

The World's Gold Reserves and Production Capacity

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Volume 7, Number 2, June 1980

URI: https://id.erudit.org/iderudit/geocan7_2art04

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Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)

1911-4850 (digital)

[Explore this journal](#)

Cite this article

Kavanagh, P. M. (1980). The World's Gold Reserves and Production Capacity. *Geoscience Canada*, 7(2), 73–78.



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Editor's Note: A version of this paper was presented in Toronto at the 1980 Annual Meeting of the Prospectors and Developers Association.

Introduction

Now that the price of gold has increased so markedly, I have considered it appropriate to present this current appraisal of the world's gold reserves and production capability.

My first study on this subject was in 1967 in a paper entitled "Have 6000 Years Exhausted The World's Gold Reserves?" (Kavanagh, 1968). Though the price of gold at that time was only \$35 US an ounce and very little was known of Soviet reserves, my answer to that question was 'no', mainly because South Africa, which at that time had produced 750 million ounces – approximately 25% of all the 3 billion ounces the world had produced in those 6000 years – still had economic reserves in excess of 500 million ounces in 1 billion tons of ore. In 1967 South Africa was producing more than 32 million ounces a year and the rest of the western world about 10 million ounces. With no increase in the price of gold and if no other mines were found, I predicted that the whole western world's production would stay above 40 million ounces annually through 1971; it would then fall gradually to 36 million ounces in 1976 and then precipitously to about 5 million by the turn of the century.

I prepared an updated version of that paper in 1976 entitled "Gold Reserves of the World" (Kavanagh, 1976). The price of gold was about \$130 US an ounce. Even though South Africa had produced approximately 260 million ounces in the 1967-1976 interval, I still predicted that

South Africa's reserves were in excess of 500 million ounces because of previously excluded tonnages which the higher price of gold had permitted to be classed as economic. In 1975 South Africa produced 23 million ounces and the rest of the western world 7.7 million. At that time I predicted that the whole western world's production would fall slightly to 28 million ounces annually in the early 1990s and would remain at that level through the end of the century.

In 1975 some information was becoming available for the first time about Soviet gold production capability. The Consolidated Gold Fields organization in London, which is one of South Africa's largest gold mining companies, estimated that Soviet production had risen from 4.5 million ounces annually in 1950 to 14.2 million in 1975. Based on that remarkable increase together with additional information about new Soviet gold discoveries and expanding placer production capability, I predicted that Soviet production would overtake South Africa's by 1985 and would be 25 million ounces annually by the end of the century, representing reserves in the order of 500 million ounces.

Note that Canada's annual production had fallen from 3.4 million ounces in 1966 to 1.7 million in 1975.

Comparison of 1973, 1975 and 1978 Western World Gold Production Data

Table I shows comparative 1975 and 1978 western world gold production data taken from the Consolidated Gold Fields "Gold 1979" report (Glynn, 1979). The price of

gold at year-end 1975 and 1978 was \$140 US and \$225 US per ounce respectively. Of particular interest are the substantial production increases in every Asian and Latin American country except Colombia and India, indicating ability to greatly increase production because of the higher gold price. Colombia and India had decreased production probably because the higher gold price allowed them to mine lower grade ore from their existing mines during a period when few new mines were as yet being brought into production as a result of the higher price. That condition is well illustrated by the South African scene. In 1966, with the price of gold at \$35 US per ounce, the major mines in the Witwatersrand region had a capability to produce 29 million ounces annually from 60 million tons of ore at an average grade of 0.5 ounces per ton. As a result of the rise in the price of gold in 1973 to over \$100 US per ounce, the major mines milled, in the twelve-month period ending March 31, 1974, 70.8 million tons at a reduced average grade of 0.35 ounces per ton to produce 24.8 million ounces. With the price of gold averaging almost \$200 US per ounce in 1978, the major mines – in the twelve-month period ending March 31, 1979 – milled 80 million tons at a further reduced average grade of 0.27 ounces per ton to produce 21.9 million ounces. Average costs in the five-year interval had risen markedly from \$50 US to \$116 US per ounce.

In a similar respect it is also of interest to examine the record of gold mines in North America. In 1973 the thirteen gold

Table I Comparative Western World gold production data for 1975 and 1978 (10³ ounces)

	1975	1978	% Change
SOUTH AFRICA	22,900	22,700	-1
CANADA	1,650	1,700	+3
USA	1,040	970	-7
OTHER AFRICA	1,270	1,070	-16
BRAZIL	401	418	+4
DOMINICAN REPUBLIC	96	347	—
COLOMBIA	347	289	-17
MEXICO	151	199	+32
PERU	93	119	+28
NICARAGUA	61	074	+21
OTHER LATIN AMERICAN	193	273	+41
PHILIPPINES	517	649	+25
JAPAN	151	196	+30
INDIA	96	90	-6
OTHER ASIA	087	096	+10
EUROPE	353	402	+14
PAPUA NEW GUINEA	575	752	+31
AUSTRALIA	524	649	+24
OTHER OCEANIA	103	151	+47
	30.6 million ounces	31.1 million ounces	+2%

mines in Canada's Precambrian Shield (Table II) had an average reserves grade of 0.31 ounces per ton. In 1978 the thirteen Canadian mines listed for that year in Table II (the McIntyre mine had been incorporated into Pamour, and Agnico-Eagle had been started) had a reduced average grade of 0.28 ounces per ton. The average cost of their 1978 production was \$125 Can. per ounce, double that of 1973.

The record of the Homestake mine in South Dakota is comparable: a reserves grade reduction from 0.28 ounces per ton, 1973 to 0.20 in 1978 and a 135% increase in costs from \$75 to \$176 US per ounce (Table II).

The South African Scene

South Africa's 1979 gold production is estimated to have been 22.6 million ounces, slightly less than in 1978, probably still reflecting an ability of the mines in the Witwatersrand to continue to mine lower grade ore because of the increasing price of gold (an average of \$307 US per ounce in 1979 in contrast to \$200 US per ounce in 1978). The higher gold prices have given a renewed lease on life to veteran mines in the Rand, have further stimulated gold recovery from mine dumps and have accelerated the development of new mines. Three new major mines started last year, the Elandsrand

and Deelkraal in the Far West Rand with, respectively, reserves of 66 million tons grading 0.59 ounces per ton and 45 million tons grading 0.53 ounces per ton (with annual capacities of 960,000 and 870,000 tons), and the Unisel mine in the Orange Free State with reserves of 15 million ounces grading 0.64 ounces per ton and a 600,000 ounce annual capacity (Fig. 1). With the present high gold prices it is probable that those mines have considerably larger reserves than stated, of lower yet very profitable grades, and that they will be mined at lower grades than stated.

With respect to new developments in the known fields, Anglo American has recently announced an \$872 US million expansion of its Western Deep Levels mining property in the Far West Rand to produce a further 160,000 tons of ore per month starting in 1986. Consolidated Gold Fields has indicated the probability of up to three new mines in the locale between the West Rand and the Far West Rand.

Anglo American's \$175 US million, East Rand Gold and Uranium Company Limited (ERGO) tailings recovery project, is an example of several new developments involving parallel production of gold and uranium.

A great deal of regional exploration drilling has been carried out in the Rand in recent years. One most significant result is

the possibility that an entirely new mining area has been discovered some 30 kilometres south of the Orange Free State field. Union Corporation is developing a new mine, the Beisa, and has announced the likelihood of another mine southeast of Beisa known as the Beatrix. The Beisa will be primarily a uranium producer grading about 1 lb U₃O₈ per ton with a 0.2 ounce per ton gold by-product. Unofficial data for Beatrix are reserves of 30 million tons grading better than 0.2 ounce gold and 0.2 lbs U₃O₈ per ton. Anglo American and Consolidated Gold Fields are also very active in that new locale and it is probable that once the unusually structurally-complicated stratigraphy is better understood, more mines will be found.

Given the mitigating factors, i.e., the greatly increased price of gold, the new mines, the expected continued decline of several major mines in the Orange Free State, I estimate that the Rand still has well in excess of 500 million ounces in economic reserves and that it will maintain an annual production of approximately 22 million ounces well into the next century.

Table II Comparative data re North American Precambrian gold mines.

MINE	1978				1973			
	RESERVES (MILLION TONS)	GRADE (OUNCES)	OUNCES PRODUCED (000)	COSTS PER OUNCE (\$ CAN.)	RESERVES (MILLION TONS)	GRADE (OUNCES)	OUNCES PRODUCED (000)	COSTS PER OUNCE (\$ CAN.)
Agnico - Eagle	1.24	0.25	63	116	0.88	0.31		
Camflo	2.18	0.16	76	84	2.63	0.22	98	30
Campbell Red Lake	1.90	0.66	184	63	1.48	0.70	196	26
Con	1.65	0.57	107	82 (est)	1.20	0.62	95	35 (est)
Dickenson	0.35	0.57	60	158	0.45	0.56	72	55
Dome	1.86	0.22	351	112	1.69	0.25	149	58
East Malartic	1.50	0.10	49	148	2.68	0.12	63	73
Giant Yellowknife	1.22	0.27	95	167	1.17	0.38	158	59
Kerr Addison	0.32	0.37	83	142	1.35	0.54	128	102
Lamaque	0.40	0.15	57	171	0.59	0.15	63	75
Macassa	0.40	0.51	54	165	0.25	0.57	51	73
Mc Intyre							54	75
Pamour	2.51	0.10	161	185	2.91	0.17	134	82
Sigma	1.26	0.20	73	143	1.24	0.22	78	68
Totals & Averages	16.79	0.28	1,413,000	\$125	18.52	0.31	1,339,000	\$60
Homestake	16.56	0.20	286,000	\$176 U.S.	15.87	0.28	358,000	\$75

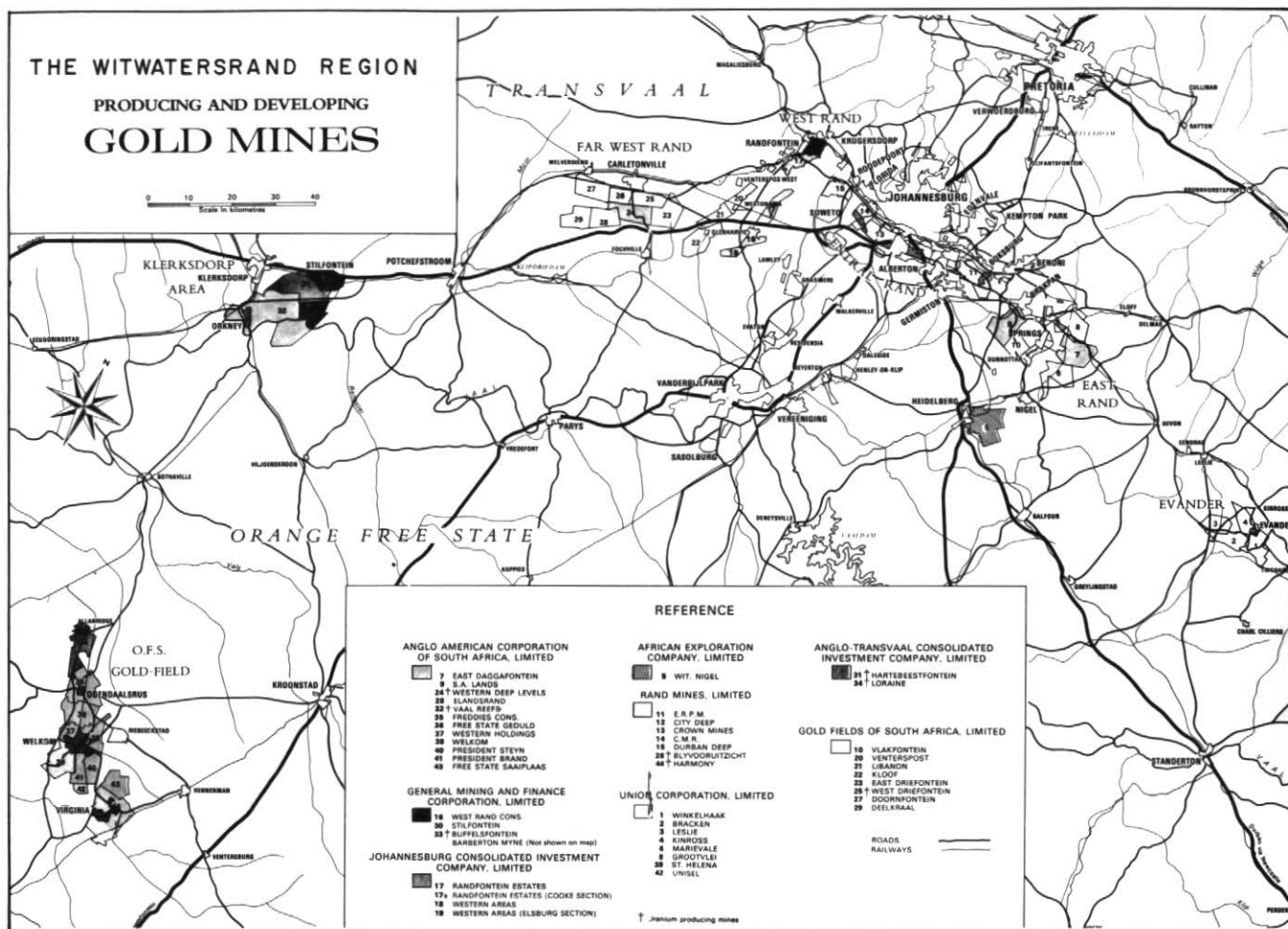


Figure 1 Map of the gold producing region in Witwatersrand, South Africa. (From "Gold in

South Africa" - a publication of the Chamber of Mines of South Africa.)

The Canadian Scene

Before relating the many positive features of the Canadian gold-mining scene prevailing today, it is sobering to note that Canada's gold production fell from 1,733,000 ounces in 1978 to 1,580,000 ounces last year. It did so, however, because the rising price of gold gave the operating mines continuing ability to mine lower grade ore and because none of the pending new gold mines came into production last year.

- Examples of Canadian activity are:
- Dome - \$50 million expansion of its mine from 2000 to 3000 tons per day; the mill-head grade will be 0.12 ounces per ton.
- Campbell Red Lake - increasing mill capacity from 820 to 1070 tons per day. It will mine 0.30 ounces per ton mill-head grade rather than the reserves grade of 0.66 ounces per ton.
- Dickenson - will likely increase its milling capacity from 350 to 850 tons per day. They state that there is the potential for millions of tons in the 0.1 to 0.2 ounce per ton category.

- Kerr - has extended its life by two years at its current 800 tons per day milling rate.
 - Camflo - mining at a 0.146 ounce per ton mill-head grade, down from the .016 ounces per reserves grade cited in their 1978 annual report.
 - Pamour - developing a custom ore business within a 75-mile radius of its mill; by year-end 1980, expects to double the 2.5 million ton reserve of year-end 1978.
 - Lamaque - investigating its outlying No. 4 plug; pursuing custom milling business.
 - Northair - has reduced its reserve grade from 0.71 to 0.35 ounces per ton, with corresponding increases in reserve tonnages.
 - Con and Giant (NWT) - both carrying out exploration programmes on the surface and underground.
- The data given in Table II for the thirteen operating Precambrian gold mines in Canada in 1978 indicate that they had stated total reserves of approximately 5 million ounces at year-end 1978. Given the reported expansions and new developments which I have referred to,

and the high price of gold, I have no hesitation in estimating - without the benefit of their 1979 annual reports - that those 13 gold mines now have a total of at least 15 million ounces in economic reserves and that as a group they will produce 1.5 million ounces per year for at least the next 10 years, i.e., somewhat more than they did in 1978, expanded facilities more than offsetting the lower grade of ore being mined. By-product sources plus the Northair mine in British Columbia and placer production from the Yukon yielded approximately 300,000 ounces in 1978 and will continue to do so annually for many years to come.

Table III lists 23 new and definitely-planned lode gold mines in Canada. They have reported total reserves of approximately 6 million ounces contained in 30.5 million tons of ore with an average grade of approximately 0.2 ounces per ton. It is reasonable to estimate that by 1985 those mines, as a group, will be mining 2 million tons of ore per year yielding 400,000 ounces.

Table III New and definitely-planned Canadian lode gold mines.

<u>NAME & LOCATION</u>	<u>RESERVES</u> (tons)	<u>GRADE</u> (oz. per ton)	<u>REMARKS</u>
Amalgamated Larder , Ontario	4 00,000	0.12	mill in area
Amoco , Ontario	10,000,000	0.2	
Belmoral, Quebec	940,000	0.21	mill in area
Bras d'Or, Quebec	691,000	0.22	mill in area
Camlaren, Northwest Territories	56,000	0.62	portable mill
Carolin, British Columbia	2,000,000	0.127	
Chadbourne, Quebec	1,135,000	0.15	mill in area
Chapelle, B.C.	52,000	1.07 (23.2 Ag)	
Dumagami, Quebec	2,400,000	0.1	mill in area
El Coco, Quebec	200,000	0.12	mill in area
Goldlund, Ontario	1,000,000	0.1	
Gwillim, Quebec	135,000	0.2	mill in area
Kiena, Quebec	2,767,000	0.23	mill in area
Matachewan Cons. - Young Davidson, Ont.	1,000,000	0.1	mill in area
Montauban, Quebec	552,000	0.24	
Mosquito Creek, B.C.	28,000	1.0	
Nu - Energy, B.C.	50,000	0.6	125 tpd mill
O'Brien, N.W.T.	300,000	0.75	
Quebec Sturgeon, Quebec	967,000	0.19	
Rengold, Ontario	500,000	0.2	
Scottie, B.C.	206,000	0.77	
Silver Stack, Quebec	4,400,000	0.175	mill in area
Thompson Bousquet, Quebec	775,000	0.22	mill in area
	30.5 million tons	0.19 oz/ton	
	5,800,000 ounces		

In my research for this paper, I compiled a list of some 46 other probable and possible new lode gold mines in Canada having reported total reserves of approximately 7.5 million ounces contained in 63 million tons with an average grade of 0.12 ounces per ton. If the price of gold were to remain at least \$400 US per ounce, it is reasonable to estimate that by 1985 these deposits, as a group, could produce another 2 million tons of ore mined a year yielding approximately 250,000 ounces.

From all sources therefore, Canada could be producing approximately 2.5 million ounces a year by 1985, from economic reserves totalling in excess of 50 million ounces.

The United States Scene

Gold production in the United States fell from 970,000 ounces in 1978 to 910,000 ounces last year because, as elsewhere, the rising price of gold gave the operating mines continuing ability to mine lower grade ore and because there was as yet not significant production from new mines. The Homestake mine, which pro-

duced 286,000 ounces in 1978 and approximately 250,000 ounces last year, is expected to produce 275,000 ounces this year. The reserves of that great gold mine as well as of Carlin, the other principal gold mine in the United States, have undoubtedly been increased by the high price of gold. By-product gold from the Bingham porphyry copper mine amounted to approximately 240,000 ounces last year, about 25% of the United States total production. Given the high price of gold which will likely result in some expansion of existing facilities, I estimate that annual production from all current gold sources in the United States will be 1 million ounces for many years to come.

Table IV lists new and definitely-planned gold mines in the United States, most of them being Carlin-type and in Nevada. They have reported total reserves of approximately 7.3 million ounces contained in 86.6 million tons of ore with an average grade of approximately 0.08 ounces per ton. It is reasonable to estimate that by 1985 those mines as a group will be

mining 6 million tons of ore per year yielding 500,000 ounces. Also slated for production are the placer deposits at Livengood, Alaska, reported to contain 30 million cubic yards grading \$10 per cu. yd. at a \$500 US per ounce price.

There are many other gold properties in the United States which can now be classed as possible producers. A few examples are the Gray Eagle deposit in California (1 million tons at 0.22 oz/ton), the Preble deposit in Nevada (1.5 million tons at 0.08 oz/ton), deposits at Mina, Nevada (1.5 million tons at 0.07 oz/ton) and the TRV property in Idaho (6 million tons at 0.07 oz/ton). If the price of gold were to remain at least \$400 US per ounce, it is reasonable to estimate that by 1985 production from such deposits as a group could be 250,000 ounces per year.

From all sources therefore, the United States could be producing approximately 1,750,000 ounces a year by 1985, from economic reserves which I estimate to total in excess of 50 million ounces. With respect to the reserves potential, it is of

Table IV New and definitely-planned United States gold mines.

<u>NAME & LOCATION</u>	<u>RESERVES</u> (tons)	<u>GRADE</u> (oz. per ton)	<u>REMARKS</u>
Alligator Ridge , Nevada	5,000,000	0.12	
Comstock Lode , Nevada	1,500,000	0.06	
Duval , Nevada	9,000,000	0.09	
Empire Mine , California	—	—	70 tpd startup in late 1979 - new 200 tpd mill in 1980
Jerritt Canyon , Nevada	11,900,000	0.22	
Manhattan , Nevada	500,000	0.12	
Northumberland , Nevada	10,000,000	0.06	
Pegasus , Montana	18,700,000	0.027	
Pinson , Nevada	1,500,000	0.152	
Placer , Montana	15,000,000	0.06	
Round Mountain , Nevada	11,000,000	0.06	
Tourmaline - Elkhorn , Montana	1,000,000	0.07	
	86.6 million tons	0.08 oz/ton	
	7,300,000 ounces		

interest to note that the U.S. Bureau of Mines (1980) estimated the United States mine reserves of gold at 45 million ounces.

The Scene in Rest of Western World

The rest of the western world, i.e., excluding South Africa, Canada and the United States, produced 5.7 million ounces of gold in 1978, a 14% increase over the 5 million ounce production in 1975. Five countries, i.e., Papua New Guinea (752,000 ounces), Australia (649,000), the Philippines (649,000), Brazil (418,000) and the Dominican Republic (347,000) contributed 50% of that 1978 total. Papua New Guinea's production comes from the Bougainville porphyry copper mine which has a gold content of 0.025 ounces per ton of ore and which produce 634,000 ounces last year. I expect that Bougainville will maintain an annual production rate of some 675,000 ounces. Australia, the Philippines, Brazil and the Dominican Republic all have expansion plans for gold production either underway or planned. In Australia, Homestake, which operates the 100,000 ounce per year Mt. Charlotte mine in the Kalgoorlie district, has recently announced that it is reactivating the Fimiston mine in the same area at a rate of 91,000 ounces per year starting early next year. Numerous other mining concerns, including Northgate's Whim Creek Consolidated, have either already reactivated old producers or are planning to do so. Notwithstanding that Australia's largest producer, the Telfer mine which produced

227,000 ounces in 1978, is expected to decline because of lower grade ore to about 125,000 ounces annually for its remaining 10-year projected life, I estimate that Australia will shortly start producing 750,000 ounces annually.

Two new gold mines have started up in the Philippines, the Masbate mine of Atlas Consolidated and the Dizon copper-gold mine of Benquet Consolidated at 90,000 and 100,000 ounces respectively annually, and at least one other is being brought in by Lepanto. The Philippine Bureau of Mines recently stated that seven former gold producers with 15 million tons of total reserves may be reopened in the next few years. Philippine gold production should reach one million ounces annually.

Most of Brazil's gold production comes from the Morro Velho mine in the Minas Gerais region. Anglo American, which acquired control of that mine a few years ago, stated in its 1978 annual report that it had indicated 6 to 10 million tons grading 0.3 ounces per ton in Proterozoic conglomerate in the Jacobina region of Brazil. When Jacobina comes into production Brazil's annual production could reach 750,000 ounces.

Gold production from the Dominican Republic comes almost entirely from the Pueblo Viejo mine. Two other potential sources of gold production are the zone of complex sulphide mineralization underlying the productive oxidized ore at Pueblo Viejo and the low grade Las Cacaos gold-silver deposits adjacent to Pueblo Viejo.

They could boost the Dominican Republic's annual production to 500,000 ounces.

There is no doubt that the high gold prices of the past few years have prompted increased gold production in every other gold-producing country in the western world. The following are a few examples:

Costa Rica: United Hearne bringing in the 5 million ton - 0.05 oz. per ton Santa Clara deposit, initially at 500 tpd, ultimately to be at 3,000 tpd.

El Salvador: Bruneau Mining bringing in the 217,000 ton - 0.25 oz. per ton El Dorado mine.

Fiji: Emperor Gold reopening former mining areas.

India: The new 0.25 oz per ton Hutti mine north of the Kolar field.

New Zealand: MIM (Mount Isa Mines) contemplating dredging on the Mikonui River.

Peru: 1979 gold production reported to be 116,400 ounces, a 50% increase over 1978.

Rhodesia: RTZ (Rio Tinto-Zinc) planning to expand the Renco mine.

Venezuela: Reopening of the 0.65 oz. per ton El Callao mine.

Chile has become a gold producer with St. Joe's 2.4 million ton high grade El Indio mine grading 0.47 oz gold per ton in addition to 7.4 oz silver and 2.25% copper. The mine will yield, annually, approximately 100,000 ounces of gold.

Given all of their new gold mines and developments, it is reasonable to estimate

that those countries in the western world (excluding South Africa, Canada, the United States, Papua New Guinea, Australia, the Philippines, Brazil and the Dominican Republic) which as a group produced approximately 2,850,000 ounces of gold in 1978 will shortly be producing 3,250,000 ounces annually. Countries in the western world other than South Africa, Canada and the United States have economic reserves in the order of 150 million ounces.

The Soviet Scene

In 1979 the Consolidated Gold Fields organization suspended the inclusion of Soviet and other Communist country gold production estimates in its annual gold reports while it carried out a detailed review of Soviet gold production. The "Gold 1979" (Glynn, 1979) report advised that publication was expected to be resumed in this year's report. It did give a detailed progress report on the new Muruntau gold mine in Uzbekistan. Consolidated Gold Fields estimates that Muruntau produces 2.6 million ounces a year, making it the largest single gold mine in the world. (Val Reefs, the largest mine in South Africa, produced approximately 2.2 million ounces in the twelve-month period ending March 31, 1979.) Muruntau accounted for over 20% of 1978 Soviet gold output, implying that Soviet gold production in 1978 was less than 15 million ounces, approximately the same as the 14.2 million ounce production which Consolidated Gold Fields estimated for Soviet production in 1975 and well below the 17.5 million ounce level that in 1976 I predicted it would be at in 1978 (Kavanagh, 1976). South African sources estimate that Soviet production will rise to 16 million ounces (500 metric tons) annually by 1985. I consider that Soviet gold reserves exceed 500 million ounces and that the U.S.S.R. will have the capacity to produce 20 million ounces annually by the turn of the century. For the location of USSR producing regions see Figure 7 in Kavanagh (1976).

The Scene in Other Communist Countries

In Consolidated Gold Fields' "Gold 1978" report (Glynn, 1978), gold production from Communist countries other than the U.S.S.R. is given as 20 metric tons (approximately 640,000 ounces) for each of the years 1975, 1976 and 1977. I have no other information except a map of China in the January, 1980 issue of World Mining which shows five gold mining and/or mineralized areas, indicative to me of an expanding gold production environment in China. It is reasonable to estimate that overall production from Communist countries other than the U.S.S.R. is and will continue to be in the order of 1 million

ounces a year from reserves in excess of 25 million ounces.

Summation

Because of the high price of gold which is enabling low-grade reserves to be classed as economic, I estimate the western world's gold reserves to exceed 750 million ounces, 65% of which are in South Africa. The more than 500 million ounces I estimate for the U.S.S.R., together with some 25 million ounces in other Communist countries, give a total world reserve of approximately 1.3 billion ounces.

I predict that South Africa, with its great ability to mine at lower grades because of the high price of gold, will offset that inherent reduced production of gold and the decline of several major mines by production from many new mines. The net effect will be to maintain a production rate of approximately 22 million ounces annually well into the next century. With the other gold-producing countries in the western world considerably increasing their production with new mines, the western world as a whole should attain a production level of some 33 million ounces a year by 1985 (Fig. 2).

I continue to be positive about Soviet gold production capability and estimate that it will reach 16 million ounces annually by 1985, resulting in an overall annual world production of 50 million ounces. The world's production could exceed 55 million ounces a year if, as I predict, Soviet production were to continue to increase to 20 million ounces annually by the turn of the century (Fig. 2).

Acknowledgements

I gratefully acknowledge the assistance of Wendy Carruthers, my secretary, and the research done for me by the staff of the Rio Algom library and Pat Sheahan of Konsult International.

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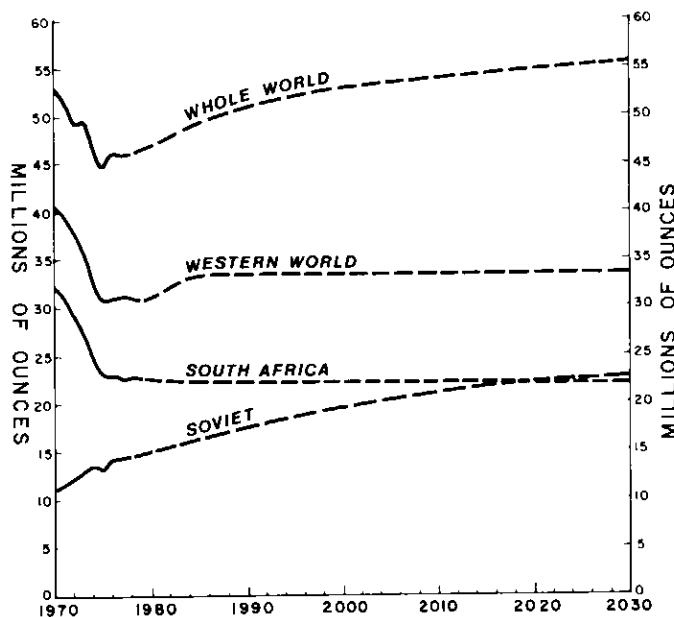


Figure 2 Gold production forecasts based on \$400 U.S. per ounce price.