HEAP LEACHING OF LOW GRADE URANIUM ORES AT SOMAIR

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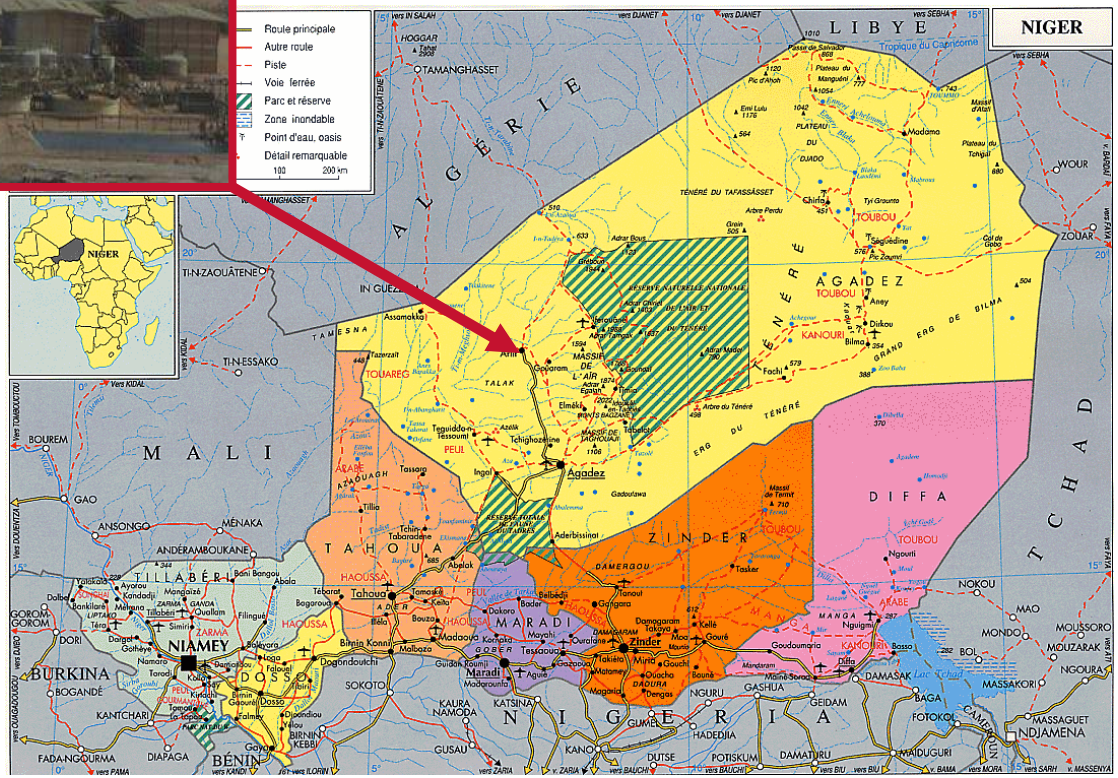
Heap Leaching of Low Grade Uranium Ores at Somaïr



Somaïr

More than 40 000 t of uranium produced from 1968
Production in 2006 : 1565 t of U – Production in 2009 : 1808 t of U
Estimation for 2010 : Up to 2500 t of U with heap leaching production

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Heap Leaching History at Somaïr

- Production by heap leaching from 1971 to 1988
- Heap leaching of the marginal run of mine ores with strong acid irrigation
- 5900 t U produced by heap leaching during that period of time
- Until 500 to 600 t U /y
- Low recovery : around or less than 50%

- 1988 – 2009 - More than 10 millions tons of marginal ores stored on the site – Average grade : 800 ppm (range 400 to 1000 ppm)
- Renewal of U market

=> Necessity to define new modern heap leach process according to other mineral industry (Cu, Au…)

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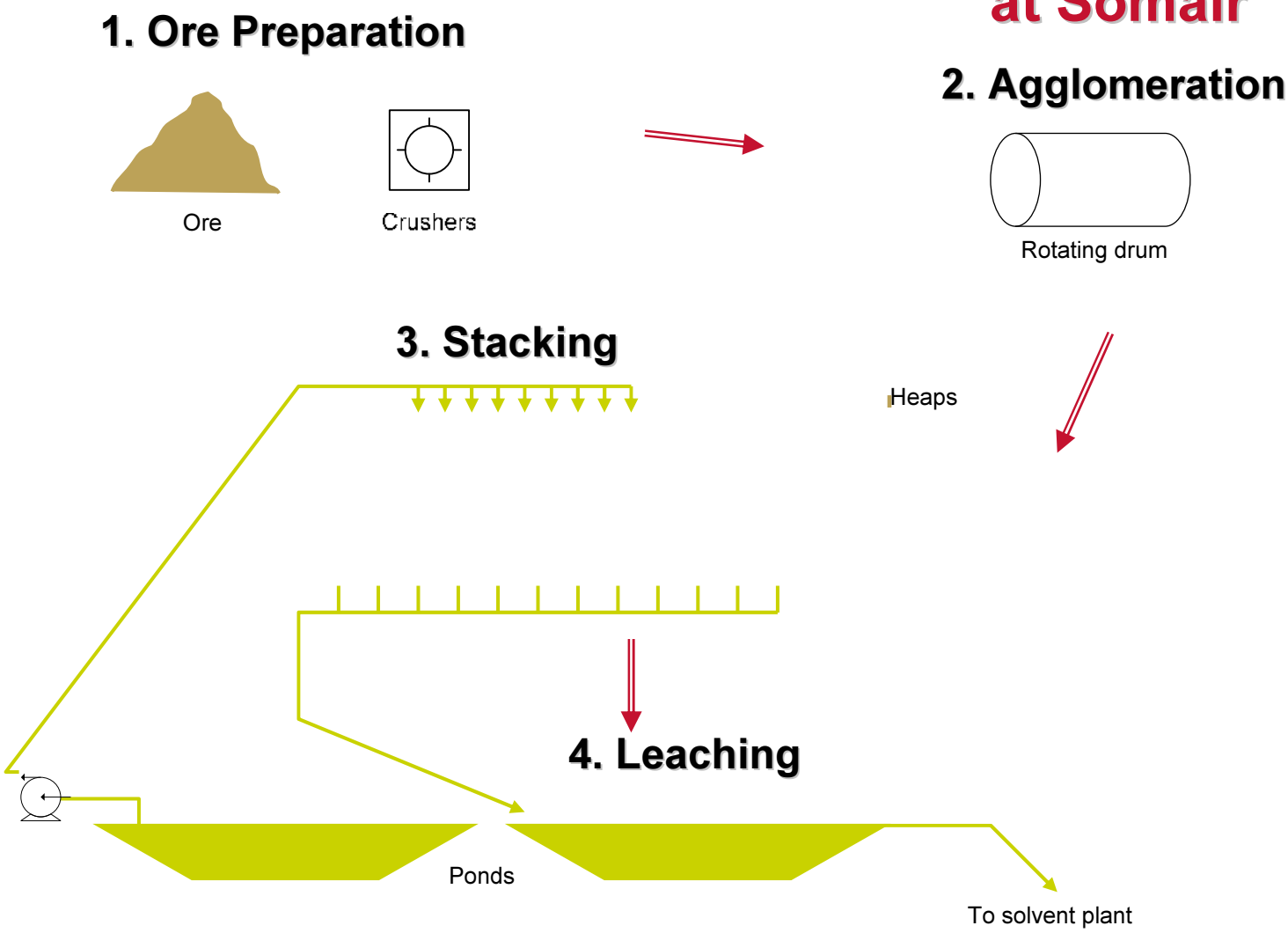

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Heap Leaching of Low Grade Uranium Ores at Somaïr

1. Ore Preparation

- Particle size ?
- Number of crushers ?

2. Agglomeration

Rotating drum

3. Stacking

Heaps

4. Leaching

Ponds

To solvent plant

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Heap Leaching of Low Grade Uranium Ores at Somaïr

1. Ore Preparation

- Particle size ?
- Number of crushers ?

2. Agglomeration

- Water flowrate ?
- Flowrate and concentration of acid ?
- Use of a binder ?
- Size and rotating speed of the drum ?
- Final moisture ?
- Way of reagents addition ?

3. Stacking

Heaps

4. Leaching

Ponds

To solvent plant

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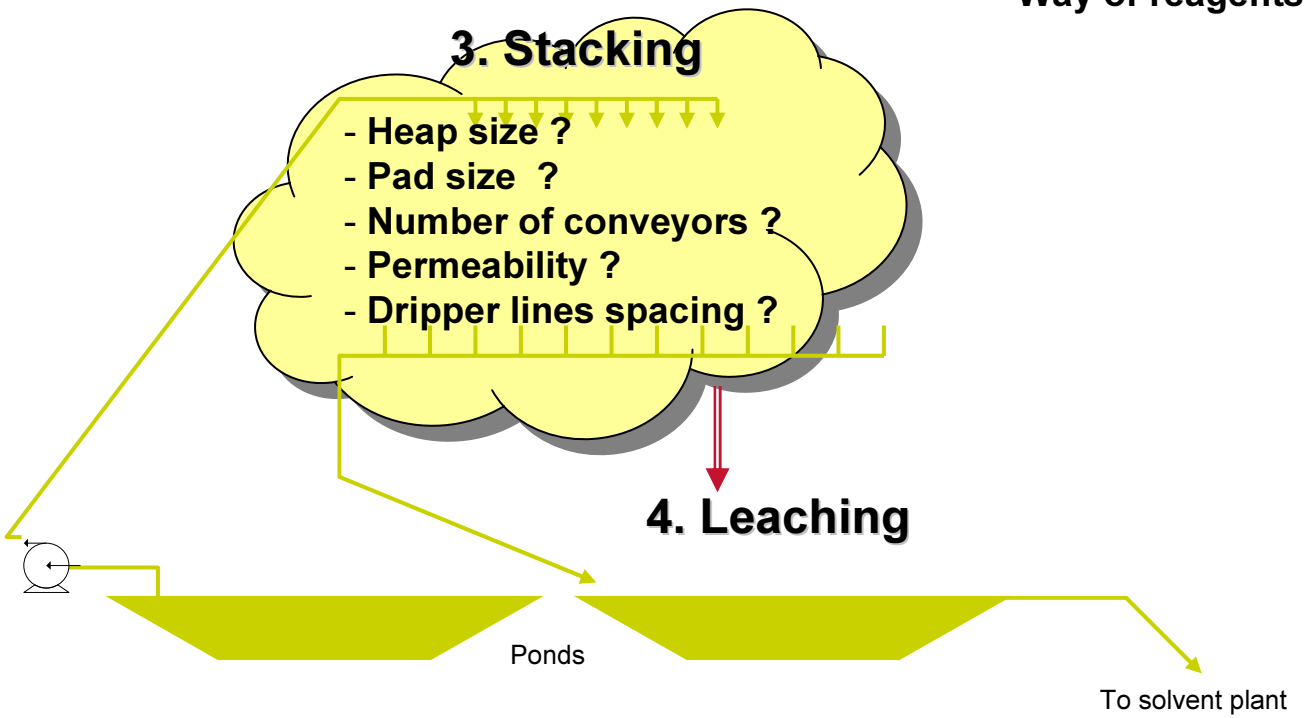
Heap Leaching of Low Grade Uranium Ores at Somaïr

1. Ore Preparation

- Particle size ?
- Number of crushers ?

2. Agglomeration

- Water flowrate ?
- Flowrate and concentration of acid ?
- Use of a binder ?
- Size and rotating speed of the drum ?
- Way of reagents addition ?



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1. Ore Preparation

- Sampling ?
- Composite ?
- Particule size ?
- Number of crushers ?

2. Agglomeration

- Water flowrate ?
- Flowrate and concentration of acid ?
- Use of a binder ?
- Size and rotating speed of the drum ?
- Way of reagents addition ?

3. Stacking

- Heap size ?
- Pad size ?
- Number of conveyors ?
- Permeability ?
- Dripper lines spacing ?

4. Leaching

- % recovery ?
- Specific flowrate ?
- Total irrigation flowrate ?
- Acid concentration ?
- Oxidizing agent ?

- Acid consumption ?
- Impurities concentration ?
- Ponds capacities ?
- Leach time ?
- Irrigation cycles ?
- Evaporation datas ?
- Recycling considerations ?

Heap Leaching of Low Grade Uranium Ores at Somaïr

Ores characterization

Ores dedicated to heap leaching process come from marginal ores stored during the last twenty years :

- Eight different deposit studied + two other ores to study in the future
- More than 10Mt of heaps
- Multiple quantities and grades
- Two very clayey ores
- Similar impurities in the ores (Mo – Zr – V)
- Project for 500 to 750 t/y of uranium with 1.4 Mt/y of stacking

Heap Leaching of Low Grade Uranium Ores at Somaïr

Studies carried out in 4 steps :

- Lab tests :
  - ✓ Identification of highest acid consuming ores
  - ✓ Estimation of uranium recovery
  - ✓ Constraint of acid availibility on site – Optimisation required at first

- Column tests on an average sample of all deposits :
  - ✓ Determination of mean uranium recovery and acid consumption for feasability study
  - ✓ Identification of the most significant parameters

- Column tests on specific sample of each deposit :
  - ✓ Optimisation of leaching conditions for each ore
  - ✓ Determination of uranium recovery and acid consumption for each ore

- Pilot tests in boxes (6m high ; 9m^2 area) :
  - ✓ Validation of process parameters
  - ✓ Training for operators

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Preliminary lab tests in agitated tanks

- Leaching tests in agitated tanks for :
  - Estimation of acid consumptions
  - Comparison beetween each deposit
  - Average recovery determination

- Main results showed
  - Lowest U recoveries for lowest grade ores
  - Highest acid consumptions for clayey ores
  - Variation of recovery from 50 to 70 % according to the acid availability

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Column tests - Agglomeration

Sampling

Composites

Preparation - Agglomeration

Heap Leaching of Low Grade Uranium Ores at Somaïr

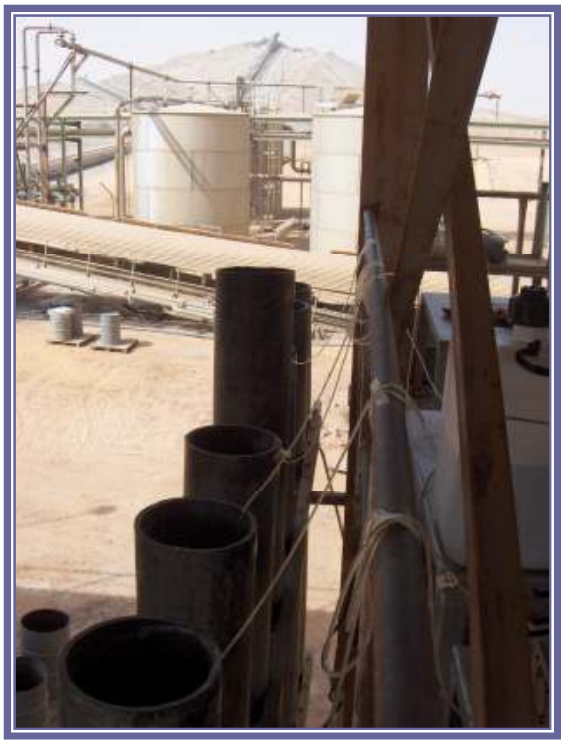
Column tests - Leaching

Height

Diameter

Filling

Irrigation



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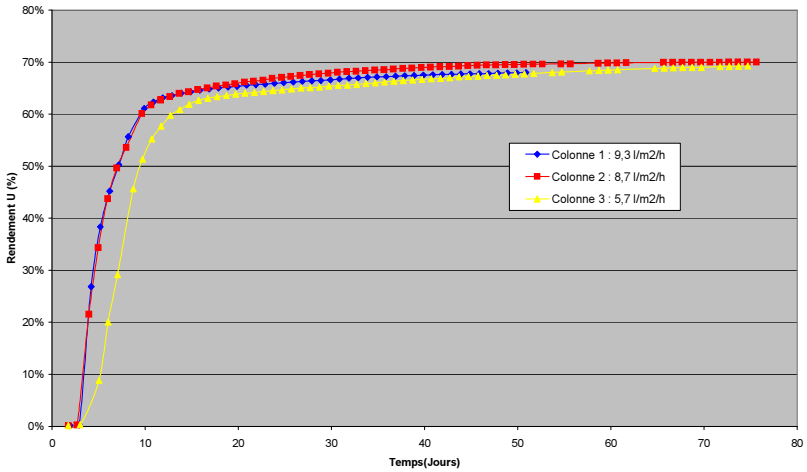
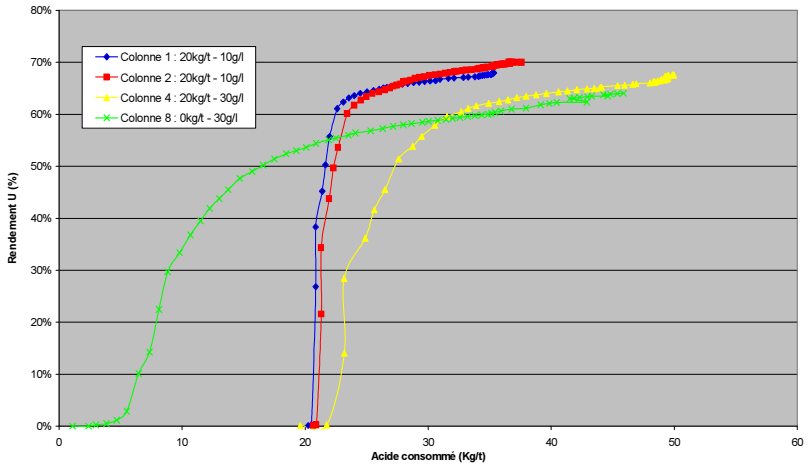
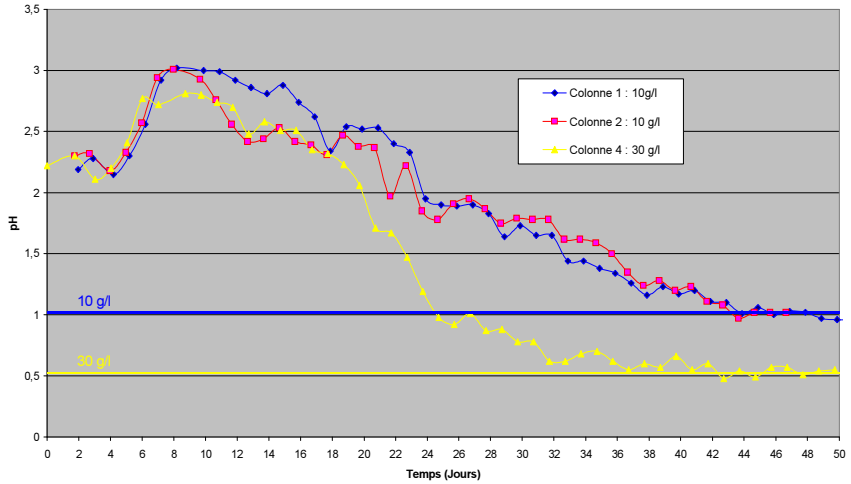
Column tests – Follow up







Precise sampling and follow up :

- ✓Added volumes
- ✓Collected volumes
- ✓Ore compression - permeability
- ✓pH, Redox, U and impurities analysis in collected volume
- ✓U and impurities grades in residues
- ✓Moisture of the residues
- ✓Gradient determinations
- ✓…

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Column tests on an average sample of all ores

- 19 columns tests
- Study with a statistical analysis :
  - Variance for uranium recovery : 0.9 %
  - Variance for acid consumption : 0.5 kg/t
  - Determination of significant and insignificant parameters according to the range of study
- Plugging risks if ore dries before stacking
- Average leaching recovery determined
- Average acid consumption determined

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Column tests on specific samples of each deposit and blending

- 57 columns tests
- 8 deposits tested
- Uranium recovery range
- Acid consumption range
- Oxidant may be required for some ores
- Plugging risks with clayey ore

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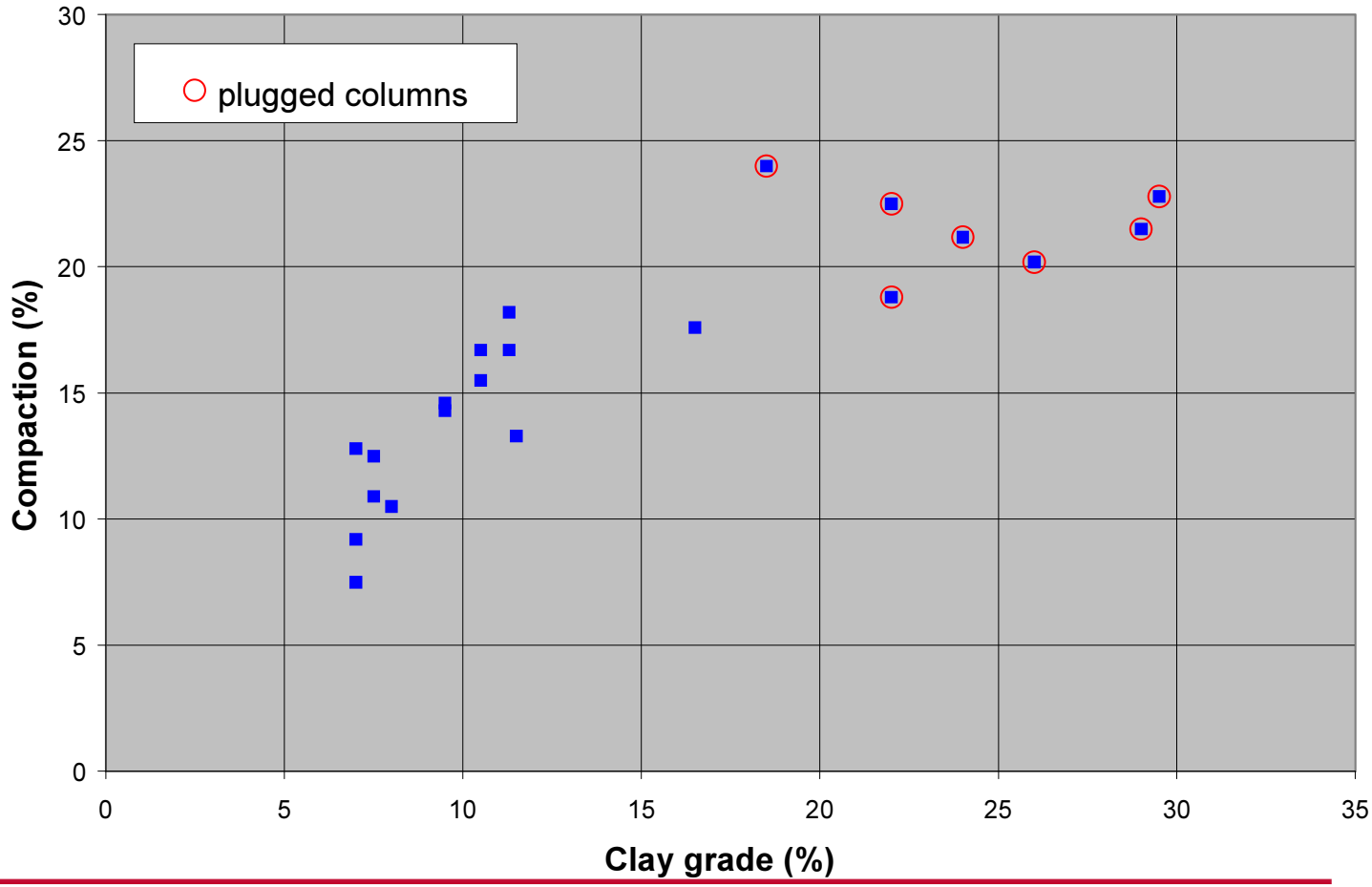
Column tests on specific samples of each deposit



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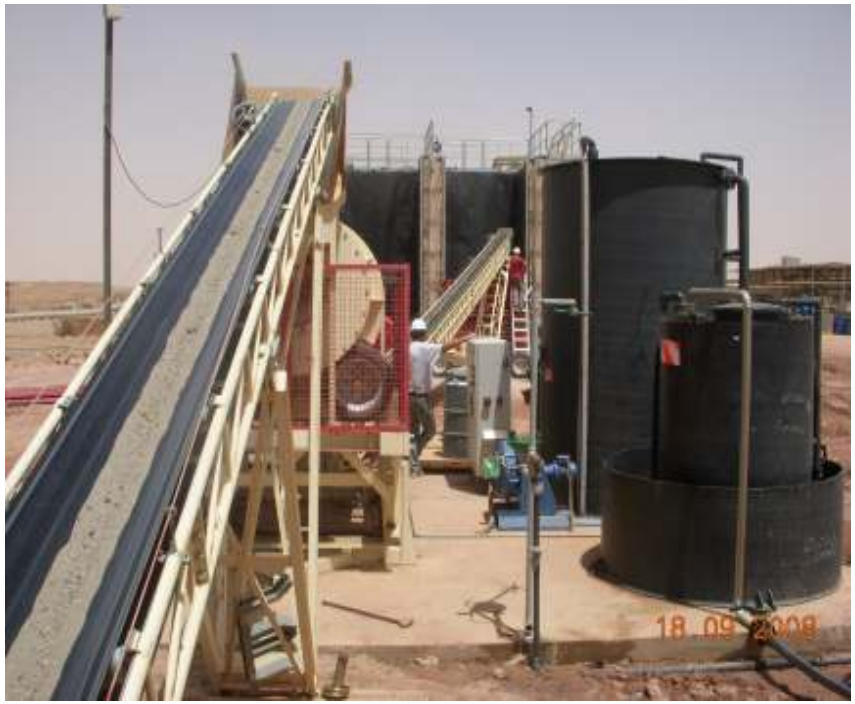
Pilot tests with 6m high boxes

Irrigation



Agglomerator feeding and tanks

Boxes

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Pilot tests with 6m high boxes

- Sampling & Crushing 200 tons ore
- Continuous agglomeration
- Stacking at 7 t/h
- Height : 6 meters
- Drop irrigation
- Day per day follow up of parameters
- Decommissioning with rigorous sampling
- Analyses

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Pilot tests

Sampling & Crushing

Drain

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Heap Leaching of Low Grade Uranium Ores at Somaïr

Pilot tests

Stacking

Decommissionning

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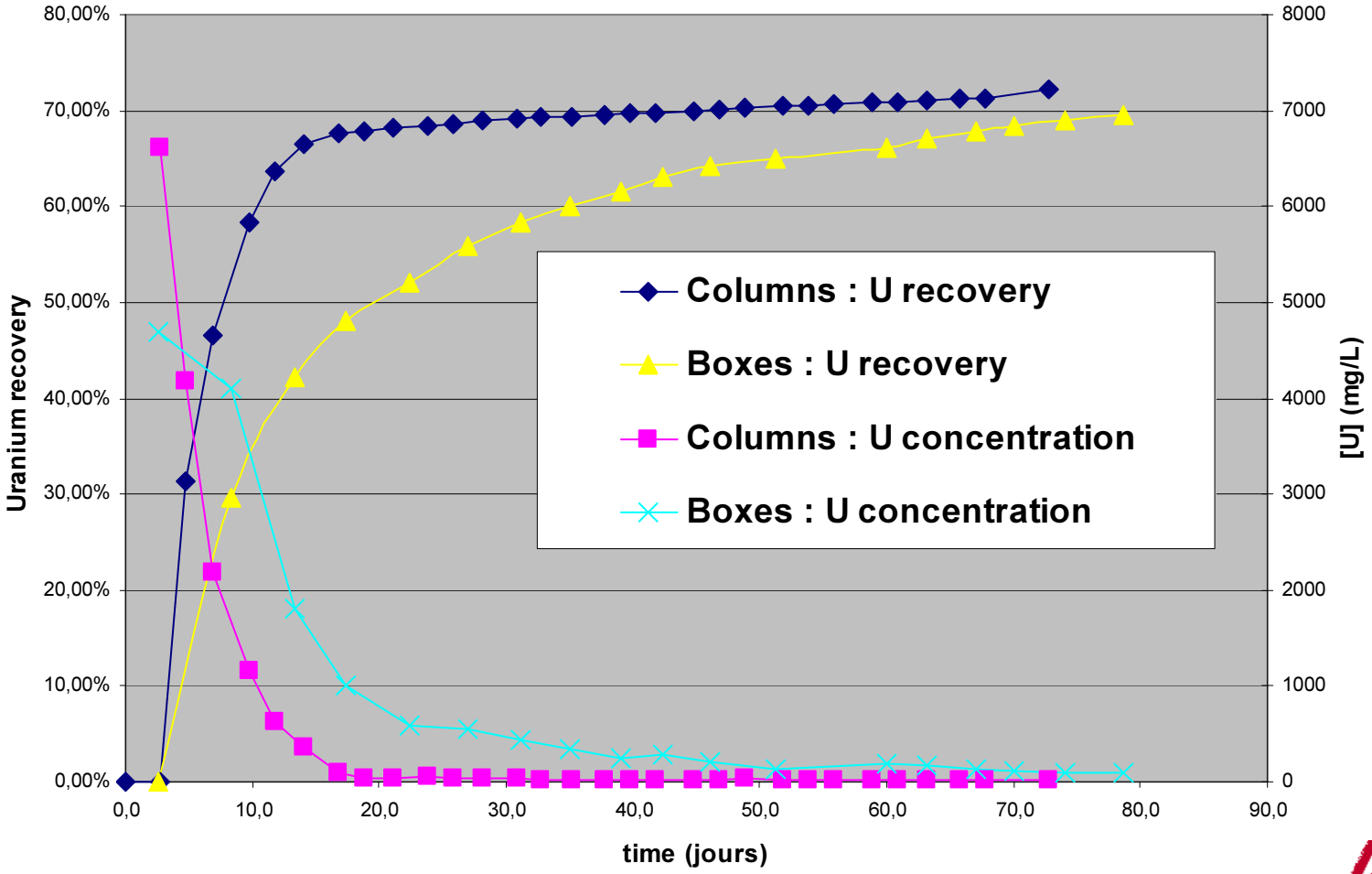
Pilot tests with 6m high boxes



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2005 :
Scoping study
Ore sampling
Lab tests

2006 :
First column tests
Feasability study
Solvent configuration piloting

2007 :
Complementary column tests
Engineering
Supplying equipment

Planning

2008 :
Complementary column tests
Pilot tests in boxes
Heap pad building

2009 :
Refurbishing of the back end of the plant
Complementary pilot tests in boxes
Production start up (July)

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Operations

Ore crushing

1st Pad construction (176500 m²)

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Pad preparation

Pad drain

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Ore stacking

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Main results of tests

✓Uranium recovery : > 65 %
✓Weak acid consumption : 20 to 35 kg/t
✓Oxidant possible
✓Plugging risks with clayey ore to manage
✓Good confidence and reproductibility from columns to boxes but longer time leaching

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Main conclusions

✓ Need time and tests to define process data

✓ Process very sensitive to the ore characteristics

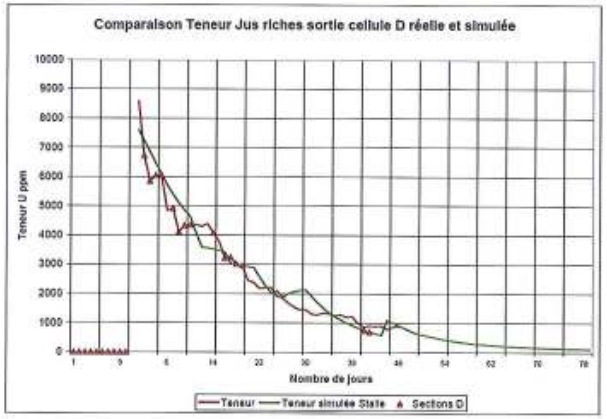
✓ Result checking by pilot test with boxes

✓ Feed back required (on going)

✓ Follow up of more tests for more optimisation and better recovery (≥ 80 % expected)

✓ As Areva will produce a significant part of its productions by heap leaching (acid and alkaline), extensive R & D studies are in progress for :

- ✓ Modelling
- ✓ Define faster and reliable testing strategies



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Thank you for your attention

Questions ?

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