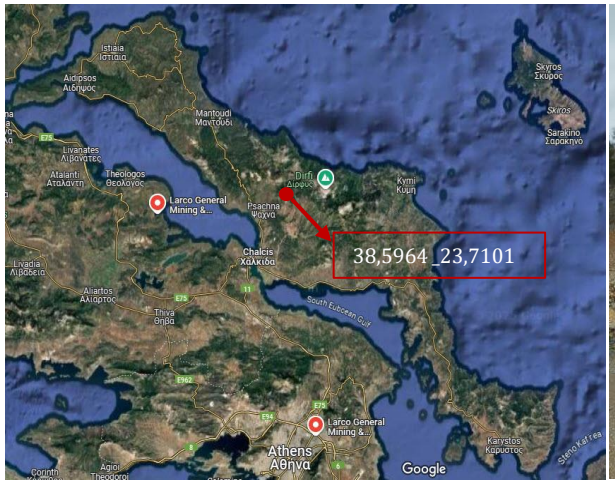
Isoma

Closed Mine Site, Environmental Rehabilitation-Reforestation



Overview | CRM Ni | Location
Environmental Rehabilitation | VEs Map | 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 metalloids enhanced the ecological environment growth, and after a few years, a pit lake was created. The pit lake's depth ranges from 0 to 80 meters, while plenty of fish species exist.

Info from active sites | Mining Ore Information | LOM Flowchart

Info from Previously Active Mine 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 reforested area, as it was the most optimal environmental solution. The area has been environmentally monitored for 10 consecutive years since its primary planting. The occurrence of pseudoaccacia is observed as it is one of the most suitable plants at a height between 100-200 meters (over the sea level).

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 Ore Information

The pictures below show some of the previously active mining operations. The upper ramble networks are now reforested and demonstrated in this VE.

Deposit

Inclined Road

Sterile Material

Square and Mining Face

Deposit

Bench

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

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.

Environmental Management-Info

Environmental Management Plan at Isoma-Agia Triada mine site – Environmental Rehabilitation

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, plant, 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, due to the non-hazardous soil waste, there are no environmental risks, so special plants were reforested to rehabilitate the previously active mine site.

The main criteria for the selection of the most suitable plants to reforest the previously active mine site are a) the area characteristics, and b) the soil chemical analysis.
The consecutive environmental monitoring system is maintained by the administration of the company.

Area Characteristics | Soil & Chemical Analysis

Area Characteristics

Environmental Management Plan at Isoma-Agia Triada closed mine site

The forest vegetation of the wider area, phytogeographically belongs to the Mediterranean vegetation zone (evergreen-broadleaf zone) Quevetalia Ilicis, subzone Quercion Ilicis, and growthspace Orno-Quercetum Ilicis. In this zone, various plant communities appear that are partly degraded and partly dependent on the soil.

Thus, on the ridges and southern exposures of slopes, associations with Erica Manipuliflora and Erica Arborea (heather), Calycotone Vilosa, Spartium, Junceum usually appear, and in the wetter places (Misgangies – Northern exposures of slopes), Quercus ilex (holm oak), Phillyrea Latifolia, Pinus Halepensis (Aleppo Pine) appear.

From an agricultural point of view, olive cultivation is at its cold limits. Viticulture thrives in excellent growing conditions, as do cereal crops.

	Indicative Forest species
1	Quercus coccifera (hollow oak)
2	Pistacia lentiscus (rope)
3	Pistacia terebinthius (turf)
4	Myrtus conmunis (myrtle)
5	Rosa sempervirens (wild rose)
6	Rinus conmunis (black locust)
7	Robinia pseudoacacia (false locust)

Soil Chemical Analysis

Environmental Management Plan at Isoma-Agia Triada closed mine site

The chemical composition of the soil in central Evia varies, but generally includes: mechanical composition (sand, silt, clay), pH, electrical conductivity, calcium carbonate content, organic matter, exchangeable cations (Ca, Mg, K, Fe), and assimilable phosphorus, trace elements (Fe, Mn).

The table shows a typical soil specification analysis of the Central Euboea ground soil.

Soil Samples	pH	Organic Compound	Soil Classification			Exchangable Cations (%/100 gr of Soil)				ppm in Mn
		gr %	Clay Soil%	Silt Soil%	Sand Soil%	Ca^{2+}	Mg^{2+}	K^{+}	Fe^{2+}	Mn^{2+}
1	8.35	23	17.96	21.36	60.68	52.5	9.58	0.37	13	18
2	8.3	35	19.96	22.08	57.96	52.5	2.27	0.27	20	32
3	8.0	77	44.96	23.26	31.68	62	7.08	0.45	7	7
4	8.3	56	18.96	16.36	64.68	55	3	0.37	8	14
5	8.3	78	20.96	17.08	61.98	55	0.91	0.2	4	5
6	8.35	49	23.96	20.00	56.04	57.5	1.08	0.22	5	3

Soil Characteristics

Environmental Management Plan at Isoma-Agia Triada closed mine site

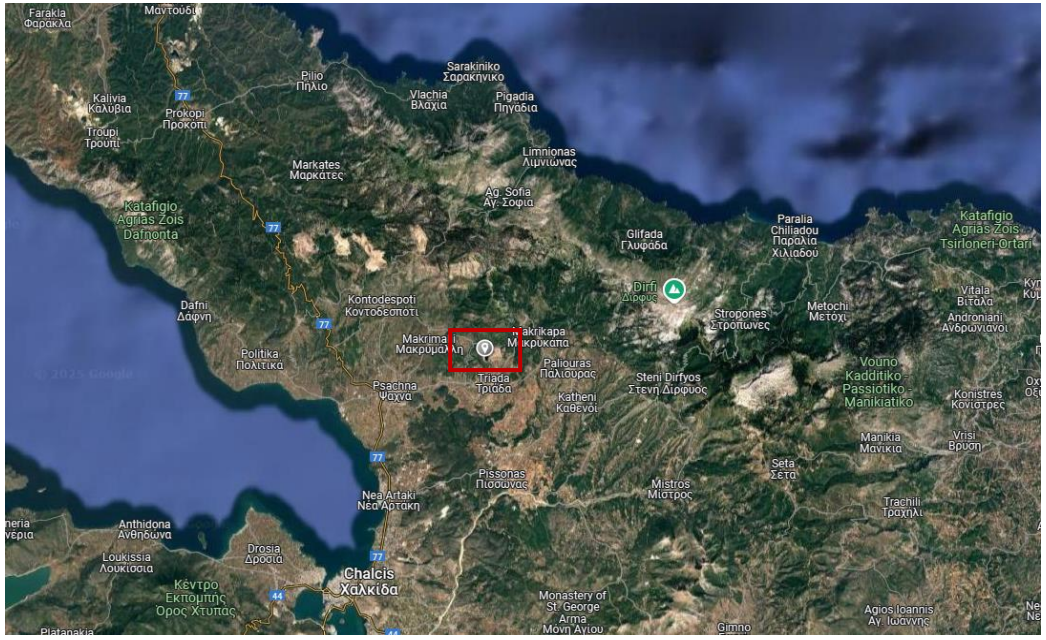
Soil organic matter plays an important role in plant growth, as it:

a) transfers nutrients to plants through humic substances,
b) improves protein synthesis and photosynthesis,
c) acts as a growth hormone for plants,
d) improves enzyme activity,
e) improves the solubility of nutrients, especially trace elements (Fe, Mn) and macroelements (K, Ca, Mg),
f) reduces the toxicity of heavy metals,
g) improves soil microbial activity,
h) supplies the soil with nutrients through the hydrolysis and dissolution of minerals.

Metal elements such as (Ca, Mg, K, Fe, Mn, etc) have a significant effect on fertilizing. Considering that the disposed non-hazardous sterile mining ore contains all these elements, reforestation is the optimal environmental solution to rehabilitate the previously active mining area. Source

Click to see the Chemical Analysis of the local post mining area

Map of the Virtual Excursion



LARCO GMMSA_Rehabilitated Area of Isoma closed mine site-Reforestation
Latitude_38°59’64’’ Longitude_23°71’01’’

CRM-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.

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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