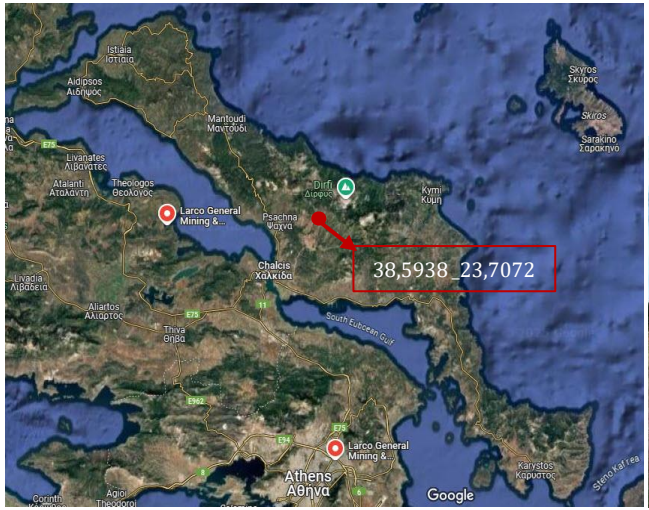
Isoma

Non Active Mining Site

Pit Lake



Overview	CRM Ni	Location
Environmental Management	VEs Map	Pit-Lake VE
Mining to Closure	Disclaimer	Mining to Closure VE

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Overview

General Information

LARCO is a temporary, under special corporate management regime, mining company. Until 2022, LARCO GMMSA mining company was recognized as one of the world's top 10 ferronickel producers and was a highly trusted brand. The mining company was an entirely export industry and the unique ferronickel producer in Europe using domestic ore.

It operated continuously from 1966 until 2022. Most major stainless steel manufacturers in Europe were successfully using LARCO granulated ferronickel in their facilities.

Specific Information

Surface mining in the mines of Euboea referred to an average nickel concentration of approximately 1,01 %, and an average annual production of 1.3 Mtonnes. 63.016.879 tonnes of FeNi have been extracted from 1969 to 2022. Removal of the waste material is estimated at 612.391.167 tonnes for the same time. The stripping ratio (waste/FeNi)equals 9,7/1 w/w, while the average FeNi concentration was approximately 1,017%.

The 360 panoramas in the current VE refer to the rehabilitated ferro-nickel mine site of Agia Triada-Euboea after its closure. The previous active mine site was smoothly earthworked. Moreover, the slopping of the ground soil and its content in metal elements enhanced the ecological environment growth, and after a few years, a pit lake was created.

Pit-Lake refers to a water reservoir that is formed naturally or artificially from open-pit mine sites after the mining operation closure. Source 1 Source 2

Flowchart of LOM (Life of Mine)

(LOM) & Environmental Management

- The Life of Mine (LOM) includes five basic tasks that should be implemented.
- The first task focuses on the geological survey that evaluates a site area as suitable for exploitation.
- The second task refers to the optimization of mining engineering design, including a memorandum of activities that should be accomplished before the actual primary extraction.
- The third task refers to the implementation of design activities.
- The fourth task involves all the working activities and is crucial for the productivity of the mining site. The final task focuses on the optimization of the environmental management action plan depending on the physical conditions of each mining site.
- The environmental management system involves the actions of environmental rehabilitation, planting, creating pit lakes, earthworks, or alternative uses of the produced waste in terms of the Sustainable Mining respecting the 4Rs Policy and regulation of the Circular Economy.

It is essential to mention that closure activities have a significant impact on the brand name of a mining company while enhancing social approval, securing funding, and increasing political support for similar activities.

Info from Previously Active sites

Overview of Pit-Lakes

Mining Operation Information

Info from Active Sites

The table shows productivity information from the previously active mine sites of the LARCO GMMSA mining company. Especially in Isoma Agia Triada-Euboea, one of the previously active local mine sites was rehabilitated and transitioned to a pit lake, as it was the most optimal environmental solution. The pit lake has been environmentally monitored for 10 consecutive years since its primary construction. The Occurrence of fish verifies the environmental sustainability of the rehabilitation project.

Site	Production (Tonne/Year)		Land & Rehabilitation (m^2*1000/Year)	
	Laterite/FeNi	Waste/Slag	Land Occupation	Number of Plants
Euboea Mines	1.300.000	16.000.000	9.880	4.600
Agios Ioannis Mines	600.000	5.900.000	2.130	8.800
Kastoria Mines	400.000	6.000.000	1.300	15.900
Larymna Mines	17.500	1.650.000	-	-

Mining Operation Information

Deposit

Inclined Road

Sterile Material

Square and Mining Face

Deposit

Bench

Ore separation from waste (dilution control) and loading into trucks

Environmental Management-Info

Environmental Management Plan at Isoma-Agia Triada mine site

After the completion of mining activities in a section of the Isoma mine, LARCO GMMSA mining company was responsible for rehabilitating the area that had been exploited. Ground soil was purified in different elemental metalloids, suitable for fertilizing plants and habitat growth. Therefore, the environmental management action plan included:

1. Earthworks to smoothly slope the rambles, by structuring a road network that permitted entrance for the workers to reforest.
2. Following the consultancy of the agronomists, geologists, and foresters, the mining company made a business decision to structure the whole area in a way that the rainwater could be collected to support different species and plants.
3. After the design of the previously exploited area, the bottom of the lake was constructed based on a closed pit.

Within a period of at least 10 years, reforestation and pit-lake presence are observed. The structured pit-lake's depth is approximately 80 meters, while plenty of freshwater fish exist in it.

Environmental & Structural Parameters

Isoma-Pit Lake info

Overview of Pit-Lakes

Pit Lake: Pit-Lake refers to a water reservoir that is formed naturally or artificially from open-pit mine sites after the mining operation closure.

Source 1 | Source 2

Environmental Policy-European Guidance:

In accordance with the terms and conditions of the Directives 2001/42/EC, 2006/21/EC, 2008/98/EC regarding mine closure, the mining sector is mandated to rehabilitate mine sites. Moreover, Directive **2001/42/EC** mandates the implementation of environmental assessments, which must include plans and programs for forestry, fishery, waste management, water management, and land use for future development. All these guidance are expressed through the Green Deal, enhancing the practical application of the "Zero Pollution Action Plan" declared in it. **2001/42/EC** **2006/21/EC** **2008/98/EC**

Mine Closure & Pit-Lakes: Considering the nature of the open-pit mining activities (surface mining operations), each mining company adopts a specific mine closure action plan that depends on the final structure of the exploited area. The construction of Pit Lakes usually occurs when the final depth of excavation reaches the ground and surface zone. In cases of open-pit mine sites where the extraction of the beneficial ore is stopped before the underground water, the indicative method for rehabilitation is reforestation. Source 3

Artificial Pit Lakes: The artificial Pit Lakes refer to water reservoirs formed by rainfall, runoff, and groundwater after the end of excavation. Source 3

Open Pit Lakes: The open Pit Lakes refer to water reservoirs formed by underground water after the end of excavation. Source 3

**Click on the tabs above to see further information!*

Environmental & Structural Parameters

Environmental Parameters to be considered for the Pit Lake configuration/construction	
1	Chemical composition of the mining ore. For instance, if sulfides are present, there is a high probability of acid mine drainage, necessitating technical support for dewatering. Otherwise, there is only the need for earthwork to structure the water reservoir.
2	Depth of the aquifer zone
3	Climate conditions at the closed mine site area (temperature, height of rainfall, etc)
4	Hydraulic specifications of the groundwater
5	Geological and Geochemical factors
6	Ecological Factors. For instance, habitat species that usually live in the area of the pit lake, or plants that occur in the nearby area.

Source 1 | Source 2 | Source 4 | Source 5

**Click on the tabs above to see further information!*

Structural Specifications of Pit Lakes	
1	Geometric and water data. For instance, the water rise stabilization, the associated disturbance of the lake water inflow and outflow, the surface and the volume of the lake, the shape and the pit's depth, the morphology and slopes and banks, etc.
2	Geological information regarding the nature of the tectonics and rockmass (considering groundwater levels, water supply sources, annual precipitation, and exceptional rainfalls, permeability, pore pressure, and other hydrological parameters)
3	Geotechnical specifications such as the thickness and quality of the rocks and soils, the grade of homogeneity or heterogeneity, the hydraulic and mechanical characteristics, etc.
4	The necessary parameters must be monitored to select the most optimal technical system for environmental control. For instance, key considerations include the density and frequency of measurements, crisis management procedures in case of potential incidents or accidents, inclines, piezometers, pressure cells, etc.
5	Construction of the pit lake conforms to the indicative guidance provided by the required environmental safety plans.
6	A Risk Management plan that considers all technical and economic parameters to achieve a sustainable operation mode.

Isoma Pit Lake-Info

Pit Lake Construction

Considering the non-hazardous extractive waste from the past mining operations, and conforming with the corresponding legislation for the mining sector Directives 2001/42/EC, 2006/21/EC, and 2008/98/EC, Larco GMMSA rehabilitated the closed mine site in which the final depth of the excavation met the piezometric surface of the underground water by constructing a pit lake.

1. It is essential to mention that there was no need for the establishment of a technical system to dewater the collected water to the constructed water reservoir, due to the non-hazardous quality of the waste mining ore. So, the most optimal environmental solution was the creation of a combined open-artificial pit lake.
2. Following the environmental scientists' consultancy, an indicative solution for the environmental monitoring of the constructed pit lake was the experimental activity of observing whether the fish that were introduced into the lake would survive after tactical monitoring periods.
3. After tactical observing periods within a period of 10 years, the efficiency of the provided environmental solution was verified.

Within a period of at least 10 years, reforestation and pit-lake presence are observed. The structured pit-lake's depth is approximately 80 meters, while plenty of freshwater fish exist in it. Furthermore, there are environmental monitoring data that evaluate the variable depth of the pit lake depending on the climate conditions of each season in each year.

The consecutive environmental monitoring system is maintained by the administration of the company.

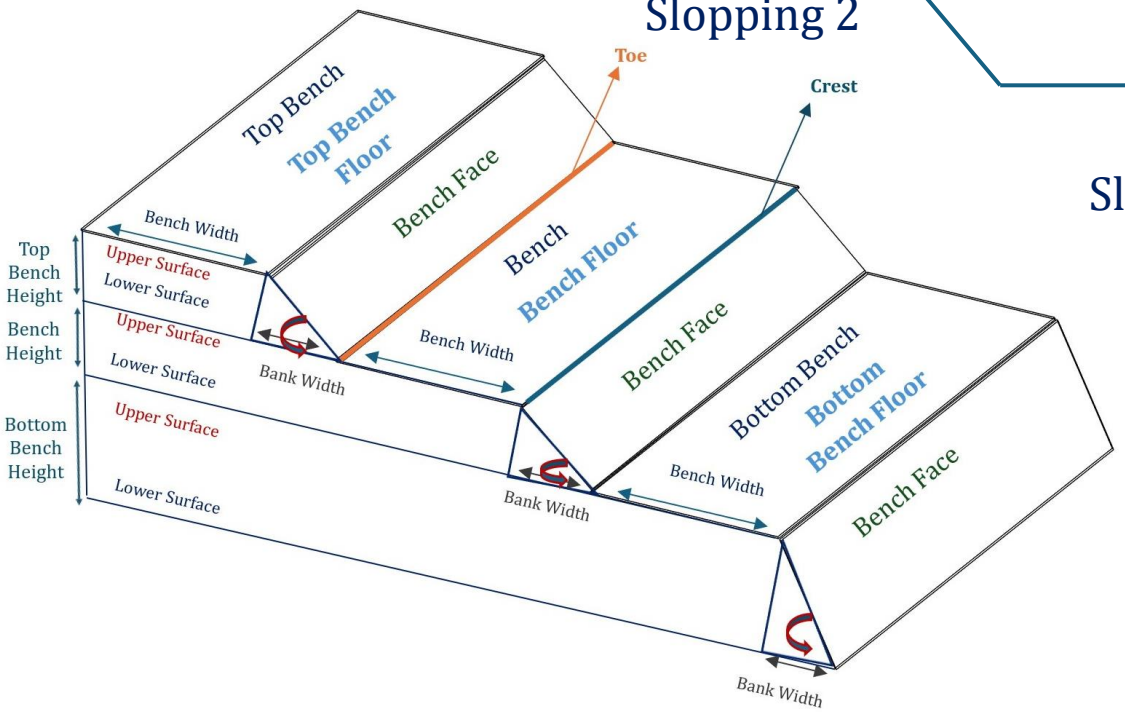
Mining to Closure

Mining

To extract the Ni-CRM, benching for the primary extraction of the beneficial Fe-Ni mining ore is required as shown in the Benching and Slopping Figures.

Slopping 1

Slopping 2



Slopping 3

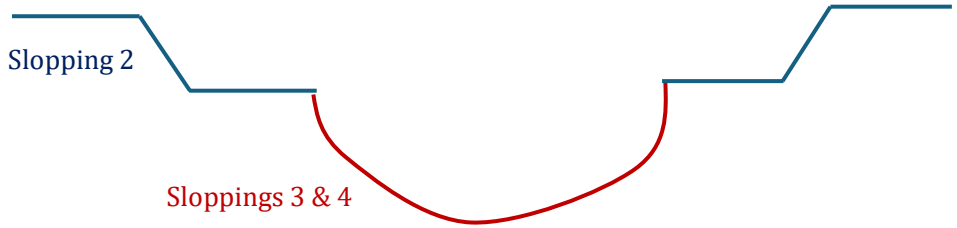
Slopping 4

Bottom of the Benching-Reaching the underground water surface

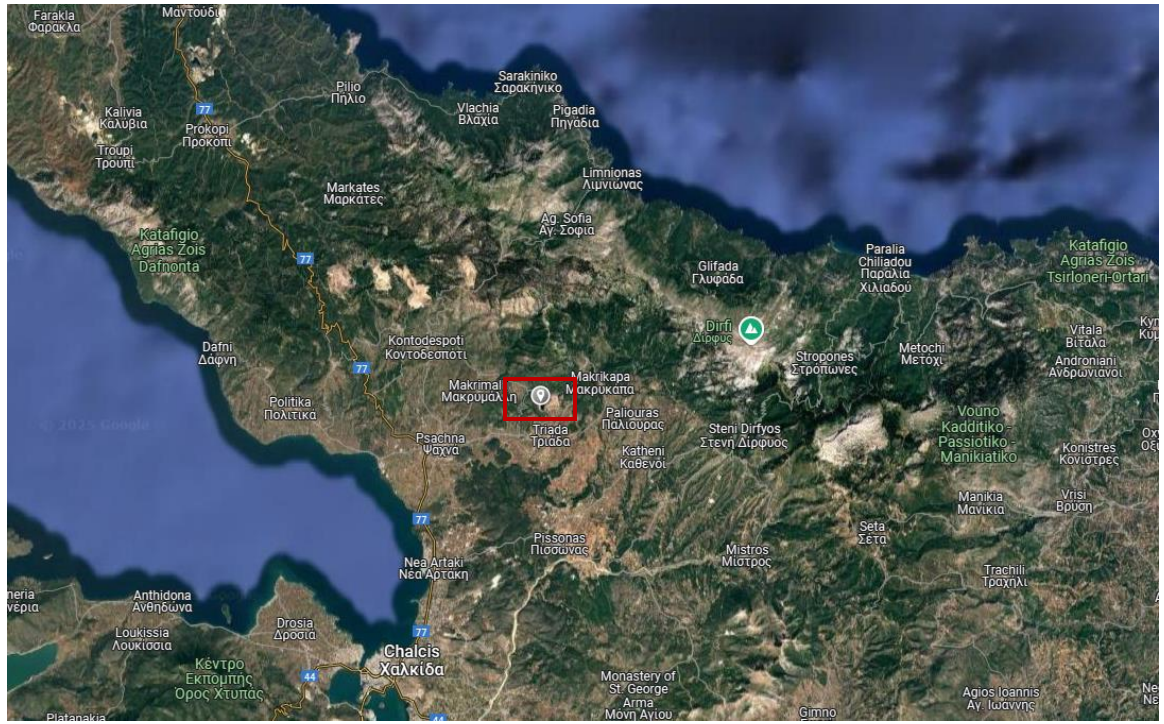
Closure-Pit Lake

Earth working begins to cover the Bench Face smoothly with upper sterile soil.

This is a high-severity procedure to provide the required stability for the constructive pit lake against the hydrostatic pressure of the enclosed water.
The main scope is to transition slopping 3 and 4, as shown



Map of the Virtual Excursion



LARCO GMMSA_Rehabilitated Area of Isoma mine site-Pit Lake

Latitude_38°59’38’’ Longitude_23°70’72’’

CRM – Nickel (Ni)
Click to see Criticality Assessment of Ni

CRM	Supply Risk SR	Economic Importance EI	Criticality CR
Nickel (Ni)	0.5	5.7	2.85
Ranges for SR, EI, CR	0-5	0-9	0-45
Impact on SR, EI, CR (%) (Numerical Value of the CRM) ÷(Maximum Threshold)	$(SR)_{CRM} \div (SR)_{Max}$ 10%	$(EI)_{CRM} \div (EI)_{Max}$ 63.3%	$(CR)_{CRM} \div (CR)_{Max}$ 6.3%

Click to see the uses of Ni

Nickel is a metallic material that is applied in plenty of industrial applications. For instance, nickel is used as a structural material for battery production, in automotive manufacturing, for the construction of energy production units, in stainless steel production, in aerospace engineering, and rarely in the medical industry to produce pharmaceutical products. Despite its low supply risk grade, its economic importance is high. Therefore, according to the European Commission Ni belongs to the critical raw materials and not only a typical base metal.

Supply Risk: Risk Grade of the material resources
Economic Importance: Grade of the material's price value to the market
Criticality: Grade of material's impact on the Market

Source: European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Grohol, M. and Veeh, C., *Study on the critical raw materials for the EU 2023 – Final report*, Publications Office of the European Union, 2023, **https://data.europa.eu/doi/10.2873/725585**

Criticality Matrix

Criticality Matrix		Supply Risk (SR)				
		1	2	3	4	5
(CR)=(EI)*(SR)						
Economic Importance (EI)	1	1	2 **(Ni=2.85)**	3	4	5
	2	2 **(Ni=2.85)**	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25
	6	6	12	18	24	30
	7	7	14	21	28	35
	8	8	16	24	32	40
	9	9	18	27	36	45

- The **Criticality Matrix** displays a quantitative assessment of the Criticality grade for each examined raw material, based on the information contained in the European Study on CRMs, as shown below on this slide.
- The **Supply Risk (SR)** and **Economic Importance (EI)** refer to variable parameters that depends on the entire resources of raw materials and their configured price values according to their demand, respectively. i.e. the SR of a raw material could fluctuate within a period. Therefore, depending on the global resources data and industrial needs, the corresponding Study for CRMs could be updated, including the existing SR and EI indices for raw materials.
- The **Criticality (CR)** is configured by the multiplication of EI and SR grades. The CR index shows the criticality grade of each examined raw material.

Source: European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Grohol, M. and Veeh, C., *Study on the critical raw materials for the EU 2023 – Final report*, Publications Office of the European Union, 2023, **https://data.europa.eu/doi/10.2873/725585**

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