



Zero Ground Project for environmental recovery in Brumadinho (MG) – section of the Paraopeba river



Before environmental recovery works in Brumadinho in (MG) – section of the Paraopeba river

VALE'S PRODUCTION AND SALES IN 4Q19 AND 2019

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Production and sales in 4Q19

Rio de Janeiro, February 11th, 2020 – Vale S.A (“Vale”) ended 2019, the most challenging year of its history, with the steady commitment to resume and stabilize production, while implementing the highest safety standards across its operations. The company’s endurance and operational flexibility have prevailed and the roadmap for de-risking its operations is being followed. Vale remains committed to becoming one of the safest and most reliable mining companies in the world.

Sales volumes of iron ore fines¹ and pellets reached 312.5 Mt in 2019, in line with the annual guidance of 307-312 Mt. Vale’s iron ore fines production² totalled 302.0 Mt, 21.5% lower than in 2018, while pellets production was 41.8 Mt in 2019, 24.4% lower than in 2018. The operational disruption which followed the Dam I rupture, with interdictions at the Vargem Grande, Fábrica, Brucutu, Timbopeba and Alegria operations, together with the stronger than usual weather-related seasonality in 1H19, caused major impacts in production, partly offset by (i) the S11D ramp-up, (ii) inventory drawdowns, and (iii) the gradual resumption of the Vargem Grande³, Brucutu and Alegria operations.

On a quarterly basis, Vale’s iron ore fines¹ and pellets sales amounted to 88.9 Mt in 4Q19, 4.4% higher than the previous quarter and higher than production as a result of inventory drawdown. The share of premium products totalled 87% in 4Q19. Iron ore fines and pellets quality premiums reached US\$ 6.4/t⁴ in 4Q19 vs. US\$ 5.9/t in 3Q19, mainly as an outcome of the higher pellet adjustment contribution due to seasonal dividends received⁵.

Vale reinforces its commitment to resume and stabilize production under the highest safety conditions. In 2020, production from the Alegria mine, restored in November 2019, will contribute with approximately 8 Mt, as formerly disclosed⁶, adding approximately 5 Mt production in relation to 2019. The logistics at the Vargem Grande Complex have been freed up, following the resumption of operations at the TFA⁷ Rail Terminal in January, which will enable rail shipments of approximately 7 Mt of stranded product inventory.

As for the plan to resume approximately 40 Mtpy of halted capacity, enabling additional 15 Mt and 25 Mt production in 2020 and 2021, respectively, Vale is making progress with discussions with the National Mining Agency (“ANM”), the Minas Gerais State Public Prosecutor’s Office (“MPMG”) and the external audit firms to start site tests and gradually resume production.

¹ Including third party purchases and run-of-mine.

² Including third party purchases, run-of-mine and feed for pelletizing plants.

³ Partial return of dry processing operations at the Vargem Grande Complex, as disclosed on July, 27th, 2019.

⁴ Iron ore premium of US\$ 3.8/t and weighted average contribution of pellets of US\$2.6/t.

⁵ Dividends from leased pelletizing plants, which are usually paid every 6 months (in 2Q and 4Q).

⁶ Following the approval by the National Mining Agency (“ANM”).

⁷ Terminal Ferroviário de Andaime.

Further details on the resumption plan for the Timbopeba, Vargem Grande and Fábrica complexes are provided in the “Iron Ore” section.

S11D is expected to contribute to the total 2020 production volume with 90 Mt of high-quality, low-cost iron ore. Regarding Northern and Eastern ranges, Vale expects to produce around 120 Mt in 2020, mainly due to impacts associated with the ramp up of Morro 1 mining section.

Aiming to promote the safe resumption of the Laranjeiras dam, Vale will extend the suspension of tailings disposal at least to the end of March 2020, when we expect to have the findings of the geotechnical assessment of the conditions of the structure. The findings will determine the corrective actions, if any, to resume tailings disposal at Laranjeiras dam. As a result, the Brucutu plant will continue to operate with approximately 40% of its capacity, through wet processing with tailings filtration. Short-term alternatives for tailings disposal, such as optimizing the usage of Sul dam, are being evaluated by geotechnical and operational teams and could increase the Brucutu plant capacity to 80%.

Concerning the heavy rains in the Brazilian state of Minas Gerais in January and February, Vale expresses its solidarity with the victims and communities impacted and informs that due to temporary production and transportation disruptions in the Southern and the Southeastern Systems, production loss was approximately 1 Mt.

Despite the combined impacts on production, Vale’s iron ore fines production guidance in 2020 is kept at 340-355 Mt. Production volumes will depend mostly on the granting of external authorizations to resume halted production, while the achievement of the higher end of production range continues to be possible depending on several upsides being explored.

Due to the lower availability of pellet feed and to the abovementioned suspension of tailings disposal at Laranjeiras dam, the annual guidance for pellets production was revised to 44 Mt, while the iron ore fines production guidance for 1Q20 was revised to 63-68 Mt.

The abovementioned estimates do not factor in any second-order effects of the Coronavirus epidemic, which at the time of writing seems to be accommodated through price changes only.

Vale reinforces its strategy of margin over volume, prioritizing blended products in its portfolio, therefore inventories will be replenished in 2020 to ensure supply as appropriate, which may imply lower sales in comparison to production volumes.

Production of finished nickel reached 208 kt in 2019, in line with the annual guidance of 210–220 kt, and 15.0% lower than 2018. Production reflected lower feed from third parties, lower source ore from Thompson and VNC, the latter due to limited availability of process plant operational assets during the year, as well as lower production from Onça Puma prior to receiving judicial authorisation to resume both mine and processing activities in September.

Nickel operations were also impacted during the year due to maintenance shutdowns at the North Atlantic refineries, which have been resumed and are now operating at regular rates.

The refining activities in VNC, responsible for processing the feed into nickel oxide, will cease from April 2020 onwards, as part of the process to improve short-term cash flow. With this flowsheet simplification, VNC's nickel product mix will be solely comprised of nickel hydroxide cake.

Production of finished copper reached 381.1 kt in 2019, in line with the annual guidance of 382–386 kt, and slightly lower than in 2018, due to lower production from Sossego, which was partially offset by the all-time record production from Sudbury. In 4Q19, Sossego production was impacted by unscheduled maintenance, which has now been completed. That site will operate at regular rates from 1Q20 onwards.

Production summary

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
Iron ore ¹	78,344	86,704	100,988	301,972	384,638	-9.6%	-22.4%	-21.5%
Pellets	9,415	11,133	15,812	41,794	55,304	-15.4%	-40.5%	-24.4%
Manganese Ore	450	443	495	1,576	1,832	1.7%	-9.2%	-13.9%
Coal	1,876	2,310	3,107	8,770	11,605	-18.8%	-39.6%	-24.4%
Nickel	56.7	51.4	64.0	208.0	244.6	10.3%	-11.4%	-15.0%
Copper	90.3	98.7	109.8	381.1	395.5	-8.5%	-17.8%	-3.6%
Cobalt (metric tons)	1,140	1,009	1,437	4,376	5,093	13.0%	-20.7%	-14.1%
Gold (000' oz troy)	132	122	133	480	477	8.2%	-0.8%	0.6%

¹ Including third party purchases, run-of-mine and feed for pelletizing plants.

Sales summary

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
Iron ore ¹	77,907	74,039	80,495	269,306	308,981	5.2%	-3.2%	-12.8%
Pellets	10,966	11,077	15,987	43,199	56,592	-1.0%	-31.4%	-23.7%
Manganese Ore	570	150	442	1,063	1,572	280.0%	28.9%	-32.4%
Coal	2,042	2,254	3,433	8,783	11,633	-9.4%	-40.5%	-24.5%
Nickel	47.0	50.9	59.6	205.7	236.4	-7.7%	-21.1%	-13.0%
Copper	87.8	92.0	104.1	365.2	378.9	-4.6%	-15.7%	-3.6%

¹ Including third party purchases and run-of-mine.

Iron ore

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
Northern System	50,729	55,401	52,911	188,721	193,641	-8.4%	-4.1%	-2.5%
Northern and Eastern ranges	31,438	35,047	37,023	115,352	135,615	-10.3%	-15.1%	-14.9%
S11D	19,291	20,354	15,888	73,369	58,026	-5.2%	21.4%	26.4%
Southeastern System	17,019	20,695	26,532	73,148	104,390	-17.8%	-35.9%	-29.9%
Itabira (Cauê, Conceição and others)	8,067	9,836	11,254	35,969	41,719	-18.0%	-28.3%	-13.8%
Minas Centrais (Brucutu and others)	6,600	8,849	9,184	25,883	36,016	-25.4%	-28.1%	-28.1%
Mariana (Alegria, Timbopeba and others)	2,352	2,010	6,094	11,296	26,655	17.0%	-61.4%	-57.6%
Southern System	9,980	9,806	20,985	37,733	84,137	1.8%	-52.4%	-55.2%
Paraopeba (Mutuca, Fábrica and others)	4,997	7,109	10,352	24,637	40,979	-29.7%	-51.7%	-39.9%
Vargem Grande (Vargem Grande, Pico and others)	4,983	2,697	10,633	13,096	43,158	84.8%	-53.1%	-69.7%
Midwestern System	616	802	559	2,370	2,470	-23.2%	10.2%	-4.0%
Corumbá	616	802	559	2,370	2,470	-23.2%	10.2%	-4.0%
IRON ORE PRODUCTION¹	78,344	86,704	100,988	301,972	384,638	-9.6%	-22.4%	-21.5%
IRON ORE SALES²	77,907	74,039	80,495	269,306	308,981	5.2%	-3.2%	-12.8%
IRON ORE AND PELLETS SALES	88,873	85,116	96,481	312,505	365,573	4.4%	-7.9%	-14.5%

¹ Including third party purchases, run-of-mine and feed for pelletizing plants.

² Including third party purchases and run-of-mine.

Production and sales overview

Sales volumes of iron ore fines and pellets reached 312.5 Mt in 2019, in line with the guidance of 307-312 Mt. Impacts on sales related to the Dam I rupture, with interdictions of the Vargem Grande, Fábrica, Brucutu, Timbopeba and Alegria operations, were partly offset in the year by inventory drawdowns of approximately 14 Mt⁸, among other factors, reflecting Vale's supply chain flexibility. Vale's iron ore fines production⁹ was 302.0 in 2019, 21.5% lower than 2018, mainly due to the impacts following the Dam I rupture and the stronger than usual weather-related seasonality in 1H19.

On a quarterly basis, Vale's iron ore fines⁹ production was 78.3 Mt in 4Q19, 9.6% lower than in 3Q19, mainly (i) as a result of unscheduled maintenance stoppages carried out at Northern range's crushers and beneficiation plant, and (ii) due to the suspension of tailings disposal at the Itabiruçu and Laranjeiras dams, sourced by the Conceição and Brucutu plants, respectively, while assessing the dams' geotechnical characteristics.

Regarding the resumption plan of 40 Mtpy for the Timbopeba, Fábrica and Vargem Grande complexes, discussions with the ANM, MPMG and the external audit firms are in progress:

⁸ Including feed for pelletizing plants and pellets.

⁹ Including third party purchases, run-of-mine and feed for pelletizing plants.

- Vale expects to receive the necessary authorization from the MPMG to restart the Timbopeba site in 1Q20 using dry processing, after the appraisal of the external audit by the MPMG. Wet processing activities are expected to be resumed in 4Q20 following the completion of a pipeline to dispose tailings at Timbopeba pit. Alternatives are being evaluated to anticipate the use of wet processing.
- The Fábrica operation is expected to be resumed in 2Q20. Firstly, it is necessary to run vibration trigger tests to certify the absence of impacts on the site's structures, which relies on approval by the ANM and the MPMG's external audit. Vale expects to operate using wet processing with tailings disposal at Forquilha V dam, starting in 3Q20.
- The Vargem Grande pellet plant is expected to be resumed in 3Q20. The pellet feed for pellet production will be sourced from the site's beneficiation plant, which will require tailings disposal at the Maravilhas I dam and Cianita waste dump until the start-up of the Maravilhas III dam, which is expected for 4Q20. Running trigger tests at the pellet plant relies on approval by MPMG's external audit, while the beneficiation plant restart and its economic mining plan depends on approval by the ANM.

The 2020 production plan, previously announced, already foresaw the stoppage of Itabiruçu dam for most of the year, being resumed in 4Q20 and, as a short term alternative Conceição tailings' will be disposed at Onça and Piriquito pits.

In 4Q19, Vale's product portfolio Fe content reached 64.2%, with alumina 1.3% and silica 3.5%.

Northern System

The Northern System, which is comprised of the Carajás and S11D mines, produced 50.7 Mt in 4Q19, 4.7 Mt and 2.2 Mt lower than in 3Q19 and 4Q18, respectively, mainly due to scheduled and unscheduled maintenance stoppages on crushers and beneficiation plants in the Northern range.

Southeastern System

The Southeastern System, which encompasses the Itabira, Minas Centrais and Mariana mining hubs, produced 17.0 Mt in 4Q19, 3.7 Mt and 9.5 Mt lower than in 3Q19 and 4Q18, respectively, mainly due to the suspension of tailings disposal at the Itabiruçu and Laranjeiras dams, sourced from the Conceição and Brucutu plants, respectively, while assessing the dams' geotechnical characteristics.

As announced in November, Vale was authorized by the National Mining Agency to resume the operations at the Alegria mine, which had been halted since March 2019. The authorization enabled approximately 8 Mtpy of production capacity at the Alegria mine.

Southern System

The Southern System, which encompasses the Paraopeba and Vargem Grande mining hubs, produced 10.0 Mt in 4Q19, in line with 3Q19 and 11.0 Mt lower than in 4Q18, mainly due to the stoppage of the Córrego do Feijão, Vargem Grande Complex and Fábrica operations and lower third party purchases.

On January 11th, 2020, Vale resumed operations at the TFA Rail Terminal, an important step for unlocking logistics at the Vargem Grande Complex.

Midwestern System

The Midwestern System produced 0.6 Mt in 4Q19, 0.2 Mt lower than 3Q19 and in line with 4Q18, mainly due to scheduled maintenance stoppage.

Pellets

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
Northern System	1,152	1,090	919	3,997	950	5.7%	25.4%	320.7%
São Luis	1,152	1,090	919	3,997	950	5.7%	25.4%	320.7%
Southeastern System	5,859	7,628	9,087	27,329	33,570	-23.2%	-35.5%	-18.6%
Tubarão 1 and 2	34	1,012	1,214	2,727	3,750	-96.6%	-97.2%	-27.3%
Itabrasco (Tubarão 3)	989	868	1,136	3,172	4,336	13.9%	-12.9%	-26.8%
Hispanobras (Tubarão 4)	1,018	942	1,145	3,607	4,103	8.1%	-11.1%	-12.1%
Nibrasco (Tubarão 5 and 6)	1,333	2,042	2,405	7,343	9,270	-34.7%	-44.6%	-20.8%
Kobrasco (Tubarão 7)	897	995	1,312	3,819	4,774	-9.8%	-31.6%	-20.0%
Tubarão 8	1,588	1,769	1,875	6,661	7,337	-10.2%	-15.3%	-9.2%
Southern System	-	-	2,564	1,069	10,617	-100.0%	-100.0%	-89.9%
Fábrica	-	-	991	515	4,062	-100.0%	-100.0%	-87.3%
Vargem Grande	-	-	1,573	554	6,555	-100.0%	-100.0%	-91.5%
Oman	2,404	2,415	2,612	9,245	9,537	-0.5%	-8.0%	-3.1%
Others¹	-	-	630	154	630	-100.0%	-100.0%	-75.6%
PELLETS PRODUCTION	9,415	11,133	15,812	41,794	55,304	-15.4%	-40.5%	-24.4%
PELLETS SALES	10,966	11,077	15,987	43,199	56,592	-1.0%	-31.4%	-23.7%

¹ Third party capacity utilization.

Production overview

Vale's pellet production was 41.8 Mt, 24.4% lower than in 2018, mainly due to (i) the stoppage of the Fábrica and Vargem Grande pellet plants, following the Dam I rupture, and (ii) the decision to halt operations at Tubarão 1 & 2 pelletizing plants, as a means of adapting Vale's portfolio to optimize margins and meet market conditions.

On a quarterly basis, Vale's pellet production was 9.4 Mt in 4Q19, 15.4% and 40.5% lower than in 3Q19 and 4Q18, respectively.

Due to the suspension of tailings disposal at the Laranjeiras dam and the consequent impact on the Brucutu plant operation, an important pellet feed source, Vale reviewed its pellet production guidance from 49 Mt to 44 Mt in 2020.

Northern System

Production at the São Luís pellet plant was 1.2 Mt in 4Q19, in line with 3Q19 and 0.2 Mt higher than in 4Q18, as a result of the plant's ramp-up.

Southeastern System

Production at the Tubarão pellet plants was 5.9 Mt in 4Q19, 1.8 Mt lower than in 3Q19 and 3.2 Mt lower than in 4Q18, mainly due to the voluntary stoppage of Tubarão 1 & 2 plants and scheduled maintenance carried out at the Tubarão 6 plant in October and November. The Tubarão 6 plant will be halted during most of 1Q20 to perform unscheduled maintenance activities. The resumption of operations is expected in March 2020.

Southern System

Fábrica and Vargem Grande pellet plants operations were halted on February 20th, 2019, following a decision from the ANM¹⁰.

Oman operations

The Oman pellet plant production was 2.4 Mt in 4Q19, in line with 3Q19 and 4Q18.

¹⁰ Brazil's National Mining Agency.

Manganese ore and ferroalloys

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
MANGANESE ORE PRODUCTION	450	443	495	1,576	1,832	1.7%	-9.2%	-13.9%
Azul	251	267	289	1,003	1,028	-6.0%	-13.1%	-2.4%
Urucum	164	132	167	411	670	24.6%	-1.5%	-38.6%
Morro da Mina	35	44	40	162	133	-20.1%	-12.3%	21.2%
MANGANESE ORE SALES	570	150	442	1,063	1,572	280.0%	28.9%	-32.4%
FERROALLOYS PRODUCTION	28	40	43	151	168	-31.1%	-35.7%	-10.1%
FERROALLOYS SALES	35	29	36	127	141	22.8%	-3.0%	-9.9%

Production and sales overview

Manganese ore production totalled 450 kt in 4Q19 and 1,576 kt in 2019, 1.7% higher and 13.9% lower than in 3Q19 and 2018, respectively. Manganese ore sales volumes reached 570 kt and 1,063 kt in 4Q19 and 2019, 280.0% higher and 32.4% lower than in 3Q19 and 2018, respectively.

The year-on-year decreases in production and sales represent the combined impacts of (i) operational improvements and maintenance conducted at the Urucum mine in 2Q19, followed by gradual resumption to regular levels of production, and (ii) unusual weather-related conditions in the first half of 2019, which affected more seriously operations at the Ponta da Madeira port. Operations were ramped-up in the second half of 2019, with 4Q19 sales exceeding 28.9% over 4Q18. For 2020, regular production levels are expected.

Ferroalloys production totalled 28 kt in 4Q19 and 151 kt in 2019, 31.1% and 10.1% lower than 3Q19 and 2018, respectively. Ferroalloys sales volumes totalled 35 kt in 4Q19 and 127 kt in 2019, 22.8% higher and 9.9% lower than in 3Q19 and 2018, respectively. Decreases are mainly related to a temporary lower domestic demand following a prolonged shutdown and maintenance period.

Nickel

Finished production by source

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
Canada	26.1	24.8	27.1	97.4	103.9	5.2%	-3.7%	-6.3%
Sudbury	15.3	13.3	14.1	50.8	50.6	15.0%	8.5%	0.4%
Thompson	2.8	2.7	1.9	11.3	14.8	3.7%	47.4%	-23.6%
Voisey's Bay	8.0	8.7	11.1	35.4	38.6	-8.0%	-27.9%	-8.3%
Indonesia	20.7	18.5	19.9	68.1	72.1	11.9%	4.0%	-5.5%
New Caledonia ¹	4.8	6.4	8.3	23.4	32.5	-25.0%	-42.2%	-28.0%
Brazil	3.3	0.1	5.5	11.6	22.9	-	-40.0%	-49.3%
Feed from third parties ²	1.8	1.5	3.2	7.3	13.1	20.0%	-43.8%	-44.3%
NICKEL PRODUCTION	56.7	51.4	64.0	208.0	244.6	10.3%	-11.4%	-15.0%
NICKEL SALES	47.0	50.9	59.6	205.7	236.4	-7.7%	-21.1%	-13.0%

¹ Production at VNC reached 6.900 kt in 4Q19, while production of finished nickel from VNC totalled 4.800 kt in 4Q19, the differences stemming from the time required for processing into finished nickel.

² External feed purchased from third parties and processed into finished nickel in Vale's Canadian operations.

Production and sales overview

Production of finished nickel reached 208 kt in 2019, 15.0% lower than 2018, mainly due to lower feed from third parties, lower source ore from Thompson and VNC, the latter due to limited availability of process plant operational assets during the year, as well as lower production from Onça Puma, which obtained authorization to resume mining and processing activities in September 2019. Nickel operations were also impacted during the year due to maintenance shutdowns at the refineries. These operations have been resumed and are now operating at regular rates.

Production of finished nickel reached 56.7 kt in 4Q19, 10.3% higher than 3Q19 and 11.4% lower than 4Q18. The increase over 3Q19 was mainly due to the resumption of regular production at Onça Puma and the ramp-up in production at the Copper Cliff and Clydach refineries after maintenance activities.

Nickel sales volumes were 47.0 kt in 4Q19, 7.7% lower than 3Q19, as a result of management's decision to retain inventory for better market conditions. Overall, 2019 sales volumes were 205.7 kt, 13.0% lower than in 2018, reflecting lower production levels.

The refining activities in VNC responsible for processing the feed into nickel oxide will cease from April 2020 onwards, as part of the process to improve short-term cash flow. With this flowsheet simplification, VNC's nickel product mix will be solely comprised of nickel hydroxide cake.

Vale's nickel production guidance is 200-210 kt in 2020.

Canadian operations

The Copper Cliff and Clydach refineries were operating at regular rates for the full fourth quarter of 2019, positively impacting production in the period, after going through scheduled and unscheduled maintenance activities earlier in the year.

Production from Sudbury source ore reached 15.3 kt in 4Q19, 15.0% and 8.5% higher than 3Q19 and 4Q18, respectively, reflecting the full return to operation at the Copper Cliff and Clydach refineries in 4Q19. Production increased vs. 4Q18 mainly due to strong performance at Sudbury.

Production from Thompson source ore reached 2.8 kt in 4Q19, 3.7% and 47.4% higher than 3Q19 and 4Q18, respectively. Production increases were mainly due to timing of inventory drawdown through the supply chain as Thompson fully transitioned to a mine-mill operation in 2018, and the return to full production at both Copper Cliff and Clydach refineries in 4Q19.

Production from Voisey's Bay source ore reached 8.0 kt in 4Q19, 8.0% and 27.9% lower than 3Q19 and 4Q18, respectively. Production was lower than in previous periods mainly as result of planned maintenance activities at the Long Harbour refinery in October.

Indonesian operation (PTVI)

Production of finished nickel from PTVI reached 20.7 kt in 4Q19, 11.9% and 4.0% higher than 3Q19 and 4Q18, respectively. Production was higher than in 3Q19 as the Clydach refinery returned to full operation after the previously scheduled and unscheduled maintenance activities in the prior quarters, leading to a higher consumption of PTVI source material.

Nickel in matte production at the PTVI site reached 20.5 kt in 4Q19, in line with both 3Q19 and 4Q18.

New Caledonia operation (VNC)

Production of finished nickel from VNC reached 4.8 kt in 4Q19, 25.0% and 42.2% lower than 3Q19 and 4Q18, respectively. Production was lower than in previous periods due to limited availability of process plant operational assets in 4Q19. The refining activities in VNC responsible for processing the feed into nickel oxide will cease from April 2020 onwards, as part of the process to improve short-term cash flow. With this flowsheet simplification, VNC's nickel product mix will be solely comprised of nickel hydroxide cake.

Production of nickel oxide and nickel hydroxide cake at the VNC site reached 6.9 kt in 4Q19, 9.5% higher than 3Q19 and 21.5% lower than 4Q18. Nickel oxide represented 79% and nickel hydroxide cake 21% of VNC's 4Q19 site production.

Brazilian operation (Onça Puma)

Production at Onça Puma reached 3.3 kt in 4Q19, reflecting an increase of 3.2 kt compared 3Q19 and 40.0% lower than 4Q18. Mining activities in Onça Puma had been suspended since 2017. Production was higher than in 3Q19, due to a favourable decision by the courts that allowed both mining and processing activities to be resumed in September 2019. Processing activities immediately restarted their ramp-up whereas the positive impact of better feed grades is expected to be felt with the increase of mining activities throughout the year.

Copper

Finished production by source

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
BRAZIL	58.8	69.0	77.3	254.9	284.8	-14.8%	-23.9%	-10.5%
Salobo	51.9	50.9	52.2	189.4	192.6	2.0%	-0.6%	-1.7%
Sossego	6.9	18.1	25.1	65.5	92.2	-61.9%	-72.5%	-29.0%
CANADA	31.6	29.6	32.5	126.2	110.6	6.8%	-2.8%	14.1%
Sudbury	23.3	21.8 ¹	21.8	92.8	72.3	6.9%	6.9%	28.4%
Thompson	0.2	0.3	0.3	0.9	1.3	-33.3%	-33.3%	-30.8%
Voisey's Bay	6.3	5.9	7.8	25.0	25.7	6.8%	-19.2%	-2.7%
Feed from third parties	1.9	1.6	2.6	7.5	11.3	18.8%	-26.9%	-33.6%
COPPER PRODUCTION	90.3	98.7	109.8	381.1	395.5	-8.5%	-17.8%	-3.6%
COPPER SALES	87.8	92.0	104.1	365.2	378.9	-4.6%	-15.7%	-3.6%
Copper Sales Brazil	55.0	67.9	74.5	243.7	273.6	-19.0%	-26.2%	-10.9%
Copper Sales Canada	32.8	24.1	29.7	121.6	105.4	36.1%	10.4%	15.4%

¹ Copper production in Sudbury was reconciled to 21.8 kt from 21.5 kt in 3Q19.

Production and sales overview

Production of finished copper reached 381.1 kt in 2019, 3.6 % lower than 2018, mainly due to lower production from Sossego, which was partly offset by the all-time record production of copper concentrate from Sudbury.

Copper production reached 90.3 kt in 4Q19, 8.5% lower than 3Q19 and 17.8% lower than 4Q18. Production in 4Q19 was lower than in previous periods mainly due to the unscheduled maintenance shutdown at the processing plant in Sossego carried out in the quarter, which was completed in December. That site will operate at regular rates from 1Q20 onwards.

Sales volumes of copper were 87.8 kt in 4Q19, 4.6% lower than in 3Q19. This primarily reflected lower South Atlantic production volumes which were partly offset by the timing of customer deliveries and higher production in Canadian operations in the quarter. Copper sales in 2019 were 365.2 kt, 3.6% lower than in 2018, also due to lower production volumes during the year, more specifically in the South Atlantic operations.

Sales volumes are lower compared to production volumes due to payable copper vs. contained copper content: part of the copper contained in the concentrates is lost in the smelting and refining process, hence payable quantities of copper are approximately 3.5% lower than production volumes.

Brazilian operations

Production of copper in concentrate at Salobo reached 51.9 kt in 4Q19, in line with both 3Q19 and 4Q18. In 4Q19, Salobo continued its strong performance with high production rates as per the previous quarters.

Production of copper in concentrate at Sossego totalled 6.9 kt in 4Q19, 61.9% and 72.5% lower than 3Q19 and 4Q18, respectively. Production decreases were due to unscheduled maintenance at the conveyor belt and the sag mill in the quarter. The maintenance has been completed and, from 1Q20 onwards, the plant will be operating at regular rates.

Canadian operations

Production of copper from Sudbury reached 23.3 kt in 4Q19, 6.9% higher than 3Q19 and 4Q18. Production was higher than 3Q19 mainly due to scheduled maintenance at the Sudbury mines and surface plants in 3Q19. Production was partly impacted by unscheduled maintenance at the Copper Cliff mine in 4Q19, which resulted in lower production numbers in November and December, a situation that is expected to be normalized in the next quarter.

Production of copper from Voisey's Bay reached 6.3 kt in 4Q19, 6.8% higher than 3Q19 and 19.2% lower than 4Q18. Production was higher than 3Q19 as a result of maintenance activities that occurred in July. Production was lower than 4Q18 due to scheduled maintenance at the mine and mill in October 2019.

Cobalt and other by-products

Finished production by source

Metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
COBALT	1,140	1,009	1,437	4,376	5,093	13.0%	-20.7%	-14.1%
Sudbury	137	90	158	495	520	52.2%	-13.3%	-4.8%
Thompson	21	18	24	80	198	16.7%	-12.5%	-59.6%
Voisey's Bay	364	372	557	1,608	1,902	-2.2%	-34.6%	-15.5%
VNC	516	428	561	1,703	2,104	20.6%	-8.0%	-19.1%
Others	103	101	137	490	371	2.0%	-24.8%	32.1%
PLATINUM (000' oz troy)	45	25	32	148	135	80.0%	40.6%	9.6%
PALLADIUM (000' oz troy)	56	32	42	182	218	75.0%	33.3%	-16.5%
GOLD BY-PRODUCT (000' oz troy)	132	122	133	480	477	8.2%	-0.8%	0.6%

Coal

000' metric tons	4Q19	3Q19	4Q18	2019	2018	% change		
						4Q19/3Q19	4Q19/4Q18	2019/2018
COAL PRODUCTION¹	1,876	2,310	3,107	8,770	11,605	-18.8%	-39.6%	-24.4%
Metallurgical Coal	825	1,020	1,641	4,032	6,161	-19.1%	-49.7%	-34.6%
Thermal Coal	1,051	1,290	1,466	4,738	5,444	-18.5%	-28.2%	-13.0%
COAL SALES	2,042	2,254	3,433	8,783	11,633	-9.4%	-40.5%	-24.5%
Metallurgical Coal	1,017	1,082	1,790	4,427	6,240	-6.0%	-43.2%	-29.1%
Thermal Coal	1,025	1,172	1,643	4,356	5,393	-12.5%	-37.6%	-19.2%

¹ Coal production was reconciled to 2.310 Mt from 2.351 Mt in 3Q19.

Production and sales overview

Coal production totalled 1.9 Mt in 4Q19 and 8.8 Mt in 2019, reflecting the impacts of lower productivity at the processing plants throughout the year. As a response, Vale reviewed its business plan in 2019 and has been implementing two initiatives, which are expected to produce sustainable results – a new mining plan and a new operational strategy for the processing plants, both previously disclosed.

The new mining plan prioritizes better-quality ore bodies and has a lower stripping ratio, which is expected to result in an improved product mix and cost savings.

The plant will be adapted for that mining plan with a new operational flowsheet, which will be implemented during a 3-month period¹¹. The execution of improvements at the plant will impact production in the first half of the year, generating an irregular production during that period. Once the new operational flowsheet is fully implemented in the beginning of 3Q20, Vale expects to resume the ramp-up, achieving a 15 Mtpy run rate in 4Q20, with higher reliability and yield.

As a result of the ongoing implementation of these structural changes, coal production guidance is expected to range between 8 Mt and 10 Mt in 2020.

¹¹ Estimated start in May, 2020.