ÖkoRess III

Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

El Teniente

Codelco, Chile

ID: 36

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

El Teniente

Copper

General information

Indicator or criteria	Description and values
Name of mine	El Teniente
Description of mining area	The El Teniente is located in the municipality of Machalí, in the middle of the Andes, between 2,200 and 3,200 meters above sea level. It is distant to 54 kilometers of Rancagua, capital of the region of Libertador Bernardo O'Higgins. It is the largest underground copper mine in the world and among its productive units are the Diablo Regiments Phase IV, Esmeralda, Dacita, Reservas Norte, Pipa Norte, Sur Andes Pipa, Pilar Norte and Teniente 4 Sur. It also has an operation on the surface, the South Rajo, located between 2,730 and 3,240 meters above sea level, which became operational at the end of 2012. The main operations of the industrial complex are the mine, the concentrator (Colón, Sewell) and the smelter (Caletones) (Codelco 2019). The deposit is part of the Upper Tertiary Farellones Formation also described locally as the Teniente Volcanic Complex (Kelm et al. 2009). The principal ore minerals are chalcopyrite, bornite, molydenite, galena, tennantite/tetrahedrite, chalcocite and covellite (Camus 1975).
Surface extension	83.31km^2 83.31 km^2 (Image date: 05.03.2018; Viewing height: 5.43 km) (Google Earth)
In operation since	1905 1905 (Codelco 2011)
Operator	Codelco
Owner	Codelco
Closest town	Rancagua ca. 54 km northeast of the operation (Codelco 2019).
Province	Municipality of Machalí
Country	Chile
Longitude	-70.4603556°

Latitude	-34.0876°
Altitude	3200 m a.s.l. Varying: 2,200 and 3,200 m a.s.l (Codelco 2019)
Main product and by-products	Main product: copper, by-products: sulfuric acid, molybdenum, gold, silver (Codelco 2018a)
On-site processing stages	Blasting (underground), crushing (underground), milling, flotation, smelting process also takes place on site (Codelco 2011)
Annual production	In 2017: copper 464,328 t, molybdenum: 6,199 t, sulfuric acid: 1,214,941 t, gold: 823 kg, silver: 96,664 kg (Codelco 2018a)
Proven Reserves	In 2017: 744 Mt Ore, 7.4 Mt Cu (Codelco 2018a)
Probable Reserves	In 2017: 563 Mt Ore, 3.8 Mt Cu (Codelco 2018a)

Geology

Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	Copper is a chalcophilic element. At El Teniente, it is obtained from sulphides, which which are particularly prone to AMD (Codelco 2011; Dehoust et al. 2017b)	The extraction of sulphidic minerals has a high environmental hazard potential with regard to AMD.	High	A = high, can be derived directly from available data
Paragenesis with heavy metals	Soil samples close to Caletones smelter and closed tailings indicate elavated levels of at least As, Cu, Zn (Kelm et al. 2009).	Academic research of soil condition in the mining area indicate that there are elevated heavy metal concentrations. Moreover copper is a heavy metal itself. Accordingly, the mine poses a high environmental hazard potential for the contamination with heavy metals.	High	A = high, can be derived directly from available data

Paragenesis with radioactive components	No indication of paragenesis with thorium (Th) and uranium (U) could be determined.	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	In 2017 the total reserves amounted to 1,307 Mt ore by an copper grade of 0.86 %. This results to 11.2 Mt of fine Copper (Codelco 2018a).	Production already started in 1905. By considering historic statistical data, a total production of 18.5 Mt copper between 1905 and 2017 was estimated (own calculation based on (COCHILCO 2016; Codelco 2011). Adding the current reserves of 2017 (11.2 Mt copper) , the total depositit size is 29.7 Mt copper. The deposit is classified as very large and, hence, is evaluated with a high EHP.	High	A = high, can be derived directly from available data
Ore grade	In 2017: 0.86 % refers to total mineral reserves (Codelco 2018a)	With a copper ore grade of 0.86 %, the El Teniente deposit is classified as an 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	Underground mine (main activity) and open pit (Rajo Sur was opened in 2012) (Codelco	Underground mines have compared to open-pit mines a smaller impact on land	Low	A = high, can be derived directly

	2011). The open-pit mine contributes between 6 % and 12 % of total annual production. The project is only limited to eight years (Codelco 2014).	consumption. Accordingly, the EHP resulting from the mining method is low. Besides the main activity a small scale open-pit activity occurs at the site. Due to the fact that the underground mine has by far the main contribution to production, the corresponding low EHP is chosen but the special circumstances in this exceptional case should be noted.		from available data
Use of auxiliary substances	Block caving, milling and flotation (using water and chemical reagents) (Codelco 2011)	The processing of the ore at El Teniente involves a flotation process where toxic reagents are added. Accordingly, the environmental hazard potential caused by the processing method is high.	High	A = high, can be derived directly from available data
Mining waste	Due to the long operation time of the mine, several tailings were installed. Barahona 1 & 2, Cauquenes and Colihues already reached maximum capacity. Since 1986 the active tailing of El Teniente is Embalse Carén which is located 86 km West of the mine site (Kelm et al. 2009). The tailing material flows in a concrete chanel downhill. Carén has the permission for operation until 2064. It's maximum capacity is 2.192 Mt of tailing material. This will cover an area of 3.289 ha. At the final stage the wall will be 137 m (Consejo Minero 2018).	The disposal of mine-waste in large-volume and large-scale tailing dams are evaluated with a high EHP.	High	A = high, can be derived directly from available data
Remediation measures	Codelco fully complies with the Mine Site Closure Law (N° 20.551). The closure plan for El Teniente was approved in 2015 and	There are detailed plans for mine closure in place which is approved by the relevant authorities. Accordingly, the EHP is low.	Low	A = high, can be derived directly from available data

	financial garantuees of 38,812,050 UF are consituted (Codelco 2018b).			

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 well known earthquake region (Andean Region). All sites of the El Teniente complex have a high EHP for earthquakes which determines the evaluation result. Additionally, three out of eight sites have a high EHP for landslides. Concerning the flood hazard, only the Cauquenes tailing meets a high EHP. Due to geographic location the EHP for tropical strom and Arctic region is low.	High	A = high, can be derived directly from available data
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.	All sites of the El Teniente complex have a high EHP for waterstress which determines the overall result. The mine is not located in a desert region.	High	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	The mine site is not situated in designated protected areas and AZE sites, which results in a low EHP.	Low	A = high, can be derived directly from available data

	described in the draft standard of the Initiative for Responsible Mining Assurance (IRMA 2014).			

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 2019)
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?	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?	No The BMW Group and the Chilean copper mining company Codelco have signed an agreement to cooperate on a sustainable and transparent supply of copper (BMW Group 2018).
Responsible Copper (RC): Is the mine certified?	No information available No information available
Responsible Mining Index (RMI): Has the mine been rated?	0.67 / 6.00 0.67 / 6.00 (RMI 2018)
Responsible Mining Index Company indicator „Working conditions“	0.664 0.664 / 1.000 (RMI 2018)
Responsible Mining Index Company indicator „Environmental sustainability“	0.326 0.326 / 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?	Yes Yes (Codelco 2011)
CSR-directive 2014/95/EU: Does the mine owning company have its headquarters in an EU country?	No No (Codelco 2018a)
OECD Guidelines: Does the company have its headquarters in a signatory state?	Yes Yes (Codelco 2018a)
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 for current investment available. Codelco received loans in the past (1976-1982) from the Worldbank to construct underground crusher system at El Teniente (The World Bank 2019).
Equator Principles (EP): Is the mine financed to a major extend by a bank adherent to the EP?	No information obtained No information available

*by companies own account.

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A Glossary

Table 1 Legend

Environmental hazard potential

low

medium

high

Data quality

low

- 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.

medium

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

high

- 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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