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PLATINUM AND PALLADIUM

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GOVERNMENT OF INDIA
MINISTRY OF MINES
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13 Platinum and Palladium

Platinum and palladium belong to platinum group of metals (PGM). The six platinum group of elements or PGEs (Ru, Rh, Pd, Os, Ir and Pt) are a family of six greyish to silver-white metals, except for osmium which has a slight bluish tinge with close chemical and physical affinities. These six elements are classified into two groups with reference to the specific gravity of gold (19.2). The elements, Ru, Rh, Pd (sp. gr. 12-12.4) are lighter, while the other three elements, Os, Ir and Pt are heavier than gold with sp. gr. in the range of 21.0-21.5. Major applications of platinum and palladium are in automotive sector for emission control and in chemical and petroleum refining.

RESOURCES

In India, appreciable values of platinum group of elements (PGEs) were traced in the Precambrian mafic/ ultramafic complexes in Sukinda and Nuasahi sectors of Odisha and Sittampundi in Tamil Nadu. Sampling of chromite ore bodies and their associated rocks revealed occurrence of PGE in these areas. Preliminary assessment of PGMs in Sukinda ultramafic field indicated isolated anomalous values in chromite. Platinum values of 2 to 400 ppb and palladium values of 1 to 500 ppb were established on analysis. The limonite cappings over ultramafic rocks showed combined platinum and palladium values between 40 and 290 ppb. In Boula-Nuasahi ultramafic complex, the easternmost chromite band known as Shankar-Ganga load, investigations revealed potential PGM mineralisation. In Sittampundi Complex, Salem district, Tamil Nadu, analysis of chromite bands showed 0.03 to 0.75 ppm Pt and 0.1 to 1.0 ppm Pd, whereas amphibolite samples showed 0.03 to 0.05 ppm Pt and 0.03 to 0.5 ppm Pd. A platinum-rich chromite-ferro-chromite breccia zone stretching to about hundred metres in gabbroic matrix was identified in the southern extension of the already known Boula-Nuasahi area in Keonjhar district, Odisha. In Usgaon area, Southern Goa, PGM samples analysed up to 0.03 ppm Pt and 0.03 to 0.15 ppm Pd. In recent past, occurrences of PGE mineralisation were reported in mafic-ultramafic complex of Shimoga schist belt in Davangere district of Karnataka. Three zones having 10 to 830 ppb of platinum and 50 to 1500 ppb of palladium were established.

The major part of 15.7 tonnes UNFC resources of PGMs estimated so far, i.e. 14.2 tonnes are located in Nilgiri, Boula-Nuasahi and Sukinda areas in Odisha and remaining 1.5 tonnes in Hanumalpura area in Shimoga schist belt of Karnataka. About 49% resources are in pre-feasibility category and the remaining in inferred and reconnaissance category. The resources of PGM as on 1.4.2010 as per UNFC system are given in Table-1.

EXPLORATION

GSI carried out exploration in various areas in the states of Andhra Pradesh, Karnataka, Kerala, Manipur, Maharashtra, Odisha (Jointly with OMC Ltd) and Tamil Nadu. DMG, Karnataka conducted exploration work in Mandya district. The details are given in Table-2.

USES

Platinum and palladium are primarily used as catalyst in controlling the toxicity of emissions from automobile, chemical and petroleum refining plants. Nearly half of the total platinum used worldwide is as catalysts in catalytic converters in automobiles. Catalysts for automobile sector use platinum and palladium. Automobiles that run on diesel predominantly use platinum for catalytic conversion. The chemical inertness and refractory properties of these metals are conducive for their applications in electrical, electronics, dental, medical fields and glass industry. These metals are also used as catalyst in various chemical processes, viz, in organic synthesis in hydrogenation,de-hydrogenation and isomerisation, production of nitric acid as also in the manufacture of fertilizers, explosives & polymers and fabrication of laboratory equipment.

Platinum, palladium and a variety of complex gold-silver-copper alloys are used as dental restorative materials. The unique properties of platinum find varied applications in the medical field. Platinum's excellent compatibility with living tissue, as it does not get affected by the oxidising reaction of blood, enables its utility in pacemakers.

Table – 1: Reserves/Resources of PGM as on 1.4.2010

(In tonnes of metal content)

State	Reserves Total (A)	Remaining resources				Total resources (A+B)
		Pre-feasibility STD 222	Inferred STD 333	Reconnaissance STD 334	Total (B)	
India	**-**	**7.7**	**6.5**	**1.5**	**15.7**	**15.7**
Karnataka	-	-	-	1.5	1.5	1.5
Odisha	-	7.7	6.5	-	14.2	14.2

The primary usage of PGM is in chemotherapy for treatment of cancer. It has the ability to prevent division of certain living cells, a remarkable characteristic which finds profound application in treatment of cancer. Besides, platinum-iridium alloys are extensively used in prosthetics and biomedical devices.

Platinum's excellent conductivity lends itself for use in the electrodes of phosphoric acid fuel cells for generating electricity. Another significant use of platinum and its alloys, in cast or wrought form is in jewellery. Platinum-iridium alloys find major application in making crucibles for growing crystals. Glass made with platinum and rhodium is used in housing construction, flat screen televisions, computer monitors, display panels, automobile displays, factory monitoring equipment, etc. Recently, a new metallic glass featuring micro-alloys of palladium with silicon, germanium, silver, etc. was reportedly developed at University of California. The glass is characterised by strength and toughness. Platinum is used to enhance storage capacity of devices, such as computer hard discs, cell phones, digital cameras and personal music players. Recently, palladium-silver resistors have been used in secondary lightning surge protection devices. In electronic industry, palladium's use is for multi-layer ceramic capacitors (MLCC). The effect of miniaturisation of MLCC has not reduced the quantum of palladium used as more number of MLCC are required for the same electronic device.

Rhodium usage is also on the rise in the automotive industry apart from fibre glass. Platinum is the catalyst used by fuel cells to convert hydrogen and oxygen to electricity. Palladium is also likely to play a role in fuel cells.

SUBSTITUTES

It is usually easier to substitute metals of the platinum group for one another, especially in alloys, than to use alternative materials, which is evident from the total dominance of ruthenium-based resistors over the palladium-silver resistors for high-powered applications. Substitutes in electrical use include tungsten, nickel, silver, gold and silicon carbide. Alternative catalysts include nickel, molybdenum, tungsten, chromium, cobalt, vanadium, silver and rare earths. Rhenium, however, has been used most satisfactorily as substitute for platinum as a catalyst in petroleum refining. Stainless steel and ceramics can be substituted where resistance to corrosion is the primary concern. Some motor vehicle manufacturers have substituted platinum by palladium in catalytic converters, especially for petrol engines. Particulate matter and residual sulphur contaminate palladium and hence, it was excluded from catalysts used in diesel vehicles. A new technology now allows up to 25% substitution of platinum in diesel catalytic converters with palladium.

Similarly, manufacturers of electronic parts are also reducing the average palladium content of the conductive pastes used to form the electrodes of multi-layer ceramic capacitors, substituting base metals or silver-palladium pastes which contain significantly less palladium.

Table – 2 : Details of Exploration Activities for PGM, 2011-12

Agency/ State/ District	Location/ Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks
		Scale	Area (sq km)	No. of bore-holes	Meterage		Reserves/resources estimated
GSI/ Andhra Pradesh							
	Konda Motu - Enamuralagutta Ramgiri Schist belts	-	-	-	-	-	The reconnaissance stage investigation was completed. NNW-SSE trending narrow discontinuous, linear ultra - mafic bodies over a strike length of 14 km were traced. The bands show pinching & swelling. EPMA study has indicated presence of chrome- spinel with magnetite.XRF Studies indicated Cr values between 458 & 6973 ppm, Ni values between 443 & 3001 ppm, PGE values from less than 5 to 55 ppb of Pt &10 ppb to 80 ppb of Pd.
Karnataka							
	Tagadur, Nuggehalli Bakhtarahalli Nuggehalli Schist belt	-	-	-	-	-	The reconnaissance stage (G-4) study was completed. Chromite occurs in various forms like veins, lenses, pods, lamination & disseminations. Titaniferous-vanadiferous magnetite bands are located within mafic layers near Tagadur and Ranganatha Gudda.
Kerala							
Palakkad and Mala-ppuram	Attapadi valley Maddalapara Kalkandi & Narasimukku	-	-	-	-	-	The reconnaissance stage (G-4) study was completed. In Kalkandi and Narasimukku chromite bearing ultramafics were identified. An ultramafic rock with average width of 20 m was traced for 1.25 km continuously from Kavundi-kal to Gulikadavu village & intermittently for 2.2 km. EPMA and SEM studies identified PGE in significant proportion in form of copper-osmium alloy within B.I.F. near Nallasinge and in metapyroxe-nites near Narsimukku and Kalkandi.
Maharashtra							
Chandrapur	Heti	-	-	-	-	-	The prospecting stage (G-3) operation was completed. SEM-EDX studies of drill core samples identified Moncheite (Pt Pd Te) and gold grains which later were confirmed by EPMA studies. Though analytical results from different laborato-ries are not encouraging, four samples of 1 m width show values of Ni from 335-571 ppm.

(Contd.)

Table-2 (Contd.)

Agency/ State/ District	Location/ Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks
		Scale	Area (sq km)	No. of bore-holes	Meterage		Reserves/resources estimated
Maharashtra							
Sindhudurg	Kankavali- and Janoli, Vagde	-	-	-	-	-	A reconnaissance stage (G-4) investigation was completed. Groove samples were collected across all the ultramafic bodies in Janoli & Vagde area. A sample from an abandoned chromite mine gave high PGE concentration of 650 ppb from talc-tremolite schist & even higher at 805 ppb from chromite but lower in serpentinite schist. Nickel values ranging from 0.12% to 0.30% were also recorded in chromiferous serpentinite.
Manipur							
Ukhrul	Siruhi, - Gamnom, Pushing	-	-	-	-		The reconnaissance stage (G-4) study was completed. The serpentinised periodotites as probable host rocks were of size 30 to 40 m width in form of outcrops. In polished sections, grains suspected as PGE were observed.
Odisha							
Keonjhar	Bangur and Banaipank Leaseholds	-	-	-	-	2500 (Pedogeo-chemical)	The General exploration stage (G-2) operation was completed as a sponsored item with Odisha Mining Corporation (OMC) in its lease hold areas such as Bangur & Banaipank. In Bangur area, a prominent breccia zone was found as the host for PGE mineralisation. The SEM-EDX EPMA and petromineragraphic study of breccia was done to identify the PG inerals. This zone extends for about 550 m intermittently with ore bodies at varying depths totalling 8-14 m in thickness up to 100 m below ground level. In Baniapank, grid pattern sampling was done & several anomalous zone high in Ni ranging in values up to 77300 ppm and 1815 ppm were recorded.

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Agency/ State/ District	Location/ Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks
		Scale	Area (sq km)	No. of bore-holes	Meterage		Reserves/resources estimated
Tamil Nadu	Solvanur, Karappadi Mallanaya-kanpalaiga	-	-	10	NA	42	A reconnaissance stage (G-4) study was continued in this block of Mettupalayam mafic-ultramafic complex in which scout drilling, detailed mapping, pitting & trench-ing were also carried out. Ten bore holes were completed. Of these, one was in Solavanur, two in Karappadi and seven in Mallanayakanpalayam block to various depths.The meta-pyroxenite, Chromitite bands were intersected and different widths of PGM mineralisation and values ranging from 5 to 255 ppb of Pt, 10 to 730 ppb of Pd were recorded. EPMA & petrographic studies on selected sections have given moderate to high PGE values.Work is continued.
-do-	Mettupalayam Belt	1:12500	-	-	-	-	A reconnaissance stage (G-4) investigation for PGE was taken up, involving mapping and sampling, in 8 areas within this ultramafic belt. A total of ten metapyroxenite bodies have been demarketed. Two major bands/ bodies were in Devangapuram-Vadavalli and Melbavi villages striking over 2 km & 1 km respectively. This activity is completed.
-do-	Tasampalayam block Karunagalpatti block	-	-	13	-	-	A reconnaissance stage (G-4) study was continued in this block of Sittampundi layered mafic-ultramafic complex. The complex is divided into 3 main blocks, viz., Karungalpatti, Chettiyampalayam and Tasampalayam. In addition to drilling, close spaced trenching was done. Some core samples showed high values of PGE. As this activity is completed, a new prospecting stage investigation will be taken up in eastern part of the block.
DMG Karnataka							
Mandya	Karighatta schit belt	1:50000	80	-	-	12	Work will continue in next field season. The area has mafic and ultramafic sequences of Sargur group like peridoties & serpentinites.

TECHNICAL POSSIBILITIES

The spent converters contain platinum and palladium in 3:1 ratio, but heavy shift towards use of palladium to meet stringent emission controls will change this proportion of recovery.

The emergence of polymer electrolytic membrane (PEM) fuel cells developed for passenger cars and trucks will boost prospects of platinum in near future by replacing the high energy battery-operated options for emission controls. The costs of higher range of driving and quick refuelling of fuel cells are, however, 10 times more than the cost of petrol engine.

The development of Solid Oxide Fuel Cell (SOFC) in Japan will eliminate the use of platinum converter as it is compact and gives consistent performance as conversion of conventional fuels into hydrogen is avoided.

RESEARCH & DEVELOPMENT

The mineral processing department of the Institute of Minerals & Material Technology (IMMT), Bhubaneswar (CSIR) was envisaging research focused on recovery of PGE values from the low tenor hosts like Boula-Nausahi igneous complex, by adopting suitable beneficiation tests and development of process flow sheet for recovery of PGE from Indian ores. The methods adopted elsewhere in the world perhaps may not suit in India as here, the PGE occurs in oxide of chromium and sulphide facies in very fine inclusions & exsolution form.

WORLD REVIEW

The largest reserves of PGMs are located in Bushveld Complex in South Africa. The world reserves of PGMs are estimated at 66,000 tonnes concentrated mostly in South Africa (95%), followed by Russia (2%) and the USA (1%) (Table-3).

The world mine production of PGMs increased to 492 tonnes of contained metals in 2011 from 481 tonnes in 2010. South Africa continued to be the leading producing country of PGM, contributing about 59% of world production, followed by Russia (28%), Canada and Zimbabwe (5% each) and the USA (3%) (Table-4).

Recycling of PGMs was from three main sources, i.e., autocatalysts, electronics and jewellery. Globally, the share of platinum recovery from autocatalysts increased by 13% in 2011 as compared to 2010. Similarly, an increase of 10% in recovery from jewellery was recorded over 2010, whereas recovery from electronic secter remained static.

In case of palladium, recovery from autocatalysts rose by 26% as compared to 2010. The recovery from electronics increased by 9% and that from jewellery increased significantly by 110% over 2010.

Global platinum consumption increased slightly as compared to 2010. Of the total consumption, autocatalyst industry accounted for 39%, jewellery 31% and glass industry 7%. Palladium consumption decreased by 13% in 2011, of which 71% was by autocatalyst industry and 16% by electronics industry. About 68% of world consumption of platinum in jewellery was by China. The consumption of platinum as equipment in glass industry surged from 10,700 kg in 2010 to 17,300 kg in 2011.

Canada

SMC carried out an environmental assessment, detailed engineering plans for development of a pit and processing plant on its Marathon PGM-Copper project in Ontario. The mine was designed for 6220 kg per year production for about 12 years based on 91.4 million tonnes of ore grading 0.83 gm/t Pd, 0.23 gm/t Pt. SMC also had plans to conduct explortion at its Geordie Lake, Ontario and Bird river, Manitoba properties acquired in 2010. North American Palladium Ltd, reported higher production of Pd & Pt from its Lac des Isles Mine in Ontario after its reopening in April, 2010 due to improved metal prices. Mine expansion was in progress. Vale Inco Ltd recovered 7,710 kg Pd and 5,410 kg Pt as by-product from its nickel operations in Sudbury, after end of a year-long strike since July, 2010.

South Africa

Though South Africa continued to be the largest producer of PGM in the world, its production was slightly less as compared to 2010 due to losses in production reported by major producers, viz., Bathopele, Tumela, Union Mines, Marula Mines. Incomplete infrastructure developments, strikes and prevailing low prices were mainly responsible for the losses. Platinum Australia continued with a feasibility of Kalahari Platinum Project and planned to extract a bulk sample for pilot plant treatment in 2012.

Zimbabwe

The first full year production from Amplats Unki Mine which commenced working in January, 2011 reflected increase in the country's overall production of PGM. The Mimosa Mine of Acquarious and Impala also operated with full capacity. The expansion Phase-I of Zimplats and Phase-II of Ngezi Mine was also under progress and may be completed in 2014.

FOREIGN TRADE

Exports

Exports of platinum alloys and related metals significantly decreased to 382 kg valued at ₹ 21 crore in 2011-12 from 3,367 kg valued at ₹ 23 crore in the previous year. Exports in 2011-12 comprised platnium unwrought, platinum powder and others at 110 kg, 20 kg & 222 kg, respectively. Export of other metals of platinum group was only 30 kg entirely to Germany. In 2011-12, 1 kg of platinum-clad base/precious metals was exported to the USA (Tables - 5 to 10).

Imports

Imports of platinum alloys and related metals increased in 2011-12 to 6,129 kg valued at ₹ 1173 crore as against 5,072 kg valued at ₹ 845 crore in the previous year. Imports in 2011-12 comprised platinum (powder, unwrought & others) 3,219 kg, platinum (others) 832 kg and other metals of platinum group 2,078 kg. Imports were mainly from the UK (28%),Germany (16%), Japan (11%), South Africa and the USA (8% each). Besides, there were imports of platinum-clad base/ precious metals to the tune of 7 kg in 2011-12. Japan was the main supplier (Tables -11 to 17).

Table – 3 : World Reserves of PGMs (By Principal Countries)

(In tonnes)

Country	Reserves
World: Total (rounded)	**66000**
Canada	310
Russia	1100
South Africa	63000
USA	900
Other countries	800

Source: *Mineral Commodity Summaries, 2013.*
Note: Figures for Colombia, Zimbabwe included with other countries.

Table – 4 : World Mine Production of PGMs (By Principal Countries)

(In tonnes of metal content)

Country	2009	2010	2011
World: Total	**462.00**	**481.00**	**492.00**
Botswana			
Platinum	0.75	0.45	0.37
Palladium	4.73	2.83	2.11
Canada[e]			
Platinum	4.00	3.60	8.00
Palladium	6.90	6.20	14.00
Other platinum metals	0.50	0.40	0.90
Russia			
Platinum	24.40	26.50	26.50
Palladium	113.10	115.70	107.50
Other platinum metals	2.20	2.20	2.10
South Africa			
Platinum	140.82	147.79	148.00
Palladium	75.12	82.22	82.73
Other platinum metals	55.45	57.29	58.11
USA			
Platinum	3.83	3.45	3.70
Palladium	12.66	11.60	12.50
Zimbabwe			
Platinum	6.85	8.64	10.83
Palladium	5.35	6.91	8.42
Other platinum metals	1.19	1.53	2.16
Other countries	4.14	3.69	4.07

Source*: World Mineral Production, 2007-2011.*

Table – 5 : Exports of Platinum Alloys & Related Metals : Total (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**3367**	**231945**	**382**	**213170**
USA	153	84482	85	136615
Germany	10	10540	35	36267
UK	2928	52721	36	25829
Belgium	38	1000	184	7093
UAE	2	5444	2	4882
Israel	-	-	33	843
Brazil	-	-	1	739
Italy	3	7534	1	277
Saudi Arabia	2	477	1	256
Congo, Rep. of	-	-	1	225
Other countries	231	69747	3	144

Table – 6 : Exports of Platinum (Unwrought) (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**187**	**174951**	**110**	**115346**
USA	34	76033	37	91150
Germany	1	41	5	11995
UAE	2	5444	2	4882
UK	128	46863	28	4871
Israel	-	-	33	843
Brazil	-	-	1	739
Italy	-	-	1	277
Saudi Arabia	2	477	1	256
Congo, Rep. of	-	-	1	225
Hong Kong	-	-	1	108
Other countries	20	46093	-	-

Table – 7 : Exports of Platinum (Others) (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**3176**	**48742**	**222**	**29279**
UK	2800	5858	7	20778
Belgium	38	1000	184	7093
USA	115	198	30	1371
Hong Kong	-	-	1	36
Other countries	223	41686	++	1

Table – 8 : Exports of Platinum (Powder) (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**4**	**8252**	**20**	**44274**
USA	4	8252	18	44093
UK	-	-	1	179
Maldives	-	-	1	2

Table – 9 : Exports of Other Metals of Platinum Group (By Country)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**-**	**-**	**30**	**24271**
Germany	-	-	30	24271

Table – 10 : Exports of Platinum-Clad Base/ Precious Metal (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**640**	**24653**	**1**	**362**
USA	638	24635	1	362
Other countries	2	18	-	-

Table – 11 : Imports of Platinum Alloys and Related Metals (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**5072**	**8451719**	**6129**	**11732833**
UK	2105	3088588	1845	3454610
Japan	75	86036	790	1539641
Germany	134	276412	650	1478009
USA	319	655032	472	881357
South Africa	1037	1835593	418	867873
Italy	297	259315	331	525020
China	56	327311	291	493715
Norway	96	244385	202	297811
Belgium	230	539372	112	263756
Russia	328	419756	190	231619
Other countries	395	719919	828	1699422

Table – 12 : Imports of Platinum (Powder, Unwrought & Others) (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**2275**	**5872712**	**3219**	**8406188**
UK	738	1853466	911	2383989
Germany	103	244525	514	1339024
Japan	12	29023	350	908509
USA	265	637259	270	721674
South Africa	441	1123150	259	669135
Italy	85	224516	167	438655
Belgium	205	510307	99	261048
Switzerland	53	133113	87	220978
China	52	316672	66	177545
Brazil	-	-	68	167441
Other countries	321	800631	428	1118190

Table – 13: Imports of Other Metals of Platinum Group (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**2220**	**2202898**	**2078**	**2657404**
UK	1144	964443	715	839725
Japan	47	42338	431	621932
China	3	10383	171	269700
South Africa	565	696639	154	194430
Sweden	-	-	174	191549
Russia	273	277144	172	184806
USA	2	662	95	107542
Germany	13	26230	60	101006
Malaysia	-	-	41	52048
Poland	-	-	43	48564
Other countries	173	185059	22	46102

Table – 14: Imports of Platinum (Others) (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**577**	**376109**	**832**	**669241**
UK	223	270680	219	230895
Norway	-	-	155	174898
Italy	211	34538	164	86365
USA	52	17111	107	52141
China	1	256	54	46469
Germany	18	5657	76	37979
Japan	16	14675	9	9201
Hong Kong	1	639	2	8381
South Africa	31	15804	5	4309
Korea Rep. of	-	-	6	3569
Other countries	24	16749	35	15034

Table – 15 : Imports of Platinum-Clad Base/Precious Metal (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**5**	**405**	**7**	**1435**
Japan	-	-	6	902
Germany	-	-	1	533
Other countries	5	405	-	-

Table – 16 : Imports of Platinum -Unwrought (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**1157**	**3065756**	**1567**	**4135706**
UK	252	651370	599	1586473
Germany	72	170376	285	757151
South Africa	315	801596	211	542244
Japan	12	29023	140	368058
Switzerland	1	38	87	220978
USA	140	319750	74	210076
Italy	58	148276	31	91881
Singapore	1	43	28	80309
Jordan	-	-	28	68010
China	52	316672	19	51451
Other countries	254	628612	65	159075

Table – 17 : Imports of Platinum -Powder (By Countries)

Country	2010-11		2011-12	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**1118**	**2806956**	**1652**	**4270482**
UK	486	1202096	312	797516
Germany	31	74149	229	581873
Japan	-	-	210	540451
USA	125	317509	196	511598
Italy	27	76240	136	346774
Belgium	81	201693	99	261048
Brazil	-	-	67	164816
France	-	-	52	140745
South Africa	126	321554	48	126891
China	-	-	47	126094
Other countries	242	613715	256	672676

FUTURE OUTLOOK

India is not a platinum group of elements (PGEs) producing country and is meeting its demand entirely by imports. The demand for PGEs is expected to touch 80 tonnes by 2017 and may touch 120 tonnes by 2025, as per the Report of the Sub Group for 12th Plan period. Assuming the success of sustained efforts directed towards mining of the known resources at BNUC (Odisha) and development of a beneficiation flow sheet during the 12th Plan, a plant of 2 tonnes per annum capacity can be envisaged by the middle of the 13th Plan. The Sub Group recommends that the preparation of beneficiation feasibility report in this regard may be assigned to any National Laboratory on priority basis. It expects that an additional 10-20 tonnes per annum should be recovered from recycling by 2017.

There has been an increase in demand for these metals because of increased demand from the automobile industry and that from the emerging Asian markets particularly in China and India. However, platinum is losing market share to palladium in petrol-driven engines and palladium has replaced some platinum in diesel catalytic converters. The automobile sector plays a crucial role in the demand for platinum. The Kyoto Protocol on exhaust emissions and the commercial success of the fuel cell technology development, on which sustained efforts are being made world over are the key drivers for the future demand of platinum, palladium and rhodium.

About 40% of the world supply of platinum is consumed by the jewellery sector. Palladium, rhodium, iridium and ruthenium are used in electronic and electro-chemical industries, while osmium finds applications in the medical field, such as in chemotherapy and pace-makers (alloy of Pt and Os). These metals are poised to play a vital role in fuel cell technology once the economic viability of fuel cell is established for which sustained efforts are being made around the world. As the supply of all PGEs together is less than 600 tonnes with about 500 tonnes coming from mine production, the boom in the demand for platinum jewellery and also as an investment can be expected. South African local issues, compounded by falling grades, deep mining, etc. are likely to determine whether sufficient platinum and rhodium supply can be foreseen, which in turn will dictate future prices.