# After an Absence of Nearly 30 Years, Interest in North Dakota's Uranium Deposits Is Back

**By Ed C. Murphy**

## Early Mining

Uranium was first discovered in some of the lignite beds in western North Dakota during the late 1940's. Government and industry scientists explored the area for uranium during the 1950's and early 1960's. Uranium mining took place in southwestern North Dakota from 1962 to 1967 (Karsmizki, 1990) with between 9 and 16 mines producing 85,000 tons of ore which resulted in 592,288 pounds of "yellow cake" ($U_3O_8$). We will likely never know the exact number of mines because the mining records from that time period are very incomplete (fig. 1). Typically, these mines were shallow pits excavated to the top of uraniferous (uranium-bearing) lignites. Several of the mines burned the uraniferous lignite in place using old tires and/or diesel fuel as the fire starter. This open-pit burning process reportedly took 30 to 60 days to complete. After 1964, the uraniferous lignite could also be mined and shipped to processing sites (kilns) at either Belfield or Griffin (a railroad siding west of Bowman). Once the uraniferous lignite was reduced to ash, either at the mine site or at the Belfield or Griffin sites, it was typically shipped to South Dakota, Colorado, or Utah for further processing.

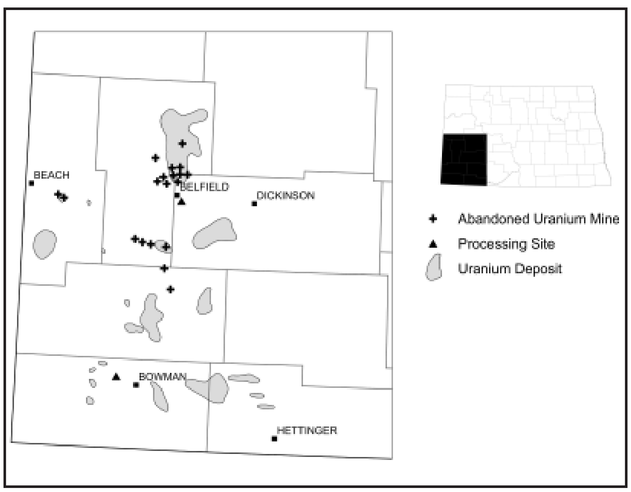


Figure 1. Uranium deposits and known abandoned uranium mines and processing sites in western North Dakota.

## Exploration in the 1970's

In 1976, after almost ten years of inactivity, mineral companies responded to an increase in the price of uranium with renewed uranium exploration in western North Dakota. More than 1,300 exploration holes were drilled between 1976 and 1978. Most test holes were drilled in Slope, Bowman, Adams, Billings, and Stark counties. An accident at the Three Mile Island nuclear power plant in Pennsylvania in March of 1979, which coincided with the release of the movie The China Syndrome (a movie critical of nuclear power plant safety) turned public opinion in the United States against nuclear power. As a result, orders for new power plants ceased, most uranium exploration in the region came to a halt, and energy companies disbanded their mineral divisions. There has been no uranium exploration in North Dakota since 1979 and for more than 25 years, the North Dakota Geological Survey fielded no questions on uranium other than in regard to health-related issues.

## Current Market for Uranium

In June, 2007, the spot market price for $U_3O_8$ was $135 per pound – up from $21 in January of 2005 and $9.60 per pound in January, 2002 (fig. 2). This dramatic price increase is a result of the shortfall of uranium between what the 435 nuclear reactors operating in the world consume and current production. The shortfall, which equates to 70 million pounds of uranium per year, has been made up by depleting stockpiles built up during the 1970's boom cycle and the conversion of nuclear weapons, both of which are diminishing (Mathews, 2006). Projections show this shortfall steadily increasing in the future as many countries expand their nuclear energy programs. For example, China and India are expected to build 43 new plants over the course of the next 15 years (Bland and Scholle, 2007). As a result, for the first time in 28 years, there is renewed interest in North Dakota's uranium deposits.

## Uranium Deposits in Western North Dakota

The North Dakota Geological Survey (NDGS) anticipated the renewed interest in uranium and began mapping the uranium deposits in southwestern North Dakota several years ago. To date, we have identified 20 uranium

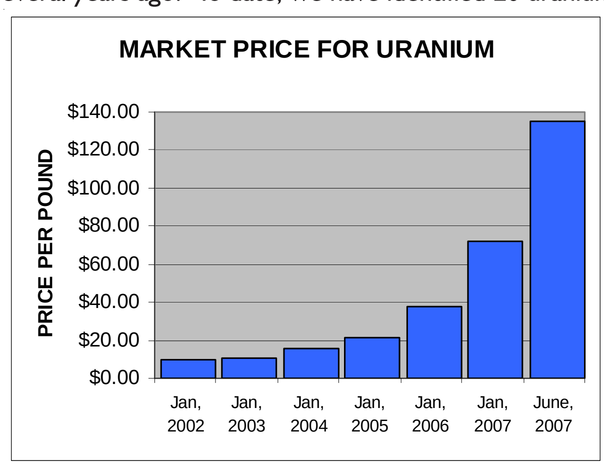


Figure 2. The market price for uranium from 2002 to 2007.

deposits that encompass an area of 250,000 acres in western North Dakota (Murphy 2005, 2006 a-c, and 2007a-c). Seven of these deposits are larger than 10,000 acres and one, a deposit north of Belfield, covers more than 83,000 acres (fig. 3). This is the first time that uranium deposits in North Dakota have been accurately defined (that is, mapped at scales of 1:24,000). The deposits were identified by interpreting gamma logs from coal and uranium exploration holes, NDGS test holes, oil wells, and ND State Water Commission monitoring wells. It was determined during theses studies that uranium occurs primarily within lignite beds, sandstones, and carbonaceous mudstones in the Fort Union Group (Paleocene).

## Predictive Model for Uranium in Western North Dakota

The NDGS has been working on a predictive model for uranium occurrence in western North Dakota. Such a model would not only be useful to companies exploring for uranium, but could be used to determine if water supply wells are potentially screened within zones of high uranium concentration. The scientists exploring for uranium in southwestern North Dakota in the 1950's and 1960's concluded that the volcanic-rich rocks of the White River Group (Eocene\Oligocene) and the Arikaree Formation (Oligocene\Miocene) were the likely sources of the uranium found in the underlying rocks in southwestern North Dakota (Hager, 1954; Denson et al., 1959; Denson and Gill, 1965). The White River and Arikaree rocks sit unconformably (hundreds of feet of rock are missing because they were eroded before the White River and Arikaree strata were deposited) on progressively older rocks from north to south (Killdeer Mountains to Medicine Pole Hills) across western North Dakota. In western North Dakota, the remnants of White River and Arikaree rocks are generally only preserved at the tops of major buttes that are scattered across western North Dakota (Murphy et al., 1993). Recent studies of gamma logs by the ND Geological Survey validate the White River and Arikaree source rock theory. These studies also concluded that uranium is present more than 800 feet below the probable position of the White River unconformity, much deeper than earlier studies predicted (Murphy, 2005; 2006a-c; 2007a-c).

## State Geological Surveys Respond to Uranium Interest

State geological surveys across the western U.S. have been quick to respond to both the immediate and anticipated needs of the mineral industry in their states for uranium information, as well as the basic geologic data that all types of mineral exploration require. In some cases, state surveys are

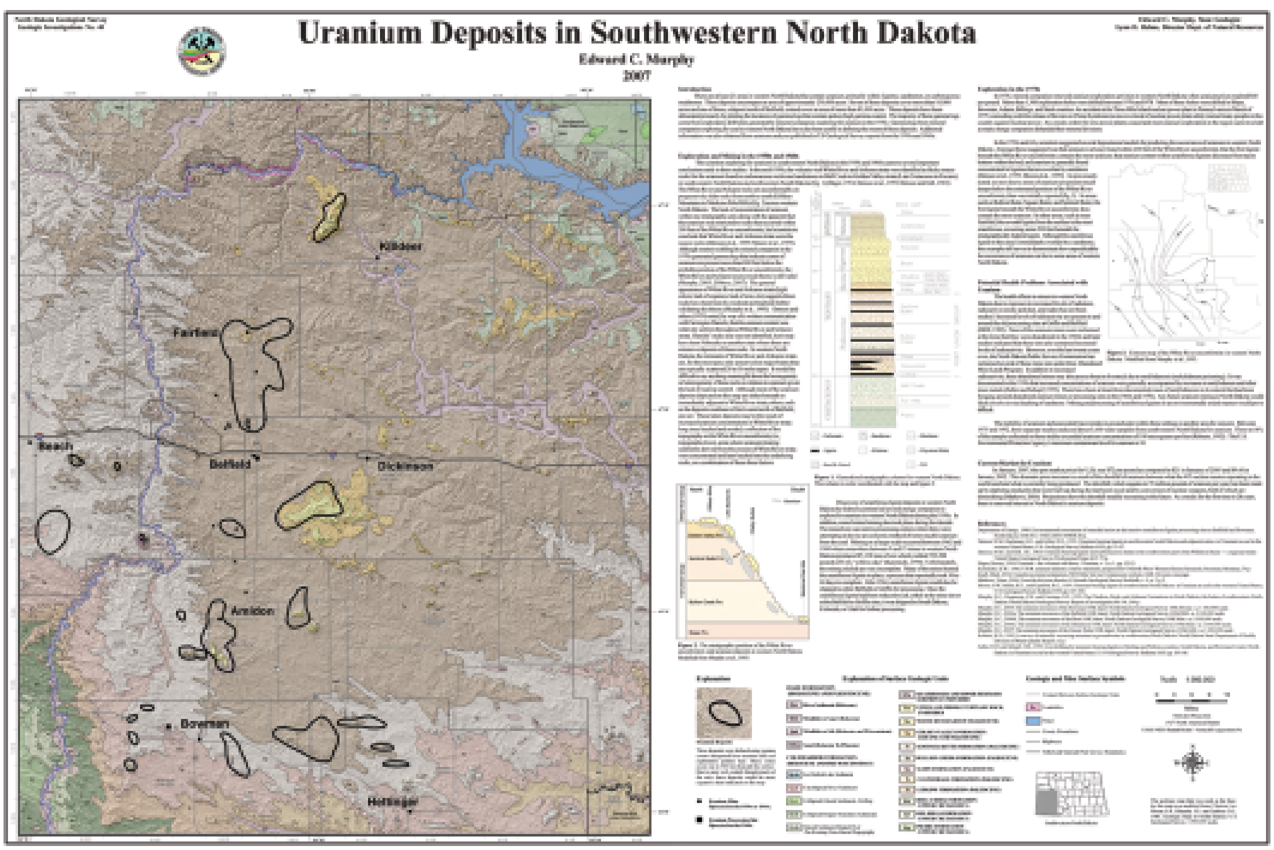


Figure 3. Geologic Investigation no. 40 is one of several uranium maps recently published by the ND Geological Survey. The uranium deposits are outlined in black on a geologic map to demonstrate that they occur in several stratigraphic units. This poster can be downloaded from the Geological Survey website (www.dmr.nd.gov/ndgs/)

reprinting uranium publications to meet the sudden increase in demand for reports that had been gathering dust for thirty years. Recent newsletters of the Colorado and New Mexico Geological Surveys did an excellent job of documenting the renewed interest in uranium (ROCKTALK, Fall, 2006; New Mexico Earth Matters, Winter, 2007). To meet this demand, the NDGS has been placing the 100K uranium map sheets on our website as soon as they are published (https://www.dmr.nd.gov/ndgs/uraniummaps/uraniummaps100k.asp). As a result, we have received a number of uranium inquiries from across North America.

### What Does the Future Hold for North Dakota's Uranium Deposits

The projection of rapidly increasing world energy needs and the concern for climate change have the energy industry reassessing nuclear power and the economic potential of the uranium deposits in western North Dakota. Farmers and ranchers in western North Dakota are likely to be apprehensive about potential development given the industry's very poor environmental record during mining in the 1960's. Not only did both the open-pit burning and kiln processes pose potential environmental problems, but when mining stopped, companies walked away having done no site reclamation. In several cases, uranium-bearing rocks were left lying discarded at the surface with the rest of the spoil material at these mine sites. In addition to increased radioactivity, these abandoned mines posed a threat to livestock from molybdenosis (molybdenum poisoning). It was documented in the 1950's that increased concentrations of uranium were generally accompanied by increases in molybdenum and other trace metals (Zeller and Schopf, 1959). There have been at least three reported cases of molybdenosis in livestock that had been foraging around abandoned uranium mines or processing sites in the 1960's and 1970's. Six cattle and 2,500 sheep reportedly died from molybdenosis in the Griffin area in the early 1970's (Ell, undated). As strange as it sounds, the infected sheep were reported to have "glowed a blue hue" around their heads and backbones in the early morning sunlight. Molybdenosis also reportedly affected 50 cattle at a uranium mine north of Belfield in the 1960's (Ell, 1979). The ND Public Service Commission reclaimed several of these old mine sites because they had posed environmental risks for decades (Knell, 2004). The old processing sites at Griffin and Belfield also contain elevated levels of radioactivity according to a 1989 study by the US Department of Energy. The health effects to miners in western North Dakota due to exposure to increased levels of radiation, radioactive smoke and dust, and radon has been left unstudied.

While any future uranium mining in North Dakota is speculative, what is clear is both the federal government and the State of North Dakota have much more stringent environmental laws than were in effect four decades ago. These laws would protect the health and safety of the miners as well as local landowners. Quite obviously, the burning of uraniferous lignites in open-pits or open kilns would not be permitted due to the inability to capture radioactive elements and other pollutants. In fact, it is entirely possible that any future development of the State's uranium resources will not involve lignite beds at all. More recent technology known as in situ leaching (ISL) uses a series of injection and extraction wells to remove uranium from sandstones (fig. 4). Water is removed from the sand body, pumped to the surface (where an oxidant such as hydrogen peroxide is added), and then pumped back into the sand body. The injected fluid dissolves the uranium minerals and the uranium-bearing water is pumped back to the surface through extraction wells. The extracted water is then filtered through ion-exchange pellets that remove the uranium in a process much like the water filters under many kitchen sinks and in refrigerators. The pellets are

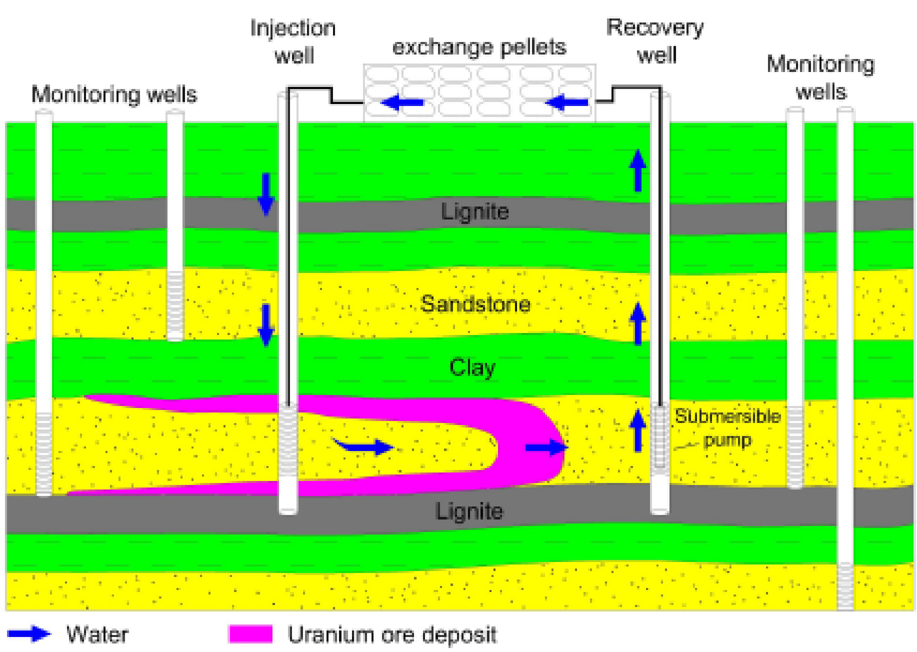


Figure 4. In situ leaching (ISL) is a mining method that could be utilized if there is future uranium mining in North Dakota. This diagram was modified from a diagram in Bland and Scholle (2007) which they adopted from the World Nuclear Association (2005).

periodically shipped to a processing site where the uranium is stripped and concentrated into yellow cake, and the pellets are sent back to the mine site. Excess water and contaminants are injected into deep disposal zones below horizons containing water that is suitable for human use. This in situ technology was used to mine uranium in Texas for nearly 25 years and is currently being utilized in at least three operating mines (two in Wyoming and one in Nebraska). Because of the health risks posed by uranium, any mining method would have to be very carefully monitored. ISL technology requires a thorough understanding of the local and regional groundwater flow conditions and a sufficient number of monitoring wells carefully located to insure that the ISL site is properly containing all the uranium and other trace metals. While an improperly operated ISL project has the potential to degrade an aquifer, a well-designed project can potentially improve water quality by removing uranium and other undesirable trace metals from the groundwater system.

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