

ÖkoRess III

Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

Paraopeba Iron Ore Complex

Vale S.A., Brazil

ID: 16

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”¹ (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.

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

Paraopeba Iron Ore Complex

Iron ore

General information 	
Indicator or criteria	Description and values
Name of mine	Paraopeba Iron Ore Complex
Description of mining area	Paraopeba's integrated operations (in operation since 2001) include the Jangada and Corrego do Feijao Mines sub complex and the Mar Azul (Mutuc) and Capão Xavier Mines as a second sub complex. Additionally, Capim Branco deposit is part of the complex but is not currently in operation (MDO 2019; Vale 2019a). The mine sites are clustered in two groups (see above) being 12 km apart from each other. They are located in the north western border of the Iron Quadrangle of Minas Gerais and consist mainly of banded iron formation. Operations are presently interrupted due to the Feijao Mine dam collapse in January 2019.
Surface extension	7.81km ² 7.81 km ² (Image date: 28.07.2019; Viewing height: 6.07 km) (Google Earth)
In operation since	2001 2001 (Vale 2019a)
Operator	Vale S.A.
Owner	Vale S.A.
Closest town	7 km west (Jangada and Corrego do Feijao Mines) and 10 km northeast (Mar Azul and Capão Xavier Mines) of the town of Casa Branca.
Province	State of Minas Gerais
Country	Brazil
Longitude	-44.071644°
Latitude	-20.06009°
Altitude	1400 m a.s.l. Between 900 and 1400 m a.s.l. (Google Earth)

Main product and by-products	Main product: Iron ore; 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 (MDO 2019; Vale 2019a).
Annual production	Paraopeba Complex 2018: 27.3 Mt (Vale 2019a)
Proven Reserves	42.9 Mt with 63.2 % of Fe (Vale 2019a)
Probable Reserves	123.2 Mt with 60.6 % ore grade (Vale 2019a)

Geology



Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	The Paraopeba 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 siderophilic 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) siderophilic ore deposits are classified with a medium environmental hazard potential (EHP).	Medium	A = high, can be derived directly from available data
Paragenesis with heavy metals	No heavy metal paragenesis could be determined from Paraopeba Complex. According to Wellmer and Hageluecken (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 2019a) in 2018 proven ore reserves amount to 42.9 Mt with 63.2 % of Fe and probable reserves amount to 123.2 Mt with 60.6 % ore grade, totalling 166.1 Mt with 61.3 % ore grade.	Considering the total reserves of about 166.1 Mt and adding the already extracted amount of iron ore extracted in the past (the Complex is in operation since 2001 = 17 years- with an average of 25 Mt/year = 425 Mt; the total deposit size sums up to slightly more than 591.1 Mt (Vale 2019a). Assuming an average grade of 60 % Fe the total Fe amounts to about 354.7 Mt. According to the measuring instructions, 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	63.2 % (Vale 2019a)	With 61.3 % average ore grade of total reserves and 63.2 % ore grade of proven reserves, the specific grade is slightly above high grade in accordance with the measurement instructions (Priester et al. 2019). Considering the specific site situation (considerable quantities of waste and tailings already present on the site) the specific grade however is classified as average grade with a medium EHP.	Medium	A = high, can be derived directly from available data

Technology				
Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Mine type	Open pit mining	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; drilling and blasting. 3 major beneficiation plants are in operation (Vale 2019a), where processing standard procedures are carried out: crushing, classification, grinding, concentration and magnetic separation. Concentration steps such as floatation with organic compounds like ether amines as collectors and starch depressants are utilised according to G.M. 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 dams 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. 10 priority dams with upstream characteristics are part of the Jangada-Feijao Mines. In Capão Xavier-Mara	According to ICOLD (2018) the Barragem I tailing dam, which caused the dam breach disaster of Brumadinho, is a large dam with 87 m height and a capacity of 12.7 Mm ³ . Additionally, the fact that existing dams in the Paraopeba Complex with minor capacity still have upstream technology resulting in	High	A = high, can be derived directly from available data



	<p>Azul Mines, Barragem 5 and Barragem 3_4, the dams have heights of 55 m and capacities of 7.5 respectively 1.5 Mm3 (Vale 2016).</p>	<p>unstable tailing ponds justifies that the indicator for the Complex is classified with a high EHP.</p>		
<p>Remediation measures</p>	<p>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. Paraopebas upstream dams in Jangada –Feijao Mines will be decommissioned (drainage, removal of waste, restoration of an appropriate topography and of the soil, reforestation) in the next 3 years (Alvarenga 2019).</p>	<p>Vale mobilized teams for monitoring and installation of sediment control barrier in the Paraopeba River basin, for wildlife rescuing and to support sanitation measures (Vale 2019b). However recently discovered deficiencies in state and private governance may point to the possibility that compliance with the standards and remediation measures is not assured, so that a high EHP must be assigned.</p>	<p>High</p>	<p>B2 = medium, classified according to measurement instructions</p>

Framework conditions natural environment



Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
<p>Accident hazard due to floods, earthquake, storms, landslides</p>	<p>The rating system for the 4 sub-indicators uses georeferenced data from publicly 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.</p>	<p>For the Paraopeba Complex there is a medium EHP for landslides which determines the evaluation result. The EHP for the other sub-indicators is low.</p>	<p>Medium</p>	<p>A = high, can be derived directly from available data</p>

<p>Water Stress Index (WSI) und desert areas</p>	<p>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.</p>	<p>The water stress for the mining area is low and it is not situated in a desert area, which results in a low EHP.</p>	<p>Low</p>	<p>A = high, can be derived directly from available data</p>
<p>Protected areas and AZE sites</p>	<p>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).</p>	<p>The complex violates a highly protected area which results in a high EHP</p>	<p>High</p>	<p>A = high, can be derived directly from available data</p>

State Governance

<p>Indicators</p>	
<p>WGI 1 -Voice and Accountability</p>	<p>61.58^{ooo}</p>
<p>WGI 2 -Political Stability and Absence of Violence/ Terrorism</p>	<p>31.43^{ooo}</p>
<p>WGI 3 - Government Effectiveness</p>	<p>41.83^{ooo}</p>
<p>WGI 4 -Regulatory Quality</p>	<p>51.44^{ooo}</p>
<p>WGI 5 - Rule of Law</p>	<p>43.75^{ooo}</p>

WGI 6 -Control of Corruption	36.06 °°°
EPI (Environmental Performance Index)	60.7
EITI membership	No
International Agreements	
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)
Legal framework	

<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?	No No (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 2019)
Australian Steel Stewardship Forum: Is the mine certified?	No No (ASSF 2019)
ISO and CSR reporting	
ISO 14001 (ISO 14004): Is the mine ISO 14001 certified?	Yes Yes (Vale n.d.)
CSR-directive 2014/95/EU: Does the mine owning company have its headquarters in an EU country?	No No (RMI 2018)
OECD Guidelines: Does the company have its headquarters in a signatory state?	Yes Yes (OECD 2019)
ISO 26000: Does the mine implement ISO 26000?*	No No
Banking Standards	
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.

Sources

- Alvarenga, D. (2019): Veja onde estão e saiba mais sobre as 10 barragens que a Vale promete eliminar. In: G1.Globo. <https://g1.globo.com/economia/noticia/2019/02/05/veja-onde-estao-e-saiba-mais-sobre-as-10-barragens-que-a-vale-promete-eliminar.ghtml>. (29.07.2019).
- ASSF (2019): Membership. In: Australian Steel Stewardship Forum (ASSF). <http://steelstewardship.com/membership/>. (01.11.2019).
- Cattabriga, L.; Castro, N. F. (2014): Saúde e segurança no trabalho. In: Tecnologia de rochas Ornamentais. CETEM/MCTI, Rio de Janeiro.
- Dehoust, G.; Manhart, A.; Möck, A.; Kießling, L.; Vogt, R.; Kämper, C.; Giegrich, J.; Auberger, A.; Priester, M.; Rechlin, A.; Dolega, P. (2017a): Erörterung ökologischer Grenzen der Primärrohstoffgewinnung und Entwicklung einer Methode zur Bewertung der ökologischen Rohstoffverfügbarkeit zur Weiterentwicklung des Kritikalitätskonzeptes (ökoRes I) - Konzeptband. Umweltbundesamt, Dessau-Roßlau.
- Dehoust, G.; Manhart, A.; Möck, A.; Kießling, L.; Vogt, R.; Kämper, C.; Giegrich, J.; Auberger, A.; Priester, M.; Rechlin, A.; Dolega, P. (2017b): Erörterung ökologischer Grenzen der Primärrohstoffgewinnung und Entwicklung einer Methode zur Bewertung der ökologischen Rohstoffverfügbarkeit zur Weiterentwicklung des Kritikalitätskonzeptes (ökoRes I) - Methode für einen standortbezogenen Ansatz. Umweltbundesamt, Dessau-Roßlau.
- DNPM (2001): Portaria No 237, de 18 de Outubro 2001. Departamento Nacional de Produção Mineral (DNPM). <http://www.dnpm.gov.br/aceso-a-informacao/legislacao/portarias-do-diretor-geral-do-dnpm/portarias-do-diretor-geral/portaria-no-237-em-18-10-2001-do-diretor-geral-do-dnpm> (13.05.2019).
- EITI (2019): EITI Countries. In: Extractive Industries Transparency Initiative. <https://eiti.org/countries>. (16.04.2019).
- Elgstrand, K.; Vingård, E. (2013): Occupational safety and health in mining: anthology on the situation in 16 mining countries. Occupational and Environmental Medicine, University of Gothenburg, Göteborg.
- Hua, L. (2011): The Situation of NORM in Non-Uranium Mining in China. China National Nuclear safety Administration. <http://www.icrp.org/docs/Liu%20Hua%20NORM%20in%20Non-Uranium%20Mining%20in%20China.pdf> (22.01.2016).
- ICMM (2019): Member companies. In: International Council on Mining and Metals (ICMM). <https://www.icmm.com/en-gb/members/member-companies>. (16.04.2019).

ICOLD (2018): World Register of Dams - General Synthesis. In: International Commission on Large Dams (ICOLD). https://www.icold-cigb.org/GB/World_register/general_synthesis.asp. (12.06.2019).

ILO (2017): Ratifications for Brazil. In: International Labour Organization (ILO). https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:102571. (13.05.2019).

IRMA (2014): Standard for Responsible Mining. Draft v1.0. Initiative for Responsible Mining Assurance (IRMA). https://responsiblemining.net/wp-content/uploads/2018/09/IRMA_Standard_Draft_v1.007-14.pdf.

IRMA (2018): Responsible Mining Map. In: Initiative for Responsible Mining Assurance (IRMA). <https://map.responsiblemining.net/>. (16.04.2019).

Leonhardt, R. D.; Stump, D. (2018): Brazil: Environment and Climate Change Law 2019. In: International Comparative Legal Guides. <https://iclg.com/practice-areas/environment-and-climate-change-laws-and-regulations/brazil>. (13.05.2019).

Lopes, G. M. (2009): Flotação direta de minério de ferro. Escola de Minas da Universidade Federal de Ouro Preto, Ouro Preto.

MAC (2019): Our Members. In: The Mining Association of Canada (MAC). <http://mining.ca/members-partners/our-members>. (16.04.2019).

MDNP (2018): Country Fiche Brazil. In: EU - Latin America Mineral Development Network Platform (MDNP). https://www.mineralplatform.eu/system/files/CountryFiche/MDNP_country-fiche_Brazil_02.pdf. (19.09.2019).

MDO (2019): Major Mines & Projects - Paraopeba Mine. In: Mining Data Online (MDO). <https://miningdataonline.com/property/553/Paraopeba-Complex.aspx>. (19.09.2019).

MineHutte (2019): Brazil - Mining & Environmental Law & Regulations. In: MineHutte - Regulatory Risk Ratings & Analysis of Global Mining Laws. <https://minehutte.com/jurisdiction/brazil/>. (13.05.2019).

OECD (2019): Member Countries. In: Organisation for Economic Co-operation and Development (OECD). <https://www.oecd.org/about/members-and-partners/>. (05.11.2019).

Pfister, S.; Koehler, A.; Hellweg, S. (2009): Assessing the Environmental Impacts of Freshwater Consumption in LCA. In: Environmental science & technology. Vol. 43, No.11, S. 4098–4104.

Priester, M.; Ericsson, M.; Dolega, P.; Löf, O. (2019): Mineral Grades: An important indicator for environmental impact of mineral exploitation. In: Mineral Economics. Raw Materials Report. Springer Nature Vol. 32, No.2, S. 127–256.

RMI (2018): Vale - Company report. In: Responsible Mining Index (RMI). </en/companies/30>. (13.05.2019).

USGS (2015): Mineral Commodity Summaries 2015. U S Geological Survey, Washington.

Vale (2016): Barragens de mineracao.

Vale (2017): Environmental Management. <http://www.vale.com/EN/aboutvale/transparencia-e-sustentabilidade/ambiental-gestao-ambiental/Pages/default.aspx>. (12.11.2019).

Vale (2019a): Relatório 20-F. <http://www.vale.com/brasil/pt/investors/information-market/annual-reports/20f/paginas/default.aspx> (23.10.2019).

Vale (2019b): Vale updates on latest information about Brumadinho. <http://www.vale.com/EN/aboutvale/news/Pages/vale-updates-on-latest-information-about-Brumadinho.aspx>. (29.07.2019).

Wellmer, F.-W.; Hagelüken, C. (2015): The Feedback Control Cycle of Mineral Supply, Increase of Raw Material Efficiency, and Sustainable Development. In: Minerals. Vol. 5, No.4, S. 815–836.

Wendling, Z. A.; Emerson, J. W.; de Sherbinin, A.; Esty, D. C. (2020): 2020 Environmental Performance Index. Yale Center for Environmental Law & Policy, New Haven, CT. <https://epi.yale.edu/epi-results/2020/component/epi> (11.08.2020).

WGI (2019): The Worldwide Governance Indicators (WGI). The World Bank. <http://info.worldbank.org/governance/WGI/#home>. (10.12.2018).

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

Publisher:

German Environment Agency
Section III 2.2
PO Box 14 06
06813 Dessau-Rosslau, Germany
Tel: +49 340-2103-0
info@umweltbundesamt.de
www.umweltbundesamt.de

Contact:

Jan Kosmol – jan.kosmol@uba.de

Project period: 03/2018 –02/2021

The research project has been commissioned by the German Environment Agency as part of the Environmental Research Plan of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and funded by the Federal Government (FKZ: 3717 35 306 0).

Contractor:

Projekt-Consult GmbH
Eulenkrogstrasse 82
22359 Hamburg, Germany
T +49 (40) 60306-740
F +49 (40) 60306-199
www.projekt-consult.de

Contact:

Dr. Aissa Rechlin – aissa.rechlin@projekt-consult.de
Christopher Demel – christopher.demel@projekt-consult.de

Project Partners:

- ifeu – Institut für Energie-und Umweltforschung Heidelberg gGmbH (Institute for Energy and Environmental Research)
- Öko-Institut e.V. (Institute for Applied Ecology)