Building a Uranium Heap Leach Project

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The Plan

1. The Project
2. The Geologist
3. Heap Leach Overview
4. Process Comparison
5. Project Implementation
   - Test Work
6. Operations
7. Example Projects

QUESTIONS?
The Project

Mine Development Cycle

Prospecting/Exploration  Feasibility and Financing  Engineering  Construction  Commissioning  Operations  Decommissioning  Long-Term Stewardship

Phase

Exploration  Conceptual  Pre-feasibility  Feasibility  Engineering

Remember each stage requires Financing
The geologist is an optimist
And every resource is exploitable!
Every project needs a “Champion”
Heap Leach is Simple!
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- **Heap Leach is considered simple because………**
  - Simple concept – stack, irrigate, reap the riches!
  - Simple Equipment – crush, convey, pump solutions
  - No Grinding
  - No Leach plant
  - **No liquid-solid separation**
  - No Tailings……………(well maybe a pile left behind)

- **What about**
  - Operating Costs? – generally lower
  - Capital Costs? – generally lower
  - Environmental – generally easier
  - **Metal Recovery? – lower**

  - **Risks?**

It all sounds TOO easy!
Why choose Heap Leach?
- Small deposit
- Low grade
- Limited water supply
- Country risk
- Poor conventional recovery
- Tailings
- Supplemental production
- Costs
- ...

Why Not?
- Poor recovery
- Environmental concerns
- Other process options
- Clayey ore
- Will not agglomerate!
- Topography
- Climate
- Large Area
- ...

Conceptual/Pre-feasibility
Process Choice
Gold Heap Leach

- Applicable mainly to low grade, finely disseminated ores.
- Eliminates grinding, tank leaching and solid/liquid separation.
- Recovery only slightly reduced.
- Not applicable to sulphide ores, or those with coarse gold.
- Some work (Newmont) on bacterial oxidation of sulphide refractory ores.
- Typical leach times of 30 to 60 days.
Copper Heap Leach

- Limited application to oxide ores or secondary sulphide ores using bacterial leach.
- About 20% of world copper production.
- For oxide ores, recovery only slightly reduced - with 2 to 4 month leach times.
- Produces high purity 99.999% Cu.
- Cost effective for copper production in range of US$0.35 to 0.50 per lb Cu.
- Advantage of eliminating smelter operation.
- Bacterial leach only applied to a handful of operations with leach times in range of 1 year.
Uranium Heap Leach

- Some work in 1970’s/1980’s
- Some investigations for bacterial leach.
- Generally problem with oxidation of U+4 species, recoveries in 70% range.
- Eliminates grinding, tank leach and solid/liquid separation.
- Should be applicable to lower grade uranium ores of many types.
- Leach times expected in 1 to 6 month range.
Who is in charge?

Where is our “champion”?
The decision is made for heap leach and now how about:

- Production rate?
- pad size?
- permanent versus on-off pads?
- Schedule?
What a GOOD Heap Can Deliver

- Recoverable metal to solution of 80%+
- Leach times of <300 days
- Results that are consistent & independent of location within the heap
- Virtually no solids in the PLS (no requirement for S/L separation step)
- Little sensitivity to head grade
- Heap stability
Elements of a GOOD Heap

- A sound base
- Suitably impermeable liner
- Good solution drainage base
- Robust solution collection system
- Irrigation system
- Heap surface covers to limit heat and evaporation losses
- Diversion berms
  - To keep out rain water
  - To keep in heap failures
What about Test Work?
Bottle Roll Testing
Agglomeration
Pilot Plant
Demonstration Heap

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The time to put test work into design:
  • we never have enough information
  • make use of experience of others
  • be aware of need versus wants
  • ..............
  • Final costs estimate – always too high!
Beware!

Cost Reduction – Value Engineering
Construction

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The time to discover!

- the ore is different
- permeability and heap failures
- leach time and pad size
- about those 1 in 100 years storms?
- liner failures and all those other horror stories
Start-up is over eventually - now we settle down to?
Operations – reduce costs!
Operations – heap permeability
Operations – heap failure
Operations – ditch failure
Despite all these we have seen many HL successes and many interesting projects coming down the pipe.

- Previous experience in Uranium with previous ROM projects in France (Bessines, Langone), Niger (Somair), Canada (Agnew Lake) and other locations had provided some basic background.
- Heap leach based on copper experience with crushed ore has operated for many years in Brazil (Caetite)
- Many gold operations for many decades in all climates and continents
- Copper at +20% of production, many in Chile, but also now in many other countries.
- Uranium with agglomerated crushed ores is now becoming more prominent – Somair, Imouraren, Trekkopje
- Work also ongoing for Ranger, Rossing, and in consideration for other projects.
- Other notable work in Nickel, and multi-metal such as Talvivaara
Trekkopje
Talvivaara
Heap leach is an important metallurgical process, that has shown huge potential for reducing costs or liberating metals for challenging deposits.

However in the rush to reduce costs we have seen many failures.

Okay to apply low cost option, but do NOT reduce to point of failure.
Questions?