Uranium Committee Report
Michael D. Campbell, P.G., P.H., Chairman
June 6, 2009 Report – Revised June 11

The Uranium Committee is working diligently on gathering information and watching trends in terms of industry activities. Since the last Committee Report in early 2008, the Committee has produced a number of reports for the benefit of the members of EMD and of the AAPG in general:

- Campbell, M. D., J. D. King, H.M. Wise, B. Handley, and M. David Campbell, 2009, "The role of nuclear power in space exploration and the associated environmental safeguards: an overview," Report of the Uranium Committee, Energy Minerals Division to the Astrogeology Committee of AAPG. To be presented at the Conference of the AAPG-Energy Minerals Division and Astrogeology Committee Sessions, June 8-10, held in Denver, CO. (Click here).

- Campbell, M. D., B. Handley, H. M. Wise, J. D. King, and M. David Campbell, 2009, "Developing Industrial Minerals, Nuclear Minerals and Commodities of Interest via Off-World Exploration and Mining," Paper/Poster at the Conference of the American Association of Petroleum Geologist (AAPG), Energy Minerals Division Sessions, June 9, Denver, CO., 27 p. (Click here).

- Campbell, M. D., 2009, "Uranium," *in Unconventional Energy Resources and Geospatial Information: 2008 Review by the Energy Minerals Division, American Assoc. Petroleum Geologists*, of the Journal of *Natural Resources Research*, Vol. 18., No. 1, January. (Uranium section in Paper).

- Campbell, M. D., H. M Wise, and J. D. King, 2008, "Nuclear Fuel Exploration, In Situ Recovery, and Environmental Issues in context with the National Energy Needs through Year 2040," *Proc. Texas Commission of Environmental Quality Conference and Trade Fair*, Session: "Underground Injection Control," Invited Presentation, Austin, Texas, April 30, 2008 (Click here).

- Campbell, M. D., J. D. King, H. M. Wise, R. I. Rackley, and B. Handley, 2008 "The Nature and Extent of Uranium Reserves and Resources and Their Environmental Development in the U.S. and Overseas," AAPG – Energy Minerals Division Conference, April 23, 2008, Session: "Uranium Geology and Associated Ground Water Issues", San Antonio, Texas (Click here).

In addition, the Chairman continues to work with AGI to complete the AGI Publication: ***Nuclear Energy and the Environment*** during 2009**.**

On behalf of the EMD Uranium Committee, Chairman Campbell and a Uranium Committee Member (Henry Wise) were invited to attend the Energy Institute Meeting in Houston, December 4, 2008. A lengthy and spirited discussion was held by attendees representing solar, wind, coal, geothermal, and nuclear interests.

Chairman Campbell presented a preliminary presentation on the EMD Uranium Committee's investigations of off-world applications of nuclear power entitled: "Nuclear Power in Space Exploration and on Earth: An Overview" to members attending the Houston Geological Society's Environmental and Engineering Dinner Meeting on January 20, 2009 in Houston.

On March 18, 2009, EMD's Uranium Committee was invited to provide an update on uranium exploration and a summary of exploration and yellowcake production in the U.S. during the British-Consulate-General and United Kingdom Trade and Investment Group's private industry lunch following the Nuclear Roundtable. Chairman Campbell and Committee Member Henry Wise represented the EMD's Uranium Committee.

On May 19, 2009, Uranium Committee, Chairman Campbell and a Uranium Committee Member (Henry Wise) attended Houston Town Hall Forum sponsored by the AAPG Foundation with President, Dr. Scott Tinker as the keynote speaker.

Summary of U.S. Industry Activities

Fourth quarter 2008 production of uranium concentrate in the United States was 1,058,386 pounds (480,076 kg) U_3O_8, up 8% from the previous quarter, but down 10% from the fourth quarter 2007. During the fourth quarter 2008, in the United States, uranium oxide (U_3O_8) was produced at one mill: White Mesa Mill, and six in situ-recovery (ISR) plants: Alta Mesa Project, Crow Butte Operation, Kingsville Dome, Rosita, Smith Ranch-Highland Operation, and Vasquez.

Production of uranium concentrate in the United States totaled 3,922,823 pounds (1,779,363 kg) U_3O_8 in 2008. This amount was 13% lower than the 4,533,578 pounds (2,056,396 kg) produced in 2007. Uranium mines in the United States produced 4.5 million pounds (2,041,166 kg) of uranium oxide (U_3O_8) in 2007, 3% less than in 2006 (Figure 1 and Table 1). Six underground mines produced uranium during 2007, one more than in 2006. Six in situ-recovery mining operations produced uranium in the United States in 2008, up one from 2007. Overall, there were 12 mines in the United States that produced uranium during part or all of 2008.

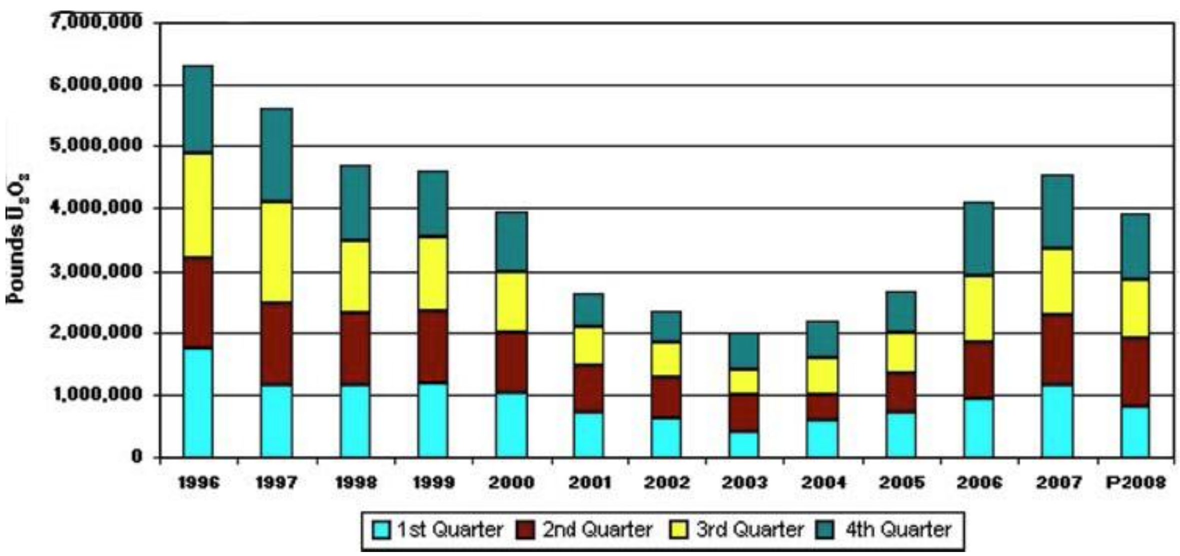


Figure 1- Uranium Concentrate Production in the U.S. P= Preliminary Data from EIA-851A and 851Q

Table 1 Total Production of Uranium Concentrate in the United States, 1996—4th Quarter 2007 (Pounds U_3O_8)

Calendar Year Quarter	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	P2008
1st quarter	1,734,427	1,149,050	1,151,587	1,196,225	1,018,683	709,177	620,952	E400,000	E600,000	709,600	931,065	1,162,737	810,189
2nd quarter	1,460,058	1,321,079	1,143,942	1,132,566	983,330	748,298	643,432	E600,000	E400,000	630,053	894,268	1,119,536	1,073,315
3rd quarter	1,691,796	1,631,384	1,203,042	1,204,984	981,948	628,720	579,723	E400,000	588,738	663,068	1,083,808	1,075,460	980,933
4th quarter	1,434,425	1,541,052	1,206,003	1,076,897	973,585	553,060	E500,000	E600,000	E600,000	686,456	1,196,485	1,175,845	1,058,386
Calendar year total	6,320,706	5,642,565	4,704,574	4,610,672	3,957,545	2,639,256	E2,344,107	E2,000,000	2,282,406	2,689,178	4,105,626	4,533,578	3,922,823

P = Preliminary data.
E = Estimate data – The reported 4th quarter 2002 production amount was adjusted by rounding to the nearest 100,000 pounds to avoid disclosure of individual company data. This also affects the 2002 annual production. The reported 2003 and 1st, 2nd, and 4th quarter 2004 production amounts were adjusted by rounding to the nearest 200,000 pounds to avoid disclosure of individual company data. This also affects the 2003 and 2004 annual production totals.
Note: Totals may not equal sum of components because of independent rounding.
Sources: Energy Information Administration: Form EIA-851A and Form EIA-851Q, "Domestic Uranium Production Report."

Total employment in the U.S. uranium production industry was 1,231 person-years for 2007, an increase of 63% from the 2006 total (Figure 2). Mining employment increased the most (213%) and exploration employment showed the second largest increase (100%), and is expected to increase further in 2008. Uranium milling and processing employment rose 11%, while reclamation employment did not change from 2006 to 2007 but is expected to have risen in 2008.

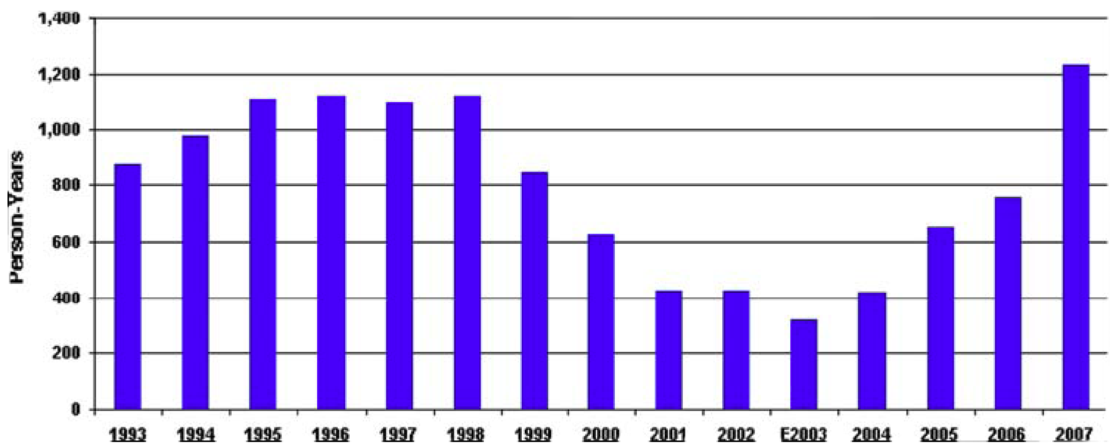


Figure 2 – Total employment in the uranium production industry: 1993 through 2007 (EIA-851)

In Situ Uranium Recovery

In situ recovery of uranium continued to expand in Wyoming and especially in Texas and elsewhere in the United States and overseas. However, recent economic issues (4th Quarter, 2008) have cooled expansion, but recovery is anticipated in 2009. The total U.S. production capacity is summarized in Table 2.

Table 2 U.S. Uranium In Situ-Leach Plants by Owner, Capacity, and Operating Status: 2007–2008

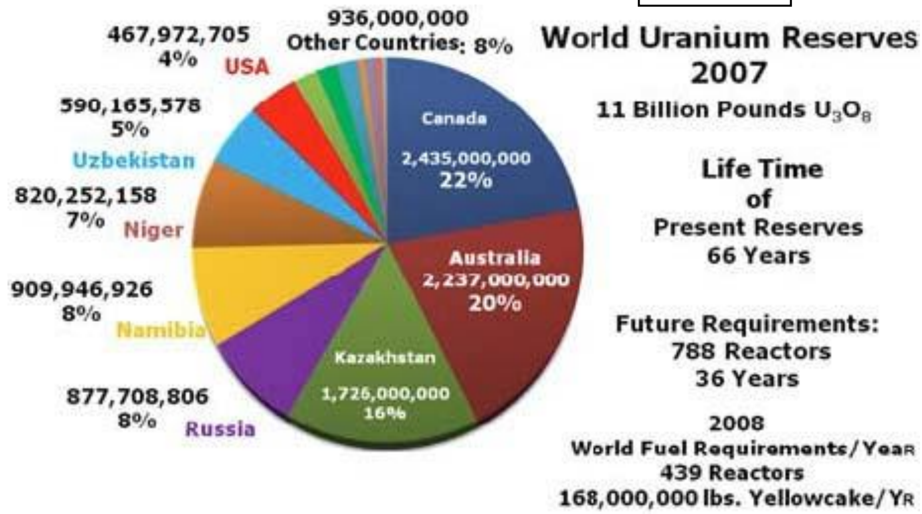
In situ-Leach Plant Owner	In situ-Leach Plant Name	Production Capacity (Pounds U_3O_8 per year)	Operating Status at End of				
			2007	1st Quarter 2008	2nd Quarter 2008	3rd Quarter 2008	4th Quarter 2008
COGEMA Mining, Inc.	Christensen Ranch	650,000	Changing license to operational	Changing license to operational	Changing license to operational	Changing license to operational	Standby
COGEMA Mining, Inc.	Irigaray Ranch	–	Inactive	Inactive	Inactive	Changing license to operational	Standby
COGEMA Mining, Inc.	Texas Operations	–	Reclamation	Reclamation	Reclamation	Reclamation	Reclamation
Cameco Corporation	Crow Butte Operation	1,000,000	Operating	Operating	Operating	Operating	Operating
HRI, Inc.	Church Rock	1,000,000	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed
HRI, Inc.	Crownpoint	1,000,000	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed
Lost Creek ISR LLC	Lost Creek Project	2,000,000	–	Developing	Developing	Developing	Developing
Mestena Uranium LLC	Alta Mesa Project	1,000,000	Producing	Producing	Producing	Producing	Producing
Power Resources, Inc. dba Cameco Resources	Smith Ranch-Highland Operation	5,500,000	Operating	Operating	Operating	Operating	Operating
Powertech Uranium Corp.	Centennial Project	–	–	–	–	–	Undeveloped
Powertech Uranium Corp.	Dewey Burdock Project	–	–	–	–	–	Undeveloped
South Texas Mining Venture, LLP	Hobson ISR Plant	1,000,000	Under construction	Under construction	Under construction	Operational	Operational
South Texas Mining Venture, LLP	La Palangana	1,000,000	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed	Partially permitted and licensed
URI, Inc.	Kingsville Dome	1,000,000	Producing	Producing	Producing	Producing	Producing
URI, Inc.	Rosita	1,000,000	Standby	Standby	Standby	Producing	Producing
URI, Inc.	Vasquez	800,000	Producing	Producing	Producing	Producing	Producing
Uranerz Energy Corporation	Nichols Ranch ISR Project	–	–	–	–	Developing	Developing
Uranium Energy Corporation	Goliad ISR Uranium Project	–	–	–	–	–	Partially permitted and licensed
Uranium Energy Corporation	Nichols Project	–	–	–	–	–	Developing
Uranium One, Inc.	Jab and Antelope	2,000,000	–	–	–	–	Developing
Uranium One, Inc.	Moore Ranch	2,000,000	–	Developing	Developing	Developing	Developing
Total Production Capacity:		*20,950,000*					

– = No data reported.
Note: An operating status of "operating" usually indicates the in situ-leach plant was producing uranium concentrate at the end of the period.
Source: Energy Information Administration: Form EIA-851A and Form EIA-851Q, "Domestic Uranium Production Report."

World Uranium Reserves

While uranium exploration has picked up in the United States, activity around the world has been expanding substantially over the past few years. Recently, the International Atomic Energy Association (IAEA) announced reserves numbers for 2007. Canada, Australia, and Kazakhstan still control nearly 60% of the known reverses (Figure 3), although new discoveries are expected from other parts of the world that will increase the reserves, especially in Africa, Canada, and South America.

Figure 3



The need for viable energy fuel will become critical by mid-century. All conventional energy sources are predicted to peak during this period and alternative resources are anticipated to fill the gap. However, nuclear power utilities and associated uranium exploration industry have sufficient identified reserves to last well past the year 2074.

Even with the anticipated nuclear power expansion from about 439 to some 788 reactors over the next 30 years, present reserves will likely meet the demand; reserves typically increase as the fuel price rises and as demand stimulates exploration. Uranium in present economic concentrations occurs on Earth ranging in rocks of the Precambrian to the sediments of Tertiary age. It also is available as by-products from nuclear devices, from processing phosphate deposits, and from other sources. Some alternative energy scenarios phase out coal, fuel oil, and dams for electrical generation, and combine expanding the use of nuclear and natural gas. Nuclear power can provide most of the electricity but less-developed countries may use the remaining inexpensive carbon-based fuels over the coming decades.

The economic and social fabric of America depends on how rapidly the United States can develop and implement a viable energy plan (see Kucewicz, 2007). With the declining oil and gas resources, and with coal becoming an unacceptable energy source on the basis of its socio-economic limitations extending over the next 30 years, nuclear power appears to be the only viable source of energy to generate the large quantities of electrical power that will be required. Also, as uranium reserves are consumed in the early twenty-second century, there is no reason to conclude that additional resources will not be discovered. Also, recycling of uranium (and plutonium) almost certainly will be re-instated for development (Leventhal and Dolley, 1994; Campbell, Wise, and Evensen, 2005; U.S. Department of Energy, 2007; Campbell, Wise, and Rackley, 2007; Campbell and others, 2008; Campbell, Wise, and King, 2008).

The use of thorium as a fuel to generate electricity also will play an increasing role (see Sorensen, 2006; and older, but still relevant information in U.S. Atomic Energy Commission, 1969). Furthermore, over the past 10 years, helium-3 (aka 3He) has received considerable attention for its potential to produce significant fusion energy. 3He, a gas, is apparently present in substantial concentrations, trapped within certain minerals present in the lunar regolith, having accumulated after billions of years of bombardment by the solar wind (Campbell and others, 2009).

Lastly, it also is not unreasonable to assume that economic uranium (thorium and helium-3) deposits will be discovered elsewhere in the solar system, i.e., on other planets, moons, or asteroids. The environmental processes that form the younger types of uranium mineralization (of Tertiary age) require the presence of water, bacteria and associated enzymes, and may not be present on many of these distant bodies. However, water may be more pervasive than originally assumed. Geologically older types of uranium mineralization associated with igneous and metamorphic rocks similar to deposits that occur in Proterozoic gneiss and amphibolites (Christopher, 2007) and to the younger rocks in the United States (Armbrustmacher and others, 1995), as well as the well-known, developed uranium deposits in Canada and northern Australia and those under development in Africa, would be analogues for the types of deposits that would be expected to occur elsewhere in the solar system. Some early speculations about uranium, thorium, and associated geochemistry have already begun (Surkov and others, 1980; Zolotov, Krot, and Moroz, 1993).

With the number of unmanned missions planned in the next few years, additional information should become available to begin looking actively for resources in our solar system, hopefully within the next 20–30 years and beyond, supported by both solar and nuclear power (Campbell and others, 2009).

U.S. Socio-Economic Issues

Socio-economic issues have become an integral part of uranium exploration and recovery projects today. Uranium occurs naturally in aquifers and this is the reason for background ground-water studies before uranium recovery operations are initiated. Community support for in situ uranium recovery continues to improve in many parts of the United States, but is often hampered by anti-uranium activist groups. State regulatory and Federal agencies have tightened regulations of the 1970s to meet today's concerns for appropriate environmental controls, and the uranium industry is changing to meet the new regulations. At present, the uranium recovery industry has an outstanding record in Texas, for example, for remediating past in situ operations. Texas has never recorded an incident of affected ground-water drinking water outside of known areas containing natural uranium and its associated radiogenic products, ^{226}Radium, ^{222}Radon, and others and the associated remediation projects conducted to date (Table 3).

While the aquifer may contain suitable drinking-water quality over an extensive area, the area of the aquifer containing uranium mineralization has been naturally contaminated and was contaminated long before humans drilled water wells. The fact that the aquifer contains uranium mineralization has been misunderstood by landowners, which has resulted in numerous protests and added costs that uranium companies must spend to respond to this misunderstanding, even on frivolous lawsuits.

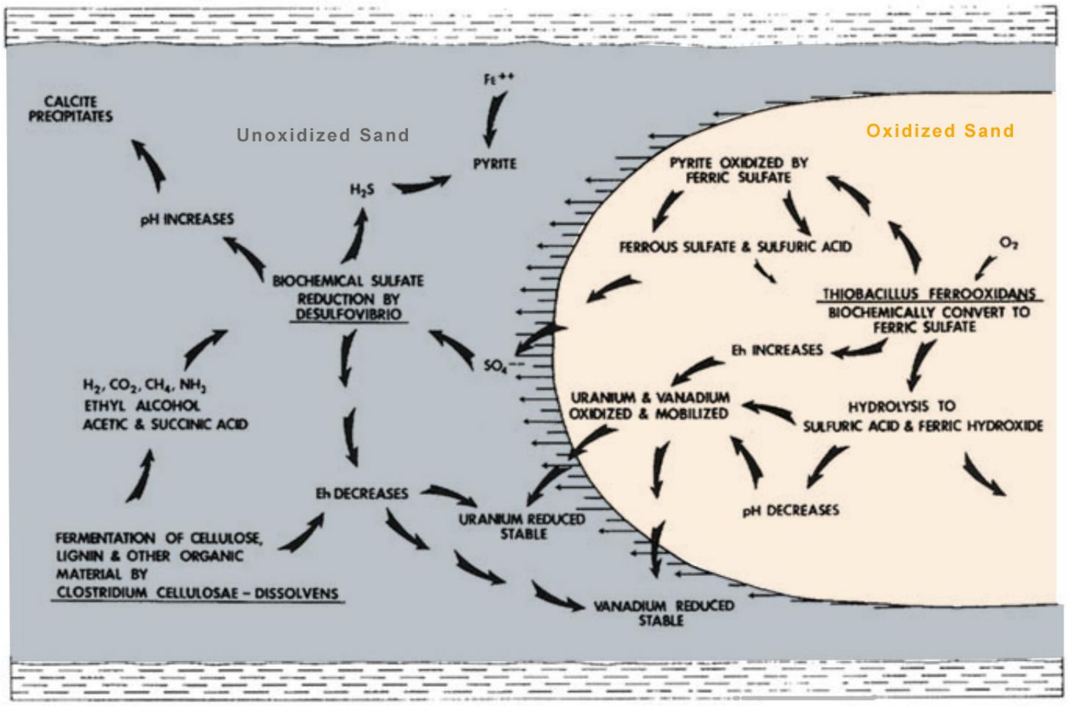
Table 3 In Situ Leach Uranium Recovery Reclamation Status—2007

Operation	Status	County	Regional Aquifer
Caithness-McBride	G.W. Restored/Plugged/D&D	Duval	Oakville
Cheveron-Palangana	G.W. Restored/Plugged/D&D	Duval	Goliad
Cogema-Holiday	G.W. Restored/Plugged	Duval	Catahoula
Cogema-El Mesquite	G.W. Restored/Plugged	Duval	Catahoula
Cogema-O'Hern	G.W. Restored/Plugged/D&D	Duval	Catahoula
Cogemaa-Cole	G.W. Restored/Plugged/D&D	Duval	Catahoula
Conoco-Trevino	G.W. Restored/Plugged/D&D	Duval	Oakville
Everest-Hobson	G.W. Restored/Plugged/D&D	Karnes	Oakville
Everst-Las Palmas	G.W. Restored/Plugged/D&D	Duval	Oakville
Everst-Mt Lucas	G.W. Restored/Plugged	Live Oak	Goliad
Everest-Tex-1	G.W. Restored/Plugged/D&D	Karnes	Oakville
IEC-Pawnee	G.W. Restored/Plugged/D&D	Bee	Oakville
IEC-Zamzow	G.W. Restored/Plugged/D&D	Live Oak	Oakville
IEC-Lamprechr	G.W. Restored/Plugged	Live Oak	Oakville
Mestena-Alta Mesa	Operation	Brooks	Goliad
URI-Benavides	G.W. Restored/Plugged/D&D	Duval	Catahoula
URI-KVD	G.W. Restoration/Operation	Kleberg	Goliad
URI-Longoria	G.W. Restored/Plugged/D&D	Duval	Catahoula
URI-Rosita	G.W. Restoration/Operation	Duval	Goliad
URI-Vasquez	Operation	Duval	Goliad
U.S. Steel-Boors	G.W. Restored/Plugged/D&D	Live Oak	Oakville
U.S. Steel-Burns	G.W. Restored/Plugged/D&D	Live Oak	Oakville
U.S. Steel-Clay West	G.W. Restored/Plugged/D&D	Live Oak	Oakville
U.S. Steel-Mosier	G.W. Restored/Plugged/D&D	Live Oak	Oakville

Source: Pelizza (2007).

The state regulatory agencies now understand and have enacted regulations to prohibit the use of ground water as a source of drinking water in the aquifer(s) containing uranium mineralization. Therefore, establishing baseline-environmental conditions are essential for providing clear and reasonable guidelines for closure of operations that lease owners and surrounding landowners will understand and support. Surveys and meteorological studies are conducted to determine seasonal variations well before uranium recovery begins.

To a large extent, in situ recovery of uranium is both a natural resource development project and a natural contaminant remediation project. Although uranium ore is a natural energy resource, it is also a bacterial-waste product that was formed within the bio-geochemical cell under the influence of reductants, either hydrogen sulfide or methane, present within the roll-front within the aquifer(s) (Figure 4). Uranium ore is a by-product of anaerobic and aerobic bacterial respiration that forms within the bio-geochemical cell. Both rely heavily on, and are driven by, geological and hydrogeological processes including: the hydraulic conductivity of the sands involved either within the ore zone or in the monitored sands above and below the ore zone; the hydraulic gradient of each of the sands; and the porosity of the sands involved and of the ore-zone. To this, the hydrochemistry of ore zone fluids and injection fluids must be added (both within the ore zone and at proximal and distal parts of the aquifer designated by the state as a uranium production zone and not to be used as a source of drinking water).



After Rackley, 1975

Figure 4 – Formation of bio-geochemical cell (roll-front)

Exploration for new uranium deposits is not only needed to fuel nuclear reactors, but also to locate naturally contaminated deposits in aquifers that unaware rural residents may have been using for drinking water. This condition easily can be identified by the rural landowner thorough testing of ground-water supplies. Yearly sampling of the water supply should be undertaken as a regular activity of rural well maintenance. Water should be tested for normal constituents including pH, iron, and manganese. Rural residences may become alarmed when their water turns a muddy red with flakes of biomass in the water, indicating that iron bacteria and the often associated sulfate-reducing bacteria have infected the well. This can be remediated by the local water well contractor, usually by chlorinating and cleaning out the well. It is the responsibility of the well owner to maintain the water quality and the man-made devices designed to extract the ground water, that is, the pump and the water well. The increase of iron bacteria in the ground water of water wells in the area have nothing to do with uranium drilling or development as believed by a few well-meaning but vociferous landowners and as reported by some news media pandering to the fears of the local residents (Figure 5).

With the general public becoming more environmentally conscious, it is imperative that an ISR uranium company be prepared to respond to all spills and releases immediately and inform concerned persons of the conditions. This may not eliminate problems and misunderstandings, but a community approach should minimize most of the associated problems.

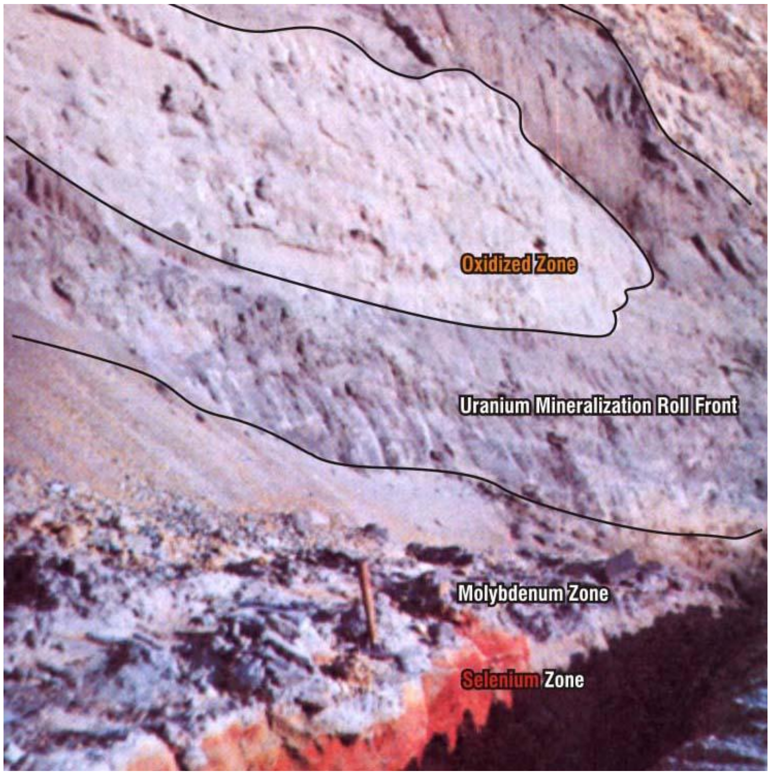


Figure 5 – Pit wall cross section of uranium roll-front (bio-geochemical cell) (After Dickinson and Duval, 1977)

Lingering problems involve local news media reporting on uranium company activities by making statements that have no basis in fact or appropriate reference, or by combining and confusing subjects in the article to encourage the reader to draw certain conclusions that the general public might not otherwise make. There are also problems with paid activists who are credentialed in one academic field but who claim knowledge in another and attempt to influence others on subjects about which they know very little, even to the point of practicing geology and engineering without a state license, a regulation which was intended to protect the public from just such misleading information.

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