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Feature

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REVERSING MOTHER NATURE

The Gurus Explain ISR Mining, Step by Step

The In Situ Recovery (ISR) Series
Part Three of a Three-Part Series


The Gurus of In Situ Recovery Mining (ISR). Harry Anthony (left), Doug Norris (center) and Dennis Stover (right). Harry Anthony and Doug Norris lead the ISR engineering team for Uranium Energy Corp (OTC BB: URME) and Dennis Stover is the Chief Operating Officer of Energy Metals Corporation (TSX: EMC).

Summary: We talked to North America's leading In Situ Recovery (ISR) uranium mining engineers, and had them explain exactly how ISR worked. Most of the significant ISR operations in the United States were designed and/or constructed by these engineers. They explained how ISR mining is really just reversing the process of Mother Nature.

By James Finch

"Blossom" is what underground uranium miners called the crystals forming on the tunnel walls. Because the ore was in contact with air inside an underground mine, and as ground water moved slowly against the mine's walls, a visible crust of uranium crystals would precipitate, or blossom along those walls. Making the uranium soluble doesn't require a lot of oxygen and water because oxidization is a natural process. Adding more oxygen to the groundwater found in, and around, a uranium-mineralized orebody is the principle upon which present-day In Situ Recovery (ISR) uranium mining is based.

Eons ago, the uranium was soluble and moved, on or below the surface, with the ground water. "In roll front uranium deposits the uranium was transported into the area through the natural groundwater system and precipitated from solution due to some reducing environment," explained Harry Anthony, Chief Operating Officer of Uranium Energy Corp. Often, the reducing agent was something organic, such as coal, deep-seated oil and gas deposits, or hydrogen sulfide gases. In its reduced form, the uranium crystals are insoluble. "It will precipitate as a coating on the existing sand grains of the sandstone," added Anthony. "As more water containing uranium sweeps through this area, and encounters this reducing environment, more uranium is precipitated until there is a sufficient concentration to make it a commercial deposit."

After the geological team has delineated a company's uranium "roll front" deposit and determined it is of economic value, the company must turn to its ISR design engineers to complete the "mining" process. While it takes stellar geologists such as David Miller of Strathmore Minerals, Bill Sheriff of Energy Metals, or William Boberg of UR-Energy to accumulate large, proven uranium-mineralized holdings, as they have done in Wyoming, New Mexico, Texas or elsewhere, each must turn to their engineers to extract the uranium from those sand grains and process them to produce an economic quantity of uranium oxide, or U3O8. The overwhelming majority of ISR facilities, designed in the United States, were engineered by Harry Anthony, Doug Norris and Dennis Stover.

Trained as a mechanical engineer, Harry Anthony has been involved with more than ten ISR uranium operations from Union Carbide's Palangana in 1976 to Uranium Resources' Bruni, Benavides, North Platte, Kingsville Dome and Rosita ISR projects. Anthony's consulting work has taken him to ISR projects in Kazakhstan, Uzbekistan and the Czech Republic. Dennis Stover is best remembered for designing Smith Ranch in Wyoming, now owned by Cameco Corp. With a PhD in chemical engineering from the University of Michigan, Dr. Stover helped develop the first commercial alkaline ISR project in south Texas for Atlantic Richfield and helped develop an additional five small ISR operations in south Texas. Also a chemical engineer by training, Doug Norris's paths have crossed with both Stover and Anthony. He helped build the Highland and Smith Ranch ISR operations in Wyoming, and designed Mestena's Alta Mesa ISR operation in south Texas.

Inside a "header house." Many who know how ISR (Solution Mining) operations work compare this to a water treatment plant. The tubes connect to the aquifer from where the uranium is extracted. Right: Water in; water out. Just as you would find at a water treatment facility.

One of Harry Anthony's many ISR accomplishments

How Does ISR Mining Reverse Mother Nature?

"In its natural, reduced environment, uranium exists as a solid in the +4 valence," Anthony explained. "In the mining stage, we are reversing Mother Nature's process by adding oxygen, oxidizing the uranium from a valence of +4 to a valence of +6." The uranium was oxidized at one time, but then reduced by Mother Nature. By drilling wells into the ore zone, circulating the water and adding oxygen to it, the uranium is made soluble again.

Is it really this simple? Yes and no. Energy Metals Chief Operating Officer Dennis Stover outlined the process, "You're simply adding, into the injection well, gaseous oxygen, just pure oxygen, but you're doing it under the water level in the well. The natural pressure, created by that column of water above the injection point, allows the oxygen to dissolve into the water so that there's no free gas being put into the well."

Stover compared the oxygen dissolved in the liquid to the carbon dioxide dissolved in a bottle of soda. The soda remains clear, dissolved in the liquid, when stationery. "But when you shake it up, the gas will break out," added Stover. "The pressure that's available that lets you dissolve the oxygen is determined by the amount of naturally occurring water pressure that's on the uranium deposit." Stover explained that if the deposit is 100 feet below the water table, you can dissolve a certain amount of oxygen. "If the uranium deposit is 200 feet below the water table, or twice as deep, you can dissolve twice as much oxygen."

Historically, ISR mining evolved from acid leaching to leaching with sodium bicarbonate or sodium carbonate. "Most people add only carbon dioxide in dissolved oxygen at this point," Stover explained. "There's a chemical relationship between carbon dioxide gas, bicarbonate, and the carbonate ion. The host rock typically contains calcium carbonate or sodium carbonate minerals." By adding the carbon dioxide, Stover said, "It will lower the PH of the solution just slightly." That enhances the solubility of the naturally occurring calcium carbonate." According to Stover and the other experts, the addition of carbon dioxide is an effective replacement for the previously added bicarbonate ion.

The goal is to get the uranium out of the sandstone and soluble. "We're accelerating Mother Nature and making the uranium soluble again," said Doug Norris, engineering manager for Uranium Energy. "When it's soluble, we can just pump it out of the ground. But it is dissolved in the water like salt in sea water. You can't see it, but it's there."

"Mining" the Uranium

ISR "mining" and processing the uranium is a very simple process. It's a water treatment plant with hundreds of water wells. There are two types of wells: injection and production. The water plus reagent (oxygen, carbon dioxide) is injected into the ground via water wells. Outside the United States, where environmental regulations may be less restrictive, an ISR's aquifer may be bombarded with harsh acid leaching. On Harry Anthony's engineering services website (http://www.hanthony.com/), he describes the process he observed in the Czech Republic, "Over 4,100,000 tons of H2SO4 (sulfuric acid), 270,000 tons of HNO3 (nitric acid), 100,000 tons of NH3 (ammonia), and 25,000 tons of HF (hydrofloric acid) were consumed by the mine."

It would be nearly impossible to get an ISR project permitted in the United States using these chemicals to leach the uranium. The water quality division, within a state's Department of Environmental Quality (DQE), demands restoration to background, which is about where the groundwater was before ISR mining began. "The less things you add, the less you have to reclaim at the end of the process," Doug Norris pointed out. "The more stuff you add trying to get it out of the ground, the more you have to clean up."

Dennis Stover explained how the fluids presently used came about, "Historically, most ISR operations had a great deal of difficulty with plugging or fouling of their injection wells due to the precipitation of excessive amounts of salts." He pointed out that the chemistry miners were using in conventional milling operations didn't work in ISR mining. "Because they had very high concentrated salt solutions, they were trying to accelerate everything," Stover told us. "When you take those concentrated solutions and put them underground, Mother Nature is not always happy. Other salts that were present in the rock would dissolve, solutions would become supersaturated and they would precipitate out. The wells would plug up."

Norris explained that often you have to add a carbonate source, such as carbon dioxide "to stabilize the dissolved uranium as uranyl dicarbonate." Norris said, "The uranium is in a solid state in the ore, as Mother Nature left it. We oxidize it and turn it into uranyl dicarbonate." What goes to the processing plant is called lixiviate, the dissolved uranium in its ionic form. According to Anthony, "Today, most ISR mining operates at neutral pH, and the uranium is complexed as a dicarbonate."

Water is circulated through the injection wells with the expressed purpose of separating the uranium coating the sandstone. Each time you circulate the water through the orebody, you are capturing some of the uranium. Each pass-through is called a pore volume. "It's like filling up a bucket of sand with water," explained Anthony. "Once you have the bucket full of sand, you can still pour in water. The amount of water you can pour in until you just bring it up to the top of the sand is termed a 'pore volume.' Pore volume is the interspatial volume."

In Anthony's models for operating an economic ISR plant, he calculates 20 pore volumes (PV). Porosity, or the spaces in between the sand particles, where the water can travel (permeability), helps determine how much uranium can be recovered. "It takes about 20 PV to 30PV to recover the highest percentage," said David Miller, who was Cogema's chief ISR geologist in the United States, before becoming President of Strathmore Minerals. "But, as the price of uranium keeps going higher, it may be economic to recover a higher percentage of the orebody. Maybe 40PV to 50PV will be possible with the direction the prices are moving. Of course, your average processed grade will go down. A few years ago, you would want to shut wells off at 15 parts per million (ppm), but now you might want to run them at 10ppm. At $50/pound uranium, you may be able to run at 7 or 8ppm."

CO_2 Addition

CO_2 is added upstream of the resin, favoring the formation of uranyl dicarbonate.

With one-half the ionic charge, uranyl dicarbonate loads twice the mass of uranium as does uranyl tricarbonate.

- $[UO_2(CO_3)_2]^{-2} + 2R^+Cl^- \rightarrow R_2^{+2}[UO_2(CO_3)_2]^{-2} + 2Cl^-$ (fluid pH = 6.5 to 7.9)
- $[UO_2(CO_3)_3]^{-4} + 4R^+Cl^- \rightarrow R_4^{+4}[UO_2(CO_3)_3]^{-4} + 4Cl^-$ (fluid pH > 7.9)

Typically, an ISR operation should recover about 70 percent of the uranium in the ore, under the 20PV to 30PV scenario. However, in the case of the Czech Republic's Diamo project, once Europe's largest uranium mining operation, only 55 percent was recovered. Clearly, the more uranium recovered with the least number of pore volumes, the lower the operating costs. Trying to recover more uranium is only possible if you have the plant capacity. Because of the rising price of uranium, we would expect more companies to attempt to recover a higher percentage of uranium. Miller warns, however, "You will not make your production quota if your plant is 'sized' at a certain gallons per minutes at a certain grade to meet your annual production. If you lower the average grade and fail to increase your flow rate, your annual production will decrease."

ISR Extraction and Processing

During ISR mining, water is pumped to the surface from production wells that contain uranium in very low concentrations, on the order of parts per million concentrations. The next step in the ISR process is to extract the uranium dicarbonate. Extraction is done by chemically exchanging ions inside a processing facility. "The ion exchange process is very analogous to a home Culligan® water softener," Anthony revealed. "It removes hardness or calcium from the water by replacing it with sodium, using ion exchange resins. If you go to Lowe's or Home Depot, and buy a water softener, you basically have a home version of a uranium extraction plant." The main difference is your water softener will have a cation exchanger. "For a uranium plant to function properly, you need to use an anion exchange resin, which is specifically designed to load uranium," Anthony clarified.

And what is this magical "ion exchange resin"? The resin is comprised of little polymer beads, which are charged particles having an affinity for uranium anions. "There are literally millions of these small resin beads in a vessel, which can adsorb low concentration of uranium in solution," said Anthony. Adsorption is when some-

Millions of small polymer resin beads adsorb the uranium in solution.

thing is attracted to something else or clings to it, like static electricity.

Why do you have to process uranium like this? “In essence, the ion exchange process is a beneficiation (reduction) process that concentrates large volumes of low concentrate uranium solution into a much smaller volume containing a much higher concentration of uranium,” said Anthony. In other words, the beneficiation is just concentrating the uranium from the large volume of water in which it is mined into a more compact form. The preferred means is through an ion exchange.

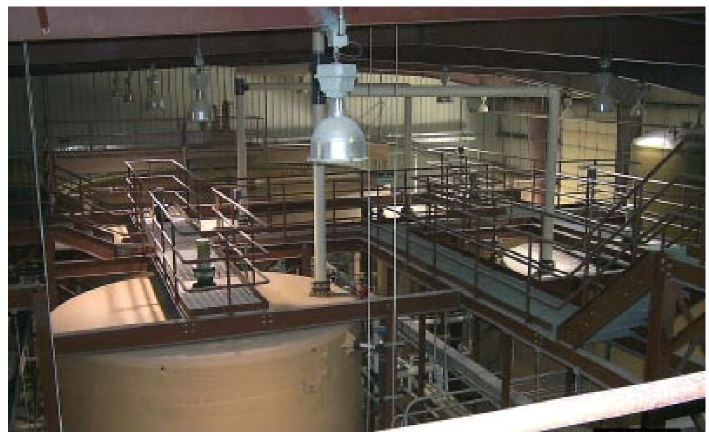
Anthony gave a real-life example of the beneficiation process, “Three million gallons of wellfield solution containing dilute concentrations of uranium, of 100 parts per million minus 0.10 grams/

Each 11.5 ft. ID ion exchange vessel contains 500 Ft3 resin. Three trains of vessels are installed. Each train consists of two vessels that are operated in series. Upon exiting the 2nd ion exchange vessel, the lixiviate is pressurized by the 2nd booster pump station, refortified with oxygen and injected into the Well Fields.

liter, is passed through a bed of ion exchange resin. This might take 24 hours to achieve if the solution is flowing at 2,500 gallons per minute. After this length of time, the resin becomes loaded with approximately 2,500 pounds of uranium.”

Stripping the Uranium

Stripping the uranium is called the elution process. This is done through a chemical exchange of positively and negatively charged ions. Resins are classified by the charge on the active sites. “The active sites on the resin are positively charged for anion resins and negatively charged for cation resins,” Norris enlightened us. “The resin’s ability to extract chemical ions from a solution is derived from what’s called an active site,” he continued. “In our case, chloride ions obtained from ordinary table salt are used to stabilize or temporarily neutralize this positively charged active site.” The negatively charged chloride ion sticks to the positively charged site, held in place by what Norris called “electrostatic forces.” When the negatively charged ions, such as uranyl dicarbonate, are placed in contact with the solution, it will kick off the chloride and replace that with the uranyl dicarbonate.

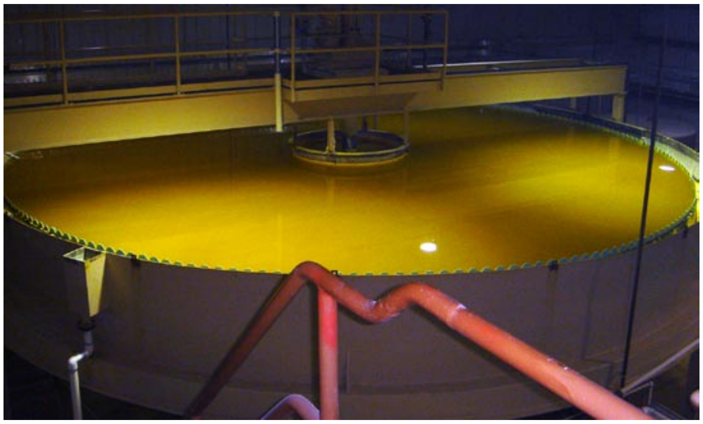


A three-staged elution circuit is used for uranium concentration that is required for precipitation of a yellowcake product. As an eluate batch advances forward and contacts a new resin bed, the uranium concentration in the batch is increased. Over 90% removal efficiency is achieved in the first elution step.

That was the chemistry lesson. Anthony summed it up in a nutshell, “They just displace it. There’s a greater affinity for the chloride ion to the resin than there is for the uranium. So, the uranium is stripped from the resin bed.” The processing facility chemically strips the loaded uranium from the resin by soaking the entire package of uranium-laden resin in a salt bath solution. “The volume of salt solution is on the order of 10,000 gallons resulting in a solution concentration of 30 grams/liter uranium,” Anthony said, describing the process of how the uranium becomes concentrated. “The stripped uranium solution concentration is magnified 300 times more than the wellfield solution,” he informed us. “The concentration level can now be economically processed for recovery: precipitation, dewatering, drying and drumming for a nuclear facility.”

Getting the Uranium into the Drum

After the uranium has been removed from the solution, it is precipitated. At this point in the processing stage, you have yellowcake slurry. Up close, it looks like a sort of yellowish and wet, runny cement mixture. The dewatering process does just that, it removes the water from the yellowcake mixture.



The suspension of uranyl peroxide crystals is pumped to a cone-bottom thickener where the solids settle and concentrate. The liquid overflows the thickener and is routed to a Reverse Osmosis (R.O.) unit

"I use a filter press, a device that is designed to separate solids from solutions," explained Anthony. Filter presses are extensively used in various types of food, chemical and drug processing across the world. "The uranium solids, now looking more like yellowcake, are retained in the filter press, where they can be washed and later air dried, before drying them to a powder with a low temperature vacuum dryer," said Anthony taking us step by step through this process.

Yellowcake slurry is pumped from the bottom of the thickener and routed to a recessed plate filter press where to solids are captured and dewatered. To meet the converter's specification, fresh water is used to flush dissolved contaminates from the filter cake. By using the filter press, the cake is flushed in plug-flow fashion. When compared to simple dilution that requires up to 110 pore volume, plug-flow washing reduces water requirements to 6 pore volumes. Once washed, typical dried yellowcake contains 200 to 300 PPM chloride, well within the converter's specification of 500 PPM.

So what is the filter press and how do you end up with the finished yellowcake when you're done? "It's a series of plates and hollow frames, or it could be a series of recessed chambers," Anthony answered. "Filter cloth is draped over the plates or chalked in the recessed chambers. The yellowcake slurry is pumped through the filter allowing the liquid phase to pass through the filter cloth, trapping the uranium oxide inside the device." Anthony likes to pack the filter press up with as much yellowcake as it can hold. "It is then washed with clean water to displace the chloride ions to a low level," Anthony explained. If you don't remove the chloride concentrations to the acceptable level required by an uranium enrichment facility, a fine is assessed against that shipment.

Washed yellowcake is pumped to one of two rotary vacuum dryers. The slurry is dried under vacuums of up to 20 in. Hg for about 17 hours. The vacuum drier prevents the formation of insoluble uranium compounds in the final yellowcake product.

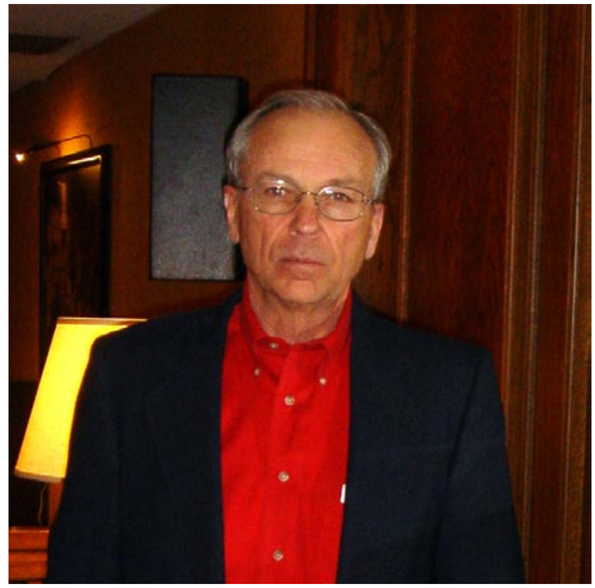
The final steps include conveying the yellowcake to the vacuum dryer. The uranium oxide's color depends on how high or low a temperature is used to dry the "yellowcake." Patrick Drummond, the Smith-Highland Ranch plant superintendent, showed us pure uranium oxide dried at high temperatures. It was nearly black. After the drying process is complete, the uranium is packaged up in DOE-approved 55 gallon drums and transported to an enrichment facility. It is then when the enriched uranium can finally be used to power a nuclear reactor and provide an inexpensive source of electricity.

Cleaning Up the Project

Not so fast. Shipping the uranium out of the ISR plant isn't the final step. The water has to be cleaned up, the property returned to its original condition. If done properly, then the footprint of the ISR uranium operation should have been nearly erased. In an earlier article, we talked to Pat Drummond at Smith Ranch about this process:

> *The company is meticulous in restoring the landscape as well. Any restoration work on the surface is called "reclamation." That can involve farming. "When we start a well field, we have to, by license, remove the topsoil and store it somewhere," Drummond explained. "When we go back to reclaim the property, we take all the pipes out, we take the houses down, and cut our*

Patrick Drummond



Uranerz Energy Glenn Catchpole is both a mining engineer and a hydrologist with experience in ISR operations

> *wells off. It's all identified. We put an ID marker on the well. In 50 years time, when Farmer Joe comes around and wonders what was there, the state can say, 'That was a uranium well.' From the time we've stopped mining, we put everything back to normal."*
>
> - From Wyoming Uranium: Now and the Future
> http://www.stockinterview.com/wyoming5.html

The one item we did not address in our previous article was cleaning up the water after the orebody has been mined out. Why is restoring the water back to background important? "In the mining process, you're basically elevating sulfate," explained Anthony. "You're also elevating calcium because you're lowering the pH a little bit, down to 6.5 to 7. Because you run it across the ion exchange circuits, you get a little leakage of chlorides into the lixiviant." Subsequently, the water will have sulfate, chloride, calcium and bicarbonate circulating within it. "When you add carbon dioxide, you're forming bicarbonate," Anthony noted. "These are the major ion groups you are elevating during the mining process." He also added that in some projects, you may get arsenic, vanadium and/or selenium. "They all go into the solution so that at the end of your mining process, these ions will be elevated above their baseline values." The water will need to undergo a purification process to return them back to a quality consistent with baseline values."

What does the ISR operator do with the water once the facility has mined out the uranium? There are three options, which we discussed with Glenn Catchpole, who has also set up previous ISR operations. In 1996, Catchpole was the General Manager and Managing Director of the Inkai uranium solution mining project in Kazakhstan. He is currently the Chief Executive of Uranerz Energy. "Here's my order of priority: If you have a receiver formation for deep disposal on your project, that's my first choice." Sometimes, a project may not have access to a deep disposal aquifer, warned Catchpole.

The water is sent down the receiver formation, down about 4000 feet. "You're usually sending this water to a formation that is very briny, a poorer quality than what you're sending down," Anthony pointed out. Another option, according to Catchpole, would be operations ponds, or evaporating ponds, where the water is evaporated. A third option is "land applied." Catchpole explained this was for land application. "You take your waste stream, you treat it to remove the certain level of impurities, according to the government requirement, and then you're allowed to disperse it on the land surface, as if you were irrigating." When applied to the land, it is soaking into the land. "It's growing grass, and it's going into the groundwater system," concluded Catchpole, "Whatever water quality standard they allow for you to put that water in the land, they want to ensure it doesn't accumulate some particular chemical over time that is going to build up and contaminate the land."

Generally, during the restoration process, the water is circulated through the barren orebody about eight times. It's another instance of pore volumes – eight more times through the sandstone formation. Anthony explained, "Normally, the first pore volume is evacuated and disposed of via a disposal well." But he warned, "This will cause an inflow of surrounding native water back into the mine zone. The resulting water is pumped to the surface and processed through a reverse osmosis unit." Anthony compared this to the desalination of seawater. "The reverse osmosis equipment acts like an 'ion filter,' allowing pure water to pass through a membrane and filtering out ions of sulfate, calcium, uranium, bicarbonate and so forth," Anthony explained.

Two streams of water are produced by the reverse osmosis unit. One stream is called "product water," and is normally consistent with drinking water quality. The smaller stream of water is called "brine." It contains, according to Anthony, "95 percent of all the dissolved ions that were in solution." He said, "The brine is disposed down a deep well into an underground formation, which is typically not suitable for any use."

Conclusion

For all the lip service and media attention paid to the environmental movement in terms of financial support, recognition and respect, it is the ISR miner who cares more about the environment, about preserving Mother Nature. Environmentalists remain ignorant of, or care not to publicize, the dangers of coal-fired electrical generation. Mining and burning coal to generate power for industry and residential electricity poses a greater threat to Mother Nature than ISR mining and nuclear power-generated electricity. No more evident a case in point is New Mexico, where the Navajo Nation "banned" uranium mining, because their president was misled by environmentalists in believing ISR uranium mining could pose a threat to groundwater. At the same time, the Navajo Nation enjoys over $100 million in coal royalties each year, as their air is polluted by carcinogens filling their air from coal mining in the San Juan Basin and coal-fired plants, which produce most of their electricity. It is time for the world's environmentalist movements to wake up and smell the air they are breathing.

Unfortunately, ISR uranium mining will not replace conventional uranium mining in many deposits across the world. According to the World Nuclear Association, ISR mining accounted for 21 percent of worldwide uranium mining in 2004. "The overriding constraint of ISR is the technology is only applicable to selected uranium deposits," Stover cautioned. "It's those deposits wherein the uranium ore resides in a permeable environment, where you can flow water through the deposit and where you can bring the dissolved oxygen and carbon dioxide into contact with the uranium." Stover explained that, during the evolution of ISR mining, a number of projects failed because the uranium was associated with organic material, was not accessible to the leaching solution, or the uranium was tied up in clays or shale-like material. "They were not able to flow fluid through it," explained Stover. "The key issue at the onset is a careful characterization of the host environment in which the uranium exists."

The key advantage to ISR is the far lower capital costs to start up a project, compared to the hundreds of millions required for a conventional mining and mill complex. For example, UR-Energy's William Boberg and Uranerz Energy's Glenn Catchpole both believe they can install an ISR operation on their Wyoming properties for as little as $10 million. Labor costs are also less. Doug Norris pointed out, "In its heyday, the Highland mine probably had 4,000 working in it." By comparison, Cameco's Smith-Highland ranch in Wyoming may soon ramp up to nearly 100 employees. "We're talking about installing a centralized water treatment plant supported by a large number of water wells, typically completed with PVC," Stover explained. "That's in contrast with conventional mining, where you have extensive earth moving, in the case of an open pit or extensive underground workings, and a more complicated, much larger processing plant."

In terms of environmental impact, ISR offers something sensible to the environmentalists. "ISR is much less intrusive, and it is short lived," Stover said, echoing the sentiments of all who have been involved in this type of uranium mining. "It's acceptance by the general public is much more favorable," he concluded.

What does the future hold for ISR uranium mining in the United States? "Up until 2004, prices were flat," Norris pointed out. "The economic picture has just now switched to where mines can start coming on again, but it does take years to properly define where the ore is. It takes a lot of geologic drilling and time to decipher it. Then there are the regulatory requirements, and that can take several years. Even if everybody reacted right now to what's out there, it would still be several years, upwards of five years, before production jumped from its existing rate to 10 to 20 million pounds at the most."

About...

Harry Anthony, M.Sc.
Chief Operating Officer and Director, Uranium Energy Corp

Mr. Anthony has been a professional engineer for 36 years, and is particularly noted as being a pioneer of the emerging extraction technology for uranium mining sector known as In-Situ-Recovery, or ISR. He has been involved with every notable ISR uranium mine in the US and abroad, at all levels of development, including feasibility, design, operations, and management. Mr. Anthony was a senior officer and director of Uranium Resources Inc, a public company, and a significant uranium producer in the US. During his 20-year tenure at URI, he was responsible for all technical aspects of mine development. He has also provided technical services and mine plans for companies such as Union Carbide, Urangesellschaft, Kennecott, Rio Algom, Heathgate Resources, and others.

Dennis E. Stover, Ph.D.
President, Energy Metals US

Dr. Dennis Stover began his career with Atlantic Richfield Company where he developed 3-D computer simulators for in-situ recovery, and managed field R&D program for ISR technology. During the 1980s, he was chief engineer for Everest Minerals Corporation, where he helped design the Highland uranium project and other projects. As director of ISR technology with Rio Algom Mining, he helped develop the Smith Ranch uranium recovery facilities. He holds a number of U.S. patents concerning solution mining and reservoir restoration.

James Douglas (Doug) Norris, BSc Chemical Engineering, PEng
Engineering Manager, Uranium Energy Corp

Mr. Norris is a professional engineer with twenty years experience designing and constructing uranium mining facilities. Having held senior engineering, as well as operational positions for uranium producers Rio Algom (now BHP Billiton) and Power Resources (now Cameco), Mr. Norris has been responsible for all phases of mine development, from the grass roots, through to operations management. He was integral to the development of well-known US uranium mines, Smith Ranch and the Highland, both ISR mines. Mr. Norris has also been ISO certified to prepare health and safety risk analyses and mitigation techniques during the plant design, construction and operational phases.

David Miller, , P. Geol.
President & COO, Strathmore Minerals Corp.

Mr. Miller, is a minerals industry expert in exploration, acquisition and operations. His primary focus has been on uranium, coal bed methane and gold. David worked with Cogema, the second largest producer of uranium in the world, the last 4 years with them as their chief geologist for in-situ operations in the US. Mr. Miller has over 25 years of experience in exploration and acquisition of uranium properties. Mr. Miller has consulted in uranium exploration, deposits, mining, and "in-situ" recovery for the IAEA. Mr.

Miller is also an elected member of the Wyoming Legislature, committee assignments include Minerals and the Energy Council.

Glenn Catchpole, M.S., P.Eng.
President and Chief Executive Officer, Uranerz Energy Corp.

In 1988 Mr. Catchpole joined Uranerz U.S.A., Inc. and became Director of Regulatory Affairs, Environmental Engineering and Solution Mining. In 1996 Mr. Catchpole was appointed General Manager and Managing Director of the Inkai uranium solution mining project located in the Republic of Kazakhstan (Central Asia). In 1998 Cameco Corporation acquired Uranerz U.S.A. Inc., and Mr. Catchpole continued his post with the Inkai project. Mr. Catchpole spent six years taking the Inkai project from acquisition through feasibility study, joint venture formulation, government licensing, environmental permitting, design, construction and the first phase start-up.

Websites and Trading Symbols of companies mentioned in this report:		
Strathmore Minerals Corp	www.strathmoreminerals.com	TSX:STM
Uranerz Energy Corporation	www.uranerz.com	OTC BB: URNZ
UR-Energy Inc.	www.ur-energy.com	TSX:URE
Energy Metals Corporation	www.energymetalscorp.com	TSX: EMC
Uranium Energy Corporation	www.uraniumenergy.com	OTC BB: URME