IAEA
International Atomic Energy Agency

Building a Uranium Heap Leach Project

Henry SCHNELL

URAM 2014 Conference - Vienna, June 2014

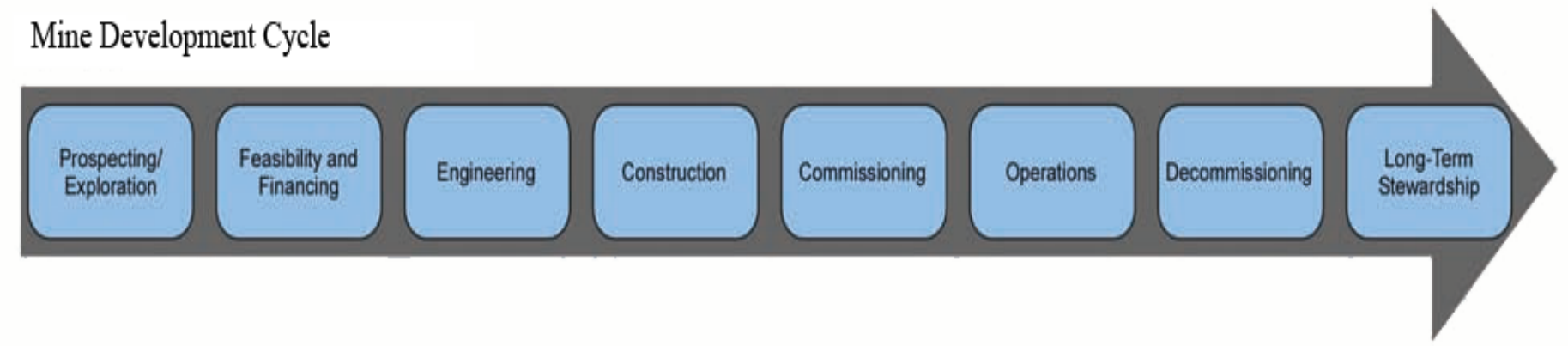
HA SCHNELL Consulting Inc. **hatschnell@xplornet.com**

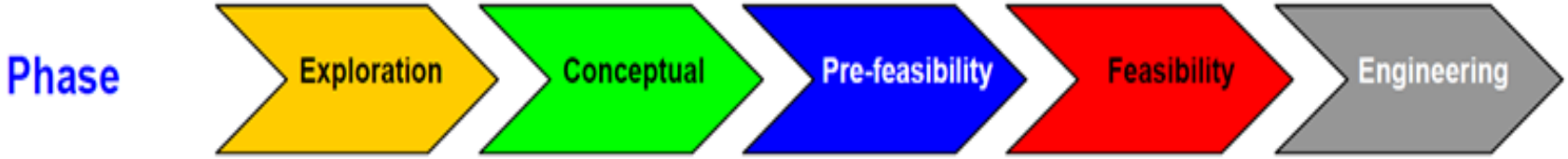
The Plan

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



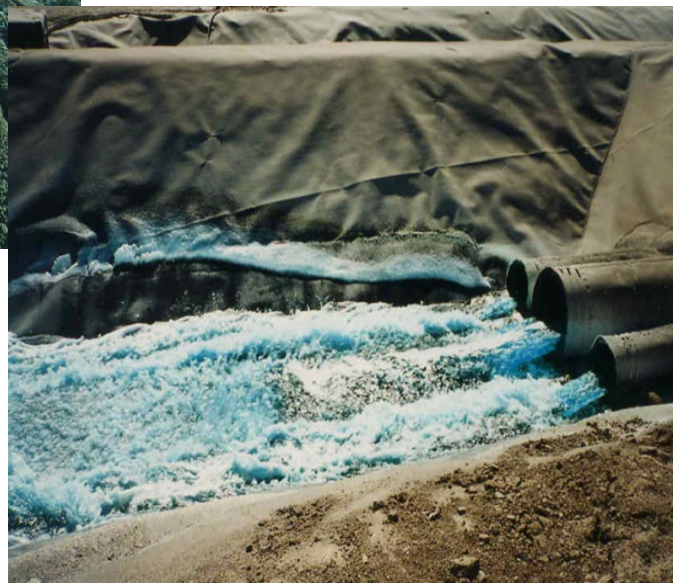


Remember each stage requires Financing

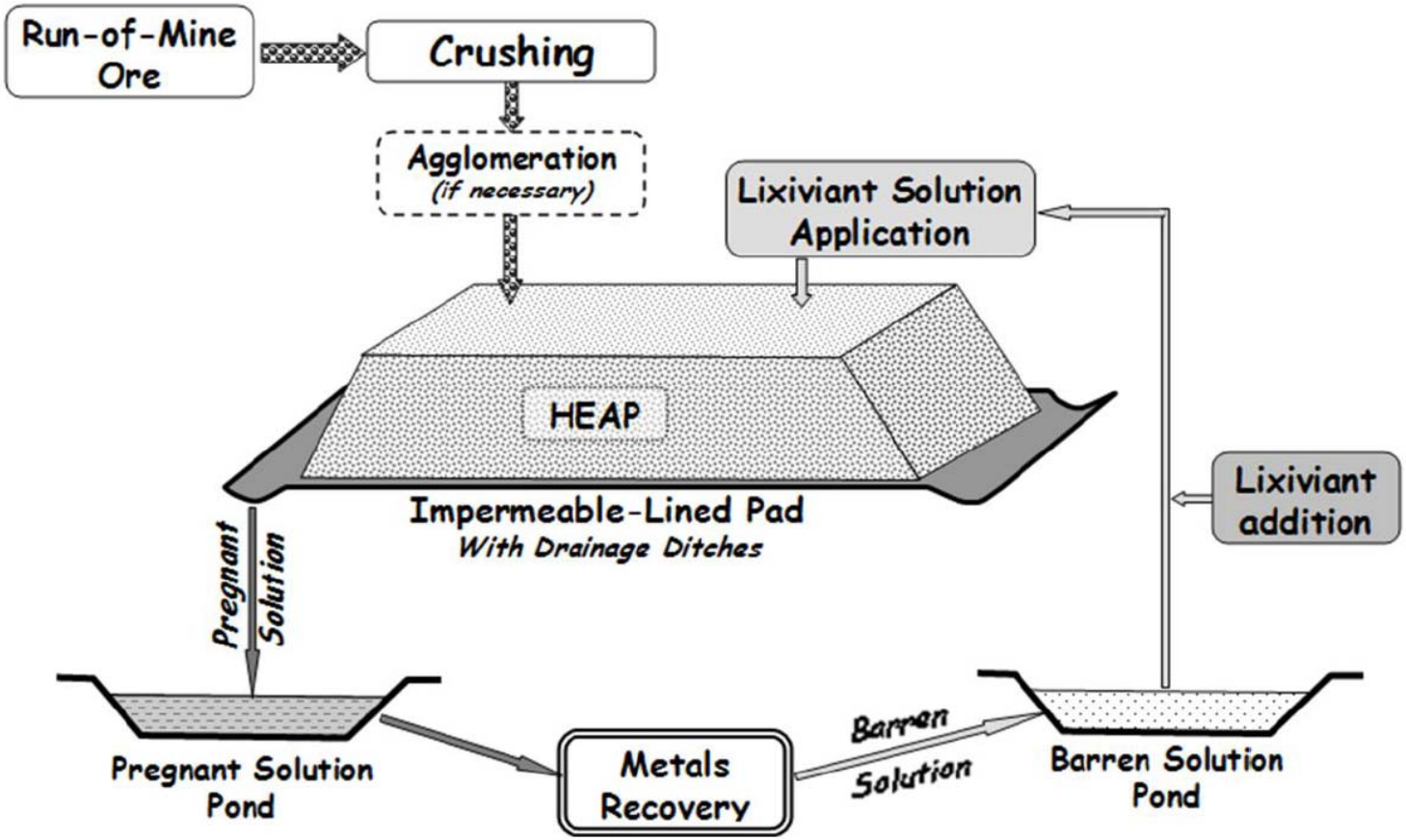
The Geologist

- The geologist is an optimist
- And every resource is exploitable!
- Every project needs a “Champion”

Heap Leach is Simple!



Heap Leach is Simple!



Heap Leach is Simple!

- **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**

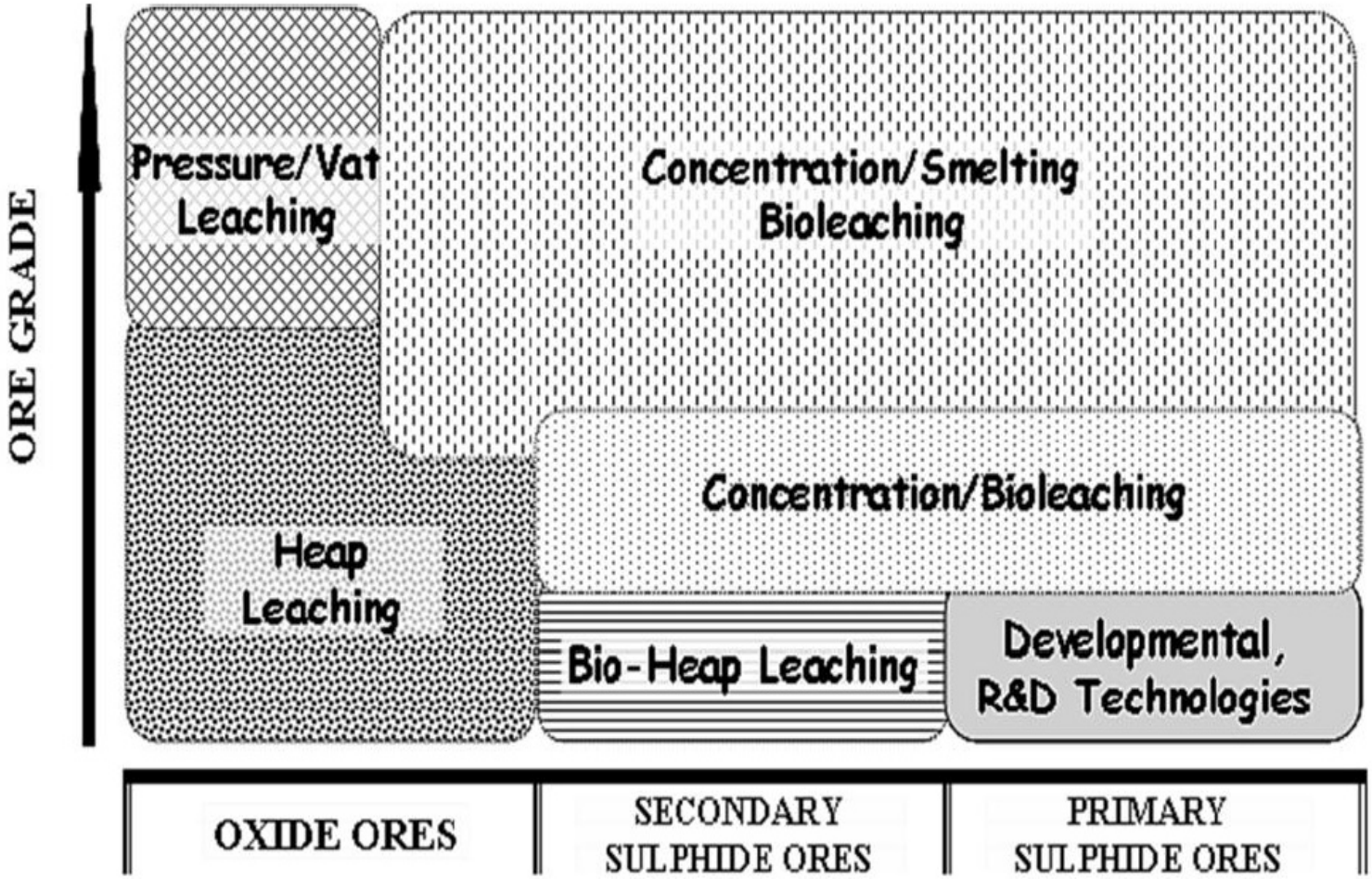
  - **Risks?**

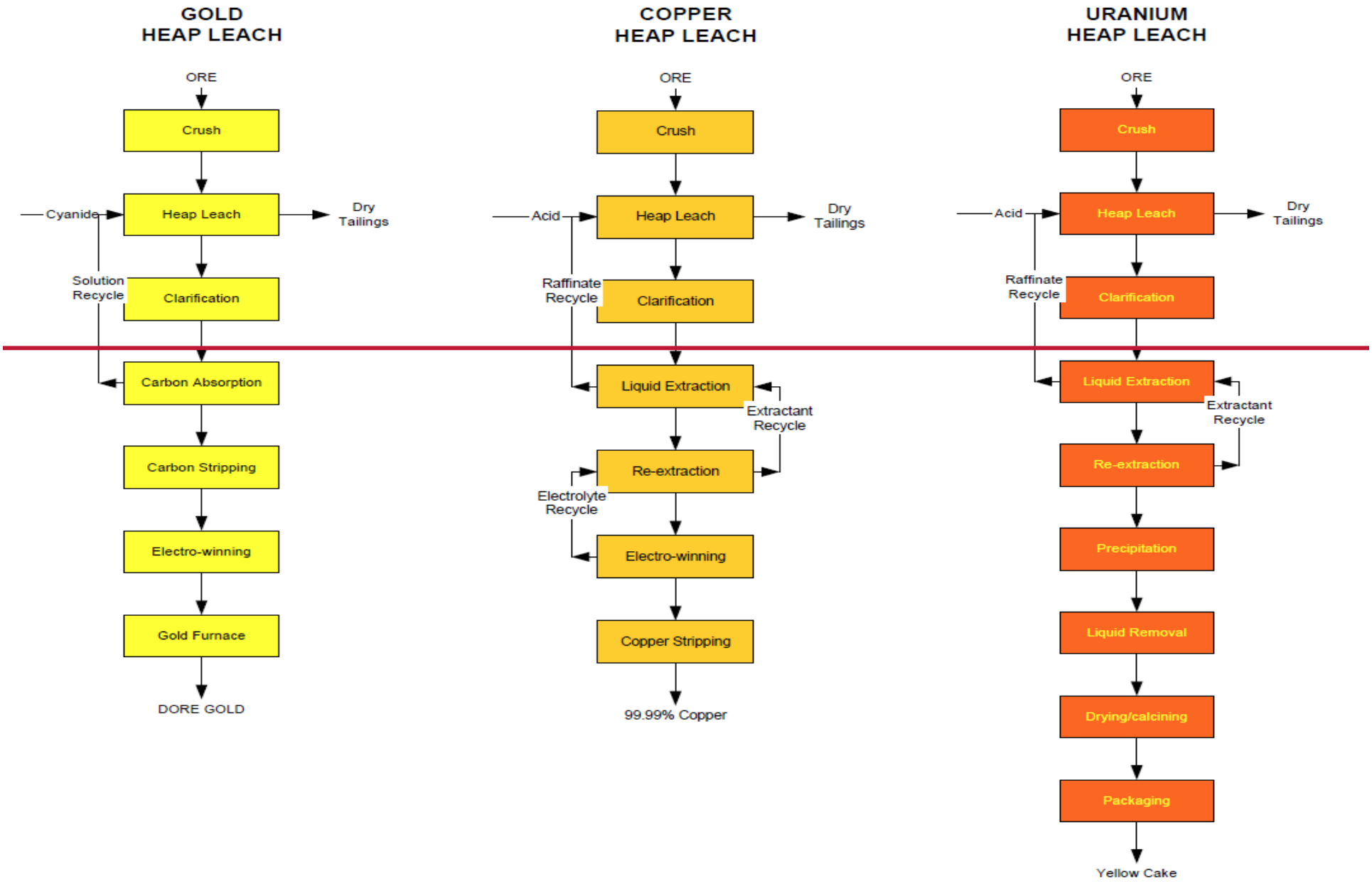
It all sounds TOO easy!

Conceptual/Pre-feasibility

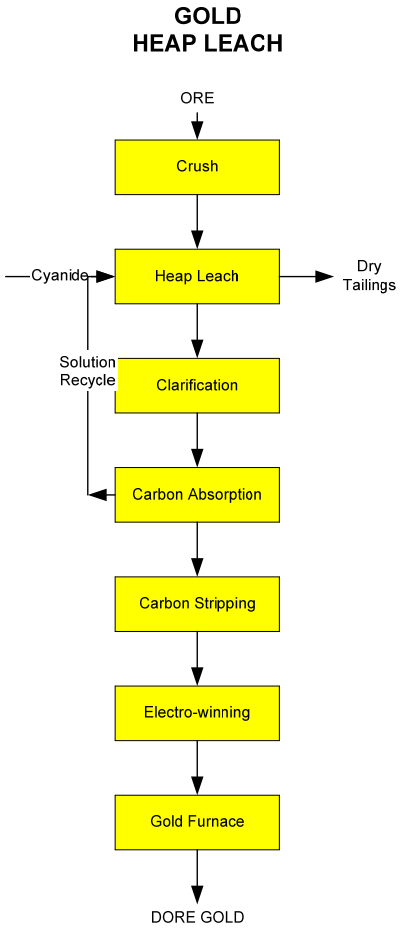
- **Why choose Heap Leach?**
  - Small deposit
  - Low grade
  - Limited water supply
  - Country risk
  - Poor conventional recovery
  - Tailings
  - Supplemental production
  - Costs
  - …
- **Why Not?**
  - Poor recovery
  - Environmental concerns
  - Other process options
  - Clayey ore
  - Will not agglomerate!
  - Topography
  - Climate
  - Large Area
  - …

Process Choice



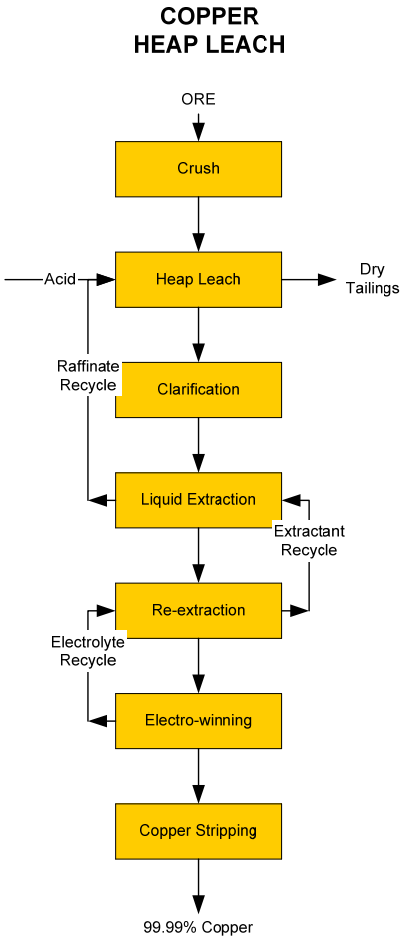

GOLD
HEAP LEACH
ORE
Crush
Cyanide
Heap Leach
Dry
Tailings
Solution
Recycle
Clarification
Carbon Absorption
Carbon Stripping
Electro-winning
Gold Furnace
DORE GOLD
COPPER
HEAP LEACH
ORE
Crush
Acid
Heap Leach
Dry
Tailings
Raffinate
Recycle
Clarification
Liquid Extraction
Extractant
Recycle
Re-extraction
Electrolyte
Recycle
Electro-winning
Copper Stripping
99.99% Copper
URANIUM
HEAP LEACH
ORE
Crush
Acid
Heap Leach
Dry
Tailings
Raffinate
Recycle
Clarification
Liquid Extraction
Extractant
Recycle
Re-extraction
Precipitation
Liquid Removal
Drying/calcining
Packaging
Yellow Cake

Gold Heap Leach



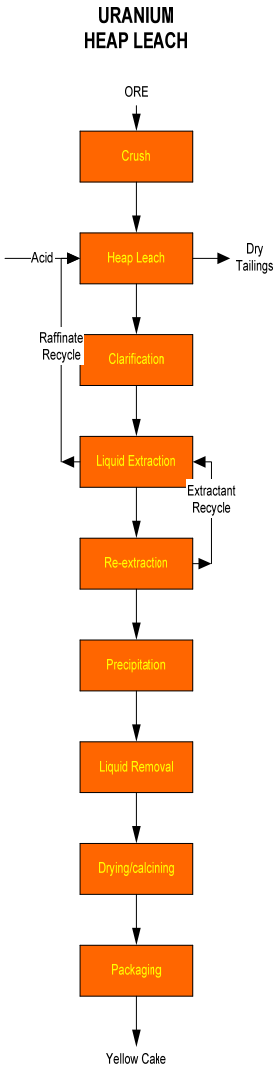
- Applicable mainly to low grade, finely disseminated ores.
- Eliminates grinding, tank leaching and solid/liquid separation.
- Recovery only slightly reduced.
- Not applicable to sulphide ores, or those with coarse gold.
- Some work (Newmont) on bacterial oxidation of sulphide refractory ores.
- Typical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

Copper Heap Leach



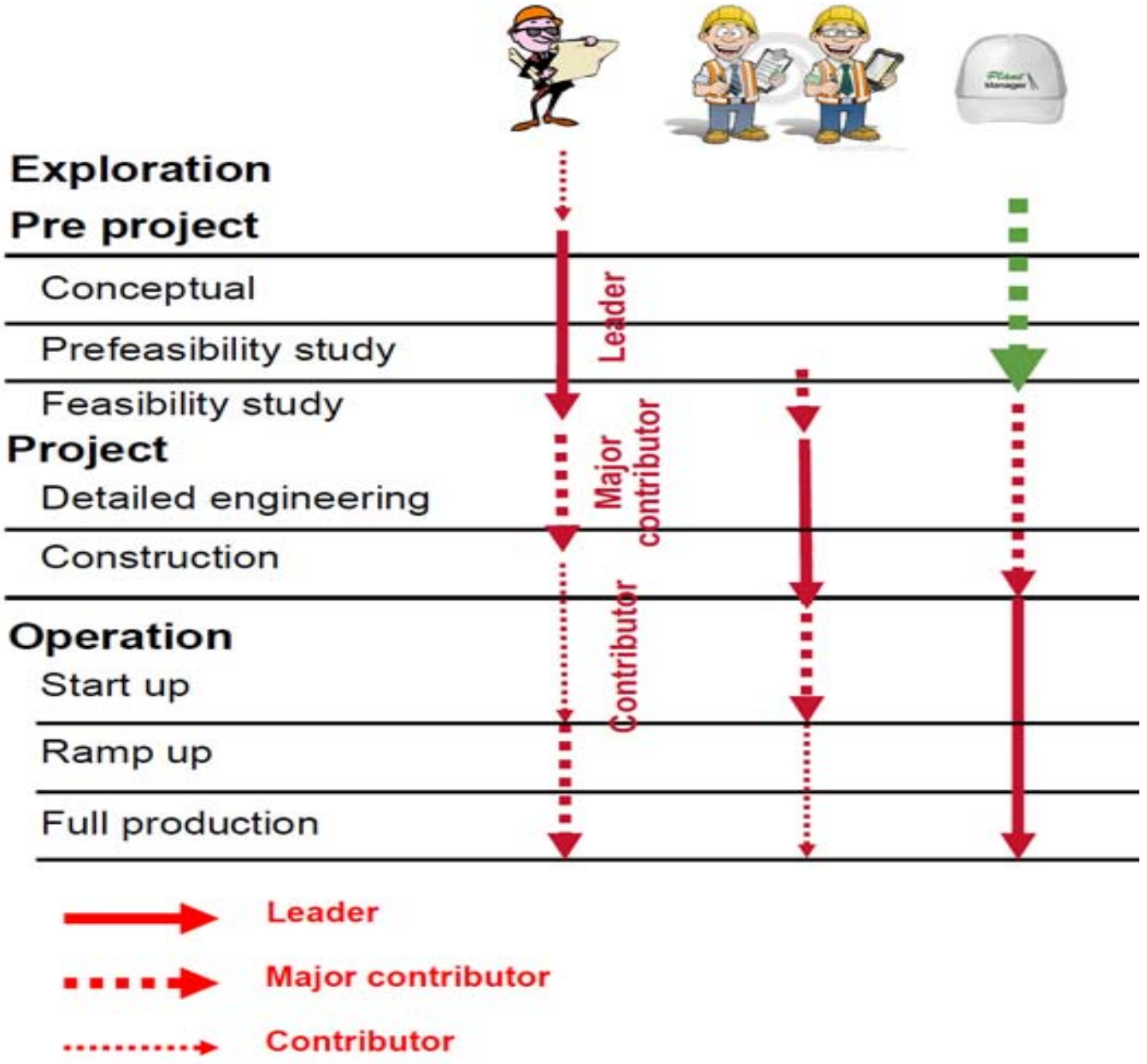
- Limited application to oxide ores or secondary sulphide ores using bacterial leach.
- About 20% of world copper production.
- For oxide ores, recovery only slightly reduced - with 2 to 4 month leach times.
- Produces high purity 99.999% Cu.
- Cost effective for copper production in range of US$0.35 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"?

Feasibility

- **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

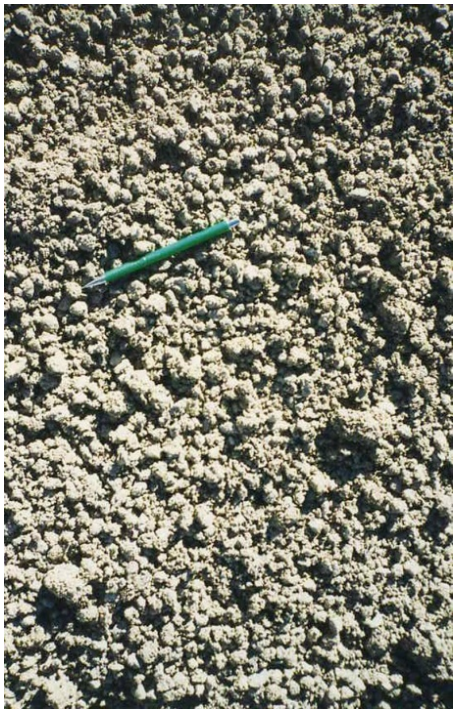
- A sound base
- Suitably impermeable liner
- Good solution drainage base
- Robust solution collection system
- Irrigation system
- Heap surface covers to limit heat and evaporation losses
- Diversion berms
  - To keep out rain water
  - To keep in heap failures

What about Test Work?

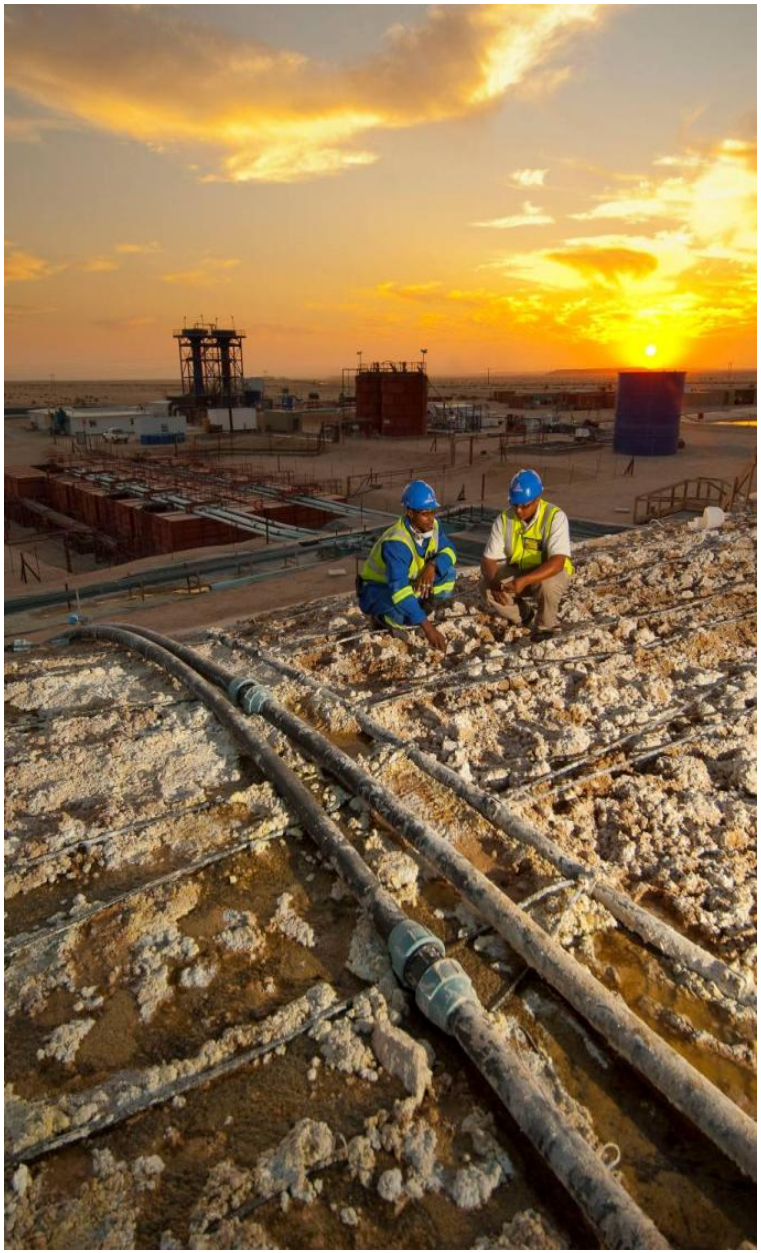
Bottle Roll Testing

Column

Agglomeration

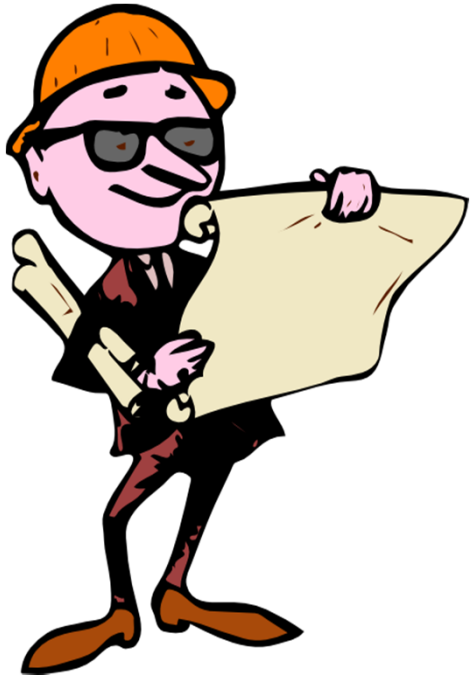


Pilot Plant



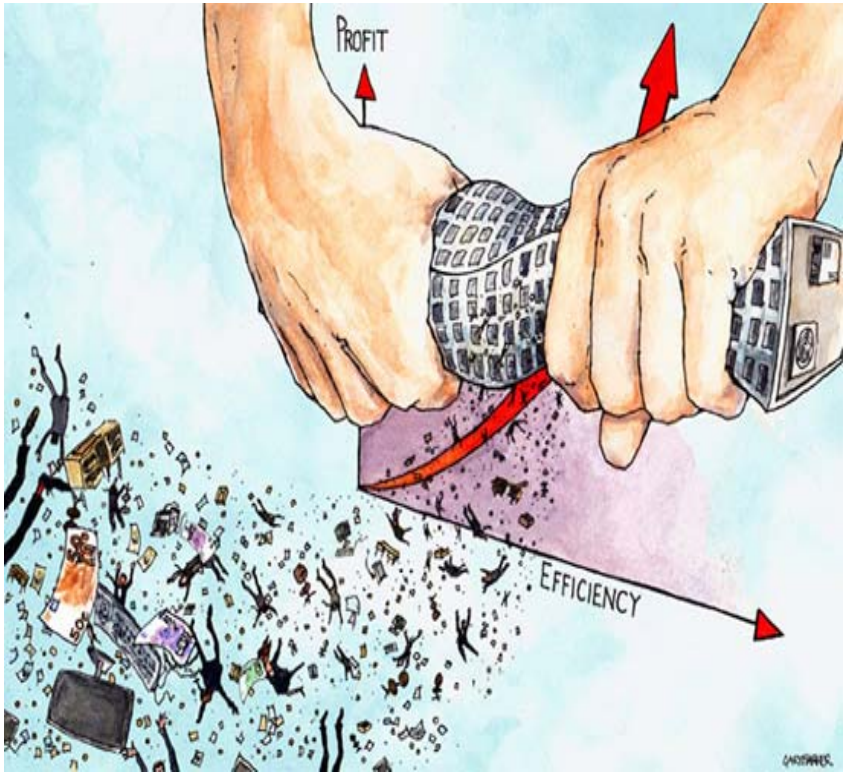
Engineering

- **The time to put test work put 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!**



Cost Reduction – Value Engineering

BEWARE!



Construction

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

Conclusions:

- **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**

Somair - Niger

Trekkopje

Talvivaara

Final Word

- **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?