



Breast Cancer Awareness Month – Pink October in Itabira, MG

VALE'S PRODUCTION AND SALES IN 3Q19

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Production and sales in 3Q19

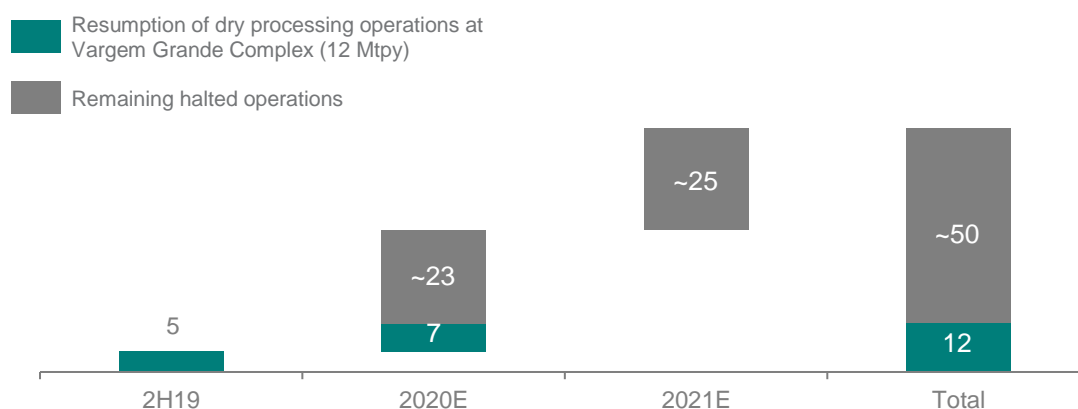
Rio de Janeiro, October 14th, 2019 – Vale S.A (“Vale”) iron ore fines production and sales had a significant increase in 3Q19, as a result of the continuous progress in the resumption of operations in the Southern and Southeastern Systems and also due to the strong operational performance and shipments normalization in the Northern System.

Iron ore fines production¹ reached 86.7 Mt in 3Q19, 35.4% higher than 2Q19. The resumption of Brucutu operations and the partial resumption of the dry processing operations at the Vargem Grande Complex, announced in June and July, respectively, contributed to this result.

Vale expects to resume the remaining production of approximately 50 Mt by 2021, as several milestones were achieved and others are ongoing, including the approval of trigger tests on the mines to resume dry processing operations and the authorization of trigger tests at the TFA Rail Terminal (*Terminal Ferroviário de Andaime*), an important step toward debottlenecking the Vargem Grande Complex logistics.

Additional iron ore production from halted operations

Mt



The Northern System showed strong operational performance with a production volume of 55.4Mt in 3Q19, 33.3% higher than 2Q19 and 2.7% higher than 3Q18, including S11D’s production record of 20.4 Mt, following its successful ramp-up. Vale expects to produce 90 Mt in S11D in 2020.

Vale’s pellet production² amounted to 11.1 Mt in 3Q19, 22.7% higher than 2Q19, mainly due to higher productivity from pellet plants after a maintenance period in 2Q19 and to the resumption of Brucutu operations, which increased the quality of pellet feed supplied to Southeastern System plants.

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

² Including third party capacity utilization.

Aligned with the margin over volume strategy and to meet prevailing market conditions, on September 26th, 2019, Vale revised its 2019 pellets production guidance to 43 Mt from the 45 Mt previously announced.

Iron ore fines and pellet sales volume amounted to 85.1 Mt in 3Q19, 20.2% higher than 2Q19 as a result of the above mentioned production resumption. Vale reaffirms its 2019 iron ore and pellets sales guidance of 307-332 million tons, with sales estimated to be around the midpoint of the range.

Finished nickel production reached 51.4 kt in 3Q19, 14.2% higher than in 2Q19, as operations gradually returned to regular rates over 3Q19, after scheduled and unscheduled maintenance at the refineries at in the North Atlantic and Asia. In Brazil, the judicial authorization to resume both mining and processing operations at Onça Puma, granted in September, was another milestone achieved towards production stability. As all refineries should operate at regular rates for the full fourth quarter and with Onça Puma's resumption, a stronger production upcoming quarter is expected.

Copper production reached 98.3 kt in 3Q19, in line with 2Q19 and 4.0% higher than 3Q18. Salobo continues to show strong operational performance, with an all-time monthly production record in July, totalling 50.9 kt in the quarter, 11.4% higher than 2Q19, mainly due to higher grades and high productivity at the mine and processing plants.

Production summary

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
Iron ore ¹	86,704	64,507	104,945	223,631	283,652	35.4%	-17.4%	-21.2%
Pellets	11,133	9,071	13,878	32,378	39,497	22.7%	-19.8%	-18.0%
Manganese Ore	443	318	482	1,126	1,336	39.3%	-8.1%	-15.7%
Coal	2,351	2,370	3,194	6,935	8,497	-0.8%	-26.4%	-18.4%
Nickel	51.4	45.0	55.7	151.2	180.6	14.2%	-7.7%	-16.3%
Copper	98.3	98.3	94.5	290.4	285.7	0.0%	4.0%	1.6%
Cobalt (metric tons)	1,009	1,032	1,028	3,236	3,657	-2.2%	-1.8%	-11.5%
Gold (000' oz troy)	122	119	117	349	344	2.5%	4.3%	1.5%

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

Sales summary

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
Iron ore ¹	74,039	61,945	83,976	191,400	228,486	19.5%	-11.8%	-16.2%
Pellets	11,077	8,842	14,250	32,223	40,606	25.3%	-22.3%	-20.6%
Manganese Ore	150	92	553	494	1,130	63.0%	-72.9%	-56.3%
Coal	2,254	2,093	3,195	6,741	8,201	7.7%	-29.4%	-17.8%
Nickel	50.9	57.5	57.3	158.6	176.8	-11.5%	-11.2%	-10.3%
Copper	92.0	95.0	92.4	277.4	274.8	-3.2%	-0.4%	0.9%

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

Iron ore

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
Northern System	55,401	41,576	53,919	137,992	140,730	33.3%	2.7%	-1.9%
Northern and Eastern ranges	35,047	25,838	37,784	83,914	98,592	35.6%	-7.2%	-14.9%
S11D	20,354	15,738	16,135	54,078	42,138	29.3%	26.1%	28.3%
Southeastern System	20,695	15,856	28,016	56,129	77,858	30.5%	-26.1%	-27.9%
Itabira (Cauê, Conceição and others)	9,836	8,774	10,929	27,902	30,465	12.1%	-10.0%	-8.4%
Minas Centrais (Brucutu and others)	8,849	5,243	9,705	19,283	26,832	68.8%	-8.8%	-28.1%
Mariana (Alegria, Timbopeba and others)	2,010	1,839	7,382	8,944	20,561	9.3%	-72.8%	-56.5%
Southern System³	9,806	6,173	22,378	27,753	63,152	58.8%	-56.2%	-56.1%
Paraopeba (Mutuca, Fábrica and others)	7,109	5,736	10,861	19,640	30,627	23.9%	-34.5%	-35.9%
Vargem Grande (Vargem Grande, Pico and others)	2,697	0,436	11,517	8,113	32,525	518.0%	-76.6%	75.1%
Midwestern System	802	451	632	1,754	1,911	77.8%	26.9%	-8.2%
Corumbá	802	451	632	1,754	1,911	77.8%	26.9%	-8.2%
IRON ORE PRODUCTION¹	86,704	64,057	104,945	223,628	283,652	35.4%	-17.4%	-21.2%
IRON ORE SALES²	74,039	61,945	83,976	191,400	228,486	19.5%	-11.8%	-16.2%
IRON ORE AND PELLETS SALES	85,116	70,787	98,226	223,633	269,092	20.2%	-13.3%	-16.9%

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

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

³ Minas Itabirito complex was redistributed in the Southern System, in order to reflect Ferrous organizational structure. More details can be found in Vale's website: [click here](#)

Production and sales overview

Iron ore fines production³ reached 86.7 Mt in 3Q19, 35.4% higher than in 2Q19 and 17.4% lower than in 3Q18, mainly as a result of the resumption of Brucutu operations in June and the improvement in operational performance in the Northern System, which was impacted by unusual weather-related conditions in 2Q19.

As previously announced, the National Mining Agency (Agência Nacional de Mineração – ANM) authorized the partial resumption of the dry processing operations at the Vargem Grande Complex. The above-mentioned decision will enable 5 Mt of additional production in 2019, equivalent to 12 Mt on an annualized basis.

For 2020, Vale expects to produce an additional ~30 Mt from the halted operations related to the Brumadinho tragedy, with 7 Mt coming from the resumption of the dry processing operations at the Vargem Grande Complex in 2019 and the remaining from Fábrica, Timbopeba dry processing operations and others. For 2021, Vale expects to add the remaining production of ~25 Mt, mainly coming from wet processing operations at Timbopeba and Vargem Grande Complex.

³ Including third party purchases, run-of-mine and feed for pelletizing plants.

Sales volumes of iron ore and pellets totaled 85.1 Mt, 20.2% higher than in 2Q19, due to the above mentioned production resumption and operational improvements at Ponta da Madeira port operations, which were impacted by abnormal rains in 2Q19.

The share of premium products⁴ totaled 86% in 3Q19. Iron ore fines and pellets quality premiums reached US\$ 5.9/t⁵ in 3Q19 vs. US\$ 11.4/t in 2Q19, due to temporary unfavourable premium market conditions, mainly as a consequence of high quality iron ore supply imbalance, high 62% benchmark price and reduced steel margins.

In 3Q19, Vale's product portfolio Fe content reached 64.7%, alumina 1.2% and silica 3.1%.

Northern System

The Northern System, which is comprised of the Carajás and S11D mines, produced 55.4 Mt in 3Q19, 13.8 Mt and 1.5 Mt higher than in 2Q19 and 3Q18, respectively, mainly due to strong operational performance, achieving a production record of 20.4 Mt in 3Q19 in S11D.

Southeastern System

The Southeastern System, which encompasses the Itabira, Minas Centrais and Mariana mining hubs, produced 20.7 Mt in 3Q19, 4.8 Mt higher than in 2Q19, mainly due to the resumption of Brucutu operations in June, and 7.3 Mt lower than in 3Q18, mainly due to stoppage at the Alegria and Timbopeba operations in 1Q19.

At the Mariana Complex, the stoppage was mainly due to Public Civil Actions, which suspended activities on Doutor and Campo Grande dams and ultimately halted operations at Timbopeba and Alegria. Since then, Vale: (i) entered into an agreement with the Public Prosecutors about steps towards resuming production; (ii) submitted a technical report to ANM to resume operations at Alegria mine; and (iii) is planning the construction of a tailings pipeline from the plant to the Timbopeba pit. The resumption of operations at both Alegria and Timbopeba mines is expected by 2020.

Southern System

The Southern System, which encompasses the Paraopeba and Vargem Grande mining hubs, produced 9.8 Mt in 3Q19, 3.6 Mt higher than in 2Q19, mainly due to a partial return of dry processing production in the Vargem Grande complex, and 12.6 Mt lower than in 3Q18, mainly due to stoppage at the Córrego do Feijão, Fábrica and Vargem Grande complex operations.

⁴ Pellets, Carajás, BRBF (Brazilian Blend Fines), pellet feed and Sinter Feed Low Alumina (SFLA).

⁵ Iron ore premium of US\$ 4.0/t and weighted average contribution of pellets of US\$ 1.9/t.

At the Vargem Grande Complex, the stoppage was mainly due to an interdiction by ANM⁶ and Public Civil Actions, which stopped activities at the following dams: Maravilhas II, Dique III, Vargem Grande, Capitão do Mato and Dique B. Since then, Vale: (i) increased the safety factor of Vargem Grande dam, lowering the emergency level from 2 to 1; and (ii) initiated period of tests on the mine activities. Following that, part of the dry processing operations was resumed⁷. As well, on October 2nd, ANM approved testing at the TFA Rail Terminal, an important step towards debottlenecking the Vargem Grande Complex logistics. The TFA and Vargem Grande pelletizing plant are expected to have operations resumed within 6 months. The resumption of the remaining 20Mt is expected within 2 years.

At the Paraopeba Complex, the stoppage at Fábrica was mainly due to the interdiction by ANM of Forquilha I and III dams⁸ and Forquilha II and Grupo dams⁹, as well as Public Civil Actions which stopped any operation that could increase the dams' risk. Since then, Vale: (i) entered into an agreement with the Public Prosecutors about steps towards resuming production; (ii) requested trigger tests to ANM to resume operations; and (iii) initiated the construction of a containment structure to protect the Self-Saving Zone¹⁰, with completion by 1H20. The resumption of operations at Fábrica is expected by 2020.

Midwestern System

The Midwestern System produced 0.8 Mt in 3Q19, 0.4 Mt and 0.2 Mt higher than 2Q19 and 3Q18, respectively, mainly due to increase of ROM consumption.

⁶ The Brazilian National Mining Agency.

⁷ As announced by Vale on July 23rd, 2019, "Vale on the partial return of dry processing operations at the Vargem Grande complex".

⁸ In level 3 emergency alert.

⁹ In level 2 emergency alert.

¹⁰ Also known as the Self-Rescue Zone, equivalent to the region up to 10km or 30 minutes from the potential dam breach point.

Pellets

000' metric tons							% change	
	3Q19	2Q19	3Q18	9M19	9M18	3Q19/2Q19	3Q19/3Q18	9M19/9M18
Northern System	1,090	535	32	2,846	32	103.7%	3,306.3%	8,793.8%
São Luis	1,090	535	32	2,846	32	103.7%	3,306.3%	8,793.8%
Southeastern System	7,628	6,080	8,701	21,468	24,485	25.5%	-12.3%	-12.3%
Tubarão 1 and 2	1,012	514	1,112	2,692	2,537	96.9%	-9.0%	6.1%
Itabrasco (Tubarão 3)	868	740	1,093	2,183	3,201	17.3%	-20.6%	-31.8%
Hispanobras (Tubarão 4)	942	693	1,122	2,590	2,959	35.9%	-16.0%	-12.5%
Nibrasco (Tubarão 5 and 6)	2,042	1,781	2,264	6,009	6,865	14.7%	-9.8%	-12.5%
Kobrasco (Tubarão 7)	995	841	1,232	2,922	3,462	18.3%	-19.2%	-15.6%
Tubarão 8	1,769	1,511	1,878	5,072	5,462	17.1%	-5.8%	-7.1%
Southern System	-	-	2,543	1,069	8,052	n.m.	n.m.	-86.7%
Fábrica	-	-	1,057	515	3,071	n.m.	n.m.	-83.2%
Vargem Grande	-	-	1,485	554	4,981	n.m.	n.m.	-88.9%
Oman	2,415	2,456	2,603	6,841	6,927	-1.7%	-7.2%	-1.2%
Others¹	-	-	-	154	-	n.m.	n.m.	n.m.
PELLETS PRODUCTION	11,133	9,071	13,878	32,378	39,497	22.7%	-19.8%	-18.0%
PELLETS SALES	11,077	8,842	14,250	32,233	40,606	25.3%	-22.3%	-20.6%

¹ Third party capacity utilization.

Production overview

Vale's pellets production¹¹ was 11.1 Mt in 3Q19, 22.7% higher than in 2Q19, mainly due to better operational performance, which was impacted in 2Q19 by the maintenance carried out at the Tubarão plants, and 19.8% lower than in 3Q18, mainly due to stoppage at the Fábrica and Vargem Grande operations.

On September 26th, 2019, Vale revised its pellets production guidance to 43 Mt from the 45 Mt previously announced in "Vale's Production and Sales in 2Q19" report to adapt its product portfolio to temporary market conditions.

Northern system

Production at the São Luís pellet plant was 1.1 Mt in 3Q19, 0.6 Mt higher than in 2Q19, mainly due to restored pellet feed moisture, which was impacted in 2Q19 as a result of abnormal rains in the Northern System.

Southeastern system

Production at the Tubarão pellet plants – Tubarão 1, 2, 3, 4, 5, 6, 7 and 8 – was 7.6 Mt in 3Q19, 1.5 Mt higher than in 2Q19 and 1.1 Mt lower than in 3Q18, mainly due to greater productivity at the plants, which was partially offset by scheduled maintenance carried out at plants 5 and 6 and maintenance stoppage at plants 3 and 4.

¹¹ Including third party capacity utilization.

Southern system

Fábrica and Vargem Grande pellet plants operations were halted on February 20th, 2019, following an ANM (Brazil's Mining National Agency) decision.

Oman operations

The Oman pellet plant production was 2.4 Mt in 3Q19, in line with 2Q19 and 3Q18.

Manganese ore and ferroalloys

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	3Q19/2Q19	% change	
							3Q19/3Q18	9M19/9M18
MANGANESE ORE PRODUCTION	443	318	482	1,126	1,336	39.3%	-8.1%	-15.7%
Azul	267	242	272	752	739	10.3%	-1.8%	1.8%
Urucum	132	32	175	247	504	312.5%	-24.6%	-51.0%
Morro da Mina	44	44	34	127	93	-	29.4%	36.6%
MANGANESE ORE SALES	150	92	553	494	1,130	63.0%	-72.9%	-56.3%
FERROALLOYS PRODUCTION	40	42	43	123	126	-4.8%	-7.0%	-2.4%
FERROALLOYS SALES	29	39	37	93	105	-25.6%	-21.6%	-11.4%

Production and sales overview

Manganese ore production totaled 443 kt in 3Q19, 39.3% higher than in 2Q19. The increase represents the gradual resumption to regular levels of production following operational improvements and maintenance conducted at the Urucum mine in 2Q19.

Manganese ore sales volumes reached 150 kt in 3Q19, 63.0% higher than in 2Q19, basically recovering from the unusual weather-related conditions faced last quarter by operations at Ponta da Madeira port.

Ferroalloy production totaled 40 kt in 3Q19, in line with 2Q19. Ferroalloys sales volumes totaled 29 kt in 2Q19, 25.6% lower than in 2Q19 mainly due to a temporary decrease in domestic client demand following a prolonged shutdown and maintenance period.

Nickel

Finished production by source

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
Canada	24.8	20.7	19.5	71.3	77.0	19.8%	27.2%	-7.4%
Sudbury	13.3	9.6	9.2	35.5	36.5	38.5%	44.6%	-2.7%
Thompson	2.7	2.6	1.9	8.4	12.9	3.8%	42.1%	-34.9%
Voisey's Bay	8.7	8.5	8.4	27.4	27.5	2.4%	3.6%	-0.4%
Indonesia	18.5	13.2	20.6	47.4	52.2	40.2%	-10.2%	-9.2%
New Caledonia ¹	6.4	5.9	7.5	18.6	24.2	8.5%	-14.7%	-23.1%
Brazil	0.1	3.9	6.1	8.3	17.4	-97.4%	-98.4%	-52.3%
Feed from third parties ²	1.5	1.3	2.1	5.5	9.9	15.4%	-28.6%	-44.4%
NICKEL PRODUCTION	51.4	45.0	55.7	151.2	180.6	14.2%	-7.7%	-16.3%
NICKEL SALES	50.9	57.5	57.3	158.6	176.8	-11.5%	-11.2%	-10.3%

¹ Production at VNC reached 6,300 kt in 3Q19, while production of finished nickel from VNC totalled 6,400 kt in 3Q19, 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 our Canadian operations.

Production and sales overview

Production of finished nickel reached 51.4 kt in 3Q19, 14.2% higher than 2Q19 and 7.7% lower than 3Q18. The increase over 2Q19 is due to the resumption to regular production from Sudbury and PTVI source feed after the scheduled and unscheduled maintenance activities at the Copper Cliff Nickel Refinery, in Sudbury, as well as at the Clydach, Matsusaka and Long Harbour refineries.

Nickel sales volumes were 50.9 kt in 3Q19, 11.5% lower than 2Q19, as a result of the higher sales in 2Q19 from the drawdown of saleable product inventories at that time.

Canadian operations

Production resumed to regular rates in 3Q19, after being impacted by scheduled and unscheduled maintenance activities at North Atlantic refineries during 2Q19 which gradually resumed throughout the third quarter. All refineries should operate at regular rates for the full fourth quarter which will help to a stronger production upcoming quarter.

The North Atlantic operations are now operating as planned and also drawing down previously stockpiled material that had been accumulated during the period of maintenance shutdowns at the refineries – the accumulation of intermediate feed that is currently being refined reflects the lack of any impacts on the upstream mine, mill and smelting activities.

Production from Sudbury source ore reached 13.3 kt in 3Q19, 38.5% and 44.6% higher than 2Q19 and 3Q18, respectively, reflecting the return to operation, throughout 3Q19, after the unscheduled maintenance at Copper Cliff Nickel Refinery and the scheduled maintenance

activities at the Clydach refinery, in Wales, in which started in 2Q19. Copper Cliff Nickel Refinery activities were still impacted by some operational issues in September, that have now been fully restored. Production increased vs. 3Q18 as, last year, Sudbury underwent scheduled maintenance.

Production from Thompson source ore reached 2.7 kt in 3Q19, 3.8% and 42.1% higher than 2Q19 and 3Q18, respectively. Production increases were mainly due to timing of inventory utilization through the supply chain.

Production from Voisey's Bay source ore reached 8.7 kt in 3Q19, 2.4% and 3.6% higher than 2Q19 and 3Q18, respectively, mainly as a result of Long Harbour ramping up to operation after maintenance in June.

Indonesian operation (PTVI)

Production of finished nickel from PTVI reached 18.5 kt in 3Q19, 40.2% higher than 2Q19 and 10.2% lower than 3Q18. Production was higher than in 2Q19 as both Matsusaka and Clydach refineries returned to full operation after the scheduled maintenance activities in 2Q19, as well as a result of processing part of PTVI source feed through the Dalian refinery with a shorter route to market. Production decreased vs. 3Q18 as the Clydach refinery produced higher quantities of PTVI source finished nickel in that quarter.

Nickel in matte production at the PTVI site reached 19.8 kt in 3Q19, 12.5% and 5.3% higher than 2Q19 and 3Q18, respectively. Performance was strong in 3Q19, reaching the highest production for a third quarter since 2017,

New Caledonia operation (VNC)

Production of finished nickel from VNC reached 6.4 kt in 3Q19, 8.5% higher than 2Q19 and 14.7% lower than 3Q18. Production increased vs. 2Q19 due to the shorter route to market associated with the nickel hydroxide cake, whose share in the product mix was increased in 3Q19. Production decreased vs. 3Q18 as VNC source feed was being processed at higher rates at Dalian refinery in 3Q18.

Production of nickel oxide and nickel hydroxide cake at the VNC site reached 6.3 kt in 3Q19, 21.2% higher than 2Q19 and 8.7% lower than 3Q18. Nickel oxide represented 57% and nickel hydroxide cake 43% of VNC's 3Q19 site production. The share of nickel hydroxide cake increased as a result of operational issues at the roasters, which limited, in the month of September, the production of nickel oxide at the site.

Brazilian operation (Onça Puma)

Production at Onça Puma reached 0.1 kt in 3Q19, reflecting the stoppage, in June 2019, of all nickel processing activities at the site following a judicial order. Mining activities in Onça Puma had been suspended since 2017. In September, Vale received a favourable decision by the courts, with the support of reports from appointed experts, and both mining and processing activities have been allowed to be resumed. The processing activities have immediately restarted their ramp-up whereas mining activities are being prepared, with hiring and training of personnel at the mine site. Processing activities are being resumed using lower grade previously stockpiled ore, higher grade ore from the mine will increase production in the upcoming quarters, as the ramp-up of the mine activities is completed.

Copper

Finished production by source

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
BRAZIL	69.0	65.7	72.8	196.2	207.6	5.0%	-5.2%	-5.5%
Salobo	50.9	45.7	50.0	137.6	140.4	11.4%	1.8%	-2.0%
Sossego	18.1	20.0	22.8	58.6	67.2	-9.5%	-20.6%	-12.8%
CANADA	29.3	32.5	21.7	88.7	78.1	-9.8%	35.0%	13.6%
Sudbury	21.5	24.4	17.1	69.2	50.6	-11.9%	25.7%	36.8%
Thompson	0.3	0.2	0.4	0.8	1.0	50.0%	-25.0%	-20.0%
Voisey's Bay	5.9	6.4	2.5	18.7	17.8	-7.8%	136.0%	5.1%
Feed from third parties	1.6	1.6	1.7	5.6	8.7	0.0%	-5.9%	-35.6%
COPPER PRODUCTION	98.3	98.3	94.5	290.4	285.7	0.0%	4.0%	1.6%
COPPER SALES	92.0	95.0	92.4	277.4	274.8	-3.2%	-0.4%	0.9%
Copper Sales Brazil	67.9	62.5	71.4	188.7	199.1	8.6%	-4.9%	-5.2%
Copper Sales Canada	24.1	32.5	21.0	88.8	75.7	-25.8%	14.8%	17.3%

Production and sales overview

Copper production reached 98.3 kt in 3Q19, in line with 2Q19 and 4.0% higher than 3Q18. Strong operational performance at Salobo more than offset lower production from Sudbury and Sossego.

Sales volumes of copper reached 92 kt in 3Q19, 3.2% lower than in 2Q19, reflecting the build-up of inventories as well as timing of customer deliveries. 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 50.9 kt in 3Q19, 11.4% and 1.8% higher than 2Q19 and 3Q18, respectively. In July, Salobo achieved all-time monthly production records for copper and gold, with impacts to be seen on unit costs after by-products as a result of high grades and strong plant performance.

Production of copper in concentrate at Sossego totaled 18.1 kt in 3Q19, 9.5% and 20.6% lower than 2Q19 and 3Q18, respectively. Production decreases were due to unscheduled maintenance at the processing plant in the quarter. The maintenance was completed and, from 4Q19 onwards, we expect the plant to run at regular rates.

Canadian operations

Production of copper from Sudbury reached 21.5 kt t in 3Q19, 11.9% lower than 2Q19 and 25.7% higher than 3Q18. Production was lower than 2Q19 mainly due to scheduled maintenance at the Sudbury mines and mill, an effect that was not felt in nickel due to the longer supply chain and higher in-process intermediate inventories in the nickel production chain. Production was higher than 3Q18 as, in 2018, the smelter and refineries were under maintenance in that quarter.

Production of copper from Voisey's Bay reached 5.9 kt in 3Q19, 7.8% lower than 2Q19 and 136% higher than 3Q18. Production was lower than 2Q19 due to lower mill productivity and higher than 3Q18 as, in that quarter, copper production was impacted by the strategic decision to reduce Voisey's Bay production as a means to match the life of mine of the current Ovoid mine to the VBME¹² development schedule.

¹² Voisey's Bay underground mine extension project.

Cobalt by-product

Finished production by source

	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
COBALT (metric tons)	1,009	1,032	1,028	3,236	3,657	-2.2%	-1.8%	-11.5%
Sudbury	90	139	83	358	362	-35.3%	8.4%	-1.1%
Thompson	18	20	37	59	174	-10.0%	-51.4%	-66.1%
Voisey's Bay	372	405	371	1,244	1,345	-8.1%	0.3%	-7.5%
VNC	428	347	460	1,187	1,543	23.3%	-7.0%	-23.1%
Others	101	120	77	318	234	-15.8%	31.2%	35.9%

Production overview

Cobalt production reached 1,009 t in 3Q19, in line with 2Q19 and 3Q18. The increase in cobalt production from VNC offset the decreases from other operations.

Cobalt production from Sudbury was 90 t in 3Q19, 35.3% lower than 2Q19 and 8.4% higher than 3Q18. Production was lower than 2Q19 as a result of the impact of the refineries' maintenance shutdown in 2Q19 flowing into the cobalt flowsheet in 3Q19.

Production from Thompson source was 18 t in 3Q19, 10.0% and 51.4% lower than in 2Q19 and 3Q18, respectively. The production decrease relative to 2Q19 was in line with the equivalent decrease of Thompson sourced nickel in the quarter, whereas the decrease relative to 3Q18 was due to the changes in the cobalt flowsheet with Thompson's transition to a mine-mill operation and subsequent smelting and refining in Sudbury, which led to a weaker cobalt recovery.

Production from Voisey's Bay was 372 t in 3Q19, 8.1% lower than 2Q19 and in line with 3Q18. Production was lower than in the previous quarter due to normal fluctuations of in-process inventories which had impact on cobalt.

Production from New Caledonia reached 428 t in 3Q19, 23.3% higher than 2Q19 and 7.0% lower than 3Q18. Cobalt output increased vs. 2Q19 in line with the higher nickel production in the quarter.

Production from other sources was 101 t in 3Q19, 15.8% lower than 2Q19 as an effect of the longer route to the market of the cobalt flowsheet – even with the nickel refineries returning to full operation after their maintenance in 2Q19, cobalt still has a longer time to market as it needs to be processed at Port Colborne. Other source production varies according to the cobalt content of external feeds that are consumed in the processes and it also includes PTVI source material being processed through the Port Colborne refinery in the North Atlantic operations.

Other by-products

	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
PLATINUM (000' oz troy)	25	43	40	103	103	-41.9%	-37.5%	-0.1%
PALLADIUM (000' oz troy)	32	52	50	126	176	-38.5%	-36.0%	-28.4%
GOLD BY-PRODUCT (000' oz troy)	122	119	117	349	344	2.5%	4.3%	1.5%

Coal

000' metric tons	3Q19	2Q19	3Q18	9M19	9M18	% change		
						3Q19/2Q19	3Q19/3Q18	9M19/9M18
COAL PRODUCTION	2,351	2,370	3,194	6,935	8,497	-0.8%	-26.4%	-18.4%
Metallurgical Coal	1,043	1,136	1,560	3,229	4,519	-8.2%	-33.2%	-28.5%
Thermal Coal	1,309	1,234	1,634	3,706	3,978	6.0%	-19.9%	-6.9%
COAL SALES	2,254	2,093	3,195	6,741	8,200	7.7%	-29.4%	-17.8%
Metallurgical Coal	1,082	1,037	1,611	3,411	4,450	4.4%	-32.8%	-23.4%
Thermal Coal	1,172	1,056	1,584	3,330	3,750	11.0%	-26.0%	-11.2%

Production and sales overview

Coal production totaled 2.3 Mt in 3Q19, in line with 2Q19, still affected by lower productivity at the processing plants, caused by a decrease in equipment availability, despite high total movement in the mine front.

The challenges faced by Vale's coal operations demanded the reassessment of the business strategy, with the implementation of a new mining plan and a maintenance program for the plant recovery.

The new mining plan is expected to reach ore bodies with a lower stripping ratio¹³, better ROM grade quality and better product mix. A reduction of both mine lifetime and reserves is expected, however with strong improvement in economic value.

The maintenance program for plant recovery aims to debottleneck the processing plants by increasing equipment availability, productivity and yield. Some changes in the flowsheet will be required, and Vale is currently planning major interventions in the process plants in 1H20 in which the goal to speed up the turnaround and reach much higher production rates.

¹³ Stripping Ratio = Overburden / ROM