URANIUM MINING AND MILLING IN NIGERIA

First, kindly note that Nigeria is yet to commence operation on Uranium Mining and Milling, therefore questions answered was as a reference to this effect. Uranium can be found in six states namely: Cross River, Adamawa, Taraba, Plateau, Bauchi and Kano. Uranium deposit in Northern Nigeria occurs in sandstone-hosted (Sandstone-hosted deposits occurs in sedimentary/volcano sedimentary) and vein-type mineralization ({hydrothermal}: Some of the accessory minerals that often contain uranium are apatite, sphene, zircon, allanite, monazite, pyrochlore, uraninite, and xenotime).

Description of Uranium: is a chemical element with symbol **U** and atomic number 92. It is a silvery-white metal in the actinide series of the periodic table. A uranium atom has 92 protons and 92 electrons, of which 6 are valence electrons. Uranium is weakly radioactive because all its isotopes are unstable (with half-lives of the six naturally known isotopes, uranium-233 to uranium-238, varying between 69 years and 4.5 billion years). The most common isotopes in natural uranium are uranium-238 (which has 146 neutrons and accounts for over 99%) and uranium-235 (which has 143 neutrons). Uranium has the second highest atomic weight of the primordially occurring elements, lighter only than plutonium Its density is about 70% higher than that of lead, and slightly lower than that of gold or tungsten. It occurs naturally in low concentrations of a few parts per million in soils, rock and water, and is commercially extracted from uranium-bearing minerals such as uraninite. .

In nature, uranium is found as uranium-238 (99.2739–99.2752%), uranium-235 (0.7198–0.7202%), and a very small amount of uranium-234 (0.0050–0.0059%).Uranium decays slowly by emitting an alpha particle. The half-life of uranium-238 is about 4.47 billion years and that of uranium-235 is 704 million years,[6] making them useful in dating the age of the Earth..

Many contemporary uses of uranium exploit its unique nuclear properties. Uranium-235 has the distinction of being the only naturally occurring fissile isotope. Uranium-238 is fissionable by fast neutrons, and is *fertile*, meaning it can be transmuted to fissile plutonium-239 in a nuclear reactor. Another fissile isotope, uranium-233, can be produced from natural thorium and is also important in nuclear technology. Uranium-238 has a small probability for spontaneous fission or even induced fission with fast neutrons; uranium-235 and to a lesser degree uranium-233 have a much higher fission cross-section for slow neutrons. In sufficient concentration, these isotopes maintain a sustained nuclear chain reaction. This generates the heat in nuclear power reactors, and produces the fissile material for nuclear weapons. Depleted uranium (^{238}U) is used in kinetic energy penetrators and armor plating.[7] Uranium is used as a colorant in uranium glass, producing lemon yellow to green colors. Uranium glass fluoresces green in ultraviolet light. It was also used for tinting and shading in early photography.

What is being done to control the Radiation Level: NNRA has designed a Draft Regulation on Nigerian Uranium Exploration, Mining and Processing which is currently at the Ministry of Justice. The general objective of this regulation is to set up the basic technical and organizational requirements to be complied with by the uranium mining, milling and processing operators in order to limit, to a reasonable level and in a manner that is consistent with Nigeria's international obligations of the risks to national security, the health and safety of persons and environment that are associated with exploration, mining and processing of uranium. Section 5 and 8 of the document states the Radiation Management, Standards and Levels and Schedule 1 talks about the dose limits.

Regulation 8 involves the development of a RMP which shall contain a description of the operations to which it applies, and the measures that are intended to be taken to control the exposure of employees and members of the public to radiation at or from the practice including.

- demonstrated access to appropriate professional expertise in radiation protection;
- a plan for monitoring radiation exposure and for assessing the doses received by exposed employees;
- the provision of appropriate equipment, staffing, facilities and operational procedures;
- details of induction and training courses;
- record keeping and reporting Such as:

1) The implementation of the radiation protection program
2) Radiation Survey and instrument calibration
3) Occupational doses and planned special exposures
4) Doses to members of the public
5) Waste Disposal
6) Receipt and transfer of source byproducts material
7) Spills

Moreover, the above regulation shall be in addition to: Nigeria Basic Ionizing Radiation Regulations, 2003 (NiBIRR); Nigerian Radioactive Waste Management Regulations, 2006; Nigerian Naturally Occurring Radioactive Materials (NORM) Regulations, 2008; and any other existing ionizing radiation and nuclear regulations as well as any transport regulations in force at the commencement of these regulations

Who will be responsible for the site and maintain it after the company has left: The Stakeholder Body (Ministry of Mines & Solid Mineral/ Environment) submits a long Term Surveillance Plan (LTSP) to the Licensing body (NNRA) and after all conditions are met, the site can be licensed under a General closure license has required by the NNRA Act, 1995. The Stakeholder Body (Ministry of Mines) performs the Long Term Care Functions.

Who will pay for the cleanup/ how long will the rehabilitation take? The Licensee is responsible for any payment that is involved in the Cleanup and Rehabilitation process taking place at the licensed site. From the Section 9(h) of the Regulation, a RWMP is required to be submitted by the operator and it states a plan for decommissioning the operation and the associated waste management facilities and rehabilitating the site.

Are the safety standards set by the authorities for workers and the public met: Currently, Mining and Milling of Uranium Ore is yet to be officially licensed by the NNRA but safety regulations and guides have been put in place to regulate future operation to guarantee safety of both workers and the public at large.

How will the Uranium/ yellowcake be dispatched from the uranium mine/mill and will it be transported through residential areas: During the milling process uranium is extracted from the mined ore through a series of physical and chemical treatment steps. At the mill, the ore is crushed and then passes through several stages of leaching so that the recoverable uranium is subsequently in solution; The uranium is separated from the solution and concentrated to create a precipitate in the form of a yellow slurry. The slurry is washed to remove contaminants, dried to form "yellowcake" and placed into 200lts drums for offsite shipment. Yellowcake usually contains between 60% and 90% uranium by weight. Mills may be co-located with the mine or they may be located offsite, but in close proximity to the site; Depending on the location of the NPP, the Uranium yellow cake could be transported through residential areas.

The product of uranium mining is normally uranium oxide concentrate – U_3O_8 – which is shipped from the mines in 200-litre drums. This is barely radioactive, but has chemical toxicity similar to lead, so occupational hygiene precautions are taken similar to those in a lead smelter. Most of the radioactivity from the ore ends up in the tailings.

How will the tailings facility(ies) be made safe: Reprocessing tails is really economical considering if a new and more efficient extraction methodology is used or the price of uranium has been increased. The tailings are stabilized and covers are placed over the tailings to minimize the entry of water and escape of radon. Monitoring is required to ensure that the structure of the tailings and dams continue to function as licensed for as long as is require

Once the operations have been completed, will the area be restored for public use: After closure of the uranium mining and milling operation, there will continue to be controls by the operator and the regulatory authority over future uses of the site for the long-term

What is the worldwide reserve of uranium for the long term production of electricity from nuclear energy:

- Uranium is a relatively common metal, found in rocks and seawater. Economic concentrations of it are not uncommon.
- Its availability to supply world energy needs is great both geologically and because of the technology for its use.
- Quantities of mineral resources are greater than commonly perceived.
- The world's known uranium resources increased by at least one-quarter in the last decade due to increased mineral exploration.

Uranium is a relatively common element in the crust of the Earth (very much more than in the mantle). It is a metal approximately as common as tin or zinc, and it is a constituent of most rocks and even of the sea. Some typical concentrations are: (ppm = parts per million).

Very high-grade ore (Canada) – 20% U	200,000 ppm U
High-grade ore – 2% U,	20,000 ppm U
Low-grade ore – 0.1% U,	1,000 ppm U
Very low-grade ore* (Namibia) – 0.01% U	100 ppm U
Granite	3-5 ppm U
Sedimentary rock	2-3 ppm U
Earth's continental crust (av)	2.8 ppm U
Seawater	0.003 ppm U

* Where uranium is at low levels in rock or sands (certainly less than 1000 ppm) it needs to be in a form which is easily separated for those concentrations to be called 'ore' – that is, implying that the uranium can be recovered economically. This means that it needs to be in a mineral form that can easily be dissolved by sulfuric acid or sodium carbonate leaching.

An Orebody is, by definition, an occurrence of mineralisation from which the metal is economically recoverable. It is therefore relative to both costs of extraction and market prices. At present neither the oceans nor any granites are orebodies, but conceivably either could become so if prices were to rise sufficiently.

Measured resources of uranium, the amount known to be economically recoverable from orebodies, are thus also relative to costs and prices. They are also dependent on the intensity of past exploration effort, and are basically a statement about what is known rather than what is there in the Earth's crust – epistemology rather than geology.

Changes in costs or prices, or further exploration, may alter measured resource figures markedly. At ten times the current price*, seawater might become a potential source of vast amounts of uranium. Thus, any predictions of the future availability of any mineral, including uranium, which are based on current cost and price data and current geological knowledge are likely to be extremely conservative.

From time to time concerns are raised that the known resources might be insufficient when judged as a multiple of present rate of use. But this is the Limits to Growth fallacy, a major intellectual blunder recycled from the 1970s, which takes no account of the very limited nature of the knowledge we have at any time of what is actually in the Earth's crust. Our knowledge of geology is such that we can be confident that identified resources of metal minerals are a small fraction of what is there

Uranium availability

With those major qualifications the following Table gives some idea of our present knowledge of uranium resources. It can be seen that Australia has a substantial part (about 29 percent) of the world's uranium, Kazakhstan 12 percent, Russia nine percent and Canada eight percent.

Known Recoverable Resources of Uranium 2013

	tonnes U	percentage of world
Australia	1,706,100	29%
Kazakhstan	679,300	12%
Russian Fed	505,900	9%
Canada	493,900	8%
Niger	404,900	7%
Namibia	382,800	6%
South Africa	338,100	6%
Brazil	276,100	5%
USA	207,400	4%
China	199,100	4%
Mongolia	141,500	2%
Ukraine	117,700	2%
Uzbekistan	91,300	2%
Botswana	68,800	1%
Tanzania	58,500	1%
Jordan	33,800	1%
Other	191,500	3%
World total	**5,902,500**	

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