

42 Gold

Gold is a noble metal highly valued by mankind since antiquity as an adornment for cultural status and decorative purposes as possessions that symbolise wealth and for coinage. It is also owned as an investment. For most consumers, the motivations are intertwined. Gold is a relatively scarce metal in the world and a scarce commodity in India. Properties of gold which make it useful in industry are malleability, ductility, colour, resistance to corrosion, high electrical conductivity, reflecting power and therapeutic effects of some of its salts. India is a minor producer of gold but has huge demand in the country mainly in ornament sector. The domestic demand is mainly met through imports of gold.

RESOURCES

As per UNFC system, as on 1.4.2005, the total resources of gold ore in the country were estimated at 390.29 million tonnes. Out of these, 19.25 million tonnes were placed under reserves category and the remaining 371.04 million tonnes under remaining resources category. Total resources of gold (primary), in terms of metal, stood at 490.81 tonnes. Out of these, 85.12 tonnes were placed under reserves category and 405.69 tonnes under remaining resources category. The resources include placer-type gold ore in Kerala estimated at 26.12 million tonnes containing 5.86 tonnes gold metal. By States, largest resources (57%) are located in Bihar in terms of gold ore (primary) followed by Karnataka and Rajasthan (17%) each, West Bengal and Andhra Pradesh (3%) each, Madhya Pradesh (2%), etc., while in terms of metal content, Karnataka remained on top followed by Rajasthan, West Bengal, Bihar, Andhra Pradesh, etc. (Table-1).

EXPLORATION & DEVELOPMENT

GSI, MECL, HGML and DMG, Rajasthan and Karnataka carried out exploration for gold in 2009-10. Gold, along with other minerals, continued to be the principal thrust area for exploration by GSI in Andhra Pradesh, Bihar, Jharkhand, Karnataka, Rajasthan and Uttarakhand.

MECL carried out exploration for gold in Jharkhand. HGML conducted exploration in its mining lease areas viz, Hutti, Hira-Buddini and Uti Gold Mines in Raichur district in Karnataka. DMG, Rajasthan and DMG, Karnataka carried out exploratory work in Jaipur district and Davangere district, respectively. Details of exploration activities undertaken in 2009-10 by various exploratory agencies are furnished in Table - 2.

PRODUCTION AND STOCKS

The production of gold ore at 518 thousand tonnes in 2009-10 decreased by 12% as compared to that in the previous year. The quantity of ore treated decreased from 577 thousand tonnes to 541 thousand tonnes registering a fall of 6% as compared to previous year. Four mines reported production of gold ore in 2009-10, same as in 2008-09.

The average grade of gold ore produced during 2009-10 was 5.65 g/t as against 5.84 g/t in 2008-09, whereas, the average grade of ore treated during 2009-10 was 3.80 g/t as against 4.23 g/t in 2008-09.

Total production of gold (primary) in 2009-10 at 2,106 kg decreased by 14% as compared to that in the preceding year. No production of secondary gold was reported since 2007-08 from domestic ores.

HGML, a Karnataka State Government Undertaking was the leading producer of gold accounting for more than 99% of the total production. The remaining production was reported from Jharkhand (Tables - 3 to 7).

In addition, around 4,871 kg and 9,114 kg of secondary gold were recovered from imported copper concentrates during 2008-09 and 2009-10, respectively, by Birla Copper Complex of Hindalco Industries Ltd at Dahej in Bharuch district, Gujarat. The total production of gold bullion is furnished in Table-8.

The average daily employment of labour strength in 2009-10 was 3,846 as against 3,210 in the previous year.

**Table – 1 : Reserves/Resources of Gold as on 1.4.2005
(By Grades/States)**

(In tonnes)

Grade/State	Reserves			Remaining resources						Total resources (A+B)	
	Proved STD111	Probable		Total (A)	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334		Total (B)
		STD121	STD122								
All India : Total											
Ore (Primary)	15554089	1075868	2623994	19253951	1724132	27062651	83529855	118635315	140083333	371035286	390289237
Metal (Primary)	66.92	3.8	14.4	85.12	6.74	62.08	118.4	52.74	165.73	405.69	490.81
Ore (Placer)	-	-	-	-	-	-	2552000	23569000	-	26121000	26121000
Metal (Placer)	-	-	-	-	-	-	2.29	3.57	-	5.86	5.86
By States											
Andhra Pradesh											
Ore (Primary)	655133	-	889515	1544648	-	8200000	661000	1692699	-	10553699	12098347
Metal (Primary)	2.45	-	3.57	6.02	-	17.28	0.69	7.59	-	25.56	31.58
Bihar											
Ore (Primary)	-	-	-	-	-	-	27042744	101842116	94000000	222884860	222884860
Metal (Primary)	-	-	-	-	-	-	3.33	18.27	16	37.6	37.6
Chhattisgarh											
Ore (Primary)	-	-	-	-	-	-	600000	300000	-	900000	900000
Metal (Primary)	-	-	-	-	-	-	1.8	0.9	-	2.7	2.7
Jharkhand											
Ore (Primary)	-	-	92850	92850	-	-	-	254000	-	254000	346850
Metal (Primary)	-	-	0.83	0.83	-	-	-	2.29	-	2.29	3.12
Karnataka											
Ore (Primary)	14898956	1075868	1641629	17616453	1724132	3676371	7914931	1990500	33250000	48555934	66172387
Metal (Primary)	64.47	3.8	10	78.27	6.74	17.43	20.12	5.12	25.73	75.14	153.41

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Table - 1 (Concl.d.)

Grade/State	Reserves			Remaining resources					Total resources (A+B)	
	Proved STD111	Probable		Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334		
		STD121	STD122							Total (A)
Kerala										
Ore (Primary)	-	-	-	-	462280	96180	-	-	558460	558460
Metal (Primary)	-	-	-	-	0.17	0.03	-	-	0.2	0.2
Ore (Placer)	-	-	-	-	-	2552000	23569000	-	26121000	26121000
Metal (Placer)	-	-	-	-	-	2.29	3.57	-	5.86	5.86
Madhya Pradesh										
Ore (Primary)	-	-	-	-	-	5375000	1947000	-	7322000	7322000
Metal (Primary)	-	-	-	-	-	5.59	2.22	-	7.81	7.81
Maharashtra										
Ore (Primary)	-	-	-	-	-	-	1517000	-	1517000	1517000
Metal (Primary)	-	-	-	-	-	-	3.55	-	3.55	3.55
Rajasthan										
Ore (Primary)	-	-	-	-	14724000	41840000	9025000	-	65589000	65589000
Metal (Primary)	-	-	-	-	27.2	84.55	14.09	-	125.84	125.84
Tamil Nadu										
Ore (Primary)	-	-	-	-	-	-	67000	-	67000	67000
Metal (Primary)	-	-	-	-	-	-	1	-	1	1
West Bengal										
Ore (Primary)	-	-	-	-	-	-	-	12833333	12833333	12833333
Metal (Primary)	-	-	-	-	-	-	-	124	124	124

Figures rounded off.

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Table – 2 : Details of Exploration Activities for Gold, 2009-10

Agency State/District	Location	Mapping		Drilling		Sampling	Remarks and Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
GSI							
Andhra Pradesh							
Anantapur	Northern part of Ramagiri-Penakacherla	large -scale	NA	–	–	–	The mapping indicated silicification, epidotisation and sericitisation in the area. Disseminations of sulphide mostly pyrite and pyrrhotite was noticed at places. Analytical results of samples collected did not indicate any significant gold values.
Mahaboobnagar	North of River Krishna	–	–	–	–	184	Geochemical soil, trenching and bedrock samples in Nandimalla and Patharchad blocks indicated gold values 40, 80 and 160 ppb.
Bihar							
Nalanda	Munger- Ranchi	large-scale	NA	–	–	–	Sulphide mineralisation has been noted over a strike length of 4 km along the limb of a major fold near Giriak. Analytical results of bed rock samples indicated gold values ranging from 28 to 200 ppb in 17 samples. Analytical results of the remaining samples are awaited.
Jharkhand							
East and West Singhbhum	Tilaitanr Sobhapur	–	–	–	–	–	Mineralisation in the form of discontinuous exposures of grey quartz veins containing disseminated grains of pyrite over a distance of about 150 m with thickness varying from 10- 30 cm were delineated. Disseminations of chalcopyrite, pyrite, arsenopyrite and suspected native gold are noted mostly in quartz/quartz carbonate veins in southern part of the area. Analytical results of trench samples were awaited.
Ranchi	Sindauri East block	–	–	5	–	–	Gold potentiality of the six mineralised zones, extending from the adjacent Kotadih-Sindauri block have been traced. All the boreholes intersected significant zones of gold mineralisation at various intervals which indicated gold values ranging from 0.16 to 20.10 g/t. A total of 3.10 million tonnes resources having an average grade of 1.81g/t Au at 5g/t cut-off has been estimated.

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Table - 2 (Contd.)

Agency State/District	Location	Mapping		Drilling		Sampling	Remarks and Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Karnataka							
Chitradurga	Belaghatta block	-	-	-	-	-	Three sheared alteration carbonatised zones and one sheared silicified zone were delineated along N-S to NNW-SSE with width varying from 8 m to 14 m. The bedrock samples from silicified zone show Au values ranging from 35-345 ppb. Trench samples from carbonatised zones showed gold values of 0.56 g/t over 4 m width. Stream sediment samples have also analysed Au values up to 250 ppb.
Gulbarga	Northern part of Manglur Schist belt	-	-	-	-	-	Mineralisation in the form of dissemination of sulphide zone that is structurally controlled seemed to continue in quartz vein. Analytical results of the bedrock, sedimentary and trench samples did not indicate any significant gold values. However, a few bedrock and trench samples indicated gold values from 25 to 88 ppb.
Tumkur	Ajjanahalli Block-D	-	-	-	-	-	The mineralised zones 5 & 6 were proved by drilling. Two boreholes AGD-1 and AGD-2 intersected the bands 5 & 6 at various depths. Analytical results of core samples are awaited. The zones 7 & 8 were assessed by trenching and bedrock sampling. The analysis of bedrock samples indicated gold values of 0.65 g/t and that of trench samples indicated gold values ranging from 0.10 to 1.20 g/t. Based on the work carried out in the previous year the resources of gold ore in Block-C were estimated at 0.995 million tonnes with average grade of 2.17 g/t (cut-off 1.0 g/t) and 0.214 million tonnes with average grade 1.45 g/t (cut-off 0.5 g/t).

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Table - 2 (Contd.)

Agency State/District	Location	Mapping		Drilling		Sampling	Remarks and Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Rajasthan							
Banswara	Delwara West block (Bhukia Gold Belt)	-	-	25	-	-	First 11 boreholes intersected 4 to 24 sulphide zones (1.00 m to 56.80 m wide) 10,12,14 and 16 intersected 9-23 sulphide zones (1.00 m to 55.25 m width). 17 intersected 3-8 sulphide zones (1.00 m to 7.00 m thick) 27 intersected 15 sulphide zones (1.00 m to 37.20 m thick) The boreholes DWB-17 to 22 intersected 3 to 8 sulphide zones (1.0 to 7.0 m thick) Boreholes DWB-23 and 24 intersected 1.0 to 16.90 m thick 6 & 8 sulphide zones respectively. DWB-27 intersected 1.00 to 37.20 m thick 15 sulphide zones. On the basis of analytical results, a resource of 1.62 million tonnes has been estimated during the year. (cut-off grade 0.2 and 0.5 g/t) Hence the total gold resources of Delwara west block have been estimated at 34.73 million tonnes with an average gold value of 1.87 g/t.
Banswara	Gundelpara North- West Block	-	-	-	-	-	Surface evidences of mineralisation are in the form of old workings, gossan, malachite stains and pyrite mineralisation presence of grinding implements in nearby areas. Sulphides are brown to bluish-black in colour and contain mainly copper minerals.
-do-	Gundelpara Block	-	-	-	-	-	On the basis of earlier exploration, an inferred resource (333) of 1.932 million tonnes of gold ore with an average grade of 3.978 g/t has been estimated during the year.
Dungarpur	Bharkundi Block	-	-	-	-	-	On the basis of earlier exploration a reconnaissance resource (334) of 4.5 million tonnes of gold ore with an average grade of 0.25 g/t Au has been estimated.

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Table - 2 (Contd.)

Agency State/District	Location	Mapping		Drilling		Sampling	Remarks and Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Uttarakhand							
Chamoli & Pithoragarh	Martoli-Milam & Niti area	-	-	-	-	-	Two auriferous lenses have been delineated. i) Lens-1 - An auriferous lens that extends to about 90 m with two zones of 0.65 g/t Au X 10 m for over a strike length of 60 m ii) Lens-2 extends up to 135 m strike length and has two zones namely 0.4 g/t Au X 3-5 m and 0.5 g/t Au X 4 m for a strike length of 40 m.
MECL							
Jharkhand							
Ranchi	Parsi (Central Block) Phase - I	-	1.25	17	2806.0	2937	Strike length of the deposit was 706 m and an average thickness of lodes was 6.40 m. Depth persistence was about 154.0 m. A total of 5.16 million tonnes gold resources were estimated. Out of which 3.486 million tonnes with an average grade of 1.05 g/t Au (at 0.50g/t Au cut-off) and 1.67 million tonnes with an average grade of 1.72 g/t Au (at 1.00 g/t Au cut-off)
-do-	Parasi (Central block) Phase - II	-	1.25	08	1962.90	1823	A total of 11.18 million tonnes resources of gold was estimated out of which 7.47 million tonnes with 0.98 g/t Au (at 0.50 g/t Au cut-off) and 3.71 million tonnes with 1.65 g/t Au (at 1.0 g/t Au cut-off) were indicated.
DMG							
Rajasthan							
Jaipur	N/V Pachhapur,1:10,000 Gol, Matasula Teh. Jamwa- Ramgarh		10.5	-	-	229	Indications of noble metal mineralisation are revealed in the form of Gossan, old workings, slag, malachite-azurite staining, etc. within the quartzite belonging to Ajabgarh group of Delhi Supergroup over a strike length of 20 km. Resources were not estimated.

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Table - 2 (Concl.d.)

Agency State/District	Location	Mapping		Drilling		Sampling	Remarks and Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
DMG							
Karnataka Davangere	Kudrekonda	1:50,000	150	–	–	15	The area under exploration forms the south eastern part of Dharwar craton covering a part of Shimoga belt. General trend is NNW-SSE dipping to about 60° to 80° east. fifteen stream sediments and bulk samples were collected. Detailed investigation will be carried out only if the result of the chemical analysis is found encouraging.
HGML							
Karnataka Raichur	Hutti mines	1:400	4639.00 (U/G)	–	–	26412	About 4639.00 m of geological mapping was done and about 9.18 million tonnes with 5.6894 g/t Au were estimated. Out of which 9.16 million tonnes were placed under proved and probable category (at 5.68 g/t).
-do-	Uti mines	1:2,000	3.00	–	–	1538	Exploratory mining (about 294.60 m) was carried out and about 61.48 million tonnes resources containing 2.51 g/t Au were estimated.
-do-	Hira Buddini	–	–	–	–	2080	About 567.10 m of exploratory mining was carried out and about 0.75 million tonnes resources with 3.36 g/t Au were estimated.

Table – 3 : Producers of Gold, 2009-10

Name and address of the producer	Location of the mine	
	State	District
The Hutti Gold Mines Co. Ltd, No. 6/13, Guruappa Avenue, Primrose Road Cross, Bengaluru - 560 025, Karnataka.	Karnataka	Raichur
Manmohan Industries (P) Ltd, Shantiniketan, 286, New Patliputra Colony, Patna, Bihar.	Jharkhand	Singhbhum East

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**Table – 4 : Production of Gold Ore
2008-09 and 2009-10
(By States)**

State	(In tonnes)			
	2008-09		2009-10(P)	
	Ore Produced	Avg. Grade (g/t)	Ore Produced	Avg. Grade (g/t)
India	587215	5.84	517599	5.65
Jharkhand	4307	3.80	5066	2.54
Karnataka	582908	5.85	512533	5.65

**Table – 5 : Gold Ore Treated
2008-09 and 2009-10
(By States)**

State	(In tonnes)			
	2008-09		2009-10(P)	
	Ore Treated	Avg. Grade (g/t)	Ore Treated	Avg. Grade (g/t)
India	577025	4.23	541270	3.80
Jharkhand	6578	3.09	4214	2.37
Karnataka	570447	4.24	537056	3.80

**Table – 6 : Production of Gold*, 2007-08 to 2009-10
(By States)**

State	(Quantity in kg; Value in Rs.'000)					
	2007-08		2008-09		2009-10(P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	2969	3017382	2438	3152620	2106	3313896
Primary Gold	2969	3017382	2438	3152620	2106	3313896
Jharkhand	27	26498	18	21883	14	21448
Karnataka	2942	2990884	2420	3130737	2092	3292448

* Recovered from indigenous ores.

**Table – 7 : Production of Gold*, 2008-09 and 2009-10
(By Sectors/States/Districts)**

State/District	(Quantity in kg; value in Rs. '000)					
	No. of mines	2008-09		No. of mines	2009-10 (P)	
		Quantity	Value		Quantity	Value
India	4	2438	3152620	4	2106	3313896
Public sector	3	2420	3130737	3	2092	3292448
Private sector	1	18	21883	1	14	21448
Primary Gold	4	2438	3152620	4	2106	3313896
Jharkhand	1	18	21883	1	14	21448
Singhbhum East	1	18	21883	1	14	21448
Karnataka	3	2420	3130737	3	2092	3292448
Raichur	3	2420	3130737	3	2092	3292448

* Recovered from indigenous ores.

Gold Bullion

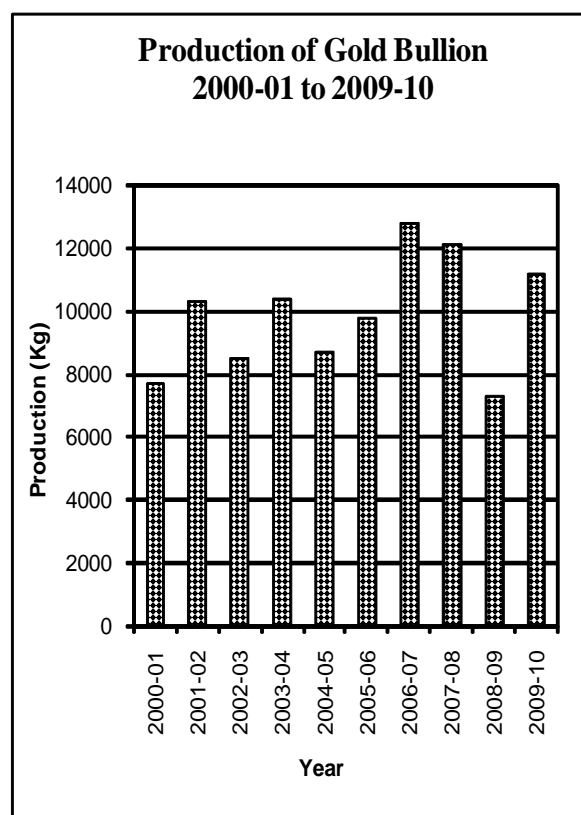
Production of gold bullion in India is reported both in primary and secondary forms. Total production of gold bullion during 2009-10 at 11,220 kg increased by about 54% as compared to 7,309 kg in the previous year (Table - 8).

Table – 8 : Production of Gold Bullion*
2007-08 to 2009-10

(Quantity in kg; Value is Rs. '000)

Year	Quantity	Value
2007-08	12104	11617074
2008-09	7309	9277886
2009-10(P)	11220	17798126

* Includes gold recovered as by-product from copper concentrates by Hindalco Industries Ltd.



MINING & MILLING

Presently, HGML is the only public sector company producing gold in the country. Manmohan Industries Pvt. Ltd in private sector is also engaged in mine production of gold. HGML operates mines at Hutti, Uti and Hira-Buddini in Raichur district, Karnataka. The total installed capacity of these mines is 7.02 lakh tpy gold ore. Implementation of mechanisation of mining operations at Hutti mine was in progress. Exploratory developments were taken up in all reefs and cross-cutting in south shaft 3rd and 6th level is under way. Sub-level and LDBH stoping methods are employed to exploit the gold ore. The Uti mine is opencast and the ore from this mine is transported to Hutti mine for processing at the mills. The present capacity of the mine is 25,960 tpy of ore. As per the feasibility studies, opencast mining is viable and will be continued to 90 m vertical depth. Underground exploratory mining too is in progress. Several operations at Hira-Buddini gold unit, such as exploratory mine development and deepening and re-equipping of main shaft are in progress. The present production capacity of the mine is 20,050 tpy. Exploratory mine development using manual compressed air jackhammer drilling and electrical hoist for winding in the shaft too is presently underway. Based on the development work and feasibility, the locomotive loaders, wagon drills and other required machinery will be used to increase the OMS. Further forays to carry out detailed exploration by exploratory mine development are under consideration. The stoping preparation was in progress.

At the Hutti Mineral Treatment Plant, the r.o.m. of -8" size is crushed. The final product from crushing plant, i.e., -10 mm size is stored in a 1,500 tonnes capacity fine ore bin for subsequent treatment, i.e., grinding. The Milling/Grinding process of gold ore employs two distinct grinding techniques. In the first technique, grinding is done in two stages, i.e., primary grinding and then secondary grinding for further comminution. One primary mill and three tube mills constitute one

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stream of grinding in which pebble and smaller size balls are used as composite grinding media. There are two such streams and strake tables are used to collect coarse gold as concentrate for this circuit. In the second technique, grinding is done by four ball mills of different sizes and each of them is an independent circuit in which large size balls are used as grinding media. In these circuits, Knelson concentrator is used to collect coarse gold as concentrate. In all, the milling techniques, cyclones are in close circuits with the mills so as to get the required sizes (80% passing 75 micron) for the subsequent treatment process.

The concentrate collected from both the techniques is upgraded on James Table. The upgraded concentrates are roasted, magneted and finally smelted into bullion buttons.

All the cyclone overflow, i.e., finely ground ore in the form of slurry from the two streams of first technique and 4 streams of second technique join together in a distributor box from which finely ground ore slurry is fed to High Rate Thickener for thickening purpose. The thickened pulp (60% solid w/w) thus obtained from thickeners is subjected to cyanidation process in which cyanide accessible gold in slurry makes complexes with cyanide in presence of oxygen and dissolves in solution at high pH. To increase the oxygen potential of slurry, H_2O_2 is added in addition to compressed air. The cyanidation or leaching process is carried out in a series of mechanically agitated agitators of different sizes.

The cyanide leached pulp is then fed to two Carbon-in Pulp (CIP) plants. The CIP plants are of 1,000 tpd size each and are parallel in circuit. The objective of CIP plant is to absorb the dissolved gold in activated carbon from the solution.

The gold-loaded carbon is removed from the CIP plant periodically, subjected to acid and alkaline wash and then eluted in four elution columns with 1.0% NaOH and 0.1% NaCN solution at 95°C for a period of 60 hours. The solution is then passed through four electrowinning cells in which gold is deposited on steel wool cathodes.

The gold loaded steel wool cathodes are manually removed periodically, subjected to acid digestion, drying and smelting to obtain bullion buttons. The bullion buttons thus obtained from table concentrate and steel wool are cast into bullion bars weighing 4 to 11 kg and then despatched for sales.

Manmohan Industries, a private sector company, operates Kunderkocha mine in Singhbhum East district, Jharkhand. The mining is carried out by underground method.

In the past, gold was produced by the Central Government undertaking, namely, BGML. BGML earlier mined and processed the ore from Chigargunta reef in Chittoor district, Andhra Pradesh, Mysore mines of Kolar Gold Fields in Karnataka and Yeppamana mine in Anantapur district, Andhra Pradesh. All activities of BGML were stopped and BGML was closed w.e.f. 1.3.2001 under Section 25 (O) of the Industrial Disputes Act, 1947 in terms of Ministry of Labour, Government of India's order dated 29.1.2001. To augment gold production in the country, as per XI Plan document, Chigargunta and Bisanthan mines deserve active consideration for opening and commencement of operations.

DEVELOPMENT

HGML was the 40th member of the World Gold Council and also enjoyed reputation as the first one from India.

The Deccan Gold Mines Ltd (DGML), India's first and largest listed gold exploration company, collected rock and stream sediment samples and analysed them. DGML has plans for geophysical studies and drilling prospects at areas located in proximity to existing old mines and also at earlier explored areas in Hutti belt, Manglur belt, Dharwar-Shimoga belt in Karnataka; Attapadi Project in Kerala; and Ramgiri belt in Andhra Pradesh. The main prospects for gold at Ganajur and Karajgi have progressed into advanced stages of exploration. Inferred resources of 186,000 Ounces of contained gold have been

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estimated averaging 3.87 g/t of gold. The structure of rock formations and types of rocks in these prospects are similar to those in Australia where major gold discoveries have been made. The presence of old workings by ancient civilisations and presence of gold in rocks and stream sediments found during sampling and chemical analysis thereto were the reason for increasing interest of global mining companies in India. DGML is understood to have filed RP applications in Andhra Pradesh, Kerala and Karnataka; PL applications in Andhra Pradesh, Chhattisgarh, Kerala, Karnataka; and ML applications in Andhra Pradesh, Karnataka and Rajasthan. Out of these, one RP and one PL in Karnataka were executed.

Birla Copper Complex of Hindalco Industries Ltd situated at Dahej, District Bharuch, Gujarat has an installed capacity of 15 tpy for gold recovery from imported copper concentrates. In 2008-09, it produced 4.87 tonnes gold and about 9.11 tonnes in 2009-10.

HCL which recovers by-product secondary gold from indigenous copper ores at its ICC plant in Jharkhand has an installed capacity of 434 kg per annum gold recovery plant. This plant, however, did not report production since 2007-08.

Sterlite Industries (India) Ltd, has a copper smelter of 3 lakh tpy capacity at Thoothukudi, Tamil Nadu. The Company is in the process of obtaining world class technology for recovery of minor metals from copper concentrates and copper smelter by-products.

POLICY

Foreign Direct Investment (FDI) up to 100% in mining sector in respect of gold is eligible for automatic approval.

Gold being a specified mineral, Mineral Concessions, viz, reconnaissance permits (RP), prospecting licences (PL) and mining leases (ML) for gold are granted by the State Governments after prior approval of the Central Government.

The Government announced Foreign Trade Policy (FTP), 2009-14 w.e.f. 27.8.2009. In the revised Export-Import Policy comprised in the FTP, gold ores and concentrates are in freely importable category. Under Heading No.7108, the import of non-monetary gold metal also falls under Free category subject to RBI regulations while import of gold metal in monetary form is restricted.

ENVIRONMENTAL CONCERNS

Gold is recovered from ores by two main methods, both of which affect environment. Earlier, for recovery of gold, amalgamation processes were used in which ore was mixed with mercury that selectively dissolved gold which was then recovered by evaporation. Mercury from these operations was never recovered and remained as pollutant in many old mining areas. The cyanide process is based on the property of precious metals of forming soluble complex ions with cyanide anion. Cyanide does not dissolve quartz, iron oxides and other common gangue minerals and yields a relatively simple gold-bearing solution known as pregnant solution. In some gold mines, gold is dissolved from the ore by crushing and grinding followed by mixing with cyanide solution in large vats.

Gold is sometimes recovered from the pregnant solutions by adding zinc to form soluble zinc cyanide and precipitate of gold & silver. The pregnant solution can also be passed with activated carbon which absorbs dissolved gold. Gold from either process is cast into bars, bullion and dore (when it contains silver), which must be further refined to remove impurities, such as mercury, arsenic and copper. Some ores cannot be treated by cyanide processing as gold in them is in small inclusions or even by solid solutions in minerals, such as pyrite. This gold is generally recovered by roasting which converts pyrite into porous iron oxides containing small grains of gold that can be dissolved by cyanide.

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Cyanide is a highly toxic compound. Although it is found in common plants, such as almond and cassava, concentration in solutions is higher and requires special handling. During ore treatment, pH of cyanide solution must be kept at about 11 to prevent cyanide from reacting with hydrogen ion to produce HCN, a deadly gas. Although less toxic substitutes of cyanide are known, it is not yet clear whether such substances will be cost-effective or environment-friendly.

DEMAND & CONSUMPTION

Jewellery accounted for major consumption of gold, i.e., 85%, followed by electronics 6%, medal and coins 2% and other sectors 7%. The Industrial demand for gold is dominated by Electrical Sector due to its excellent thermal and electrical properties, besides a significant amount is consumed in dentistry and medicine. Continuing research has discovered new applications for gold as catalyst and in nanotechnology. No proper estimation of gold demand in the country could be attempted due to lack of proper consumption data of the end-use industry. However, from overall evaluation it is seen that India has a traditional and stable market for gold consumption. There is increase in demand from Ornamental and Electronic Sectors. A huge gap exists between demand and indigenous production which is likely to continue. Apparent consumption of gold in the country during 2009-10 was about 839 tonnes as compared to 775 tonnes reported in the preceding year.

SUBSTITUTES

Platinum and palladium substitute gold to some extent but their use is influenced by price relationship and by an established consumer preference for gold. Silver can be a substitute, but it offers less resistance to corrosion. Gold-plated palladium and bright tin-nickel can be used in electronics. Titanium and chromium-based alloys can be used in dental work. High prices encourage substitutes, particularly base metal

clad with gold in Electronic & Electrical Industry and in jewellery products. No metal or alloy substitute has all the properties of gold and therefore the emphasis is on reduction of gold content rather than substitution.

WORLD REVIEW

The estimated reserves for gold was about 47,000 tonnes of metal. The gold reserves are mainly located in South Africa (13%), Australia (12%), Russia (11%), Indonesia & USA (6% each) and Brazil, Chile, China and Uzbekistan (4% each). The world reserve of gold is given in Table-9.

The world mine production of gold was estimated at 2,460 tonnes in 2009. China contributed about 13% in world's total mine production of gold followed by USA & Australia (9% each), Russia & South Africa (8% each), Peru (7%), Indonesia (5%) and Canada (4%) (Table-10).

**Table – 9 : World Reserves of Gold
(By Principal Countries)**

(In tonnes of gold content)

Country	Reserves
World: Total (rounded)	47000
Australia	5800
Brazil	2000
Canada	1000
Chile	2000
China	1900
Ghana	1600
Indonesia	3000
Mexico	1400
Papua New Guinea	1200
Peru	1400
Russia	5000
South Africa	6000
Uzbekistan	1700
USA	3000
Other countries	10000

Source: Mineral Commodity Summaries, 2010.

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**Table – 10 : World Mine Production of Gold
(By Principal Countries)**

(In tonnes of metal content)			
Country	2007	2008	2009
World : Total	2340	2290	2460
Argentina	42	42	47
Australia	247	215	222
Brazil	50	54	57
Chile	42	39	40
Canada	102	96	97
China [@]	275	285	320
Columbia	15	34	48
Ghana	84	81	97
Indonesia	118	64	128
Papua New Guinea	58	67	68
Philippines	39	36	37
Peru	170	180	182
Mali	53	41	42
Mexico	39	50	51
Russia	157	184	205
South Africa	252	213	198
Tanzania	40	36	39
USA	238	233	223
Uzbekistan	73	73 ^(e)	73 ^(e)
Other countries	246	267	286

Source: World Mineral Production, 2005-2009.

@ Metal production.

Traditionally dominant gold producers viz, South Africa, USA and Canada are losing ground to new producers. Gold output declined in 2009 in USA by 4%, and in South Africa by 7%. Indonesian production rose to 128 tonnes mainly because some copper producers produced significant quantity of gold as by-product.

A number of new mines were developed or came on stream during 2009. In addition to primary production, recycling is a significant resource of gold, annually contributing around 28% to the world supply.

Prices

The gold prices since 2001 have increased steadily from average price of US \$ 271 per troy ounce to US \$ 871 per troy ounce during 2008. By October 2009 gold was trading in excess of US \$ 1,000 per troy ounce and in early December reached a new all time high of more than US \$ 1,200 per troy ounce. The average price of gold during 2009 was US \$ 974.68 per troy ounce, an increase of 12% over 2008 average price. It was also the highest average annual price so far.

WORLD REVIEW

Australia

Two new mines, namely, Boddington Mine of Newmont and Prominent Hill copper mine of OZ Mineral Ltd, commenced production in 2009.

Azerbaijan

Gedabek copper and gold project of Anglo Asian Mining plc. commenced production operations in May 2009.

Brazil

Expansion project at Paractu Mine of Kinross commenced operation. The Mine reported 88% higher Production.

Burkina Faso

Kalska Mine of Cluff Gold plc. was fully commissioned in June 2009.

Canada

Agnico-Eagle Mine Ltd. operated three mines, namely, Goldex which was into its first full year production; Lapa went into commercial production in May 2009; and the La Ronde mine, all in Quebec. In 2010, the company planned to open Meadowbank mine in Nunavut Territory. Black Fox mine of Apollo commenced production in May 2009 and Holloway Mine of st. Andrew Goldfields Ltd. in October 2009.

Cote d'Ivoire

In september 2009, Angovia Mine of Cluff Gold was fully commissioned for production.

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Dominican Republic

Construction of Pueblo Viejo project continued in 2009. The mine is slated to start production in late 2011.

Ghana

Akwaaba underground mine began commercial production. The mine is part of the Chirano gold mine. Mining operation started at Hwini-Butre deposit in 2009.

Mexico

Dolores mine of Minefinders Corp. started commercial production in May 2009. Gold production commenced at the Palmarejo Mine of Coeur d'Arvence in 2009. In November, commercial production started at the Pinos Altos Mine of Agnico-Eagle in Chihuahua State. The underground operations were to start in 2010.

Senegal

Construction at Sabodala gold mine was completed in March 2009, which marked the opening of the first major gold mine in Senegal.

South Africa

Three companies, namely, Gold Fields, Anglo Gold and Harmony Gold Mining Co. Ltd accounted for more than 80% of the country's gold production. Increased output from PGM mines resulted in higher by-product gold recovery.

Tanzania

Buzwagi Mine of Barrick started production in May 2009.

USA

Construction of heap-leach facility was completed at Walter Creek in Alaska in November 2009 and the first gold was poured. Summit silver-gold mine of Santa Fe Gold Corp. was nearing completion and production was to start in early 2010.

FOREIGN TRADE

Exports

The export of gold ores and concentrates decreased to 7,568 kg. in 2009-10 from that of the previous year. The exports were mainly to Philippines and Bangladesh. The value of exports of gold (non-monetary & monetary) increased to Rs. 982.72 crore in 2009-10 from Rs. 128.93 crore in the previous year. Almost entire exports in 2009-10 were to UAE in terms of volume and value (Tables - 11 to 16).

Imports

Imports of monetary and non-monetary gold which were 771.04 tonnes valued at Rs. 95,323.86 crore in 2008-09 increased to 851.02 tonnes valued at Rs. 135883.19 crore in 2009-10. In 2009-10 share of non-monetary other unwrought forms was 99% in the total value of gold imported. Imports of gold were mainly from Switzerland (44%), followed by Australia (20%), UAE (19%) and South Africa (12%) in terms of volume (Tables - 17 to 21).

**Table – 11 : Exports of Gold Ores & Concentrates
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs. '000)	Qty (kg)	Value (Rs. '000)
All Countries	20000	1021	7568	8121
Philippines	–	–	6068	8106
Bangladesh	–	–	1500	15
Australia	20000	1021	–	–

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**Table – 12 : Exports of Gold (Non-monetary & Monetary) : Total
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs. '000)	Qty (kg)	Value (Rs. '000)
All Countries	3680	1289329	22990	9827212
UAE	1908	930292	22938	9804073
Hong Kong	519	18010	14	17722
USA	931	153595	10	3237
France	-	-	2	637
Kenya	-	-	25	67
Germany	1	54	-	-
Qatar	9	11733	-	-
Singapore	46	29115	-	-
UK	105	146416	-	-
Unspecified	-	-	1	1476
Other countries	161	114	-	-

**Table – 13 : Exports of Gold, Non-monetary :
Other Semi-manufactured Forms
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs. '000)	Qty (kg)	Value (Rs. '000)
All Countries	1414	65712	297	430703
UAE	10	2865	271	407736
Hong Kong	519	18010	14	17722
USA	830	3988	10	3237
France	-	-	1	532
Qatar	9	11733	-	-
Singapore	46	29115	-	-
Unspecified	-	-	1	1476
Other countries	++	1	-	-

**Table – 14 : Exports of Gold, Non-monetary :
Powder
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs.'000)	Qty (kg)	Value (Rs.'000)
All Countries	130	39	25	67
Kenya	-	-	25	67
Nepal	10	1	-	-
Sri Lanka	120	38	-	-

**Table – 15 : Exports of Gold, Monetary
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs.'000)	Qty (kg)	Value (Rs.'000)
All Countries	236	296055	1	105
France	-	-	1	105
Nepal	30	32	-	-
UK	105	146416	-	-
USA	101	149607	-	-

**Table – 16 : Exports of Gold-clad Metals/
Base Metals, NES
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	++	947	1	1473
USA	++	4	++	1254
Thailand	-	-	++	117
Nepal	++	441	1	44
Spain	-	-	++	44
Italy	-	-	++	14
Belgium	++	30	-	-
France	++	20	-	-
Saudi Arabia	++	452	-	-

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**Table – 17 : Imports of Gold
(Non-monetary & Monetary) : Total
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs.'000)	Qty (kg)	Value (Rs.'000)
All Countries	771045	953238640	851023	1358831868
Switzerland	353905	425037726	371534	601204521
Australia	138021	187332754	170825	271174818
UAE	151694	186950264	160793	258777517
South Africa	83250	99430739	100775	158840113
USA	18436	22249132	18367	28662135
Hong Kong	7213	9384190	10579	17124039
UK	9943	11838562	5538	8644497
Turkey	486	880397	3225	5416725
Canada	1738	2035781	2052	3116506
Indonesia	817	1185750	1005	1587967
Other countries	5542	6913345	2730	4283030

**Table – 18 : Imports of Gold, Non-monetary :
Powder
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs.'000)	Qty (kg)	Value (Rs.'000)
All Countries	1	628	32	52810
Switzerland	-	-	31	52739
Germany	++	4	1	71
UK	1	594	-	-
USA	++	30	-	-

**Table – 19 : Imports of Gold, Non-monetary :
Other Semi-manufactured Forms
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs.'000)	Qty (kg)	Value (Rs.'000)
All Countries	139603	164426453	4760	7638289
Switzerland	71547	84672826	3775	6005393
Australia	12973	15014716	500	850361
UAE	21547	25262829	116	199164
USA	7269	8582784	103	183310
Singapore	58	100190	28	73574
Hong Kong	1419	1827401	46	62180
UK	1297	1584442	11	12311
Indonesia	285	377518	-	-
Mexico	1507	1672644	-	-
South Africa	21475	25063209	-	-
Other countries	226	267894	181	251996

**Table – 20 : Imports of Gold, Non-monetary : Other Unwrought Forms
(By Countries)**

Country	2008-09		2009-10	
	Qty (kg)	Value (Rs. '000)	Qty (kg)	Value (Rs. '000)
All Countries	631441	788811559	846231	1351140769
Switzerland	282358	340364900	371328	595146389
Australia	125048	172318038	170325	270324457
UAE	130147	161687435	160677	258578353
South Africa	61775	74367530	100775	158840113
USA	11166	13666318	18264	28478825
Hong Kong	5794	7556789	10533	17061859
UK	8645	10253525	5527	8632186
Turkey	486	880397	3225	5416725
Canada	1648	1929390	2052	3116506
Singapore	889	1169573	838	1330399
Other countries	3485	4617664	2687	4214957

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**Table – 21 : Imports of Gold-clad Metals/Base Metals, NES
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs. '000)	Qty (t)	Value (Rs. '000)
All Countries	2	7236	++	11849
USA	1	5859	++	6938
Italy	1	1344	++	4494
China	++	6	++	282
Hong Kong	-	-	++	77
Spain	-	-	++	30
Liberia	-	-	++	28
Indonesia	++	5	-	-
UK	++	22	-	-

FUTURE OUTLOOK

India is a traditional and stable market for gold consumption. The present and future production of gold will not be sufficient to meet the ever increasing demand. Therefore, efforts will be required to reduce the gap between production

and demand. Some strategies have been planned in XIth Five Year Plan for gold exploration and production. Small deposits are being planned for cluster mining and large potential areas of gold mineralisation have been identified for further search for gold.