

# Interactive, Computer- Based Training Program for Radiological Workers

*P.A. Trinoskey, P.I. Camacho and L. Wells*

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# **Interactive, Computer-Based Training Program for Radiological Workers**

P.A. Trinoskey, P.I. Camacho, and L. Wells

Lawrence Livermore National Laboratory, University of California

## **INTRODUCTION**

Lawrence Livermore National Laboratory (LLNL) is redesigning its Computer-Based Training (CBT) program for radiological workers. The redesign represents a major effort to produce a single, highly interactive and flexible CBT program that will meet the training needs of a wide range of radiological workers—from researchers and x-ray operators to individuals working in tritium, uranium, plutonium, and accelerator facilities. The new CBT program addresses the broad diversity of backgrounds found at a national laboratory.

When a training audience is homogenous in terms of education level and type of work performed, it is difficult to duplicate the effectiveness of a flexible, technically competent instructor who can tailor a course to the express needs and concerns of a course's participants. Unfortunately, such homogeneity is rare. At Lawrence Livermore, we have a diverse workforce engaged in a wide range of radiological activities, from the fairly common to the quite exotic. As a result, the Laboratory must offer a wide variety of radiological worker courses. These include a general contamination-control course in addition to radioactive-material-handling courses for both low-level laboratory (i.e., bench-top) activities as well as high-level work in tritium, uranium, and plutonium facilities. We also offer training courses for employees who work with radiation-generating devices—x-ray, accelerator, and E-beam operators, for instance.

However, even with the number and variety of courses the Laboratory offers, we are constrained by the diversity of backgrounds (i.e., knowledge and experience) of those to be trained. Moreover, time constraints often preclude in-depth coverage of site- and/or task-specific details. In response to this situation, several years ago LLNL began moving toward computer-based training for radiological workers. Today, that CBT effort includes a general radiological safety course developed by the Department of Energy's Hanford facility and a contamination-control program developed by LLNL. A comprehensive study guide and a post-training practical exam supplement the CBT effort. The "hands-on" practical is particularly important in that it gives participants not only the opportunity to demonstrate what they've learned, but to ask questions about their individual work situations.

The challenge is how to make the CBT program more facility- and task-specific while, at the same time, making the program more in tune with the education and/or experience levels of individual trainees. To that end, we have designed a CBT program, which we refer to as an "onion." That is, the course is layered, going from the general to the more and more specific. Also, the path through a given module can vary from one trainee to another, depending on answers given by the trainee to an initial, on-line questionnaire. This questionnaire asks where the person works (type of facility), what he/she does (specific job tasks/activities), and how much education/experience he/she has. Based on this information, the computer then tailors the training module to that individual's job needs and education/experience level. The trainee can then peel the CBT "onion" to whatever level of explanation or detail he/she wants.

## **PROGRAM DESCRIPTION**

The new CBT program will be recorded on an interactive, multi-platform (i.e., Mac and PC) CD-ROM. When complete, the new program will include ten modules, each including information on specific areas of radiation safety (e.g., x-ray, accelerator, laboratory, and contamination control). In addition to the CD format, we are exploring ways to deliver the training via internet/intranet. Again, though, the key feature of the new training is that the student tailors the CBT package to his/her needs by first answering a set of questions at the beginning.

The CBT program is being designed to allow the easy insertion of photos, text, and graphics so that the training can be customized and used by other University of California (UC) and Department of Energy (DOE) sites. This is also important because the use of interactive multimedia (e.g., video, sound, animation, and enhanced graphics) has been shown to enhance learning by providing just-in-time assistance and by having students do more than just read text.

### **Advantages of new CBT Program**

- The program will be packaged into short (10- to 15-minute) modules, considered an ideal length for adult learning.
- A test-out option will let students bypass modules they already know, reducing the time to take the course by as much as half.
- All required material will be integrated onto one CD, saving students time by not having to sift through repetitive material with each module.
- No overlap of material because information common to all radworker courses need not be repeated for each module.
- Training can be tailored to LLNL—as well as other DOE and UC—site operations.
- Can be updated easily to keep material current and relevant. Lessons learned, for example, can be incorporated on a timely basis.
- Student tailors training to his/her needs, based on pre-start questionnaire.
- Special options let the trainee focus on his/her individual work situation (e.g., specific radionuclides handled and equipment used)
- Training will be more facility-specific than current CBT program.
- Training will be available on demand (e.g., for visiting researchers and staff).
- Retraining can be tailored to the student's needs as he/she takes the course.

### **Key Features**

- Ability to customize with site-specific policies and procedures.
- Potential to interface with the Worldwide Web; for example, to access test questions on the DOE Test Bank server.
- Ability to encrypt Test Bank questions on the CBT CD-ROM.
- Multi-platform capability (Mac and PC) on a stand-alone (single-disk) design.
- UC copyright, which enables unlimited use at other UC and DOE sites.
- Course administration software is built into the master copy of each site-specific disk, which means the CBT program can be tailored to how the site wishes to manage the training program.

## **PROGRAM WALKTHROUGH**

The following sections present a brief overview of how the new CBT radiological safety program will appear to the trainee.

### **Title Page**

This screen, which simply identifies the training program, can be modified to reflect the particular site where the training is being given.

### **How To Use the System**

Here, instructions are given on how to use the computer and how to navigate through the course.

## Questionnaire

Basically, this screen asked questions about where the student works and what the student does. Based on the information provided, the computer program then determines which submodules the student must complete. In addition, facility-specific information is inserted where appropriate throughout the CBT program.

## Main Menu

This screen outlines the course, listing the ten required modules as “clickable” buttons. The various modules can be accessed in any order; however, the student is encouraged to take the modules in sequence.

<b>MAIN MENU</b>	
<b>Completed</b>	<b>1.0 Introduction</b>
	<b>2.0 History and Uses of Radiation</b>
	<b>3.0 Basic Radiation Theory and Fundamentals</b>
	<b>4.0 Background Radiation</b>
	<b>5.0 Biological Effects and Risks of Exposure to Ionizing Radiation</b>
	<b>6.0 Characteristics and Concerns</b>
	<b>7.0 Radiological Controls</b>
	<b>8.0 Radiation/Contamination Monitoring</b>
	<b>9.0 Response to Abnormal Conditions</b>
	<b>10.0 Responsibilities</b>
	<b>QUIT</b>

## *Expanded Menu*

The following expanded menu lists the submodules being built into the new CBT program. Many of these submodules also contain sections and subsections. The program is designed much like an onion, with multiple layers. Navigation through the program is set by the questionnaire. All submodules are available to the student, but only certain ones are required. Required submodules are highlighted in the submenus and must be completed successfully to complete the module. Once a module has been completed successfully, a checkmark appears by that module on the **MAIN MENU**.

- 1.0 INTRODUCTION
  - 1.1 ISM
  - 1.2 What's New
  - 1.3 Lessons Learned
  
- 2.0 HISTORY AND USES
  - 2.1 Early History
  - 2.2 Sources and Uses of Tritium
  - 2.3 History and Uses of Uranium
    - 2.3.1 *Early History and Discovery*
      - 2.3.1.1 Why is uranium important?
      - 2.3.1.2 Natural uranium reactors
        - a. Location of the Gabon reactors
        - b. Discovery of the Gabon reactors
        - c. How is it possible?
        - d. The importance of the discovery
      - 2.3.1.3 Discovery of uranium in Europe
      - 2.3.1.3 The discovery of radioactivity
    - 2.3.2 *Manhattan Project*
    - 2.3.3 *Uranium Fuel Cycle*
    - 2.3.4 *Uses for Uranium*
  - 2.4 History and Uses of Plutonium
  - 2.5 Beyond Trinity
  - 2.6 History and Uses of Accelerators
  
- 3.0 BASIC RADIATION THEORY AND FUNDAMENTALS
  - 3.1 Atoms
  - 3.2 Radioactivity and Radioactive Decay
  - 3.3 Units
  
- 4.0 BACKGROUND RADIATION
  
- 5.0 BIOLOGICAL EFFECTS AND RISKS OF EXPOSURE TO IONIZING RADIATION
  
- 6.0 CHARACTERISTICS AND CONCERNS
  - 6.1 Common Radionuclides
  - 6.2 Tritium
  - 6.3 Uranium
  - 6.4 Plutonium
  - 6.5 X-Ray Devices
  - 6.6 E-Beam Devices
  - 6.7 Radiography Devices
  - 6.8 Accelerators
  
- 7.0 RADIOLOGICAL CONTROLS
  - 7.1 Limits, ALARA, Hierarchy
  - 7.2 Procedures, Postings, Labels
  - 7.3 Radiation-Generating Devices
    - 7.3.1 *X-Ray Devices*
    - 7.3.2 *E-Beam Devices*
    - 7.3.3 *Radiography Devices*
    - 7.3.4 *Accelerators – generic*
      - a. to j. *facility-specific*
    - 7.3.5 *Radioactive Material Handling*
      - a. PPE – *generic*

- b. Low-Level Laboratory
- c. Tritium Facilities
- d. Uranium Facilities
- e. Plutonium Facilities

## 8.0 RADIOLOGICAL MONITORING

- 8.1 Personnel Monitoring
- 8.2 Workplace Monitoring
- 8.3 Radiation Survey Instruments
  - 8.3.1 *Contamination*
  - 8.3.2 *Dose rates*
- 8.4 Environmental Monitoring

## 9.0 RESPONSE TO ABNORMAL CONDITIONS

- 9.1 General
- 9.2 Radioactive Material Areas
  - 9.2.1 *Spills*
  - 9.2.2 *Injuries*
  - 9.2.3 *Alarm – facility specific*
- 9.3 RGDs
  - 9.3x *facility-specific*

## 10.0 RESPONSIBILITIES

### **Testing**

Not all modules or submodules require a test for successful completion. However, for those that do, the student is given the option of testing out of the module/submodule by taking a comprehensive pre-test. This option remains a “hot button” (i.e., available) throughout the module/submodule—unless and until the person tries and fails the pre-test, at which time the test-out option becomes no longer available.



Where required, randomly generated tests are administered at the end of a module or submodule. Feedback is provided for any incorrect answers. The test must be completed successfully to get credit for that module/submodule.

### **“Hands-On” Practical**

The CBT training is supplemented with a practical exercise under simulated working conditions. This can be a one-on-one exercise with the trainer or a self-paced exercise followed by questions and answers with the trainer.

### **EXAMPLE**

The expanded menu—for the “History and Uses” module—is presented in the following sections, including storyboards of submodule 2.3, “History and Uses of Uranium.” Trainees who work in a uranium facility are required to view this module and its subsections. Trainees are not required to go beyond the four sections. However, in our experience, most trainees go further because they feel the additional information is both interesting and useful.

2.0 HISTORY AND USES

2.1 Early History

2.2 Sources and Uses of Tritium

2.3 History and Uses of Uranium

2.3.1 *Early History and Discovery*

2.3.1.1 Why is uranium important?

2.3.1.2 Natural uranium reactors

- a. Location of the Gabon reactors
- b. Discovery of the Gabon reactors
- c. How is it possible?
- d. The importance of the discovery

2.3.1.3 Discovery of uranium in Europe

2.3.1.3 Discovery of radioactivity

**Main Menu**

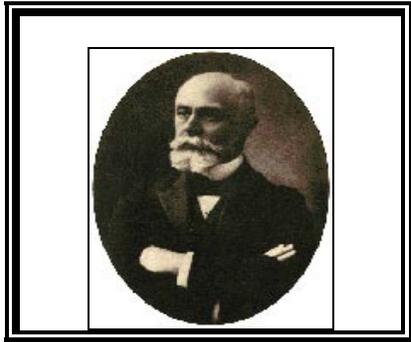
**2.0  
History and  
Uses**

**2.3  
History and  
Uses of U**

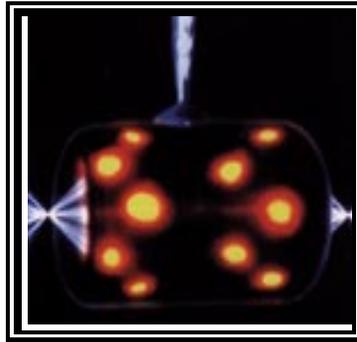
**2.3.1  
Early History  
of U**

**2.3.1.2  
Natural  
Reactors**

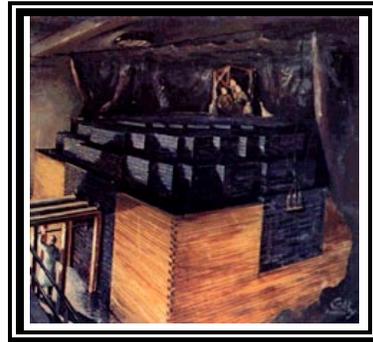
**History and Uses (menu)**



**2.1 Early History**



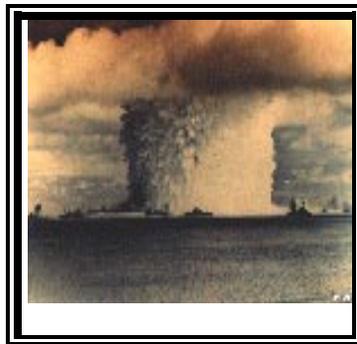
**2.2 Sources and Uses of  
Tritium**



**2.3 History and Uses of  
Uranium**



**2.4 History and Uses of  
Plutonium**



**2.5 Beyond Trinity**

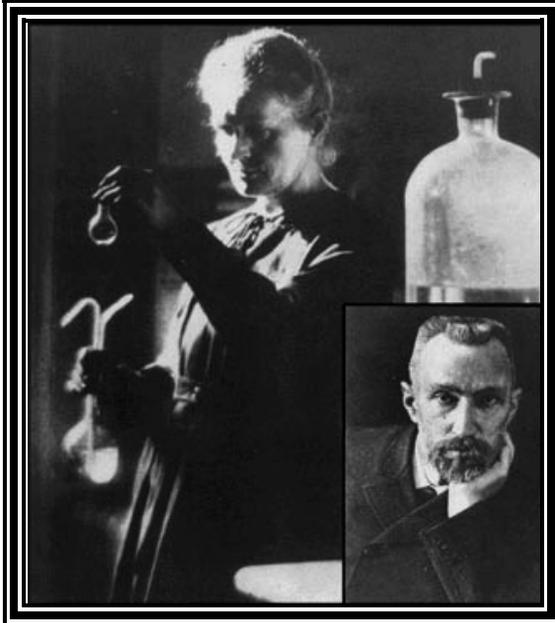


**2.6 History and Uses of  
Accelerators**

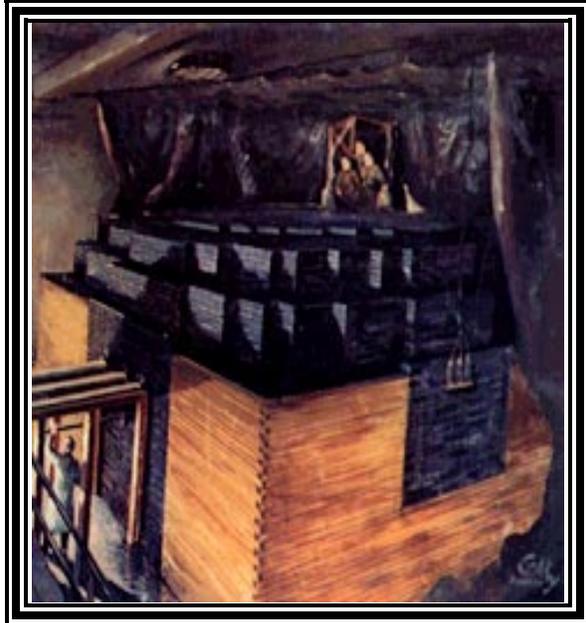
## History and Uses of Uranium (submenu)

This submodule traces the history of uranium in our society, from its discovery in 1789 through its uses today. The submodule includes the following required sections:

- 2.3.1 Early history and discovery of uranium
- 2.3.2 Role of uranium in the Manhattan Project
- 2.3.3 Steps in the nuclear fuel cycle and common forms (and significance) of uranium found in the cycle
- 2.3.4 Importance and primary uses of uranium



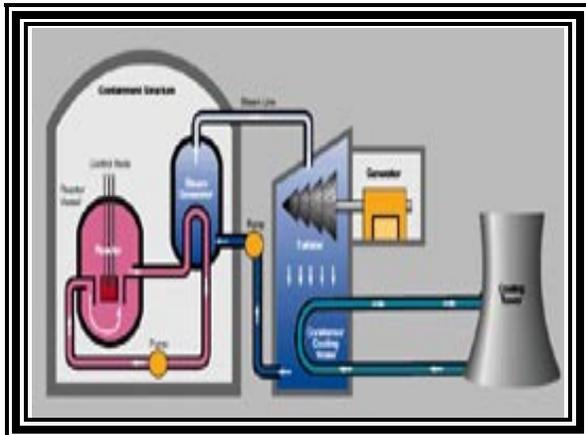
2.3.1 Early History and Discovery



2.3.2 Manhattan Project



2.3.3 Uranium Fuel Cycle

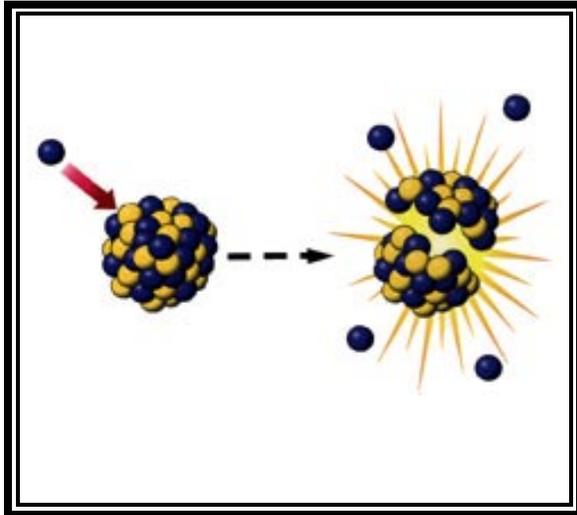


2.3.4 Uses of Uranium

[Return to History Menu](#)

## Early History (submenu)

Uranium, from which the fuel for most of the world's reactors is obtained, is a chemical element, symbol U. It was named after one of the Earth's planets, Uranus. Uranium is heavy—one of the heaviest of all metals. It weighs about 65% more than lead. A piece of uranium the size of a soft drink can weighs about 17 pounds.



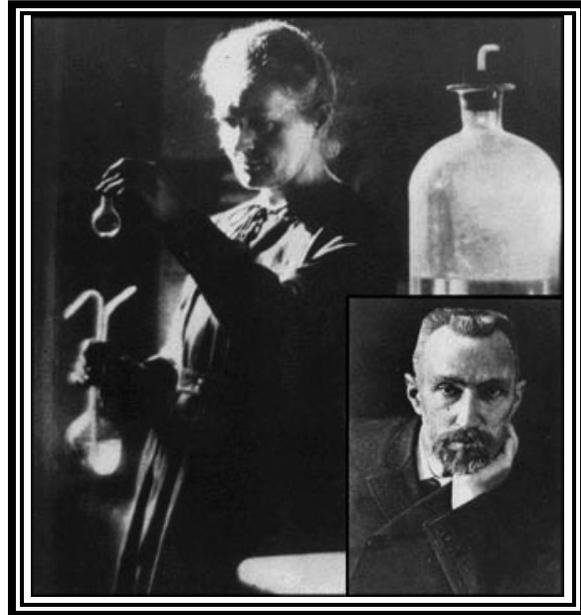
Importance of Uranium



Natural Reactors



Discovery of Uranium



Discovery of Radioactivity

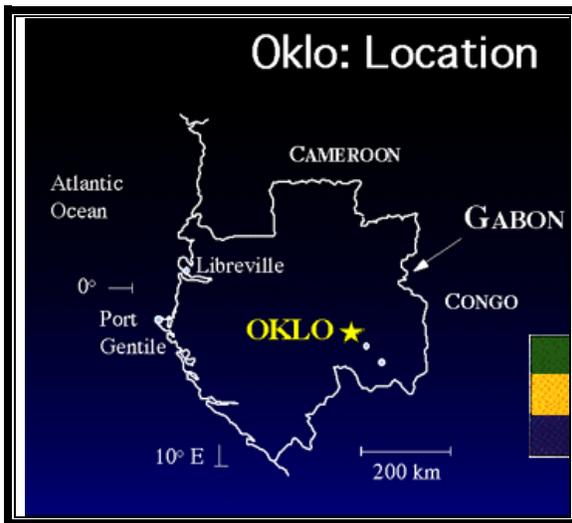
[Return to Uranium Menu](#)

## Natural Reactors (submenu)

In the early 1960s, a very rich uranium ore deposit was found on a West African upland (Oklo). In 1972, sampling of the ore showed a different  $^{235}\text{U}$  concentration from that found in other uranium deposits worldwide. Why? Within a few years a team of scientists from the French Atomic Energy Commission had the answer. In each of half a dozen locations in the Oklo ore body, about a ton of  $^{238}\text{U}$  had “fissioned” away instead of decaying naturally. This remnant of a natural reactor is believed to have operated for millions of years. (See July 1976 issue of *Scientific American* for more information.)

Today, even highly enriched natural uranium ore bodies cannot form fission reactors because there is insufficient  $^{235}\text{U}$  in today's naturally occurring uranium. In fact, it has not been possible for uranium ore bodies to form natural reactors for the over a billion years.

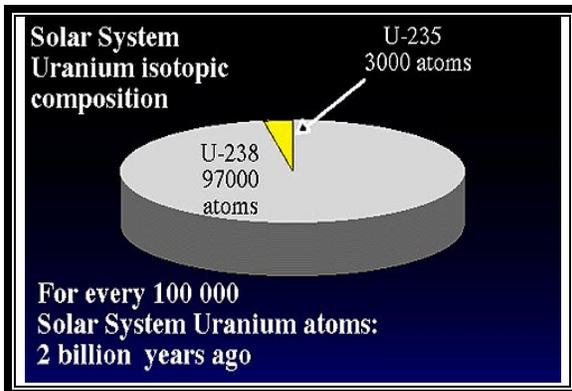
For more information, [CLICK](#) on the pictures.



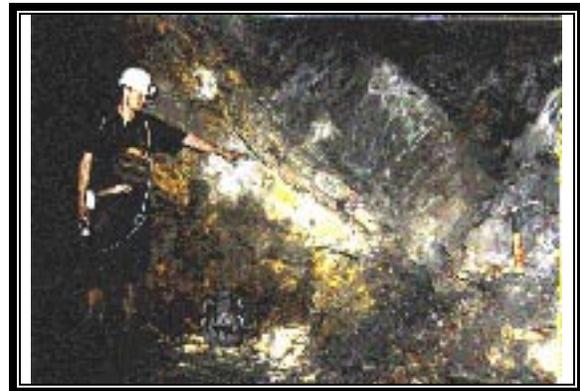
Location of Gabon Reactors



Discovery of the Reactor



How is it possible?

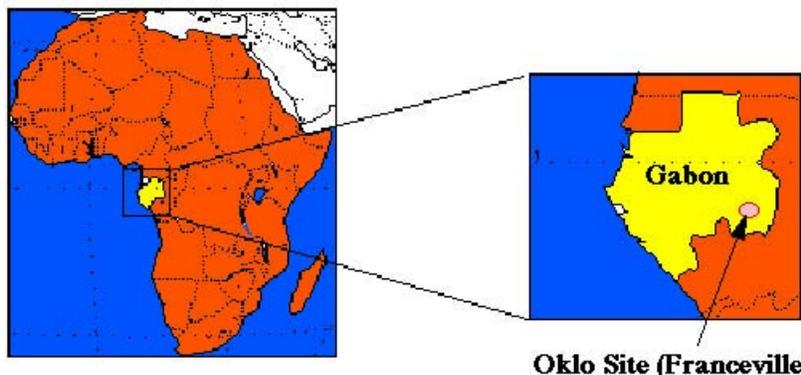
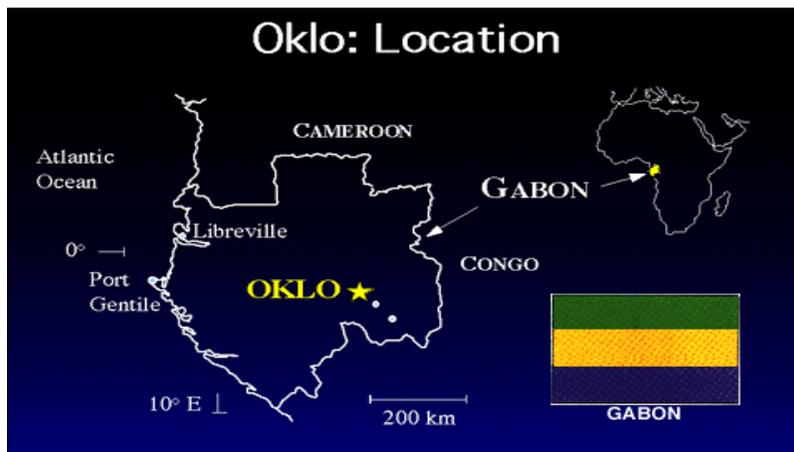


Importance of the Discovery

[Return to Uranium Early History Menu](#)

## Location of Gabon Reactors (screen)

To date, natural fossil reactors have only been found in the country of Gabon in equatorial Africa. All but one of these reactors are located at a place known as the Oklo uranium deposit, located in the southeastern corner of the country. Another fossil reactor has been discovered in Gabon at another uranium deposit at Bangombe, some 22 miles (35 km) southeast of the Oklo mine.



Even though Gabon is an equatorial country, the countryside around Oklo consists of grassy highlands. During the 1960s, mining interests conducted geochemical explorations of these highlands at the boundary of what is known as the Franceville Basin. These explorations revealed extensive deposits of highly enriched uranium. A large body of uranium ore was discovered at a place called Oklo. Subsequently, the main ore body was found to be several kilometers long and to contain pockets of highly enriched (up to 70% pure) uranium as uranium dioxide ( $UO_2$ ), which they began mining shortly thereafter.

For more information: <http://www.curtin/centre/waisrc/OKLO/author.html>

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