



New Mexico Tech

801 Leroy Place  
Socorro, NM 87801

Phone: 575 8355059 Fax:

E-Mail: [iwalder@ees.nmt.edu](mailto:iwalder@ees.nmt.edu) Web: [www.ees.nmt.edu](http://www.ees.nmt.edu)

I-IWG  
WORKSHOP ON  
URANIUM *IN-SITU* LEACHING  
Sevilleta National Refuge

January 11-13, 2016

Dr. Ingar F. Walder PI, New Mexico Tech, [IWALDER@EES.NMT.EDU](mailto:IWALDER@EES.NMT.EDU)

Draft of this report was written by Bonny Fry reviewed by several of the participants of the workshop.

## **OBJECTIVES OF THE WORKSHOP**

New Mexico was once very important uranium producer and there are still large resources left in the Grants mining district. In-situ leaching is very important source of uranium. The host rock for the New Mexico deposits are in several locations favorable for in-situ leaching, however there is no current in-situ leaching operations in New Mexico. The focus of this workshop is on the methodology and environmental aspects of in-situ leaching to potentially develop research proposal to enhance methods used for in-situ leaching and at the same time reduce environmental impact of such mining.

Approximately 45% of the uranium extracted in 2013 was by in-situ leaching (Nuclear Energy Association) and this is steadily increasing. The method is based on injecting a leaching agent (sulfuric acid with ferric iron) into the ore. The uranium minerals will oxidize and uranium is solubilized as a U(VI) (uranyl depending on the solution chemistry). The uranium-enriched solution can then be extracted through pumping wells. The hydrogeology is an important part of *in-situ*: getting the leaching solution to the uranium enriched layers; and capturing the uranium enriched pregnant leach solution. These are issues that need to be well understood. We will be discussed these and other issues in detail during the workshop, and hopefully come with suggested areas of research that we can collaborate on.

## **SUMMARY OF KEY IDEAS DISCUSSED**

On Jan. 11-13, 2016, a team of experts in the uranium industry and researchers from two New Mexico universities assembled at the Sevilleta National Wildlife Refuge to discuss topics associated with in-situ recovery mining of uranium. It is very likely that uranium mining will resume in New Mexico in the near future. Part of the motivation for this workshop was the recognition that there has been little new research done in the uranium industry, and much current uranium work is based on research, mapping and technology from the 1970s and 1980s. Researchers and industry workers today have new technology available to help reevaluate exploration, mining, processing, reclamation and restoration. Furthermore, today's industry has become much more open to sharing data, in part because today's strenuous permitting process has turned previously proprietary information into public record. We hope that today's mining environment can encourage collaboration among researchers, industry, government agencies and community representatives.

The team was tasked with generating several deliverables: 1) produce a set of papers on several topics regarding uranium in-situ leaching; 2) determine a venue for future conference presentations; and 3) identify future research opportunities. Discussion was facilitated with presentations by several attendees:

- U and co-occurring elements in abandoned mine wastes – Cerrato
- In-Situ Recovery of Sandstone Uranium Deposits in New Mexico: Past, Present, and Future Concerns and Potential – McLemore
- Introduction to Uranium In-Situ Recovery Technology – Pelizza
- Uranium Mining & Milling: Solubility, Leaching & Recovery – Thomson
- The Grants Mineral Belt and ISR – Do They Make Sense Together? – Wilton
- Roca Honda Mine – Kapostasy

- Modeling In-Situ Uranium Mining – Lichtner
- Leaching of Uranium Ores – Ruiz

## **DISTRIBUTION OF INFORMATION**

In discussing possible publication targets, industry and academic attendees alike agreed that the most impact on industry and the public could be achieved by publishing in a New Mexico journal rather than seeking publication in national journals. The group agreed to produce a special edition of New Mexico Geology, which is a peer-reviewed, regional journal published by the New Mexico Bureau of Geology and Mineral Resources. Likely papers will be produced by Ted Wilton, Ginger McLemore and Mark Pelizza. Cynthia Ardito volunteered to be a reviewer. It was recommended that someone from a regulating agency be encouraged to contribute a paper on the permitting processes. The editor of New Mexico Geology has agreed in principle to such a volume and these two papers will be published in the October issue.

The group also determined that a conference held within New Mexico would be the best venue for showcasing the current research and collected knowledge associated with today's uranium industry, rather than a conference held elsewhere. Ginger McLemore and Bonnie Frey volunteered to co-chair a key-note session on in-situ uranium issues for the 2017 spring meeting of the New Mexico Geological Society. A proposal will be presented to the NMGS executive committee on Jan. 15, 2016.

## **OUTCOME**

In addition to the outcome discussed above regarding the distribution of information, there were more in depth discussion about were the field of uranium exploitation from exploration to closure has a need for increasing the knowledge.

In depth discussion during the three-day workshop resulted in a list of future research opportunities that fell into six categories. Below is a list of these categories along with several subcategories for each. Although the scope of the list is well beyond the combined efforts of the workshop attendees, we hope this list can help focus future research and funding efforts to aid in determining the feasibility of uranium mining in New Mexico and elsewhere.

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1) Workforce training             <ol style="list-style-type: none"> <li>a. Next generation of geologists and engineers</li> <li>b. Workshops / Education</li> <li>c. STEM involvement</li> <li>d. Writing</li> <li>e. Geophysical logging training</li> <li>f. Field logging</li> <li>g. Data interpretation (logs, etc.</li> </ol> </li> <li>2) Resource characterization             <ol style="list-style-type: none"> <li>a. Tracers</li> <li>b. Logging tools</li> <li>c. Mineralogy</li> <li>d. Geohydrology</li> </ol> </li> </ol> | <ol style="list-style-type: none"> <li>e. Ore delineation mapping</li> <li>f. Core samples</li> <li>g. Ore models</li> <li>h. Data management</li> </ol> <ol style="list-style-type: none"> <li>3) Modeling / information processing             <ol style="list-style-type: none"> <li>a. Conceptual model</li> <li>b. Calibration</li> <li>c. Processing</li> <li>d. Tracers</li> <li>e. Ore Models</li> <li>f. Reactive Transport</li> <li>g. Productivity modeling                 <ol style="list-style-type: none"> <li>i. Mineralogical modeling</li> <li>ii. Aquifer characterization</li> </ol> </li> </ol> </li> </ol> |
|---|--|

- iii. Production calibration
- 4) Environmental / Regulatory
  - a. Water Quality
  - b. Resources (archaeological, cultural, environmental)
  - c. Sustainability / life cycle assessment (LCA)
  - d. SJBRRUS
  - e. Outreach to regulatory community
- 5) Basic Science
  - a. Mineralogy
  - b. Pyrite and U phases (brannerite)
  - c. Microbiology
  - d. Geochemistry
- e. Organics – humates vs. organic plant trash
- f. Reactions and rates
- g. U source
- h. Formation changes with ISR
- i. Isotopic Studies
- 6) Recovery / Restoration
  - a. Drilling
  - b. Leaching
  - c. Restoration
  - d. Engineering issues
  - e. Waste management
  - f. Mining Processes

As an outcome from the workshop, several of these topics are on our plans for joint UNM-NMT proposals as part of the EPSCoR with cofounding from the industry. This proposal will be submitted within the next few months for startup research in the fall of 2016. The group is also discussing several other avenues for funding, but no concrete plans were formulated. Dr. Walder will however, work on setting up follows up meeting with the group.

In conclusion, we hope our efforts can help New Mexicans effectively address issues that will provide a sound scientific basis for evaluating the health and economic challenges posed by renewed mining of uranium in New Mexico, especially with new concerns of protecting water supplies. A fundamental question to be addressed in future work is whether with the knowledge that has accumulated during mining in the state from 1950 into the 1980s combined with renewed research efforts, is it possible to avoid the legacy issues from the past.

While receiving workshop attendees, Dr. Ingar Walder became very ill and was taken to Socorro General Hospital where he was kept overnight for tests. Although he has since regained his health, Dr. Walder was unable to attend the workshop described in this report. The rest of the team continued with the workshop and produced a rough draft of this document to present to Dr. Walder for his final report. The general consensus among the workshop attendees was that, despite Dr. Walder's absence, the workshop was nevertheless a highly productive experience facilitated by Dr. Walder's careful selection of participants and assignment of presentations.

## **PARTICIPANTS**

The following individuals attended the workshop:

- José M. Cerrato, assistant professor of Civil Engineering, University of New Mexico
- Ted Wilton, chief geologist, Uranium Resources, Inc., Utah
- Dan Kapostasy, senior development geologist, Energy Fuels Resources, Wyoming
- Cynthia Ardito, senior vice president and principal hydrogeologist, Intera Geoscience & Engineering Solutions, New Mexico
- Peter C. Lichtner, director, OFM Research – Southwest, New Mexico
- Virginia T. McLemore, senior economic geologist, New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech
- Mark S. Pelizza, Principal, M.S. Pelizza & Associates, Texas
- Matthew Rhoades, director and New Mexico state geologist, New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech
- Omar Ruiz, graduate student in Civil Engineering, University of New Mexico
- Ytian Li, graduate student in Earth & Environmental Sciences, New Mexico Tech
- Bruce Thomson, regents professor of Civil Engineering, University of New Mexico
- A. Winton, graduate student in Earth & Environmental Sciences, New Mexico Tech
- Bonnie Frey, geochemist and laboratory manager, New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech
- Ingar Walder, workshop organizer and visiting professor in Earth & Environmental Sciences, New Mexico Tech (became ill at the beginning of the workshop and could not return)



**ENERGIZE NEW MEXICO**

**URANIUM IN-SITU LEACHING WORKSHOP**  
January 11 – January 13, 2016  
at Sevilleta National Wildlife refuge

Organized by Reactive Transport Research group at New Mexico Tech in cooperation with EPSCoR New Mexico.

**Program**

<b>12.00-12.30</b>	<b>REGISTRATION</b>		
<b>12.30-1.30PM</b>	<b>LUNCH</b>		
	Ingar Walder	Introduction	
	Matt Rhoades	New Mexico Bureau of Mines and Mineral resources	
	✓ Mark S. Pelizza	Overview insitu leaching technology	
	Tom Keith	Microbial activity in uranium mine waste	<b>Canceled</b>
	Virginia MacLmore	Grants area uranium deposits	
<b>7PM</b>	<b>DINNER</b>		
<b>TUESDAY 12TH</b>			
<b>8-9AM</b>	<b>BREAKFAST</b>		
	Jose Manuel Cerrato	Waste rock from uranium mining	
	Cindy Ardito	Hydrogeology of In-situ leaching, remediation, etc.	
	✓ Daniel Kapostasy	The Roca Honda project	
<b>12-1PM</b>	<b>LUNCH</b>		
	Bruce Thomson	Leaching of Uranium ores	
	✓ Peter Lichtner	Reactive Transport Modeling of in-situ leaching	
	✓ Paul W. Reimus	Restoration issues related to the Smith Ranch ISR site in Wyoming	
	Ted Wilton	?	
<b>7PM</b>	<b>DINNER</b>		
<b>WEDNESDAY 13TH</b>			
<b>8-9AM</b>	<b>BREAKFAST</b>		
	Bruce Thomson	Political-public awareness issues related to in-situ leaching of uranium	
	✓ Cindy Ardito	New Abatement Standards for St. Anthony Mine, New Mexico	
	Ingar Walder	Where do we go from here	
<b>12-1PM</b>	<b>LUNCH</b>		
<b>THE END</b>			
	<b>Coffee breaks when needed and/or wanted</b>		

