ÖkoRess III

Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

Los Bronces

Anglo American , Chile

ID: 41

German Environment Agency

Umwelt Bundesamt

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.

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

Los Bronces

Copper

General information

Indicator or criteria	Description and values
Name of mine	Los Bronces
Description of mining area	The Los Bronces copper mine is located in the Andean mountains in central Chile, ca. 65 km distant from Santiago de Chile. On an altitude of 3,500 m above sea level, the mine is situated in a high mountain region with rough relief and low population density. Los Bronces and the adjacent Andina mine extract the Miocene to Pliocene Río Blanco-Los Bronces porphyry system, which is interspersed by Breccia complexes. Primary sulphides such as Chalcopyrite and bornite are the dominant minerals of the orebody at Los Bronces (Mining Technology n.d.; Porter GeoConsultancy 2015).
Surface extension	50.09km^2 50.09 km^2 (Image date: 03.01.2019; Viewing height: 15.36 km) (Google Earth)
In operation since	1980 1980 (Consejo Minero n.d.)
Operator	Anglo American Sur
Owner	Anglo American
Closest town	Lo Barnechea (Google Maps)
Province	Región Metropolitana (Google Maps)
Country	Chile
Longitude	-70.2781°
Latitude	-33.14829°
Altitude	3500 m a.s.l. 3,500 m a.s.l. (Anglo American n.d.)

Main product and by-products	Main product: copper; by-product:molybdenum (Anglo American n.d.)
On-site processing stages	Milling (Anglo American n.d.)
Annual production	330,500 t of copper concentrate in 2018 (Anglo American 2019a)
Proven Reserves	746.2 Mt ore, 0.64 % Cu (Anglo American 2018)
Probable Reserves	308.6 Mt ore, 0.54 % Cu (Anglo American 2018)

Geology

Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	Copper is a chalcophilic element. It is obtained from Sulphides at Los Bronces which pose a high risk for AMD (Porter Geoconsultancy 2015, see measurement instructions).	The extraction of sulphidic minerals has a high environmental hazard potential with regard to AMD.	High	B1 = medium, can be estimated on the basis of available information
Paragenesis with heavy metals	Copper is a heavy metal itself and moreover often associated with zinc, lead, nickel and arsenic (Dehoust et al. 2017b p. 22). In the deposit of Los Bronces, minor arsenic has been found in pyrite, arsenopyrite, luzonite and copper sulphoarsenides (Porter GeoConsultancy 2015). No information about paragenesis with other heavy metals could be found.	Copper is a heavy metal itself. The extraction of copper is consequently always evaluated with a high environmental hazard potential (EHP).	High	B2 = medium, classified according to measurement instructions

Paragenesis with radioactive components	No indication of paragenesis with thorium (Th) and uranium (U) could be found.	In accordance with the measurement instructions, copper ore deposits are evaluated with a medium EHP, if no other information is available.	Medium	B2 = medium, classified according to measurement instructions
Deposit size	Total current reserve (2017): 1,054.9 Mt of copper with an ore grade of 0.61% leads to a total metal content of 6.4 Mt (Anglo American 2018)	Calculating with an average annual production of ca. 267.038t and 37 years of production (Consejo Minero n.d.), the total size of the deposit is roughly estimated to be almost 16.3 Mt (Annual reports Anglo American 2003-2017). A deposit of this size is very large, leading to a high EHP.	High	B2 = medium, classified according to measurement instructions
Ore grade	0.61% (Anglo American 2018)	With a copper content of 0.61%, the Los Bronces deposit can be assessed as average grade deposit.	Medium	A = high, can be derived directly from available data

Technology

Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Mine type	Hard-rock open pit mine (Anglo American n.d.)	Conventional solid rock open pit mining is evaluated with a medium EHP. During open pit mining in solid rocks, the mining activities are restricted to the horizontal and vertical extension of the	Medium	A = high, can be derived directly from available data

		ore body/mineralized zone. The impact is higher than in underground mining but less pronounced then in mining of alluvial or unconsolidated sediments.		
Use of auxiliary substances	Mining is carried out with trucks and shovel-loaders after drilling and blasting (Chacana 2018). The milled ore is then conveyed to a flotation plant ca. 56km distant from the mine site (Anglo American n.d.).	Flotation is often conducted with the help of toxic additives such as organic hydrocarbons, leading to a high EHP in the evaluation result.	High	A = high, can be derived directly from available data
Mining waste	Tailings are stored in the Los Tórtolas tailings dam. The TSF has a current filling volume of 200 million m^3 of waste water and is up to 100 m deep (Moore 2019). The facility has a complete capacity of 1.900Mt (until 2042) and currently extends over 960 ha. Maximum dam height is currently 18.8m (Consejo Minero 2019).	According to the definiton of the ICOLD (2011) at least one of the tailings storage facilities is very likely to be large. The disposal of waste in large-volume and large-scale tailing dams are evaluated with a high EHP.	High	B2 = medium, classified according to measurement instructions
Remediation measures	Anglo American cooperates with local nature sanctuaries and municipalities in the region of Los Bronces. Operations with these stakeholders maintain nature conservation and reforestation activities and landscape rehabilitation programmes (Anglo American 2019b). In 2018, Anglo American developed a new strategy for progressive rehabilitation, parallel to the existing integrated closure planning system for all operations (ibid.).	The EHP is determined as low due to the ongoing recultivation and compensation activities concomitantly to the mining process.	Low	B1 = medium, can be estimated on the basis of available information

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 (Dehoust et al. 2017b)). Metrics are directly taken from the given risk assessment. The indicator total is determined by the highest hazard level of the sub-indicators.	The mine is located in a seismic active area (Andean Region) with a high EHP for earthquakes and landslides which determines the evaluation result. The other sub-indicators have a low EHP.	High	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 availablility 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 EHP for water stress is high which determines the evaluation result. The mine is not situated in a desert area.	High	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).	The mine site is not situated in designated protected areas and AZE sites, which results in a low EHP.	Low	B2 = medium, classified according to measurement instructions

State Governance

Indicators	
WGI 1 -Voice and Accountability	79.31 °°°
WGI 2 -Political Stability and Absence of Violence/ Terrorism	60.95 °°°
WGI 3 - Government Effectiveness	77.88 °°°
WGI 4 -Regulatory Quality	88.94 °°°
WGI 5 - Rule of Law	81.73 °°°
WGI 6 -Control of Corruption	82.21 °°°
EPI (Environmental Performance Index)	57.49
EITI membership	n.d.
International Agreements	
ILO 176	No

Others	Ratification of the Minamata Convention on Mercury 27.08.2018 (UNEP 2019) Signature of the Paris Agreement on Climate Change (which entered into force on 12.03.2017) (UNFCCC 2016).
Legal framework	
Areas of Law: Environment	The Chilean state is obliged to guarantee a pollution-free environment through environmental legislation. The Environmental Law 19.300 includes the statutory environmental framework and defines that Environmental Impact Assessments (EIA) are mandatory to obtain an environmental license for projects in the mining sector. To these belong, e.g., projects for minerals, oil, gas and coal at different stages of the mine life cycle (exploration to mine closure), (EI SourceBook 2016). The design of the EIAs differ, depending on the potential hazards to a number of social or environmental circumstances. Previous consent of indigenous communities need to be obtained, if these communities are directly affected by a mining project (Minehutte 2019). Three main institutions -with different and defined roles- enforce the environmental regulations: The Ministry of Environment, the Environmental Assessment Service and the Environmental Superintendence. Moreover, according to Law No. 20.600, Environmental Courts have the power to resolve environmental disputes. EIS are presented to the responsible Regional Commission on the Environment or the Executive Directorate of the National Commission on the environment if several regions are affected (Minehutte 2019).

Areas of Law: Occupational Health and Safety (OHS)	Chile ratified the ILO Convention N° 161 Occupational Health Services Convention since 1999 (MDNP 2018). The Supreme Decree No. 132/2004 of the Ministry of Mining regulates occupational health and safety (OHS) measures in the mining sector with the objective to protect the life and physical integrity of all humans that work in or are related to the mining industry. It, furthermore, aims to protect facilities and infrastructure that allow mining operations and their continuance (MDNP 2018)(National Library of Congress 2017). In this framework, companies with more than 100 workers are required to have a Risk Prevention Department in place. This department is headed by an expert qualified by the National Geology and Mining Service (SERNAGEOMIN). The development of plans and programs for the prevention of accidents and occupational diseases is mandatory (MDNP 2018). In general, employers are obliged to ensure the safety of employees, machines and buildings (through training, protective clothing, maintenance of machines). At the same time, employees must ensure that occupational safety and safety rules are observed and controlled (ICLG 2018).

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 2017)
Towards Sustainable Mining (TSM) Is the mine owning company a member of the Mining Association of Canada (MAC)?	No No (MAC 2019)
Towards Sustainable Mining (TSM) outside Canada: Are TSM standards implemented*?	No information available No information available
Initiative for Responsible Mining Assurance (IRMA): Is the mine owning company a member?	Yes Yes (IRMA 2018)
Initiative for Responsible Mining Assurance (IRMA): Is the mine certified?	Yes Yes (IRMA 2018)
Responsible Copper (RC): Is the mine owning company a member of RC?	No information available No information available
Responsible Copper (RC): Is the mine certified?	No information available No information available
Responsible Mining Index (RMI): Has the mine been rated?	1.67 / 6.00 1.67 / 6.00 (RMI 2018)
Responsible Mining Index Company indicator „Working conditions“	0.788 0.788 / 1.000 (RMI 2018)
Responsible Mining Index Company indicator „Environmental sustainability“	0.668 0.668 / 1.000 (RMI 2018)
Responsible Steel (RS): Is the mine owner a member of the RS?	Not applicable Not applicable
Responsible Steel (RS): Is the mine certified?	Not applicable Not applicable
Australian Steel Stewardship Forum (ASSF): Is the owner a member of the ASSF?	Not applicable Not applicable

Australian Steel Stewardship Forum: Is the mine certified?	Not applicable Not applicable
ISO and CSR reporting	
ISO 14001 (ISO 14004): Is the mine ISO 14001 certified?	No information obtained No information available
CSR-directive 2014/95/EU: Does the mine owning company have its headquarters in an EU country?	Yes Yes (UK) (RMI 2018)
OECD Guidelines: Does the company have its headquarters in a signatory state?	Yes Yes (UK) (RMI 2018)
ISO 26000: Does the mine implement ISO 26000?*	No information obtained No information available
Banking Standards	
WB Standards / IFC Performance Standards: Is the mine financed to a major extend by the world bank?	No information obtained No information available
Equator Principles (EP): Is the mine financed to a major extend by a bank adherent to the EP?	No No (EP n.d.)

*by companies own account.

Sources

Anglo American (2018): Ore Reserves and Mineral Resources Report 2017. S. 56.

Anglo American (2019a): Annual Report 2018. https://www.angloamerican.com/~/media/Files/A/Anglo-American-Group/PLC/investors/annual-reporting/2019/aa-annual-report-2018.pdf. (24.10.2019).
Anglo American (2019b): Sustainability Report 2018. https://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/documents/annual-updates-2019/aa-sustainability-report-2018.pdf (23.07.2019).
Anglo American (n.d.): Los Bronces. https://chile.angloamerican.com/operaciones/los-bronces?sc_lang=es-ES. (23.07.2019).
Chacana, P. (2018): Los Bronces site visit.
Consejo Minero (2019): Las Tortolas. In: Consejo Minero.
Consejo Minero (n.d.): Los Bronces. In: Consejo Minero. https://consejominero.cl/quienes-somos/mapa-minero/los-bronces/. (23.07.2019).
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 (ökoRess 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 (ökoRess I) - Methode für einen standortbezogenen Ansatz. Umweltbundesamt, Dessau-Roßlau.
EI SourceBook (2016): Text of the Law No 19.300 General Bases for the Environment, published on the official gazette on 9th of March 1994. http://www.eisourcebook.org/cms/February%202016/Chile%20General%20Environment%20Law%201994.pdf. (28.12.2018).
EITI (n.d.): Countries - Implementation Status. In: Extractive Industries Transparency Initiative (EITI). https://eiti.org/countries. (30.09.2019).
EP (n.d.): EP Association Members & Reporting. In: Equator Principles. https://equator-principles.com/members-reporting/. (13.05.2019).
ICLG (2018): Chile: Mining Law 2019. In: International Comparative Legal Guides. https://iclg.com/practice-areas/mining-laws-and-regulations/chile. (12.04.2018).
ICMM (2017): Member reporting and performance. In: International Council on Mining and Metals (ICMM). https://www.icmm.com/en-gb/members/member-reporting-and-performance. (13.06.2019).
ILO (2017): Ratifications of C176 - Safety and Health in Mines Convention, 1995 (No. 176). In: International Labour Organization (ILO). http://www.ilo.org/dyn/normlex/en/f?p=1000:11300:0::NO:11300:P11300_INSTRUMENT_ID:312321. (12.04.2018).
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).
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 Chile. In: EU - Latin America Mineral Development Network Platform (MDNP). https://www.mineralplatform.eu/system/files/CountryFiche/MDNP_country-fiche_Chile_02.pdf. (19.09.2019).
Minehutte (2019): Chile - Mining & Environmental Law & Regulations. In: MineHutte - Regulatory Risk Ratings & Analysis of Global Mining Laws. https://minehutte.com/jurisdiction/chile/. (28.12.2018).
Mining Technology (n.d.): Los Bronces Copper and Molybdenum Mine. In: Mining Technology | Mining News and Views Updated Daily. https://www.mining-technology.com/projects/los-bronces-copper-and-molybdenum-mine/. (23.07.2019).
Moore, P. (2019): Anglo's Los Bronces to recycle water sucked from the bottom of the tailings dam. In: International Mining. https://im-mining.com/2019/03/04/anglos-los-bronces-recycle-water-sucked-bottom-tailings-dam/. (23.07.2019).
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.
Porter GeoConsultancy (2015): Los Bronces - Disputada, Rio Blanco - Andina, Sur Sur. http://www.portergeo.com.au/database/mineinfo.asp?mineid=mn200. (23.07.2019).
RMI (2018): Anglo American - Company report. In: Responsible Mining Index (RMI). /en/companies/1. (23.07.2019).
Stedman, A.; Green, K. P. (2018): Fraser Institute Annual Survey of Mining Companies 2017. Fraser Institute. S. 72. https://www.fraserinstitute.org/sites/default/files/survey-of-mining-companies-2017.pdf.
UNEP (2019): Minamata Convention on Mercury: Parties and Signatories. In: UN Environment Programme (UNEP) - Minamata Convention on Mercury. http://www.mercuryconvention.org/Countries/Parties/tabid/3428/language/en-US/Default.aspx. (05.11.2019).
UNFCCC (2016): Paris Agreement Signatories Rise to 187. In: United Nations Framework Convention on Climate Change (UNFCCC). https://unfccc.int/news/malawi-armenia-zambia-and-chile-sign-paris-agreement. (23.07.2019).
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

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