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PLATINUM AND PALLADIUM

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GOVERNMENT OF INDIA
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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. They have similar physical and chemical properties and tend to occur together in the same mineral deposits. 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. Platinum is an extremely rare metal occurring at a concentration of only 0.005 ppm in earth's crust. 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 Kendujhar 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 Shivamogga schist belt in Davanagere 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 million tonnes UNFC resources of PGE estimated so far, i.e. 14.2 million tonnes of PGE ore are located in Nilgiri, Boula-Nuasahi and Sukinda areas in Odisha and remaining 1.5 million tonnes of PGE ore in Hanumalpura area in Shivamogga schist belt of Karnataka. About 49% resources are under pre-feasibility category and the remaining under inferred and reconnaissance category. The resources of PGM as on 1.4.2010 as per UNFC system are furnished in Table-1.

EXPLORATION

GSI carried out exploration in various areas in the states of Odisha, Tamil Nadu and Kerala. 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. 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, the raw material for 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 non-corrosive and non-allergic properties of platinum find varied applications in the medical field. Platinum's excellent compatibility with living tissue unaffected by the oxidising reaction of blood, enables its utility in pacemakers.

Table – 1: Reserves/Resources of PGE Ore as on 1.4.2010

(In million tonnes of ore)

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.

Rhenium, tungsten and molybdenum as substitute for platinum in aeromatics hydrogenation catalysts have been investigated. Recently, a new type of iron and carbon - based catalysts have been discovered which is stable and active in both acidic and alkaline media and may even eliminate the need of platinum in catalysts and thus revolutionise the Proton Exchange Membrane Fuel Cell (PEFC) Industry.

Table – 2 : Details of Exploration Activities for PGM/PGE, 2014-15

Agency/ State/ District	Location/ Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks
		Scale	Area (sq km)	No. of bore-holes	Meterage		Reserves/resources estimated
GSI							
Odisha							
Kendujhar and Dhenkanal	Patakhali Balijori and Ghuturigaon-Mundasahi	1:12500	-	-	-	156	A G4 stage investigation was taken up in this area with objective of delineating prospective areas for PGE. No significant surface indication of mineralisation (chromites/sulphides) for PGE has been observed. Fine disseminations of chromites/sulphides were noticed in peridotite unit. Analytical results of BRS show no encouraging PGE values. The investigation will be continued in FS 2015-16.
Tamil Nadu							
Namakkal	Tasampalalyam block (T 3 Sector)		7	70 m to 284 m		162	A G3 stage investigation was taken up to prove the depth persistence of the PGE mineralisation in the central part of Tasampalalyam block (T3 sector). The PGE mineralised zones delineated in T3 sector show considerable variation in grade and width both along the strike and dip directions and the chromitite bands which host the PGE mineralization occur as discontinuous bodies which show pinch and swell structure. In T3 sector the northern zone is delineated for a cumulative strike length 700 m and close spaced trenching and systematic drilling is carried out to check the strike continuity and depth persistence of the PGE mineralised zones and also to see the western extension of this zone.
Tamil Nadu							
Namakkal and Tiruchirapalli	Tattayyan-garpettai -Turaiyur	1:12500	40 sq km	-	-	-	G4 stage investigation was taken up to delineate potential zones of PGE mineralisation and to bring out the nature and control of mineralisation.The area forms another potential zone of meta-ultramafics that is present in the eastern segment of the PCSZ in the proximity of its southern boundary i.e. the cauvery shear zone. The major rock types exposed in the area are hornblende gneiss & chornockite. A total of 24 nos. of Pyroxenite bands & 07 nos. of altered ultramatics were delineated. Talc and Chlorite alternations have also been noticed. The investigations has been completed.
Kerala							
Palakkad	Kavundikal Kunnanchala Narasimukk, Bhutivali, east of Dodagatti, Kalpatti area						G4 investigation was taken up for delineating chromitite zones within the ultramafics and to evaluate its PGE potential. During detailed mapping the mafic & ultramafic rocks were mapped along with the gnissic country rock. Since the Chromites in the area are known to be PGE- bearing importance was given to trace the chromite-bearing zones in the ultramafics. The analytical results of the trench & groove samples by ICPMS method show that some metapyroxenites show encouraging PGE values 200 ppb. The platinum values in all rock types show a range from <5PPb-317 PPb. palladium show a range from <5-106 PPb, iridium values are all <3-56 PPb, ruthenium values range from <3-18 PPb and rhodium values range from <3-47 PPb. The investigation has been completed.

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) had envisaged projects to pursue research focused on recovery of PGE values from the low tenor hosts like Boula-Nuasahi 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 because the PGE occur in oxide of chromium and sulphide facies in very fine inclusions & exsolution form.

WORLD REVIEW

In 2014, world mine production of PGMs decreased by 18% to 373 tonnes from 453 tonnes in 2013 (Table 4). South Africa accounted for 51% of total PGM mine production in 2014; Russia 28%, Canada 8%, Zimbabwe 7%, USA 4%, and other countries 2%. In 2014, world platinum mine production decreased by 24%. In South Africa, which accounted for 66% of world platinum production, production totalled 94,000 kg of platinum, a 32% decrease from that in 2013, accounting for most of the decrease in global production. Global mine production of palladium in 2014 decreased by 10% to 1,81,000 kg, with Russia and South Africa accounting for 45% and 32%, respectively, of the total production; Canada and the USA accounted for 10% and 7%, respectively while Zimbabwe accounted for 6%. World mine production of other PGMs (iridium, osmium, rhodium, and rethenium) decreased by 26% in 2014 as compared with that of 2013. South Africa, which accounted for 84% of global production, accounted for most of the decrease of other PGMs. Estimated production in Russia, the second leading producer, remained unchanged.

Canada

North American Palladium Ltd produced 5,420 kg of palladium and 407 kg of platinum from its Lac des Isles Mine in Ontario registering an increase of 29% and 28%, respectively as compared to that of the production in 2013. The increases were attributed to increased mining and processing rates from the newly developed off set-zone and of low-grade stockpiled material.

Russia

Norilsk Nickel produced 82,700 kg of palladium and 19,400 kg of platinum in 2014, an increase of 3% palladium and marginally less in case of platinum from the production of 2013.

South Africa

In 2014, the South African Platinum Mining Industry was subject to the longest worker's strike in South Africa's mining history. About 70,000 workers at the three leading PGM mining companies, Anglo American Platinum Ltd (Amplats), Impala Platinum Holdings Ltd and Lonmin plc were on strike from January until June to demand higher wages. According to the mining companies, lost production totalled 33,600 kg of platinum and lost revenue totalled $ 2.3 billion. Rampup to full production levels took several months following the end of the strike, adding to the production and revenue losses.

Zimbabwe

In 2014, palladium and platinum production increased by 5% each as compared to 2013 production. Amplats' Unki Mine produced 1,900 kg of platinum, 10% less than that produced in 2013. Production at the Mimosa Mine, a joint venture between Aquarius and Impala, was 2,700 kg of palladium and 3,400 kg of platinum,the figures showed an increase of 9% and 10%, respectively, from those of 2013. At Zimplats Holdings Ltd's a subsidiary of Impala Ngezi project, a major underground collapse in July resulted in the suspension of mining at the Bimha Mine. Redevelopment of the mine is under progress.

FOREIGN TRADE

Exports

Exports of platinum alloys and related metals decreased drastically to 78 kg valued at ₹ 8.37 crore in 2014-15 from 1,357 kg valued at ₹ 98.54 crore in the previous year. Exports in 2014-15 comprised platinum unwrought, platinum (powder) and platinum others at 41 kg, 1 kg & 35 kg, respectively. During 2014-15 export of other metals of platinum group was only 1 kg, solely to UAE. In 2014-15, 11 kg of platinum-clad base/precious metals was exported to Switzerland (73%), Mauritius , Srilanka and Bahrain (9% each) (Tables- 5 to 10).

Imports

Imports of platinum alloys and related metals increased marginally in 2014-15 to 7,818 kg valued at ₹ 1,525 crore as against 6,493 kg valued at ₹ 1,402 crore in the previous year. Imports in 2014-15 comprised of platinum (powder, unwrought & others) 3,900 kg, platinum (others) 2,130 kg and other metals of platinum group 1,788 kg. Imports of other metals of platinum group were mainly from South Africa (32%), UK (28%), Japan (14%), Germany (10%) and USA (9%) (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, 2016.*
Note: *Figure for Zimbabwe is included with other countries.*

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

(In tonnes of metal content)

Country	2012	2013	2014
World: Total	**440.34**	**453.38**	**373.04**
Botswana			
Platinum	0.44	0.22	0.09
Palladium	2.58	1.34	0.56
Canada[e]			
Platinum	8.20	9.70	10.70
Palladium	14.40	16.80	18.70
Other platinum metals	0.90	1.10	1.20
Russia			
Platinum	24.90	25.00	22.00
Palladium	89.90	84.00	81.30
Other platinum metals	2.80	2.60	2.80
South Africa			
Platinum	128.59	137.02	93.99
Palladium	74.74	76.01	58.41
Other platinum metals	51.01	51.16	36.04
USA			
Platinum	3.67	3.72	3.65[e]
Palladium	12.30	12.60	12.2[e]
Zimbabwe			
Platinum	10.52	13.07	12.48
Palladium	8.14	10.15	10.14
Other platinum metals	2.09	2.68	2.80[e]
Other countries	5.16	6.21	5.98

Source: *World Mineral Production, 2010-2014.*

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**1357**	**985444**	**78**	**83710**
UAE	11	559	20	47631
Italy	1	237	6	8445
Hong Kong	6	24602	9	7471
USA	63	6930	7	6573
France	14	1332	2	5259
Israel	3	1018	3	3258
Belgium	693	17374	17	1772
Germany	5	377	3	1548
UK	485	924648	3	645
Iran	-	-	1	612
Other countries	76	8367	7	496

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**265**	**397134**	**41**	**69015**
UAE	11	559	19	6036
USA	2	1298	2	46625
France	14	1332	2	5259
Hong Kong	6	24602	6	5049
Israel	3	1018	3	3258
Germany	5	377	2	1367
Iran	-	-	1	612
Belgium	-	-	1	498
Australia	2	185	1	100
Singapore	-	-	1	94
Other countries	222	367763	3	117

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**826**	**49867**	**35**	**13643**
Italy	1	237	6	8445
Hong Kong	-	-	3	2422
Belgium	693	17374	16	1274
UK	67	26055	2	566
USA	61	5632	5	538
Germany	-	-	1	182
Nicaragua	-	-	1	110
Spain	-	-	1	106
Other countries	4	569	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**257**	**538026**	**1**	**46**
Singapore	-	-	1	46
Other countries	257	538026	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**9**	**417**	**1**	**1006**
UAE	-	-	1	1006
Other countries	9	417	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**152**	**524**	**11**	**625**
Switzerland	-	-	8	546
Mauritius	1	27	1	40
Sri Lanka	-	-	1	29
Bahrain	-	-	1	10
Other countries	151	497	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**6493**	**14017329**	**7818**	**15247930**
UK	2060	4907771	1917	4224722
USA	1011	1490755	2308	3941780
South Africa	1507	3706970	1575	2652000
Belgium	1	321	644	1701335
Germany	584	1482475	538	1238147
Japan	274	398834	293	499548
Italy	226	266224	150	267150
Egypt	62	155481	125	203653
Switzerland	228	652610	92	158537
Iran	25	74237	55	136045
Other countries	515	881651	121	225013

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**3500**	**10088028**	**3900**	**9251188**
UK	1312	3857632	919	2571757
USA	334	856408	799	1753218
South Africa	1002	2951350	930	1734372
Belgium	-	-	626	1672559
Germany	393	1127845	279	751373
Italy	47	135801	85	220937
Egypt	61	155289	106	156691
Iran	25	74237	55	136045
Hong Kong	17	42506	24	67752
Russia	9	25259	20	50219
Other countries	300	861701	57	136265

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**1690**	**2466199**	**1788**	**2819171**
South Africa	339	515856	577	874650
UK	665	928470	496	809945
Japan	191	267859	249	410755
Germany	152	296381	179	354340
USA	88	69126	159	181745
Switzerland	-	-	86	145909
Belgium	-	-	17	28678
Korea, Rep. of	-	-	4	9274
Hong Kong	-	-	20	3332
Italy	3	2520	1	543
Other countries	252	385987	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**1303**	**1463102**	**2130**	**3177572**
USA	589	565220	1350	2006817
UK	83	121669	502	843020
Germany	39	58249	80	132434
Egypt	-	-	19	46962
Italy	176	127903	64	45672
South Africa	166	239764	68	42978
Japan	70	95043	25	40577
Russia	64	95968	6	10965
Singapore	1	1775	3	4287
Hong Kong	-	-	1	1595
Other countries	115	157511	12	2265

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**1106**	**3196077**	**1002**	**2692541**
USA	200	613664	425	1127784
Germany	362	1043475	220	591175
South Africa	444	1256639	128	348679
Belgium	-	-	113	333887
UK	27	72619	75	189873
Italy	17	51777	41	101143
Other coutnries	56	157903	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**27**	**3424**	**27**	**22865**
UAE	-	-	9	17869
USA	27	3424	15	2936
Italy	-	-	1	1863
Hong Kong	-	-	1	113
China	-	-	1	84
Other countries	-	-	-	-

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

Country	2013-14		2014-15 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**2394**	**6891951**	**2898**	**6558646**
UK	1285	3785013	844	2381884
South Africa	558	1694711	802	1385693
Belgium	-	-	513	1338673
USA	134	242744	374	625434
Germany	31	84370	59	160198
Egypt	61	155289	106	156691
Iran	25	74237	55	136045
Italy	30	84024	44	119793
Hong Kong	17	42506	24	67752
Russia	-	-	20	50219
Other countries	253	729057	57	136264

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 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.