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Natural Nuclear

The Osgood File (CBS Radio Network): 5/24/05

Two billion years ago a nuclear reaction ignited all by itself.

An ancient, naturally occurring nuclear reactor might give researchers insights into how to more safely store radioactive waste from modern nuclear power plants. Two billion years ago in a West African deposit of underground uranium, something incredible happened: a nuclear reaction ignited all by itself. Modern nuclear power plants produce energy using the same explosive reaction, but they use exhaustive safeguards and constant supervision to prevent it from spiraling out of control. Scientists were stunned to find that the natural "reactor" produced energy with no human management for 150 thousand years, never exploding. They wanted to find out how.

Nuclear power is controversial - it produces relatively pollutant-free energy and is independent of oil, but is dangerous and generates extraordinary radioactive waste. The natural nuclear reactor in Africa provided a sort of natural laboratory where scientists could study what happened billions of years ago and then use this knowledge to more safely store waste from modern plants.

Back in 1972, French scientists looking for a new deposit of uranium to mine for their nuclear power plants came upon an underground deposit of uranium in Oklo, Gabon, Africa. While studying the uranium to see if it would be useful in their reactors, the scientists discovered that some of the Oklo uranium looked just like uranium from modern reactors that had already undergone fission.

After more study, they discovered something amazing: two billion years ago a series of at least sixteen different self-sustaining nuclear chain reactions had occurred within the large uranium deposit at Oklo – each chain reaction was just like the chain reactions that produce energy at modern nuclear power plants, but they miraculously and never spiraled out of control and exploded, or lost power and fizzled out.

Scientists say the Oklo reactors ran for 150 thousand years 2 billion years ago, until conditions were no longer good for the fission and they stopped altogether. A natural nuclear reactor like this could never occur today: conditions just happened to be perfect two billion years ago – the right amount of the right kind of uranium existed in the right spot.

Modern nuclear power plants – or nuclear reactors - face two huge issues: The first one is the careful management of the dangerous nuclear reactions that produce the plant's energy. This process is very delicate. Dozens of specially trained technicians monitor and regulate the fission at each reactor so it doesn't snowball out of control and explode – like what happened in Chernobyl, in 1986. The second issue is the safe storage of the radioactive waste each plant produces. How to store radioactive waste is a difficult problem, and bitter debate between the government, environmentalists, and the states.

Oklo also generated radioactive waste – the same type modern reactors spend so much time trying to safely store. At Oklo, however, scientists have found over the years that some of the waste was trapped within certain minerals around the reactor and didn't escape into the atmosphere.

For the past fifteen years, physicist Alex Meshik at Washington University has been one of many scientists trying to figure out exactly how the Oklo reactor worked. In the October 29, 2004 issue of *Physical Review Letters*, he and his team describe how they investigated minerals and fission byproducts in a 1/8th inch slice of rock from Oklo. What they found helped confirm the theory that water was key to moderating the nuclear chain reaction there. They also discovered that a mineral in the area called aluminum phosphate trapped some of the radioactive waste from the fission reactions for the last two billion years.

It has been known since the beginning of the nuclear age that water encourages nuclear chain reactions by slowing neutrons down so they are more likely to split more uranium atoms. In the case of Oklo, Meshik found that there was enough water around the uranium for fission to occur for 30 minutes at a time. After 30 minutes, the heat generated from the fission boiled off all the water into steam. With the water gone, the fission shut off for 2.5 hours until the area cooled off, the water returned as a liquid, and the whole process cycled again.

The researchers also found that a nearby mineral called aluminum phosphate actually acted like a cage and trapped a lot of the radioactive byproducts of the fission reaction, denying them passage to the outside world for two billion years. The waste has since degraded and is no longer radioactive.

Scientist Mary Lou Dunzik-Gougar, Ph.D., an Assistant Professor of Nuclear Engineering at Idaho State University, says Oklo is a natural example of what happens to radioactive waste over billions of years underground. Meshik's study (along with many others on the reactor) helps determine which minerals, like aluminum phosphate, can trap which types of radioactive waste; which minerals can slow the waste down; and under what conditions all this occurs.

Finding a place to put all the radioactive waste that modern nuclear power plants generate is very controversial: take Yucca Mountain, for example. Scientists hope that what they learn from Oklo's natural example could help us solve the problem of where and how to store radioactive waste.

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LINKS

[*The Osgood File*](#)

[WCBS Newsradio 880](#) in New York City features an archive of transcripts of stories broadcast on *The Osgood File*.

[The Office of Civilian Radioactive Waste Management \(OCRWM\)](#) is a program of the U.S. Department of Energy assigned to develop and manage a federal system for disposing of spent nuclear fuel from commercial nuclear reactors and high-level radioactive waste from national defense activities. This site has information on the Yucca Mountain Project.

[Information on fission](#) can be found in this online encyclopedia.

[This site has information on Oklo Natural Nuclear Reactors](#)

[Article in Nature](#) on Meshik's paper

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