# Arsenic removal using AMD sludge coated sand



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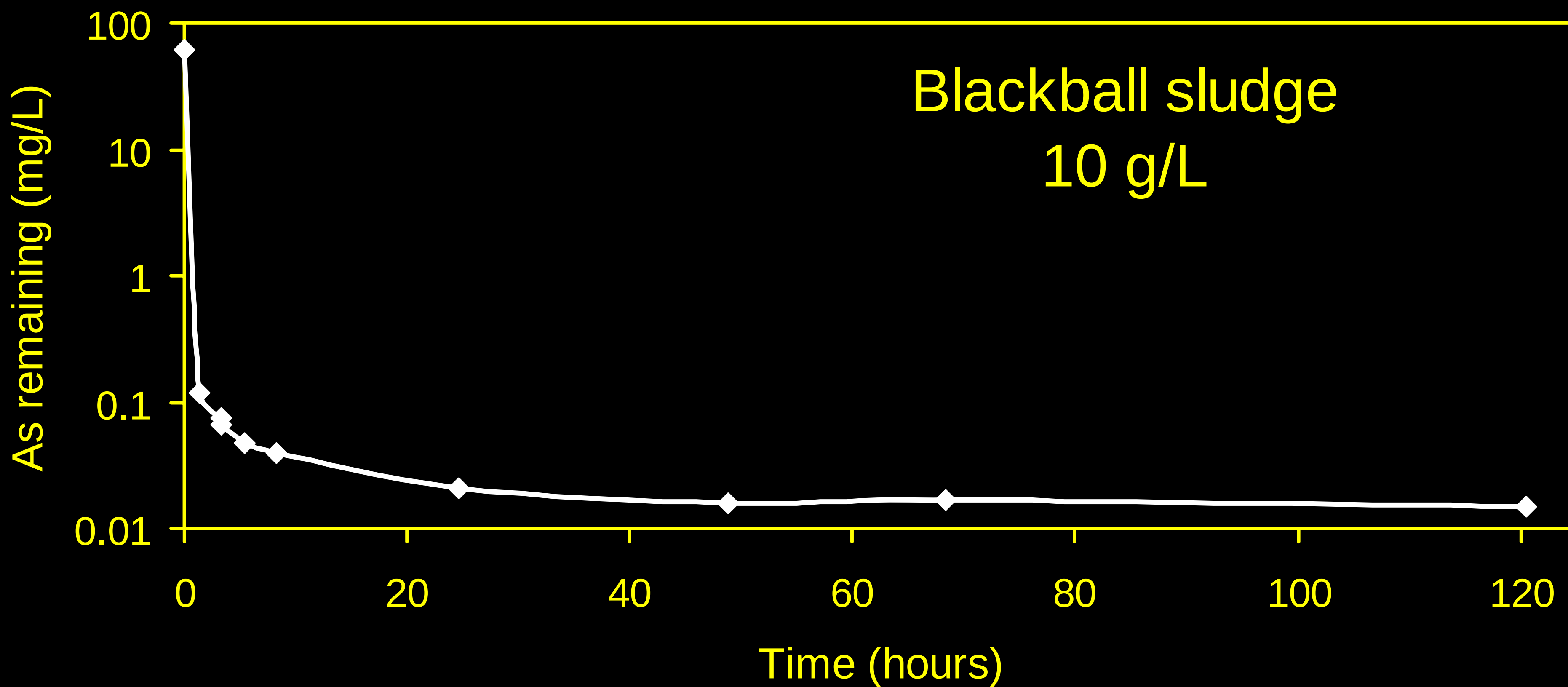
- AMD sludge
  - Blackball sludge: Fe rich (>90%)
  - Solid Energy sludge: Ca (18%), Al (36%) and Fe (21%)

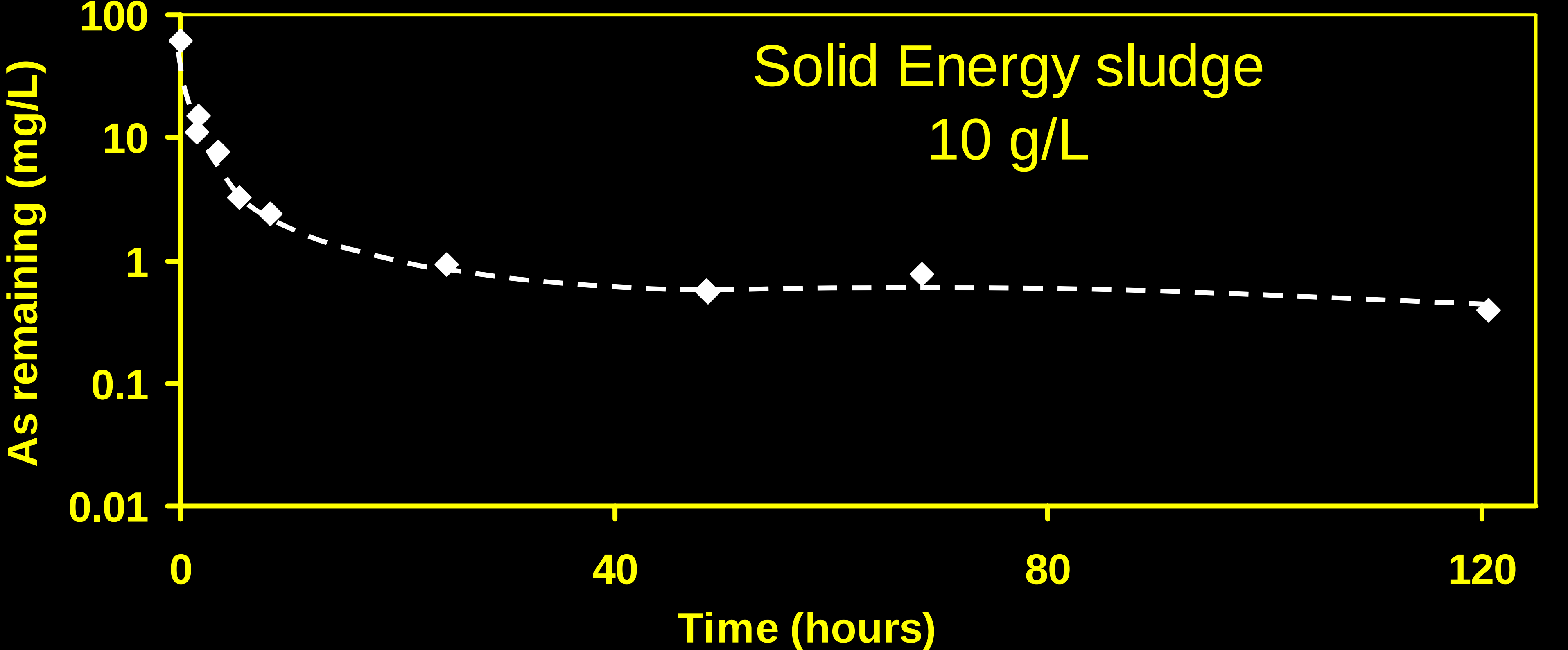
- Arsenic water
  - Waiuta historic gold mine
  - 52-99 mg/L
  - pH 4.47

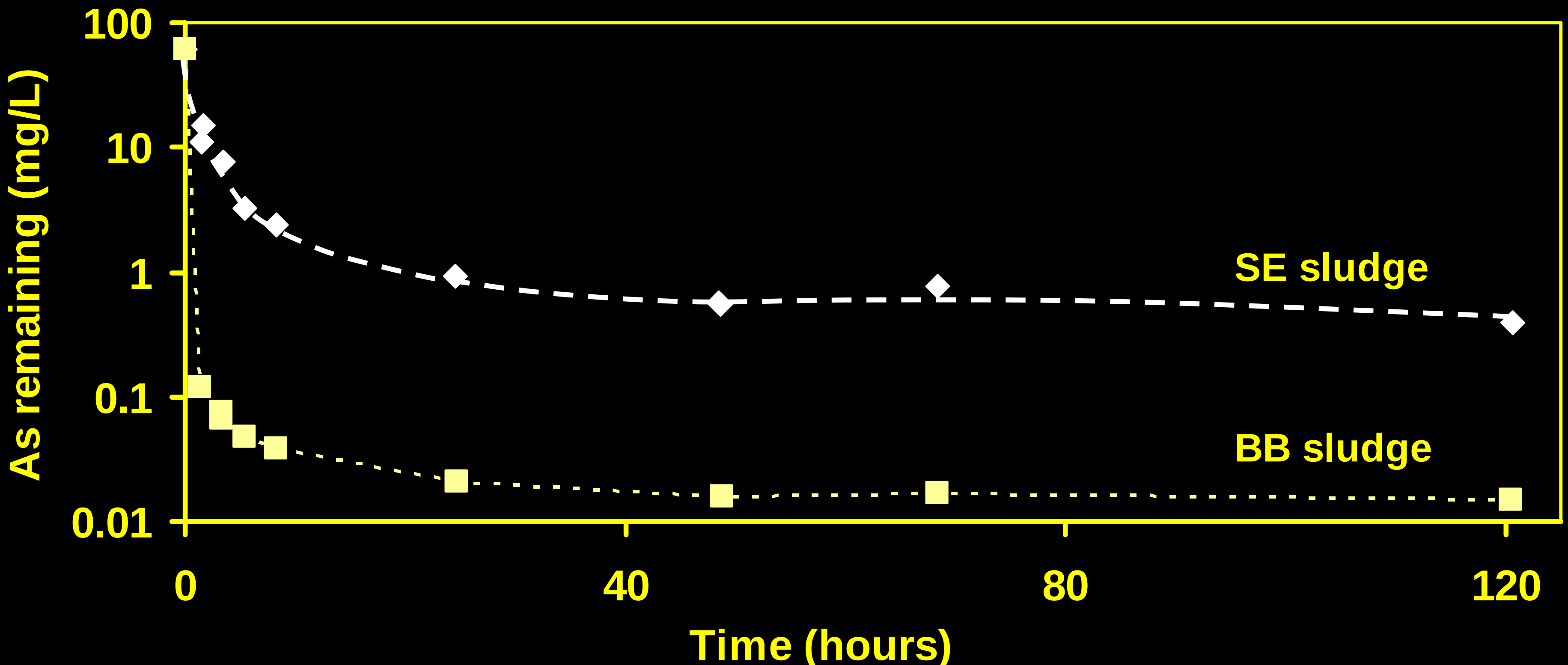
# Batch experiments I

## Constant sludge/As water ratio

- 40mL arsenic water
- 0.4 g sludge
- 2 types of AMD sludge
- Shaken continuously
- 1 hr to 120 hrs


Blackball sludge
10 g/L
As remaining (mg/L)
100
10
1
0.1
0.01
0
20
40
60
80
100
120
Time (hours)


Solid Energy sludge
10 g/L
As remaining (mg/L)
100
10
1
0.1
0.01
0
40
80
120
Time (hours)



As remaining (mg/L)
100
10
1
0.1
0.01
0
40
80
120
Time (hours)
SE sludge
BB sludge

# Batch results II
## 48 hours, variable ratio

| Solid Energy Sludge | |
|---|---|
| AMD sludge to arsenic water (g/L) | Arsenic remaining (mg/L) |
| 1 | 67 |
| 5 | 39 |
| 10 | 0.57 |
| 25 | 0.087 |
| 50 | 0.008 |
| 100 | 0.0096 |

| Blackball Sludge | |
|---|---|
| AMD sludge to arsenic water (g/L) | Arsenic remaining (mg/L) |
| 1 | 25 |
| 2.5 | 0.21 |
| 5 | 0.07 |
| 10 | 0.016 |
| 25 | 0.0051 |
| 50 | 0.0017 |
| 100 | 0.0023 |

# Column experiments

- PVC columns
- Graded sand mixed with powdered AMD sludge
- Average 2 L/day water flow
- 10 day experiments
- Sampling once a day, effluent and source
- 40 mg/L As

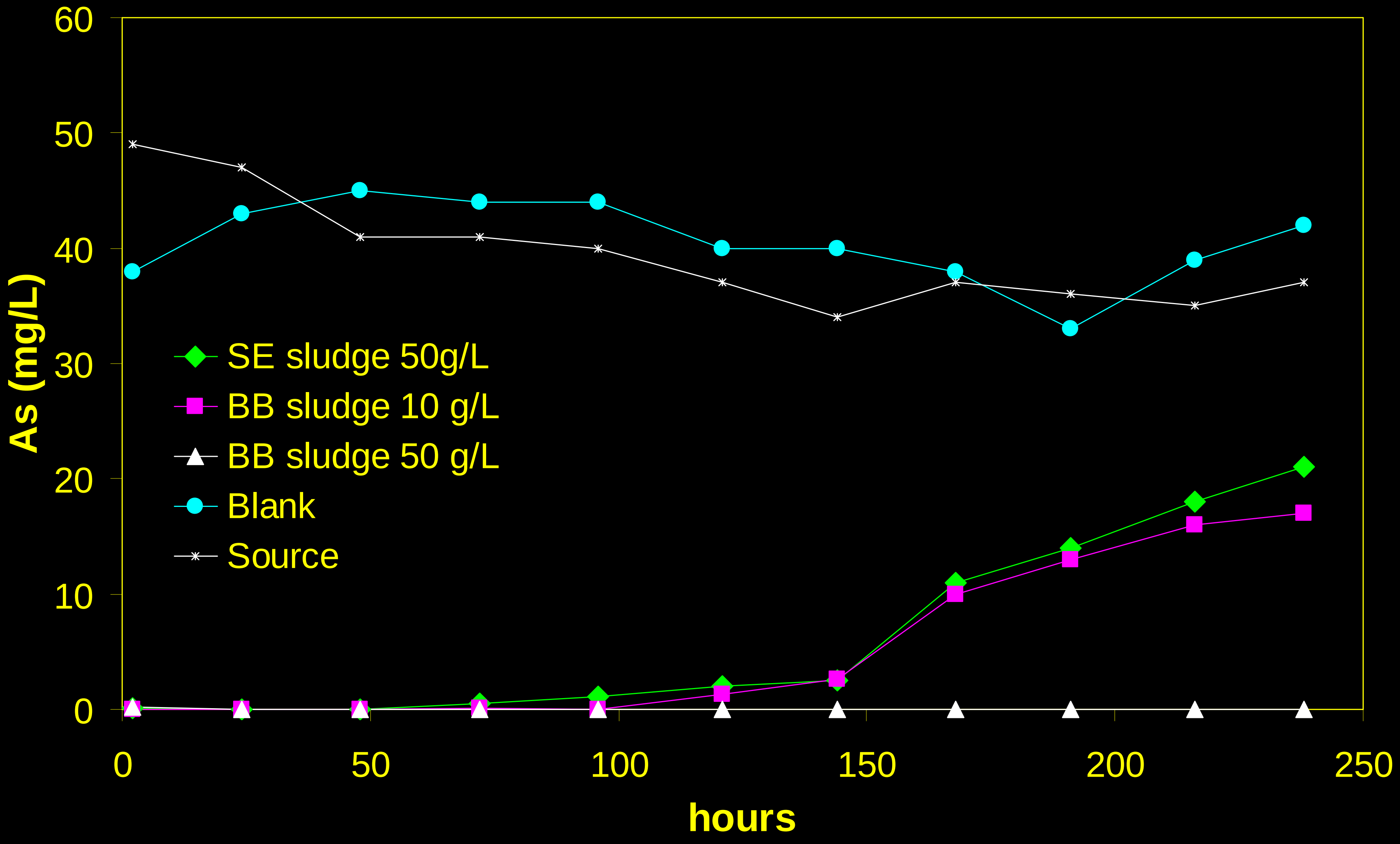
| Column 1 | Column 2 | Column 3 | Column 4 |
|---|---|---|---|
| SE sludge $\approx$50 g sludge/L As water | BB sludge $\approx$10 g sludge/L As water | BB sludge $\approx$50 g sludge/L As water | No Sludge |

Blackball
Sludge

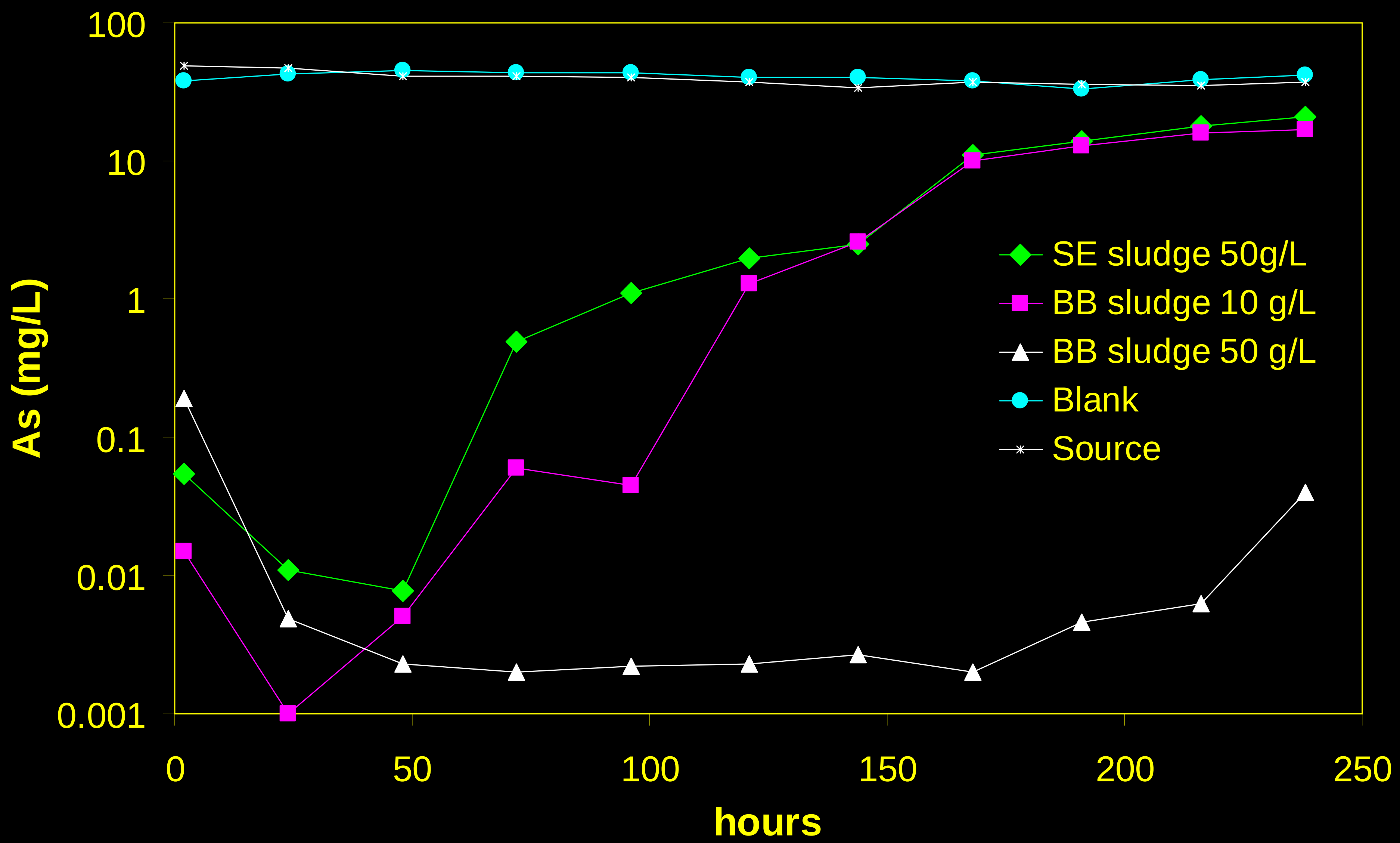
Solid Energy
Sludge

# Experimental setup

# Results



60
50
40
30
20
10
0
As (mg/L)
0
50
100
150
200
250
hours
SE sludge 50g/L
BB sludge 10 g/L
BB sludge 50 g/L
Blank
Source



100
10
1
0.1
0.01
0.001
As (mg/L)
0
50
100
150
200
250
hours
SE sludge 50g/L
BB sludge 10 g/L
BB sludge 50 g/L
Blank
Source

# Conclusion

- Removal of arsenic to levels < 0.01 mg/L
- Adsorption sites for both AMD sludges filled at low ratios of sludge to water
- Viable technique if at optimal sludge to As ratio

# Implications

- AMD sludge high in Fe can remove As
- Fine powdered sludge can be mobile
- Adsorption sites have a limit

## Where to from here?

- Analyse gravel/AMD
- Calculate kinetics
- Larger scale, longer time frame experiments