Status of Project for Landmine Detection by Nuclear Techniques in Libya

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In this paper, the problem of landmines in Libya is briefly discussed with indication to their social and economic impact. Description is also given to the techniques that are used to locate the positions of the buried landmines in the ground. These techniques are based mainly on metal detectors and are therefore ineffective for identifying landmines of plastic or wooden casing. This makes the operation of demining in Libya a very tedious, slow, costly and dangerous task. Accordingly it becomes very necessary to find other methods that detect landmines by the recognition of explosive material. This is only possible by either nuclear or sniffing methods.

A technical cooperation project, Lib_1_006 was initiated in 2005 with the IAEA to develop and adopt landmine detection techniques based on using neutrons emitted from small radio-isotopic sources and from sealed tube neutron generators with D,D and D,T reactions. This project is concerned with the performance of theoretical and experimental studies to develop and adopt the more promising nuclear techniques, i.e., neutron backscattering and elemental analysis by fast and thermal neutron activation.

1. Introduction

According to published information by the United Nations, more than 100 million of landmines are laid buried in vast areas of land of several countries world wide [1,2], where Libya is one of them. These abandoned landmines go on killing and maiming a lot of innocent civilians long after hostilities have ended without differentiating between intended targets and victims. The psychological effect of mines on supervisors and their families is devastating.

The largest numbers of landmines in Libya are buried in the Eastern Desert. Although most of these landmines are Anti Tank Mines (ATM), the long period of burial makes the triggering system very sensitive to explode under the human pressure due to the erosion of the metallic part. This makes even the ATM very sensitive to personnel even for children Accordingly, these abandoned landmines kill and maim a lot of civilian every year ravaging about 300,000 hectares of land in the Eastern Desert and more than 70,000 hectares south of Eastern Desert. This leads to a very serious social and economic threat.

Governmental and non-governmental organizations in Libya have recently been active in publicizing the problem of landmines and facing the international community to its responsibility in this regard [3]. However, the cooperation between Libya and other international organization, to address the problem is still modest. Thus, the problem of mine removal in Libya is still one of the main obstacles to the overall economic and developing issues.

2. Research Program

Theoretical and experimental studies will be performed to develop and adopt the previously mentioned two nuclear techniques to distinguish between explosive material, soil and other scattered debris in mined areas [4,5]. These objectives will be achieved through the performance of the following activities.

2.1. Theoretical Studies

Theoretical studies will be performed to optimize the source strength and configurations, detector areas and sensitivity, source and detector shield material and thickness and measuring arrangements. This will be carried out using Monte Carlo Code to study the following:

- Design simulator that is more likely to the field applications using sources of different energy spectrum.
2.2. Experimental Studies

Experimental studies are going to be performed to assess the capability of neutron backscattering and elemental analysis by fast and thermal neutrons. This will be achieved through the performance of the following activities:

- Design a soil bed of volume $100 \times 100 \times 75$ cm$^3$ filled with soil collected from landmine field.
- Collection of soil samples from different areas of mine fields of Amsaad, Tripoli, El-Gabal El-Khaddar, Toubrok, Bin Walled, Musrata and Benghazi.
- Studying the physical, chemical, and elemental constituents of the collected soils.
- Calculating the fluxes and energy distributions of fast/thermal neutrons and gamma rays inside plain soil and soil embedded with different debris, including landmines of different amount of explosive materials.
- Calculating the back scattered fast and thermal neutrons and gamma rays resulting from the irradiation of soil and soil embedded with landmines and other commonly found objects in mine fields. These calculations will be repeated at different depths.
- The above-mentioned calculations will be repeated for soils of different moisture content.

The obtained results will be used to establish a database for landmine fields in Libya.
- Design of source housing and detector collimators that suit the use of different sources and detectors and can be used for different arrangements.
- Designing and constructing the experimental tools and mechanical parts necessary to perform different measurements.
- Installation and calibration of the different measuring systems, i.e., NBS system, $\gamma$ measuring system and fast neutron backscattered spectrometer.
- Performing measurements to study the dependence of thermal neutrons backscattered from plain soil and soils embedded with landmines of different explosive content and with different casing materials. The measurements will be repeated for soil embedded with objects of different materials. All measurements will be performed using neutrons emitted from $^{252}$Cf and Pu/$\alpha$/Be neutron sources. $^3$He detectors will measure the backscattered thermal neutrons.
- Performing measurements to assess gamma rays resulting from the interaction of fast and thermal neutrons with the explosive materials of landmines buried at different depths in the ground.
Table 1: Atom density ($\times 10^{22}$) of average soil.

<table>
<thead>
<tr>
<th>Soil Element</th>
<th>Atom Density</th>
</tr>
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<tbody>
<tr>
<td>Hydrogen</td>
<td>1.4930</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.24</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>–</td>
</tr>
<tr>
<td>Oxygen</td>
<td>7.2</td>
</tr>
<tr>
<td>Silicon</td>
<td>3.2</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.045</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.039</td>
</tr>
</tbody>
</table>

- Data analysis to recognize the effectiveness and weakness of each technique for the detection of landmines in different environmental conditions.
- Writing a report with a discussion to the obtained results and with indication to the parameters that stem out from both theoretical and experimental studies.

3. Project Achievements

Soil samples are collected at different depths from different landmine fields in Libya. The collected samples are physically and chemically studied. The obtained results were used for preparing a database for each landmine field in Libya.

- Design the suitable simulator for theoretical calculations shown in Fig. 1.
- Calculating the number densities and cross sections for different elements that constitute explosive, soil, and other common materials found in landmine fields. An example is given in Table 1.
- Designing and constructing all necessary source and detector housing and radiation collimators.
- Designing and constructing soil bed and all experimental and mechanical facilities needed for different measurements. These include the trolley for carrying the two $^3$He detector shown in Fig. 2.
- Installing and calibrating the NBS device with the two $^3$He detectors.

4. Conclusions and Recommendations

The obtained results for physical and chemical analysis indicate that soils of all landmine fields in Libya do not contain nitrogen element or nitrogen compounds. In addition, the moisture content is less than 3%. This gives indication to the validity of applying nuclear techniques based on using neutrons for landmine detection and identification.

The use of detection devices based on NBS and elemental analysis by fast and thermal neutrons in an integrated system with metal detectors and data fusion will enhance the demining operation in Libya.

International and regional collaborations in the field developing and adopting nuclear techniques and other innovative technologies for landmine allocation and identification will help Libya to overcome the problem resulting from contaminations of vast areas of land with landmines.
REFERENCES


4. F.D. Brook, Detection of Explosives by Neutron Scattering Advisory Group Meeting on Detection of Explosives (in particular Landmines) by low-cost Methods, IAEA HO, Vienna, 9-12 December. 1997