

# ÖkoRess III

## Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

**Vargem Grande Iron Ore Complex**

**Vale S.A., Brazil**

ID: 17

## Note

The qualitative assessment of Environmental Hazard Potentials (EHPs) in this factsheet was conducted according to the method developed in the precursor project ÖkoRess I “Discussion of the environmental limits of primary raw material extraction and development of a method for assessing the environmental availability of raw materials to further develop the criticality concept”<sup>1</sup> (Dehoust et al. 2017a). The measurement instructions applied here are described in Dehoust et al. 2017b. The method is tested and further developed within this project (ÖkoRess III).

The information in this factsheet refers exclusively to publicly available, designated sources that have been classified as serious by the authors. It is specifically pointed out that no statement is made about the implementation and quality of agreements or standards that are applied. The implementation of agreements through memberships, certifications, etc. is the responsibility of the companies.

The surface extension of each mine area has been estimated based on publically accessible satellite images as official land-use plans from the public authorities or mine operators are not consistently available. It therefore only corresponds to the apparent area where mining, processing facilities, heaps, etc. and related infrastructure are clearly identifiable.

The fact sheets make no claim to completeness of all relevant voluntary standards. Mentioning a membership in one of the listed voluntary standards does not imply an assessment of the suitability of the standard in itself, nor does it make any statement about the member's success in implementation.

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<sup>1</sup>TEXTE 87/2017 <https://www.umweltbundesamt.de/publikationen/discussion-of-the-environmental-limits-of-primary>

# Vargem Grande Iron Ore Complex

## Iron ore

General information	
Indicator or criteria	Description and values
Name of mine	Vargem Grande Iron Ore Complex
Description of mining area	Vargem Grande Iron Ore Complex is part of Vale's Southern System and consists of three mines (Abóboras, Capitão do Mato and Tamanduá ) and two major beneficiation plants, located in the southwestern border of the Iron Quadrangle of Minas Gerais. They consist mainly of banded iron formations. The ore reserves have high ratios of itabirite type ore relative to hematitic ore. The operations at the Vargem Grande plant have been suspended since February 2019, due to failures of tailing dams which support operations in Vargem Grande Complex and have been partially re-established in July (Globo G1 2019c; Vale 2019a).
Surface extension	22.31km <sup>2</sup> 22.31 km <sup>2</sup> (Image date: 10.07.2018; Viewing height: 6.57 km) (Google Earth)
In operation since	1993 1993 (Vale 2019b p. 75)
Operator	Vale S.A.
Owner	Vale S.A.
Closest town	14 km northwest of Itaberito
Province	State of Minas Gerais
Country	Brazil
Longitude	-43.872593°
Latitude	-20.175628°
Altitude	1400 m a.s.l. Between 1000 and 1400 m a.s.l. (Google Earth)



Main product and by-products	Main product: Iron ore (sinter feed, lump ore and pellet feed); no by-products
On-site processing stages	Standard crushing, classification, grinding and concentration steps (floatation, magnetic separation) to produce sinter feed, lump ore and pellet feed in 2 major beneficiation plants located at the mining complex; transport to smelters off-site. Operations stopped in February 2019, however dry processing operations were partially resumed (Vale 2019c).
Annual production	Vargem Grande Complex 2018: 21.4 Mt (Vale 2019b p. 41)
Proven Reserves	368,9 Mt with 44 % ore grade (Vale 2019c)
Probable Reserves	1170.5 Mt with 47.9 % ore grade (Vale 2019c)

## Geology

Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	The Vargem Grande complex comprises oxidic iron ore minerals such as hematite, itaberrite and lateritic ore. No sulphides are reported. Limited geochemical preconditions for acid mine drainage are given.	Iron is a siderophile element; therefore no preconditions for acid mine drainage for this ore type is given. According to the site-related Oekoress measurement instructions (Dehoust et al. 2017b), siderophile ore deposits are classified with a medium environmental hazard potential (EPH).	Medium	A = high, can be derived directly from available data
Paragenesis with heavy metals	No heavy metal paragenesis could be determined from Vargem Grande Complex. According to (Wellmer / Hagelüken 2015) heavy metals and arsenic may have limited relevance for the extraction of oxidic iron ores.	According to the measurement instructions (Dehoust et al. 2017b), heavy metals like lead, zinc, copper, chrome and arsenic may potentially be associated to oxidic iron ores. The EHP is thus classified as medium.	Medium	B1 = medium, can be estimated on the basis of available information

Paragenesis with radioactive components	No indication of paragenesis with thorium and uranium or other radioactive components were determined.	In accordance with the measurement instructions (Dehoust et al. 2017b), iron ore deposits are evaluated with a medium EHP, if no further information is available. This class division is based on average thorium and uranium activity levels in Chinese iron ore deposits (Hua 2011; USGS 2015).	Medium	B1 = medium, can be estimated on the basis of available information
Deposit size	According to annual report (Vale 2019b p. 74) in 2018, proven ore reserves amount to 368.9 Mt with 44 % of Fe and probable reserves amount to 1,170.5 Mt with 47.9 % ore grade, totalling 1,539.3 Mt with 47 % ore grade.	Considering the total reserves of about 1,539.3 Mt and adding the amount of iron ore extracted in the past (the Complex is in operation since 1993 and stopped in beginning of 2019 = 25 years- with an average of 20 Mt/year = 500 Mt; the total deposit size sums up to slightly more than 2,000. Assuming an average grade of 47 % Fe the total Fe amounts to about 940 Mt. According to the measurement instructions (Priester et al. 2019), the complex is thus classified as medium size and evaluated with a medium EPH.	Medium	B1 = medium, can be estimated on the basis of available information
Ore grade	47% (Vale 2019b p. 74)	With 47 % average ore grade of total reserves, the specific grade is considered medium grade in accordance with the measurement instructions (Dehoust et al. 2017b)	Medium	A = high, can be derived directly from available data

<b>Technology</b>				
Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Mine type	Open pit hard rock mining (Vale 2019c)	Mining is restricted to the horizontal and vertical extension of the ore body/mineralized zone; depleted pits are used for waste disposal. According to measurement instructions (Dehoust et al. 2017b) a Medium EHP can be assigned.	Medium	B1 = medium, can be estimated on the basis of available information
Use of auxiliary substances	Mining by truck and shovel-loader; drilling and blasting. 2 major beneficiation plants are in operation where processing standard procedures are carried out: crushing, classification, grinding, concentration and magnetic separation (Vale 2019c). Concentration steps such as floatation with organic compounds like ether amines as collectors and starch depressants are commonly utilised in iron ore beneficiation in Brazil according to (Lopes 2009).	This indicator is evaluated with a high EHP due to the use of potentially toxic substances.	High	B2 = medium, classified according to measurement instructions
Mining waste	Mine tailings are stored in tailing ponds some of which have upstream dam technology. Since the dam collapse of Feijao Mine in the Paraopeba Complex, these dams have been considered as unsafe and are in the process of decommissioning. In Aboboras pit, Vargem Grande dam with 35	According to ICOLD (ICOLD 2018), the Vargem Grande dam is a large dam with 35 m height and a capacity of 9.5 Mm <sup>3</sup> . Additionally, the fact that operation in the complex have been closed down due to unsafe conditions of upstream technology dams resulting in unstable	High	A = high, can be derived directly from available data



	m height and 9.5 Mm <sup>3</sup> and Dique Fernandinho with 19 m and 1.02 Mm <sup>3</sup> have upstream technology (ANM 2019; Vale 2016). To ensure safety and agility in the modification of upstream dams, production was temporarily halted in the units where the structures are located, including the pellet plants of Vargem Grande and small communities were allocated (Globo G1 2019a; Vale 2019d).	tailing ponds as long as stabilization measures have not been completed justifies that the indicator for the Complex is classified with a high EHP.		
Remediation measures	Since the Feijao Mine dam breach emergency actions, safeguarding and remediation measures target the mitigation of the disastrous effects of the liberation of mine tailings and the safety of human lives rather than environmental remediation of the existing mine sites. Vargem Grande upstream dams in Aboboras (Globo G1 2019b) are in the process of decommission (drainage, removal of waste, restoration of topography and of the soil, reforestation) in the next 3 years (Globo G1 2019c).	Recently discovered deficiencies in state and private corporative governance regarding Vale's mines in Brazil may point to potential risks also regarding the safety of Vargem Grande dams like Dique III in Aboboras pit and the possibility that compliance with the standards and remediation measures is not yet fully assured (Estado MG 2019). For this reason a high EHP is assigned.	High	B2 = medium, classified according to measurement instructions

### Framework conditions natural environment



Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Accident hazard due to floods,	The rating system for the 4 sub-indicators uses georeferenced data from publicly	For all three mines of the Complex (Aboboras, Tamandua, Capitaio do Mato	Medium	A = high, can be derived directly

earthquake, storms, landslides	available risk maps (see measurement instructions). Metrics are directly taken from the given risk assessment. The indicator total is determined by the highest hazard level of the sub-indicators.	Mines), a medium land slide hazard is assigned while the other sub-indicators do not indicate any hazards. For this reason, a medium composite EHP is assigned.		from available data
Water Stress Index (WSI) und desert areas	The WSI by (Pfister et al. 2009) provides characterization factors on the relative water availability at watershed level. Absolute water shortages in dry areas is supplemented by desert areas. The highest hazard level of the sub-indicators determines the total result.	The water stress for the three mining areas is low and they are not situated in a desert area, which results in a low EHP.	Low	A = high, can be derived directly from available data
Protected areas and AZE sites	Georeferenced data for designated protected areas are used to assess hazards posed by mining extraction. The metric to evaluate EHPs corresponds to the method first described in the draft standard of the Initiative for Responsible Mining Assurance (IRMA 2014).	All mine areas of the complex overlap with protected areas which results in a medium EHP.	Medium	A = high, can be derived directly from available data

## State Governance

Indicators	
WGI 1 -Voice and Accountability	61.58 <sup>ooo</sup>
WGI 2 -Political Stability and Absence of Violence/ Terrorism	31.43 <sup>ooo</sup>
WGI 3 - Government Effectiveness	41.83 <sup>ooo</sup>



WGI 4 -Regulatory Quality	51.44 °°°
WGI 5 - Rule of Law	43.75 °°°
WGI 6 -Control of Corruption	36.06 °°°
EPI (Environmental Performance Index)	60.7
EITI membership	No
<b>International Agreements</b>	
ILO 176	Brazil is part of ILO 176
Others	Reaffirmation of commitment with the 2030 Agenda for Sustainable Development in 2017 (Mercosur countries). Signature of the Paris Agreement on Climate Change and participation at COP 22. (MDNP 2018)
<b>Legal framework</b>	

<p>Areas of Law: Environment</p>	<p>Comprehensive legal framework on federal level with norms regarding licensing (compulsory for mining and industry), environmental impact assessment including the need for public consultations during the primary licence process and Environmental management and mine closure plan in the course the installation licence (MineHutte 2019), environmental crimes, waste management, water and groundwater protection, contaminated land exist (Leonhardt / Stump 2018). Federal states have legislation and regulation autonomy, however (with exception of some states in the industrialized southeast) limited enforcement capacity (ibid.). "Polluter pays" and joint liability are basic principles regarding recovery/mitigation of impacts. The public prosecutor being represented by the independent public ministry (Ministerio Publico) on federal and state level has controlling function also over environmental authorities (ibid.). Environmental and mining authorities still need to align licensing procedures. Sector Plans for Mitigation and Adaptation to Climate Change in Mining aims at the reduction of CO2 in the mining sector (MDNP 2018).</p>
<p>Areas of Law: Occupational Health and Safety (OHS)</p>	<p>Brazil implements the National Norm NR-22 since 1999 through its Ministry of Labour. The norm specifies the conditions for safe working and health conditions in mining, in accordance to ILO 176 criteria and is also responsible for the inspections of compliance with occupational health and safety (OHS) regulations (Cattabriga / Castro 2014). Companies inform all accidents to the INSS, an agency of the Ministry of Social Welfare (MPAS), which administers a compulsory employer-funded compensation insurance system (Elgstrand et al. 2013). The National Department for Mineral Production – DNPM published the Mining Regulatory Standard in 2001, which supports the establishment of specific sectorial and state standards of OHS in Mining (DNPM 2001) .</p>

## Corporate Social Responsibility (CSR)

Voluntary Standards	
Aluminium Stewardship Initiative (ASI): Is the mine owning company a member?	Not applicable Not applicable
Aluminium Stewardship Initiative (ASI): Is the mine certified?	Not applicable Not applicable
International Council of Mining & Metals (ICMM): Is the mine owning company a member?	Yes Yes (ICMM 2019)
Towards Sustainable Mining (TSM) Is the mine owning company a member of the Mining Association of Canada (MAC)?	Yes Yes (MAC 2019)
Towards Sustainable Mining (TSM) outside Canada: Are TSM standards implemented*?	No information available No information obtained
Initiative for Responsible Mining Assurance (IRMA): Is the mine owning company a member?	No No (IRMA 2018)
Initiative for Responsible Mining Assurance (IRMA): Is the mine certified?	No No (IRMA 2018)
Responsible Copper (RC): Is the mine owning company a member of RC?	Not applicable Not applicable
Responsible Copper (RC): Is the mine certified?	Not applicable Not applicable
Responsible Mining Index (RMI): Has the mine been rated?	Yes Yes (RMI 2018)
Responsible Mining Index Company indicator „Working conditions“	0.575 0.575 (RMI 2018)

Responsible Mining Index Company indicator „Environmental sustainability“	0.391 0.391 (RMI 2018)
Responsible Steel (RS): Is the mine owner a member of the RS?	No information obtained No information obtained
Responsible Steel (RS): Is the mine certified?	No information obtained No information obtained
Australian Steel Stewardship Forum (ASSF): Is the owner a member of the ASSF?	No No (ASSF 2018)
Australian Steel Stewardship Forum: Is the mine certified?	No No (ASSF 2018)
<b>ISO and CSR reporting</b>	
ISO 14001 (ISO 14004): Is the mine ISO 14001 certified?	Yes Yes (Vale 2019c)
CSR-directive 2014/95/EU: Does the mine owning company have its headquarters in an EU country?	No No
OECD Guidelines: Does the company have its headquarters in a signatory state?	Yes Yes
ISO 26000: Does the mine implement ISO 26000?*	No No
<b>Banking Standards</b>	
WB Standards / IFC Performance Standards: Is the mine financed to a major extend by the world bank?	No information obtained No information obtained
Equator Principles (EP): Is the mine financed to a major extend by a bank adherent to the EP?	No information obtained No information obtained

\*by companies own account.

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## A Glossary

Table 1 Legend

### Environmental hazard potential



*low*



*medium*



*high*

### Data quality



*low*



*medium*



*high*

- No concrete information, no general specifications of the measurement instructions, expert estimation.
- Assessment not possible due to lack of data at the site, as there is also no evidence for an assessment and there are no generalized assessment rules.

- Assessable on the basis of available information.
- Generalized classification according to measurement instructions.

- Can be derived directly from available data.



## B Abbreviations

EHP	Environmental hazard potential
FY	Financial year
kt	Kilo tonnes
m a.s.l.	Meters above sea level
Mt	Million tonnes
OHS	Occupational Health and Safety
t	tonnes
TSF	Tailing Storage Facility
WGI	World Governance Indicators
WHS	Work Health and Safety

## C Imprint

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