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An Eye-Bird View of Facing Scarcity of Gold Mining in Indonesia

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ABSTRACT

It is realized that based on the life time of extraction of the existing gold deposits in Indonesia, gold production faces scarcity or does not exceed within the next thirty years from now or seventy years after the COW production started in the early of 1970s, it is recommended that the new continuing activity of exploration should be reinvented with the new climate of investment policy including fiscal regime and the right supportive regulation should be enforced. Modification or improvement of the related regulations to the mining activity such as the laws or regulations of forestry, environmental protection, tax, regional autonomy, and labor should also necessarily be carried out. Toward creating this condition, the new policy regime should be reintroduced with the spirit of creating new incentives. Geologically, the prospective exploratory area could be carried out in volcanic arc, epithermal zone, 'ring of fire' and even in gold-bearing sedimentary rocks.

Key words*:* Indonesia, gold mining, scarcity

INTRODUCTION

Geology

Geologically, areas where gold and silver mineralization process occurs are usually concentrated in the area stretching from the northern to the southern Sumatera, and then continued on to the island of Java. Besides gold and silver, in some area platinum is also discovered in addition to the sulphide minerals such as copper, lead and zinc**.**

Ore deposits are found in the earth crusts as the results of epithermal and hydrothermal activities affected by the andesite volcanic activity during the Middle and Upper Tertiary period. Furthermore, the mineralization process is also affected by the andesitic, liparitic, and granitic rock intrusions, and also due to the metasomatic contacts with the shale and slate of the Paleozoic period. The gold mineralizations in Western Kalimantan are different, and addition to gold and silver, other sulphidic minerals are also discovered. The area belongs to the so called *basement complex* with intrusive bodies of various ages from the Pre-Upper Triassic to Post-Paleogene, and various

compositions ranging from granitic to andesitic. Gold mineralization in North Sulawesi actually has been known long ago, and it has been exploited to some extent although it has never really been known. An Australian company, PT Tropic Endeavor Indonesia which signed the contract of work on 10 July 1970, recently discovered some veins in the Wohudu Breccia within the copper, lead and zinc rich volcanic rocks in the Gorontalo region. Besides the primary gold, gold is also discovered as the by-product of primary copper deposits. In addition, the placer gold deposits are discovered in some other areas. Gold deposits are also found at Gosowong in Halmahera island. Then it was also known as porphiry deposit associated with copper and silver in the belt of Jaya Wijaya mountain range in Papua which is currently exploited by PT Freeport Indonesia Company. The newest big gold deposit as associated mineral copper was recently found out in Sumbawa island and then in 1999 was initially mined by PT Newmont Nusa Tenggara. (Sunarya, 1989; Erickson, 1992).

Statistical reserves of gold deposits in Indonesia per 2001 can be seen in Table 1 (Anonymous (a) up to Anonymous (p)), and the map of gold deposits and occurences in their Indonesian geological setting in Figures 1 and 2 (Anonymous (a) up to Anonymous (p)) .

History

The island of Sumatera is also known as the island of gold in which it has been long mined by the people. The same situation occurred in West Kalimantan where Chinese have been involved in the businesses since a long time ago. Modern mining technique was started in the Lebong Donok, Bengkulu in 1989. Then it was followed in other area as Simau (1910), Lebong Simpang (1921), Tambang Sawah (1923), Salida (1914), Gunung Arum (1935), and Muara Sipongi (1936). These mines are of primary gold deposits. Most of those mining activities were conducted in Logas, Riau (1937-1940) and Meulaboh, Aceh (1940). On the other hand, in Kalimantan and Sulawesi there were no significant gold mines, but only small gold mining business and individual enterprises. Entering 1940, the Cikotok gold mine was opened.

In order to process the gold ore in Indonesia, in 1937 PT Breackensieck built the smelter and refinery plant for gold and silver. Some of the working gold mines at the time nearing the outbreak of Worl War II, were then acquired and run by the Japanese. During the independence war, the Indonesian government managed to continue the operation of the last mines such as in Cikotok and Lebong Tandai. In West Java, the gold mine Pongkor owned by PT Aneka Tambang about twenty years ago.

Many other new gold mines were in operation within the last three or four decades, among others are PT Kelian Equatorial Mining in East Kalimantan, PT Newmont Minahasa Raya in North Sulawesi and PT Freeport Indonesia Company in Papua. The newest gold mine is PT Newmont Nusa Tenggara in Sumbawa for another 10 years to come.

MATERIALS AND METHODS

In principle, evaluation on the scarcity of the gold mining is the life time of the mining activity which is obtained as the result of the reserves divided by the annual rate of extraction. Systematically, it is evaluated based on theory of exhaustion ,i.e., the Hotelling's rule and Hamiltonian rule (Vogely, 1976; Howe, 1979), then it is related to the resource contribution to GNP (Soelistijo, 2003,2012, 2013).

Hotelling's rule : $S = \int \pi (x, t)\, e^{-vt} - \lambda(\int x\, dx - R);\ x = \int R(t)\, dt.$

Hamiltonian rule : $H = f(S, R, t) + \lambda\, q(S, R, t);$

$GNP = g(L,R,t) = h(S,R,t)\, e^{-rt}$

where $\lambda = \frac{\delta f}{\delta R}$ = marginal user cost or scarcity rent;

$P(\text{price}) = mc + \lambda$; mc = marginal cost ;

S = stock effects (reserves);

R = resource commodity production (production rate);

t = time;

GNP = gross national product;

L = labor or capital input factors.

Since continuing the production over time needs to increase the reserves, then the substantial increase of production input factors such as capital, labor and others are systematically required.

RESULT AND DISCUSSION

Results

The national gold production consisting of PT Aneka Tambang and the Contract of Work companies can be seen in Table 2. Mostly of the "old mines" are terminated in 1990s and early of 2000s due to facing their gold deposit reserves.

Activities of PT Aneka Tambang

PT Aneka Tambang as the State-owned Company operates gold mines in Cikotok and Pongkor. Both are located in West Java. The gold mining authorization area held by PT Aneka Tambang in West Java is around 29,138.3 hectares, of which 27,148 hectares is for exploration and 1,990.3 hectares is for exploitation.

The Cikotok Gold Mining Unit

The gold mine operated by the Cikotok Gold Mining Unit is located in the Lebak Regency, South Banten, in Banten Province. Gold was found in South Banten after an exploration was conducted there just before 1930s. The rock is in the form of *Old Andesite* which has been drophulitized. The Old Andesite Formation was aged between the Upper Miocene until the Lower Miocene. Veins of this rock contain sulphide minerals which is rich of gold, silver, lead, zinc and others. Before the World War II, mining activity was conducted by Mijnbouw Maatschappij Zuid Bantam. After the end of war, this company was sold to Perusahaan Pembangunan Pertambangan NV(the Mining Development Enterprise NV) which was formed by Bank Industri Negara (the State Bank of Industry). Rehabilitation efforts were started in 1954, and the first production was released in 1957.

Table 1

The depleted reserves and resources of gold deposits in Indonesia, 2001

NO.	CRITERIA/ COMPANY	Ore reserves	Resources		
			Au	Ag	Cu
1	**A. Papua island:** PT FIC	1,090,000,000 t*) *(Papua 4,041,169,000)**)* *(3,769 t gold metal)*	1.18 g/t (1,286.200 t) *(308,500,000 t)**)* *(293 t gold metal)*	3.78 g/t (4,120.200 t)	11.7 g/t (12,753,000 t)
2	**B.Kalimantan island:** PT KEM (East Kalimantan)	77,900,000 t *)	1.97 g/t (153.463 t)	na	na
			na		

3		na		na	na
4	PT PLM PT AMP	(terminated in 1997) 12,762,181 m^3 (terminated in 1998)	0.275 mg/m^3 (3.509 t)	na	na
5	PT MMM	41,000,000 m^3 (terminated in 1997)	0.142 mg/m^3 (5.822 t)	na	na
6	- PT IMK (Central Kalimantan)	8,262,000 t 1,489,000 (6 t gold metal) (terminated in 2001)	4.19 g/t (34.617 t)	94.30 g/t (779,106 t)	na
7	PT Ensbury Kalteng Mining (Central Kalimantan)	na	na	na	na
8	**C. Sulawesi Island:** PT NMR (North Sulawesi)	7,755,000 t (terminated in 2006)	5.6 g/t (43.428 t)	7.30 g/t	na
9	PT BTM	2,600,000 t (terminated in 1999)	24.49 g/t (63.774 t)	22.49 g/t (58,474 t)	na
10	**D. Java Island:** PT ANTAM (West Java)	5,398,900 t 27 t (planned to terminate in 2015)	12.15 g/t (65.596 t)	130.90 g/t (706,716 t)	na
11	**E. Nusa Tenggara Islands:** PT NNT (West Nusa Tenggara)	930,700,000 t	0.38 g/t (353.666 t)	na	0.52 g/t (48,396.4 t)
	F.Sumatera and other islands: **				
12	North Sumatera	107 t			
13	Lampung	15 t			
14	North Sulawesi	69 t			
15	Gorontalo	132 t			
16	North Maluku	90 t			

Source s: *) Departemen Pertambangan dan Energi (1999, 2000, 2001. **) Directorate General of Coal and Mineral resources (2011).

Legend:

- PT FIC: Freeport Indonesia Company, PT KEM: Kelian Equatorial Mining, PT PLM: Prima Lirang Mining, PT AMP: Ampalit Mas Perdana, PT MMM: Monterado Mas Mining, PT IMK: Indo Muro Kencana, PT NMR: Newmont

Minahasa Raya, PT BTM: Barisan Tropical Mining, PT ANTAM Tbk:Aneka Tambang Tbk, PT NNT: Newmont Nusa Tenggara,

- na : data not available

- 2001: Σ Au: 1,651.092 t, Σ Ag: 6,018.166 t, Σ Cu: 12,753,000 t

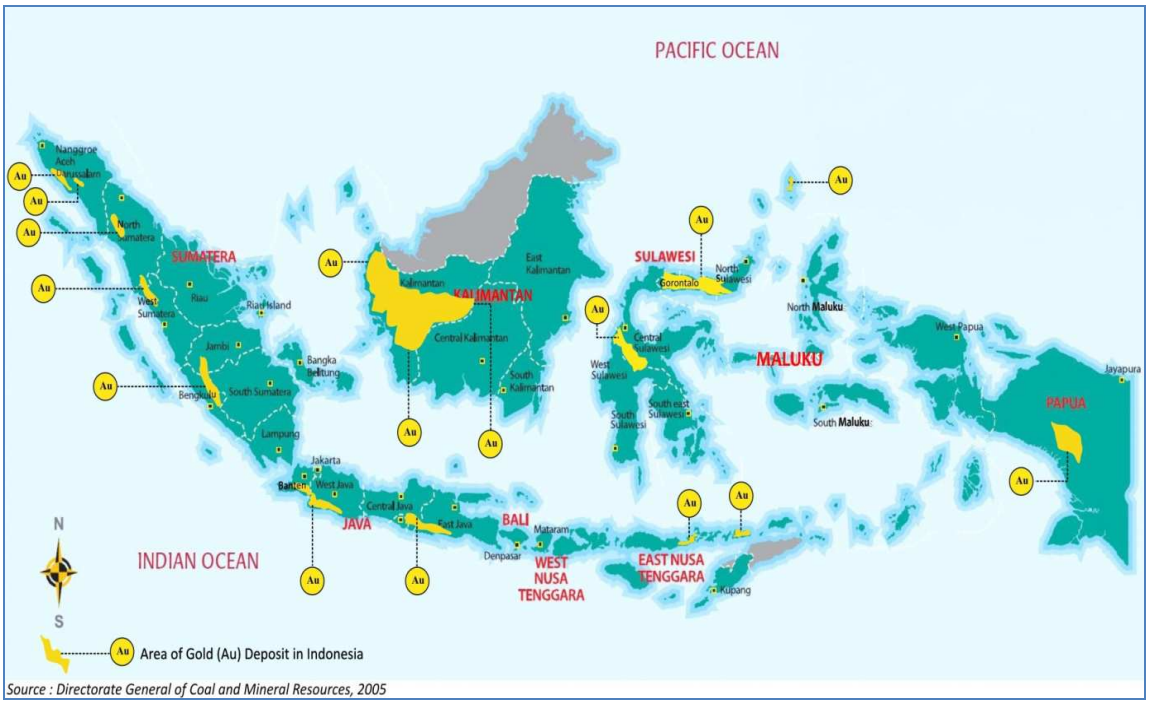

Figure 1. Areas of gold deposit in Indonesia

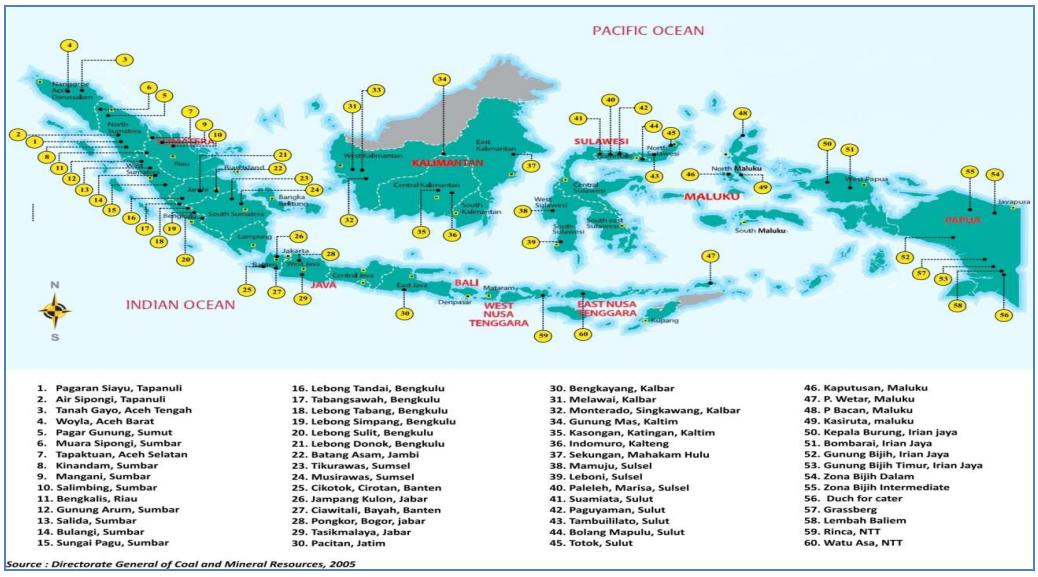

Figure 2. Further detail locations of gold deposits in Indonesia

The Pongkor Gold Mining Unit

The Pongkor gold mining area, with the permitted mining exploitation area 893-West Java of around 4,058 hectares, is located in around 54 kilometers west of Bogor.

The exploitation was pioneered by the geological team of PT Aneka Tambang where mineralization was found at around Gunung Pongkor area in 1988, and this effort was followed by a more detailed and integrated exploration activity at the Cikotok mining authorization area (KP), and also in the other ten KPs in West Java.

The exploration revealed that the probable geological reserves were predicted to be around 6,021,614 million tons of ore with gold content of about 103.23 tons, and silver at 990.65 tons in the three major veins, namely Cigua, Kubang Cicau and Ciurug.

Table 2

The output of PT Aneka Tambang's and Gresik refinery of precious metals (kg)

Source of concentrates	Year	Gold	Silver
PT Aneka Tambang	1990	135	2,113
	1991	107	2,006
	1992	79	1,372
	1993	178	1,529
	1994	1,156	13,660
	1995	1,812	17,283
	1996	1,855	14,946
	1997	2,113	15,745
	1998	1,858	13,352
	1999	3,227	22,370
	2000	4,210	28,587
	2001	3,957	27,492
	2006	2,780	23,876
	2009	2, 627	22,589
	2011	2,667	n.a
Contract of Work Companies	1990	1,624.1	3,700.2
	1991	3,183.8	14,389.2
	1992	17,199.5	33,448.9
	1993	16,490.2	28,316.7
	1994	16,119.8	41,634.0
	1995	18,981.0	166,503.0
	1996	26,651.0	148,924.0
	1997	28,495.4	155,200.6
	1998	31,115.9	172,130.3
	1999	31,903.1	127,743.5
	2000	119,784	226,856.0
	2001	162,134	320,840.0
	2006	141,687	304,427.0
	2009	126,217	305,205.0
	2011	72,090	n.a
	1990	1,759.1	5,813.2
	1991	3,290.8	16,395.2
	1992	17,278.5	34,820.9

Total	1993	16,668.2	29,845.7
	1994	17,275.8	55,294.0
	1995	20,793.0	183,786.0
	1996	28,506.7	163,870.0
	1997	30,608.4	170,945.6
	1998	32,973.9	185,662.3
	1999	35,130.1	150,113.5
	2000	123,994	111,340.4
	2001	166,091	348,332.0
	2006	144,467	328,303
	2009	128,844	327,794
	2011	74,757	n.a

Source: Departemen/Kementerian Pertambangan dan Energi (1999, 2000, 2001),Directorate of Mineral and Coal Enterprises (2002), Directorate General of Coal and Mineral Resources, (2011).

Mining activity was started at the end of 1992 with the first blast to make the main haulage level with the opening dimension of 3.33 meters.

The mining technique used at Pongkor is cut and fill technique, which is similar to the Cikotok mine. The extraction process of the Pongkor gold ore adopts the standard cyanidation process, namely the process of CIL (carbon in leach) is then followed by eluation process, and one being the special characteristics is the use of electrowinning to recover gold and silver, instead of the Meril Crowe's Zinc cementation. The result, dore bullion, is then further processed at the processing and refinery unit in Jakarta.

Production

The year of 1994 was as a transition period in which PT Aneka Tambang expanded its gold mining areas to Pongkor new gold mine. In 1994, the total of gold and silver ore mined from the five gold mines (Cirotan, Gunung Sopal, Ciputer, Cipicung and Hatemi) was 4,518 tons, which below the 1993 figure of 5,636 tons. Despite receiving supply from the Pongkor mine which totaled 4,938 tons, the production of gold was only 21.08%, and silver was 24.63% from the target. Since the first semester of 1994, gold mining activity at Pongkor produced some 98,028 tons of wasted rock which contained 1,124 kgs of gold and 13,069 kgs of silver **(Table 3).** Then this production increased up to 4,040 kgs of gold and 27,416 kgs of silver in 1999/2000, so that PT Aneka Tambang produced gold and silver from both Cikotok and Pongkor amounted to 122.3 kgs of gold and 2,081.9 kgs of silver in 1990; 1,174.6 kgs of gold and 13,846.4 kgs of silver in 1994, then 2,536 kgs of gold and 17,977.9 kgs of silver in 2001.

Table 3

Gold and silver production of PT Aneka Tambang (1990-2011)

Year	Ore Mined (tonne)		Gold Production (kg)		Silver Production (kg)	
	Cikotok	Pongkor	Cikotok	Pongkor	Cikotok	Pongkor
1990	56,950	-	133.417	-	2,157.628	-
1991	45,985	-	102.064	-	2,002.959	-
1992	21,257	-	75.398	-	1,202.054	-
1993	19,782 *)	-	190.535	-	1,661.462	-
1994	9,456 *)	98,028	53.137	1,123.627	823.715	13,069.032
1995	323	-	-	1,805.743	-	17,139.706
1996	-	165,337	-	1,674.329	-	13,509.398
1997	12,058	232,204	108.444	2,004.636	394.855	15,350.210
1998	44,960	183,005	282.000	1.569	1.140	12.392

1999	35,504	286,287	271.007	2,956.190	1,306.009	21,063.916
2000	-	n.a	-	4,210.000	-	28,587.000
2001	-	n.a	-	3,957.000	-	27,492.000
2006	-	n.a	-	2,873.000	-	23,876.000
2007	-	n.a	-	2,791,000	-	24,125.000
2008	-	n.a	-	2,834,000	-	25,349.000
2009	-	n.a	-	2,627,000	-	22,859.000
2010	-	n.a	-	2,780,000	-	18,529.000
2011	-	n.a	-	2,667.000	-	n.a

*) Including ore supplied from Pongkor Source: Departemen/Kementerian Pertambangan dan Energi (1999, 2000, 2001) Directorate of Mineral and Coal Enterprises (2011)

Extraction activities of the contract of work (COW) companies in gold and silver.

Until the end of December 1994, only five companies which have been in operation under COW agreement on general mining have started producing gold and the associated minerals. Then, the six companies were PT Monterado Mas Mining, PT Lusang Mining, PT Ampalit Mas Perdana, PT Prima Lirang Mining, PT Newmont Minahasa Raya and PT Kelian Equatorial Mining, even though PT Monterado Mas Mining, PT Lusang Mining, PT Prima Lirang were also terminated in the year of 1996, 1995 and 1998 respectively.

Then in the year of 2000 up to the present there are only four COW gold mining companies, i.e., PT Kelian Equatorial Mining, PT Newmont Minahasa Raya, PT Newmont Nusa Tenggara, and PT Nusa Halmahera. The COW copper mining company which also produces gold is PT Freeport Indonesia Company.

All of those COW gold mining companies, except PT Freeport and PT Newmont Nusa Tenggara, have produced dore bullion which have to be purified at the precious metal unit of PT Aneka Tambang in Jakarta.

PT Kelian Equatorial Mining

On January 1, 1992, to PT Kelian Equatorial Mining, a permit was granted to start commercial production activities in the COW area for the mining of gold, situated in the Regency of Kutai, East Kalimantan Province.

The COW area which is still maintained covers an area of 18,335 hectares and which include a mining area, the infrastructure and other means (plants, offices, housing, store houses, and roads leading to the mines), as well as the unexplored area in the Sungai Mangerang region, which covers an area of 4,000 hectares.

The method of mining which should be applied is the open pit mine, while the separation of the gold and silver from the ore should be done by cyanidation process. The absorption of the gold and silver should be done by using activated carbon, or by the so-called “carbon in pulp leaching” process. The settled down layer should further be smelted to separate the quicksilver content and to be furtherprocessed into bullions.

To build the gold mine, PT Kelian Equatorial Mining had invested the sum of US$ 601,625,000. The production of ore and bullion from 1992 to 2001 is seen in **Table 4**.

Dore bullion which has been produced is not allowed to be exported directly because according to the stipulations in the COW agreement that it should first be purified within the country itself. The production of gold and silver in 1992 was of about 14,536 kgs and 5,333 kgs of silver down to 14,100 kgs of gold and 10,502 kgs of silver in 2001.

PT Newmont Nusa Tenggara

The Batu Hijau gold and copper mine on Sumbawa island was currently financed at a total cost of US$ 1.9 billion and started production in 1999. The project company, PT Newmont Nusa Tenggara, is owned by Newmont Indonesia (45%) and Sumitomo Corp. (35% through its subsidiary Nusa Tenggara Mining Corp). Indonesia party accounts for the remaining of 20%. The financing structure is expected to consist of a US$ 1 billion senior loan package with export credit agency participation and US$ 888 million of subordinated debt and equity. The production of gold started in 1999 was 9,947.56 kgs in the copper concentrate containing 236,005 tonnes of copper and 37,797 kgs of silver. Then it increased production of gold of 13,918 kgs, 46,179 kgs of silver and 679,746 tonnes of copper in 2001.

Table 4

Ore and dore bullion production of PT Kelian Equatorial Mining (1992-2000)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total ore mined (ton)	946,416	10,468,060	8,617,998	7,618,587	7,413,049	8,236,153	7,992,540	4,729,875	+)	+)
Average gold content (grs/ton)	1.63	1.74	1.79	1.65	1.52	0.75	1.90	1.73	+)	+)
Total processed ore (ton)	6,198,631	6,569,671	6,743,227	6,578,660	6,807,941	7,352,939	7,782,044	7,672,927	+)	+)
Dore bullion obtained (kg)	30,052	26,943	21,723	21,679	27,520	26,407	28,600	25,426	21,586	25,495
Gold content in dore (kg)	14,536	14,424	11,465	11,473	14,098	15,051	14,228	13,704	10,516	14,100
Silver content in dore (kg)	5,333	12,281	9,948	9,760	11,138	10,424	13,494	10,730	10,145	10,502
Side product quick-silver (kg)	405	148	37	124	17.8	12.9	120	10	+)	+)

+) Data not available Source: Departemen/Kementerian Pertambangan dan Energi (1999, 2000, 2001)
Directorate of Mineral and Coal Enterprises (2002)

PT Newmont Minahasa Raya

This company was under the COW of Generation IV located in North Sulawesi Province with the area of 26,805 hectares. The production stage started in 1996. The production in 1999 was 1,135,807 tonnes of ore containing 10,702 kgs of gold. It inceased to 11,394 kgs of gold in 2000 but then declining to 8,318 kgs in 2001.

PT Nusa Halmahera

The new gold mine owned by PT Nusa Halmahera started production in 2000 of 7,802.0 kgs of gold and of 4,687.9 kgs of silver and 6,505.9 kgs of gold and 7,514.6 kgs of silver in 2001.

PT Freeport Indonesia Corporation (PT FIC)

PT FIC has one of the world's largest and most exciting mineral exploration programs, located in Papua. PT FIC exploration activities are positioned along the *ring of fire* where the Indonesia-Australian and Pacific plates collide, making it one of the highest potential mineralization zones in the world. PT FIC includes COW A, an area of ten thousand hectares surrounding the mining activities of Grassberg, and COW B currently approximately 1.3 million hectares across Papua's mountains. A sister company PT Irja Eastern Minerals covers a further 700,000 hectares in Papua and is operated by Freeport's Exploration Team. Reserves total over 2 billion tones of ore which contains, (i) wolrd's single gold reserves over 55 million ounces (1,721.39 tones of Au), and (ii) world's third largest copper reserve over 20 million ounces (or 625.96 tones). Production of gold, silver and copper exploited by the company can be seen in **Table 5**.

The other terminated gold mines

a. PT Ampalit Mas Perdana, terminated in 1998

Alluvial gold or reserves in the COW area of PT Ampalit Mas Perdana which can economically be mined by using dredgers, is thought to have exhausted at the end of 1994. The same is true with the terrace reserves which contains alluvial gold ore deposit which can be mined by using squirt guns, was exhausted in June 1994, and terminated in 1998, which produced 262.9 kgs of dore bullion containing 214.7 kgs of gold and 6.2 kgs of silver, then produced the last dore bullion of 186.4 kgs in 1997 (**Table 6**).

b. PT Lusang Mining, terminated in 1995

The gold mine of PT Lusang Mining which is located at Lebong Tandai in the Province of Bengkulu in Southern Sumatera, had in persuance of the Ministerial Decree of Mines and Energy Number 748.K/2013/M.PE/86, on April 1 1986 officially started production.

The highest amount of production made since that time was 8,370.07 kgs dore bullion containing 900 kgs of gold and 4,900 kgs of silver. Since 1990, however, the production of the company continued to decline due to decreasing deposit of gold and silver to be mined.

In 1994, the last amount of ore from the mines was 84,423 tonnes which are processed to be 5,388.9 kgs of dore bullion containing gold and silver of 363.5 kgs and 1,625.9 kgs respectively. The price paid for those two metals was US$ 7,714,744. Unfortunately then the mines were terminated in 1995 because of several technical problems.

The statistic of the PT Lusang Mining's production and sales of gold and silver until the end of 1994, then terminated in 1995, can be seen on **Table 7.**

Table 5

Gold, silver and copper production of PT Freeport Indonesia (1991-2011)

Year	Production		
	Gold (kg)	Silver (kg)	Copper (ton)
1991	12,793	63,223	204,656
1992	20,703	65,069	290,880
1993	25,411	60,020	309,744
1994	25,326	51,731	333,865
1995	42,324	81,899	459,687
1996	54,754	93,539	525,914
1997	57,665	95,608	548,278
1998	91,045	163,324	809,077
1999	92,235	141,744	766,027
2000	77,121	136,931	776,048
2001	109,178	163,803	756,385
2005	108,448	224,293	793,505
2010	61,833	172,777	632,325
2011	45,400	n.a	n.a

Table 6

Dore bullion production and sale of
PT Ampalit Mas Perdana sent to PT Aneka Tambang (1991-1997)

Year	Dore (kg)	Gold (kg)	Silver (kg)	Value (US$)
1990	341.03	338.81	9.24	+)
1991	403.78	391.02	11.30	4,495,280
1992	372.12	360.96	10.42	4,018,198
1993	100.92	96.87	+)	1,571,815
1994	138.83	132.59	4.131	1,351,830
1995	278.15	268.48	8.87	3,477,275
1996	262.94	214.69	6.22	+)
1997	186.45	180.85	7.99	+)
1998*)	-	-	-	-

*) Terminated +) Data not available Source: Departemen Pertambangan dan Energi (1999, 2000, 2001)

Table 7

Production and sale of gold by PT Lusang Mining (1990-1994)

Year	Ore (ton)	Bullion (ton)	Bullion (kg)	Gold (kg)	Silver (kg)	Value (US$)
1990	-	-	-	906.32	3,816.87	-
1991	99,844.50	7,713.50	7,746.0	685.2	3,273.4	9,197,527
1992	67,839.00	5,185.93	6,172.0	430.5	1,734.4	5,027,400
1993	63,142.00	4,807.47	4,925.4	425.0	1,872.0	4,978,041
1994	84,423.00	9,260.39	5,389.0	363.0	1,625.0	7,714,744
1995*)	-	-	-	-	-	-

*) terminated Source: Departemen Pertambangan dan Energi (1999, 2000, 2001)

c. PT Monterado Mas Mining, terminated in 1997

PT Monterado Mas Mining had received a permit from the Indonesian government to start as of August 1, 1989 with commercial production of its alluvial gold mine. The permit was valid for apart of the area under COW agreement and was 8,383.87 hectares, located in the Monterado region in the West Kalimantan Province, as stated in the Decree of the Directorate General for Mining Number 825.K/29/DDJP/1989. The other part of COW area has still to be explored in detail.

In 1992 the majority share of PT Monterado Mas Mining was transferred to Advocate Resource PTE Ltd, a Singaporean company, and the other parts have been submitted to PT Puncak Cyclop Minerals and PT Prima Searco as minority shareholders. Thus, the composition of the shareholding of PT Monterado Mas Mining was as follows: Advocate Resource PTE Ltd (Singapore) 57.77%, PT Puncak Cyclop Minerals (Indonesia) 38.46%, and PT Prima Searco (Indonesia) 5.77%.

The transfer of shares have been agreed upon by the Coordinating Agency for Capital Investment (BKPM) pursuant to its letter Number 138/III/PMA/1993.

The entire production of PT Monterado Mas Mining in the form of dore bullion is purified and sold through the Unit Logam Mulia, a shareholder of PT Aneka Tambang. The statistics concerning the sale of dore bullion of PT Monterado Mas Mining to PT Aneka Tambang on **Table 8**. The last production of dore bullion in 1996 of about 29.8 kgs containing 25.1 kgs of gold and 3.6 kgs of silver.

Table 8

Dore bullion production and sale of

PT Monterado Mas Mining sent to PT Aneka Tambang (1990-1996)

Year	Dore (kg)	Gold (kg)	Silver (kg)	Value (US$)

1990	290.83	286.89	10.17	+)
1991	47.905	40.001	6.802	552,000
1992	85.212	69.865	15.367	764,000
1993	306.271	249.610	44.409	2,590,452
1994	261.390	218.100	32.820	2,720,603
1995	280.000	236.390	33.960	2,609,590
1996	29.80	25.14	3.57	+)
1997*)	-	-	-	-

*) Terminated +) Data not available Source: Departemen Pertambangan dan Energi (1999, 2000, 2001)

PT Prima Lirang Mining, terminated in 1997

PT Prima Lirang Mining had during its exploration stage discovered a gold deposit which associated with barite in part of its COW area in Wetar island in Southwest Maluku, in the Lerokis region which 4,801 hectares large. A feasibility study and a study of analysis concerning the impact analysis on the environment (AMDAL) revealed that the place is technically and economically feasible to have priority for mining.

By the Decree of the Directorate General of Mining, number 368.K/29/DDJP/1991, to PT Prima Lirang Mining was given a permit to start commercial production activities in the above-mentioned area.

Because the gold ore deposit in that area is associated with barite, PT Prima Lirang Mining is besides building a plant to process dore bullion out of gold ore, the company is also owning a plant to process barite powder.

However, in 1994 the barite powder plant was shut because it was discovered to be uneconomic as its marketing and quality below standard.

In 1994, mining activities were conducted in the Kelian Kuning region, while in the other COW regions exploration activities were still continuing. In the first four years of its operation, the production is on **Table 9**. The production was started in 1991 of 13,317 kgs of dore bullion containing 1,908.7 kgs of gold and 10,983.5 kgs of silver, and the last production in 1997 of dore bullion of 7,369.6 kgs containing 617.5 kgs of gold and 6,157.4 kgs of silver.

Table 9

Dore bullion production of PT Prima Lirang Mining (1991-1997)

Year	Dore bullion (kg)	Gold (kg)	Silver (kg)	Barite (kg)	Mercury (kg)
1991	13,317	1,908.71	10,983.45	6,119	+)
1992	20,446	2,107.61	16,901.33	18,086	+)
1993	18,873	1,514.75	14,114.81	21,248	+)
1994	33,619	1,811.41	28,994.23	6,803	1,366
1995	63,654	2,781.75	61,479.42	6,806	1,452
1996	45,998	3,253.37	38,709.39	+)	14,090

1997	7,369	617.51	6,157.47	+)	+)
1998*)	-	-	-	-	-

*) Terminated +) Data not available Source: Departemen Pertambangan dan Energi (1999, 2000, 2001)

PT Indo Muro Kencana, terminated in 2001

PT Indo Muro Kencana was terminated in 2001. The production of gold started in 1995 was 4,374.61 kgs of gold and 104,914 kgs of silver and reached 5,452.29 kgs in 1999, but then down to 3,002.05 kgs of gold in 2000 (**Table 10**).

Table 10

Dore bullion production of PT Indo Muro Kencana (1995-2001)

Year	Dore bullion (kg)	Gold (kg)	Silver (kg)
1995	116,062	4,375	104,914
1996	97,946	5,362	91,769
1997	133,861	5,538	129,197
1998	70,093	2,938	65,216
1999	89,618	5,452	84,168
2000	40,297	3,002	37,295
2001*)	+)	3,792	80,630

Sources: Departemen Pertambangan dan Energi (1999, 2000, 2001) *) terminated +) data not available Source: Directorate of Mineral and Coal Enterprises (2002)

PT Barisan Tropical Mining, terminated in 1999.

The very short life time of PT Barisan Tropical Mining of 3 years only produced dore bullion of 13,839 kgs in 1997 containing 1,669.2 kgs of gold and 12,165.7 kgs of silver, and then 33,476.9 kgs dore bullion containing 2,061.7 kgs of gold and 29,389.7 kgs of silver in 1999.

g. Other small gold minings operated in production that could be neglected due to their irregular and sporadic activities.

Production of Gold and Scarcity of Gold Deposit in Indonesia

Statistical production of gold in Indonesia per 2010 is shown on **Table 11**. Based on the current reserves (**Table 1**) and production of gold in Indonesia, scarcity of gold deposits in Indonesia is measured by its life time of the mines (**Figure 3**) can be resulted as follows:

a. PT Antam Tbk (West Java):

- reserves 65.596 tonnes of gold, production 1.9 tonnes/year, life time 34.5 years.

- updated reserves 27 tonnes of gold, production 2.6 tonnes/year, life time around 10 years up to 2015.

b. PT FIC (Papua):

- reserves 1,286.2 tonnes of gold, production 57.67 tonnes/year, life time 22.3 years (the first COW: 1971-2001; the second COW: 2001-2020).

- updated reserves 2,664,932,000 tonnes of ore (31 December 2008, Freeport McMoran Copper and Gold, 2011), 2,372 tonnes of gold, production 75 tonnes/year, life time around 30 years (the expected third COW: 2021-2041).

c. PT NNT (West Nusa Tenggara):

- reserves 353.666 tonnes of gold, production 15 tonnes/year, life time 23.5 years (COW: 1999-2022).

d. PT KEM : reserves 153.463 tonnes of gold, production 14.5 tonnes/year, life time 10.5 years.

e. PT BTM: reserves 63.774 tons of gold, production 1.6 tons/year, life time 3.65 years (terminated in 1999).

f. PT NMR: reserves 43.428 tons of gold, production 6.3 tons/year, life time 6.9 years (terminated in 2005).

g. PT IMK: reserves 34.617 tons of gold, production 5.3 tons/year, life time 6.5 years (terminated in 2001).

h. PT AMP: reserves 3.509 tons of gold, production 0.23 tons/year, life time 15.2 years (terminated in 1998).

i. PT MMM: reserves 5.822 tons of gold, production (terminated in 1997).

In principle, in the case of identified gold reserves it can be forwarded based on a competitive market where marginal user cost equals with the price of marginal in situ resources.

Analysis

Demand and suppply curve of gold

The demand for gold consisted of export and domestic sale. The imported gold is less than 3% of the production. The increasing demand should be met be the increasing supply that mainly coming from domestic production (Tables 11 and 12). It is shown on Figure 3 and Table 11 that the increasing average annual growth rate of domestic sale of around 52.5% and export of about 5.3% within the last decade should be anticipated by the supply of production of around 2.5%, facing the continuing depleting present reserves of gold deposit over time.

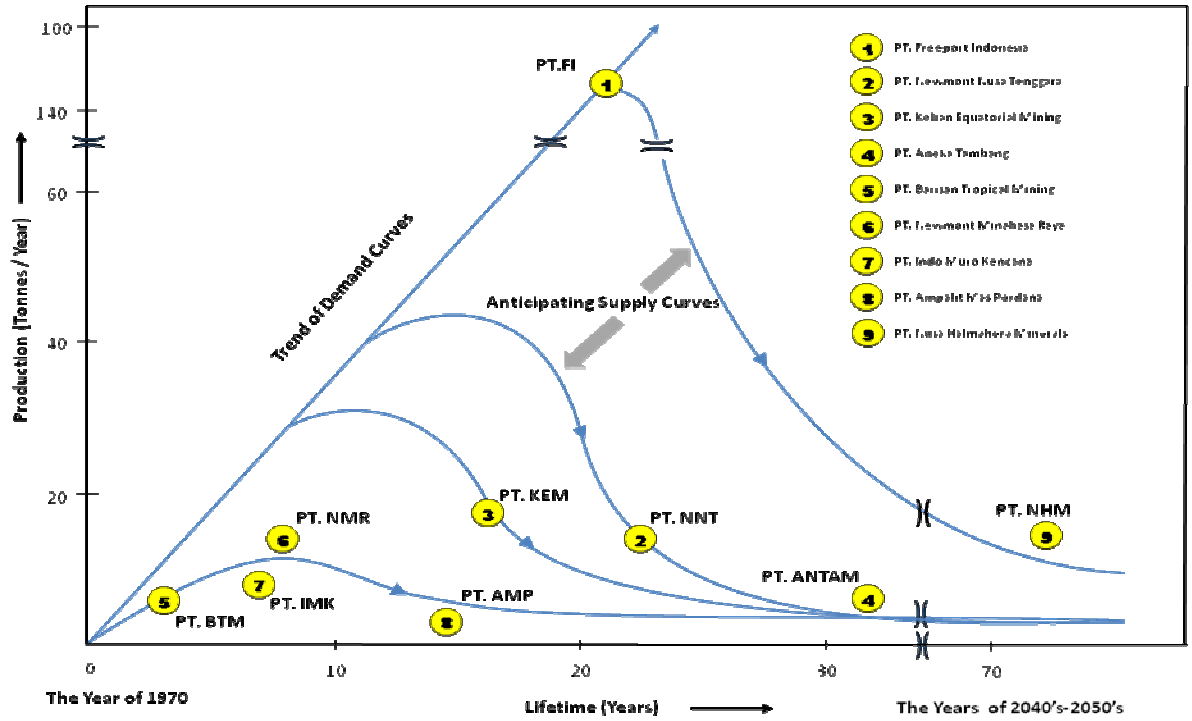

Figure 3. Scarcity curve of gold extraction in Indonesia

Outlook

By considering that Indonesia archipelago located in the ring of fire within the Pacific geological region, it s necessarily required to do grass root exploration to increase the level of upstream added value from the stage of unknown gold resource potential into known resources, then from the known resources into the level of proved reserves and then finally the mineable ones. The known resources of gold are about 3.49 tonnes of ore or around 4,220 tonnes of gold metal. It is consisted of primary gold of 1.8 billion tonnes ore or 4,112 tonnes of gold metal and placer gold of 1.6 billion tonnes ore or 108 tonnes of gold metal or 51.6 % of primary gold ore and 48.4 % of placer gold one or 97.4 % of primary gold metal and 2.6 % of placer gold metal (Table 13).

Primary gold resources are located in Sumatera (Provinces of Nanggroe Aceh Darussalam, North Sumatera, West Sumatera, Riau, Bengkulu, South Sumatera and Lampung), Java (West, Central and East Java), Kalimantan (West, East, Central and South Kalimantan), Nusa Tenggara, Sulawesi, Papua and Maluku (Anonymous (g), 2011). The six biggest primary gold resources are mostly located in Gorontalo Province in Sulawesi, Papua, East Kaimantan, Central Kalimantan, North Maluku, East Java, and the six biggest placer gold resources are mostly located in Papua, West Kalimantan, Riau, Central Kalimantan, Gorontalo Sulawesi that has resources of greater than 100 million tonnes of gold ore respectively. (see Table 13).

Then it could be figured out into demand and supply curve as shown on Figure 4. The base line shows the figure, it is expected that the minimum amount of gold supply could be mined by the method of "people, traditional or artisanal mining".

In general, there would be a transition period from the current era of gold mining based on the current or present gold reserves to the future era of gold minig based on the resources of gold at present , where it needs doing detail or comprehensive exploration to transfer the present resources into the future resrves beyond the years of 2040s-2050s (Figure 4). At the other sides, the resources

and reserves of placer gold ore could be used as "buffer stock of gold" at the level of 40-50 tonnes of gold produced per annum over time especially for domestic demand.

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Based on the 1995 input-ouput transaction table which has been updated into 1998, the contribution of the gold sector in the GDP about 0.084% or 37.41% of the gold total revenue (output). The contribution of the general mining sector of about 3.07% to the total GDP. In 2008 I-O Table, the general mining sector contribution increased up to 4.56% and gold up to 0.75%.

It is approximately figured out that in 2000 the contribution of the general mining to the GDP is about 3.34%., increasing up to 6.76% in 2011. If the contribution of the gold sector is around 0.75%, then gold is still expected to have an increasing role of contribution to the GDP, due to the availability of gold deposit in Indonesia based on the geological potentiality.

The very promising international price trend of gold, it is expected that the serious effort of doing grass root exploration of gold deposit in Indonesia (Figure 5) still would be able to strongly support the Indonesian economy in the coming years. In the curves, it looks likely that the trend of the international oil price followed by the trend of gold international price, however, at one side when the price of oil a little bit decilining, the price of gold is still consistently increasing. At the other sides it looks likely that the production (P) , domestic sale (DS) and export (X) are also still increasing with the regression equations of P (tonnes) = -14008 + 7.061 t (year) (R2= 0.578), DS (tonnes) = -9634 + 4.682 t (R2= 0.459) and X (tonnes) = -5322 + 2.669 t (R2= 0.470) respectively (Figure 6).

Table 11. The existing gold mines in Indonesia: Total production, domestic sale and export,1995-2010

No	Province / Island	Year (Tonnes)												
	Company	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	*Papua*													
	PT. FI / 1972*	12.79	22.52	50.72	109.17	97.84	99.68	48.56	108.44	108.45	57.26	82.68	94.58	61.83
2	*West Nusa Tenggara*													
	PT. NNT	–	0.362	10.19*	16.06	15.31	18.68	22.35	22.76	22.76	13.92	17.50	17.40	22.93
3	*North Maluku*													
	PT. NHM / 2000*	–	–	7.42*	8.84	3.40	0.47	5.88	6.06	8.52	11.66	12.95	11.56	13.97
4	*Java (West)*													
	PT. ANTAM	0.1 1994*	1.80	4.12	4.26	4.09	4.49	3.95	2.91	2.8	2.79	2.83	2.62	2.78
5	*Sulawesi*													
	PT. NMR / 1996*	–	–	6.63	11.12	5.16	3.34	2.16	T	–	–	–	–	–
	PT. Avocet BM	–	–	n.a	n.a	n.a	n.a	n.a	1.47*	1.51	2.35	1.34	1.49	1.48
6	*Kalimantan*													

	PT. KEM	–	**n.a**	**8.67**	**14.09**	**16.77**	**14.58**	**10.19**	**1.327**	**T**	–	–	–	–
	PT. IMK	–	**8.37**	**5.36**	**3.79**	**n.a**	**n.a**	**n.a**	**0.31**	**0.3**	**1.26**	**1.42**	**1.16**	**1.27**
	PT. Ensbury KTM / 2010*	–	**18.90**	–	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**0.003**
	PTGC / 2005*	–	–	–	**n.a**	**n.a**	**n.a**	**n.a**	**0.01**	**0.036**	**0.017**	**0.014**	**n.a**	**n.a**
7	***Sumatera***													
	PT. NM Lampung	–	–	–	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**n.a**	**0.267 ***
	Others	**3.00**												
Total Production (Tonnes of Gold)		**15.89**	**63.26**	**123.9**	**162.6**	**142.2**	**141.0**	**92.9**	**143.2**	**144.4**	**87.29**	**118.7**	**128.8**	**104.5**
Annual Change (%)				**20.7**	**31.2**	**-12.5**	**-0.8**	**-34.1**	**54.1**	**0.8**	**-39.5**	**36**	**8.5**	**-18.9**
% Average / Year		**2.5**												
Total Export (Tonnes of Gold)		**13.94**	**52.84**	**91.93**	**122.9**	**103.5**	**112.1**	**88.7**	**141.2**	**84.5**	**83.1**	**56.8**	**104.1**	**81.2**
Annual Change (%)				**79.8**	**33.7**	**-15.8**	**8.3**	**-20.9**	**59.2**	**-40.2**	**-1.7**	**-31.6**	**83.3**	**-22**
% Average / Year		**5.3**												
Total Domestic Sale (Tonnes of Gold)		**14.99**	**5.44**	**17.15**	**30**	**24.4**	**17.7**	**10.34**	**55.7**	**18.1**	**41.7**	**20.3**	**33.2**	**22**
Annual Change (%)				**134.7**	**74.9**	**-18.7**	**-27.5**	**-41.6**	**438.7**	**-67.5**	**130.4**	**-51.3**	**63.5**	**-33.7**
% Average / Year		**52.7**												

Legend:
* Year of starting production.
T = terminated.
- The existing gold mining: PT FI= PT Freeport Indonesia ; PT NNT= PT Newmont Tenggara; PT NHM= PT North Halmahera Mining; PT ANTAM= PT Aneka Tambang that owns Ciktotok gold mining in West Java operated by 1940 and re-operated in 1961-1994, then Pongkor gold mining operates in 1994-2015; PT NMR= PT Newmont Minahasa Raya; PT Avocet BM= PT Avocet Boolang Mongondow; PT KEM= PT Kelian Equator Mining; PT IMK= PT Indomuro Kencana; PT Ensbury KTM = PT Ensbury Kalteng Mining; PT GK = PT Galuh Cempaka; PT NM= PT Natarang Mining.
- Other terminated gold mining compnies: PT Lusang Mining, Bengkulu, Sumatera (T 1995); PT Ampalit Mas Perdana, Kalimantan (T 1997); PT Prima Lirang Mining, Maluku (T 1998); PT Indo Muro Kencana, Central Kalimantan (T 2002); PTBarisan Tropical Mining, South Sumatera (1997-1998) (T 2000).

Table 12

Production of gold in Indonesia

		Tonnes				
No.	Year	Production			Domestic sale	Export
		Other than PT FIC	PT FIC *)	Total		

1	1992	17.58033	20.70318	38.28351	2.15	37.91
2	1993	16.68622	25.41076	42.09698		
3	1994	17.28396	25.32085	42.60481	5.44	52.84
4	1995	20.33700	42.47460	62.81160	2.14	71.82
5	1996	28.51605	54.75400	83.26700	1.90	82.60
6	1997	30.60837	57.66355	88.27192	2.34	108.48
7	1998	91.23100	91.04500	182.27600	15.15	105.33
8	1999	34.94900	92.23500	127.18400	17.15	91.93
9	2000	46.87300	77.12100	123.99400	30.00	122.9
10	2001	56.91300	109.17800	166.09100	40.7	83.1
11	2007	32.014	57.628	89.642	20.3	56.8
12	2008	70.807	82.682	118.765	33.2	104.1
13	2009	34.258	94.586	128.844	22.0	81.2
14	2010	42.717	61.833	104.550	22.4	78.6
15	2011	29.357	45.400	74.757		

Sources: Departemen Pertambangan dan Energi (1999, 2000, 2001) Directorate of Mineral and Coal Enterprises (2002) Directorate General of Coal and Mineral Resources (2011).

*) Cu concentrate is smelted overseas, since 1997 37.5% of the concentrate product (of around 750,000 tonnes/annum) smelted domestically.

1997 gold production by companies:
- PT Antam Tbk. 1.9350365
- PT Ampalit Mas Perdana 0.2307445
- PT Kelian Equatorial Mining 14.5248429
- PT Prima Lirang Mining 0.6353429
- PT Indo Muro Kencana Mining 5.3011222
- PT Estara Melawai Mining 0.0103811
- PT Karya Bukit Utama 0.0039140
- PT Newmont Minahasa Raya 6.3014333
- PT Burry B Mungkin 0.0016000
- PT Permas 0.0004550
- PT Barisan Tropical Mining 1.6020036
- KUD Mandiri Panca Usaha 0.00029130
- PT Freeport Indonesia Corporation 57.66355
-

2001 gold production by companies:
- PT Antam Tbk. 3.957
- PT Kelian Equatorial Mining 14.1
- PT Indo Muro Kencana Mining 3.792
- PT Newmont Minahasa Raya 10.155
- PT Newmont Nusa Tenggara 16.064
- PT Nusa Halmahera Mineral 8.845
- PT Freeport Indonesia Corporation 109.178

2011 gold production by companies : (tonnes)
- PT FI, 45.400
- PT Avocet Bolang M., 1.321
- PT Indomuro Kencana,0,750
- PT Ensbury Kalteng Mining, 0.045
- PT Newmont NT, 8.890
- PT Nusa Halmahera Minerals, 13.449
- PT Aneka Tambang, 2.667
- PT Natarang Mining,1.234

Table 13. The known resources of gold deposits in Indonesia -

Primary gold resources			Placer gold resources		
Location	Ore (thousand tonnes)	Gold metal (Au) (tonnes)	Location	Ore (thousand tonnes)	Gold metal (Au) (tonnes)
1.Gorontalo	402,100	185	1. Papua	509,640	12
2.Papua	308,500	293	2. Weat Kalimantan	452,724	59
3.East Kalimantan	300,000	690	3. Riau	233,666	n.a
4.Central Kalimantan	279,028	1,196	4. Central Kalimantan	170,944	24
5.North Maluku	173,394	169	5. Gorontalo	143,703	n.a
6.East Java	144,010	852	6. North Maluku	8,111	n.a
7. Others (17 locations/provinces): North and West Sumatera, Jambi, Bengkulu, South Sumatera, Lampung, Banten,	224,519	727	7.Other locations/provinces): West Sumatera, Jambi, Lampunbg, East Java, East kalimantan. South Kalimantan, North	139,869	13

West and Central Java, West and East Nusa Tenggara, Central sulawesi, and Maluku)			Sumatera, South Sumatera)		
Total	1,831,551	4,112		1,658,657	108

Source: Directorate General of Coal and Mineral Resources, 2011.

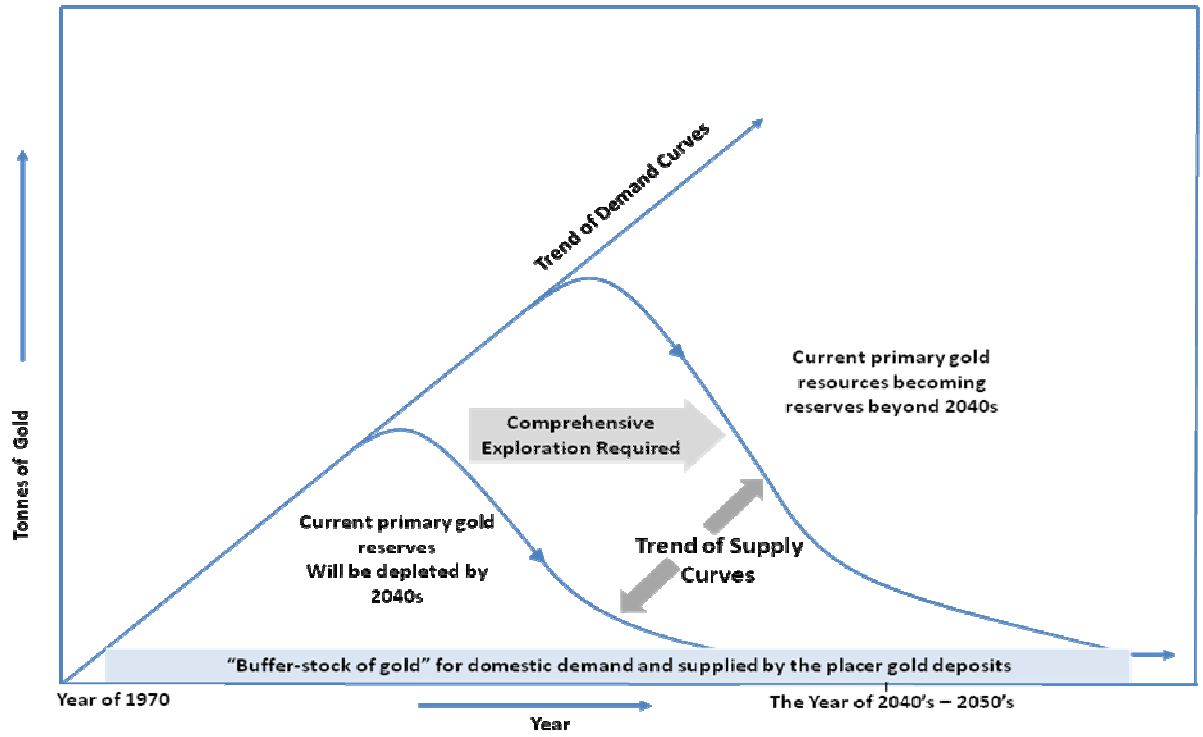

Figure 4. Transition of current gold supply curve to future gold supply one

Based on the 1995 input-ouput transaction table which has been updated into 1998, the contribution of the gold sector in the GDP about 0.084% or 37.41% of the gold total revenue (output). The contribution of the general mining sector of about 3.07% to the total GDP. In 2005 I-O Table, the general mining sector contribution increased up to 4.56% and gold up to 0.75%.

It is approximately figured out that in 2000 the contribution of the general mining to the GDP is about 3.34%., increasing up to 6.76% in 2011. If the contribution of the gold sector is around 0.75%, then gold is still expected to have an increasing role of contribution to the GDP, due to the availability of gold deposit in Indonesia based on the geological potentiality.

The very promising international price trend of gold, it is expected that the serious effort of doing grass root exploration of gold deposit in Indonesia (Figure 5) still would be able to strongly support the Indonesian economy in the coming years. In the curves, it looks likely that the trend of the international oil price followed by the trend of gold international price, however, at one side when the price of oil a little bit decilining, the price of gold is still consistently increasing. At the other sides it looks likely that the production (P) , domestic sale (DS) and export (X) are also still increasing with the equations of P (tonnes) = -14008 + 7.061 t (year) (R2= 0.578), DS (tonnes) = -9634 + 4.682 t (R2= 0.459) and X (tonnes) = -5322 + 2.669 t (R2= 0.470) respectively (Figure 6).

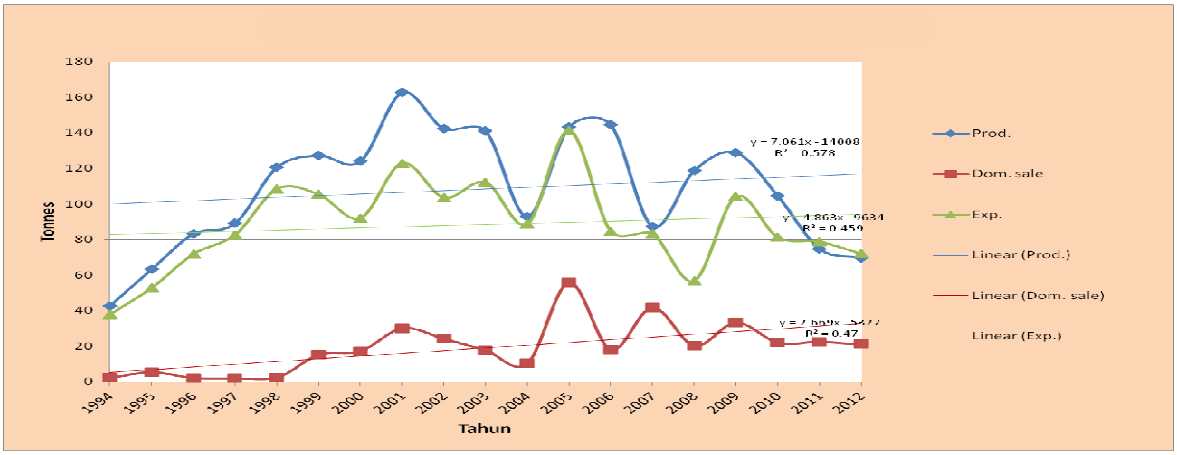

Figure 6. Linear regression of gold production, domestic sale and export in Indonesia, 1994-2012

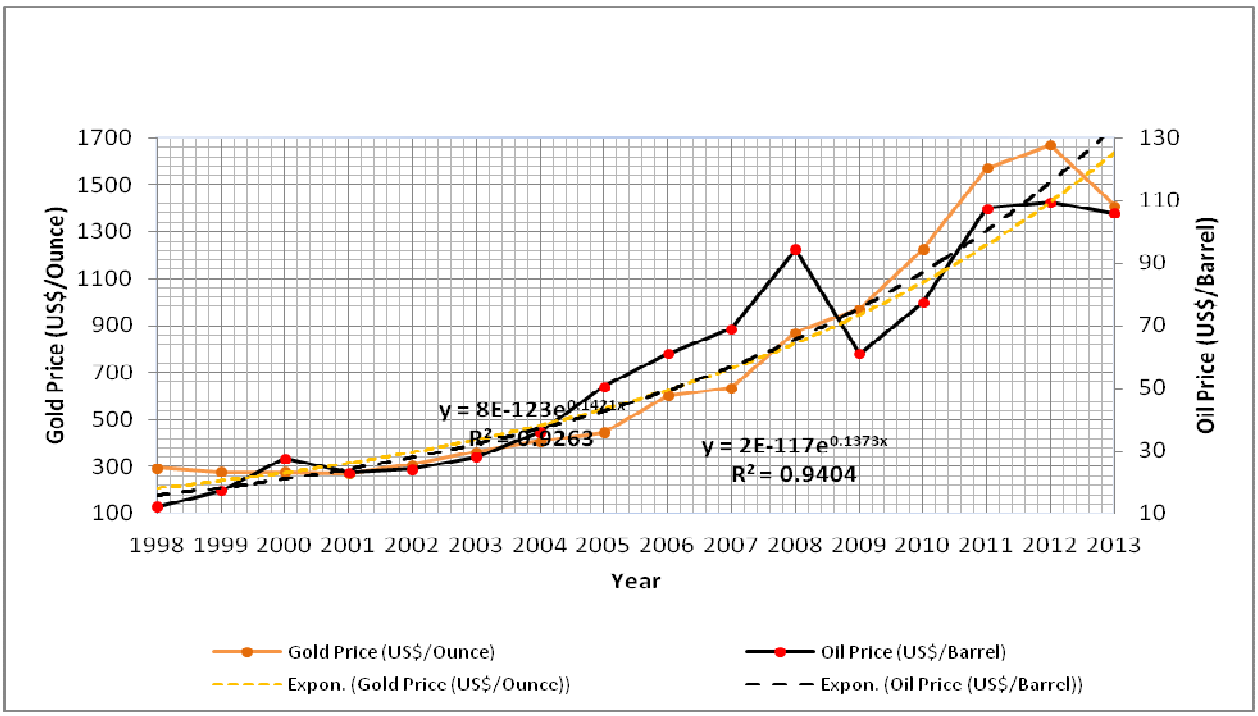

Figure 5. Yearly basket price of gold , 1998-2013

However, if we might have a look in the period of 2000-2012, it is shown that the curves of gold production and export would tend to decrease that have downward sloping with the equations of regression of P = 10653 – 5.2516 t (R2= 0.4761) and X = 6439.8 - 3.1635 t (R2= 0.2991). At the other side, it looks likely that the domestic sale curve shows the gently positive upward sloping or tends to increase with the regression equation of DS = -296.86 + 0.1608 t (R2= 0.0027) (Figure 7). The exposition of the curves shows that Indonesia is facing the declining production of gold due to the declining the quality of reserves, so that she should decrease the export if the domestic sale should be increased to gain higher added value besides creating employment through supporting the downsteam gold manufacturing industry such as jewelry and so on.

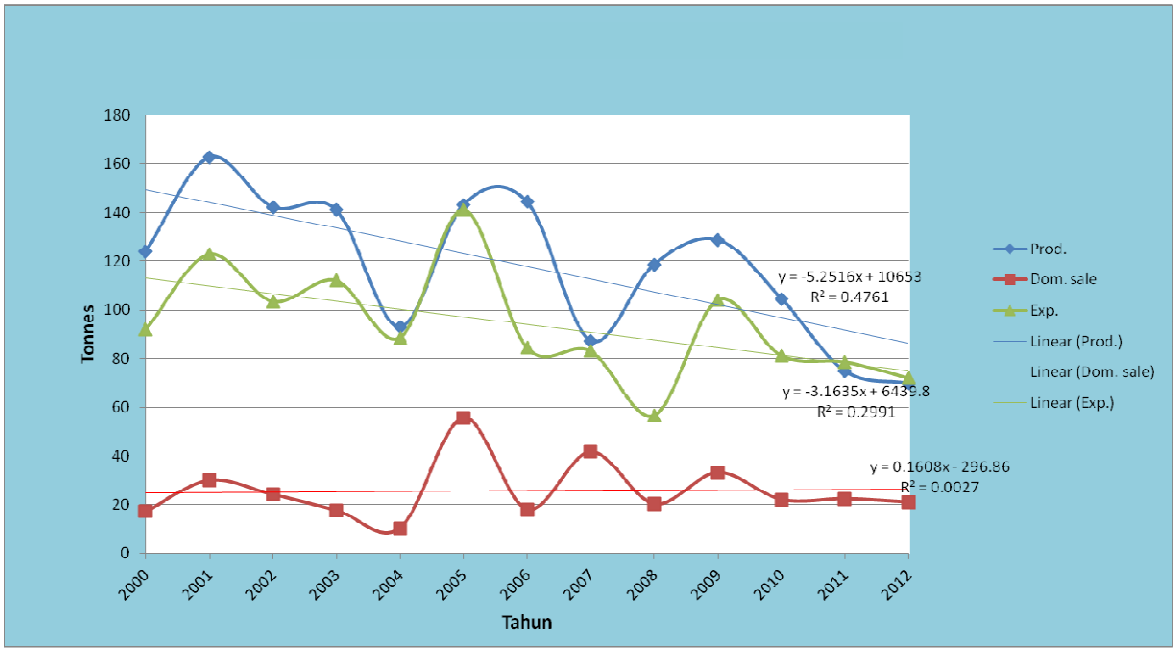

Figure 7. Linear regression of gold production, domestic sale and export curves in Indonesia, 2000-2012

CONCLUSION

Based on the predicted life time of extraction of the existing known gold deposits in Indonesia, gold production does not exceed within the next thirty years or seventy years after the COW production started in the early of 1970's. It is recommended that the new activity of exploration should be reinvented with the new climate of investment policy including fiscal regime and the right supportive regulation should be enforced. Modification or improvement of the related regulations to the mining activity such as the laws or regulations of forestry, environmental protection, regional autonomy, tax and labor should also be carried out.

Toward creating this condition the new policy regime should be reintroduced with the spirit of creating new incentives. Area of the prospective exploration is suggested in volcanic arc, epithermal zone, 'ring of fire' (where two or more plates collide like in Papua, Maluku and Sulawesi) and even in gold-bearing sedimentary rocks like in West Kalimantan.

It is strongly recommended that the GOI ought to allocate certain amount of revenue coming from gold or mineral in general to do comprehensive systematic exploration over time to assure the resources and reserves of gold and mineral as a whole due to the very promising location of Indonesia in the ring of fire within the Pacific region. Then, mineral resource endowment in this country is still promising to support the national economic growth based on the concept of pro-growth, pro-environment and pro-poor as long as Indonesia has very large amount of population as the biggest four in the world, where mineral resource endowment is also still able to have role to support econmic growth besides eleviating poverty in the country from now and on.

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