



Operational review

REEF MINED

4.63 Mt

down 5.1%
(2018: 4.88 Mt)

PGM PRODUCTION
(5PGE + Au)

139.7 koz

down 8.2%
(2018: 152.2 koz)

CHROME CONCENTRATE
PRODUCTION

1.29 Mt

down 10.9%
(2018: 1.45 Mt)

CHROME CONCENTRATE
SALES

1.40 Mt

down 15.1%
(2018: 1.65 Mt)

PRODUCTION STATISTICS

		FY2019	FY2018
LTIFR	per 200 000 hours	0.27	0.18
Reef mined (ROM)	kt	4 627.1	4 875.0
Stripping ratio	m ³ waste: m ³ reef	8.3	7.9
Rougher PGM grade	g/t	1.47	1.51
PGM recovery	%	82.1	84.1
PGM production	5PGE + Au koz	139.7	152.2
ROM chrome feed grade	% Cr ₂ O ₃	18.1	18.2
Chrome recovery	%	62.0	66.0
Chrome yield	%	26.7	28.4
Chrome concentrate production	kt	1 290.0	1 448.0
– Metallurgical grade	kt	977.9	1 080.3
– Speciality grade	kt	312.1	367.7
Third party	kt	241.1	221.8

Tharisa Minerals

Tharisa Minerals is 74% owned by Tharisa and is uniquely positioned as the world's only co-producer of both PGM and chrome concentrates. Tharisa Minerals' core asset is the Tharisa Mine, which is situated on South Africa's Western Limb of the Bushveld Complex – home to more than 70% of the world's platinum and chrome resources.

Tharisa Minerals mines and processes five MG Chromitite Layers. Through innovative engineering, the mined reef is processed at two independent integrated plants extracting both PGMs and chrome concentrates, thereby reducing unit costs and positioning Tharisa Minerals in the lowest cost quartile of operating costs in South Africa for both PGMs and chrome.

Tharisa Minerals' low unit costs and multiple polymetallic products have ensured that it was well placed to manage commodity price volatility and exchange rates.

Its dual revenue streams provide a natural hedge against different commodity cycles with the products being used in different applications. PGMs are primarily used in the automotive, technology and jewellery industries while chrome is primarily used in the manufacture of stainless steel.

Safety

Tharisa acknowledges that the safety of its people is critical to its success. The LTIFR for FY2019 was 0.27 (2018: 0.18) per 200 000 man hours worked. The mine achieved three million fatality-free shifts.

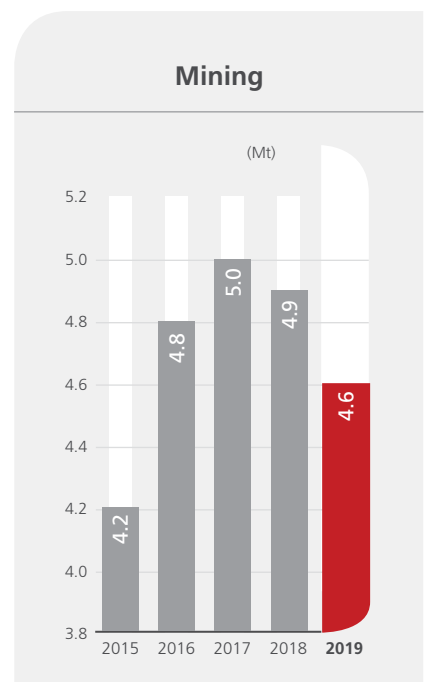
Refer to the Safety and Health section of the sustainability report on page 44.

Mining operations

Tharisa Minerals holds a Mining Right over 5 475 ha of land near the town of Rustenburg in the North West province of South Africa. The Mining Right was granted on 19 September 2008 for an initial period of 30 years, providing access to MG Chromitite Layers which outcrop with a strike length of approximately 5 km.

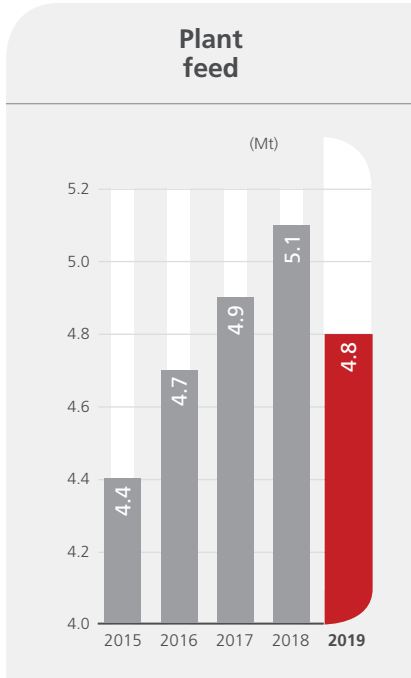
The Tharisa Mine is a 14-year open pit operation with a projected 40-year underground life of mine extension. The mining operation, which is divided into the east pit and west pit, extracts reef from five MG Chromitite Layers.

Refer to the Mineral Resource and Mineral Reserve statement on page 62.



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The change in operating model from contractor to owner-operator mining was implemented in FY2018. This change represented a logical progression given the long life of the open pit, allowing Tharisa Minerals to take direct control of its mining operations, thereby controlling the reef grades and the delivery of improved quality ore to the processing plants and optimising the feed, throughout and within the plants. FY2019 saw Tharisa Minerals invest heavily in new equipment and machinery including a new Caterpillar 6050 face shovel.

Tharisa Minerals' mining division mined 4.6 Mt of ROM for FY2019, a 5.1% decrease year on year. A total of 11.1 Mm³ of waste rock was mined for the year, as the stripping ratio improved to 8.3 on a m³:m³ basis, representing a 5.1% increase from the previous year. Mining for the year needs to be viewed in the context of Tharisa focusing on the development areas in its open pit; a redesign that saw over 1.7 Mm³ of previously mined material moved, with the aim of creating smoother benches and thus better drilling, blasting and hauling continuity. Hauling continuity was enhanced by access roads that previously ran north-south now running parallel to the pit as the pit advances. Capital investment into machinery increased to US\$27.5 million as fleet replacement accelerated.

Processing

The PGMs in the MG ore mined by Tharisa Minerals occur in the silicates and are not associated with the chromite, thus enabling the process to extract chrome before PGMs without sacrificing PGM recovery.

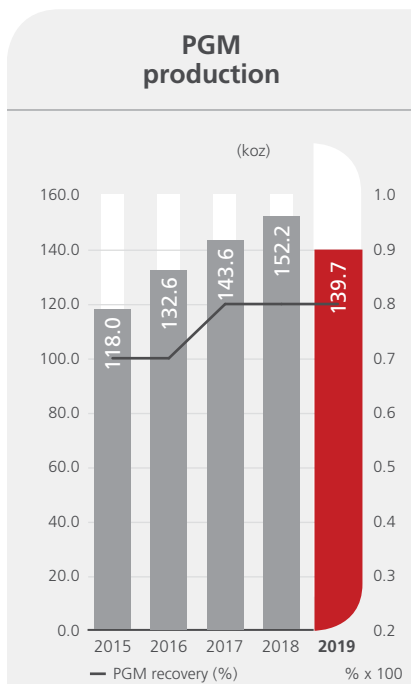
This lowers the chrome content in the PGM circuit and results in much lower chrome content in the PGM concentrate compared to typical UG2 operations. Base metal content in the MGs is also significantly lower than Merensky and UG2 ores, resulting in a low matte fall during smelting, reducing base metal refining requirements.

Tharisa Minerals' two independent processing plants are designed specifically to treat the MG Chromitite Layers of the Bushveld Complex. The smaller 1.2 Mtpa Genesis Plant, with the 100 ktpm chrome circuit, was commissioned in August 2011 with the PGM circuit being commissioned in December 2011. The larger 3.6 Mtpa Voyager Plant was commissioned in December 2012. Both plants operate at above nameplate capacity and milled collectively 4.8 Mt. The plants have a similar process flow that includes crushing and grinding, primary removal of chrome concentrate by spirals, followed by PGM flotation from the chrome tails and a second spiral recovery of chrome from the PGM tails.

Operating in parallel, the independent plants provide processing flexibility and production stability by allowing one plant to be shut down without hampering the production of the other. The modular design of the processing circuits allows sections of the plant to be stopped without affecting the rest of the operation (i.e. a crushing circuit can be stopped independently of the comminution, spiral and flotation circuits).

Using off the shelf technology, the processing circuits are uniquely engineered to deliver both PGM and chrome concentrates. This innovative approach to production has made Tharisa a world-class PGM and chrome co-producer.

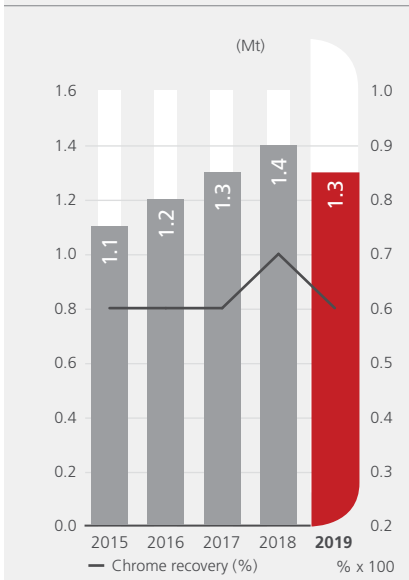
The PGM rougher feed grade was marginally lower for the year at 1.47 g/t, while the Cr₂O₃ ROM feed grade was virtually unchanged at 18.1% for the year.



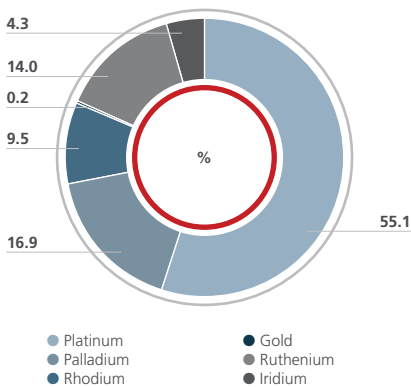


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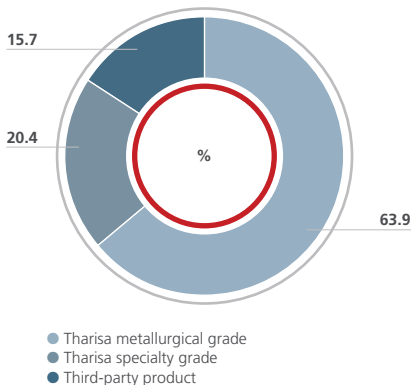
Chrome production



Prill split for FY2019



Tharisa chrome production split for FY2019



Products

The Tharisa Mine produces the following products:

PGM concentrate: PGM concentrate is produced from both processing facilities. The concentrate produced from the Voyager Plant is a higher grade than the concentrate from the Genesis Plant due to the different chromitite reefs treated by the respective plants. The major component of the PGMs is platinum, followed by palladium and ruthenium.

Average market price	FY2019 US\$/oz	FY2018 US\$/oz	Change %
Platinum	878	909	(3.4)
Palladium	1 490	996	40.6
Rhodium	2 531	1 957	29.3
Ruthenium	235	207	13.5
Iridium	1 317	1 156	13.9

Source: Johnson Matthey

Metallurgical grade chrome concentrate: The typical metallurgical grade produced by Tharisa is 40.0% to a 42.0% chrome (as Cr₂O₃) with the silica (SiO₂) lower than 5.0%.

Chemical grade chrome concentrate: The typical chemical grade produced by Tharisa is 44.0% to 46.0% Cr₂O₃ with the SiO₂ lower than 1.0%. This is a higher value chromite product than the metallurgical grade chrome concentrate.

Foundry grade chrome concentrate: The typical foundry grade produced by Tharisa is 45.0% to 46.0% Cr₂O₃ with the SiO₂ lower than 1.0%. The American Foundryman Society Grain Fineness Number (AFS Number) is managed between 45 and 50. As with the chemical grade chromite, this is a higher value chrome concentrate than the metallurgical grade chrome concentrate.

Average chrome price	FY2019 US\$/t	FY2018 US\$/t	Change %
42% metallurgical grade	162	186	(12.9)

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Tharisa targets recoveries of 80.0% for PGMs and 65.0% for chrome. In FY2019 PGM recoveries were 82.1% while chrome recoveries were 62.0%.

During the year, the Group produced PGM concentrates containing 139.7 koz of contained PGMs (5PGE + Au) and chrome concentrates of 1.29 Mt with 312.1 kt being speciality grade concentrates. Third-party chrome concentrate produced was 241.1 kt.

Speciality chrome recovery circuits are integrated into the feed circuit of the Genesis Plant, known as the Challenger Plant. The Challenger Plant, which is owned by fellow subsidiary Arxo Metals, was commissioned in July 2013 and produces chemical and foundry grade chrome concentrates.

Production of speciality grade concentrates accounted for 24.2% of Tharisa's chrome production in FY2019, and will be maintained at current levels to ensure that it maintains a strategic market share.

Vision 2020

The Vision 2020 projects are targeting an increase in Tharisa's production to 200 kozpa of PGMs and 2.0 Mt of chrome concentrates in 2020 on an annualised basis. The FY2020 production guidance for the Tharisa Mine is 155 koz to 165 koz of PGMs and 1.45 Mt to 1.55 Mt of chrome concentrates.

Crusher circuit at the Genesis Plant

The additional crusher circuit at the Genesis Plant aims to increase the Genesis Plant throughput by 15% or about 180 ktpa, targeting an increase in the higher value speciality grade chrome concentrates by adding approximately 24 ktpa of chemical grade chrome concentrate, approximately 18 ktpa of foundry grade chrome concentrate, and approximately 19 ktpa of metallurgical grade chrome concentrate.

PGM optimisation at the Voyager Plant

The addition of flotation capacity and the installation of high-energy mechanisms at the Voyager Plant is aimed at improving the PGM recoveries and increasing

PGM production. The project is being implemented via a staged approach.

Vulcan Plant

Tharisa's R&D team has developed the Vulcan process to extract the fine chrome from current in-line tailings from the combined feed of the Genesis and Voyager Plants. The primary aim of the Vulcan Plant is to increase chrome recovery from the current 65% target to 82% at the Tharisa Mine, capable of adding an additional 400 ktpa (ca. 30% of current production) of chrome concentrate output. Vulcan will use a proprietary process using existing technologies to improve chrome recoveries with the process having been rigorously tested and proven through pilot plant test work and the operation of a production scale demonstration plant. The total capital cost of US\$54.2 million includes contingency and owner's cost.

Sales and marketing

The Group's market advantage is its exposure to both the PGM and chrome markets. This dual exposure gives the Group a hedge against volatility in either of the commodity prices.





Tharisa Minerals continues to supply the majority of its PGM concentrate to Impala Platinum in terms of its offtake agreement and is paid a variable percentage of the contained PGMs and base metals contained within each tonne of concentrate in terms of an agreed market formula.

The PGM basket price improved by 17.1% to US\$1 081/oz in FY2019.

Chrome concentrate sales totalled 1.4 Mt, 314.7 kt of which was Tharisa's higher margin speciality chemical and foundry grade chrome concentrates. The bulk of the Tharisa sales are derived from metallurgical grade chrome concentrate, sales of which included 207.5 kt of third-party chrome concentrates.

Speciality grade chrome concentrates produced within the Group are sold in terms of an agency and offtake agreement. The chemical grade chrome concentrate is jointly marketed with Tharisa and an independent third party.

Spot metallurgical chrome concentrate prices were volatile during the financial year, but overall lower than in the previous year, with prices received ranging between US\$190/t and US\$142/t with the average price for metallurgical grade chrome concentrate on a CIF main ports China basis decreasing in US dollar terms to US\$162/t from US\$186/t for the previous year.

The production of the higher value speciality chrome concentrates, which typically command a premium of greater than US\$50/t provided additional margin.

The Group continued to deliver metallurgical grade chrome concentrate in terms of its five-year strategic cooperation agreement with Taiyuan Iron & Steel's ('Tisco's') joint venture company Shanxi Taigang Wanbang Furnace Charge Co. In terms of the agreement, which was effective as of September 2017, Arxo Resources will supply Tisco with a minimum of 240.0 ktpa of metallurgical grade chrome concentrate.

Metallurgical chrome production is shipped in bulk and containers via South African ports to major stainless steel and ferrochrome producers in China.

Arxo Metals

Arxo Metals owns the Challenger Plant, which is integrated into Tharisa Minerals' Genesis Plant. The Challenger Plant is dedicated to the production of speciality grade chrome concentrates, namely chemical and foundry grade concentrates. Speciality grade concentrates carry more stringent specifications and therefore fetch a higher selling price. Arxo Metals has an offtake agreement for the sale of its concentrates to customers in the chemical and foundry industries globally. Arxo Metals accounted for 64.3 kt of chemical grade chrome concentrate (2018: 81.9 t) and 15.5 kt of foundry grade chrome concentrate (2018: 26.0 kt) in FY2019. The decrease in production was driven both by the overall reduction in mining and milling, as well as a reduced demand for the product in the chosen markets.

In August 2017, Arxo Metals entered into an agreement with Western Platinum, a subsidiary of Lonmin (subsequently acquired by Sibanye-Stillwater), on the operations of its K3 UG2 chrome plant and for the sales and marketing of the UG2 chrome concentrate produced. Arxo Metals unlocks greater value from the K3 UG2 chrome plant using innovative processing already in use at our operations. The chrome production for FY2019 from K3 UG2 chrome plant was 241.1 kt, up from 221.8 kt in FY2018.

Arxo Metals is also the beneficiation, research and development arm of the Group. Arxo Metals conducts extensive research into technologies and downstream beneficiation opportunities that have the potential to improve yields and recoveries at the Tharisa Mine. The creation of increased value PGM and chrome products through the expansion and optimisation of the Group's processing operations is its core focus.

Arxo Metals has commissioned a 1 MW DC furnace to produce PGM-rich alloys on a pilot scale. The furnace, operated by Tharisa Minerals, has produced its first PGM alloy, and is ramping up to full production.

The production of PGM-rich alloys will further develop Tharisa's beneficiation capability and thereby the profitability of Tharisa's PGM segment.

Arxo Metals continues to evaluate low capital, low energy, value-adding beneficiation projects through in-house research and development.

Arxo Resources

Arxo Resources has the exclusive right to sell the metallurgical grade chrome concentrate produced by Tharisa Minerals to customers in China and other international markets. It has established a strong platform with global customers in China including stainless steel and ferrochrome producers, as well as global commodity traders.

Arxo Resources has a marketing agreement with Noble, a global commodities trading company listed on the Singapore Stock Exchange, whereby Noble acts as an agent for the marketing of 600.0 ktpa of metallurgical grade chrome concentrate produced by Tharisa Minerals.

Arxo Resources also has a joint marketing agreement for Tharisa Minerals' chemical grade chrome concentrate production.

In FY2019, Arxo Resources sold 1.1 Mt (2018: 1.3 Mt) metallurgical grade chrome concentrates, of which 0.9 Mt was produced by Tharisa Minerals.

The scale of Arxo Resources operations allows for direct access to market and price discovery. Its established contacts with customers also directly creates an excellent platform for additional sales of third-party products.