# THE PRIMARY PRODUCTION OF PLATINUM GROUP METALS (PGMs)

PLATINUM GROUP METALS
THE POWER TO *IMPROVE LIVES*

International Platinum Group Metals Association

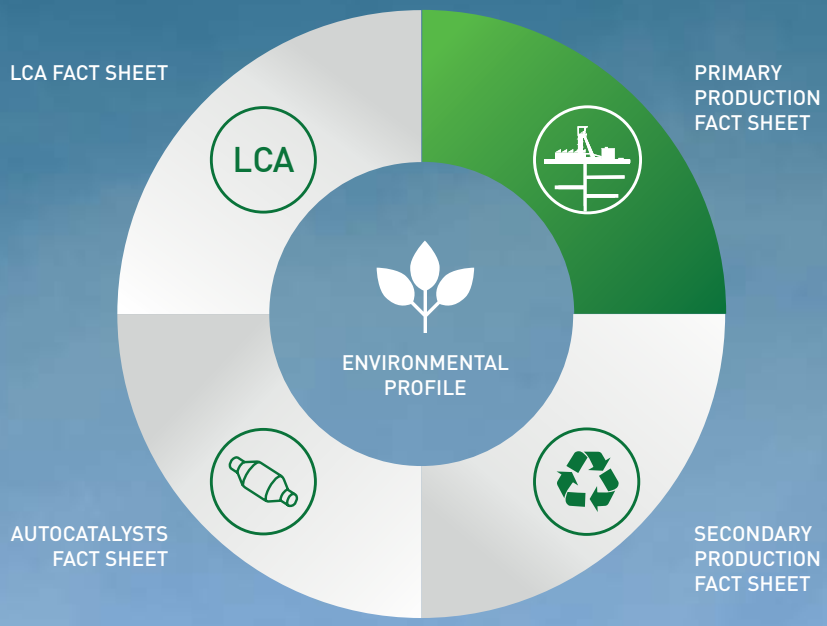


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IMAGE CREDIT

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# THE PRIMARY PRODUCTION OF PLATINUM GROUP METALS (PGMs)

## Introduction

The six platinum group metals (PGMs) occur together in nature alongside nickel and copper. Mineable deposits of PGMs are very rare, with annual production amounting to around 400 tonnes, several orders of magnitude lower than many common metals. Due to their economic values and higher quantities, platinum and palladium are the most important metals of the PGMs. The other four, rhodium, ruthenium, iridium and osmium, are mined as by-products of platinum and palladium.

58% of world PGM production takes place in South Africa[1] and Russia accounts for a further 26%, most of this as a co-product of nickel mining. Nearly all of the rest comes from Zimbabwe, Canada and the USA.

The primary production of PGMs represents the transfer of metal from below ground resource to above ground material stock and should be regarded as an investment because the metal is usually available to be recovered for reuse in subsequent product life cycles with no deterioration in quality.

Primary and secondary production of PGMs are complementary and mutually dependent. The PGM industry itself repeatedly recycles PGMs from their applications with recovery efficiencies of up to 95%. It collaborates with other stakeholders to increase recycling rates, and this growth of secondary production enables growing demand for PGMs to be met without excessively increasing primary production from mining.

## Extraction and refining

Extraction, concentration and refining of PGMs require complex, costly and energy-intensive processes that may take up to six months to produce refined metal from the time the first PGM-bearing ore is broken in a mine.

For example, in South Africa, PGM-bearing ores generally have a low PGM content of between 2 and 6 grams per tonne and it will typically take up to six months and between 10 and 40 tonnes of ore to produce one ounce (31.1035g) of platinum.[2]

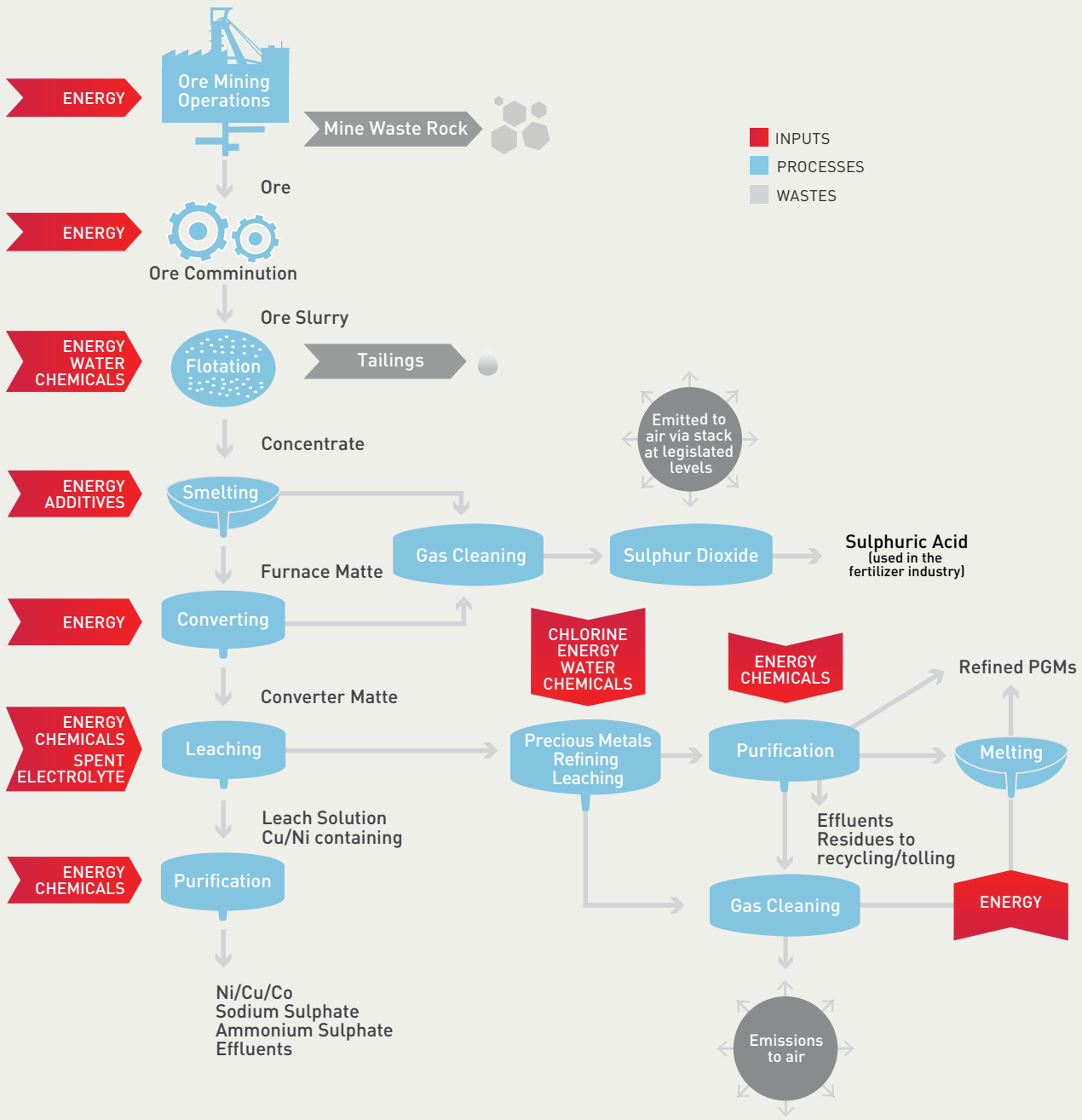
Most of the PGM mines in South Africa operate at a depth below 500 metres and up to 2 kilometres. Their orebodies are tabular and narrow, varying in width between 0.9 metres and 2.1 metres and requiring labour-intensive mining techniques. PGM ore is drilled and broken with explosives before being removed through mechanical transportation methods to the surface; electricity consumption is high, not only for ore haulage but also to drive compressed air to the miners' hand-held pneumatic drills and, because the hard rock in platinum mines has a high thermal gradient, to refrigerate the working areas.

On the surface the ore is crushed and milled into fine particles. Wet chemical treatment known as froth flotation produces a concentrate which is dried and smelted in an electric furnace at temperatures over 1,500°C. A matte containing the valuable metals is transferred to converters to remove iron and sulphur. PGMs are then separated from the base metals nickel, copper and cobalt, and refined to a high level of purity using a combination of solvent extraction, distillation and ion-exchange techniques.

*Primary production at Impala Platinum mine in South Africa.*
**IMAGE CREDIT**: ***Mining Operations,*** **Implats.**

1 Chamber of Mines of South Africa, Annual Report 2012; figure does not include recycling.
2 Johnson Matthey, http://platinum.matthey.com/about-pgm/production/south-africa.

FIGURE 1 Generic flow chart for PGM production in South Africa
SOURCE: Lonmin

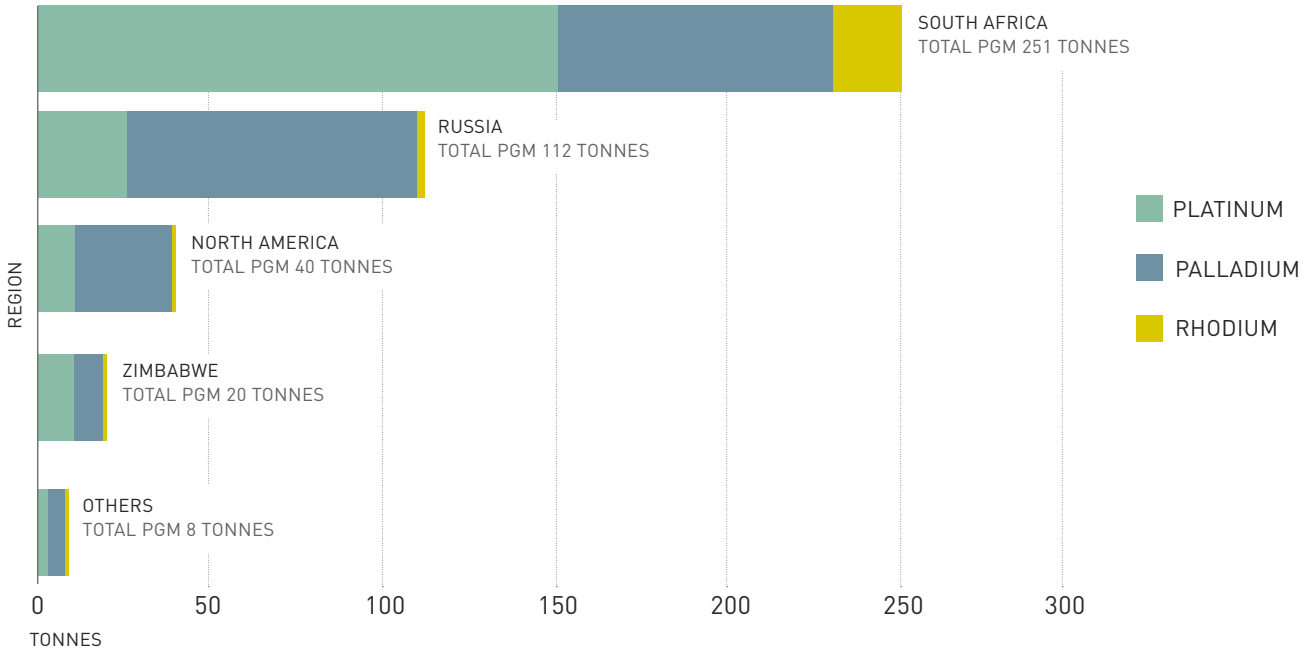



As a result of their high cost of production, PGMs are expensive in comparison with other metals. This leads to highly economical and responsible usage in applications, such as catalytic converters to control vehicle exhaust emissions. For example, the representative European average PGM content for a car equipped with a Three Way Catalyst (gasoline engine) is 2-3 grams and 7-8 grams for a car equipped with a Catalyst Soot Filter and Diesel Oxidation Catalyst (diesel engine).[3]

The extraction of natural resources and the manufacture of PGM products create large revenues and thereby contribute greatly to the economic growth and wealth of countries where the metals are mined and processed.

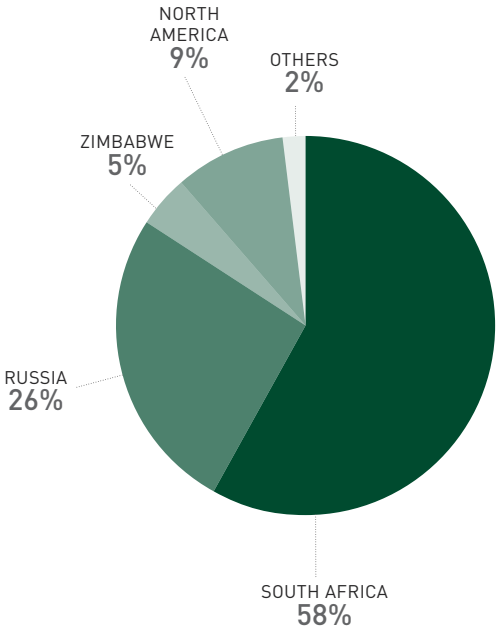
3 Average PGM content as used in the IPA LCA Study 2013 for Europe.

FIGURE 2 **Contribution of PGM producing countries in 2011**
**SOURCE** [4]




## PGM Production Quick Facts

- Global primary production of PGMs in 2011 was 430 tonnes (platinum: 202 tonnes; palladium: 205 tonnes; rhodium: 24 tonnes).[5]
- South Africa and Russia together produce around 85% of world primary PGM supply.[6]
- Deposits in Russia and North America have high palladium contents while deposits in South Africa and Zimbabwe are richer in platinum.
- 95% of the known world reserves are located in South Africa.[7]
- 33% of PGMs are produced as co-products of nickel mining.




4 Johnson Matthey Platinum 2013 Interim Review.
5 Johnson Matthey Platinum 2013 Interim Review; this does not include Russian State sales of palladium or recycling.
6 Johnson Matthey Platinum Review 2013; this does not include Russian State sales of palladium or recycling.
7 63,000 tonnes of 66,000 tonnes; source: U.S. Geological Survey, Mineral Commodity Summaries, January 2013.

# Impacts of primary production

PGMs are produced and processed by IPA Members in an environmentally responsible manner in conformance with strict regulations. As with all mining activities, the extraction and processing of PGMs has an effect on the environment.

An LCA study conducted by the IPA has quantified the environmental impact of primary production of PGMs for the first time on an industry-wide level. The results indicate that power consumption during mining and ore beneficiation and the emissions of $CO_2$ associated with these two process steps are the major impacts (72%) of PGM production.

The energy intensity of the production process and the reliance of the industry on the type of energy available in the countries of operation lead to a relatively high global warming potential per unit of PGMs produced. In South Africa, for example, more than 90% of electricity is generated through burning hard coal.

The PGM industry acknowledges its footprint and is committed to reduce adverse environmental effects. These include the gradual reduction of pollutant emissions into the air, the continuous reduction of polluted wastewater discharge into water bodies and improvements in efficiency of water use, natural gas and electricity consumption.

Mineable deposits of PGMs are very rare in the Earth's crust.

PGM mining is a capital, energy and labour intensive industry.

Annual PGM production is lower than the production of other metals; combined with the high production costs of PGMs, this results in highly economical and responsible usage.

Primary production of PGMs - the transfer of metal from below ground resource to above ground material stock - should be regarded as an investment.

Primary and secondary production (recycling) of PGMs are complementary and mutually-dependent.

Primary and secondary production of PGMs create large revenues and thereby contribute greatly to the economic growth and wealth of the countries where the metals are mined and processed.

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## ABOUT THE IPA

The IPA is a non-profit organisation representing 80% of the mining, production and fabrication companies in the global platinum group metals (PGM) industry, comprising platinum, palladium, iridium, rhodium, osmium and ruthenium.

## CONTACT INFORMATION

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