



Platinum and Palladium

Autocatalysts account for 32% of platinum, and 86% of palladium, demand

Demand for these metals could weaken if economic growth and the auto industry slow this year

Just four regions and three firms account for the majority of global platinum and palladium production

Palladium price rising more than platinum on larger supply demand imbalance

Two companies above C\$100mn market cap at the Feasibility Study Stage

Other companies below C\$100mn market cap, mostly at earlier stages

Autocatalysts the major driver

The largest driver for both platinum and palladium demand are their use in auto catalytic convertors to reduce emissions for vehicles, comprising by far the bulk of demand for palladium, but less for platinum, which also sees strong demand from jewellery, investment and petroleum and chemicals. Given our concerns that overall economic growth, including the auto industry, could slow this year, we expect that industrial driven demand for these metals could decline, although monetary factors could be supportive.

Production concentrated in a few regions, firms

Supply for platinum and palladium is limited to a few regions, South Africa, Russia, Zimbabwe and North America, with just three firms, Anglo-American, Norilsk and Impala accounting for the majority of production. Demand for palladium has outpaced supply more than for platinum, leading the price of the former to rise above the latter for the past three years. The recent palladium upswing has been driven by geopolitical tensions with Russia, the largest source of the metal.

Several small TSX and TSXV-listed companies

There are two TSX-listed companies in the sector above C\$100mn market cap, Platinum Group and Generation Mining, both at the Feasibility Study stage. The other TSX and TSXV-listed companies are quite small, below C\$100mn market cap, with Group Ten Metals, Palladium One, Clear Air Metals, New Age Metals at the PEA or drilling stage and Eastern Platinum already in production.

	Ticker	Mkt Cap CAD\$ mn	Price CAD \$	Country/ Region	Main project
Platinum Group	PTM.TO	201	2.50	South Africa	Waterberg, FS stage, 19.5mn oz PGMS
Generation Mining	GENM.TO	147	0.85	Canada	Marathon, FS stage, 4.2 oz Pd, 1.4mn oz Pt
Group Ten Metals	PGE.TO	64	0.38	USA/Canada	Drilling at Stillwater, PGE-Au-Ni-Cu
Palladium One	PDM.V	50	0.20	Finland/Canada	LK, PGE-Ni-Cu, 1.61mn oz PdEq
Clean Air Metals	AIR.V	38	0.23	Canada	Thunder Bay North, PGE-Au, 4.9mn oz PtEq
Eastern Platinum	ELR.TO	37	0.27	South Africa	Owns PGM, chrome assets around Bushveld
New Age Metals	NAM.V	21	0.10	Canada	River Valley palladium project

Source: Yahoo Finance, *Pricing as of February 18, 2022

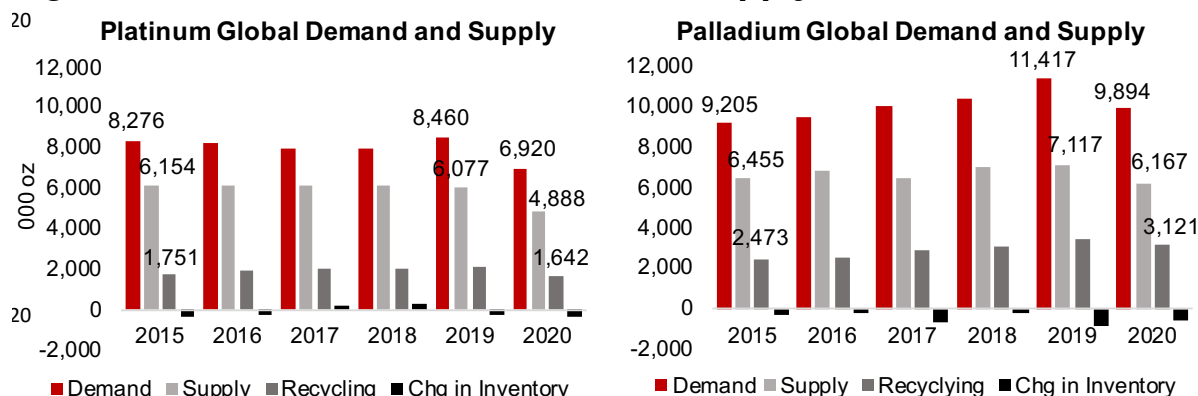
Platinum and Palladium

An Introduction to Platinum and Palladium

Platinum and palladium markets much smaller than gold

Platinum and palladium are precious metals, like gold and silver. The demand for platinum in 2020 was 6.9 mn oz, at an average US\$887.4/oz, for a market value of roughly US\$6.14bn, and for palladium at 9.9 mn oz, at US\$2,164.6/oz for a market value of US\$21.4bn (Figure 1). This compares to demand for gold of 132.6 mn oz at \$1,767.0/oz for a market value of US\$234.3bn, and for silver of 896.1mn oz, at US\$20.4/oz or a market value of US\$18.3bn. Demand for platinum has remained roughly stable since 2015, at an average 7.9mn oz per year, apart from a dip during the crisis in 2020, with supply also relatively stable at 5.9 mn oz. Much of the rest of the demand is met through recycling, at an average 1.9 mn oz since 2015. Palladium demand had trended up, rising 24.0% from 9.2mn oz in 2015 to 11.4mn oz in 2019 then dipped in the global health crisis to 9.9mn oz. Palladium supply has remained relatively flat, averaging 6.8mn oz from 2015 to 2020, with some of the gap made up by increased recycling, rising from 2.5mn oz in 2015 to 3.1mn oz in 2020, at 31.5% of total demand, compared to 23.7% of demand for platinum.

Figure 1: Platinum and Palladium total supply and demand



Source: Company

South Africa and Russia key for supply, auto industry key for demand

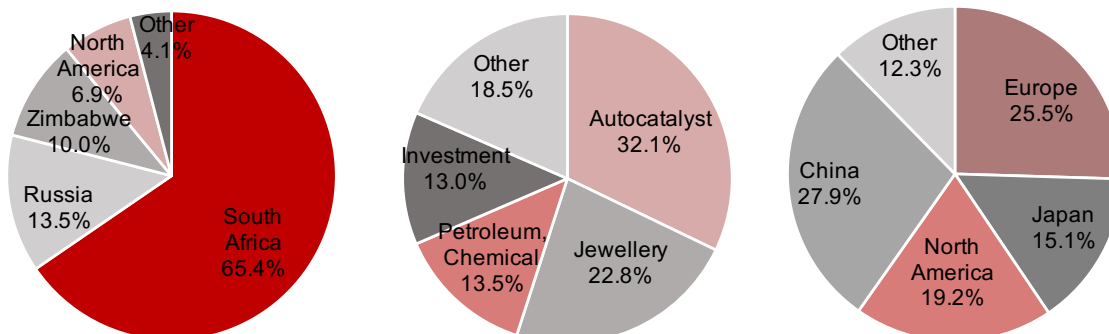
The supply for platinum and palladium are both concentrated in just a few countries, with the two major suppliers being South Africa and Russia, but North America and Zimbabwe also key sources. For platinum, 65.4% of its supply comes from South Africa, with the majority of the supply coming from a single area, the Bushveld complex, with 13.5% coming from Russia, 10.0% from Zimbabwe and 6.9% from North America (Figure 2). For palladium Russia is the largest source of supply, at 44.2%, South Africa second at 34.1%, North America third at 15.1% and Zimbabwe fourth at 6.3.% (Figure 3).

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Figure 2: Platinum supply and demand 2020 by segment, country

Platinum Supply by Country Platinum Demand by Industry Platinum Demand by Country



Source: Company

The largest component of demand for both platinum and palladium is from the auto industry, for use in auto catalytic convertors, which reduce vehicle emissions. For platinum, autocatalyst demand made up just 32.1% of demand in 2020, and tends to be used mostly in diesel powered vehicles. For palladium, autocatalysts make up almost all of its demand, at 85.9%, mainly for use in gas engines. For both, therefore, growth in the auto industry will remain a major driver and should be supported by the continued global push towards emissions reduction. While the auto industry is likely to remain by far the major driver for palladium, demand is much more mixed for platinum, with jewellery demand high, at 22.8% of the total, petroleum and chemical demand at 13.5%, investment demand at 13.0% and other demand at 18.0%.

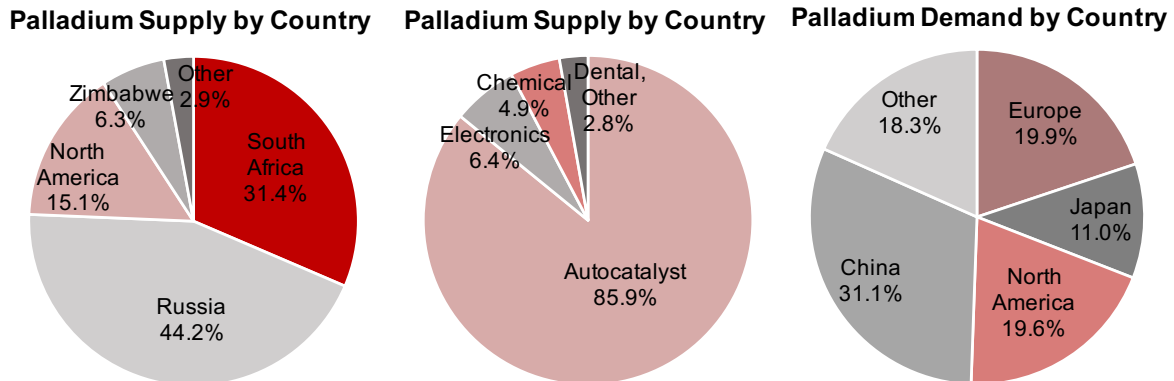
Platinum may be driven more by monetary factors than palladium

Platinum to some degree may be supported by monetary drivers, similar to gold and silver, as the combined 35.8% of jewellery and investment demand for platinum could be viewed as monetary at their root, with even most jewellery demand likely driven by using the metal as a store of value. In contrast, palladium's demand is entirely industrial, and therefore we could see its underlying trend follow other industrially metals like copper more than the other precious metals gold, silver and platinum, which all have a significant monetary component to their demand and price movement over time. Demand for both platinum and palladium is reasonably evenly split geographically, with the proportion from North America and China roughly similar for both, but for platinum, European and Japanese demand is moderately higher, with demand from other regions higher for palladium.



Platinum and Palladium

Figure 3: Palladium supply and demand 2020 by segment, country

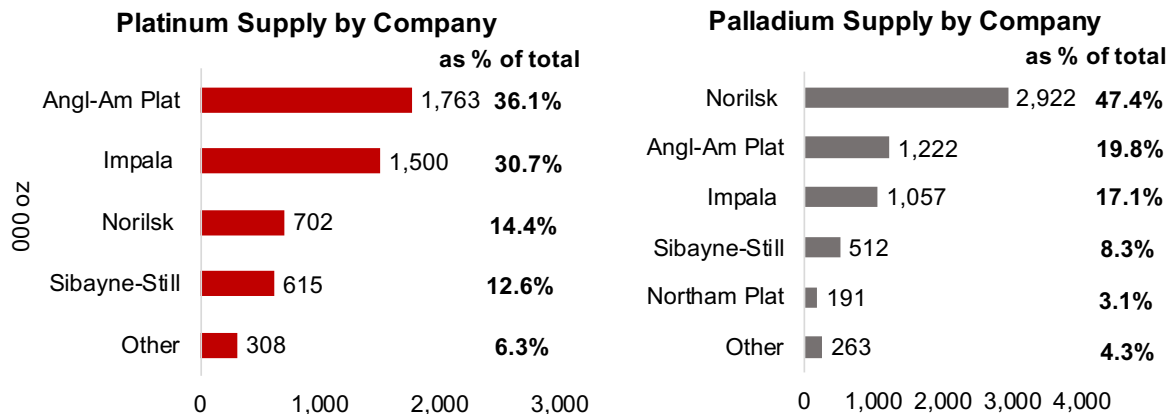


Source: Company

Platinum and palladium supply concentrated in a few companies

In addition to being concentrated in only a few countries, platinum and palladium supply also comes from just a few companies. There are three industry giants; 1) Anglo-American Platinum from South Africa, which leads platinum production, accounting for 36.1% of supply and is number two for platinum, at 19.8% of supply (Figure 4), 2) Russia's Norilsk, which produces almost half of global palladium, at 47.4%, and is the third largest producer of platinum, at 14.4%, and 3) Impala from South Africa, which is number two for platinum, at 30.7% of the total production, and number three for palladium, at 17.1%. Sibayne-Stillwater from South Africa is a mid-tier player, the fourth largest platinum and palladium producer, at 12.6% and 8.3%, respectively, and Northam Platinum is a smaller producer, account for 3.1% of global platinum supply. These five control almost the entire industry, with other players with just a 6.3% share of the global platinum supply and a 4.3% share of global palladium.

Figure 4: Platinum major producing companies



Source: Company

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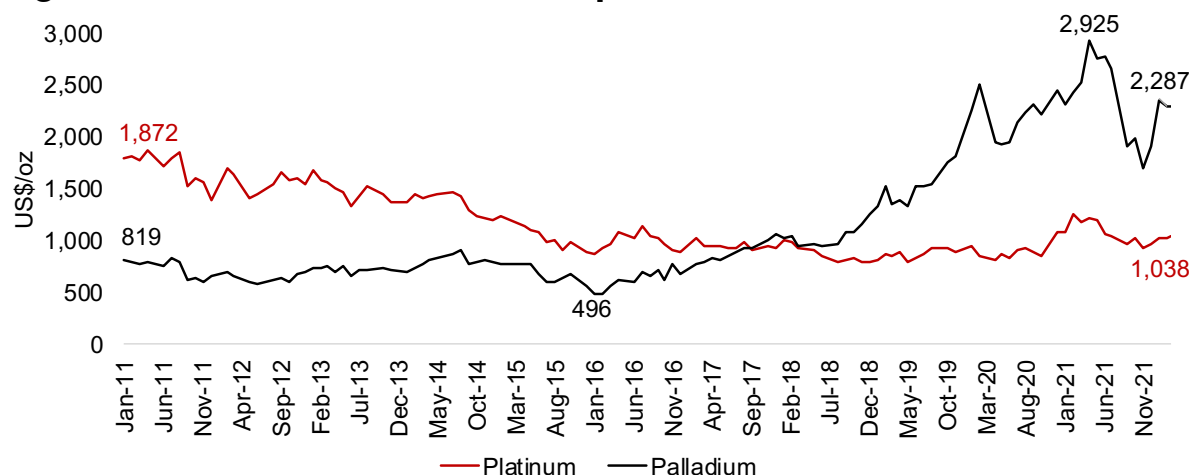
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Significant shift in platinum and palladium relative prices over past decade

There has been a significant shift in the relative prices of platinum and palladium over the past decade. The platinum price had historically been about twice the level the palladium, with about two times as much palladium needed for the same industrial function as palladium. However, technological development pushed this industrial substitution ratio closer towards one by the early 2000s. This eventually drove the prices of the metals to converge, with platinum trending down over most of the decade from US\$1,872/oz in 2011 to US\$1,038/oz in February 2022 (Figure 5). The palladium price also trended down from US\$819/oz in 2011 to US\$496/oz in 2016, but then started to rise, surpassing platinum in August 2017.

Palladium peaked at US\$2,925/oz in March 2021, and traded at US\$2,287/oz on average in February 2022, more than twice the level of platinum. This has been driven by two main factors, the first being a push to a reduced vehicle emissions driving more demand for gasoline vehicles, which use more palladium for autocatalysts, than for diesel ones, which use more platinum. The second factor has been a larger supply demand gap for palladium which rose from 2.8 mn oz in 2015 to 4.3 mn oz in 2019, than for platinum, which increased just from 2.1 mn oz to 2.4 mn oz.

Figure 5: Platinum and Palladium prices from 2011



Source: Company

Palladium and platinum performance behind silver and gold over past two years

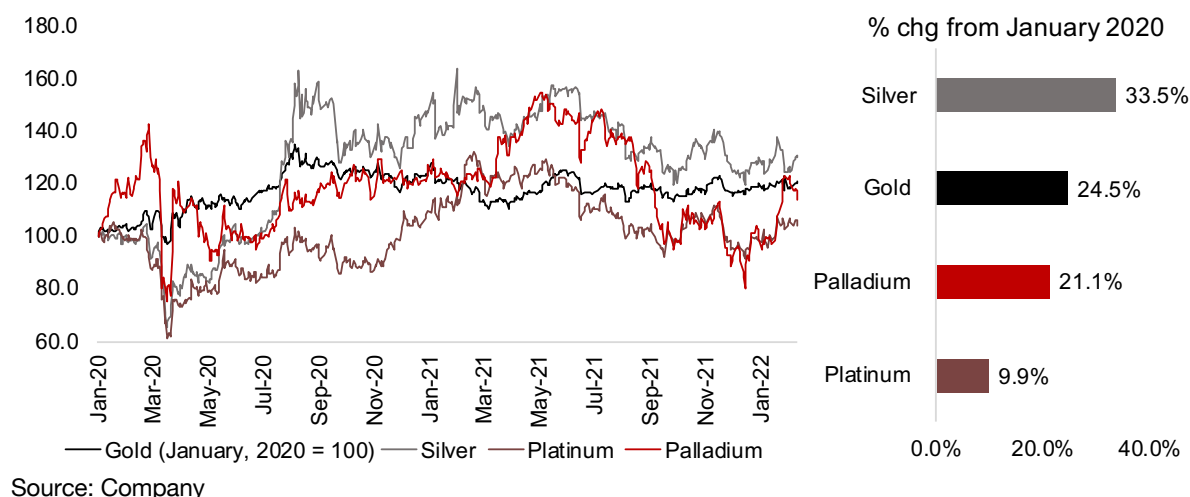
Palladium and platinum have underperformed the other two main precious metals, gold and silver, over the past two years. Silver has been the best performer since January 2020, up 33.5%, propelled both by the economic rebound and the major global monetary expansion, while gold is up 24.5%, mainly on the latter factor. Palladium is just behind gold, up 21.1%, most of which has been just in last two months as geopolitical tensions with Russia, the main supplier of the metal, increase, while platinum has considerably lagged these other three, up just 9.9%.

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Figure 6: Precious metals relative price performance from 2020



Source: Company

We believe that the outlook for the prices of these metals could be mixed in 2022. Palladium faces the risk of demand being heavily reliant on the auto sector, and we are concerned that the rebound in the economy since the crisis which has boosted the auto industry may start to slow, although continued geopolitical tensions with Russia could continue to offset this somewhat. With platinum having wider sources of demand, importantly including a monetary driven component, we believe that it could outperform palladium, given our expectation for continued high inflation. We expect the monetary driver to have much less of an effect on palladium than platinum, gold and silver, although there could be a marginal lift to the metal as a store of value.

TSX and TSXV larger palladium and platinum companies

With the supply for both platinum and palladium fixed in a few areas which are already well known, new sources of supply will remain critical, especially for the auto industry, in the context of the green push, and there will be strong demand for junior miners that can develop new deposits of these metals. There are several platinum and palladium companies listed on the TSX and TSXV, although they tend towards very small market caps, with the largest seven names ranging from CAD\$201mn down to just CAD\$21mn (Figure 7). The largest is the Platinum Group, which has two joint ventures in South Africa with a total 48.0mn oz in total 4E metals (palladium, platinum, rhodium and gold); 1) Waterberg, mining for PGMs (platinum group metals), with a feasibility study outlining a 45-year mine life, and an after-tax NPV of \$2,054mn, and 2) Lion Battery Tech, using PGMs in lithium batteries (Figures 8, 9).

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The second largest is Generation Mining, operating the Marathon project in Ontario, Canada, with resources of 4.2 mn oz palladium, 1.1bn lbs Cu and 1.4mn oz platinum, with its Feasibility Study outlining a 13-year mine life, 245k PdEq/year and an NPV of US\$800mn. The company has continued drilling at Marathon over the past year, with highlights of 2.82 g/t PdEq over 43.0m on January 5, 2021 and 0.82 g/t PdEq over 135 m on Sept 2, 2021 and 1.01g/t over 72.0 m on Nov 8, 2021 (Figure 10). The third largest is Group Ten Metals, which most recently released drill results from its PGE-Au-Ni-Cu Stillwater West project in Montana including 0.73 g/t PdEq over 728.0 m on December 20, 2021. In Ontario it operates the Black-Lake Drayton gold project, where it was announced that Heritage could acquire up to a 90% interest in November 2021, and the PGE-Au-Ni-Cu Kluane project.

Figure 7: Major TSX, TSXV Platinum and Palladium companies

	Mkt Cap \$CADmn	Country	Project	Stage	Detail
Platinum Group	201	South Africa	Waterberg	Feasibility Study	Has two joint ventures; 1) Waterberg, a large-scale low-cost mine with 19.5 m oz of PGMS in reserves, with a 45 year mine life, and 2) Lion Battery Tech, using PGMs in emerging lithium battery chemistries
Generation Mining	147	Canada - Ontario	Marathon	Feasibility Study	Resources of 4.2 oz Pd, 1.1bn lbs Cu and 1.4 m oz Pt, with the FS outlining a 13-year mine life, producing 245k PdEq/year, US\$520mn capex, an AISC of US\$809/oz PdEq, and NPV of US\$800mn
Group Ten Metals	64	USA/ Canada - Ontario	Stillwater District	Drilling	The company holds 100% in three projects, the flagship PGE-Au-Ni-Cu Stillwater West Project in Montana, PGE-Au-Ni-Cu Kluane Project and the Black-Lake Drayton Project in Ontario
Palladium One	50	Finland/ Canada - Ontario	LK Project/ Tkyo Project	Resource Estimate/ Drilling	The company operates the PGE-Ni-Cu LK Project in Finland with a resource estimate of 1.61mn oz PdEq and a PEA expected by Q4/21 and the Tkyo Cu-Ni Project in Canada currently at the drilling stage
Clean Air Metals	38	Canada - Ontario	Thunder Bay North	Resource Estimate	The company operates the PGE-Au-Ag-Cu-Ni-Co Thunder Bay North project, with a resource estimate of 4.9mn oz PtEq Indicated and Inferred released in January 2021 with drilling ongoing
Eastern Platinum	37	South Africa	Crocodile Mine	Production	The company owns several PGM and chrome assets around the Bushveld Complex, which contains 80% of global PGM, with it Crocodile River Mine re-mining and processing tailings to produce chrome and PGM
New Age Metals	21	Canada - Ontario - Manitoba/ Alaska	Eagle Mine	PEA	The company operates three projects; 1) its flagship River Valley Palladium project, at the PEA Stage 2) the Genesis Pgm-Cu-Ni project and 3) explores for Lithium and rare elements in Manitoba

Source: Company



Platinum and Palladium

The fourth largest is Palladium One, with two projects; 1) the PGE-Ni-Cu LK project in Finland, which has reached the resource stage, with 1.61mn oz PdEq and a PEA targeted for 2022, with the highlights of the drill results over the past year including 1.79 g/t PdEq over 72.2 m and 1.60 g/t PdEq over 121.1 m on Jan 11, 2022 and 2) the Tokyo Cu-Ni project in Ontario, Canada, where drilling is ongoing, with results released over H1/21 with highlights of 9.90% Ni over 3.8 m on January 19, 2021. Eastern Platinum operates the Crocodile mine, which is already in production, re-mining and processing tailing to produce chrome and PGM, as well as other PGM and Chrome assets around the Bushveld Complex.

Clean Air Metals operates the Thunder Bay North project in Ontario, Canada, at the resource estimate stage, with 4.2 mn oz PtEq in I&I Resources, with drilling continuing, and the strongest recent result including 5.67 g/t PdEq over 76.6 m on September 7, 2021 and 19.6 PtEq over 46.0 m on January 5, 2022. The smallest is New Age Metals, operating three projects with 2.9mn oz in 4E resources, including River Valley Palladium, at the PEA Stage, with a total estimated 1.7mn oz PdEq production over a 14-year mine life and an after-tax NPV of \$138mn. It also operates the Genesis PGM-Cu-Ni project in Alaska, and has exploration projects for lithium and rare elements in Manitoba. Its most recent results are over a year ago on January 12, 2021, comprising mapping and sampling data from its Silverleaf Pegmatite and Greer Lake Quarry project in Manitoba, with 3.12% Li₂O %, 0.15% Rb₂O % and 0.02 Cs₂O %.

Figure 8: Platinum and Palladium Companies Resources

	Pt	Pd	Ro	Cu	Au	Ag	Co	Ni	Pt Eq	Total 4E
	k oz	k oz	k oz	mn lbs	k oz	k oz	mn lbs	mn lbs	k oz	k oz
Platinum Group	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	47,748
Generation Mining	1,391	4,190	n/a	1,101	525	12,462	n/a	n/a	n/a	n/a
Palladium One (Pd Eq)	n/a	1,161	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Clean Air Metals	907	915	27	191	64	1,167	9	106	4,199	n/a
New Age Metals (Pd Eq)	n/a	n/a	n/a	168	n/a	n/a	14	67	n/a	3,925

Source: Company

Figure 9: Platinum, Palladium Companies Feasibility Studies, PEAs

	Platinum Group	Generation Mining	New Age Metals
	Waterberg FS	Marathon FS	River Valley PEA
Resources	19.5mn oz 4E P&P	3.2mn oz Pd Eq	1.7mn oz pdEq
Mine Life (years)	45	13	14
Initial Capex US\$m	1,104	665	495
Sustaining Capital US\$m	n/a	423	n/a
Average AISC LOM/oz US\$	n/a	809	n/a
Average Cash Cost LOM/oz US\$	640	687	709
NPV After-Tax US\$m	2,054	800	138

Source: Company

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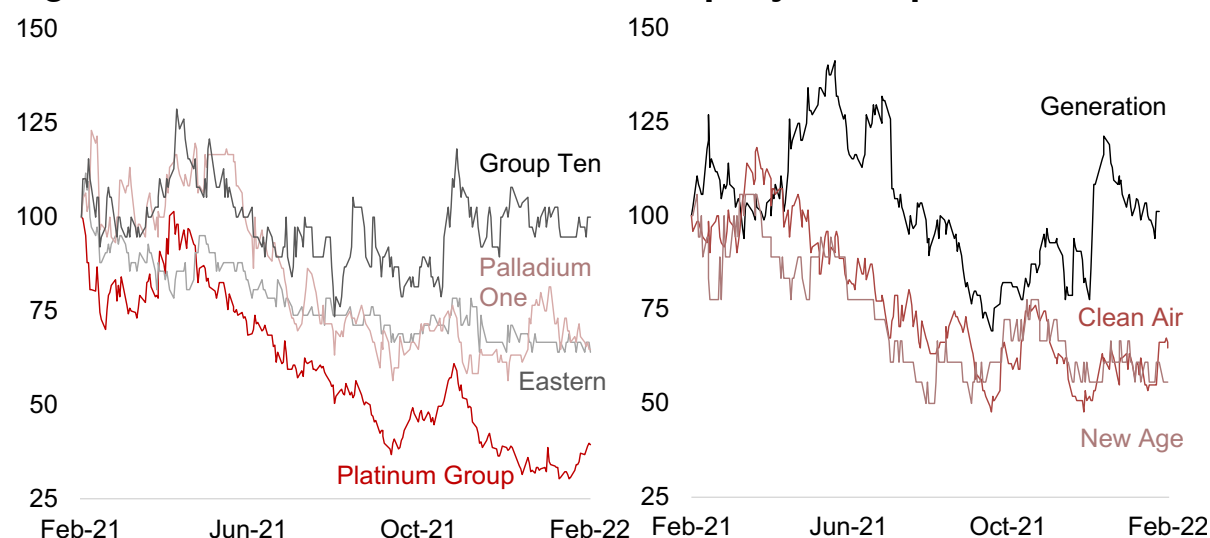
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Figure 10: Platinum, Palladium Companies Drilling Result Highlights

Palladium One			Generation Mining			Clean Air Metals		
Tyko	Ni Eq	m	Marathon	Pd Eq g/t	m	Thunder Bay North	Pt Eq	m
Nov 30, 2021	5.00%	1.4	Nov 8, 2021	1.43	12	Jan 5, 2022	19.60	46.0
	6.80%	0.8		1.01	72	including	25.00	31.0
Jun 23, 2021	10.20%	1.7	including	1.60	10		Pd Eq	m
within	7.40%	4.5	Sep 2, 2021	0.82	135	Sep 7, 2021	5.67	76.6
Jun 17, 2021	9.50%	1.7	within	2.11	16	including	9.98	21.0
within	6.00%	5.0	Aug 17, 2021	1.29	6	Jul 6, 2021	41.20	0.16
Jan 19, 2021	9.90%	3.8		0.86	61	within	31.85	0.67
within	6.10%	7.5	including	1.37	10	Jan 19, 2021	0.10	3.8
Jan 12, 2021	7.50%	4.2		2.18	4	within	0.06	7.5
including	8.80%	2.1	May 10, 2021	1.78	10			
Jan 5, 2021	8.70%	3.8		0.79	66			
including	10.10%	0.5	Jan 5, 2021	2.82	43			
				3.66	27			
LK	Pd Eq g/t	m	including	6.26	8			
Feb 7, 2022	2.60	49.3						
including	4.40	7.5						
Jan 11, 2022	1.60	121						
including	2.10	33.5						
Jun 1, 2021	1.20	116.0						
including	2.15	48.5						
May 26, 2021	1.79	72.2						
including	2.23	17.0						
May 11, 2021	2.06	37.9						
	1.22	70.5						
Apr 15, 2021	2.32	46.9						
	1.50	52.7						
Mar 18, 2021	4.21	11.6						
within	2.59	47.4						

Source: Company

Figure 11: Platinum and Palladium company share prices



Source: Company

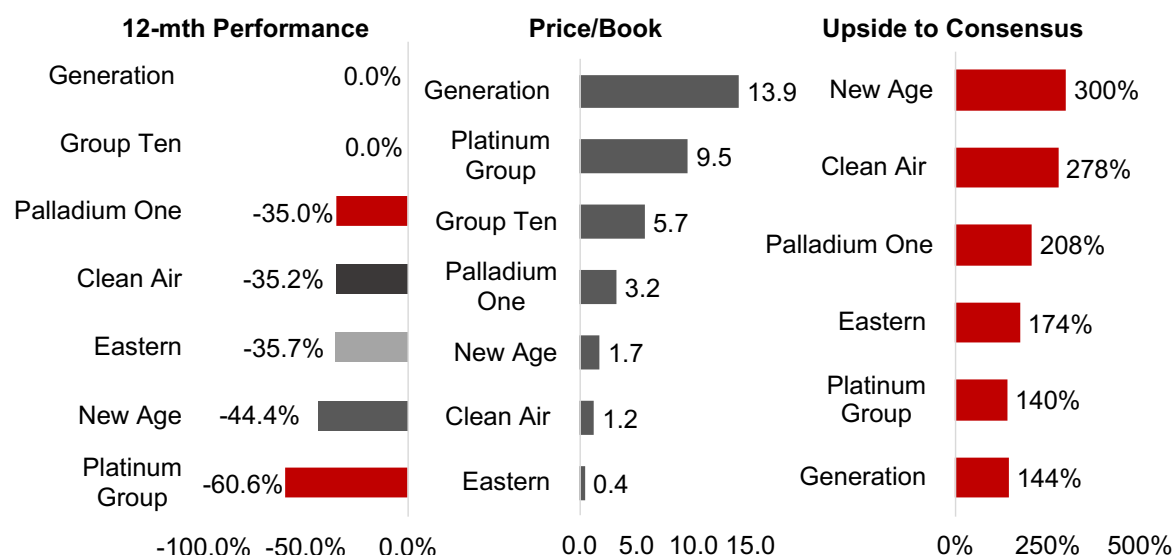
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Platinum and Palladium

Platinum and palladium stocks broadly trending down over past year

These stocks have trended down over the past year, with the best performers flat, and most down substantially from highs mostly set in early 2021 (Figure 11). The valuations for these companies can be split into roughly two groups, with four seeing reasonably high price to book (P/B) ratios, Generation Mining at 13.9x, Platinum Group at a P/B, at 9.5x, Group Ten, at 5.7x, and Palladium One, at 3.2x. Four have multiples below 2.0x, with New Age at 1.7x, Clean Air at 1.2x and Eastern at 0.4x. However, the market remains upbeat on the sector, with well over 100% upside to the consensus target prices of the companies, with the highest upside for the smaller companies New Age, at 300%, and Clean Air, at 278%.

Figure 12: Company Performance, Valuation, Upside to Target



Source: Yahoo Finance, Marketscreener

Broader downward pressure on equity markets could continue in 2022

We believe that the downward pressure on the platinum and palladium stocks could continue, given the general risk-off sentiment pervading equity markets, especially very small caps, even with the palladium price rebounding strongly and the platinum price gradually rising. We believe that platinum might actually outperform given that it has a monetary driver to offset pressure from the industrial side, and we expect high inflation. We may see more pressure on palladium, which is more heavily exposed to the industrial cycle, with the majority of its demand from the auto sector, given that we expect overall economic growth to slow. For the junior miners more broadly, we believe it is a time for caution, especially for industrially-driven metals, and while junior gold miners could see some support from rising inflation, the market may even remain wary of them, as it is increasingly avoiding small caps, and especially sectors that have been historically volatile.

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