a	3.0	8.3	$1\frac{5}{8}$	0.36	n/a	n/a	n/a	n/a
Iron Ore	4.8	1.8	$2\frac{1}{8}$	2.67	-	-	-	-	175.9	5.1	7 to $12\frac{1}{4}$	34.49
Copper - Gold - Silver	9.7	4.6	$2\frac{1}{8}$	2.11	11.3	24.0	$1\frac{1}{4}$	0.47	200.3	6.6	9 & $9\frac{7}{8}$	30.35
Nickel - Copper	2.7	0.8	$2\frac{1}{4}$ - 6	3.38	21.6	38.9	$1\frac{1}{4}$	0.56	6.6	0.5	n/a	13.20
Silver - Cobalt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-	-
Silver - Lead - Zinc	3.2	1.8	2	1.78	5.4	7.0	$1\frac{5}{8}$	0.77	30.2	1.0	9	30.20
Molybdenum	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other Metal Mines	n/a	n/a	n/a	n/a	0.3	0.8	$1\frac{1}{4}$	0.38	n/a	n/a	n/a	n/a
Total Metals[1]	22.9	10.10		2.27	45.9	93.6		0.49	413.0	13.2	-	31.29
NON-METAL MINES												
Asbestos	nil	-	-	-	n/a	n/a	$1\frac{5}{8}$	n/a	89.2	5.1	4 to 9	17.49
Gypsum	nil	-	-	-	0.9	1.9	$1\frac{1}{2}$	0.49	10.0	1.7	4	5.88
Talc - Soapstone - Pyroph	nil	-	-	-	n/a	n/a	$1\frac{1}{4}$	n/a	n/a	n/a	2	n/a
Feldspar and Quartz	nil	-	-	-	nil	-	-	-	2.3	0.5	$1\frac{1}{2}$ to $4\frac{1}{2}$	4.60
Salt	nil	-	-	-	4.7	4.4	$1\frac{7}{8}$	1.07	nil	-	-	-
Other Non-Metals[2]	0.1	0.1	$1\frac{7}{8}$	1.00	0.3	0.4	$1\frac{5}{8}$	0.75	n/a	n/a	3	n/a
Total Non-Metals[1]	0.1	0.1		1.0	5.9	6.7		0.88	101.5	7.3		13.90

(1) Totals may not balance owing to absence of data (shown n/a) which could not be published

n/a - not available

(2) Excluding potash

Source: Statistics Canada and author's estimates

TABLE 14

ROCK BREAKING ANALYSIS, CANADIAN MINES, 1974

ORE MINED	UNDERGROUND MINES								SURFACE MINES			
	LONGHOLE DRILLING				SHORTHOLE DRILLING				LONGHOLE DRILLING			
	Tons Ore & Waste Broken	Feet Drilled	Common Bit Diameter	Tons Per Foot Drilled	Tons Ore & Waste Broken	Feet Drilled	Common Bit Diameter	Tons Per Foot Drilled	Tons Ore & Waste Broken	Feet Drilled	Common Bit Diameter	Tons Per Foot Drilled
	(millions)		(inches)		(millions)		(inches)		(millions)		(inches)	
	METAL MINES											
Gold - Quarts	1.4	0.8	$1\frac{5}{9}$	1.74	5.0	15.4	$1\frac{1}{4}$	0.33	-	-	-	-
Uranium	n/a	n/a	n/a	n/a	3.1	9.0	$1\frac{3}{8}$	0.35	-	-	-	-
Iron Ore	4.3	2.2	$2\frac{1}{4}$	1.99	0.1	0.7	-	0.17	180.3	5.6	7 to 12[1]	32.41
Copper - Gold - Silver	3.3	1.0	$2\frac{1}{8}$	3.20	15.2	34.4	$1\frac{1}{2}$	0.44	236.3	8.1	9 & $9\frac{7}{8}$	29.19
Nickel - Copper	0.2	0.1	$2\frac{1}{2}$ - 6	2.19	25.7	42.7	$1\frac{1}{2}$	0.60	9.5	0.6	-	16.39
Silver - Cobalt	n/a	n/a	n/a	n/a	0.1	0.8	-	0.17	-	-	-	-
Silver - Lead - Zinc	3.8	1.0	2	3.76	4.1	12.1	$1\frac{3}{8}$	0.34	31.9	1.0	9	31.26
Molybdenum	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other Metal Mines	0.1	0.1	-	1.1	2.71	2.6	$1\frac{1}{4}$	0.43	n/a	n/a	n/a	n/a
Total Metals[1]	13.2	5.2	-	2.55	54.4	117.7	-	0.47	458.0	15.3	-	29.94
	NON-METAL MINES											
Asbestos	nil	-	-	-	n/a	n/a	$1\frac{3}{8}$	n/a	92.4	4.8	4 to 9	19.08
Gypsum	nil	-	-	-	0.70	1.3	$1\frac{1}{2}$	0.51	7.9	1.3	4	5.99
Talc - Soapstone - Pyroph	nil	-	-	-	n/a	n/a	$1\frac{1}{4}$	n/a	n/a	n/a	2	n/a
Feldspar and Quartz	nil	-	-	-	nil	-	-	-	2.2	0.5	$1\frac{1}{2}$ to $4\frac{1}{2}$	4.52
Salt	nil	-	-	-	5.4	4.9	$1\frac{7}{8}$	1.10	nil	-	-	-
Other Non-Metals[2]	0.1	0.1	$1\frac{7}{8}$	1.05	0.3	0.6	$1\frac{3}{8}$	0.54	n/a	n/a	3	n/a
Total Non-Metals[1]	0.1	0.1		1.05	6.4	6.8		0.94	102.5	6.6		15.10

[1] Totals may not balance owing to absence of data (shown n/a) which could not be published

[2] Excluding potash

n/a - not available

TABLE 15

SUMMARY OF EMPLOYMENT - CANADIAN PRODUCING MINES, 1969

ORE MINED	ORE MILLED			Total Ore & Waste Broken	EMPLOYEES				Total Paid Manhours	Total salaries & wages Paid	LABOUR COST		Tons O & W broken per Manhour
	Under-ground	Surface	Total		Admin.	Mine	Mill	Total			Per Ton Milled	Per Ton O & W Broken	
	(millions of short tons)				(thousands)				(millions $)		($)	($)	
METAL MINES													
Gold - Quartz	9.3	-	9.3	9.3	1.2	6.0	1.2	8.4	17.9	51.5	5.55	5.52	0.52
Copper - Gold	16.1	16.5	32.6	68.1	2.4	6.9	3.6	12.9	26.5	92.5	2.84	1.36	2.57
Nickel - Copper	19.8	2.2	22.0	27.9	2.9	11.9	1.1	15.9	31.1	127.8	5.80	4.58	0.90
Silver - Cobalt	0.3	-	0.3	0.2	0.1	0.3	0.1	0.5	1.1	3.2	9.13	12.70	0.24
Lead - Zinc	8.0	4.8	12.8	18.5	1.1	3.5	1.1	5.7	11.9	42.6	3.33	2.30	1.55
Uranium - Rock Mining	3.1	-	3.1	3.5	0.6	1.3	0.5	2.4	5.1	20.7	6.75	6.03	0.68
Iron Ore	3.6	82.3	85.9	136.5	2.7	3.7	4.1	10.5	22.3	101.3	1.18	0.75	6.12
All Other Metals	1.9	14.5	16.4	24.8	0.4	1.4	0.3	2.1	4.7	16.5	1.01	0.67	5.33
NON-METAL MINES													
Asbestos	1.9	23.1	25.0	88.0	1.4	2.3	3.6	7.3	17.1	59.1	2.36	0.67	5.14
Gypsum and Anhydrite	0.7	5.9	6.6	9.6	0.1	0.5	0.03	0.6	1.5	3.9	0.60	0.41	6.60
Salt (Rock Salt)	2.8	-	2.8	3.9	0.1	0.3	0.1	0.5	1.1	3.2	1.15	0.82	3.48
Barite	0.2	-	0.2	0.2	0.02	0.10	0.01	0.1	0.3	0.8	4.18	3.76	0.77
Feldspar, Quartz, Neph. Syenite	-	1.3	1.3	1.8	0.1	0.1	0.2	0.4	0.9	2.5	1.85	1.38	2.05
Potash	13.6	-	13.6	13.8	0.6	1.1	1.0	2.7	5.7	22.1	1.62	1.60	2.44
Pyrophyllite and Talc	0.02	0.03	0.05	0.05	0.02	0.06	0.01	0.1	0.2	0.4	7.47	8.12	0.27
Fluorspar and Misc.	0.3	-	0.3	0.3	0.1	0.3	0.1	0.5	1.1	3.2	10.20	11.18	0.27

Source: Statistics Canada and author's estimates.

TABLE 16

SUMMARY OF EMPLOYMENT - CANADIAN PRODUCING MINES, 1970

ORE MINED	ORE MILLED			Total Ore & Waste Broken	EMPLOYEES				Total Paid Manhours	Total Wages and Salaries	LABOUR COST		Tons O & W broken per Manhour
	Under-ground	Surface	Total		Admin.	Mine	Mill	Total			Per Ton Milled	Per Ton O & W Broken	
	(millions of net tons)					(thousands)			(millions)	(million$)	$	$	
	METAL MINES												
Gold - Quartz	8.01	-	8.01	8.49	1.18	4.77	1.06	7.01	14.64	44.86	5.60	5.28	0.58
Uranium	1.96	n/a	1.96	2.28	0.51	1.09	0.57	2.18	4.46	18.80	9.60	8.35	0.51
Iron Ore, Underground	3.43	-	3.43	3.81	0.16	0.20	0.23	0.59	1.39	6.09	1.77	1.60	2.54
Surface	-	99.52	99.52	141.77	1.65	3.03	3.31	7.99	16.89	79.42	0.80	0.56	8.42
Copper - Gold - Silver, Underground	17.27	-	17.27	18.87	2.16	5.56	2.31	10.03	21.35	83.67	4.85	4.44	0.88
Surface	-	25.16	25.16	70.59	0.46	0.89	0.97	2.32	4.87	20.14	0.80	0.29	14.50
Nickel - Copper	31.05	3.59	34.64	43.19	3.26	15.27	1.42	19.95	42.42	190.20	5.49	4.41	1.02
Silver - Cobalt	0.22	-	0.22	0.24	.07	0.29	0.06	0.42	0.81	2.70	12.27	11.24	0.30
Silver - Lead - Zinc, Underground	6.98	-	6.98	7.41	0.71	2.58	0.79	4.06	7.94	31.64	4.57	4.27	0.93
Surface	6.98	-	6.98	24.71	0.20	0.60	0.35	1.24	2.46	12.91	1.85	0.52	10.40
Molybdenum, Undergound	1.34	-	1.34	1.41	0.13	0.66	0.03	0.82	1.73	5.33	3.98	3.78	0.82
Surface	-	16.76	16.76	21.78	0.17	0.41	0.22	0.80	1.74	7.01	0.42	0.32	12.52
Other Metal Mines	1.05	3.00	4.05	6.96	0.18	0.50	0.08	0.76	1.67	6.43	1.59	0.93	4.17
	NON-METAL MINES												
Asbestos	1.79	33.14	34.93	90.50	1.41	2.60	3.74	7.74	18.18	65.19	1.87	0.72	4.98
Gypsum	0.34	5.84	6.18	7.81	0.11	0.50	0.02	0.64	1.42	3.99	0.65	0.51	5.50
Talc, Soapstone, Pyrophyllite	0.03	0.04	0.07	0.41	0.02	0.06	0.02	0.10	0.21	0.52	7.43	1.27	1.95
Feldspar and Quartz	-	1.16	1.16	1.29	0.04	0.08	0.12	0.24	0.57	1.53	1.32	1.19	2.27
Salt	4.37	-	4.37	5.32	0.09	0.44	0.09	0.62	1.32	4.78	1.09	0.90	4.06
Potash	13.93	-	13.93	13.93	0.75	1.06	0.95	2.75	5.70	22.46	1.97	1.97	2.44
Other Non-Metals	0.33	0.004	0.33	0.33	0.05	0.39	0.03	0.47	0.99	2.88	8.73	8.73	.33

Source: Statistics Canada and author's estimates.

TABLE 17

SUMMARY OF EMPLOYMENT - CANADIAN PRODUCING MINES, 1971

ORE MINED	ORE MILLED			Total Ore & Waste Broken	EMPLOYEES				Total Paid Man-hours	Total Wages and Salaries	LABOUR COST		Tons O & W Broken per Manhour
	Under-ground	Surface	Total		Admin.	Mine	Mill	Total			Per Ton Milled	Per Ton O & W Broken	
	(millions of short tons)				(thousands)				(millions $)		($)	($)	
METAL MINES													
Gold - Quartz	7.40	-	7.40	7.60	0.97	4.46	0.72	6.15	12.28	39.98	5.40	5.26	0.62
Uranium	3.20	n/a	3.20	3.42	0.48	1.04	0.52	2.04	3.92	17.81	5.56	5.21	0.87
Iron Ore - Underground	4.20	-	4.20	4.20	0.17	0.54	0.16	0.87	1.85	8.48	2.01	2.01	2.27
Surface	-	96.55	96.55	151.20	2.32	2.53	3.88	8.73	17.68	94.40	0.97	0.62	8.55
Copper - Gold - Silver													
Underground	21.95	-	21.95	23.00	2.44	6.06	2.61	11.11	22.76	100.81	4.59	4.38	1.01
Surface	-	26.78	26.78	77.80	0.60	1.19	1.21	3.00	6.12	26.27	0.98	0.34	12.71
Nickel - Copper	30.81	3.42	34.23	43.80	4.25	15.94	1.57	21.76	38.47	214.04	6.25	4.89	1.14
Silver - Cobalt	0.26	-	0.26	0.30	0.07	0.31	0.08	0.46	1.11	4.19	16.12	13.97	0.27
Silver - Lead - Zinc -													
Underground	6.36	-	6.36	6.60	0.63	2.36	0.68	3.67	7.58	32.94	5.18	4.99	0.87
Surface	-	8.04	8.04	25.10	0.24	0.56	0.31	1.11	2.16	13.02	1.62	0.52	11.62
Molybdenum - Underground	0.67	-	0.67	0.70	0.01	0.35	0.15	0.51	0.68	2.84	4.24	4.06	1.03
Surface		11.65	11.65	20.70	0.17	0.21	0.33	0.71	1.50	6.95	0.60	0.34	13.80
Other Metal Mines	0.70	3.41	4.11	6.10	0.19	0.38	0.03	0.58	1.51	6.50	1.58	1.07	4.06
NON-METAL MINES													
Asbestos	1.82	34.24	36.06	84.20	1.43	2.52	3.89	7.84	16.13	69.19	1.92	0.82	5.22
Gypsum	0.81	5.65	6.46	8.60	0.10	0.47	0.03	0.60	1.31	4.21	0.65	0.49	6.56
Talc - Soapstone - Pyrophyllite	0.03	0.04	0.07	0.34	0.02	0.04	0.02	0.08	0.19	0.49	7.00	1.44	1.79
Feldspar & Quartz	-	2.08	2.08	2.20	0.11	0.11	0.25	0.47	0.82	3.18	1.53	1.46	2.68
Salt	4.58	-	4.58	5.50	0.21	0.44	0.43	1.08	2.25	8.71	1.90	1.58	2.44
Potash	15.60	-	15.60	15.60	0.64	0.90	0.95	2.49	5.36	22.62	1.45	1.45	2.91
Other Non-Metals	0.18	0.90	1.08	1.40	0.06	0.24	0.18	0.48	0.92	3.61	3.34	2.58	1.52

Source: Statistics Canada and author's estimates.

TABLE 18

SUMMARY OF EMPLOYMENT - CANADIAN PRODUCING MINES, 1972

ORE MINED	ORE MILLED			Total Ore & Waste Broken	EMPLOYEES				Total Paid Man-hours	Total Wages and Salaries	LABOUR COST		Tons O & W Broken per Manhour
	Under-ground	Surface	Total		Admin.	Mine	Mill	Total			Per Ton Milled	Per Ton O & W Broken	
	(millions of short tons)					(thousands)			(millions $)		($)	($)	
METAL MINES													
Gold - Quartz	6.74	-	6.74	7.08	0.84	3.77	0.61	5.63	10.67	40.50	6.00	5.70	0.62
Uranium	3.20	n/a	3.20	3.48	0.45	1.28	0.21	1.95	3.81	19.69	6.20	5.70	0.91
Iron Ore - U/G	4.39	-	4.39	4.45	0.18	0.57	0.15	0.90	1.60	9.52	2.17	2.13	2.78
- Surface	-	89.20	89.20	121.37	1.98	2.54	2.96	7.48	14.63	85.14	0.96	0.70	8.30
Copper - Gold - Silver													
- U/G	20.02	-	20.02	21.97	2.17	6.22	2.11	10.73	21.03	101.32	5.05	4.60	1.02
- Surface	-	52.10	52.10	140.78	0.91	2.05	1.65	4.62	8.53	47.30	0.91	0.33	16.50
Nickel - Copper	22.97	2.49	25.46	29.35	2.98	14.36	1.54	19.02	31.40	189.27	7.46	6.48	1.03
Silver - Cobalt	0.13	-	0.13	0.15	0.05	0.15	0.04	0.24	0.46	1.83	14.10	12.20	0.33
Silver - Lead - Zinc													
- U/G	5.41	-	5.41	5.63	0.64	2.26	0.34	3.25	6.08	28.93	5.34	5.13	1.04
- Surface	-	6.93	6.93	20.33	0.22	0.57	0.23	1.01	2.21	10.30	1.54	0.52	9.20
Molybdenum	0.21	6.93	7.14	11.90	0.14	0.37	0.10	0.63	1.22	5.49	0.77	0.46	9.80
Other Metal Mines	1.11	2.50	3.62	5.33	0.25	0.53	0.12	0.90	1.79	9.07	2.50	1.80	2.97
NON-METAL MINES													
Asbestos	1.29	32.97	34.26	79.17	1.47	2.40	3.85	7.84	16.92	74.41	2.17	0.94	4.90
Gypsum	0.88	7.16	8.04	11.06	0.10	0.53	0.04	0.67	1.47	5.19	0.64	0.47	7.55
Talc - Soapstone - Pyroph	0.04	0.05	0.09	0.09	0.03	0.04	0.02	0.09	0.19	0.55	6.10	6.10	0.47
Feldspar & Quartz	-	1.99	1.99	2.18	0.10	0.11	0.25	0.45	0.95	3.54	1.78	1.62	2.30
Salt (1)	4.62	-	4.62	5.58	0.08	0.46	0.07	0.61	0.93	5.79	1.25	1.02	6.00
Potash(1)	16.99	-	16.99	16.99	0.61	0.96	0.98	2.57	4.95	24.49	1.44	1.44	3.43
Other Non-Metals	0.40	0.12	0.52	0.68	0.07	0.40	0.18	0.68	1.28	5.14	9.89	7.55	0.53

(1) Does not include brining operations.

Note: Totals may not balance owing to rounding and absence of some data (shown n/a) which could not be published.

Source: Statistics Canada and author's estimates.

TABLE 19

SUMMARY OF EMPLOYMENT - CANADIAN PRODUCING MINES, 1973

ORE MINED	ORE MILLED			Total Ore & Waste Broken	EMPLOYEES				Total Paid Man-hours	Total Wages and Salaries	LABOUR COST		Tons O & W Broken per Manhour
	Under-ground	Surface	Total		Admin.	Mine	Mill	Total			Per Ton Milled	Per Ton O & W Broken	
	(millions of short tons)					(thousands)			(millions $)		($)	($)	
METAL MINES													
Gold - Quartz	6.46	-	6.46	6.80	0.83	3.79	0.94	5.57	10.67	45.73	7.08	6.73	0.64
Uranium	3.05	n/a	3.05	3.23	0.44	1.26	0.21	1.91	3.65	20.71	6.79	6.41	0.88
Iron Ore - U/G	4.82	-	4.82	4.82	0.17	0.56	0.16	0.90	1.66	10.13	2.10	2.10	2.90
- Surface	-	115.11	115.11	175.92	2.31	3.38	3.65	9.34	18.18	120.47	1.05	0.68	9.68
Copper - Gold - Silver													
- U/G	19.22	-	19.22	21.06	2.72	5.96	2.86	11.54	21.83	114.17	5.94	5.42	0.96
- Surface	-	97.50	97.50	200.28	1.46	2.97	3.00	7.42	14.29	78.29	0.80	0.39	14.02
Nickel - Copper	22.47	3.35	25.82	31.27	3.21	13.17	1.99	18.37	31.17	207.95	8.05	6.65	0.83
Silver - Cobalt	0.12	-	0.12	0.13	0.03	0.10	0.02	0.15	0.27	1.19	9.92	9.15	0.48
Silver - Lead - Zinc													
- U/G	8.37	-	8.37	8.62	0.99	2.79	0.94	4.72	8.73	44.75	5.35	5.19	0.99
- Surface	-	8.46	8.46	30.19	0.39	0.94	0.47	1.79	3.45	21.90	2.59	0.73	8.75
Molybdenum	0.02	10.28	10.30	13.49	0.13	0.13	0.25	0.51	0.82	4.54	0.44	0.34	16.45
Other Metal Mines	0.93	3.01	3.94	6.80	0.23	0.65	0.08	0.96	1.72	9.38	2.38	1.38	3.95
NON-METAL MINES													
Asbestos	1.64	34.68	36.32	88.81	1.48	2.44	3.97	7.89	16.31	80.32	2.21	0.90	5.45
Gypsum	0.93	7.47	8.40	10.91	0.10	0.55	0.03	0.68	1.43	5.47	0.65	0.50	7.63
Talc-- Soapstone - Pyroph.	0.04	0.05	0.09	0.09	0.03	0.05	0.03	0.11	0.19	0.67	7.44	7.44	0.47
Feldspar & Quartz	-	1.95	1.95	2.30	0.08	0.08	0.25	0.41	0.82	3.57	1.83	1.55	2.80
Salt[1]	3.99	-	3.99	4.70	0.09	0.40	0.07	0.56	1.16	6.17	1.55	1.31	4.05
Potash[1]	20.65	-	20.65	20.65	0.64	1.06	1.17	2.87	5.47	30.78	1.49	1.49	3.78
Other Non-metals	0.43	0.05	0.48	0.57	0.05	0.39	0.16	0.60	1.08	4.74	9.88	8.32	0.53

(1) Does not include brining operations

Note: Totals may not balance owing to rounding and absence of some data (shown n/a) which could not be published

Source: Statistics Canada and author's estimates

TABLE 20

SUMMARY OF EMPLOYMENT - CANADIAN PRODUCING MINES, 1974

ORE MINED	ORE MILLED			Total Ore & Waste Broken	EMPLOYEES				Total Paid Man-hours	Total Wages and Salaries	LABOUR COST		Tons O & W Broken per Manhour
	Under-ground	Surface	Total		Admin.	Mine	Mill	Total			Per Ton Milled	Per Ton O & W Broken	
	(millions of short tons)					(thousands)			(millions $)		($)	($)	
	METAL MINES												
Gold - Quartz	6.17	-	6.17	6.40	0.90	3.98	0.61	5.49	10.98	58.94	9.55	9.21	0.58
Uranium	2.90	-	2.90	3.10	0.46	1.05	0.57	2.08	3.62	22.06	7.61	7.12	0.86
Iron Ore - U/G	4.40	-	4.40	4.52	0.27	0.59	0.18	1.04	2.25	14.90	3.39	3.30	2.01
- Surface	-	113.57	113.57	180.30	2.40	3.99	3.90	10.29	19.98	148.36	1.31	0.82	9.02
Copper - Gold - Silver													
- U/G	17.25	-	17.25	18.55	2.11	5.60	2.15	9.86	25.16	120.35	6.98	6.49	0.74
- Surface	-	103.15	103.15	236.34	1.19	2.87	2.74	6.80	12.31	90.44	0.88	0.38	19.26
Nickel - Copper	24.33	3.00	27.33	35.39	4.75	13.23	1.35	19.33	34.04	209.05	7.65	5.91	1.04
Silver - Cobalt	0.16	-	0.16	0.18	0.04	0.13	0.03	0.20	0.36	1.85	11.56	10.28	0.50
Silver - Lead - Zinc													
- U/G	7.52	-	7.52	7.86	0.88	2.91	0.77	4.56	7.29	43.30	5.76	5.51	1.08
- Surface	-	8.00	8.00	31.89	0.40	0.65	0.52	1.57	3.38	20.35	2.54	0.64	9.43
Molybdenum	0.47	8.76	9.23	13.77	0.15	0.18	0.26	0.59	1.20	7.56	0.82	0.55	11.48
Other Metal Mines	1.16	3.25	4.41	6.62	0.25	0.65	0.11	1.01	1.90	11.43	2.59	1.73	3.48
	NON-METAL MINES												
Asbestos	1.88	36.18	38.06	94.29	1.50	2.50	4.01	8.01	17.33	92.42	2.43	0.98	5.44
Gypsum	0.65	6.36	7.01	8.51	0.10	0.59	0.04	0.73	1.43	6.30	0.90	0.74	5.95
Talc - Soapstone - Pyroph.	0.05	0.06	0.11	0.11	0.03	0.05	0.03	0.11	0.22	0.84	7.64	7.64	0.50
Feldspar & Quartz	-	1.93	1.93	2.18	0.08	0.10	0.28	0.46	0.96	4.65	2.41	2.13	2.27
Salt[1]	3.82	-	3.82	4.43	0.05	0.40	0.01	0.46	0.87	5.85	1.53	1.32	5.09
Potash[1]	24.19	-	24.19	24.20	0.61	1.22	1.23	3.10	5.95	35.97	1.49	1.49	4.07
Other Non-metals	0.44	0.31	0.75	0.96	0.04	0.41	0.14	0.59	1.07	5.51	7.35	5.74	0.90

(1) Does not include brining operations

Note: Totals may not balance owing to rounding and absence of some date (shown n/a) which could not be published.

Source: Statistics Canada and author's estimates

were generally old and deep (gold-quartz).

Operating costs

Tables 21 to 26 give an analysis of mine operating costs for 1969 to 1974 according to type of ore and principal mining method. Many mining companies use several mining methods and operating costs are not usually broken down by method. Where one method dominates in a specific mine, costs have been allocated as a percentage of total costs comparable to the percentage of tonnage for that method. Where both underground and surface methods are used in a specific mine, the operation is normally excluded. The analysis is therefore incomplete.

Individual costs are shown as a weighted average for mining ore and waste, and not on the basis of tons milled. This tends to show lower costs at surface mining locations where large volumes of waste are drilled and blasted prior to ore mining. The tonnage of overburden removed without drilling and blasting in surface mines is not included, but the costs of stripping cannot be excluded so they are absorbed in the mining costs. Allowances have been made for these factors in an effort to obtain more accurate costs.

Costs of underground mining for all methods continue to increase sharply whereas surface mining costs have not risen to the same extent. If increases in mining costs rise in proportion to the consumer price index, even larger increases may be expected to appear for 1975.

Total estimated costs of mining and processing in the Canadian mineral industry during 1974, excluding petroleum, natural gas, sand and gravel, lime and sodium sulphate, were of the order of $1,300 and $1,600 million respectively. The values for 1974 are directly comparable with those of 1973 and 1972 owing to the same method of calculation, but are not directly comparable with the values published for previous years.

TABLE 21

ANALYSIS OF OPERATING COSTS OF SELECTED MINES

year 1969

ORE MINED	Number of Mines Analyzed	Tons O & W Broken Per Foot of Drilling	OPERATING COSTS PER TON OF ORE AND WASTE BROKEN								
			Expl. and Devel.	Mining	Sub-Total	Milling	Gen'l	Dep'n	Grand Total	Labour - Salaries and Wages	Labour - Percent of Total
SHRINKAGE STOPING											
Copper	5	0.44	0.60	3.50	4.10	1.70	2.80	1.20	9.80	3.95	40
Gold	6	0.48	1.10	4.10	5.20	2.00	1.20	0.30	8.70	4.05	47
Silver	6	0.20	3.20	6.00	9.20	3.60	2.00	0.40	15.20	9.10	60
CUT AND FILL STOPING											
Copper	8	0.36	1.00	5.90	6.90	1.80	2.50	1.50	12.70	5.90	47
Nickel	8	0.41	2.50	7.70	10.20	2.80	1.60	2.00	16.60	8.15	49
Lead - Zinc	4	0.34	2.10	8.30	10.40	2.50	2.50	2.50	17.90	7.55	42
Gold	12	0.30	1.50	9.50	11.00	2.50	2.20	0.40	16.10	9.40	58
OPEN STOPING (with longholes)											
Copper	6	1.06	0.45	2.50	2.95	1.20	2.20	1.50	7.85	2.85	36
Gold	6	0.49	0.40	3.00	3.40	1.30	1.15	0.65	6.50	3.05	47
Lead - Zinc	4	0.93	0.90	3.35	4.25	1.80	1.30	1.30	8.65	3.95	46
ROOM AND PILLAR MINING											
Lead - Zinc	3	0.6	0.40	3.90	4.30	1.30	0.70	0.30	6.60	3.20	48
BLOCK CAVING AND SUB-LEVEL CAVING											
This mining method is used in mining of asbestos, copper, and nickel. Data from an insufficient number of mines were available for publication.											
SURFACE MINING											
Asbestos	9	11.7	0.10	0.35	0.45	0.50	0.40	0.15	1.50	0.55	37
Molybdenum	3	18.5	0.10	0.55	0.65	0.90	0.50	0.55	2.60	0.55	21
Copper	7	21.0	0.10	0.60	0.70	0.55	0.40	0.30	1.95	0.50	26
Iron	12	29.0	0.20	0.90	1.10	0.85	0.35	0.30	2.60	0.75	29
Lead - Zinc	3	20.5	0.15	1.10	1.15	0.95	0.20	0.60	2.90	0.90	31

Source: Statistics Canada and author's estimates.

TABLE 22

ANALYSIS OF OPERATING COSTS OF SELECTED MINES

year 1970

ORE MINED	Number of Mines Analyzed	Tons O & W Broken Per Foot of Drilling	OPERATING COSTS PER TON OF ORE AND WASTE BROKEN ($)								
			Expl. and Devel.	Mining	Sub-Total	Milling	Gen'l	Dep'n	Grand Total	Labour - Salaries and Wages (million $)	Labour - Percent of Total
			SHRINKAGE STOPING								
Gold - Quartz	4	0.61	1.01	3.74	4.74	2.00	1.28	0.25	8.27	4.3	45
Silver - Cobalt	3	0.22	5.21	6.82	12.03	2.80	1.54	1.54	18.01	1.3	48
Other Metal Mines	8	0.36	1.81	5.01	6.82	1.59	1.84	1.10	11.35	14.3	49
			CUT AND FILL STOPING								
Gold - Quartz	7	0.32	0.94	6.95	7.89	2.02	2.43	0.42	12.76	18.1	68
Other Metals	15	0.55	2.37	6.96	9.33	2.17	2.59	1.43	15.52	57.2	43
			OPEN STOPING (with longholes)								
Gold - Quartz	3	0.75	0.32	2.88	3.20	1.10	0.56	0.13	4.99	4.6	56
Copper	9	1.43	0.90	2.63	3.53	1.27	2.08	1.66	8.54	19.4	36
Lead - Zinc	4	2.71	0.64	2.89	3.53	2.26	1.01	0.96	7.76	8.0	32
Other Metals	5	1.82	0.72	4.38	5.10	1.56	0.58	0.71	7.95	13.6	52
			ROOM AND PILLAR								
Metals	4	0.51	0.68	3.82	4.50	3.04	2.48	0.75	10.77	8.5	40
Potash	5	-	-	1.67	1.67	1.94	3.10	1.64	8.35	14.3	23
			CAVING								
Copper	3	0.70	0.29	2.84	3.13	0.91	1.32	0.73	6.09	6.4	38
			SURFACE MINES								
Asbestos	10	14.85	0.10	0.61	0.71	0.63	0.54	0.14	2.03	61.5	34
Iron Ore	10	32.70	0.19	1.31	1.50	1.02	0.37	1.36	4.25	55.3	13
Other Metals	9	34.00	0.08	0.37	0.45	0.44	0.18	0.23	1.30	33.8	26

Source: Statistics Canada and author's estimates.

TABLE 23

ANALYSIS OF OPERATING COSTS OF SELECTED MINES

year 1971

ORE MINED	Number of Mines Analyzed	Tons O & W Broken Per Foot of Drilling	OPERATING COSTS PER TON OF ORE AND WASTE BROKEN ($)							Labour - Salaries and Wages	Labour - Percent of Total
			Expl. and Devel.	Mining	Sub-Total	Milling	Gen'l	Dep'n	Grand Total (1)		
			SHRINKAGE STOPING							(million $)	
Gold - Quartz	5	0.56	0.90	3.74	4.63	1.75	1.13	0.36	7.90	6.9	53
Copper	7	0.48	0.50	2.92	3.44	1.35	3.97	1.91	10.65	7.7	36
Silver - Cobalt	4	0.34	3 83	8.15	11.95	2.46	2 64	1.15	18.69	1.9	54
Other Metal Mining	3	0.50	0.28	5.20	5.48	1.84	2.15	3.39	12.83	2.5	38
			CUT AND FILL STOPING								
Gold - Quartz	10	0.36	0 70	8.60	9.30	1.63	2.34	0.40	13.67	21.6	63
Other Metals	19	0.55	2.19	6.60	8.80	2.55	3.04	1.71	16.07	78.8	51
			OPEN STOPING (with longholes)								
Gold - Quartz	3	0.58	0.29	2.93	3.22	1.38	0 66	0.12	5.38	5.3	60
Copper	11	1.18	0.89	3.05	3.92	1.66	2.52	1.73	9.85	20.8	28
Lead - Zinc	3	3.20	0.62	3.78	4.40	2.43	1.26	1.07	9.17	4.1	35
Other Metal Mines	4	2.95	0.35	1.46	1.81	2.04	0.56	0.62	5.04	10 6	42
			ROOM AND PILLAR								
Metal Mines	5	0.54	0.63	4.31	4.94	2.97	1.31	0.88	10.09	19 8	39
Potash	7	-	-	1.16	1.16	1.57	1.99	1.40	6.12	19.7	22
			SUB-LEVEL CAVING								
Metal Mines	3	0.68	0.19	3.50	3 70	1.55	0.96	1.92	8.13	14.1	42
			CAVING								
Non-metal Mines	3	2.06	0.07	2.90	2.97	2.42	1.32	0.69	7.40	7.6	54
			SURFACE MINES								
Asbestos	10	13.54	0.12	0.72	0.83	0.76	0.60	0.16	2.36	61.5	35
Iron Ore	13	33.80	0.22	1.26	1.48	1.43	0.34	1.12	4.37	68.1	13
Other Metal Mines	9	30.90	0.10	0.44	0.54	0.39	0.20	0.22	1.34	36.5	26

(1) Totals may not balance owing to individual rounding.

Source: Statistics Canada and author's estimates.

TABLE 24

ANALYSIS OF OPERATING COSTS OF SELECTED MINES

year 1972

ORE MINED	Number of Mines Analyzed	Tons O & W Broken Per Foot of Drilling	OPERATING COSTS PER TON OF ORE AND WASTE BROKEN ($)							Labour - Salaries and Wages	Labour - Percent of Total
			Expl. and Devel.	Mining	Sub-Total	Milling	General	Dep'n.	Grand[1] Total		
			SHRINKAGE STOPING							(million $)	
Gold - Quartz	5	0.42	1.10	6.47	7.57	2.35	1.02	0.26	11.20	7.5	54
Copper	7	0.49	1.30	5.24	6.54	1.60	6.12	2.55	16.80	5.9	56
Silver - Cobalt	3	0.32	11.25	4.14	15.39	2.03	0.60	0.22	18.25	1.3	60
Other Metal Mines	3	0.42	1.28	4.94	6.22	1.68	3.02	1.05	11.96	3.5	45
			CUT AND FILL STOPING								
Gold - Quartz	8	0.40	0.69	7.01	7.70	1.99	3.29	0.40	13.38	18.3	52
Other Metal Mines	10	0.24	2.18	6.50	8.68	2.27	2.51	1.23	14.69	89.1	64
			OPEN STOPING (with longholes)								
Gold - Quartz	3	0.84	0.18	3.80	3.98	1.63	0.90	.15	6.67	6.5	61
Copper	10	0.83	3.43	2.06	5.49	1.17	0.91	0.77	8.33	22.5	43
Other Metal Mines	5	2.35	0.37	1.85	2.22	1.68	0.93	0.70	5.52	11.79	44
			OPEN STOPING (with shortholes)								
Metal Mines	6	0.53	0.89	4.90	5.79	2.32	1.95	1.56	11.80	6.2	46
			ROOM AND PILLAR								
Metal Mines	4	0.43	0.88	3.84	4.72	2.84	4.48	1.04	13.09	17.95	39
Potash	8	-	-	1.26	1.26	1.71	1.71	1.61	6.28	24.49	23
			SUB-LEVEL CAVING								
Metal Mines	3	0.78	1.11	4.45	5.56	1.52	1.84	1.73	10.66	12.04	36
			CAVING (other)								
Metal and Non-Metal Mines	4	10.5	0.83	4.62	0.50	3.26	2.66	0.66	12.03	13.9	36
			SURFACE MINES								
Asbestos	8	17.93	0.13	0.61	0.74	0.91	0.40	0.30	2.35	48.7	45
Iron Ore	12	35.00	0.09	0.68	0.77	0.84	0.42	0.29	2.31	70.2	29
Other Metal Mines	15	26.70	0.06	0.35	0.41	0.41	0.18	0.16	1.15	41.5	29

(1) Totals may not balance owing to individual rounding

Source: Statistics Canada and author's estimates.

TABLE 25

ANALYSIS OF OPERATING COSTS OF SELECTED MINES

year 1973

ORE MINED	Number of Mines Analyzed	Tons O & W Broken Per Foot of Drilling	OPERATING COSTS PER TON OF ORE AND WASTE BROKEN ($)							Labour - Salaries and Wages	Labour - Percent of Total
			Expl. and Devel.	Mining	Sub-Total	Milling	General	Dep'n.	Grand[1] Total		
			SHRINKAGE STOPING							(million $)	
Gold - Quartz	3	0.41	2.15	5.53	7.68	2.33	1.09	0.52	11.63	5.8	54
Silver - Cobalt	3	0.35	5.06	6.89	11.96	3.60	2.11	0.21	17.88	1.2	53
Other Metal Mines	3	0.38	1.10	7.24	8.34	2.15	3.02	0.56	14.07	4.6	49
			CUT AND FILL STOPING								
Gold - Quartz	9	0.32	1.58	9.58	11.16	2.85	3.63	0.53	18.17	14.9	51
Other Metal Mines	17	0.51	1.25	8.82	10.07	3.25	3.74	2.32	19.38	80.4	50
			OPEN STOPING (with longholes)								
Gold - Quartz	4	2.06	0.58	5.34	5.92	1.73	1.61	0.25	9.51	14.2	56
Copper	6	1.73	1.00	4.66	5.66	3.00	3.21	1.12	12.99	14.6	29
Other Metal Mines	4	3.20	0.35	1.82	2.17	2.02	0.76	0.51	5.46	13.5	44
			OPEN STOPING (with shortholes)								
Metal Mines	6	0.60	0.88	3.52	4.40	1.77	3.88	0.78	10.83	12.5	51
			ROOM AND PILLAR								
Metal Mines	5	0.42	0.60	4.35	4.95	3.29	5.12	1.07	14.43	19.1	38
Potash	7	-	0.06	1.60	1.66	1.99	1.13	0.74	5.52	24.7	28
			SUB-LEVEL CAVING								
Metal Mines	5	1.70	0.93	4.14	5.07	1.30	1.65	1.18	9.20	22.1	41
			CAVING (other)								
Metal and Non-metal Mines	5	1.36	0.69	3.29	3.98	2.53	1.32	1.77	9.60	9.7	42
			SURFACE MINES								
Asbestos	7	20.10	0.07	0.67	0.74	0.91	0.40	0.18	2.23	48.9	44
Iron Ore	13	33.95	0.08	0.74	0.82	0.95	0.33	0.24	2.34	120.4	33
Other Metal Mines	13	31.14	0.04	0.36	0.40	0.42	0.25	0.22	1.29	61.7	24

(1) Totals may not balance owing to individual rounding

Source: Statistics Canada and author's estimates.

TABLE 26

ANALYSIS OF OPERATING COSTS OF SELECTED MINES

year 1974

ORE MINED	Number of Mines Analyzed	Tons O & W Broken Per Foot of Drilling	OPERATING COSTS PER TON OF ORE AND WASTE BROKEN ($)							Labour - Salaries and Wages	Labour Percent of Total
			Expl. and Develop.	Mining	Sub-Total	Milling	General	Dep'n.	Grand Total[1]		
			SHRINKAGE STOPING							(million $)	
Gold - Quartz	3	0.36	2.45	6.01	8.46	2.93	2.07	0.94	14.40	5.5	65
Silver - Cobalt	3	0.27	6.96	11.27	18.23	5.40	4.06	0.23	27.92	1.8	51
Other Metal Mines	3	0.31	3.55	14.25	17.80	3.90	9.92	0.59	32.21	4.3	46
			CUT AND FILL STOPING								
Gold - Quartz	5	0.33	2.74	12.84	15.58	4.15	3.56	0.47	23.76	7.4	47
Other Metal Mines	8	0.40	1.75	7.72	9.47	4.45	4.67	1.76	20.35	24.4	38
			OPEN STOPING (with longholes)								
Gold - Quartz	4	2.74	0.87	7.84	8.71	2.21	2.52	0.62	14.06	11.5	61
Copper	4	2.09	1.20	6.64	7.84	4.35	7.15	2.15	21.49	13.3	18
Other Metal Mines	4	2.59	0.29	1.46	1.75	3.64	0.87	0.51	6.77	n/a	39
			OPEN STOPING (with shortholes)								
Metal Mines	7	0.49	0.49	5.41	5.90	2.05	3.48	0.84	12.27	29.5	47
			ROOM AND PILLAR								
Metal Mines	3	0.49	0.82	5.21	6.03	4.75	5.05	1.41	17.24	8.4	32
Potash	8	n/a	0.01	1.05	1.06	1.17	0.93	0.45	3.61	36.0	41
			SUB-LEVEL CAVING								
Metal Mines	5	0.62	1.66	4.44	6.10	1.54	2.64	1.29	11.57	25.9	41
			CAVING (other)								
Metal and Non-metal Mines	3	1.19	0.24	3.90	4.14	4.73	1.60	1.11	11.58	5.0	42
			SURFACE MINES								
Asbestos	5	22.04	0.08	0.57	0.65	0.86	0.44	0.19	2.14	24.6	35
Iron Ore	14	32.43	0.08	0.93	1.01	0.88	0.24	0.20	2.33	148.6	35
Other Metal Mines	11	29.22	0.07	0.64	0.71	0.54	0.55	0.29	2.09	65.6	21

[1] Totals may not balance owing to individual rounding

Source: Statistics Canada and author's estimates

ACKNOWLEDGEMENTS

Grateful acknowledgement is given to Joan Scott of Mining Research Laboratories who transcribed the statistical data from which the various tables in this report were calculated and compiled.

The CANMET publications listed below may be obtained from:

Publications Distribution Office, CANMET,
Department of Energy, Mines & Resources,
555 Booth Street,
Ottawa, Ontario, K1A OG1

All requests should be accompanied by a cheque or money order made payable to: Receiver-General of Canada

---

R = Research Report
IC = Information Circular
TB = Technical Bulletin
RS = Reprint Series

Cochrane, T.S., Knight, G., Richards, L.C., and Stefanich, W. Comparison of dust sampling instruments; R 250, 1971, $1.25.

Gray, W.M. and Toews, N.A. Analysis of accuracy in the determination of the ground-stress tensor by means of borehole devices; RS 109, 1972, $0.25.

Gray, W.M. and Barron, K. Stress determination from strain relief measurements on the ends of boreholes; planning, data evaluation and error assessment; RS 130, 1972, $0.25.

Coates, D.F. and Yu, Y.S. Analysis of grading effects on hydraulic and consolidated fill; and Gyenge, M. and Coates, D.F. Mine fill system design based on optimization; RS 113, 1972, $0.25.

Dubnie, A. Northern mining problems with particular reference to unit operations in permafrost; TB 148, June 1972, $0.75.

Dubnie, A. Surface mining practice in Canada; Mines Branch Information Circular 292, 1972, $3.00.

Yu, Y.S. and Coates, D.F. Analysis of rock slopes using the finite element method; R 229, October 1970, $1.25.

Dubnie, A. Problems miniers dans le nord avec reference particuliere aux chantiers d'exploitation dans le pergelisol; TB 148F, September 1972, $0.75.

Murray, D.R. Vegetation of mine waste embankments in Canada; IC 301, January 1973, $1.00.

Sage, R. and Coates, D.F. Survey of physical-mineralogical characteristics of underground mines in Canada, IC 306, May 1973, $0.75.

Norris, D.F. and Barron, K. Structural analysis of features on natural and artificial faults; RS 120, 1973, $0.25.

Bielenstein, H.V. and Barron, K. In situ stresses; RS 120, 1973, $0.25.

Tervo, R.O. and Everell, M.D. Communication methods in underground mines; RS 121, 1973, $0.25.

Coates, D.F. and Dickhout, M. Elements of planning in deep mining; RS 122, 1973, $0.25.

Hedley, D.G.F. and Grant, F. Stope-and-pillar design for the Elliot Lake Uranium Mines; RS 122, 1973, $0.25.

Larocque, G.E., Kapeller, F., and Coates, D.F. Seismic measurements and borehole photographic observation; RS 123, 1973, $0.25.

Larocque, G.E. and Coates, D.F. Comparative ground-shock measurements for evaluating pre-splitting; RS 123, 1973, $0.25.

Everell, M.D. Foncage mécanique de tunnels et de montées; IC 304F, mars 1973, $1.00.

Proceedings of the 8th Canadian Rock Mechanics Symposium, Toronto, November-December 1972; Cat. No. M37-1873, $5.00.

Coates, D.F. and Gyenge, M. Incremental design in rock mechanics; Mines Branch Monograph 880, 1973, $1.50.

Toews, N.A. and Yu, Y.S. A computer program for automatic mesh generation for the 2-D finite element program WILAX; R 272, 1974, $1.25.

Everell, M.D. and Dubnie, A. Mechanical boring of tunnels and raises; IC 304, 1974, $0.75.

Dubnie, A. Mining technology in 1972; TB 180, 1973, $0.75

Coates, D.F. and Sage, R. Rock anchors in mining; TB 181, $1.00

Coates, D.F., Bielenstein, H.U. and Hedley, D.G.F. A rock mechanics case history of Elliot Lake; RS 127, 1974, $0.25.

Tervo, R. and Tirrul, L. Lost a drill hole recently?; RS 128, 1974, $0.25.

Dubnie, A. and Gyenge, M. Studies of long-hole drilling; RS 129, 1974, $0.25.

Gyenge, M. and Dubnie, A. Long-hole drilling optimums; RS 129, 1974, $0.25.

Savich, M. Development of an anechoic chamber; RS 130, 1974, $0.25.

Proceedings of the 9th Canadian Rock Mechanics Symposium, Montreal, December, 1973, Cat. No. M37-22, $5.00.

Barron, K. The mining of thick, flat coal seams by a longwall bottom slice with caving and drawing; TB 189, $1.25.

Piteau, D.F. Plan geometry and other factors relating to natural rock slope stability applied to design of De Beers Mine; TB 190, $1.25.

Everell, M.D. and Dubnie, A. Mechanical boring of tunnels and raises; IC 304, $0.75.

Dubnie, Amil. Mining technology in 1973; MRP/MRL 75-64 (R), $0.75.

Staff, Mines Branch. Scientific and technical papers published by the staff in 1973; IC 305, $0.75.

CANMET PUBLICATIONS

Recent CANMET publications presently available or soon to be released through Printing and Publishing, Supply and Services, Canada (addresses on inside front cover), or from CANMET Publication Office, 555 Booth Street, Ottawa, Ontario K1A 0G1

CANMET Reports:

76-4 The Preparation of Mica Cylinders for the Measurement of Thermal Conductivity; by F. G. McDonald and V. V. Mirkovich;
Catalogue No. M38-13/76-4; Price: $0.50 Canada, $0.60 other countries.

76-5 Tungsten Ores Ct-1, BH-1, and TLG-1: Their Characterization and Preparation for Use as Certified Reference Materials; by G. H. Faye, W. S. Bowman and R. Sutarno;
Catalogue No. M38-13/76-5; Price: $1.00 Canada, $1.20 other countries.

76-6 On the Determination of the Lattice Type and Unit Cell Parameters of a Crystal Using Electron Diffraction; by K. S. Milliken;
Catalogue No. M38-13/76-6; Price: $0.50 Canada, $0.60 other countries.

76-7 Catalogue and Index of CANMET Scientific and Technical Papers Published in or Submitted to Periodicals and Presentations, 1967-1973; by Technology Information Division;
Catalogue No. M38-13/76-7; Price: $2.00 Canada, $2.40 other countries.

76-8 Comparison of Pull-Out Strength of Concrete with Compressive Strength of Cylinders and Cores, Pulse Velocity and Rebound Number; by V. M. Malhotra and G. Carette;
Catalogue No. M38-13/76-8; Price: $1.00 Canada, $1.20 other countries.

76-9 Catalysts for Hydrocracking and Refining Heavy Oils and Tars Part 3: The Effect of Presulphiding Conditions on Catalyst Performance; by M. Ternan and M. J. Whalley;
Catalogue No. M38-13/76-9; Price: $1.00 Canada, $1.20 other countries.

76-10 Recent Advances in Copper Electrowinning; by D. J. MacKinnon and V. I. Lakshman;
Catalogue No. M38-13/76-10; Price: $1.00 Canada, $1.20 other countries.

76-11 The Determination of Radium 226 in Uranium Ores and Mill Products by Alpha Energy Spectrometry; by J. B. Zimmerman and V. C. Armstrong;
Catalogue No. M38-13/76-11; Price: $1.00 Canada, $1.20 other countries.

76-12 Lightweight Aggregates for Structural Concrete; by H. S. Wilson;
Catalogue No. M38-13/76-12; Price: $3.75 Canada, $4.50 other countries.

76-13 Development of a Sirconia Electrolyte for Use in a Steel-Making Oxygen Probe; by T. A. Wheat;
Catalogue No. M38-13/76-13; Price: $5.00 Canada, $6.00 other countries.

76-15 Competing Reactions in Hydrotreating Coker Distillates from Athabasca Bitumen on Unpromoted and Promoted Catalysts; by R. Ranganathan, M. Ternan and B. I. Parsons;
Catalogue No. M38-13/76-15; Price: $0.50 Canada, $0.60 other countries.

76-16 A Digest of Environmental Regulations Pertinent to Open Pit Mining in Canada (Current at April 1975); by Dames and Moore, Toronto;
Catalogue No. M38-13/76-16; Price: $1.75 Canada, $2.10 other countries.