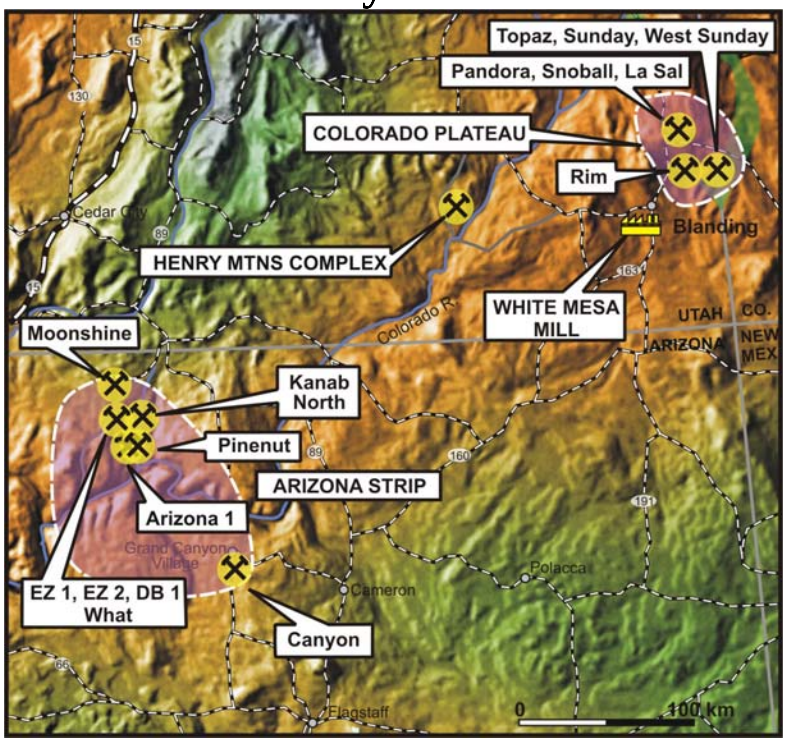
URANIUM MINING AND ACTIVITIES, PAST AND PRESENT
Update for the Arizona Game and Fish Department and Commission

May 2007



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1. Background and History of Uranium Mining

The exploration and mining of radioactive ores in the United States began around the turn of the 20th century. At this time, uranium was considered a waste product of radium and vanadium mining. Development of nuclear weaponry during the Cold War increased demand and by 1955 there were approximately 800 uranium mines producing high-trade ore on the Colorado Plateau (see Fig. 1). The industry flourished until 1970 when the Atomic Energy Commission (AEC) stopped buying uranium due to ample reserve supplies. Foreign competition, federal regulations, nuclear fears, and AEC's plentiful reserves led to the cessation of domestic uranium mining in the mid-late 1980's.

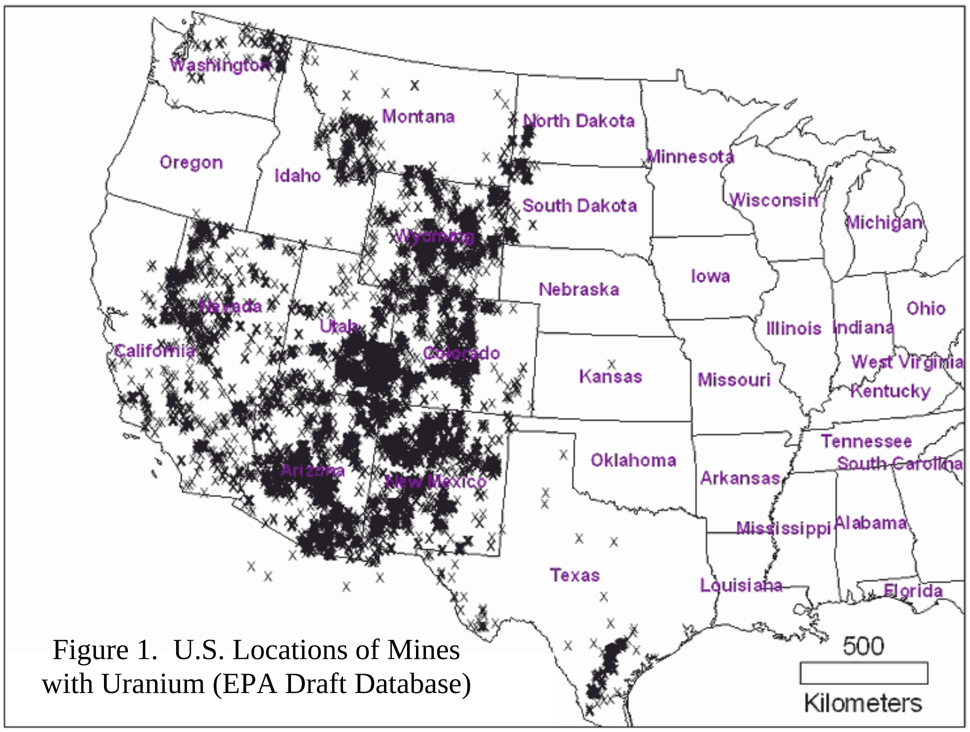

Figure 1. U.S. Locations of Mines with Uranium (EPA Draft Database)

Uranium Mining in Arizona – Historic Activities

<u>Navajo Nation</u>

In the 1940's and 1950's, uranium was discovered on the Navajo Reservation. Navajo men from the local community mined uranium ore for the U.S. atomic weapons program. When mining ceased in the late 1970's, operators abandoned mines without sealing tunnel openings, filling gaping pits, or removing piles of radioactive uranium ore and mine waste. As a result, Navajo miners and local communities were exposed to high levels of radioactivity. A 1959 report found radiation levels 90 times acceptable limits. Of the 150 Navajo miners who worked until 1970 at the uranium mine in Shiprock, New Mexico, 133 died of lung cancer or various forms of fibrosis within10 years.

Even after mining activities ceased on the Navajo Nation, the legacy of environmental harm continued. The largest accidental release of radioactive material in U.S. history occurred in 1979 when the Church Rock tailings dam burst, sending 1,100 tons of radioactive mill waste and 90 million gallons of contaminated liquid pouring down the Rio Puerco River toward Arizona. This water source remains tainted today even while a proposed new uranium solution mining project threatens the drinking water of 10,000 - 15,000 people living in the Eastern Navajo Agency in northwestern New Mexico.

The Navajo Nation has banned further uranium mining on their lands.

<u>Arizona Strip (Fig. 2 and Table 1)</u>

Uranium was discovered on Bureau of Land Management (BLM) lands in Hack canyon in 1945. Total production from this area was 2.7 million pounds in the 1950's and by the mid-late 1980's, three small mines were reported to be producing approximately 10 million pounds. All these mines have since been reclaimed.

Energy Fuels, Inc worked two additional ore bodies, discovered west of Hack canyon on the Arizona Strip, into the 1980's.

The Pigeon Mine operated from 1984-1991 near the north rim of Snake Gulch, a tributary to Kanab Canyon. This mine has been reclaimed.

The Hermit Mine operated from 1989-1992 farther west on the Kanab Plateau. This mine has been reclaimed.

South of the Hermit Mine on the Kanab Plateau, the Pinenut Mine was first drilled in 1985 with active mining starting in 1988. This mine is on "standby".

The Arizona 1 Mine, also on the Kanab Plateau, was drilled in 1986, but was not developed until 1988. This mine is on "standby" and may soon be reopened (see Section 4).

The Kanab North Mine, located about the same time as the Pigeon Mine in late 1980, is on the west wall of Kanab Canyon. Exploratory drilling in 1981 revealed uranium ore, and mining began in late 1987. The mine was closed in 1991 when uranium prices dropped. This mine is also on "standby".

During this time, many mining companies proposed to upgrade and/or pave roads associated with mining activities throughout the Arizona Strip. The Arizona Game and Fish Department opposed these upgrades, concerned with impacts to wildlife species. When uranium costs plummeted, however, road work planning did not move forward. It is likely these types of road improvement proposals will be revisited now that uranium costs have increased and there is renewed interest in mining on the Arizona Strip.

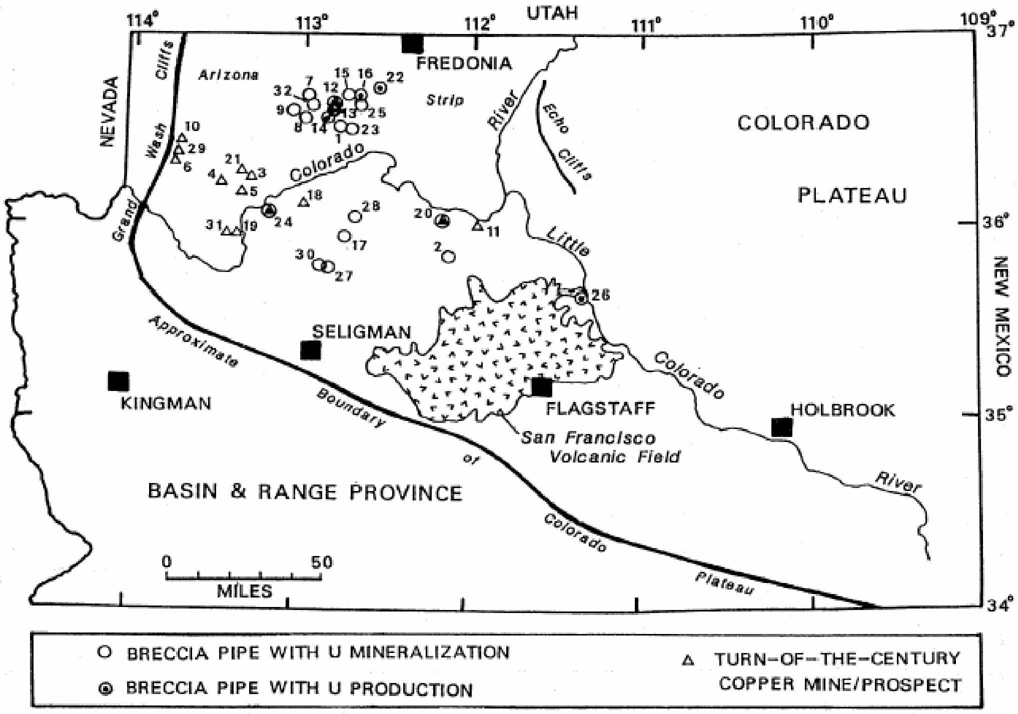

Figure 2. Map showing principle locations referred to in this review and also the numbered location of mines previously developed in mineralised breccia pipes. Not all mines necessarily produced uranium. See also Table 1. Numbers refer to the following mines: (1) Arizona 1, (2) Canyon, (3) Chapel, (4) Copper House, (5) Copper Mountain, (6) Cunningham, (7) DB-1, (8) EZ-1, (9) EZ-2, (10) Grand Gulch, (11) Grandview, (12) Hack 1, (13) Hack 2, (14) Hack 3, (15) Hermit, (16) Kanab North, (17) Lynx, (18) Mohawk Canyon, (19) Old Bonnie Tunnel, (20) Orphan, (21) Parashant, (22) Pigeon, (23) Pinenut, (24) Ridenour, (25) Rim, (26) Riverview, (27) Rose, (28) Sage, (29) Savannic, (30) SBF, (31) Snyder, (32) What. (Source: Wenrich *et al.*, 1995)

Table 1. History of uranium production at some northern Arizona mines.

Mine	Status	Opened	Closed	U_3O_8 production (lbs)	Other	Av Grade (%)	Reference
Orphan		1953	1969	4,260,000	silver, copper, vanadium	0.42	Chenoweth (1986)
Hack Canyon		1951	1964	4,993	copper, vanadium	0.18	Chenoweth (1988)
Hack 1	reclaimed			13,000,000		>0.65	Mathisen in
Hack 2	reclaimed	1980		(less 2,554,000 for		allowing for	Wenrich *et al.*
Hack 3	reclaimed			Pigeon)		Pigeon	(1989)
Pigeon	reclaimed	1982	>2/1988	2,554,292 to 2/1988	42 men, 2 × 8 hr shift, max 1600 t/d	0.57	
Hermit	reclaimed						
Pinenut	standby						
Ridenour		1961	1961	42	small		Chenoweth (1988)
Riverview		1956	1957	3,839			Chenoweth (1988)
Kanab North	standby			4,000,000			Wenrich, pers com in Silberman *et al.*, 2004)
Canyon	standby?						
Arizona 1	standby						

2. Geology - Uranium Deposit Types

<u>Breccia Pipes</u>

In Arizona, uranium is deposited within a variety of geologic formations including breccia pipes, tabular sandstone, mudstone, and volcanogenic siltstone. Breccia pipes constitute a majority of uranium deposits on the Arizona Strip; however, sandstone deposits are also present. Central and southern Arizona exhibit mudstone and siltstone. Because most activities relating to recent uranium prospecting occur on the Arizona Strip, our discussion will focus on breccia pipe mining.

Breccia pipes are formed when the overlying strata collapses into karstic-limestone solution cavities in the Redwall Limestone Formation, creating roughly cylindrical, near vertical columns of broken (brecciated) rock (Fig. 3). Breccia pipes typically range from 100 - 400 feet in diameter and can rise up to 3,000 feet. Uranium mineralization of the breccia columns extends from Toroweap and Kaibab Formation carbonates downward into Supai Group rocks. At or near the Toroweap-Coconino contact, ore-associated sulfides dramatically increase in abundance, at times exceeding 50% total rock volume. Breccia pipes are sometimes associated with sinkholes.

The uranium content of most ore is between only 0.1% and 0.2%. However, the average grade of Arizona Strip uranium ore has been reported to be 0.65% and 0.80%.

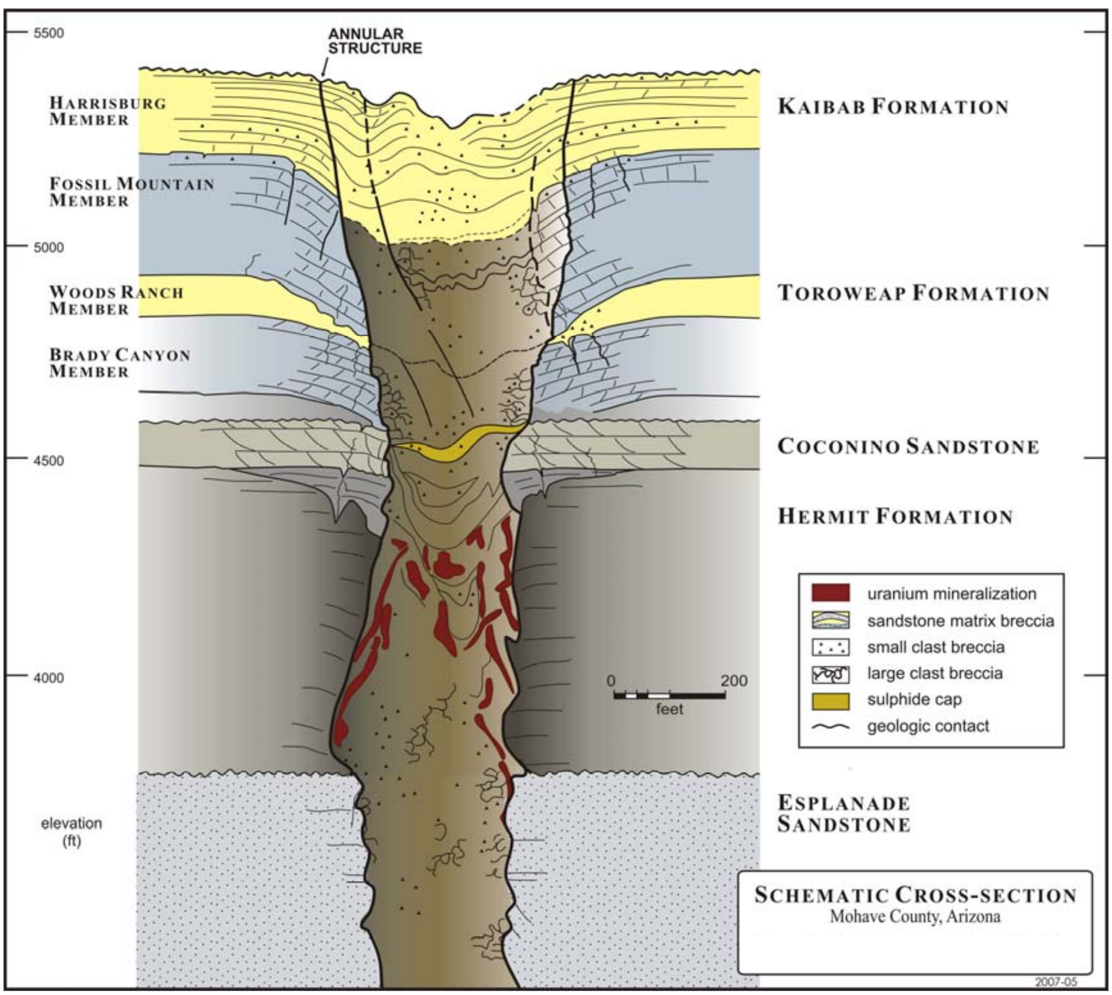

Figure 3. Breccia Pipe Uranium Mineralization

Sandstone
Sandstone-type deposits occur in medium to coarse-grained sandstone and are abundant in sedimentary rocks of the Colorado Plateau. These deposits form when uranium leached from surface rocks by oxidized groundwater flows down into aquifers where it is reduced to precipitate uraninite, the primary mineral ore of uranium.

3. Uranium Mining Methods, Techniques and Hazards

The U.S. mining industry uses two distinct methods to extract uranium ore: physical removal of ore-bearing rock from the soil prior to processing, or chemical dissolution of uranium from onsite ore deposits.

Physical removal of rock ore generally involves either open-pit mining or underground mining.

- **Open-pit mining** strips away or excavates topsoil and rock that lie above the uranium ore.
- **Underground mining** extracts rock through a tunnel or other opening. Several existing uranium mines on the Arizona Strip have extracted uranium using this technique.

Waste Rock
Waste rock may be produced from open pit mining when overburden is removed, or during underground mining as tunnels are carved through non-ore zones. Other waste piles consist of low-grade ore. Distinguishing waste rock from ore depends on the assessment of technical and economic feasibilities surrounding further processing.

Piles of waste rock often contain elevated concentrations of radioisotopes and may pose a danger to humans and the environment due to the release of radon gas and seepage of water containing radioactive and toxic materials.

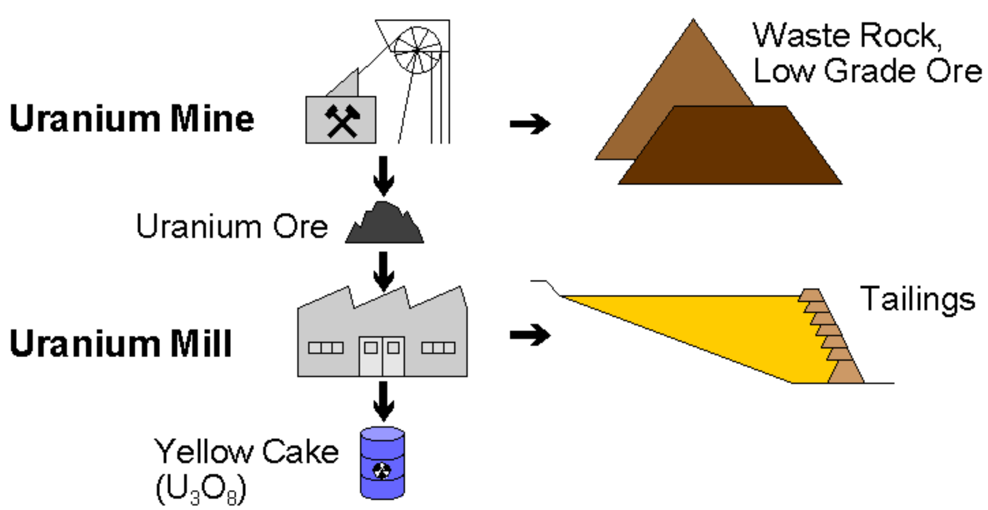

Figure 4. Nuclear Fuel Production

Milling the Ore

Ore mined in open pit or underground must be milled to remove uranium. At the mill, ore is crushed and ground, and treated with chemical leaching agents (sulfuric acid in most cases) to dissolve the uranium, which is subsequently recovered from solution. The leaching agent not only extracts uranium from the ore, but also several other constituents including molybdenum, vanadium, selenium, iron, lead and arsenic. The final mill product, commonly referred to as "yellow cake" (U_3O_8 with impurities), is packed and shipped in casks.

Tailings, or waste generated from the milling process, are stored in specially designed waste disposal facilities called impoundments. These wastes are also classified as by-product materials.

Closing down a uranium mill produces challenges regarding the safe disposal of large amounts of radioactively contaminated scrap.

Hazards and Characteristics of Mill Tailings

Processing of 0.1% grade ore results in 99.9% of the raw material left behind as sludge. The amount of sludge produced nearly equals the quantity of ore milled. Because long-lived decay products such as thorium-230 and radium-226 are not removed, sludge contains **85% of the initial ore radioactivity**. Furthermore, current extraction limitations cause sludge to retain 5-10% of the uranium initially present in the ore. Sludge also contains other heavy metals and contaminants, such as arsenic, as well as chemical reagents used during the milling process.

Mining and milling moves hazardous constituents in the ore from relatively safe underground locations and converts them initially into a fine sand and eventually into sludge. During this process, hazardous materials become more susceptible to dispersion in the environment. Moreover, harmful elements within tailings piles yield additional environmental risk. For example, in dry areas, salts containing contaminants can migrate to the pile surface where they are subject to erosion. If the mineral pyrite (FeS_2) is present in ore, precipitation and oxygen may trigger sulfuric acid formation within the deposit and lead to continuous leaching of contaminants.

Despite a relatively short half-life of 3.8 days, radon-222* gas presents a longterm hazard. Radon not only emanates directly from tailings piles, but is also continuously produced from the decay of radium-226 which has a half-life of 1600 years. Further, the parent product of radium-226, thorium-230, is also present and has a half-life of 80,000 years. The lengthy half-lives of the radioactive constituents involved means deposit safety must be monitored for very long periods of time.

* The radium-226 in tailings continuously decays to the radioactive gas radon-222**.** Radon release from the interior of tailings piles continues even after uranium mines are shut down and has been implicated as a cause of lung cancer. The U.S. Environmental Protection Agency (EPA) estimates a lifetime excess lung cancer risk of two cases per one hundred residents living near a 80 hectare bare tailings pile..

Since radon is quickly spread by wind (Fig. 5), people living locally can receive additional radiation doses on an on-going basis. Although the excess risk per individual is small, cumulative effects and the potential to affect large numbers of people raise pressing health concerns.

Figure 5. Tailings Dust – Moab Utah

After about 1 million years, tailings radioactivity and its associated radon emanation will have sufficiently decreased such that carcinogenic effects are limited to the continuous decay of thorium-230 in residual uranium.

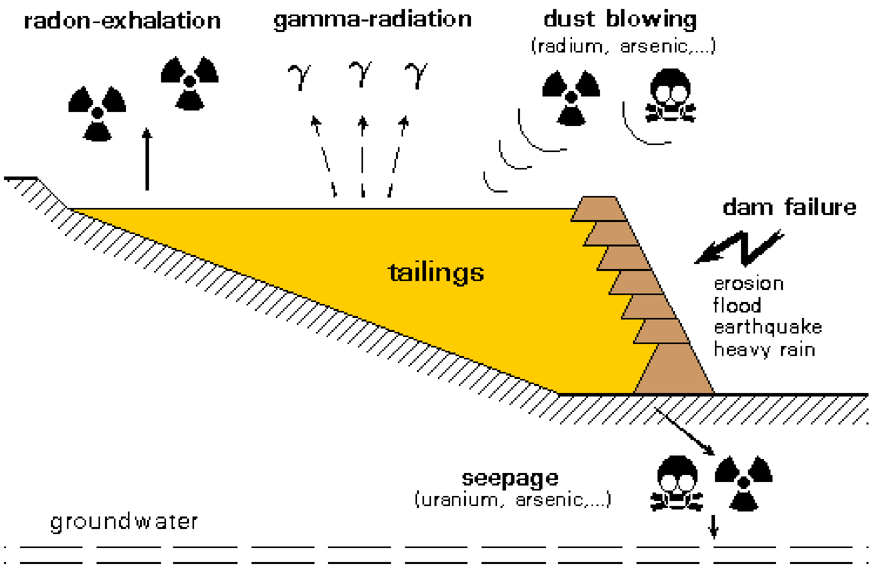

Figure 6. Uranium Mill Tailings Hazards

Tailings deposits are subject to many kinds of **erosion** (Fig. 6). Following a rainfall, erosion gullies form. Floods can destroy entire deposits and penetration of the deposit by plants and burrowing animals may disperse materials, enhance radon emanation, and make the deposit more susceptible to climatic erosion. As the surface of the pile dries, fine sands are easily carried by wind to adjacent areas.

Seepage from tailings piles poses another major hazard due to contamination of ground and surface water (Fig. 6). Residents face health risks from ingestion of radium-226, arsenic, and other hazardous substances in tainted drinking water and local fish. Pyrite-containing tailings are inherently acidic due to the production of sulfuric acid which increases migration of contaminants to the environment.

The situation is similar for tailings deposits **in former open pit mines**. Here also, seepage or other contact with ground water carries risk. Only the presence of impermeable geologic or man-made layers can prevent ground water contamination.

Chemically dissolving uranium from onsite rock ore is accomplished through either heap leaching or in-situ leaching.

- **Heap leaching** entails pouring chemicals over above-ground piles of crushed ore-bearing rock and collecting uranium through underground drains. This method is not currently used in the U.S. (EPA)
- **In-situ leaching** involves chemically treating ore located deep underground. The resulting liquids are pumped to the surface via wells.

While in-situ leaching is common throughout the U.S., it is rarely employed in Arizona. Currently all existing mining operations on the Arizona Strip involve the physical removal of ore from open pit or underground mines prior to offsite processing. It is not clear if new mining prospects, either on the Arizona Strip or elsewhere in Arizona will use in-situ leaching or more traditional techniques.

In-Situ Leaching (Fig. 7)

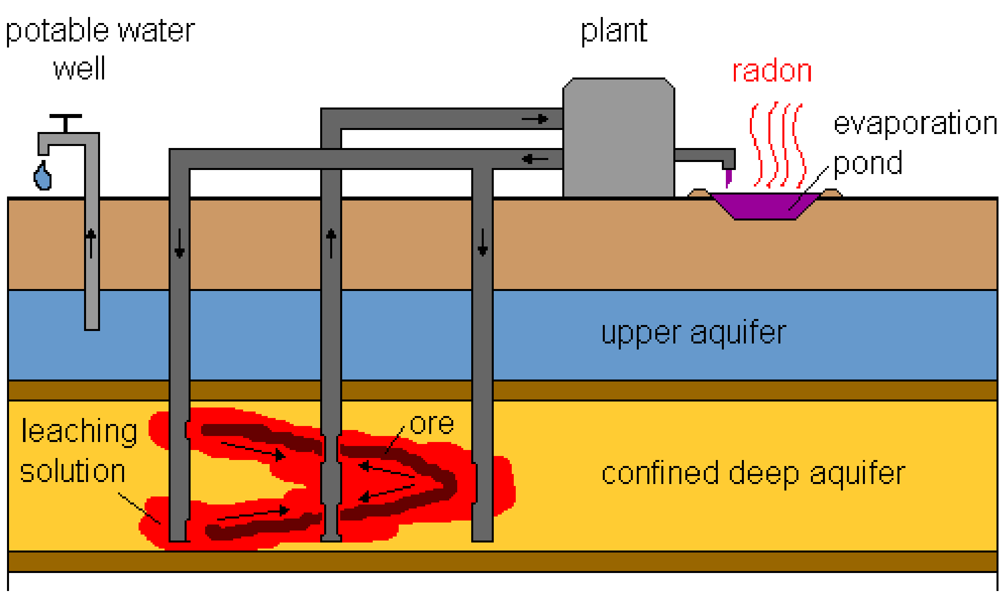

Figure 7. Illustration of In-Situ Leaching

Where the orebody exists in a saturated sandstone aquifer, drilled boreholes allow for chemical treatment of the surrounding water. Uranium is then dissolved and leached from the orebody by these circulating chemicals. The resulting solution is pumped through another series of boreholes for surface recovery of uranium. This method differs somewhat from uranium confined to underground non-permeable rock. In these cases, a leaching liquid (e.g., ammonium carbonate or sulfuric acid) is pumped through drill-holes into the ore deposit, and the uranium-bearing liquid is pumped out from below.

Note: It is currently unclear which technique will be utilized in Arizona, and on the Arizona Strip. Mines that currently exist and are on “standby” status are all underground. In-situ chemical leaching may not be feasible because of the location of uranium mineralization vs. the level of aquifers. In Arizona Strip breccia pipes, uranium deposits are thought to occur at depths of 1000-1500 feet. The water table in this area is within the Mississippian layer located around 2500 feet. On the schematic of the breccia pipe above (Fig. 3), the Mississippian layer would be located beneath the Esplanade Sandstone. It might be possible to pump in water when uranium deposits exists outside of an aquifer – but this is unclear.

Advantages of in-situ chemical leaching over physical removal of ore from open-pit or underground mines are:

- reduced risk to employees from accidents and radiation – miners are not directly exposed to the orebody;
- lower cost;
- does not produce large tailings piles – waste is confined to evaporation ponds; and
- much less ground disturbance – less environmental rehabilitation needed.

Disadvantages are:

- existence of some radiation risk during the extraction process;
- danger of leaching liquids inadvertently contaminating ground water;
- unpredictable effects of the leaching liquid on deposit host rock;
- production of small amounts of waste sludge and waste water when recovering the leaching liquid; and
- impossible to restore the leaching zone to natural conditions after processing is completed.

Following in-situ leaching, waste sludge must be dumped in a final deposit and the aquifer ore zone restored to pre-leaching conditions. Unfortunately, recent evaluations of current practices note it is nearly impossible to re-establish pre-leach levels for all parameters. Further, ground water restoration can be a very timely and burdensome process, and is not yet completely understood.

Exploration and Mining Infrastructure

Infrastructure associated with exploration is minimal. Plans generally outline the use of existing roads and potential cross-country routes to reach the target and set up rig-mounted trucks. Operators would require access to the site several times per day for about a week. The infrastructure associated with mining is more extensive and may include a mine office, mine shop/warehouse, hoist house, mineshaft, water well, powerline, evaporation pond(s), ore stock pile, as well as maintained access roads.

4. Current/Future Activities in AZ

Ten areas of known uranium production and occurrence have been identified by the Arizona Department of Mines and Mineral Resources (ADMMR) and are grouped by general landform; 1. Colorado Plateau, 2. Basin and Range Province, and 3. Transition Zone (see Fig. 8). According to ADMMR Arizona has excellent potential for development of new uranium resources. ADMMR projected that if exploration had continued at the 1980 rate, that by year 2000 over 100 million pounds of new mineralization would have been identified.

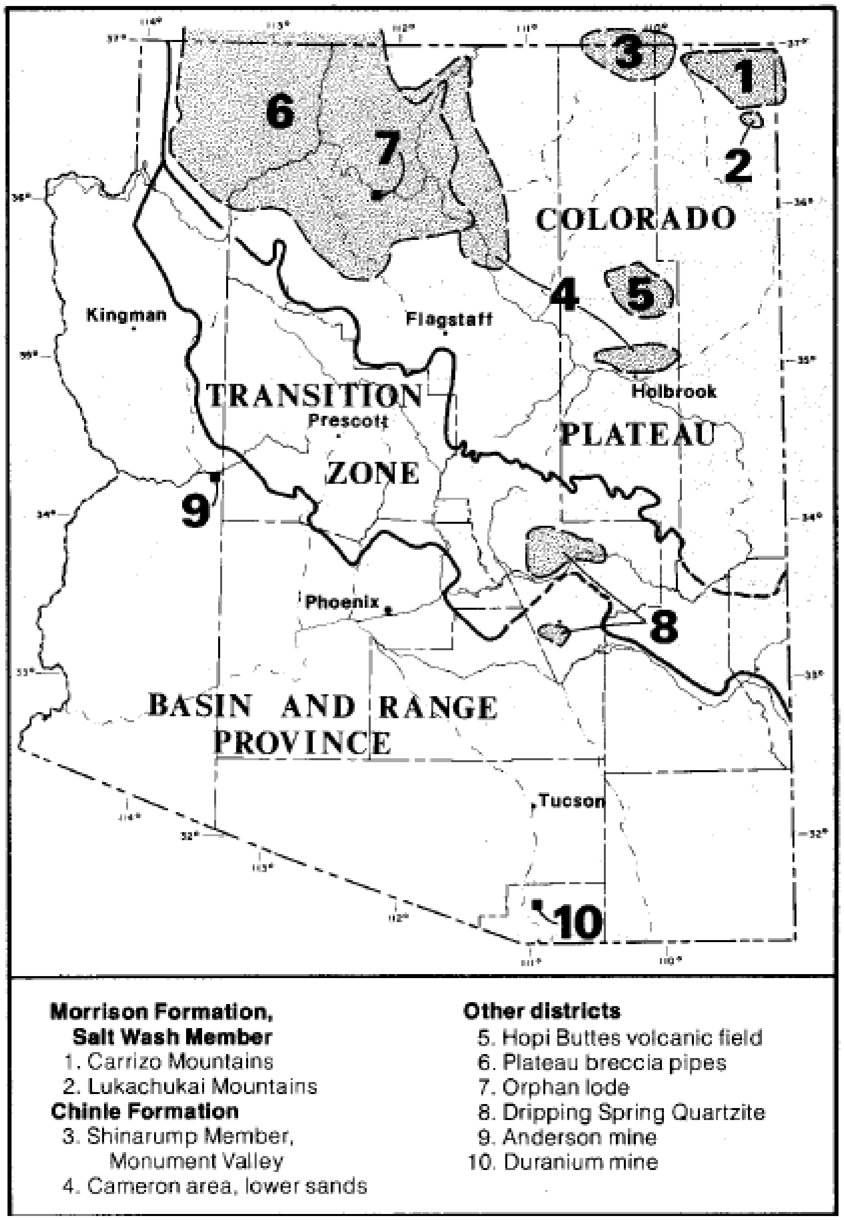

Figure 8. Areas of Known Uranium Production and Occurrence as Identified by the Arizona Department of Mines and Mineral Resources (ADMMR)

A resurgence of interest in the uranium industry has been sparked by increasing uranium prices. Current prices are up from a low of about $7 per pound in 1990 to approximately $120 per pound as of June 2007. Acquisition of uranium properties in Arizona surged during the past several years with more than 25 companies reporting acquisitions or claim staking targets (BLM pers. comm.).

In Arizona, all new mining claims on federal lands must first be recorded by the appropriate county, and then through the BLM (even for Forest Service lands). Based on recent claims activity, there have been three locations of particular interest (BLM pers. comm.):

1. Arizona Strip (Colorado Plateau) – BLM Lands
2. Anderson Mine area near Alamo Lake (Basin and Range) – BLM Lands
3. Red Butte between Valle and Tusayan (Colorado Plateau) – Kaibab National Forest

A fourth area near Workman Creek (Transition/Basin and Range) has also been identified by ADMMR as having uranium potential, with recent claims and exploratory activities.

<u>The Colorado Plateau</u>

Northwestern Arizona has been recognized as having the highest-grade uranium deposits contained within breccia pipes in the U.S.. The uranium content of most ore is frequently between 0.1% and 0.2%; however, the average grade of uranium ore mined in the Arizona Strip has been reported as 0.65% and 0.80%.

Due to the exponential increase in uranium prices and Arizona's unusually rich uranium deposits, mineral claims and exploration for uranium on the Arizona Strip have doubled in the past two years. According to the BLM, over 5,000 mining claims have been made since 2004 and 22 notices for hundreds of exploratory drill holes have been processed.

There are approximately 25 companies staking claims on the Arizona Strip (a few are detailed below). Of these, six have submitted to the BLM their Notice of Intent for operation and at least one Plan of Operation has been presented.

> *Notice of Intent for Exploration:* Notices of Intent usually encompass less than five acres outside of biologically or culturally sensitive areas. They are not considered a Federal Action (i.e., NEPA is not required); however, surveys/clearances for threatened and endangered species as well as cultural resources are completed prior to exploration.
>
> *Plan of Operation:* Plans of Operation are generally for mining or exploration disturbances exceeding five acres and/or in a biologically or culturally sensitive area. They do require NEPA, usually at the Environmental Assessment level. One example of a Plan of Operation for *exploration* is the Kanab Creek proposal. This plan is on hold because of a request to use water from Kanab Creek.

There are currently three historically developed underground mines on the Strip being considered for possible renewed production by Denison Resources (Fig. 9). They are Arizona #1, Kanab North, and Pine Nut. These mines are currently authorized under BLM mining plans of operations. Denison Resources also owns a partially developed mine, Canyon Mine, and at least five other prospects (EZ 1, EZ 2, DB 1, What, and Moonshine). All prospect holdings would be operated as underground mines (breccia pipes) except Moonshine which will likely be developed as an open-pit mine (sandstone).

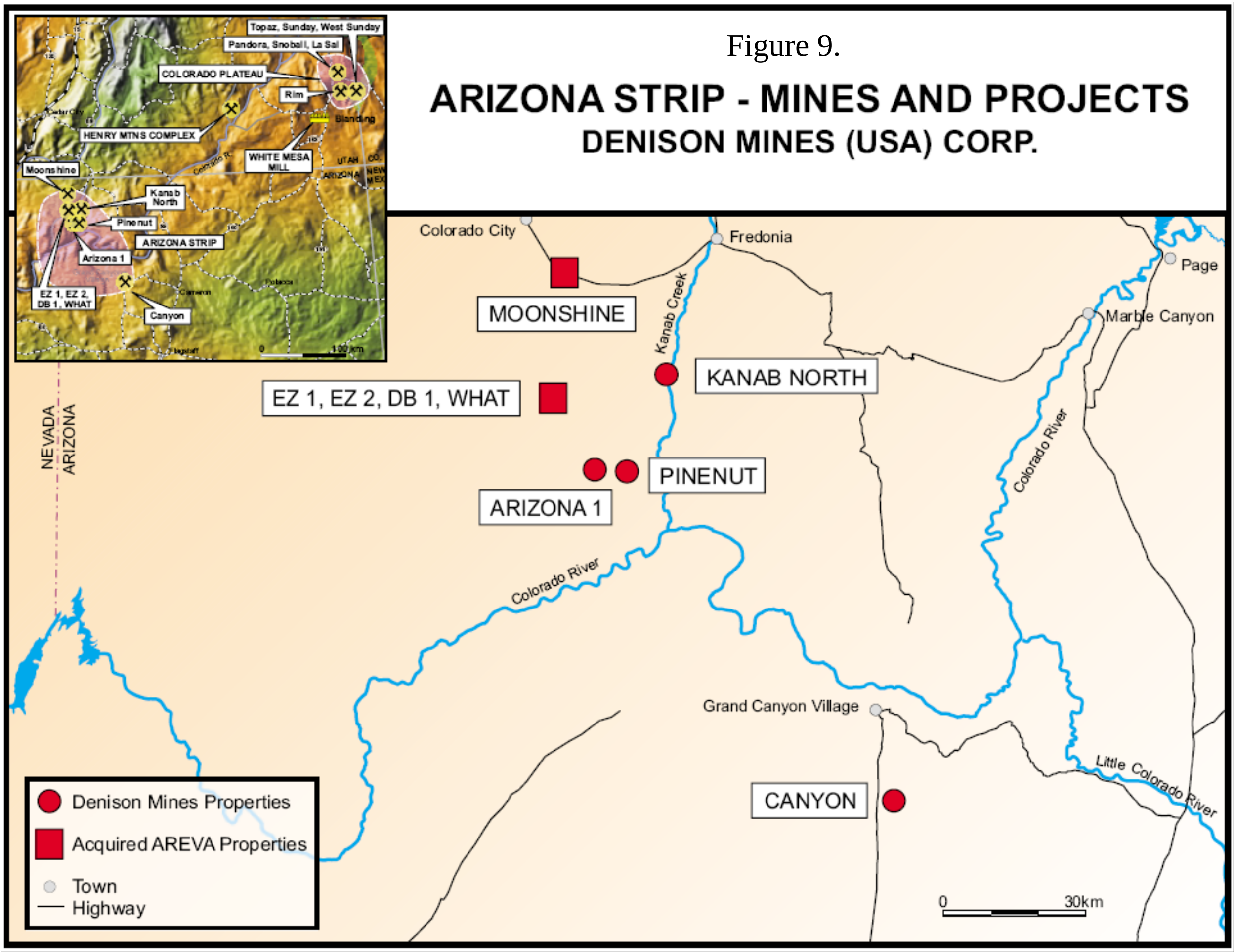

Figure 9.
ARIZONA STRIP - MINES AND PROJECTS
DENISON MINES (USA) CORP.

To re-commence operation, these mines are required to update their Reclamation Performance Bond with the BLM. They may also need to update aquifer protection permits with the Arizona Department of Environmental Quality. It is expected that within the next year Denison Resources will move forward on necessary permitting to begin mining activities. Following physical extraction, ore would be transported to Blanding, UT for processing.

In mid-2006, Tournigan acted to secure 413 federal lode and mining claims covering 8,260 acres on the Arizona Strip. This company may now be the largest holder of known and potential uranium-containing breccia pipe targets along the Strip. Ongoing field evaluations indicate that at least 20 of the 83 identified structures are true breccia pipes.

Quaterra Resources acquired claims covering 36 targets, and in early 2006 began exploring nine breccia pipe structures in northern Arizona. Three have been drilled but data is not available; the remaining six have not yet been drilled. Quincy Energy entered into an option agreement with Energy Metals covering eight properties and plans to explore the mineralized Rose breccia pipe.

Other companies acquiring previously drilled or suspected pipes as exploration targets along the Colorado Plateau include: Standard Uranium, Energy Metals, Liberty Star Gold, and VANE Minerals.

VANE also plans to search for uranium in the Red Butte and Upper Basin area on the Kaibab National Forest.

New uranium mines will not be approved by the Navajo Nation. The Nation has banned uranium mining due to severe human health issues arising from a 1950's mining operation on the reservation.

Basin and Range Province

According to the ADMMR, the Basin and Range Province has the potential to produce upwards of 126 million pounds of uranium. However, other than small open pit production in the mid 1950's, few companies are pursuing claims because deposits in this region are not as rich as the Colorado Plateau breccia pipe ore.

Concentric Energy has acquired the Anderson Mine, and Energy Metals has acquired an adjacent land-holding on drilled ground. Both are gathering and digitizing historic data as well as evaluating various development options. Concentric Energy is also assembling baseline environmental data and planning exploration.

Basin and Range Province and Transition Zone

Cooper Minerals has leased to Rodinia Minerals a claim group in the Workman Creek area. Additional claims have been staked on nearby properties and drilling is planned. Rodinia and joint venture partner Patriot Power have conducted drilling and sampling programs on the Lucky Boy and Mormon Lake (Pennsylvanian sediments) properties located in Gila County.

Summary

Arizona contains an estimated 79 million pounds of known uranium, and exploratory drilling has indicated a potential exceeding 126 million pounds for ore at greater depths. Thus far, major production of uranium in Arizona has only occurred on the Colorado Plateau.

5. Human and Environmental Effects of Uranium Mining

Information on the wildlife toxicity of uranium and its byproducts is somewhat limited. Additional review of current literature is needed to further describe these effects. Wildlife species may be directly affected by new roads, cross country travel, and road upgrades (paving, resurfacing, and improving) associated with mining and exploration activity.

Generally, mines and mining waste may release radionuclides, including radon, and other pollutants into streams, springs, and other bodies of water. The highest concentrations of radium from uranium waste and residue is found in air and water samples from areas where uranium mining has occurred. Radium in the soil may be absorbed by plants and may accumulate in fish and other aquatic organisms.

Most human health risks due to energy production have the potential to threaten wildlife as well. Air pollution harms wildlife through acidification of lakes and streams, negatively affecting forage and prey species abundance. Acid deposition can also trigger the ionic release of aluminum which kills fish and aquatic invertebrates, and impacts calcium sources resulting in weaker eggshells from calcium-deprived birds. Acid mine drainage, chemical leaks, and toxic runoff from storage piles and tailings directly endanger local waterfowl and migratory birds. Water demands from mining may further alter water availability. Acid drainage mitigation options include neutralizing acid runoff with limestone, and impounding pyrite-bearing waste rock to avoid sulfuric acid formation. Unfortunately, such solutions are impermanent at best.

A study evaluating fish responses to direct uranium exposure reported that gill membranes play a key role in the uptake of metals. The absorption of soluble metal fractions leads to distribution throughout the whole body and potential deleterious effects in target organisms.

Analysis of trace elements and radionuclide levels in aquatic invertebrates, fish, and birds from the Puerco and Little Colorado Rivers found that flycatchers feeding on insects containing various levels of aluminum experienced severe eggshell defects, reduced clutch sizes, and a high incidence of mortality. Doves appear more resilient to contaminated insects. Aluminum in concentrations detected in fish from the Little Colorado River may also present ecological risks to the survival and reproduction of resident fish-eating birds. Researchers concluded that birds with predominantly fish diets may be in danger of bioaccumulating potentially hazardous concentrations of mercury and other elements. Waterfowl and wading birds that consume primarily aquatic invertebrates may not bioaccumulate elements to the same degree as top level predators such as fish-eating birds.

Uranium mine waste from operations closed before the mid-1970s are of particular concern. In many cases, these mines are unclaimed and waste piles remain nearby. Weathering can produce radioactive dust susceptible to wind dispersal, while additional contaminants pollute surface and groundwater. There are also cases of unclaimed uranium mine waste being used for house construction, creating significant radon and radiation hazards to humans.

6. Mining Regulations Pertinent to Uranium

Mining and Mineral Leasing: several laws governing mining relate to mineral leasing on public lands.

> *Mining Act of 1872*, as amended (30 U.S.C. 21, et seq.) authorizes and governs prospecting and mining for "hardrock" minerals on public lands.
>
> *Mineral Leasing Act of 1920*, as amended (30 U.S.C. 181 et seq.) authorizes and governs leasing of public lands for development of deposits of coal, oil, gas and other hydrocarbons, sulphur, phosphate, potassium, and sodium. Section 185 of this title contains provisions relating to granting of rights-of-ways over federal lands for pipelines.
>
> 43 CFR 3809 Exploration and Mining Activities on Bureau of Land Management Lands
>
> 43 CFR 3830 Location of Mining Claims
>
> 43 CFR 3833 Recordation of Mining Claims
>
> 36 CFR 228 (A) Exploration and Mining Activities on Forest Service Lands
>
> ARS Title 27 – Minerals, Oils and Gas

U.S. Environmental Protection Agency (EPA)
EPA established environmental protection standards for mill tailings under requirements of the Uranium Mill Tailings Radiation Control Act (UMTRCA).

EPA also has other standards and special programs to control radiation in operating mines and mills, select old mines and mills, and from associated uranium-based products.

U.S. Nuclear Regulatory Commission (NRC)
NRC, or its Agreement States, license and oversee the operations of mills, heaps, and in-situ leaching solution mines.

Mill sites regulated by NRC, NRC Agreement States, and the U.S. Department of Energy have waste holding areas constructed under environmental protection standards established by EPA..

The States
Many states have signed formal agreements with NRC to assume regulatory authority over the licensing and operations of mills and in-situ leaching solution mines.

U.S. Department of Labor (DOL), Mine Safety and Health Administration (MSHA)
MSHA enforces compliance with mandatory safety and health standards to eliminate fatal accidents, reduce the frequency and severity of nonfatal accidents, minimize health hazards, and promote improved safety and health conditions in the nation's mines.

U.S. Department of Energy (DOE)

DOE takes control of closed and reclaimed mills, and reclaims some mill sites as authorized by Congress.

U.S. Department of the Interior (DOI), Bureau of Land Management (BLM)
BLM is responsible for managing 262 million acres of land (about one-eighth the total land surface of the United States) and about 300 million additional acres of subsurface mineral resources, including mines. The Office of Surface Mining provides funds to state and tribal agencies for reclaimation of uranium mines.

U.S. Department of Agriculture (USDA), National Forest Service (NFS)
NFS reclaims abandoned mines in National Forests.

U.S. Army Corps of Engineers (USACE)
The Corps of Engineers operates the Formerly Utilized Site Remedial Action Program (FUSRAP) that was originally established by DOE in 1974 to identify, investigate, and clean up contaminated sites formerly used by DOE's predecessor agencies. In some cases, these sites include mining and milling sites with radioactive levels that exceed current standards. FUSRAP coverage also pertains to sites from the early years of the nation's atomic energy program. Through FUSRAP, federal agencies, state and local governments, and property owners work cooperatively to control radioactive material. The Corps of Engineers has also assisted EPA and several Tribes in the cleanup of abandoned mines on tribal properties.

7. How the Department Can Be Involved

In order for the Department to effectively be involved in providing comments or recommendations on proposed exploration or mining activities, we must first understand how uranium mining takes place on federal lands.

> Uranium mining falls under the Minerals and Mining Program under the BLM. Uranium is considered a “locatable mineral”, which can be obtained by filing a mining claim. A mining claim is a particular parcel of federal land, for which an individual (or company) has asserted a right of possession. The right is restricted to the extraction and development of a mineral deposit as regulated by BLM or the FS. Generally speaking, a mining claim for uranium mineralization would be considered a “lode claim” that occurs as a vein of ore is located (vs. a “placer claim” that occurs when minerals are dispersed among particles of sand or gravel).
>
> Mining claims, on either BLM or FS lands, are first filed with the appropriate county and with the BLM State Office.
>
> Claims may only be placed on lands open to mineral entry. Claims may not be staked in areas closed to mineral entry by a special act of Congress, regulation, or public land order (National Monuments, Wilderness, etc.).

Department involvement can occur at various points during mining activity including the exploratory phase. Examples include the permit or authorization stage required for compliance with federal legislation such as the National Environmental Policy Act, Clean Water Act, and

Endangered Species Act, all of which require coordination with the state wildlife agency. This federal nexus allows the state an opportunity to provide comments, concerns, and mitigation recommendations to the applicant through the federal government and/or federal funding source. The Department also shares management authority with the U.S. Fish and Wildlife Service (FWS) for migratory, threatened, and endangered species through Department involvement during Section 7 Consultation processes and development of FWS Biological Opinions.

Region II will be coordinating on site field reconnaissance visits for proposed exploration activities on Arizona Strip BLM lands. In addition, the Department provides comment on new projects proposed for federal lands during agency coordination meetings, NEPA reviews, and other federal permitting activities.

8. Resources Compiled and/or Cited

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Uranium Mining and Milling Wastes: An Introduction
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http://www.wise-uranium.org/stk.html?src=stkd01e

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http://www.wise-uranium.org/uisl.html

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http://www.admmr.state.az.us/

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http://www.uraniumsa.org/processing/insitu_leaching.htm

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http://www.10antenna.nl/wise/439-440/chapter3.html

Impacts of Resource Development on Native American Lands; Environmental Impacts on the Navajo Nation from Uranium Mining
http://serc.carleton.edu/research_education/nativelands/navajo/environmental.html

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http://www.repp.org/repp_pubs/articles/envImp/04impacts.htm

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Changes in oxidative stress parameters in fish as response to direct uranium exposure. Radioprotection, Suppl. 1, vol. 40 (2005) S151-S155.
http://www.edpsciences.org/articles/radiopro/pdf/2005/02/o202.pdf?access=ok

Wildlife studies along the Puerco and Little Colorado River
http://www.fws.gov/southwest/es/Documents/R2ES/RadionuclidesAZ.pdf

Rumble, M.A. and A.J. Bjusgstad. 1986. Uranium and radon concentrations in plants growing on uranium mill tailings in South Dakota. Reclamation and Revegetation Res. 4:271-277.

U.S. Environmental Protection Agency; Uranium Mines
http://www.epa.gov/radtown/uranium-mines.htm

Uranium Mill Tailings Radiation Control Act
7 November 2005. U.S. Environmental Protection Agency
This page provides a summary of the Uranium Mill Tailings Radiation Control Act and links to pages with additional information.

Extraction and Beneficiation of Ores and Minerals (PDF) (139pp, 545Kb)
31 January 1995. U.S. Environmental Protection Agency
This document show the results of EPA's research into the uranium extraction and beneficiation of uranium in the United States.

Rad NESHAPs: Subpart B: Underground Uranium Mines
15 September 2005. U.S. Environmental Protection Agency
This site provides information on Subpart B of the National Emissions Standards for Hazardous Air Pollutants, which protects the public and the environment from the radon-222 emissions to the ambient air from underground uranium mines.

Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)
2006. U.S. Environmental Protection Agency
At this site, you can find information on health concerns, the products, processes and industries that generate TENORM and applicable EPA laws and guidelines.

Uranium: The Basics
15 September 2005. U.S. Environmental Protection Agency
This site provides basic answers to frequently asked questions about uranium.

Uranium (PDF) (15pp, 308Kb)
15 September 2005. U.S. Environmental Protection Agency
This paper discusses the process of uranium production from the types of mining techniques to enriching the uranium.
"What is Uranium? How does it work?"
31 January 2002. World Nuclear Association
This page provides information on uranium and the role it plays in creating nuclear power.

Lands and Minerals Databases
23 February 2006.U.S. Department of the Interior, Bureau of Land Management
Public land information through three popular lands and minerals databases that provide essential information to the public: GeoCommunicator, Legacy Rehost 2000 (LR2000) System reports, and public eForms.

Directory of Agreement State and Non-Agreement State Directors and State Liaison Officers
7 February 2006. U.S. Nuclear Regulatory Commission
This page provides contact information for state radiation programs.

Early Uranium Mining in the United States
30 September 1989. World Nuclear Association
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Formerly Utilized Site Remedial Action Program
19 August 1996. U.S. Department of Energy
This technical report presents the results of EPA's research into the uranium mining industry in the United States and is one in a series of profiles of major mining industry sectors.

How Is the Public Protected from Radiation?
10 December 2002. National Safety Council
This page discusses the different ways that the United States' government agencies are involved in protecting the public from unnecessary radiation exposure.

Long-Term Stabilisation of Uranium Mill Tailings (PDF) (119 pp, 1.27Mb)
7 February 2003. International Atomic Energy Agency
This document discusses the issues surrounding uranium mill tailings and the processes for stabilizing and isolating that waste.

Mine Safety and Health Administration
U.S. Department of Labor
This site is for the Mine Safety and Health Administration, ensuring worker safety and health in the nations mines.

State and Tribal Programs Site – State Regulations and Legislation
16 February 2006. U.S. Nuclear Regulatory Commission
This page lists links to state and tribal nuclear program contacts and the regulations and legislation associated with each program.

State Environmental Protection Division Listing
15 September 2005. Clay.net Environmental Professional
This page lists links to the state environmental protection agencies.

Uranium Mill Tailings
11 November 1999. U.S. Department of Energy
This page provides information on mill tailings, the residual wastes of milled ore that remain after the uranium has been recovered.