

## MINING RESIDUES AROUND LAKE OHRID

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### Abstract

*The mines pollute the environment through the mining activity itself, which assembles metals on the site, through the discharge of untreated wastewater from the extraction and production process, through the railways tracks that moved the minerals down the mountain and along the shore, and as a result of the runoff from the huge mineral - rich stockpiles of residues that remain at the sites. At the Albanian side near to the Lake Ohrid, there are 10 mines and one enrichment plant [5].*

*Thus, to ensure consistent high quality, the water quality should be monitored. Chemical analyses for the metals Fe, Ni, Co, Cu and Cr were done on the mineral residuals from the mining activity, the surface waters and streams running through the mine sites. All of these chemical elements can reach the lake through rainwater and runoff, through surface water and groundwater discharge to the lake, and through the air [9]. Analysis of the residues themselves showed that they still contained significant amounts of the target minerals. The high concentrations measured in the residues, the streams running through the mining areas, have occurred because the residue piles were exposed on the ground at these sites.*

**Key words:** *ecosystem, metals, pollution, impact, contamination, Lake Ohrid.*

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### 1. Introduction

Lake Ohrid is located at an altitude of 695m, surrounded by mountains exceeding 2000 m in height, has 87.5 km of shoreline, and covers an area of about 358 km<sup>2</sup>. The lake has an average depth of 164m and a maximum depth of 289 m, it

is a trans-boundary lake shared by Macedonia and Albania [6, 8].

Lake Ohrid is one of the oldest lakes in the world; it was formed 2-3 million years ago, in the Tertiary period [6, 8]. Because the lake is so old and has been isolated by surrounding hills and mountains, a unique collection of plants and animals has

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evolved. Some of these plants and animals were common species millions of years ago but they are now considered as relics or “living fossils” because they only persist here in Lake Ohrid as alive organisms. Many other species in Lake Ohrid are endemic, meaning they are only found in this lake. Ten of the seventeen identified fish species of the Lake Ohrid are endemic, as are many of the lake’s snails, worms, and sponges. The reed belt along the coastline of the lake serves as a spawning site for many fish species and is an important wintering site for birds. Ten of thousands of birds of more than twenty species populate the area [4].

Because of its high biodiversity and unique cultural heritage, Lake Ohrid is a lake of tremendous local and international significance. The population of the area now approaches 200,000 permanent residents. This number increases in the summer time as tens of thousands of tourists, both domestic and foreign, come into the region. In Albania, it is the second most important domestic destination for recreation on lakes [5, 6, 8].

## **2. Identification of Polluted areas in the Littoral Zone**

In Albania, the littoral zone adjacent to the town of Pogradec is heavily impacted. Impacts are also apparent to the northeast, at Tushemisht and also at the western and northwestern part, Lin. The abandoned mines and their associated waste piles are source of metal contamination to the adjacent waters and sediments<sup>[1]</sup>.

The evidence of ecological impacts of human activities is apparent in both;

macrophytes community and the phytoplankton in the near shore waters. In the region of Pogradec, phytoplankton densities are much higher than elsewhere along the shoreline, and the macrophytes community has higher tolerance on the level of pollution. In the mining area of Memelisht and Guri i Kuq, the macrophytes show evidence of metal contamination and stunted growth. As the problems of nutrient enrichment and metal contamination are addressed, these habitats should improve.

Near Lake Ohrid, on the Albanian side, there are six mines and one mineral enrichment plant all located within a distance of 2.5 km from the lakeshore. These mines, as well as four other mines located within 10km of the lakeshore, are the source of major impacts on both shore and offshore areas [5].

The mines mentioned here had been operated in their full capacity until the beginning of the 1990s, but now, only one is still operating [2].

Both the residue landfills or slag piles were separated from the ground with an impervious liner and other treatment processes, such as a drainage system to collect and treat the wastewater were generally not operated. Therefore, the mining wastewater drained essentially untreated directly to the Lake Ohrid [3]. Large depositions of residual material left in the region in open pits, which means that every time it rains, meteoric waters contact them, they are contaminate and so they pollute the underground water, streams on the site, and finally goes to the lake itself.

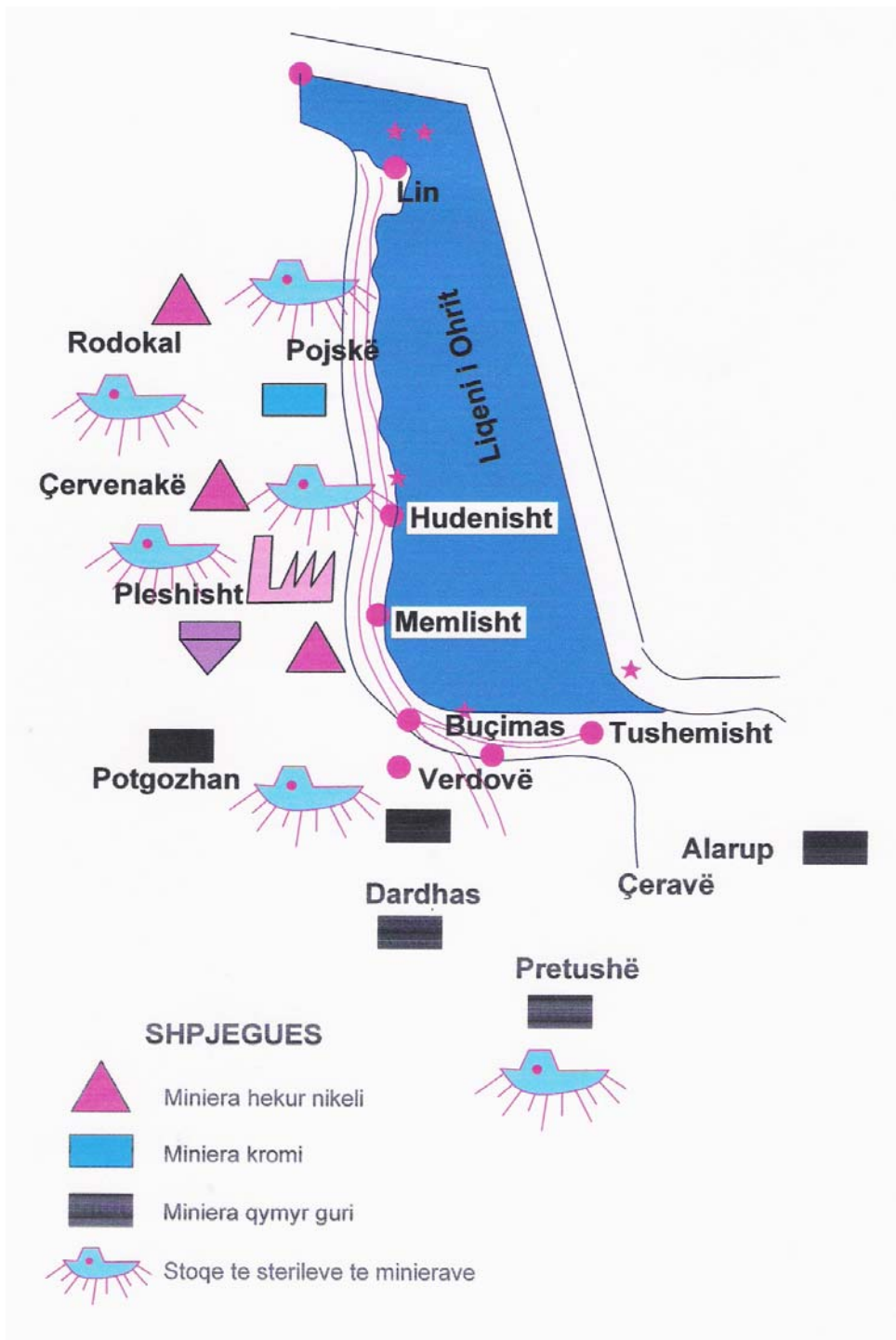


Figure 1. The mining residuals around Lake Ohrid

There is huge potential for significant ecological impact resulting from this contamination. Sediments in the littoral zone offshore of these mine sites are substantially contaminated, with potentially toxic effects on the aquatic life [2, 7]. Some of these metals create bioaccumulations, which poses a risk to fish, birds, and also to the people which use these animals as food. These metals might also directly pose a risk to the population on the area through pollution of drinking water resources [9]. Long terms, chronic exposure to Cr, Cu, Co, Fe, Ni, and other metals found in the site have documented detrimental effects to human health.

### 3. Experimental

Although a wide literature and data / analyzes made from different researchers

are taken in regard it was not enough, that's why we have taken a field observation around Lake Ohrid, and took solid and liquid samples, limited in number but useful, for chemical analyzes. We started the observation at an area considered as a "hot spot" of industrial pollution in Albania [1].

The samples for the assessment of harmful and toxic elements in water, were taken in the outpouring of the waters, the so called "flowing channel" of the Guri i Kuq mine into the lake (sample no.4) Fig. 5, on the edge of the lake at the stockpile of slag at the train station (sample no.2) Fig. 4, in the water flowing at the stockpile of slag in Hudenisht (sample no. 3) Fig. 3, and in the flowing waters of Pojska chromium mine (sample no.1) figure 2.



*Figure 2. Water flow from Pojska chromium mine*



*Figure 3. Hudenisht stock Pile*



*Figure 4. Railway train Station*



*Figure 5. Guri i Kuq under the tunnel*

As shown, the moss is an indicator of environmental pollution, where micro-elements like Ni, Cr, Pb and Zn are concentrated.

We used individual sample type “grab”. This individual sample shows the water characteristics in time and place of collection. The samples were carefully transported and preserved. The container was out of plastic (e.g. PET), having in consideration that in the water sample conservation methods for the chemical analytic those are the suitable containers for guarding the chemical contains [3].

The measurements of pH and water temperature were done in situ. We used pH/Conductivity-meter Multi 340i/Set for this analysis. To analyze the chemical

composition we used Photometer C2000 HI 830000 Series Multiparameter Bench Photometers [2]. The Atomic Absorber was used for the analytical measurements of Fe, Co, Ni, Cr, Zn, and other solids component.

The results registration and their elaboration were done with Ms Excel 2003.

#### **4. Results and Discussion**

The data must be considered as a sample which can be used only for information and not to derive conclusions, especially the time distribution of the pollution.

**Table 1.** The content of microelements in water samples

No. of Sample	Point Sample	pH	Microelements content, mg/l						
			Fe	Ni	Co	Cr	Cu	Pb	Zn
1	Pojškë (under tunnel)	7.8	-	-	-	0.001	-	0.005	0.01
2	Railway station (Lake)	7.8	0.12	0.1	0.05	0.015	0.05	0.05	0.2
3	Hudënishtit Stockpile	6.2	0.76	0.23	0.1	0.025	0.05	0.05	0.55
4	Flow waters from mine	8.2	6.82	2	0.25	0.045	0.10	0.05	0.5

Considering our measurement in confront of allowed rates of liquid discharging for several microelements (according to the Albanian law) based on Council of Ministers Decision of 31.03.2005, it results that:

The value of measured pH is within the rates allowed.

The value of Fe content (Fe = 6.82 mg/l), in waters that flows from the mine of Fe-Ni of Guri i Kuq and pours directly in the lake are 2 times higher than the rates allowed.

The value of Ni content (Ni = 2 mg/l), in waters that flows from the mine of Fe-Ni of Guri i Kuq and that pours directly in the lake are 4 times higher than the rates allowed.

The value of Co content (Co = 0.25 mg/l), in waters that flows from the mine of Fe-Ni of Guri i Kuq and that pours directly in the lake are much higher than the rates allowed.

The value of others microelements as Cr, Pb, Zn, Cu, are within the rates allowed.

The value of content of toxin microelements measured in water discharged of

slag piles of Enrichment plant of Fe-Ni in Guri i Kuq and Hudënisht are within the rates allowed.

The high concentrations of Fe and Ni in waters that flow from the mine of iron-nickel of Guri i Kuq and discharged into the lake without any obstacle or filter, have seriously affected the flora and fauna of the lake (especially some fish species), that can't resist the new habitat. Nickel is an essential element for life, but when its value exceeds the allowable limits, it may be a risk for life and classified as a carcinogen element. Value higher than 0.4 mg/l causes allergy up to irritability and heavy wounds to humans.

As we mentioned above, to assess the content of some microelement in slag of enrichment plant of Guri i Kuq, at the mineral stocks of Fe-Ni near Memelisht Lake (str. Cervenakës) and in the moss developed in waters that flows from the mine gallery of Pojska, we took three solid samples for chemical analyzes. Results of these analyzes are shown in Table 2.

**Table 2.** Results of solid samples analyzes

No. of samples	Point sample	Description	Chemical element content in % or µg/gr						
			Fe <sub>2</sub> O <sub>3</sub>	Ni	Co	Cr <sub>2</sub> O <sub>3</sub>	µg/gr Cu	µg/gr Pb	µg/gr Zn
1	Str. Çervenakës	Ore Fe-Ni	57.14	0.96	0.04	2.78	10	100	200
2	Train Station (Pg)	Slag Fe-Ni	44.44	0.86	0.05	6.64	8.9	79	175
3	Pojskë (under the tunnel)	Moss	2.40	0.04	0.004	0.5	--	50	120

As shown, the content of Fe, Ni, and Cr in the sample of ore stock of Memlisht (Str. Çervenakës), are higher (respectively 57.14%, 0.96% and 2.78%), while in slag of enrichment plant deposited in stockpile at the railway station of Guri i Kuq, is observed a very high content of chromium (Cr) that reaches till 6.64%, a potential source of chromium pollution maybe a Cr<sup>+6</sup> too. Their sliding or movement into

the lake will enrich its water with Fe, Ni and Cr (total).

According to the above accounts it results that in the shore of Pogradeci lake from Guri i Kuq till Memlisht, exists 557 091 ton Iron, 10 584 ton Nickel and 75 465 ton Chromium, which without any doubts constitute a considerable pollution source for the waters of this lake.

**Table 3.** Quantity of Fe, Ni and Cr in stockpiles

Point sample	Quantity ton/ore	Content in %			Quantity in ton/metal		
		Fe	Ni	Cr	Fe	Ni	Cr
Stockpile Memlisht	135 000	57.14	0.96	2.78	77 139	1296	3753
Stockpile at the railway station	1 080 000	44.44	0.86	6.64	479 952	9288	71712
Total:					557091	10584	75465

## 5. Conclusions

The mine fields located on the Albanian shoreline poses a potentially significant risk to the living organisms in Lake Ohrid. Limited sampling conducted to date suggests that iron, nickel, chromium, copper, and other metals are entering the lake every time it rains. Despite the fact that most of these mines had been closed, because of the large

volumes of wastes piled onshore, this threat persists. Additional analyses should be done to find adequate solutions.

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