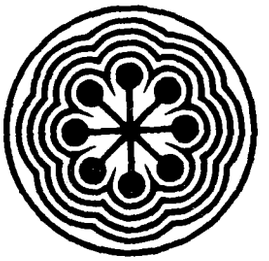
EARLY RADIOISOTOPE USES IN MEXICO

instituto nacional de investigaciones nucleares



CENTRO DE INFORMACION Y DOCUMENTACION NUCLEAR

INSTITUTO NACIONAL DE INVESTIGACIONES NUCLEARES

DIRECCION DE INVESTIGACION Y DESARROLLO

EARLY RADIOISOTOPE USES IN MEXICO.

INFORME TECNICO IA-91-27

OCTUBRE, 1991

EARLY RADIOISOTOPE USES IN MEXICO.

N. Segovia, A. Tejera, S. Bulbulian y F. Palma.
Gerencia de Investigación Aplicada.
Dirección de Investigación y Desarrollo
Instituto Nacional de Investigaciones Nucleares

INFORME TECNICO IA-91-27

OCTUBRE, 1991.

EARLY RADIOISOTOPE USES IN MEXICO

N. Segovia, A. Tejera, S. Bulbulian, F. Palma

ININ, Ap. Post. 18-1027, 11801, Mexico D.F., Mexico.

Workshop on Radium, Uranium and related medides in Industry and Medicine: History and Current uses. Badjastein, 1-3 october, 1991, Austria.

EARLY RADIOISOTOPE USES IN MEXICO

N. Segovia, A. Tejera, S. Bulbulian, F. Palma
ININ, Ap. Post. 18-1027, 11801, Mexico D.F., Mexico.

ABSTRACT

Mexico is traditionally a mining country and the first information about the presence of uranium is related to mine exploitation. Around 1945 when uranium became economicaly important, a rumor had spread that large amounts of Oaxaca's black ceramic were being purchased and sent abroad because of its assumed high uranium content. It was only in 1949 when minerals containing thorium and uranium were declared by law as "National Reserves". In those years a radium emanation plant was installed at the "Hospital General" in Mexico City with the main purpose of carrying out radon seed implantation in tumors. In the 50s' a radium dial painting facility was operating in the city of Toluca some 70 km from Mexico City.

In 1955, when the National Commission of Nuclear Energy (CNEN) was founded by a government decree, two main activities were in sight: a training program on "Radioisotope Techniques and Nuclear Instrumentation" and the creation of specialized laboratories.

In this paper a general description of these events and undertakings spanning the decades 1940 to 1970 is given.

INTRODUCTION

Mexico entered officially into the radioisotope era when the National Comission of Nuclear Energy (CNEN) was founded by a government decree in 1955. This institution regulated and controlled all available radioactive sources in the country, radioisotope importation, and exposure rates of occupationally exposed personnel and the general population.

In this paper a general description of the radioisotope applications in medicine and industry, as well as of the institutional undertakings spanning the decades 1940 to 1970 is given. Some of the information has been obtained from documents describing the early uses of uranium, radium and related nuclides in Mexico. However, the main information has been obtained directly by personal communication from professional staff that worked, from 1940 to 1970, with the available radioactive sources in the country.

URANIUM MINING

The first information about the presence of uranium in Mexico is related to mine exploitation. Mexico is traditionally a mining country. Even five centuries before the Spanish conquest, in pre Colombian times, gold, silver and copper were used for ornamental purposes. The conquistadores were also interested in the exploitation of gold and silver mines, and they started mining operations in Zacatecas in 1546. In 1792 the first mining school in the American continent was founded in Mexico City (Escuela de Mineria) by Fausto Elhûyar, discoverer of Tungsten, and Andres Manuel del Rio, discoverer of Vanadium , collaborated

with him at this prestigious school[1]

In 1868 a gold mine was discovered in the locality called "Placer de Guadalupe", 45 km from the City of Chihuahua. The gold was mixed with a black and heavy mineral which was later found to be uraninite. In 1944 Gonzalez Reyna[2] reported that the uranium in this mine was not commercially important. He also reported having found radioactive minerals in the state of Guerrero; however this statement was not proved at that time. During that period, an American laboratory reported the finding of a highly radioactve material in a mercury sample extracted from the mine "El Sotolar" in Chihuahua.

Around 1945, when uranium became economically important, a rumor had spread that large amounts of Oaxaca's black ceramic were being purchased and sent abroad because of its assumed high uranium content. The clay from Oaxaca is formed by volcanic rock decomposition within a strong mineralization system and probably has a slightly higher uranium content than other clays; therefore uranium content in the ceramic manufactured with this mud could not be very high. In fact, radioactivity measurements in these ceramics have shown mean values of 5ppm of uranium, only 2 ppm higher than the most common uranium content in clays[3]

MEDICINE AND INDUSTRY

In the 40s', one of the main hospitals in Mexico City, "Hospital General", received 1.5 g of ^{226}Ra as a donnation from the "Memorial Hospital" in New York, to be employed in a radium emanation plant. The goal of the plant, which worked until the 50s', was the preparation of radon seeds, capillary tubes

containing radon, to be used for implantation in tumors. In the early 60s' the plant was closed and the radium was encapsuled in needles and pills which were, in turn, used for tumor irradiation (Diaz Perches, 1991; De Garay, 1991; personal communications).

After Second World War, "Luminous Processes Inc." from New York, installed a radium dial painting plant in the City of Toluca. This facility probably started operation between 1954 and 1955 using radium at a rather low concentration (1-4 μg per gram of paint). This was a typical range of concentration for alarm clock dials. After changing to tritium as the main luminous agent in 1964, the plant was examined for radium contamination but none was found (Rundo, 1991; Stebbings, 1991, personal comunications).

INTERNATIONAL ACTIVITIES

Following World War II, when the USA and the European countries were devoted to the study of peaceful uses of nuclear energy, the government of Mexico undertook some actions concerning radioactive materials.

In 1949 a law declared those minerals containing thorium and uranium as "National Reserves", thus bestowing upon three independent governement agencies authority on use, exploitation and research of radioactive minerals in the country. These agencies were the General Court of Justice, the Ministry of Water Supply, and the Ministry of Education through its agency the National Institute of Scientific Research (INIC). During that time the General Court of Justice, appropriated for reasons of national security and by an act of law, all chemical reagents containing ^{235}U, such as uranil nitrate and acetate. The Water

Supply Ministry promoted uranium prospection by lending Geiger counters to all interested prospectors while purchasing their findings. The chemicals appropriated by law, and the uranium salts obtained from prospection were given to INIC, together with a large amount of uranium and thorium minerals from Oaxaca's pegmatite.

With these materials and the presence of enthusiastic Mexican scientists who had previously visited the Enrico Fermi laboratory, a project for the construction of a nuclear demonstration reactor was started at INIC (1951-1956). Unfourtunately only some aspects of the project were carried out. The planning of the whole project is shown in Figure 1 where the dashed lines indicate the unfinished activities and the continuous lines show those activities which were completed. Among them, the Inorganic Chemistry Laboratory (INIC) started operations in 1951. The laboratory was devoted to the treatment of uranium mineral and its conversion to metallic uranium. As a part of this laboratory, a pilot plant for extraction and concentration of uranium using alkaline hydrometallurgy and an analytical control section were installed. Uranium tetrachloride was the product obtained in the early period of the pilot plant. The metallic uranium was obtained by UCl_4 reduction with metallic calcium. It was only after the Conference in Switzerland, in 1955, when uranium tetrafluoride by a dry method was used for metallic uranium obtention[4].

The participation of INIC in the geological studies for uranium prospection, started at El Sotolar, Chihuahua where the already mentioned American scientists had found highly

radioactive material in mercury samples.

THE INSTITUTIONS AFTER 1955

In May 1955 two young Mexican physicists attended the "First International Course in Radioisotope Techniques for Non-U.S. Citizens" held at the Oak Ridge Institute of Nuclear Studies, Tennesse, U.S.A. In the same year, in August, Mexico participated in the "First International Atoms for Peace Conference" held in Switzerland.

With the establishement of the National Commission of Nuclear Energy (CNEN), by a government decree in December 19, 1955, two main activities started in the country: a training program on "Radioisotope Techniques and Nuclear Instrumentation" and the creation of specialized programs and laboratories. The nuclear science laboratories of INIC were incorporated to the new institution.

Some of the CNEN projects were related with uranium exploration and extraction, radioisotope applications, radiological security, radioactive standards, radioisotope dilution, genetical effects of radiations, electromagnetic radiation, plasma physics and reactor physics.

The results of the CNENs' Uranium Exploration program showed that uranium was found associated to clays, shales and rhyolites in the north of the country, in Baja California, Coahuila, Sonora and Chihuahua, four of the provinces on the USA boarder. The geological units of these regions are formed by sedimentary rocks of Cambrian, Devonic, Mississipic, Pensylvanic, Triasic, Jurasic and Cretacic origin. In the south of the country, in particular

in Oaxaca, uranium and thorium minerals were also found associated with pegmatite. In 1958 Antunez[5] had already estimated that these rocks were highly favorable for uranium content. Figure 2 shows a map of Mexico reported in 1958 where regions with radioactive mineralizations were found; these zones were recommended for prospection and exploitation of uranium.

The CNEN programs devoted to radioisotope applications in medicine, radioactive standards and radioisotope dilution worked very closely in the early 60s'.

In 1962, for the first time, tellurium was irradiated in a nuclear research reactor in exhibition in Mexico within the Cooperative Mexican - United States Atoms at Work Exhibit. On this occasion ^{131}I was obtained by distillation in small amounts[6].

By this time in Mexico, scientists specialized abroad were already working in fields such as Nuclear Reactors, Nuclear Medicine and Industrial Applications.

The first ^{131}I sample for medical use, which was imported from Canada in February 1962, was diluted and sent to the hospitals. During the first part of this year, the average ^{131}I amount bought by private and public hospitals was 30 mCi per month. The amount required at the end of the year was already 115 mCi per month and in 1967, 2 Ci per month. Fifteen differently labelled molecules were also systematicallly imported for medical uses in that year. The facilities of the dilution laboratory were not sufficient to answer the requests of the hospitals and in 1967 the laboratory moved to the Nuclear Center of Mexico within a program of Radioisotope Production.

The main industrial application of radioisotopes in the early 60s' was radiography using gamma emitters[7]

The Standards laboratory was in charge of the importation of radioactive standards and of the calibration of detection devices and radioactive material. For this purpose ^{226}Ra standards, and kits of several gamma and beta emitters were also acquired for national use. At the end of 1967, secondary standards were offered on loan to the laboratories using radioactivity detection devices.

THE NUCLEAR CENTER OF MEXICO

The CNEN laboratories moved to the Nuclear Center of Mexico between 1966 and 1970. The Nuclear Center occupies an approximate area of 1.50 km^2, 36 km west of Mexico City. Its main equipment was a Triga Mark III nuclear reactor and a Tandem accelerator. In addition to those projects already working in Mexico City, new projects were added to the activities of CNEN at the Nuclear Center such as: Radioisotopes Production, Reactor Physics and Engeneering, Solid State Detectors, Accelerator Design for Industrial Applications, Experimental Nuclear Physics, Nuclear Fuels, etc. The projects related with the exploration and exploitation of uranium were performed near the mines, mainly in the northern part of the country.

CONCLUDING REMARKS

The activities performed from 1940 to 1970 laid the basis for the laboratories and for the development of the human resources available today.

The exploration and exploitation of uranium ores run by

CNEN, renamed Instituto Nacional de Energia Nuclear in the 70s', was one of its most important projects[8] However, since the early 80s', prospection and exploitation of uranium on a national scale have been substantially reduced.

The use of radium based paintings for industrial use has evolved and nowadays, under a quality control program, some enterprises produce bulbs with thorium based paints.

For medical purposes, radium has been substituted by other radioisotopes but radium standards for calibration purposes are still used.

The nuclear fuel program for Laguna Verde nuclear power plant in the State of Veracruz represents one of the principal projects of the Instituto Nacional de Investigaciones Nucleares (formerly Instituto Nacional de Energia Nuclear).

Radioisotope importation for medical and industrial purposes has continued in larger amounts than in the 60s'. Short lived radioisotopes for medical applications and research are produced in Mexico using basically the irradiation facilities of the Triga Mark III nuclear reactor located at the Nuclear Center.

As a last remark it is worth remembering that the treaty of Tlatelolco was signed by several nations in Mexico in 1967. The nations suscribing this document agreed, among other things, on the development of the peaceful uses of nuclear energy.

ACKNOWLEDGEMENTS

The authors are grateful for the personal conversations with pionneers in the uses of radioactivity in Mexico. Special mention is given to Dr. Leon De Garay, Dr. Rodolfo Diaz Perches and I.Q.

Gustavo Barrera Echeverry. We also acknowledge the personal communications from Dr. James H. Stebbings and Dr. John Rundo. We thank E. Tamez and P. Peña for gathering information; R. Noriega for linguistic revision, C. Martinez and G. Zenteno for technical assistance. We acknowledge finantial support from CONACyT, Mexico.

REFERENCES

1. Espindola, J.M. *Minerales y Rocas*. SEP-UNAM. Mexico (1986).

2. Gonzalez Reyna, J. *Mineria y Riqueza Minera de Mexico*. Monografias Industriales del Banco de Mexico S.A. (1944).

3. Iturbe, J.L. *Determinacion de Uranio en Ceramica de Oaxaca*. Tech. Rep. ITQ 0391, ININ, Mexico (1991).

4. Palma, F.A., Herrera, M., Rios Nieto , A. *Obtencion de Uranio Metalico*. Rev. Soc. Quim. Mex. XII(4), 173A-176A (1968).

5. Antunez, F. *Manual para la Exploracion del Uranio*. CNEN, Mexico (1958).

6. Bulbulian, S. *Produccion de* ^{131}I. Thesis Universidad Nacional Autonoma de Mexico. (1963).

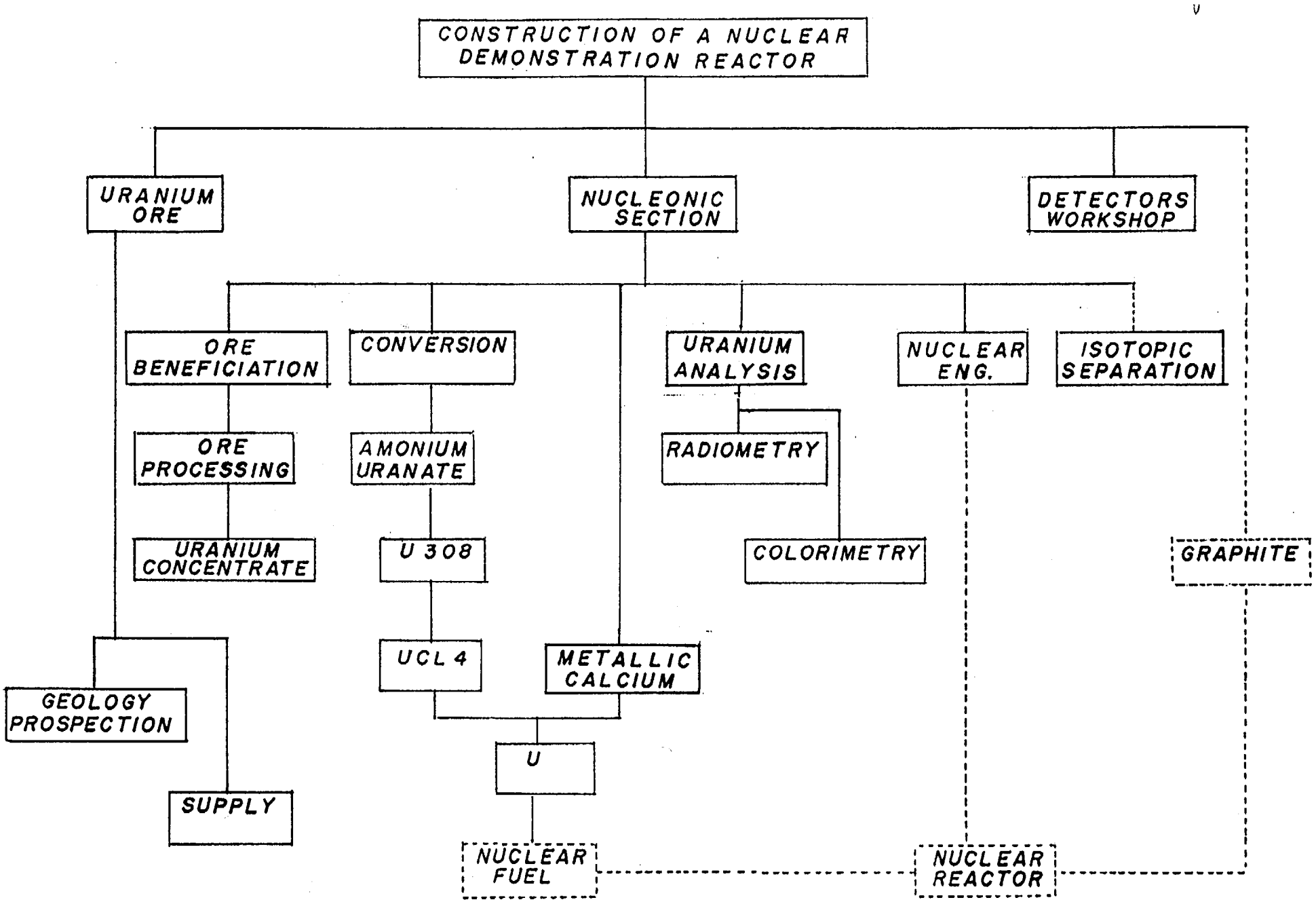
7. Garcia-Moreno, C. *Tecnicas de Gammagrafia Industrial*. Thesis. Universidad Nacional Autonoma de Mexico (1963).

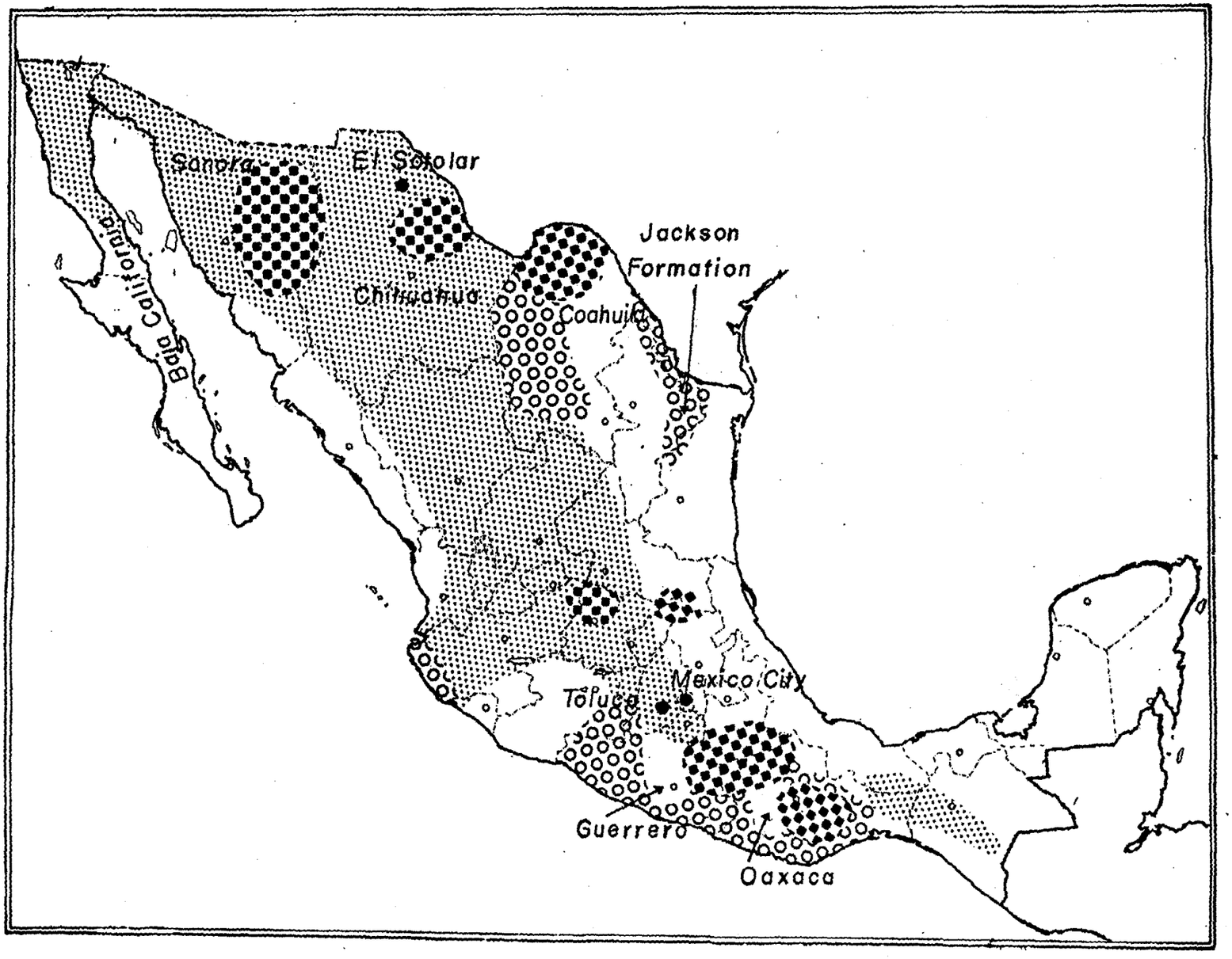
8. Tejera, A. and Rodriguez Soto, E. *La Mineria de las Materias Primas Radiactivas en Mexico*. INEN, Mexico (1977).

FIGURE CAPTION.

Fig. 1.- Project for the Construction of a Nuclear Demonstration Reactor, INIC (1951-1956).

Fig 2.- Localization of Radioactive Minerals in Mexico:  Under Exploration by CNEN;  Radioactive Minerals Known but not Explored by CNEN; Recommended for Exploration. (after Antunez, 1958).


CONSTRUCTION OF A NUCLEAR DEMONSTRATION REACTOR
URANIUM ORE
NUCLEONIC SECTION
DETECTORS WORKSHOP
ORE BENEFICIATION
CONVERSION
URANIUM ANALYSIS
NUCLEAR ENG.
ISOTOPIC SEPARATION
ORE PROCESSING
AMONIUM URANATE
RADIOMETRY
URANIUM CONCENTRATE
U 308
COLORIMETRY
GRAPHITE
UCL 4
METALLIC CALCIUM
GEOLOGY PROSPECTION
U
SUPPLY
NUCLEAR FUEL
NUCLEAR REACTOR


Sonora
El Sotolar
Jackson
Formation
Chihuahua
Coahuila
Baja California
Mexico City
Toluca
Guerrero
Oaxaca