

ÖkoRess III

Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

Mariana Iron Ore Complex

Vale S.A., Brazil

ID: 10

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>

Mariana Iron Ore Complex

Iron ore

General information 	
Indicator or criteria	Description and values
Name of mine	Mariana Iron Ore Complex
Description of mining area	The complex consists of 3 separate mine sites (Alegria, Fazendão, Fabrica Nova) including a fourth depleted mine (Germano - 9.2 km ²), with a total of 52.9km ² , including all 4 mines of the complex (AHK Brasilien 2016; Vale 2018). Capanema and Conta Historia projects are part but are not in operation. The complex is located at the East-Southeast border of the Caraça Mountain. The deposit type is a banded iron formation.
Surface extension	62.95km ² 62.95 km ² (Image date: 02.07.2019; Viewing height: 17.29 km) (Google Earth)
In operation since	1974 1974
Operator	Samarco Mineração S.A.
Owner	Vale S.A.
Closest town	Mariana, about 23 km south of the complex
Province	State of Minas Gerais
Country	Brazil
Longitude	-43.437064° (approximate centre of the complex) (Google Earth)°
Latitude	-20.022064° (approximate centre of the complex) (Google Earth)°
Altitude	1120 m a.s.l. 836 m to 1120 m a.s.l. (Google Earth)
Main product and by-products	Iron ore

On-site processing stages	Processing on-site includes steps up to flotation or magnetic separation (MDO n.d.)
Annual production	according to Vale (2018): 33.1 Mt
Proven Reserves	2017: 496.4 Mt (Vale 2018)
Probable Reserves	2017: 3,604 Mt (Vale 2018)

Geology



Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	The Mariana Complex comprises oxidic iron ore (hematite, itaberrite, lateritic/canga ore) and thus is siderophilic. No sulphides are reported.	No evidence for preconditions for acid mine drainage for this ore type found. According to the measurement instructions, 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 is reported for the Mariana complex in the analysed references. Heavy metals have been reported in the tailing slurry after Samarco Mineração S.A. dam bursts: Copper, Arsenic, manganese, zinc, chrome, cobalt, nickel, lead and others (Journal da USP 2018) reported in tailing material; however Fundação RENOVA which is in charge of the remediation activities dismissed the possibility of heavy metal source in the Mariana iron ore and tailing (personal communication during seminar). In general, heavy metals and arsenic may	Even though no heavy metals are reported from the iron ore of the Mariana complex, heavy metals are documented to be adsorbed in the fine fraction in sediments of the river bed after the dam burst. Their existence however cannot clearly be related to the slimes released in the dam burst of the mine site. Mariana complex is, thus, evaluated with a medium EHP considering the possibility of slightly increased concentrations of heavy	Medium	B1 = medium, can be estimated on the basis of available information

	have a limited relevance in the extraction of oxidic iron ores (Wellmer / Hagelüken 2015).	metals in the Samarco (Alegria) mine site.		
Paragenesis with radioactive components	No indication of paragenesis with thorium and uranium could be determined.	In accordance with the measurement instructions, 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	B2 = medium, classified according to measurement instructions
Deposit size	2017: 4,100Mt (Vale 2018)	Approximate estimated total ore content including probable reserves: 4,100 Mt with 44.2 % Fe = about 1800 Mt Fe- content. Adding already mined quantities: -Germano Mine (1974 -1984): Average Run-of-mine(ROM) of 10 Mt/a during 10 years = 100 Mt with 44.2 % Fe = about 44 Mt Fe-content -Alegria Mine (1990 -2018): estimated production of 20 Mt/a = 560 Mt with 44.2 % Fe = about 248 Mt Fe-content The total deposit size sums up to about 2100 Mt Fe-content. According to Petrow et al. (2008; in Dehoust et al. 2017b) it is considered a large deposit with high EHP.	High	A = high, can be derived directly from available data
Ore grade	2017: 44.2 % (Vale 2018)	With 44.3 % ore grade and in accordance with the measurement instructions (Priester et al. 2019) the specific grade is classified as average grade with a medium EHP.	Medium	B2 = medium, classified according to measurement instructions

Technology



Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Mine type	Solid rock open pit mining	During open pit mining in solid rocks, the mining activities are restricted to the horizontal and vertical extension of the ore body/mineralized zone. The impact is higher than in underground mining but less pronounced than in mining of alluvial or unconsolidated sediments.	Medium	A = high, can be derived directly from available data
Use of auxiliary substances	Mining by truck, shovel-loader and blasting. Processing standard crushing, classification, grinding and concentration steps (floatation with organic compounds such as amines utilised as collectors and starch as depressants, according to (Pires et al. 2003), magnetic separation; 3 processing plants (2 in operation) in Alegria Mine; Fazendão Mine processes at Timbopeba Mine. The ore is transported by conveyor belt.	Evaluated with a high EPH due to the use of toxic substances like ether amines, which are common in flotation.	High	B1 = medium, can be estimated on the basis of available information
Mining waste	In Alegria and Germano Mine: 4 tailing ponds, 3 waste piles and 7 dikes (diques). The biggest tailing pond dam burst in 2015 and released of 55 Million m ³ of tailing slimes (fine fraction). Germano and Nova Santarem dam in operation (Fundação Renova 2019; Samarco n.d.)	Even though depleted pits are being used for waste disposal and tailing ponds, several tailings dams have been in operation and are being constructed for further waste disposal. According to ICOLD, the principal Mariana dam "Fundão" with a volume of 55 million m ³ , is considered a large dam (> than 3	High	B1 = medium, can be estimated on the basis of available information

		million cubic metres). Thus, together with the nature of the slurry contained in it (slimes or fine fraction) which has a high potential of heavy metal absorption (Pires et al. 2003), the evaluation result for mining waste management - in the past- is a high EHP.		
Remediation measures	<p>Remediation measures: Fundação Renova was created through the Conduct Adjustment Term (TAC) at the instigation of the public attorney as an independent institute to repair the damages caused by the Fundão dam burst (Fundação Renova 2019). It is to receive 4 billion R\$ (roughly 1 bi US\$) by 2018 from the responsible parties. Measures shall be executed in 3 fronts (People and Communities; Land and Water; Reconstruction and Infrastructure) and comprise indemnities for reconstruction and environmental remediation, R\$ 500 million R\$ (120 million US\$) will be made available for basic sanitation works to the affected municipalities; reutilization measures: tailings are already recycled for different uses in building materials.</p>	<p>In the face of the dam burst in 2015 it became clear that deficits in compliance of the measures originally planned to prevent and mitigate environmental impact doubtlessly were insufficient. Although in investigations regarding the role of the operator, environmental authorities and external factor are still ongoing, liabilities are also due to technical and management errors of Samarco Mineração S.A.O.</p>	Medium	k.A.

Framework conditions natural environment



Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Accident hazard due to floods, earthquake, storms, landslides	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.	The environmental hazard potential (EHP) for landslides medium. The EHP is negligible for other aspects: earthquakes, tropical storms, floods and the arctic environment.	Medium	B2 = medium, classified according to measurement instructions
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.	EHP for the WSI is low and the mine is not situated in a desert area.	Low	B2 = medium, classified according to measurement instructions
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).	There is a low EHP for protected areas and AZE sites.	Low	B2 = medium, classified according to measurement instructions

State Governance

Indicators	
WGI 1 -Voice and Accountability	61.58 ^{ooo}

WGI 2 -Political Stability and Absence of Violence/ Terrorism	31.43 °°°
WGI 3 - Government Effectiveness	41.83 °°°
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
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 / 1.000 (RMI 2018)

Responsible Mining Index Company indicator „Environmental sustainability“	0.391 0.391 / 1.000 (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 (Samarco 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 (Brazil)(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?	Yes Yes, HSBC amongst others

*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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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

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Contractor:

Projekt-Consult GmbH
Eulenkruogstrasse 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)
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