An Environmental Critique of In Situ Leach Mining :

The Case Against

Uranium Solution Mining

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A Research Report for
Friends of the Earth (Fitzroy) with
The Australian Conservation Foundation

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Preface

The mining and export of Australian uranium has been a controversial issue for many years, and will continue to remain an intense political issue for many more years to come. With a depressed world uranium market, the mining industry has been seeking to cut costs in order to make projects more economically viable. One such method of achieving this is a mining process known as In Situ Leaching (ISL) or Solution Mining. It involves pumping chemicals into the ground to dissolve the uranium mineral *"in situ"* and then pumping these uranium-laden solutions back to the surface for extraction and processing of the uranium into yellowcake for export.

It is claimed by the industry to be "a controllable, safe, and environmentally benign method of mining which can operate under strict environmental controls and which often has cost advantages"[1] . This ignores the reality of many former ISL trials and mine sites across Europe and North America, and the history of ISL trial mines in Australia.

The technique of In Situ Leaching is ***not*** always controllable, safe, nor environmentally benign, and the hidden costs are usually borne by the underground environment. The process of ISL can lead to permanent contamination of groundwater, which is often used by local people and industries for drinking water supplies, and can also contaminate land which was otherwise good agriculturally productive land.

Australia is currently assessing two proposed uranium ISL mines in north-eastern South Australia, within the Lake Frome Basin. There are more deposits across Australia that would only be economic by using the ISL technique and are waiting further exploration or commercial commitment. In an attempt to document the truth of this technology and thereby influence the debate on ISL, Friends of the Earth (Fitzroy) (FoE) and the Australian Conservation Foundation (ACF) commissioned this report.

It covers the environmental importance of groundwater in the wider hydrologic cycle and the Australian environment, how the process of In Situ Leach mining works, potential technical, radiological and environmental problems that can arise, an extensive review of sites where ISL has been employed internationally, especially in the United States and Eastern Europe, and the trial experience with ISL in Australia.

The claims of the industry are then disputed and shown to be questionable.

We hope this is a valuable contribution to the "debate".

[1] *In Situ Leach Mining of Uranium*, Nuclear Issues Briefing Paper 40 - June 1997, Uranium Information Centre, Melbourne.

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Summary - ISL Mines the World Over

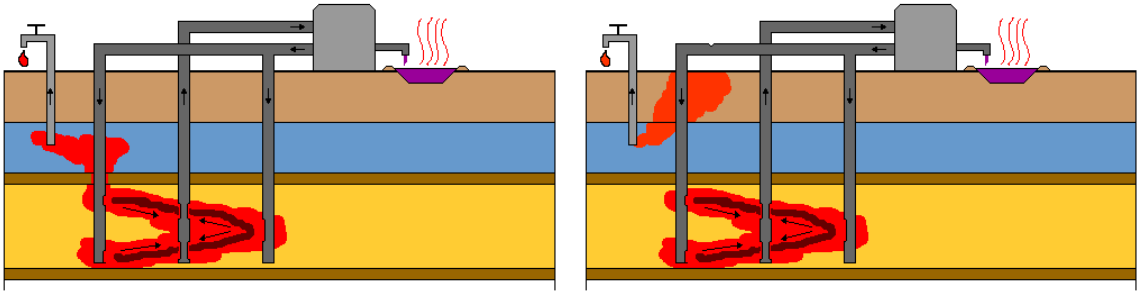
In Situ Leach (ISL) or Solution Mining is a third alternative mining technique, quite different to conventional open cut or underground mining and milling operations. The ISL process can be applied to the extraction of uranium, copper, silver, gold, nickel and many other metals. For an ore deposit to be amenable to ISL it must occur within permeable materials, such as sands or sandstones, be saturated (ie - within an "aquifer" or groundwater system), and be confined above and below by low permeability materials (such as clays or shales). Given these general criteria, chemical leaching solutions are pumped into the ore deposit "In Situ" and dissolves the metal of interest. These metal-laden solutions are then pumped back to the surface and extracted in a processing plant. In this way, instead of the ore being excavated, crushed and chemically treated in a large surface processing plant, the process chemicals are injected underground into the ore directly. As such, the ISL technique generally has lower production costs than conventional mines. The ISL mining method has many advantages as well as inherent problems, and the success of this technique applied to the extraction of uranium is contained within this report and briefly summarised here.

The ISL Technique

The ISL technique, as described above, involves the drilling and operation of an extensive series of groundwater bores, injecting and extracting the chemical solutions continuously. There are two main options for the leaching chemistry - acid or alkaline solutions. In general, acid solutions (such as sulphuric acid) will extract a higher proportion of uranium and at faster rates than alkaline solutions (such as sodium or ammonia bicarbonate). However, acidic solutions will also mobilise high levels of environmentally sensitive and toxic heavy metals (such as cadmium, selenium, vanadium, lead, and others). The level of radionuclides, such as radium, mobilised from the ore into processing solutions tends to be higher in alkaline solutions.

The most critical part of the ISL process is to control the movement of the chemical solutions within the aquifer. Any escape of these solutions outside the ore zone is considered an excursion, and can lead to contamination of surrounding groundwater systems. Some of the most common causes of excursions, identified by international operations in the United States and across Europe, can be through old exploration holes that were not plugged adequately, plugging or blocking of the aquifer causing excess water pressure buildup and breaks in bores, and failures of injection/extraction pumps.

Examples of Failure and Contamination of Groundwater from ISL



After the ore has been depleted and the maximum degree of uranium extraction achieved, it is good policy and (generally) a legal requirement to restore the water quality of the groundwater system that was mined to it's pre-mining level. That is, remove all of the remaining chemicals from the aquifer and return the uranium and heavy metals to their original concentrations. In practice, this is extremely hard to achieve, especially with acidic solutions. Despite nearly 25 years of commercial ISL uranium mines in the United States (all using alkaline leaching solutions), regulators are yet to review or approve a report on the full scale restoration of groundwater at these sites, although they describe the restoration at earlier pilot sites as "satisfactory".

With the current proposals at Beverley and Honeymoon in South Australia, and presumably for the new proposal at Manyingee in Western Australia, the restoration of groundwater is not planned nor is it being required by the regulators.

United States Experience

Texas has been the most prolific state for development of ISL uranium mines, with Wyoming also being popular for ISL sites. The first trial of ISL uranium mining was conducted at the Shirley Basin deposit by then Utah Construction & Mining Company[2] in the early 1960's with operation of an experimental full scale mine in the late 1960's. It was shut down and converted to a traditional open cut mine. The uranium industry, keen to cut costs to compete with developing overseas uranium mines, nevertheless enthusiastically developed new ISL trials and by 1975, the first large scale commercial ISL uranium mine opened in Texas at Clay West. By 1992, there had a total of 62 sites where ISL had been applied, only 24 of which reached commercial production of uranium. Currently, due to the depressed nature of the world uranium market and higher costs at conventional mines, only 5 ISL uranium mines are operating in the USA, despite 12 being licensed.

The early ISL mines, such as Irigary Wyoming and Clay West/Burns in Texas, had many technical problems which led to poor operational and environmental performance. These included mineral precipitation of gypsum ($CaSO_4$) and calcite ($CaCO_3$) plugging the aquifer, restricting groundwater flow and exacerbating excursions; complex reactions of chemicals with clays in the aquifer soils leading to permeability loss; excursions through old exploration boreholes; and excursions outside the mining zone. Problems were also noted with radiation levels, especially at some Texan ISL mines. The restoration of groundwater at many sites was not successful, and companies lobbied regulators to relax cleanup standards, and some sites still had significant problems even meeting these standards. The design of processing plants and infrastructure was also inadequate at some sites.

[2] - Changed to Utah International, now Pathfinder Mines Corp., owned by Cogema of France.

International Experience

The ISL mining technique has been enthusiastically employed at many uranium deposits across Eastern Europe and the Commonwealth of Independent States (CIS). However, the regulators and environmental policies of many of these countries was not, arguably, of a similar status as their United States counterparts. There is now a legacy of many contaminated sites and polluted groundwater across Bulgaria, the Czech Republic, the CIS and Germany, with some sites considered severe.

The majority of the ISL projects used sulphuric acid and the residual leaching solutions from ISL mines have migrated away from the mining zones. At some sites, notably in Bulgaria and the Czech Republic, these solutions have led to contamination of good quality groundwater systems that are used by nearby towns for their water supply or by local residents as their primary drinking water source. In some cases, the contaminated solutions have been demonstrated to reach these wells and valleys.

The chemical toxicity of these solutions, as well as their radiotoxicity, are a grave concern for modern regulators faced with the intractable cleanup problems now faced by the governments of the countries involved. At the Stráz site in the Czech Republic, the mined aquifer will never be able to be restored to it's pre-mining water quality, and all restoration efforts are merely aimed at minimising contamination of surrounding groundwater. The cleanup of many sites is expected to take some decades, or even centuries.

Australia's Trial of ISL

There has been two previous trials of ISL uranium extraction in Australia at Honeymoon, SA, in 1982 and at Manyingee, WA, in 1985. There are currently two trials operating, prior to Environmental Impact Statements being released or approved for Beverley, SA, and again at Honeymoon, SA, both starting in early 1998. The early trials, however, encountered significant operational and environmental problems which, combined with effective campaigning from the anti-nuclear movement across Australia, led to their refusal for further development.

The Honeymoon ISL trial in 1982 used sulphuric acid and iron sulphate leaching chemistry, and had problems with jarosite[3] precipitating and plugging the flow of leaching solutions through the aquifer. The problems were completely unexpected and led to difficulties with performance of the trial. To date there has been no disclosure of the results and environmental problems of that trial by the companies involved or the SA government.

The ISL trial during 1985 at Manyingee, north-western WA, trialled sodium bicarbonate and hydrogen peroxide leaching solutions. It lasted for a total of 6 months and injected a total of 40.5 million litres into the ore zone aquifer. There was confusion about the trial project, especially with regards to the quantity of uranium produced, where it was stored, and operational and environmental performance of the trial.

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[3] - jarosite is a potassium-iron-sulphate mineral, $KFe_3(SO_4)_3.9H_2O$.

Both the Honeymoon and Manyingee trials were not required to restore groundwater following their respective ISL trials.

With the election of the Howard Coalition government to federal government in March 1996, the old projects of Beverley and Honeymoon were quick to re-apply for development. By late 1997 they had prepared and submitted plans for ISL trial mines, and these were approved by the SA government without hesitation or public scrutiny. These trials began operation in early 1998. Heathgate Resources, subsidiary of US giant nuclear multinational General Atomics and the company behind the current proposal for Beverley, released it's EIS for an ISL mine on June 29. The new EIS for Honeymoon and extension deposits is expected towards the end of 1998.

Both of the current ISL trials at Beverley and Honeymoon have ignored the numerous potential problems found at ISL mines overseas, and especially at Honeymoon the problems of jarosite precipitation are not given any technical attention as to their cause or control. There can be significant problems expected during the operation of these trials.

The Manyingee deposit was bought by Paladin Resources in June 1998 and they immediately announced plans for an ISL mine within the next two to three years.

The Future of ISL ?

The technique of In Situ Leach uranium mining clearly entails many significant operational and environmental problems. However, as the nature of ISL mining is underground, and essentially *"Out-of-sight and Out-of-mind"*, these problems are ignored by the most toxic industry known to humanity. Successive state and federal Liberal governments appear to be blandly accepting company arguments over jobs at the expense of precious environmental assets and groundwater resources on the driest continent on the planet.

It is recommended that all current plans and operations be closed down until a full public assessment has been conducted and the restoration of groundwater proven to be successful.

The technique of In Situ Leaching is :

- **not controllable,**
- **inherently unsafe,**
- **unlikely to be able to meet "strict environmental controls",**
- **not an environmentally benign method of mining.**