

## **Appendix O**

### **Exploitation of the Nkamouna Cobalt Ore. Information and Sensitization Campaign**

**EXPLOITATION OF THE NKAMOUNA COBALT ORE**  
**INFORMATION AND SENSITISATION CAMPAIGN**

# EXPLOITATION OF THE NKAMOUNA COBALT ORE

## INFORMATION AND SENSITISATION CAMPAIGN

In may 2006, in Yaounde, Bertoua, Lomié, during the public restitution of the preliminary Environmental and social Impact Studies of the Cobalt-Nickel project by GEOVIC CAMEROON PL. The major preoccupations of the public were related to:

- The potential effects of Cobalt on human health in the exploitation zone,
- Fear of the presumed radioactivity of Cobalt
- The beneficial aspects of the mining activity.

In order to better inform and sensitize the Cameroonian society in general and the people of the locality of Lomié in particular, a multidisciplinary team of experts coordinated by the divisional delegate of industry, mines and technological development for the Upper Nyong carried out a series of activities related to the Nkamouna ore exploitation from may 25<sup>th</sup> to June 30<sup>th</sup> 2006. This team comprised:

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The mission of this team was achieved through:

- Visits at the Nkamouna site
- Radioactive measurements in the deposit, neighboring villages to the site, Lomié and Abong-Mbang.
- Assessment of the present health status of populations through a statistic study of patients in health centers, dispensaries, hospital and through free medical consultations.
- Conception, production and distribution of handouts with information related to Cobalt.

- Public conferences, true communication and exchange sessions uniting experts, administrative authorities, traditional leaders, religious leaders, locally-based NGOs, and the populations of Lomié, Zoulabot, Ngola, Kongo and Echiambor.

The present report of activities does not only contain scientific information relative to Cobalt transmitted to populations, but also the report of the information and sensitization campaign held by experts from June 23<sup>rd</sup> to 26<sup>th</sup> 2006 in Lomié.

## I COBALT: GENERAL FACTS

### 1- Definitions and fundamental properties of cobalt

Cobalt is a chemical element of symbol Co. it is metallic and greyish white and it was discovered by the Swedish chemist George Brandt in 1735; It derives its name from Kobolt, the name of one of the mysteries of Germany. On the periodic table of elements, the atomic number of Co is 27 and the mass number is 59 (27 protons + 32 neutrons). It appears in the fourth period, between iron and nickel, among which it forms the first triad of group VIIIA of the transition elements. Its mass number is equal to 58.933g.mol<sup>-1</sup>. It is a ferromagnetic metal up to 1150<sup>o</sup>C, and it is malleable and ductile. Its other physico-chemical properties, compared to those of iron and nickel, are assembled on the table below

Table1: physico-chemical constants of cobalt.

Property	Value		
	cobalt	iron	nickel
Electronegativity (Alled and Rochow)	1,70	1,64	1,75
Electronegativity (Pauling)	1,88	1,83	1,91
Atomic mass (u.m.a)	58,93	55,85	58,71
Volumic mass (g.cm <sup>-3</sup> )	8,90	7,86	8,90
Atomic radius (Å)	1,25	1,26	1,25
Oxidation state (most stable)	<b>2</b> ; 3	2 ; <b>3</b>	<b>2</b> ; 3
Ionic radius for M <sup>2+</sup> (Å)	0,74	0,76	0,72
Ionic radius for M <sup>3+</sup> (Å)	0,63	0,64	0,62
Ionization potential for Ionic radius for M <sup>2+</sup> (Volts)	17,05	16,18	18,15
Ionization potential for Ionic radius for M <sup>3+</sup> (Volts)	33,49	30,64	36,16
Crystallization system	H.C. (Co <sub>α</sub> )  (a = 2,50 Å; c = 4,07Å)  C.F.C. (Co <sub>γ</sub> )  (a = 3,55 Å)	C.I. (Fe <sub>α</sub> ) ; C.F.C. (Fe <sub>γ</sub> )	C.F.C.  (a = 3,52 Å)
Transformation temperature α ↔ γ (°C)	→ 430-500 ← 350-500	α ↔ γ : 911 γ ↔ α : 1392	
Melting temperature (°C)	1495	1536	1453
Boiling temperature (°C)	2595	3000	2730

Source : M. Garric. Chimie générale, Dunod, 3<sup>e</sup> éd., 1983, 432p

## 2- Natural occurrence and form in the ore

Cobalt shows a very little abundance in the earth crust where its average content is of the order of 10 mg/kg, that is 10 ppm. It does not occur in native form ; it is often found in relatively high concentrations, associated with copper (Cu), nickel (Ni), iron (Fe), Manganese (Mn), antimony (Sb), bismuth (Bi), oxides (asbolane,  $(\text{Co,Ni})\text{O}\cdot 2\text{MnO}_2, 4\text{H}_2\text{O}\dots$ ), arsenide (smaltine,  $\text{CoAs}\dots$ ), sulphides (linnelide,  $(\text{CoNiFe})\text{S}_4$  ; Jaipurite,  $\text{CoS}\dots$ ), thioarsenides (Cobaltine,  $\text{CoAsS}\dots$ ), sulphate (bieberite,  $\text{CoSO}_4\cdot 7\text{H}_2\text{O}$ ) < carbonates (spheccobaltite,  $\text{CoCO}_3\dots$ )... Cobalt is also present in meteorites (fragments of celestial bodies that fall on the surface of the earth).

The cobalt in Nkamouna is associated with nickel and manganese in the oxide mineral called asbolane  $(\text{Co,Ni})\text{O}\cdot 2\text{MnO}_2, n\text{H}_2\text{O}\dots$ ,

## 3- Nuclear and radioactive properties of cobalt

### 3.1- general definition of radioactivity

Radioactivity is the property of some unstable atomic nuclei to be transformed into one or more nuclei of other elements, and to emit heat and high energy radiating particles during the transformation. The most frequently emitted particles are the alpha, (helium nucleus), the beta (constituted by electrons,  $8^-$  or positons,  $8^+$ ) and gamma,  $\gamma$  (photon = electromagnetic radiations, similar to x-rays, though more highly penetrating).

The nuclei instability might be as a result of :

- a high excess of neutrons ; those neutrons are then converted to protons (that remain inside the nucleus) and to electrons which are emitted in the form of  $8^-$  Particles.

- a neutron deficiency ; the neutron therefore emits a positon,  $8^+$  and develops a negative charge . A proton then traps an electron at the peripheral cortex and becomes a neutron.

Generally the stable nuclei are those whose mass number is not so small or so large. Their mass number A varies between 20 and 190.

The radioactive radiations have the property of ionizing any surrounding gas atoms ; the irradiation of living organism by those radiations have more or less harmful effects depending on the dose received and on the type of radiation involved. In effect, alpha particles have a low penetrating power and can be stopped by a sheet of paper. Beta particles are penetrative and are electrically charged; an aluminum sheet will stop them. Finally, gamma rays are very energetic and very penetrating, but are not electrically charged; they need several centimeters of lead to stop them (note that X-rays can be stopped by a sheet of lead of a few millimeters in length).

### 3.2- Natural and artificial radioactivity

On the radioactivity point of view, there exist two types of radio-elements or radio-isotopes: those that are naturally radioactive and those which are provoked artificially. For the latter case, the radioactivity is said to be artificial.

#### 3.2.1- Natural radio-isotopes

During the formation of the earth, about some five billion years ago, matter was composed of stable and unstable atoms. But since then, the majority of the unstable atoms have undergone radioactive disintegration and a greater part of them have attained stability. However, there still exist some natural radioactive atoms:

- Radio-isotopes marked by a very long half-life like uranium 238 (4.5 billion years) and potassium 40 (1.3 billion years). They have not yet had enough time to undergo complete disintegration since the time they were created ;
- radioactive descendants of the previous ones like radium 226 which is permanently regenerated after the disintegration of uranium 238. Radium 226 undergoes slow transformation into a gas, radon 222, which is in turn radioactive.
- The radioisotopes created by the action of cosmic radiations on certain atomic nuclei. It is the case, for example, of carbon 14 which is permanently being synthesized in the atmosphere.

These natural radioactive elements are widespread all over the planet, in the atmosphere (carbon 14, radon 222), in the earth crust (uranium 238 and uranium 235, radium 226...) and in human meals (potassium 40). This is why everything that surrounds us is radioactive. Since the beginning of time, the earth and all its living things are plunged into a veritable pool of radioactivity. It was only recently (a hundred years ago) that man discovered, thanks to the works of Henri Becquerel the radioactive atmosphere under which he has been living.

Numerous works have enabled to count and to organize the terms of the three great radioactive families, basing attention on the study of radiations emitted by radioactive substances, on one hand, on their disintegration kinetics on the other hand and finally on their chemical properties which can be arranged into three groups (families) of natural radioactive isotopes

The first family is the uranium family. It encompasses 18 isotopes obtained from successive disintegrations of uranium 238, among others like radium 226, radon 222, astate 218, polonium 210 and radium G 206, term of disintegrations and stable isotope with the same mass number as that of lead 206.

The second family is that of thorium ; it groups 12 isotopes obtained by successive disintegrations of thorium 232, among others like thoron 220 and thorium D 208, end of disintegrations of disintegrations and stable isotope with the same mass number as that of lead 208.

The third family is that of actino-uranium ; it comprises 17 isotopes obtained from the successive disintegrations of actino-uranium 235, among which are others like protactinium 231, actinium 227, l'actinon 219, astate 219, astate 215 and actinium G 207 that marks the end of disintegrations and is a stable isotope with an identical mass number like lead 207.

### **3.2.2 – Artificial radio-isotopes**

The production of artificial radio-isotopes is performed with the aid of a cyclotron or a nuclear reactor and it enhances numerous applications. Certain radio-isotopes can also be used as a source of radiation for gamma radiographies (or gammagraphies) or as a source of energy for radiotherapy or for industrial applications. Such sources are currently used in medicine and in the industry. Other artificial radio-isotopes are created in nuclear reactors. Others are useless to man and constitute what is generally termed nuclear wastes. Because the latter are highly radioactive, they have to be isolated from man and should be constantly monitored.

### **3.3 Units of measuring radioactivity**

The main units used for the measurement of the degree radioactivity differ according to the radioactive matter, by the energy received by the matter irradiated or of the biological damage on the living tissues irradiated. These units are shown on table II below:

Table II : radioactivity units

Size	Units	Equivalence	Definitions
Activity	Bequerel (Bq)	1Ci = 37 billions Bq	Measurement of the number of disintegrations per second in the radioactive matter
	Curie (Ci)		
Dose absorbed	Gray (Gy)	1 Gy = 100 rd	Measurement of the energy received by the irradiated matter per unit of mass
	Rad (rd)	1 rd = 1/100 Gy	
Equivalent dose	Sievert (Sv)	1Sv = 100 Rem	Measurement of the biological damage on the living tissues irradiated (Cumulated dose from irradiation continue during the year.)
	Röntgen equivalent man (Rem)	1Rem = 1/100 Sv	
Debit dose absorbed	Gray per hour (Gy/h or $Gy.h^{-1}$ )	1Gy/h= 100rd/h	Quantity o the energy received by the irradiated matter per unit of mass per unit of time
	Rad per hour (rd/h or $rd.h^{-1}$ )	1rd/h = 1/100 Gy/h	
Debit equivalent dose	Sievert per hour (Sv/h or $Sv.h^{-1}$ )	1Sv/h=100 Rem/h	Biological damage s caused by live tissue irradiated per unit of time
	Rem per hour (Rem/h or $Rem.h^{-1}$ )	1Rem/h = 1/100 Sv/h	

### 3.4- Radioactivity of Cobalt

#### 3.4.1. Isotopes of cobalt

Cobalt possesses 19 isotopes with only one natural. The main ones appear on table III below

Table III : Principal isotopes of cobalt.

Isotope	Atomic mass	Z (protons)	A (Nucleons)	A – Z (Neutrons)	Terrestrial abundance
$^{56}_{27}Co$	55,940	27	56	29	0 % (artificial)
$^{57}_{27}Co$	56,936	27	57	30	0 % (artificial)
$^{58}_{27}Co$	57,936	27	58	31	0 % (artificial)
$^{59}_{27}Co$	<b>58,933</b>	<b>27</b>	<b>59</b>	<b>32</b>	<b>100 % (naturel)</b>
$^{60}_{27}Co$	59,934	27	60	33	0 % (artificial)
$^{61}_{27}Co$	61,000	27	61	34	0 % (artificial)

### 3.4.2- Cobalt 59 or natural cobalt

It is noticed that cobalt does not appear in any of the three families of naturally radioactive elements described in section 3.3.1. natural cobalt (cobalt 59) is thus not radioactive. This is scientifically proven in the case of the cobalt of Nkamouma. In effect, measurements of radioactivity performed from the 08<sup>th</sup> to the 12<sup>th</sup> of June 2006 in the pits of the ore deposits and in the neighboring villages gave an average debit dose value of 0.3 mSv/year or 0.03 R/year, which is much lower than the international (1mSv/year) and national regulations (5R/year) (see appendix 1 and 2).

Of the 19 isotopes of cobalt, only cobalt 59 (natural cobalt) is stable and non-radioactive. The main isotopes, which are absent in the crust and shown on table II (paragraph 3) are radioactive. Apart from cobalt 60, with a half-life of 5.3 years, the half-lives of the other isotopes seldom go beyond 300 days.

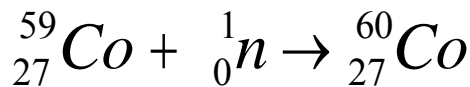
### 3.4.3- Cobalt 60 or radioactive cobalt

Cobalt 60 is a radioactive isotope derived from cobalt 59. Its mass number is A = 60. It does not occur in nature. Cobalt 60 is obtained by exposure of stable nuclei of cobalt 59 to neutrons within a reactor, and allowing it there for a period of about one year. Within this period, the atoms of cobalt 59 absorb enough neutrons and become cobalt 60, an unstable and radioactive isotope.

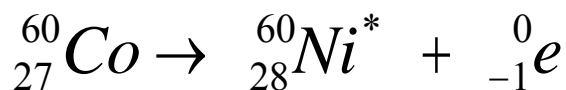
Because of the heavy load of neutrons, the unstable nucleus of cobalt 60 is subjected to a disintegration reaction of  $\beta^-$  and is transformed to nickel 60 which is found in an exciting state. Nickel 60 emit two gamma ray to be found in the fundamental state which is stable.

The reaction chain is summarised as follows:

Production of cobalt 60  $\left( {}_{27}^{60}\text{Co} \right)$  in the nuclear reactor.



Disintegration of cobalt 60  $\left( {}_{27}^{60}\text{Co} \right)$  to nickel 60  $\left( {}_{28}^{60}\text{Ni}^* \right)$



Transformation of nickel in the excited state to stable nickel with the emission of two gamma rays



Cobalt 60 has a half-life of 5.27 years, that is, the period required for it to diminish by half of its initial value. This short lifespan of cobalt 60 compared to the age of the earth (about 5 billion years) clearly explains why the unstable isotope is naturally unavailable.

Cobalt 60 is a first choice radio-isotope for numerous beneficial applications, especially in the medical field (treatment of some forms of cancer), in the food industry (sterilization of food substances, prolongation of their expiring dates, improvement of their physico-chemical properties and their hygienic conditions), it is therefore not a radioactive waste in the nuclear industry. It is a radio-element which is intentionally synthesized in a reactor so as to be used for several purposes.

## **4 – Cobalt in the environment**

### **4.1 – Cobalt in the soil and in plants**

Cobalt is not held in the atmosphere. In the soil, the oxides of manganese and clay rapidly absorb cobalt. This phenomenon of absorption makes cobalt not to move in the soluble form in the soil. The pH of soil plays an essential role in the absorption of cobalt. That is, it is more important in basic soils than in acidic soils.

These world's average of cobalt in the soil (first 50 centimeters) is form 8 ppm. It can reach 16 to 6450ppm in soils neighbouring cobalt.mines.

The absorption of cobalt by plants depends on the content of the soil. If the cobalt in the soil has a concentration of less than 40 ppm, its toxicity for plants is negligible. Generally, it is less toxic than other heavy metals to which it is often associated. Vegetables absorb more cobalt than other plants like tubers. It is important to say that , even where the top soil is rich in cobalt, it is difficult to absorb substantial quantities of cobalt in edible vegetables found there, for cobalt is never found in high concentration in plants; its content in vegetables is rarely more than 1ppm. Other foods contain cobalt in limited quantities. This last one is necessary in minute quantities for the health of animals and that of mankind. But if it goes beyond the acceptable rates, it becomes harmful.

The content abnormally high in cobalt can only be found in environments of human activities such as:

- exploitation of a cobalt deposit
- To setting up of a production industry and the utilization of chemical products based on cobalt.
- The disposal of thermal waste
- The smoke from thermal engines
- Bush fires
- Combustion of carbon

These anomalies can also be found during:

- Erosion of soils rich in cobalt, laundry with rain water
- Volcanic eruption
- Violent winds

### **4.2- Cobalt in water and in the air**

The general concentrations of cobalt are :

- air : 0.4 to 2 $\mu\text{g}/\text{m}^3$
- shallow water and sea water : 0.1 to 5  $\mu\text{g}/\text{m}^3$

Cobalt is insoluble in cold and hot water. In rivers, lakes, estuaries or marine water, cobalt is absorbed in great quantities by sediments in the bedrock of the water floor. We also find it precipitated in carbonate or hydroxide , or in the oxides of minerals present . Absorption or complication with these humic substances is equally possible, but depend on environmental

factors such as the pH. The pH of the milieu therefore, has an influence on the special distribution of cobalt.

The higher the pH, the more complex the cobalt, particularly with carbonates depending on free cobalt. Acidic soil favours cobalt in the free state. The presence of organic pollutants in aquatic milieu equally modifies the spatial distribution of cobalt: the quantities of cobalt absorbed on sediments reduce in favour of cobalt mixture and of precipitated cobalt or co-precipitated when the concentration in organic matter is augmented. From hydro sanitary and statistics studies carried out in the USA, it was shown that there is no co-relation between the presence of cobalt in water and human death resulting from cancer. In the average dose, acute toxic action is limited. In high dose, the symptoms are characterized by vomiting, diarrhoea with albumin and at times anal. Always, the susceptible quantity to be absorbed in water (10 to 15mg of cobalt sulphate per day) was for less than the therapeutic doses used (300mg per day) without a toxic effect on the mycelium.

### 5- Some domains of the use of cobalt

The domains of the use of cobalt are very numerous, as compared to those of nickel. Below are some areas where Cameroon can derive some benefits in the case of exploitation of the Lomié deposits

Animal food	Acoustic machines	Paper industry
Video camera	Heating elements	Aeronautic industry
Photographic camera	High temperature magnets.	Permanent magnets
Cells	Petrochemical fertilizer	Heat collector for the production of solar energy
Batteries (hybrid electric vehicles)	Telecommunication	X-ray production
Pigments (paint)	Electrical transformers	Laptop computers
Dyes (ceramics and glass)	Metallurgic industries	Plastic industry
Cell phones	Prostheses industry	
Automobile industry	Medical imagery	
Cutting utensils	Plant food additives	
Electrical appliances	Precise balances	

### 6- Producing countries

Table IV : Producing countries of Cobalt (survey, mineral commodity summaries, January 2004)

Countries	Production (in metric tons)	Reserve (in metric tons)
DRC	10000	3400000
Zambia	12000	270000
Australia	6600	1500000
Russia	5000	250000
Canada	4700	90000
Cuba	3200	1000000
New Caledonia	1400	230000
Others	4000	255000
Cameroon	?	?

## **II COBALT IN CAMEROON: THE CASE OF NKAMOUNA**

The first indices of ultra basic rocks were mentioned for the first time in a presentation of the French Academy of Sciences in Paris on August 27 1951. In this paper, Edmond Bruet signaled the existence of serpentinised peridotites 80 km south of Lomié. In the present state of explorations, this index can be identified with the Kondong ultra basic massive.

These indices were to be omitted later during the establishment of the first geologic maps of Cameroon, notably the geologic survey map of Abong-MBang west (1/500 000), which covers the region of Lomié.

From 1980 – 1987, within the framework of an inventory of the mining potential of South East Cameroon, a stream sediment geochemical prospection campaign had evidenced the ultrabasic massives of Kongo, Mang North, Mang South, Messea and Kondong.

The Nkamouna massive, the extreme portion of the Kongo massive situated some 13 km north of the Kongo village has been the object of important mining studies. Results from these studies reveal metaliferous concentrations of Cobalt, Nickel and Manganese in the mid zone of the alteration profile developed on serpentinites.

From 1995 till now, within the framework of a prospection permit, research permit, a mining convention and an exploitation license issued to GEOVIC Cameroon by the Cameroon government, this company has embarked on the study of this important mining index and has evidenced one of the world's most important Cobalt deposits.

### **1) Geology and mineralization**

In the Nkamouna area, some 1400 boreholes and 16 000 chemical analysis were made, and revealed that:

- The alteration profile developed on serpentinite consists of three sub horizontal lithologic units, easily distinguishable on the field. These units are:
  - An upper clay unit, generally sterile, poor in Cobalt, Nickel and Manganese mineralisations.
  - A concretionned ferruginous unit, whose base at times contains mangesiferous and aluminous concretions. This represents the zone of highest grade of Cobalt mineralizations.
  - A lower dark colored clay unit, presenting a discontinuous foliation inherited from the serpentinite structure. The prospection depth in the boreholes is limited in this unit by the presence of a water sheet.
- The lower clay unit bears about 80 % of Cobalt mineralizations
- The mean cobalt and nickel contents are respectively 0.2 % and 0.8 %.
- Mineralization occurs in the median portion of the profile, above the water sheet, and at a depth of 14m.

## 2) Reference radioactive level of the Nkamouna Ni-Co deposit.

A scientific team led by the divisional delegate of Industry, Mines and Technological Development for the Upper Nyong visited the Nkamouna Co-Ni ore deposit from June 8<sup>th</sup> to 12<sup>th</sup> 2006. The aim of this mission was to measure the reference radioactive level of the site.

### 2.1 - Apparatus used

A Radiometer and a Scintillometer whose characteristics are listed in table 1 below were used.

Table V: characteristics of radioactivity measurement devices used

	Scintillometer	Radiometer
Type	SPP2	Graetz X 5 DE
Radiation detected	(gamma)	(gamma)
Energy range		45 KeV -1.3 KeV
Measured parameter	Output dose	Output dose
Measurement range	0 – 50 $\mu$ Sv/h	0 – 20 $\mu$ Sv/h
Detection limits	0.013 $\mu$ Sv/h	0.06 $\mu$ Sv/h

The last control for the proper functioning of the Graetz X5 DE radiometer by an expert from the International Atomic Energy Agency (IAEA) was on April 30<sup>th</sup> 2003. A sample of radioactive Thorium (TS-3) was used to verify the compatibility of results produced by the two instruments. This sample was subjected to the same measurement conditions and the results obtained were:

- Graetz X DE: 2.45 $\mu$ Sv/h (electronic reading)
- SPP2: 570 counts/s (analogical display and reading in a table) thus 0.26mRem/h (conversion using tables) and 0.26mRem/h = 2.6  $\mu$ Sv/h.

The two values differ by 0.15 $\mu$ Sv/h, a 6% difference. This difference is practically acceptable. The two instruments can be said to give compatible results.

However, considering the detection limits of the SPP2 (0.013 $\mu$ Sv/h), it is preferable that this instrument be used for the measurement of low intensity radioactivity.

### 2.2-Field measurements

#### 2.2.1-Measurements in some neighboring localities

These measurements were performed some localities around the site and at precise locations in the Upper Nyong division. The SPP2 was used for these measurements because

**From left to right, we have: Radiometer, sample of radioactive thorium and scintillometer SPP2**

of its high sensitivity for low debit dose. Results of this radiometric survey are listed in table VI below.

	SPP2 ( $\mu\text{Sv/h.}$ )	Graetz X 5 DE ( $\mu\text{Sv/h.}$ )
Lomié	0.17	0.06
Eschiambor	0.12	0.06
Kongo	0.12	0.06
Ngola	0.12	0.06
Abong-Mbang	0.17	0.06

These results show that the atmospheric gamma radiation in the region is very low. The average debit dose is  $0.12 \mu\text{Sv/h.}$  The values obtained with the Graetz X 5DE are constant and equal to the detection limit of this instrument. Variations noticed in the values obtained with the SPP2 are essentially due to fluctuations encountered during the counting. These fluctuations can be accounted for by the hazardous nature of radioactivity, and also by the principle of the counting system. From these measurements, it can be deduced that the encompassing radioactivity level is constant in the region.

**Measurement of radioactivity on the Nkamouna deposit**

### **2.2.2- measurements on the site**

The aim of these site measurements is to determine the atmospheric gamma radiation level at depth. The results of the measurements performed with the SPP2 are presented in appendix 1 & 2.

Derived values of annual debit dose are comparable to the national and international limits. The nationally accepted limits are contained in decree n° 83/410 of August 24 1983 (table3). International norms are contained in the Basic Security Standard n° 115 of the IAEA.

**Measurement of radioactivity in the exploration pit prospection**

## 2.3- Radioprotection norms.

### 2.3.1 National radioprotection norms

Table VII: maximum doses accepted by the National regulation (decree n°83/410 of august 29 1983)

Organ or tissue	Workers		Pregnant women		Others
	Rem/ 3 months	Rem/year	Rem/ 3 months	Rem/year	Rem/year
Entire body, gonads, bone marrow	3	5	1.3	5	0.5
Bone, skin, thyroid	5	30	15	30	5
Hand, arms, feet and hair tissues,	38	75	38	75	7.5
Lungs and other organs or tissues	8	15	8	15	1.5

### 2.3.2-International radioprotection norms

Legal international norms of radioprotection prescribe

- An efficient dose limit of 1 mSv/yr for populations and an average of 20 mSv/yr for 5 years on persons directly subjected to ionizing radiations (nuclear industries, medical radiology),
- An equivalent dose limit (organ) of 150 mSv for the lens (eye lens) and 500 mSv for the skin and hands

For the populations, the legislator has divided the by 20 the accepted dose for workers because the population comprises people of various ages and health status, and who are not well followed up medically.

In France, the efficient dose limits prescribed by the March 31<sup>st</sup> 2003 decree are:

- For the public: 1mSv ( this concerns neither medical nor natural exposure)
- For workers: 20mSv. However pregnant and breastfeeding women should not exceed 3/10<sup>th</sup> of the limits and must not be exposed to internal doses. Apprentices must not also be exposed to more than 3/10<sup>th</sup> of this limit.

Field measurements revealed values lower than the national (5Rem/yr) and international (1mSv/yr) norms.

Considering the above, it can be concluded with certainty that the Co-Ni ore deposit of Lomié is not radioactive.

## 3 - Exploitation, treatment, transportation, mine rehabilitation, and energy production.

The Lomié Co-Ni mineralizations are found within lateritic formations at a shallow depth and above a water sheet. The exploitation method adapted for such a deposit is simple terracing using conventional surface extraction apparatus. The ore extracted using a bulldozer is

transported and deposited elsewhere for crushing and concentration, then leached and chemically treated with diluted sulfurous acid produced at Nkamouna. It should be noted that the lixiviation involves dissolution of metals, so as to better concentrate the ore-bearing solutions. The marketable Products of this lixiviation include valuable oxides of Co and Ni, as well as manganese carbonates. For a better protection of these products, mankind and the environment, they are put in impervious bags, put in containers and then transported by road to the Douala seaport.

Progressively, as the exploitation moves from one area (of 30 hectares) to another, the mined area shall be rehabilitated through the filling of pits with sterile material dug out; and reforestation with valuable species, reinforced by an improvement of soils.

#### **4- The quality of water and air during the exploitation of Co-Ni-Mn in NKAMOUNA**

A plan for the management of waste was elaborated in the impact and prefeasibility studies of the disposal of residue. The construction of a dam to retain the waste is envisaged. It shall be filled with a mixture of water and waste. Under the effect of very rapid consolidation, with the help of adding more filters, water getting out of the dam shall be filtered and recycled in a treatment factory before being diverted around the installation. This way, the impact on the hydrographical network shall be insignificant. The washing produced by the recycled water on the geological and pedological formation of the basin side shall contribute a remineralisation of water. The phreatic nape (hypodermic and \or underground) shall only be affected by the deviations and exhaustion of trickles of water.

Anywhere, the spring water analysis like actual metallic concentrations in water in different basins shall be sent out of NKAMOUNA cobalt massive ranging from:

0.00025 to 0.00322 mg/L for cobalt.  
0.0008 to 0.112 mg/L for nickel.  
0.00722 to 0.287mg/L for manganese

It should be recalled that the concentration limit imposed by WHO is :

1mg /L for cobalt.  
0,2 mg /L for nickel  
0.1mg /L for manganese.

As for manganese, without having even started exploitation, the water sent out the NKAMOUNA massive already contains manganese .Its consumption without prior treatment can be harmful.

It should however, be noted that the hydric intoxications by manganese are extremely rare; except accidental or voluntary absorption in substantial quantities. The risk is exclusively from a professional origine. Water pollution by manganese is not a problem except in case of exceptional waste. The main source of atmospheric pollution in manganese comes from metallic treatment. From the gustative point of view, manganese can give water a bad taste. Anywhere, even at very low doses (0.05mg/L),it is likely to form a black layer on the existing bedrocks of water in areas neighbouring the turbulent zone. The main characteristic of chronic intoxication is neurological pathology like Parkinson which was not found in our list of pathological finding in 2004in Lomie.

It is said that the real quality of water shall not be influenced negatively by the exploitation of Co-Ni-Mn in Nkamouna. For, water coming from the treatment circuit, with neutral pH, shall be demineralised in heavy metals and cleared of all micro organism and pathogenic virus from the extraction process of Co-Ni- Mn which shall be done in an acidic (sulphurous acid) and hot milieu. The flow from the capture zone shall be re-established after the closure of the installation.

A plan for the hydrological and hydro sanitary is envisaged. After all, the treatment of water before consumption is necessary. Geo Aid is undertaking the studies.

As concerns the quality of air, cobalt is not volatile and is emitted in the atmosphere uniquely in a particular form whose diameter does not permit it's absorption through the nasal tract. Its particles are constituted mainly of cobalt oxides. Their transportation in the air therefore depends on the height, the form and the density of the particles and the meteorological conditions surrounding the industrial zone. The extracts of the deposit under the hypodermic nape, shall be lightly soaked. Cobalt not being volatile and the process of elaboration of cobalt and its compounds going in Cameroon, its concentration in the air in Nkamouna due to exploitation of the mineral shall be null.

## **5 - Disposal and treatment of dangerous wastes of sulfur and acids used**

In order to preserve the integrity of rivers, springs and water sheets, all waste waters used during the exploitation will be recycled and no out-norm water will be discharged into the environment without treatment. Atmospheric pollution induced by dust produced by the extraction activity will be attenuated through appropriate procedures.

Dangerous mining wastes shall be treated according to the World Bank's norms and this in an appropriate disposal unit.

These readjustments will enable to reduce or overcome all environment impacts related to the mining activity, as the mined zones will be returned almost to their initial states.

For the Dja biosphere reserve, owing to its remoteness from the mining site it will not suffer any disturbance in its biodiversity. The mining activities will therefore have no effect on the forest.

During the exploitation, in order to protect the mine and the local inhabitants, a permanently guarded security perimeter shall be established around the mines. It should be noted that security at the mining site is guaranteed by the mining code.

Energy needed for the activities will be produced by the combustion of plant biomass and power generators.

## **6 - Socio-economic predictions**

GEOVIC Cameroon has elaborated the GEO AID program in order to contribute to development activities of the area as well as ensure humanitarian aid to the Lomié populations. This participation ranges from the granting of micro loans to any assistance related to:

- Housing,
- Agriculture,
- Aviculture,
- Basic education,
- Health,

- Transport;

GEOVIC will exploit the ore for exportation, but its existence will be beneficial for Cameroon as a whole and Lomié in particular. According to its plan of action, Geovic envisages the development of socio-cultural and durable economic programs related to:

- road construction and maintenance
- construction of schools and specific training centers
- construction of health centers
- construction of potable water points
- granting of loans for small local industries

In a general manner, the exploitation of the Nkamouna deposit and related activities will generate employment opportunities, which will in turn foster development and improve on the living standards of the populations.

### III- TOXICOLOGICAL VIEW

#### 1 - Cobalt toxicity

The knowledge on the toxicity of cobalt and its derivatives had been improved with the development of mines in the world. The studies have been performed by organisms of renowned blameless scientific reputation.

If the main access ways of cobalt in the human organism are the respiratory (professional exposure) and the digestive tracts, blood and skin accesses on the other hand are respectively accessory in the case of medical treatment by cobalt derivatives and professional exposure. Nevertheless, no matter the way taken, the toxicity depends on the form (chemical) of the compound.

In Nkamouna, the cobalt after processing will be in the oxide form.

#### 1.1- Absorption

The experimental studies performed on cobalt toxicity have been based mainly on the observations of employees who manipulate the substance. At the present state of knowledge, this toxicity does not concern those who manipulate the ore, and is minor for the oxide as will be the case in Nkamouna.

Most cases of intoxications are rather noticed on persons working in cobalt or some heavy metals processing firms.

The main toxic effects on man are due to the fact that, when in excess, cobalt can replace magnesium and calcium by competitive inhibition. For this reason, cobalt can influence the numerous enzymatic pathways, hence that of oxidative metabolism.

**Absorption:** It is done mainly by respiratory digestive pathway. This absorption is strongly based on its form and the possible components to which it might be linked.

**Inhalation:** The inhaled particles, based on their sizes, are fixed on the mucus of the respiratory tract where they shall then be absorbed. An estimated 30 % of cobalt oxide inhalation rate has been recorded which can secondarily be absorbed by the lungs.

**The oral pathway:** Cobalt is naturally and currently absorbed through the digestive tract in food, for, it should be recalled that cobalt constitutes part of the trace elements necessary for good health. More so, its absorption depends on its form (chemical) and nutritional factors.

The rate of absorption, thus, varies between 5 and 45 %. Iron deficit might increase the absorption rate in the digestive tract.

**The coetaneous pathway:** It is a negligible way of cobalt absorption.

## **1.2- Distribution:**

Cobalt being an essential constituent of vitamin B12 is found in the tissues of many organs of the human body. The highest concentrations are encountered in the liver and the kidneys. The total reserve in the human body is estimated at 15 mg.

## **1.3- Half life**

It ranges between 5 days and four years in the human body depending on the chemical form and the access pathway or the fixation tissue.

## **1.4 – Elimination**

The rate of cobalt oxide retention is about 50 % of the initial dose after 180 days. The observed variations depend on the size of particles. The majority of cobalt is quickly eliminated through urine and to a lesser extent in faeces. Only a mild proportion is slowly eliminated. the daily measure of urinary cobalt may constitute a method of cobalt toxicity monitoring in liable cases (exposure to soluble cobalt alloys).

## **1.5 - Target organs**

In persons manipulating cobalt powder or dust, the skin and the respiratory tracts are the most exposed parts of the body.

**The respiratory tract** : The main symptoms here are the inflammations of the upper respiratory tracts, asthma, the alveolitis. A prolonged exposure can lead to chronic bronchi obstruction, but also to pulmonary fibrosis. A condition of difficult breathing is experienced and/or whistling breathing. Patients may also complain of thoracic oppression.

**The skin** : Cases of dermatitis have been reported at this level and they are mainly of allergic and nettle-rash origins but also of photosensitisation due to cobalt, (at times crossed reaction with nickel) in the heavy metal and cement industries.

**The cardiovascular system** : Cardiomyopathy cases have been described in persons exposed on for more than 10 years in the heavy metal industry, marked by functional anomalies of ventricles.

**Blood** : Due to its stimulating effect on the production of red blood cells, it can lead, in persons exposed to cobalt of diamond polishing and other heavy metals to a polycytemia (increase in the total number of red blood cells).

**The thyroid** : A decrease in the activity of the thyroid gland has been noticed in subjects treated by cobalt oxide, for haematological affections. The decrease in the activity of the thyroid gland, though reversible, could end-up in a goitrogenous effect.

Generally, the cancerigenous effect of the cobalt oxide has not been described. The cancerigenous effect has so far been attributed to two forms which include : cobalt sulphate and cobalt chloride.

Auditory and ocular deficits have been described in persons exposed to cobalt for a long period; though those situations could improve with a stop of the exposure. No cases of abnormal development of foetus have been described in pregnant women treated with cobalt chloride for three months.

## **2. Nickel toxicity**

### **2.1- Absorption**

It is mainly contracted through by respiratory and digestive pathways, and just like for cobalt, the skin is an accessory way.

Nickel is mainly found in pesticides and other current agriculturally used products, and coins. Acute cases of toxicity are accidentally witnessed in workers of the automobile painting, during the installation of galvanisations that use liquid nickel.

### **2.2- Target organs**

The respiratory tracts are the main targets in the case of intoxications. Chronic bronchitis, emphysemas (dilation or destruction of the bronchioles) and decrease in the respiratory capacity have been observed, alongside cases of lung cancer in subjects manipulating the substances that contain soluble nickel. The pathology cannot be attributed solely to nickel since the workers observed were also exposed to other metals like arsenic, lead, iron, etc. The effective cancerigenous effect of nickel is still to be proven.

Globally, there can arise a tubular malfunction, portrayed by the urinary rate of some substances which under normal circumstances are retained. The effective cancerigenous effect if nickel remains to be proven. Same for chromosomal aberration. Moreover, cases of contact allergy and dermatitis resulting from cutaneous exposure to nickel have been described.

## **3. Manganese toxicity**

Manganese is a very common compound which can be found everywhere. Though necessary for good health, it can become (however rarely) toxic in case of high concentrations. The toxicity manifestations on the respiratory point of view are mainly bronchitis, while in the neurological point of view; they include hallucinations and loss of memory, and Parkinson disease in extreme cases.

It should be recalled that the toxicity under consideration in relation to manipulation of the metal in processing industries and not in the ore form.

## **IV. SANITARY SITUATION OF THE LOCAL INHABITANTS NEIGHBORING THE FUTURE NKAMOUNA MINING ZONE BEFORE EXPLOITATION.**

The results of mining prospection carried out in the Nkamouna locality in the Lomie region from 1995 till date by GEOCAM reveal the exploitation of cobalt using the open cast

method in the very near future in this equatorial forest region, where the population is exclusively rural.

The extent of the deposit is such that exploitation can last for more than tens of years. The population of this region will witness a significant modification. This region of Cameroon shall host people from different areas. These epidemiological data will therefore witness a significant change. The goal of this work was to describe the health conditions of the people around the mine before the effective exploitation of cobalt and related minerals.

## 1- Method

### **General objective:**

To describe the different pathologies found in the region and to determine the prevalence rate.

### **Specific objectives :**

- 1- Note the most frequent pathologies through the determination of their prevalence rates.
- 2- Compare the results with those of any other region of Cameroon.

It is a cross sectional study encompassing two main parts : a retrospective aspect and a circumstantial aspect.

For the retrospective aspect, we consulted the consultation registers of sanitary centres of the locality.

For the circumstantial one, we clinically examined the populations of three villages neighboring the mine. We distributed free of charge anti-malarial, anti-**helminthic** and **antalgic** drugs wherever it was necessary.

**Public and free medical consultation**

**Medical team in Lomié catholic health centre**

## 2 - Results

### 2.1 Circumstantial aspect:

We examined 380 subjects, that is, 224 adults and 156 children (figure 1 and 2).

The mean adult age was 48.3 years, with extremes of 16 and 74 years.

Of the 156 children, 16 were less than 2 years of age, while 130 had ages ranging between 2 and 15 years

### 2.2 Retrospective aspect

On a total number of 3577 consultations in 2004, the most frequent infections are as follows

- malarial syndrome            38 %
- respiratory infections        24 %
- Enteritis                        18 %
- Coetaneous infections        7 %

## 3- Comments

The affections encountered in the Nkamouna region are generally those of rural regions, meanwhile a characteristic disease known for the region is endemic goiter.

The different diseases are linked to :

### 3.1- mode of life :

- tobacco
- alcoholism
- rural work

### 3.2- the environment

- goiter
- malaria
- Filariasis

### 3.3- hygiene

- coetaneous infections
- dental pathology

### 3.4- other socio cultural factors

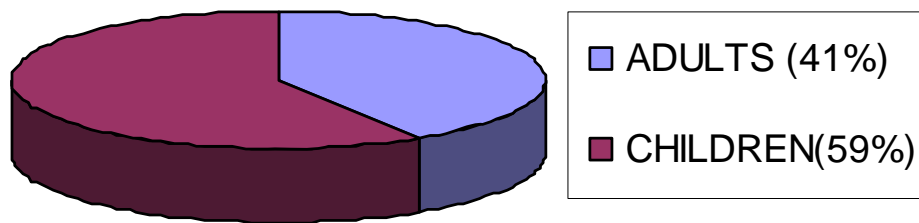
- gynecological diseases subsequent to precocious childbirth (fistulas)
- secondary infertility
- sexually transmissible infections

### 3.5- poor economic level

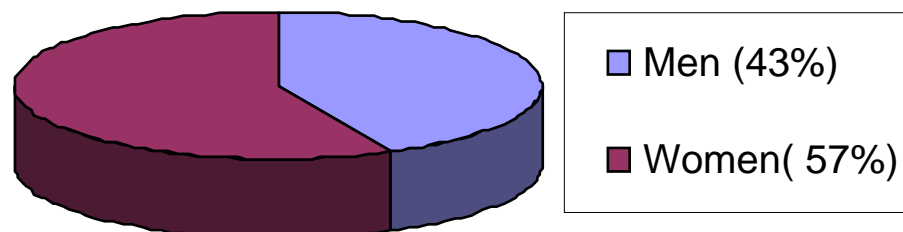
- malnutrition
- infectious enteritis

The future exploitation of the cobalt mine might lead to a modification of the actual data. It is therefore necessary to start thinking of a regular check-up of the health of the populations concerned.

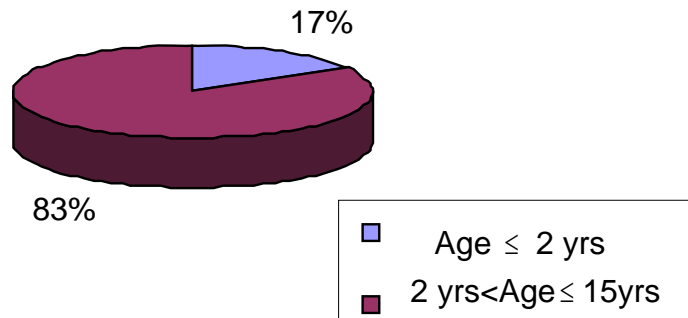
**Fig 1 : Proportions of adults and children**



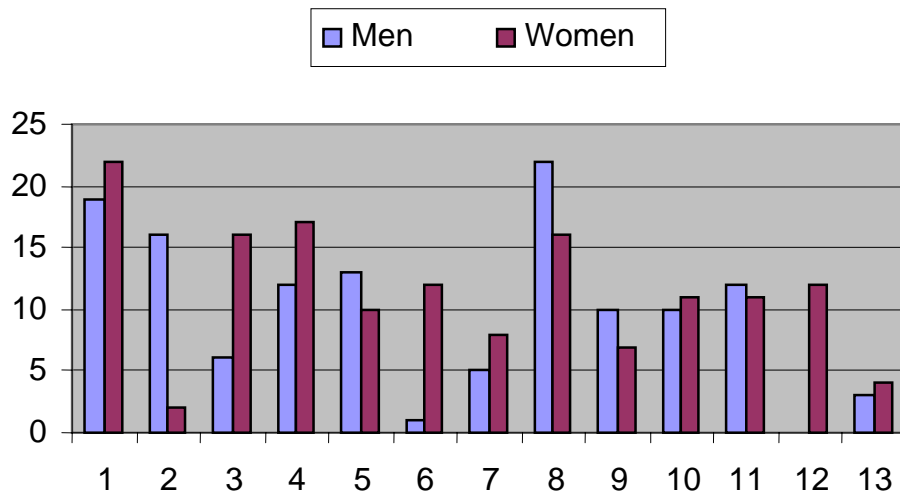
**Fig, 2 : Proportions of men and women**



**Fig. 3: Proportions of children according to ages**



**Fig. 4 : frequencies for the different affections in adults**



- 1-Malarial syndrom
- 2-Respiratory affections
- 3-Ulcer syndroms
- 4- skin affections
- 5- Sterility
- 6- Goiter

- 7- Enteritis infections
- 8- Arthropathies
- 9- Bucco-dental affections
- 10- Filaria
- 11-IST
- 12- Gynecological affections
- 13- Ocular affections

## V. INFORMATION AND SENSITIZATION CAMPAIGN

From the 21<sup>st</sup> to the 23<sup>rd</sup> of June 2006, the Divisional Delegate of Industry, Mines and Technological Development of the Upper Nyong proceeded in the sensitization and the organization of the Lomie, Ngola, Zoulabot, Kongo and Eschiambor populations for educative talks concerning the cobalt exploitation. From Friday the 23<sup>rd</sup>, at 3.00 pm, the first meeting of this tour took place in Lomie, in the reception Hall of the Raphia Hotel.

In each locality, the working method was the same. In effect, after welcome wishes were offered by the local authorities, the head of the delegation of experts, Mr. Simo Emmanuel, Divisional Delegate of Industry, Mines and Technological Development of the Upper Nyong proceeded to the General introduction during which he brought out the goal of the mission, and presented the pluridisciplinary team of experts, composed of :

- Mr. SIMO Emmanuel, mining geologist,
- Pr. NJOPWOUO Daniel, Mineralogist Chemist,
- Pr. KABEYENE BEYALA Veronique, Geologist-Geochemist of surface formations,
- Pr, NJOYA Oudou, Hepatogastroenterologist,
- Mr. NIA Paul, Hydrogeochemist,
- Mr. KAMGUEM Dieudonné, Agroforestry Engineer,

Later on, each expert briefed the public on one of the branches concerning cobalt ore exploitation in Cameroon and in the world. The aim of this section was to present the physico-chemical properties of cobalt (its geology, uses, mode of exploitation, processing, transport and the rehabilitation process of the envisaged mine at Nkamouna. Other processes that were tackled include : radioactivity of cobalt, hydrology, cobalt toxicity, environmental pollution, security, and treatment and storage of wastes. After the

**Public demonstration of the measurement of radioactivity in a conference hall**

different exposes from experts, the next step was the measure of atmospheric radioactivity, as well as that of the Nkamouna ore blocks with the help of a Scintillometer. The floor was then allowed to the audience for questions which were answered by experts.

The public sitting that lasted three to four hours was a veritable session of scientific and socio-economic exchanges that did not only enable the expression of some worries on the side of the local inhabitants, but also collected their various propositions that concerned the Cameroonian state and GEOVIC company.

## 1- The Lomié meeting

The first of the series of meetings, that were to hold during the sensitization and information campaign organized by the experts, took place on the 23<sup>rd</sup> of June 2006 from 4 pm to 9 pm. Present in the meeting were, the Sub Divisional Officer for Lomie, authorities of the District administrative services, members and representatives of Lomie based NGOs, local politicians and the population. 28 people took part at this meeting. After the speech of one of the local authorities and that of the Delegate of Industry, Mines and Technological Development of the Upper Nyong, the first part of the exposes was done on topics such as :

- the physico-chemical properties of cobalt, its form in the ore, the notion of radioactivity, cobalt and its applications by Pr. Njopwouo Daniel.
- Gitology of cobalt, world production of cobalt, extraction and processing of the ore of Nkamouna, market products and transport, cobalt and the environment, rehabilitation of the mine, notably tree replanting by Pr. KABEYENE BEYALA Veronique ;
- Cobalt and health, cobalt toxicity, by Pr. NJOYA Oudou;
- Cobalt extraction and hydrology, the water cycle, processing, storage, the outcome of the used water during the mining activity at Nkamouna, by Mr. NIA Paul.

At the end of the presentations, a demonstration of the procedure of radioactivity measurement was performed by Mr. SIMO Emmanuel ;

The second part of the meeting was mainly a question and answer session. The following questions were asked by the participants:

- 1- What measures have you taken to ensure that the information you are giving be delivered to the neighboring population of the Nkamouna mine?
- 2- Can the use of electricity during the exploitation and chemical processing of the mineral generate radioactivity?
- 3- Will the water used in the processing of the ore be thrown in nature?
- 4- Why is there no GEOVIC representative in your delegation?
- 5- Why does GEOVIC not give the names of associated minerals of cobalt during its exploitation?
- 6- To what risks are exposed the populations during exploitation?
- 7- Some local families mourn their children who happened to have died of pulmonary infection when working at GEOVIC. What is your reaction?
- 8- What share is the government reserving to the population of Lomie out the benefits derived from ore exploitation in Nkamouna?
- 9- Have the government and GEOVIC programmed an improvement relative to infrastructure and personnel of health, dispensaries and hospital centers of the Lomie region.
- 10- At the level of the villages, are the communications going to be translated into the Nzime language?
- 11- We regularly see loaded heavy trucks from Nkamouna passing and when we ask what they carry, we are told that they are carrying samples. Has the exploitation not started secretly? Is GEOVIC not building another deposit from elsewhere?
- 12- How far are we with the study of the environmental impact?
- 13- We were told that radioactivity measurement machines shall be installed along the road towards Douala? Is this measure still going to be considered?
- 14- In case of disease, what are the security measures taken by GEOVIC for the employees presently working on the ore deposit?

- 15- GEOVIC affirms having already spent billions on Nkamouna. Is it true, do they not falsify figures? Where is the part of the benefit that is reserved for the local population?
- 16- Is the recycled water going to return to the phreatic nape without modifying the nature of the water in the nape?
- 17- What mode of exploitation is programmed by GEOVIC?
- 18- Is GEOVIC going to chase out the population during exploitation?
- 19- Between the government and GEOVIC, who is responsible for improving the technical plateau of health centres?
- 20- What are the main risks involved in the inhalation of cobalt dust?
- 21- Are all the councils of the Lomie locality concerned with the “Ad Valorem” tax generated by ore exploitation at Nkamouna?

The following answers were provided by experts to the above questions?

- 1- Mr SIMO Emmanuel : We are carrying out an information and sensitization campaign and Lomie is the first step. As from tomorrow, the riparian populations shall receive the same teachings like you.
- 2- Pr. NJOPWOUO Daniel : The use of electrical current and chemical processing have no influence on the nuclear behavior of cobalt. They can therefore not create any radioactivity on the cobalt ore.
- 3- Mr. NIA Paul: The water used for the processing of the ore shall be recycled in a dam and no water that is not in conformity with international regulation shall be thrown into nature.
- 4- Pr. KABEYENE BEYALA Véronique : We are not members of GEOVIC ; we are a group of state experts who have come to instruct you on mining activity that will soon start in your locality.
- 5- Mr. Simo Emmanuel: To list all the associated minerals in the accord is not indispensable because, every exploitation of any associated mineral will be a subject of a supplementary declaration.
- 6- Mr. SIMO Emmanuel: The risks were precised in the book written on the study of the environmental and social impacts of the GEOVIC mining project. The environmental and social plans of action have also been elaborated so as to reduce or eliminate the negative impacts of the exploitation.
- 7- Pr. NJOYA Oudou : Before throwing any accusing fingers on GEOVIC, it should firstly be verified if those workers were not ill before being recruited by GEOVIC and moreover, it should be found out if infections were caused by ore dust. The medical follow-up of the population that has already started before exploitation will continue during the process. The local NGOs are equally called up to emulate. After all, ill well-diggers are found everywhere ; the phenomenon is not specific to cobalt.
- 8- Mr. SIMO Emmanuel : The Cameroon mining law has levied a tax called “Ad valorem” tax. This tax is destined to the public treasury, the mining administration which ensures administrative monitor of exploitation, the council, and the local population concerned with the mining.
- 9- Pr NJOPWOUO Daniel : Yes , the Government and GEOVIC have both agreed to reinforce the health services of the Lomie region both on the infrastructural and on the personnel point of view.
- 10- Mr. SIMO Emmanuel : of course, there will be translators of our communications in to the Nzime language.

- 11- Mr. SIMO Emmanuel : No, the exploitation has not yet started and GEOVIC cannot transport very heavy rocks as those in the mine for reconstitution of a deposit elsewhere.; it will be very unprofitable. Those samples that were sent to USA were mainly for analyses. During the exploitation, the processing of the mineral shall mainly be by hydrometallurgy in situ.
- 12- Mr. SIMO Emmanuel : The study of the environmental impact concerns mainly the ministry of Environment and Nature Protection. I believe that public hearing concerning this topic will soon take place (3<sup>rd</sup> to 11<sup>th</sup> July 2006).
- 13- Pr. KABEYENE BEYALA Véronique : It will be needless to install radioactivity measurement machines since measurements done in the ore deposit at Nkamouna and in the other localities of the Lomie region reveal that the cobalt-nickel ore is not radioactive.
- 14- Pr. NJOYA Oudou : There is a GEOVIC dispensary at Nkamouna and the company has programmed a sanitary evacuation of its employees to the Lomie hospital in case of serious illness or accident. Health wise, GEOVIC has also undertaken other measures.
- 15- Mr. SIMO Emmanuel : The GEOVIC company has not yet started the ore exploration. It is still in the investment phase. The figures that are declared have nothing to do with profit and do not concern us. The money destined for investment cannot be given to the population.
- 16- Mr. NIA Paul : The composition of the recycled water shall be very close to that of rain water. There is therefore no risk of it changing the chemical composition of the water in the nape by the time it is liberated into the nature.
- 17- Mr. SIMO Emmanuel : GEOVIC has already conceived its mode of exploitation. It involves the extraction of the ore, its crushing, its lixiviation with dilute sulfurous acid, and finally the rehabilitation of the mine through the planting of trees as explained by professor Kamgang.
- 18- Pr. NJOYA Oudou : Because the mineral is not radioactive, and the mine is far away from the villages (9 to 13 km), GEOVIC will not displace the population.
- 19- Pr NJOYA Oudou : It will be both the state and GEOVIC.
- 20- Pr NJOYA Oudou : During the ore exploitation, there shall be an obligatory wearing of an antidust protective mask by the employees so as to ensure protection against dust inhalation. We cannot therefore consider this risk.
- 21- Pr NJOYA Oudou : For now, the law recognizes only the council that hosts the mine under exploitation. Therefore, only the Lomie council shall be considered.

After the question and answer session, and renewed thanks from the participants for the rich teachings received, they (the participants) proposed that the data be put in paper form and that their diffusion be conducted by local Non-Governmental organizations NGOs and sociologists. They also wished to see the health check-up of workers to continued throughout the mining period.

## 2- The Zoulabot meeting

The second step of the information tour was the Zoulabot meeting. In this locality, the village head had previously assigned Mister OSSEA SIEM and MESSOULA Pierre as translators. 44 people took part at this meeting.

After a word of welcome from the district head and an introductory speech by Mr. SIMO Emmanuel, the experts delivered their message in the same order on the same topics as in Lomie. This was then directly followed by radioactivity measurement with the help of a scintillometer.

The following questions were asked by the audience:

**A view of the conference hall during the Zoulabot educative talks**

- 1- Mr MEBOUBO BILE, Zoulabot notable: Because of the possible health wise risks of mine workers and the population during exploitation , what are there measures taken by the government to reinforce health and hospital centres of the Lomie region?
- 2- Mr. MESSOULA Pierre, president of the Zoulabot Development committee: We wish to thank you for this rich teaching; we were really edified today. Which should we believe between the earlier information on catastrophes that we received and the completely contrary information from you? Who should we believe?
- 3- Mr OSSEA SIEM, Teacher : Is tree replanting not going to destabilize the soils, crops and multiply artificial plants ?
- 4- Mr. NYASSEM, Farmer : Could you redefine the word cobalt to us? Why are you people only fierce about cobalt meanwhile it is not the only useful substance in the Nkamouma ore deposit?
- 5- The Chief of Zoulabot : Thanks for all the stress that you people are undergoing through in order to instruct and inform us. Are the studies of the environmental impacts over? What are our expectations from GEOVIC, or in other words, what are collective and the individual benefits of the project on the view points of habitat, health, education and others?
- 6- The head of the Nzime district: What is GEOVIC? Geo Aid? Emploie Service? We are rather confused with all those names and we do not know exactly what they signify and what they do exactly.
- 7- Is the cobalt not being progressively carried away by GEOVIC? When is the exploitation of the ore supposed to start?
- 8- How will youth employment be done?

After those interventions, the reactions of the experts were as follows:

- 1- Pr NJOYA Oudou : GEOVIC has taken the adequate precautions for health and their implementation will be done with the assistance of Geo Aid. The state has also programmed other measures in this effect so as to render the health services of the region more effective and more operational.
- 2- Pr NJOYA Oudou : Believe what we tell you. I am a medical doctor and my job is to save lives. So, I cannot deceive you people and lead you to danger. We are scientific experts and we offer nothing but the scientific truth. There is no lie in what we are telling you.
- 3- Pr KABEYENE BEYALA Veronique : Do not worry . The tree replanting will involve high quality varieties followed by an improvement of soils. The forest shall be rehabilitated, as well as habitat and fauna.
- 4- Pr NJOPWOUO Daniel : Cobalt is a very useful metal to man, for, it enters into the composition of alloys and many other objects that we use daily. In the Nkamouna deposit, it is the main constituent and nickel comes second. This is therefore the main reason why it should be of primary preoccupation.
- 5- Mr. SIMO Emmanuel : I believe that environmental impact studies are over and not far from now we will begin public audiences. The Cameroon mining legislation through the “ad valorem” tax previews the financial benefits of the mineral exploitation to be shared among the state, the mining administration, the council and the local population in well defined proportions. For now, this tax is not yet operational.  
Through Geo Aid, GEOVIC shall finance micro projects related to habitats, health, education, agriculture, livestock and shall bring other socio humanitarian benefits.
- 6- Mr. SIMO Emmanuel : GEOVIC is a company that received the mining permit in 2003 for the exploitation of the cobalt-nickel ore in the Lomie region.  
Geo Aid is not a branch of GEOVIC but it is an NGO whose objective is to put in place community development programmes that accompany any mineral exploitation. Emploi Service is an independent structure with its headquarters in Douala and branches in Yaoundé and Lomié. It collects applications from all job seekers and puts them at the disposal of employers
- 7- Mr. SIMO Emmanuel : How can you think like that?. The cobalt is not being clandestinely carried away. The start of production in the mine is by the year 2009.
- 8- For youth employment, you can contact Emploi-service for more ample information.

**Presentation of a sample test of radioactive thorium during the Zoulabot educative talks.**

The question and answer session of Zouabot ended with two main proposals from the village head who wished that :

- the share of “ad valorem” tax that belongs to the local populations should be transformed into concrete realisations;
- the Zouabot health centre be reinforced both at the level of infrastructure and at the level of personnel.

After thanking the team of experts once again and closing the session, the district head invited the experts for refreshment at his residence.

### **3- The Ngola meeting**

The educative talks of Ngola constituted the third phase of the tour of experts. On the 24/06/06 between 2 pm and 6 pm, the same program that was followed in the morning was adopted at Ngola. Thus, in one of the classrooms of the primary school of the village, the same exposes and demonstrations performed in Zouabot were performed in Ngola in front of the village community. 79 people took part at this meeting. Just as in the previous case, the teacher OSSEA Siem assured the translation into the Nzime language.

**A view of the conference hall during the Ngola educative talks.**

Following this first meeting phase the following questions were posed by the audience:

- 1- NGOLA, CPDM sub-section president: Why is there no Lomie elite in your delegation of experts?
- 2- Mr. MKPAH Théophile, farmer: What are the diseases that can be contracted by absorption of cobalt? What is the situation about the cases of illnesses already observed in GEOVIC workers?
- 3- Mr. NTOULE Albin Omer : Have radioactivity measurements been done in the wells at Nkamouna?
- 4- Why is it that your information concerns mostly cobalt?
- 5- Can the exploitation of the ore in the Nkamouna region not generate earthquakes and volcanicity?
- 6- What are the risks involved as a result of coming to direct contact with the bi-products of exploitation?
- 7- Has the government undertaken any measures in favour of the workers and the population in case of any incidence during the exploitation?

- 8- Rev. Pastor MAMOHE Dieudonné : what are the inconveniences related mining exploration.
- 9- ALEOKOL, Young farmer: Which route will the ore take during its transportation to Douala?

The interventions of the experts were as follows:

- 1- Mr. SIMO Emmanuel : We have among us an elite of Abong Mbang. We thought that Lomie and Abong-Mbang both belonging to the upper Nyong Division, a geologist specialised in ore mining, originating from Abong Mbang, could satisfy your expectations. Furthermore, an elite from Lomié who we contacted for this exercise said that he was not going to be available.
- 2- Pr. NJOYA Oudou : It is only an abundant absorption due to exposure of workers to cobalt that can cause pathologies such as respiratory diseases and skin allergies. This type of exposure can only occur in hard metal industries. Those industries do not exist in Nkamouna. The sicknesses observed in GEOVIC workers are current diseases in the Lomie region. It should also be noted that a recent health study carried out in the region reveals the prevalence of pulmonary infection. These are not GEOVIC workers and the exploitation has not yet begun.
- 3- Mr. SIMO Emmanuel : Radioactive measurements have in effect been conducted in the wells, samples collected from the wells, and in the open air.
- 4- Because it is cobalt that will mainly be exploited.
- 5- Nkamouna ore exploitation will provoke neither earthquakes nor volcanicity.
- 6- Pr. NJOYA Oudou : You should not be scared, for there are no dangers.
- 7- Yes; the government and GEOVIC have improvised measures in favour of the workers and the populations in case of any incidents.
- 8- Mr SIMO Emmanuel : Just as for all economic activities, there are both advantages and disadvantages. At the right time, the disadvantages will either be reduced or completely suppressed.
- 9- The market products derived from the exploitation of will be sent to Douala by road. It will not pass through Belabo. The itinerary will be Lomie - Abong Mbang –Yaounde-Douala.

At the end of the meeting, hand outs were distributed to the participants. They expressed satisfaction for receiving such information that has cleared their worries relative to the mining at Nkamouna. The sitting was declared ended at 6pm by the head of the delegation.

#### **4- The Kongo meeting**

On the 25/06/06 from 9am to 12 noon,, the information and sensitisation campaign proceeded with the Kongo meeting, held in the community hall of the village . It brought together experts, the village head and the local population. 68 people took part at this meeting. After speeches of usual politeness, the experts then proceeded in the presentation of their exposes on the same themes and protocols as in Lomie, Zoulabot and Ngola. At the end of the presentations, the experimentation of the radioactivity measurements was performed just like in the previous meeting, with the participation of the local population.. During this meeting at Kongo, translation was done by Mr. Mpomo. This part of the educative talk lead to the following questions:

- 1- Mme EBO'O Odile, farmer, Lomie-East sub-section president of the WCPDM: During the free medical consultations by the population that you carried out in the village, some persons were absent. How shall you people consider their illnesses when analysing your results?
- 2- Mr KPAMAN, young farmer: What is the exact definition of cobalt? Can cobalt and associated products be a nuisance to the population?
- 3- Mr. NGWAMINE, village elder: I wish to thank you people for having come to clarify us on this important topic which is the exploitation of cobalt-nickel ore of Nkamouna. The population of Nkamouna is highly envied by its neighbors due to the mining activity that will soon start at Nkamouna. What has the government improvised for Kongo during the exploitation? What should be the expectations of the of the Kongo inhabitants? What is the difference between GEOVIC and Emploi-servive? Has GEOVIC been replaced by Emploi-service?
- 4- Mr NANGA EMMANA, farmer: Why did you people not come to consult the well-diggers same as you recently did with a team of medical doctors? Why did you not include in you team those elites who affirmed that the mining was dangerous and was going to exterminate the population?
- 5- Mme ABONO Apolinaire , farmer : Is GEOVIC going to treat the waters in the channels?
- 6- Mr AKOMADAB Lazard, farmer: Those gases that emanate from the wells, are they radioactive? Can they not be carried by wind to the villages where they will cause damages?
- 7- Mr. EBO'O jean Marie, farmer. Is the exploitation not going to have any climatic impacts? How will a desert be avoided?
- 8- Mme LANGA Mireille, president of the Kongo Women's Association: Woman and GEOVIC. What are the expectations? Why is it that the date for the start of exploitation is continuously being postponed? Are you sure that GEOVIC has not yet started exploiting our mine on credit basis?
- 9- Mr LANGA Joseph, Farmer: I wish to thank the delegate of mines for the upper Nyong and the delegation of experts for all the indications. Are there going to be any expropriation during the exploitation? What are the provisions for the village in terms of arrangements and development of habitat, hydraulics, electrification and health centres? We hope that GEOVIC will come closer to the Kongo man?
- 10- Mr. MBANE Valaire, farmer : We believe that it is necessary for GEOVIC to send some of us to go for ample resources from neighbouring populations of mines under

**A view of the conference hall during the Kongo educative talks.**

exploitations in other countries. Why is it that uptill date the trip has not yet been organised? Why does the director of GEOVIC not take, in addition to his interpreter, a local interpreter who can translate in Nzime so that the chief of the village can better understand what he is explaining. So also have to know that the population is much afraid of Americans after what they did in Iraq. We really need some assurance.

11- Mr. MEDJO Julio, young farmer: why did you people not hold educative talks in Ntam and Melen.

The following interventions were recorded from experts :

1- Pr NJOYA Oudou : We are not only going to use results from free consultation that you talked of, but also statistics within a period of five years, available in health centres, dispensaries and hospitals of the Lomie region. So, all the pathologies of the zone will be considered.

2- Pr NJOPWOUO Daniel : Cobalt is a chemical element classified among the transition elements . it is light grey in colour when pure. In nature, it occurs in small quantities in minerals. There should be no worry. The associated substances of nickel have no harmful effects to the population.

3- Mr SIMO Emmanuel : The Cameroon mining law envisages through “ad Valorem” tax, the financial benefits of the exploitation to be shared between the state, the mining administration, the council and the local population in well defined proportions. The inhabitants of Kongo are therefore expected to have their own share in the council.

Through Geo Aid, GEOVIC will contribute to the socio-economic development of Kongo. GEOVIC is the company responsible for cobalt-nickel ore exploitation in the Lomie region, while Emploi service is the organ responsible for the collection of application files from all sectors of employment, so as to put them at the disposal of potential employers. GEOVIC is still in the investment phase. It has not withdrawn and has not been replaced by Emploi service.

4- Pr NJOYA Oudou : Mining cough is common to workers of coal mines because of the pulverulent nature of coal. We cannot talk of this type of condition in Nkamouna.

5- Mr SIMO Emmanuel : Those consultations were not necessary. We do not know the identities of those who gave you information predicting catastrophies.

6- Mr SIMO Emmanuel : Considering that you people don't drink water from the channels, the installation policy does not take the channels into consideration. GEOVIC will not treat river water. The ore deposit is 13 km away from here, so the water from the mine will be far away from the village. And considering the fact that it will be recycled and treated, it will have no influence on the quality of the spring and river waters.

7- Pr NJOPWOUO Daniel : The gas is carbon dioxide which is not radioactive . The wind cannot blow it to the village because of its relatively small quantity. Once the gas comes out, it is dispersed into the atmosphere and absorbed by plants.

8- Pr. KABEYENE BEYALA Véronique: No, the exploitation will have no impact on the climate. No desert will be created, because the tree replanting envisaged at the end of the exploitation will regenerate the forest.

9- Mr SIMO Emmanuel : The fruits of the exploitation will concern the entire population, that is to say, both men and women. Women can draw up micro-projects and submit them to GeoAid. The exploitation will begin at the right time. GEOVIC is still in the investment phase. The exploitation has not yet started, not even clandestinely.

10- Mr. SIMO Emmanuel : the inhabitants will not be expropriated. GEOVIC will support micro-projects so as to contribute in the development of the area.

11- All the necessary information are on internet. ; a trip to a foreign country is not indispensable. The other preoccupations concerning Americans will be transmitted to GEOVIC.

12- Ntam and Melen are small villages, so we felt that their populations could join those of Kongo for the educative talks.

After the interventions from the experts, hand outs were distributed to the participants. The head of the village proposed that instead of replanting trees in the whole exploited area, a communal palm-grove on part of the area to be rehabilitated. He concluded the meeting and invited the experts for refreshment in his residence by 12 noon.

## **5- The Eschiambor meeting**

The Eschiambor phase was the last of the information and sensitization tours. This meeting of the 25/06/06 held between 1pm and 4pm was mainly based on the three previous ones. The communications and scientific demonstrations of experts were identical to those of Lomie, Kongo, Zoulabot and Ngola. During this meeting, Mr. Ekoumekan Vincent ensured the translation. 52 people took part at this meeting. The following questions were asked after the presentation of experts:

- 1- Mr. ALAMA Apollinaire : We wish to thank you for the information that you have provided to us. Now, our worries have gone, because we now better understand some notions. Is it possible for GEOVIC to set up some structures that will help to improve the standards of living of the population before the start of the exploitation, that is, health, habitat, water supply and electrification? Is it not necessary for GEOVIC to sponsor some people to go elsewhere and see the way exploitation of cobalt- nickel takes place?
- 2- Municipal counsellor, CPDM : If the risks during exploitation are minimized, then may we know some?
- 3- Mr. ALAMA Apollinaire : What are we going to do with the associated substances after the cobalt has been extracted?
- 4- Mr. ESSAH Pierre : For the present employees of GEOVIC, what are the provisions of GEOVIC in case of illness?
- 5- Mr. TCHOUKA Dieudonné : It is quite difficult for us to forget the alarming and frightening rumours diffused by the other elites. So what do we do now?
- 6- Mme. ANNON Salomé: we do not know the truth between what the other people said and what to are telling us now. We leave everything to God, for; he is our witness and will be the only judge.
- 7- Mr. AKOUN, farmer: Since the exploitation will be open cast, will not lead to scarcity in bush animals for hunting?
- 8- The Melene village head: When is the launching of the exploitation?
- 9- Mr. DOUAKA TIBA Jean Rodrigue :Is the study of environmental impact over? Which studies are still to be done, since the launching of the exploitation has been postponed for 2009?
- 10- Mr. ALAMA Appollinaire : Is it possible now for our children to carry out some specific training so that at the right time they can be recruited by GEOVIC ?

The reactions of experts were as follows :

- 1- Mr SIMO Emmanuel : Considering the fact that we are still in the investment phase, it will be difficult for GEOVIC to entirely engage in such a cumbersome expenditure. However,

only GEOVIC will be able to say whether they will or not. Any information concerning cobalt exploitation in the world can be got through the internet.

2- Pr NJOYA Oudou : The possible risks could be noise and dust . But the site is very far away from the village for the population to feel the disturbance.

3- Mr SIMO Emmanuel: Bi-products of cobalt exploitation will be stocked in Nkamouna awaiting potential buyers.

4- Pr NJOYA Oudou : There is a GEOVIC dispensary at Kongo and moreover, the company has programmed a sanitary evacuation of its employees to the Lomie Hospital in case of serious accidents or illness.

5- Pr. NJOPWOUO Daniel: We did not come here to lie you. The information we are giving to you is exact.

6- Pr NJOYA Oudou : We are also believers. God will decide.

7- Pr. KABEYENE BAYALA Veronique: The tree replanting will regenerate the forest and a re-establishment of the fauna's habitat. There will therefore be no scarcity in bush meat.

8- Mr. SIMO Emmanuel: The beginning of production in the mine is scheduled for the year 2009.

9- Mr. SIMO Emmanuel: The study of the impact is over and the public hearing will soon begin. What is retarding the exploitation does not concern studies to be carried out, but the investments at the level of the mine and the search for funds by GEOVIC are the main causes of the delay.

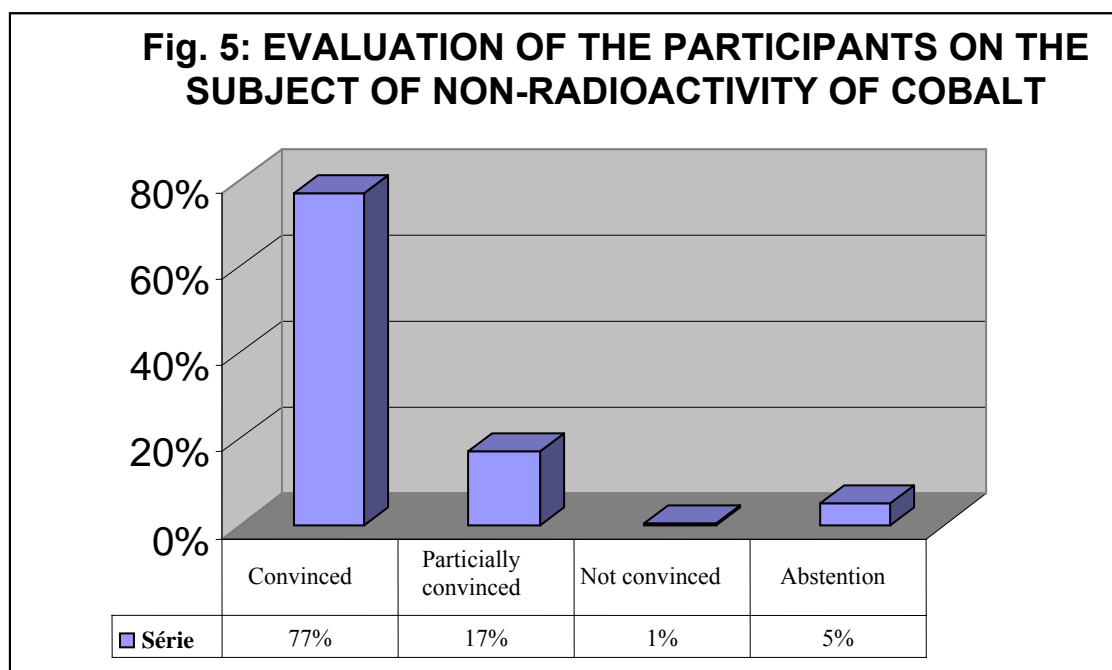
10- Pr. NJOPWOUO Daniel: your children have to train so as to be able to work in GEOVIC in the future. The scientific disciplines are more adequate.

**A view of the conference hall during the Eschiambor educative talks.**

After the interventions of experts, hand outs were distributed to the participants. The head of the delegation of experts thanked the audience once more and then close the sitting. The interim village head then offered refreshment to the group of experts.

In all, the information and sensitisation campaign went on well and the populations were very receptive and welcoming. Their main preoccupations were on health and development. The worries as concerns the radioactivity of cobalt were cleared to the satisfaction of the population as proven on the evaluation table and graph below.

TABLE VIII : EVALUATION OF THE PARTICIPANTS ON THE SUBJECTS OF NON-RADIOACTIVITY OF COBALT.						
Locality		convinced	Partially convinced	Not convinced	Abstention	Total
Lomié	Score	17	6	1	3	27
	percentage	63%	22%	1%	11%	100%
Zoulabot	Score	24	21	0	0	45
	percentage	53%	47%	0%	0%	100%
Kongo	Score	62	6	0	0	68
	percentage	91%	9%	0%	0%	100%
Eschiambor	Score	45	0	0	7	52
	percentage	87%	0%	0%	13%	100%
REGIONAL TOTAL	score	148	33	1	10	192
	percentage	77%	17%	1%	5%	100%




The chemical and nuclear characteristics of cobalt just mentioned above, the chemical composition of the Nkamouna ore deposits, the zero degree of radioactivity recorded in the pits of the ore and the widespread use of cobalt reveal that cobalt exploitation in Nkamouna, far from being dangerous, shall instead be an opportunity for Cameroon to launch the development of a veritable mining industry, and for the East province to alleviate the level of poverty of its population by at least a third by the year 2015.

Appendix 1 Shafts scintillometric survey of NKAMOUNA							
		Legal units of radioactivity in Cameroon		International legal units	Coordinates		
LOCATION	Pit number	Rems/trimester	Rems/year	mSv/year	X	Y	Z
Base Geovic		0.006	0.024	0.24	372792	3525511	
Ecole Kongo		0.006	0.024	0.24	373792	353309	
Lomié Raphia		0.0085	0.034	0.34			
Abong-Mbang(Prefecture)		0.0085	0.034	0.34			
Ngola ecole		0.006	0.024	0.24	385982	357059	
Echiambor		0.006	0.024	0.24			
NKM	1034(FL)	0.0025	0.01	0.1	370674.411	361259.073	726.166
NKM	1028(FL)	0.0025	0.01	0.1	370216.394	361210.915	698.255
NKM	S3	0.006	0.024	0.24	369004.816	361121.855	634.866
NKM	S1	0.01	0.04	0.4	371910.660	361343.460	774.553
NKM	1233(FL)	0.0025	0.01	0.1	371771.812	361293.520	768.807
NKM	1233(Breccia)	0.006	0.024	0.24	371771.812	361293.520	768.807
NKM	985	0.006	0.024	0.24	371643.296	361287.161	764.470
NKM	1232 (FL)	0.0025	0.01	0.1	371518.619	361280.868	760.380
NKM	984	0.006	0.024	0.24	371396.350	361284.621	754.991
NKM	1231 (FL)	0.0025	0.01	0.1	371275.087	361276.917	750.986
NKM	983	0.006	0.024	0.24	371148.588	361271.622	745.183
NKM	1230	0.006	0.024	0.24	371074.968	361272.926	742.714
NKM	1038	0.006	0.024	0.24	370956.798	361274.534	735.641
NKM	1037	0.006	0.024	0.24	370869.520	361267.356	733.673
NKM	1036	0.006	0.024	0.24	370802.408	361263.880	731.482
NKM	523	0.0075	0.03	0.3	370770.153	361269.271	731.193
NKM	1030	0.006	0.024	0.24	370408.496	361231.684	713.122
NKM	518	0.0075	0.03	0.3	370373.698	361247.023	712.437
NKM	197	0.006	0.024	0.24	370336.187	361218.836	708.874

Appendix 1 Shafts scintillometric survey of NKAMOUNA							
LOCATION	Pit number	Legal units of radioactivity in Cameroon		International legal units	Coordinates		
		Rems/trimester	Rems/year	mSv/year	X	Y	Z
NKM	1029	0.006	0.024	0.24	370284.692	361216.247	704.474
NKM	1023	0.0075	0.03	0.3	369897.462	361180.558	677.492
NKM	511	0.0075	0.03	0.3	369932.988	361195.849	678.037
NKM	509	0.006	0.024	0.24	369713.524	361175.044	672.004
NKM	S2	0.0075	0.03	0.3	369591.743	361159.465	667.273
NKM	1018	0.0075	0.03	0.3	369562.514	361161.346	666.958
NKM	508	0.006	0.024	0.24	369530.809	361156.240	667.812
NKM	1017(Breccia)	0.0075	0.03	0.3	369497.813	361161.145	664.857
NKM	1017(FL)	0.006	0.024	0.24	369497.813	361161.145	664.857
NKM	1016	0.0075	0.03	0.3	369430.588	361155.965	661.055
NKM	506	0.0085	0.034	0.34	369403.146	361152.590	659.308
NKM	186	0.0075	0.03	0.3	369341.448	361141.116	655.859
NKM	1014	0.0085	0.034	0.34	369302.773	361138.648	653.781
NKM	505	0.0085	0.034	0.34	369278.312	361134.138	652.493
NKM	1013	0.006	0.024	0.24	369244.428	361134.542	650.787
NKM	504	0.0075	0.03	0.3	369212.691	361129.819	649.579
NKM	1012	0.006	0.024	0.24	369179.740	361137.258	648.000
NKM	1010	0.0085	0.034	0.34	369056.697	361119.372	638.982
NKM	1010(FL)	0.0025	0.01	0.1	369056.697	361119.372	638.982
NKM	277	0.006	0.024	0.24	370491.947	361977.469	702.871
<b>Standard sample TS 3 (thorium)</b>		<b>0.13</b>	<b>0.52</b>	<b>5.2</b>			

Appendix 2: scintillometric survey of shaft NKM 1034.

Metric interval (m)	ASSAY				Lith Code	Legal units of radioactivity in Cameroon		International legal units
	Co	Ni	Mn			R/trimestre	R/année	
0 -- 1					GR	0.0125	0.05	0.5
1 -- 2					GR	0.0125	0.05	0.5
2 -- 3					GR	0.0125	0.05	0.5
3 -- 4					FB	0.015	0.06	0.6
4 -- 5					FB	0.02	0.08	0.8
5 -- 6	0.021	0.090	0.150		FB	0.02	0.08	0.8
6 -- 7	0.017	0.100	0.130		FB	0.015	0.06	0.6
7 -- 8	0.019	0.180	0.180		FB	0.0085	0.034	0.34
8 -- 9	0.056	0.35	0.48		FL	0.0125	0.05	0.5
9 -- 10	0.124	0.54	0.95		FL	0.006	0.024	0.24
10 -- 11	0.090	0.62	0.67		FL	0.0025	0.01	0.1
11 -- 12	0.183	0.63	1.12		FL	0.0025	0.01	0.1
12 -- 13	0.173	0.56	1.05		FL	0.0025	0.01	0.1
13 -- 14	0.251	0.57	1.45		FL	0.006	0.024	0.24
14 -- 15	0.199	0.58	1.21		FL	0.006	0.024	0.24
15 -- 16	0.210	0.63	1.32		FL	0.006	0.024	0.24
16 -- 17	0.192	0.66	1.19		FL	0.006	0.024	0.24

### APPENDIX III

#### DOES THE JUDICIAL FRAMEWORK GUARANTEE THE PROTECTION OF THE POPULATION, THEIR BELONGINGS AND THE ENVIRONMENT IN GENERAL?

The 1990s mark the awakening of environmental consciousness in the world in general and in Cameroon in particular. The main signs of this awakening include:

- The active participation of Cameroon in the “Planet Earth” Conference of 1992 in Rio on the environment and durable development. This conference consecrate durable development as well as the 21<sup>st</sup> century development and invited the world community to mobilise to realise the objectives of the summit outlined in Agenda 21.
- The creation of a ministry in charge of environmental problems which are elaborated according to the participative process of national environmental management adopted in 1996.
- The adoption in 1996 of a new constitution that takes note of environmental preoccupations and which recognises the right of every citizen in a healthy environment. In the preamble, it is clearly stipulated that “ All persons have the right to a healthy environment. Environmental protection is the duty of all. The state sits up for the defence and environmental protection”

To translate the components of this constitution and Cameroon’s engagements vis-à-vis the International Community, a series of legislative and regulative texts were adopted.

The mother of these texts is law 96/12 of 5<sup>th</sup> August 1996 carrying legal framework relative to environmental management which fixes the general framework of environmental management.

The legal framework in its Article 9 outlines the fundamental management and natural resources which are:

- a) The precaution principle, according to which certain absences, taking note of present scientific and technological knowledge, do not have to retard the adoption of effective and proportionate measures to preview the risk of gracious and irreversible damages to the environment at an acceptable economic cost.
- b) The principle of preventive action and of correction, by priority at the source, environmental attacks using the best available techniques at an economically acceptable cost.
- c) The polluter-payer principle, according to which the resulting charges of preventive measures, the reduction of pollution and the fight against it, and the reinstatement of the polluted sites have to be borne by the polluter.
- d) The responsibility principle, according to which all persons, by their actions, create natural conditions to attack human and environmental health, are made to assure clean conditions to avoid the said effects.
- e) The participation principle, according to which:
  - Every citizen has the right to have access to information related to the environment, comprising those related to dangerous substances and activities.

- Every citizen has the duty to sit up to safeguard the environment and to contribute to its protection.
- Public and private persons have to in all their activities conform to the same exigencies.
- The decisions concerning the environment have to be taken after concertations with the sectors of activities or the groups concerned, or after public debates which have a general impact.

From these principles, we have to insist on the first and the last.

- Every citizen has the right to have access to information related to the environment, comprising those related to dangerous substances and activities.
- The decisions concerning the environment have to be taken after concertations with the sectors of activities or the groups concerned, or after public debates which have a general impact.

The legal framework devotes the Environmental Impact Studies (E.I.S) as a tool “par excellence” to take into account the preoccupations of the population.

The decree 0577/2005 of 23<sup>rd</sup> April 2005 fixing the modalities for the realisation of E.I.S. prescribes the participation of the population in E.I.S. through public consultations and public audiences.

The E.I.S. constitute an opportunity for the involvement of the population in the realisation of projects likely to bring environmental attacks and the decree of 0577/2005 of 23<sup>rd</sup> April 2005 devoted to public consultations and public audiences as a “tool par excellence” for the involvement of the population.

Through public consultations organised during the realisation of E.I.S., the population and notably the negatively affected areas, were informed of the project, it’s social, economic, ecological impacts and the envisaged measures against these impacts. On the same occasion, the populations were called upon to express their worries, impacts and give their opinions on the project.

The public consultations constituted the framework of negotiations for environmental consensus around the project, permitting the exigencies of economic operators and the imperatives of the protection of the populations and of the environment.

The public audiences themselves concerned the projects presenting the major risks for the environment , the population and the subject to the detailed impact studies.

A public audience is a type of dialogue between the promoter and the populations, of all categories under the patronage of the Administration in charge of the environment. It is organised by the Ministry of Environment and Nature Protection (MINEP) which puts in place to this effect an ad-hoc commission. Within the framework of this process, copies of the report are put at the disposal of the public in the public lecture rooms and the opportunity is given to all those who feel concerned with the project and the Impact Studies, to read the document and list their observations in a register opened for this purpose.

The GEOVIC project shall not escape in the process or at the actual stage. There is no reason to think that they shall do otherwise.

Also, all the populations are invited to massively take part at this exercise which shall start from the 03<sup>rd</sup> to the 17<sup>th</sup> of June 2006 in Yaoundé and in the project zone.

Within the framework of its project, GEOVIC is called upon to apply the principles above based on nature to assure the protection of the populations and of the environment.