UNEP Balkans Technical Report

Analytical Results of UNEP Field Samples from Industrial Hot Spots in Albania

November 2000

Working Document Only

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1.0 Introduction

During the week of 17-24 September 2000, a UNEP mission visited Albania to assess environmental conditions in the aftermath of the Kosovo conflict. The mission divided into three subgroups that investigated the impacts of the refugee influxes into Albania; industrial 'hot spots' posing urgent threats to public health and the environment; and Albania's institutional capacities for environmental protection.

During the mission, UNEP's team of international experts worked closely with national experts from Albania. The 'hot spot' subgroup visited nine industrial sites throughout the country. At the sites, UNEP experts met with company or local officials, inspected facilities and environmental conditions, and took samples, as appropriate. The following report summarizes and interprets UNEP's sample results and contains expert observations on site conditions. To read the complete UNEP assessment, *Post-Conflict Environmental Assessment—Albania*, please refer to the UNEP Blakans website at: balkans.unep.ch. To order a hard copy of the report, please call 41 22 917 8616, send an e-mail to ljerka.gosovic@unep.ch, or write to UNEP – Balkans, International Environment House, Chemin des Anémones 15, 1219 Châtelaine, Geneva, Switzerland.

2.0 Analytical Methods

The following is a discussion of laboratory results based on soil, water and air samples taken in the field by UNEP experts.

Metals were analysed at GALAB, Geesthacht, Germany (Mr. Hempel, Mr. Jantzen, and Mr. Kuballa). Dioxin and furan analyses were made at TÜV Süddeutschland Umweltservice, Donzdorf, Germany (Mr. Höckel, Mr. Haag), using the German standard method (VDI 3499) with high resolution mass spectrometry (HRGC/HRMS). Milk analysis was conducted at SLVA in Potsdam (Mr. Volland) using GC/ECD/ECD-system according to Bundesgesetzblatt 28 Nr. 1 January 1985.

Soils and sediments were analyzed in fractions smaller than 2 millimeters. Heavy metals in sediments were analyzed in fractions smaller than 20 µm. Samples were investigated for polynuclear aromatic hydrocarbons (PAHs), phthalates, tensides (ionic and nonionic) and semi-volatile chlororganic pollutants. For polychlorinated biphenyls (PCBs), the German standard methods DIN 38414-20 and DIN EN ISO 6468 were used. PAHs were analysed according to U.S. Environmental Protection Agency (USEPA) method 610, volatile/semi-volatile chlorinated compounds by GC/MS following USEPA method 624.2.

Analysis of volatile and semi-volatile compounds were realized using the SBSE (Stir Bar Sorptive Extraction) technique in the water phase with the help of 'Twisters' donated by Gerstel GmbH, Mülheim, Germany. Air samples were characterized in a GC/MS system (full-scan measurements) after thermodesorption of tenax tubes.

Mercury was analysed with AAS after digestion with hydrochloric and nitric acid. All other elements (Cr, Cu, Mn, Ni, Cu, Zn, As, Cd, Pb, Sb, Hg) were analysed with TXRF and ICP after total digestion with nitric and hydroflouric acid.

All soil and sediment concentrations are related to dry weight.

Organic compounds were analyzed with GC/MS, HPLC and GC/ECD at the Brandenburg State Office for Environment in Potsdam, Federal Republic of Germany (B.Wronski, R. Donau).

3.0 Sites Visited and Sample Results

3.1 Pesticide and dichromate plant, Durres

Until 1990, the former chemical plant in Durres produced sodium dichromate, for leather tanning, and pesticides, such as lindane (gamma-HCH) and thiram. Both productions processes have been idle since that time and the plant's buildings have been totally destroyed. When the plant was operating, it produced 6-10 tons of lindane per year.

Families have been living in the area of the former lindane production process for several years (two children were born there). Their houses were built using contaminated bricks from the old lindane production buildings 20 meters away. As a result, the people living there are in a heavily contaminated zone.

The families are keeping domestic animals – such as cows, sheep and goats – inside the plant area. The domestic animals feed there and are exposed to the contaminated soil. A well with a depth of about 6 meters is located inside the plant and is being used to water the animals and irrigate vegetables.

UNEP analyses showed extremely high levels of technical HCH mixtures in the area of the plant and in storage facilities located two kilometers away. UNEP samples identified tetra-, penta-, hexa- and hepta-chlorinated cyclohexanes, in which the hexachlorinated isomers were dominant.

Technical HCH mixture is produced by the photochlorination of benzene. It contains 65-70% α-HCH; 7-10% β-HCH; 14-15% γ-HCH (lindane); 7% δ-HCH; 1-2% ε-HCH and 1-2% of other chlororganic compounds, e.g., heptachlor- and octachlorcyclohexanes. Lindane is separated by extraction with methanol. The mixture of the other HCH-isomers can be converted by thermic treatment to useful byproducts like trichlorbenzene and hydrogen chloride.

In general, the average concentration of these isomers in agricultural soils is 0.01 mg/kg. The water solubility of α- and γ-HCH is much higher than that of β- and δ-HCH. (The water solubility of lindane is 6 mg/l at 20°C) In Germany and other European countries the use of lindane has been prohibited since the mid-1970s.

A UNEP **soil sample** taken from the lindane production area contained **8.79 g/kg of HCH-isomers** was found (2.4 g/kg of α-HCH; 2.0 g/kg of β-HCH; 3.14 g/kg of γ-HCH; 1.29 g/kg of δ-HCH). The content of heptachlorinated cyclohexane was 10%, the tetra- and pentachlorinated cyclohexane 5 %. The sample also contained 0.172 g/kg of tri- and tetrachlorinated benzenes.

A **well water sample** contained 4.4 mg/l of chlorobenzene (solubility in water: 500 mg/l), 60 µg/l of 1,3- and 1,4-dichlorbenzene (solubility in water: 120 mg/l and 70 mg/l); and 7 µg/l of 1,2,3- and 1,2,4-trichlorobenzene (solubility in water: 30 mg/l), all of which are intermediate products of the process. The **HCH content** in this sample was **4 µg/l**. (This compares, e.g., with a German trigger value for drinking water of 0.01 µg/l.)

A **milk sample** showed a HCH content of 4.86 mg/kg of α-HCH, 7.27 mg/kg of β-HCH, 0.13 mg/kg of γ-HCH, 0.47 mg/kg of δ-HCH, and 0.084 mg/kg of ε-HCH. These levels are 40 times the German trigger level for α-HCH (0.1 mg/kg) and 100 times the trigger level for β-HCH (0.075 mg/kg). These concentrations suggest that the milk cannot be used for human nutrition without posing a serious risk for health. It can be assumed that the concentration of HCH-isomers in the animal's tissue is much higher.

A sample of **sheep's wool** contained 0.062 mg/kg of α-HCH, 0.11 mg/kg of β-HCH, and 0.14 mg/kg of δ-HCH. These results, especially for α-HCH and β-HCH, are consistent with the theoretical 100:1 ratio between the contents of fat tissues (the milk in this case) and hairs.

A **soil sample** from the area of the former dichromate plant (about 20 m from the lindane production process) contained HCH-isomers in the following quantities: 1.1 mg/kg of α-HCH, 0.71mg/kg of γ-HCH and 0.4 mg/kg of δ-HCH. An inorganic analysis of this same sample found **317 mg/kg of chromium**. The content of Cr(VI) was below 1 mg/kg.

About 1 km away from the plant is a settlement. A canal flowing from the former plant passes the settlement and flows through a pump station into the Adriatic Sea. Samples from the canal water and sediments did not find technical HCH and its byproducts.

The **sediment sample** from the canal (15m from beach) has a content of: **Cr: 24 mg/kg**; **Cr(VI): < 1 mg/kg**. **Another sediment sample** from the flood area found **264 mg/kg of Cr** and **< 1 mg/kg of Cr(VI)**. It can be assumed that the chromium compounds are distributed by wind and water from the source.

Sample results from chemical plant in Durres – 20 September 2000

UNDUA01: Air sample from 40 m behind former lindane production process

Approximately 4 ppb of pentachlorcyclohexane. (Content probably resulting from particles on sampling tube.)

UNDUA02: Air sample from 60 m behind former lindane production process

Approximately 4 ppb of pentachlorcyclohexane. (Content probably resulting from particles on sampling tube.)

UNDUOS01: Sheeps wool sample from house 20 m behind former lindane production process

Very high levels of HCH-isomers in mg/kg: α-HCH: 0.062; β-HCH: 0.11; and δ-HCH: 0.14.

UNDUOS02: Milk sample from house 20 m behind former lindane production process

High levels of HCH isomers in mg/kg fat: α-HCH: 4.86; β-HCH: 7.27; γ-HCH: 0.13; δ-HCH: 0.471; ε-HCH: 0.084; HCB: 0.02.

UNDUOS03: Pepper sample from house 20 m behind former lindane production process

No HCH in vegetable material.

UNDUS01: Soil sample from chemical reactor hall of former pesticide production process

Very high levels of HCH-isomers: α-HCH: 2,400 mg/kg; β-HCH: 2,000 mg/kg; γ-HCH: 3,140 mg/kg; δ-HCH: 1,290 mg/kg

UNDUS02: Salt sample from chemical reactor hall of former pesticide production process

Technical Na_2SO_4 as basic material for the sodium dichromate production

UNDUS03: Soil sample from sodium bichromate production

Heavy metals	Cr^{6+}	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/kg	<1	317	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
High level of HCH isomers: α-HCH: 1.1 mg/kg; β-HCH: low levels; γ-HCH: 0.71 mg/kg; δ-HCH: 0.40 mg/kg								

UNDUW01: Water sample from 6 m deep well outside house 20 m behind former lindane production process; well water used only for animals

Very high levels of chlorinated benzenes: chlorbenzene: 4.4 mg/l ; 1,3- and 1,4-dichlorbenzene 0.06 mg/l; 1,2,3 and 1,2,4-trichlorbenzene: 0.007 mg/l

UNDUW02: Water sample from 6 m deep well outside house 20 m behind former lindane production process; well water used only for animals

Very high levels of chlorinated benzenes: chlorbenzene: 4.4 mg/l ; 1,3- and 1,4-dichlorbenzene 0.06 mg/l; 1,2,3 and 1,2,4-trichlorbenzene: 0.007 mg/l

UNDUW03: Water sample from channel near pump station at waste dump

Heavy metals	Cr^{6+}	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/L	<0.005	<0.005	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
No technical HCH content.								

UNDUSD01: Sediment sample from channel near pump station at waste dump

Heavy metals	Cr^{6+}	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/kg	<1	24	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
No technical HCH content.								

UNDUSD02: Sediment sample from field near channel at waste dump

Heavy metals	Cr^{6+}	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/kg	<1	264	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
No technical HCH content.								

3.2. Chlorine alkali and PC factory, Vlore

Four miles north of Vlore is the site of a former chemical complex that produced chlorine alkali, vinyl chloride monomer and polyvinyl chloride. The plant was closed in 1992, and its buildings have been completely destroyed since that time. Families now live on and around the industrial site.

The factory encompasses approximately one km^2 and is located directly on the Adriatic Sea. A major environmental problem is posed by the destroyed former chlorine-alkali electrolysis plant. UNEP observed drops of metallic mercury in the hall of the electrolysis plant and in all of its drainage canals. A UNEP **soil sample** found **mercury levels > 10,000 mg/kg** in the area of the former plant. This level is 1,000 times greater than typical EU thresholds.

Between the former plant and the Sea is an area formerly used for the disposal of the factory's industrial wastes. It is likely to be highly polluted.

Sample results from plant in Vlore – 19 September 2000

UNVLS01: Soil sample from wastewater canal near Hg - alkaline electrolysis process

Heavy metals	Cr	Cu	Zn	Ni	Mn	Pb	Cd	Hg
mg/kg	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	>10,000 (visible)

UNVLS02: Soil sample from under transformer station

Typical fingerprint of old, decomposing mineral oil: disulfide; no PCBs.

The principle of chlorine-alkali electrolysis

Chlorine-alkali electrolysis has been used in the production of caustic soda, potash lye and chlorine. The mercury leakage at Vlore was probably a result of damage to the plant facilities. As the following description of chlorine-alkali electrolysis illustrates, mercury leaks do not ordinarily occur during the normal functioning of the process.

The electrolysis of alkali chloride solutions (e.g., sodium chloride) can be described as follows:

Equation of cathodic reaction: $2\,H_2O + 2e^- + (2\,Na^+) \rightarrow H_2 + 2\,OH^- + (2\,Na^+)$

Equation of anodic reaction: $2\,Cl^- \rightarrow Cl_2 + 2e^-$

Leading to the total reaction equation:

$$2\,Cl^- + 2\,H_2O + (2\,Na^+) \rightarrow H_2 + Cl_2 + 2\,OH^- + (2\,Na^+)$$

Mercury, a cathodic material, eliminates sodium instead of hydrogen.

$$Na^+ + e^- + xHg \rightarrow NaHg_x$$

The amalgam, $NaHg_x$, is destroyed separately, forming sodium hydroxide:

$$NaHgx + H_2O \rightarrow Na^+ + OH^- + 1/2\,H_2 + xHg$$

During the process, a highly concentrated lye with very low chloride is obtained.

Because the mercury circulates in a closed technical process, environmental risks are not expected under normal process conditions. Throughout the process, the mercury retains its metallic character. Sodium hypochloride and sodium chlorate, however, can leak out when the system is not tightly secured.

3.3 Marize oil field, Patos

The Marize oil field in Patos is one of Albania's largest oil fields. It covers 200 square kilometers and contains 2,000 wells. The field produces 400 tons of crude oil per day. Vast areas of the oil field are covered with leaked crude oil. The leaked crude oil is contaminating soil and groundwater in the area.

The field is also a source of air pollution. Oil stored in open tanks evaporates into hydrocarbons and enter the atmosphere. A UNEP **air sample** from the oil field showed a concentration of aliphatic and aromatic **hydrocarbons** in the range of **4 – 90 µg/m^3**.

Sample results from oil field in Patos – 21 September 2000

UNPAA01: Air sample from oilfield in Patos

Low level of aromatic and branched aliphatic hydrocarbons in range of 4-90 µg/m^3.

3.4 Oil refinery, Ballsh

The refinery in Ballsh produces 300,000 tons of refined oil per year. The crude oil it receives from domestic oil fields is impure, with high contents of sulphur and clastic materials. The refinery is leaking large quantities of oil. A second major problem is soil pollution caused by the separation of crude oil components with water. Highly contaminated wastewater is draining into the Gjanica River without any treatment. The oil phase of the water collects on the walls of the drains, and the soil is saturated with crude oil and its compounds.

A UNEP **water sample** taken from the Gjanica River 2.5 - 3 km downstream the refinery found **traces of oil**. Most of the oil remains on the riverbanks and the drains.

Sample results from oil refinery in Ballsh – 21 September 2000

UNBAW01: Water sample from bank of the Gjanica River 3 km downstream from refinery

Traces of oil fingerprint.

UNBA002: Oil sample from bank of the Gjanica River 3 km downstream from refinery

Typical fingerprint of mineral oil components (i.e., aliphatic hydrocarbons)

3.5 Waste Disposal Site, Sharra

Sharra is Tirana's principal landfill. It stores most forms of non-industrial urban waste, including medical waste. The area's soil and water is vulnerable to pollution due to the geological structure of the soil (sand, gravel and clay), the lack of a protective lining, untreated drainage water and the hydrological connections between groundwater and the surface water of the Erzen River. The chemical and microbiological conditions of the soil and water require a detailed assessment.

UNEP samples were analyzed for organic and inorganic pollutants. **Soil samples** from the landfill contained **urban organic compounds**, such as **fatty acids** (mono – and dicarbonoic acids), **phthalates**, ionic and non-ionic **tensides** in the range of approximately **10 mg/kg**. The dioxin content of the soil was not significant.

Significant air pollution is being caused by the burning of waste, especially plastics. An **air sample** contained traces of substances typical of combustion, such as **alkylated benzenes** and **PAHs**. The propellant **trichlormonofluoromethane** was also found. Because the dumpsite is completely accessible to domestic animals and people, higher levels of these pollutants are probably being directly inhaled.

The nearest village is Peze Helmet, 2.5 km downstream from the dumpsite. UNEP **water samples** from the Erzen River in Peze-Helmet contained **higher levels of tensides**. The heavy metal content of the water was not significant.

UNEP also took samples from the Peze e Vogel water treatment station on the bank of the Erzen River. The station provides drinking water to eight nearby villages. Due to the natural filtration and adsorption provided by the river bank's sand layers, the levels of organic compounds in the treatment station's water were lower than those found in the river.

Sample results from Sharra Landfill – 18 September 2000

UNTIS01: Soil sample from Sharra landfill

Urban organic compounds: fatty acids; phthalates and tensides.

UNTIS02: Soil sample from Sharra landfill

PCDD	ng / kg TS
2,3,7,8-TetraCDD	n.d.
1,2,3,7,8-PentaCDD	n.d.
1,2,3,4,7,8-HexaCDD	1.2
1,2,3,6,7,8- HexaCDD	2.0
1,2,3,7,8,9- HexaCDD	1.1
1,2,3,4,6,7,8-HeptaCDD	12.9
OctaCDD	26.1
PCDF	ng / kg TS
2,3,7,8-TetraCDF	2.0
1,2,3,7,8(+1,2,3,4,8)-PentaCDF	1.6
2,3,4,7,8-PentaCDF	1.3
1,2,3,4,7,8(+1,2,3,4,7,9)-HexaCDF	2.5
1,2,3,6,7,8-HexaCDF	2.9
1,2,3,7,8,9-HexaCDF	n.d.
2,3,4,6,7,8-HexaCDF	2.2
1,2,3,4,6,7,8-HeptaCDF	8.9
1,2,3,4,7,8,9-HeptaCDF	n.d.
OctaCDF	4.5

UNTIA01: Air sample from Sharra landfill

Traces of benzene derivatives (combustion), greenhouse gases, freons.

UNTIW01: Water sample from Peze-Helmet landfill, 2.5 km from Sharra landfill

Approximately 10 mg/l of urban organic compounds: fatty acids; phthalates and tensides.

UNTIW02: Water sample from Peze-Helmet landfill, 2.5 km from Sharra landfill

Heavy metals	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/l	<0.005	<0.005	0.009	0.013	0.034	<0.02	<0.005

UNTIW03: Water sample from Peze-Helmet landfill, 2.5 km from Sharra landfill

Heavy metals	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/l	<0.005	<0.005	0.009	0.013	0.034	<0.02	<0.005

UNTIW04: Water sample Peze e Vogel water treatment station

Low level of organic pollution.

3.6 Nitrate fertilizer plant, Fier

The fertilizer plant in Fier was productive between 1967 and 1992. During four of those years (1967-71) the raw material for production of the fertilizer was crude oil with high sulfur content. Today, an environmental risk is posed by the storage of approximately 850 m^3 of arsenite/arsenate solution in 30 year-old steel columns. The steel columns are corroded, and leakage of the stored solution is possible. A large amount of arsenite/arsenate solution could pollute the environment, because the volume of the stored solution significantly exceeds the volume of a concrete basin under the columns.

UNEP took **soil samples** in the area. The concentration of **arsenic** in soil located 50 m from the steel columns was **830 mg/kg**. Values of arsenic as high as **172,300 mg/kg** were established outside the basin, near a pile of used Raschig rings. Soil inside the concrete basin under the columns contained **42,133 mg/kg** of arsenic. A sample of **wastewater** from the outlet of the basin was polluted with **97.7 mg/l of arsenic**. Given the levels of pollution, it can be assumed that arsenic compounds are being transported from the source by wind and water. Spread of this pollution to the groundwater and surface water must be prevented.

The fertilizer production process

The fertilizer production process can be divided into several steps.

1. The crude oil is thermally cracked following desulfurization with sodium arsenite and arsenate solution by the Gimmarco-Vetrocohe process:

$$2\ H_3AsO_4 \quad + \quad 5\ S^{2-} \longrightarrow As_2S_3 \ + \quad 2\ S\downarrow \quad + \quad 8\ H_2O$$

   The sulphur is eliminated mainly in the form of thioles, sulfides, sulfurated hydrogen and heterocyclic compounds. The arsenate solution is the carrier of oxygen. Hydrochinone is the process catalyst. The eliminated sulphur is contaminated with arsenic.

2. Synthesis gas is produced.

3. Ammonia is produced by the classical Haber Bosch process:

$$3H_2 \ + N_2 \longrightarrow 2NH_3$$

4. Nitric acid is produced by nitrous gases, and ammonium fertilizer is produced from the nitric acid and ammonia.

Sample results from fertilizer plant in Fier – 19 September 2000

UNFIS01: Soil sample from fertilizer plant; near storage container for As-solution

Heavy metals	As
mg/kg	830

UNFIS02: Soil sample from fertilizer plant; near storage container for As-solution

Heavy metals	As
mg/kg	172,300

UNFIS03: Soil sample from fertilizer plant; near storage container for As-solution

Heavy metals	As
mg/kg	42,133

UNFIW01: Sample of plant wastewater at basin outlet

Heavy metals	As
mg/l	97.7

3.7 Metallurgical complex, Elbasan

The metallurgical complex in Elbasan was in full operation between 1977 and 1990. During this period, the complex emitted quantities of SO_2, CO_2, NH_3, cyanides, phenols, H_2S and dust.

Since 1990, all of the processes have been closed, except a scrap steel smelter. The smelter emits particles, CO, SO_2 and iron dust.

The main environmental problem today is caused by a hydro-tailing sediment site containing tailings and dust from a former coke production process. A UNEP **soil sample** contained high levels of chromium and other heavy metals: **Cr: 13,077 mg/kg; Cu: 41 mg/kg; Zn: 128 mg/kg; Ni: 5,174 mg/kg; Mn: 2,572 mg/kg**. All other pollutants were not found in significant quantities.

In addition, the complex contains the only biological sewage treatment station in Albania. It no longer functions, however, and the complex discharges untreated wastewater.

Sample results from metallurgical complex in Elbasan – 20 September 2000

UNELS01: Soil from hydro-tailing sedimentation wall

Heavy metals	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/kg	13,077	41	128	5,174	2,572	94	<10

3.8 Copper factory, Rubik

Until it closed in 1998, the copper factory in Rubik produced refined copper products for wiring. Copper residues from the production that were formerly sold for sandblasting now remain deposited on the site, near the Fanit River. No protective lining was installed underneath the slag to protect the soil. UNEP **soil sampling** found that the slag contains copper, chromium and lead in the following concentrations: **Cu: 1,696 mg/kg; Cr: 492 mg/kg; Pb: 99 mg/kg**.

Under normal conditions the heavy metals are immobilized in the slag. If the slag is rinsed **with acidic rainwater** containing pH~3, however, conditions change. The heavy metals are washed out, and the acidic water contains copper, chromium and cadmium. A UNEP analysis found: **Cu: 22.46 mg/l; Cr: 0.04 mg/l; Cd: 0.012 mg/l**. Acidic rain occurs when sulfuric dioxide emitted by ore factories clings to rainwater. If the ore processing is closed, acidic rain will not be produced or deposited onto the slag.

Sample results from copper factory in Rubik – 22 September 2000

UNRUS01: Soil sample of mine slag

Heavy metals	As	Sb	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/kg	<10	<10	492	1,696	n.d.	n.d.	n.d.	99	<10

UNRUS01: Water sample of acidic extract from slag (water with sulphuric acid pH=3):

Heavy metals	As	Sb	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/l	<0.02	<0.02	0.04	22.46	n.d.	n.d.	n.d.	<0.02	0.012

3.9 Phosphate fertilizer factory, Lac

The former phosphate fertilizer factory in Lac closed down in early 2000, after 33 years of production. When it was in operation the factory used calcium phosphate to manufacture fertilizer. The process involved converting copper sulfide and ferro sulfide to sulfuric acid. Next, calcium phosphate was processed with the sulfuric acid to create superphosphate fertilizer.

Today, a slagheap containing residue from the production process remains on the factory site. No protective lining was installed underneath the slag. UNEP **soil sampling** found that the main components of the stored slag were: **Cu: 1,422 mg/kg; As: 526 mg/kg; and Pb: 43 mg/kg**. After treatment **with acidic water** containing pH~3, the resulting solution contained**: Cu: 26.36 mg/l; As: 8.5 mg/l; Cd: 0.014 mg/l; Cr: 0.011 mg/l**.

Sample results from phosphate fertilizer factory in Lac – 22 September 2000

UNLAS01: Soil sample from slag heap

Heavy metals	As	Sb	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/kg	526	<10	<10	1,422	n.d.	n.d.	n.d.	43	<10

UNLAS01: Sample of acidic extract from slag (water with sulphuric acid pH=3):

Heavy metals	As	Sb	Cr	Cu	Zn	Ni	Mn	Pb	Cd
mg/l	8.5	<0.02	0.011	26.36	n.d.	n.d.	n.d.	<0.02	0.014